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Developing multinational radioactive waste repositories: Infrastructural framework and scenarios of cooperation

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FOREWORD

Currently the management of radioactive wastes centres on national strategies for collection, treatment, interim storage and disposal. This tendency to focus exclusively on national strategies reflects the fact that radioactive waste is a sensitive political issue, making cooperation among countries difficult. It is consistent with the accepted principle that a country that enjoys the benefit of nuclear energy, or the utilization of nuclear technology, should also take full responsibility for managing the generated radioactive waste. However, there are countries whose radioactive waste volumes do not easily justify a national repository, and/or countries that do not have the resources or favourable natural conditions for waste disposal to dedicate to a national repository project or would prefer to collaborate in shared initiatives because of their economic advantages. In such cases it may be appropriate for these countries to engage in a multinational collaborative effort to ensure that they have access to a common repository, in order that they can fulfil their responsibilities for their managing wastes safely.

In response to requests from several Member States expressing an interest in multinational disposal options, the IAEA produced in 1998 a TECDOC outlining the important factors to be taken into account in the process of realizing such options. These factors include for example, technical (safety), institutional (legal, safeguards), economic (financial) socio-political (public acceptance) and ethical considerations.

The present report reviews the work done in the previous study, taking into account developments since its publication as well as current activities in the field of multinational repositories. The report attempts to define the concepts involved in the creation of multinational repositories, to explore the likely scenarios, to examine the conditions for successful implementation, and to point out the benefits and challenges inherent to multinational repositories. In essence, it attempts to define a framework dealing with institutional and other aspects (called “infrastructural”) of repository development that could be employed for the establishment of multinational repositories.

The IAEA wishes to express its thanks to all participants in the work. Special thanks are due to P. Bredell for his leading role in the discussions during the consultancies and the technical meeting, and to C. McCombie for his contribution in finalizing the report. The IAEA officer responsible for this report was S. Hossain of the Division of Nuclear Fuel Cycle and Waste Technology.

EDITORIAL NOTE

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CONTENTS

1. INTRODUCTION

1.1. BACKGROUND

This report reviews the possibilities for the realization of multinational repositories. To date, multinational cooperation on radioactive waste disposal has been intensive, but has been largely limited to the area of R&D. In all cases, specific repository development programmes have been initiated on a strictly national basis, without a prior explicit analysis of considering the technical, economic and financial viability of implementing multinational disposal facilities. The possibility of adopting a multinational approach to the disposal of radioactive wastes therefore needs to be examined, especially with a view to determining the parameters involved in creating such a cooperative system.

There are several examples of international or bilateral agreements in waste management, in which commercial organizations in some countries accepted responsibility and custody of waste generated in other countries. This form of cooperation resulted from implementation of reprocessing contracts, which in the early years did not contain clauses on returning the waste to the country where the power was generated. Other examples are the return of enriched spent research reactor fuel to the USA — a practice which was discontinued in 1988 and has been resumed again to continue until 2006 at least — and the return to the Russian Federation of commercial spent fuel originating from the former Soviet Union. In the recent past, a wish or a need for multinational cooperation has been expressed by a number of countries, which are not in a favourable position to implement self sufficiently national repository programmes for all types of waste arising in their countries and/or which seek to benefit from multinational cooperation for the implementation of a nuclear repository. (e.g. Belgium, Bulgaria, Hungary, Italy, Latvia, Lithuania, Netherlands, Norway, Republic of Korea, Switzerland, Taiwan). In addition, the potential advantages of the concept were pointed out by various institutions, including the IAEA, European Community (EC), US National Academies and the World Nuclear Association (WNA).

Despite these examples of interest in the transfer of radioactive materials, the management of radioactive wastes still centres on national strategies, not only for collection, interim storage and treatment, but also for disposal. This tendency towards unilateral action reflects the fact that radioactive waste is a sensitive political issue, making cooperation among countries difficult. It is consistent with the accepted principle that a country that enjoys the benefit of nuclear energy, or the utilization of nuclear technology, should also take full responsibility for managing the generated radioactive waste. This principle, however, does not necessarily imply that each country should exclusively develop its own national repositories, regardless of the technical, economic, financial and institutional implications. What is required is for each country to fully accept its national responsibility and to manage waste safely to the best of its ability in the most feasible manner, including international collaboration.

In response to requests from several Member States expressing an interest in multinational disposal options, the IAEA produced in 1998 a report [1] outlining the important factors to be taken into account in the process of realizing such options. These factors include for example, technical (safety), institutional (legal, safeguards), economic (financial) socio-political (public acceptance) and ethical considerations. After examination of many rational arguments, potential benefits and challenges for the development and implementation of multinational repositories, the report concluded that:

"- the multinational repository concept does not contradict ethical considerations;
- *the high ratio of fixed to variable costs for a repository ensures that considerable economies of scale will apply; and*
- *transport of nuclear material is so safe that the distances resulting from a multinational repository will not have a significant impact on public health."*

The present report reviews the work done in the previous study, taking into account developments since its publication in 1998 as well as current activities in the field of multinational repositories. This resulted in more specific examination of possible implementation scenarios and more detailed specification of requirements. The aim is to produce a reference publication for Member States potentially interested in multinational repository concepts, whether as hosting, partner or third party countries.

An important development in the international arena that had a bearing, albeit indirectly, on the concept of multinational repositories was the signing of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (Joint Convention) [2]. This convention, whilst encouraging Contracting Parties to take responsibility for the management of their radioactive waste, and also recognizing in its Preamble

"that any State has the right to ban import into its territory of foreign spent fuel and radioactive waste"

goes on to state

"that, in certain circumstances, safe and efficient management of spent fuel and radioactive waste might be fostered through agreements among Contracting Parties to use facilities in one of them for the benefit of the other Parties, particularly where waste originates from joint projects".

Because of its international significance, adherence to the Joint Convention is considered necessary for future participants in a multinational repository project, just as it is for all countries pursuing a purely national approach to repository development. In this report, due cognisance is therefore taken of the principles embodied in the Joint Convention.

As a basic point of departure, it is recognized that successful implementation of ongoing national programmes is essential for the safe and secure management of spent nuclear fuel and high level waste. Moreover, it is recognized that the development of national repositories could significantly facilitate the development of multinational repositories. Ultimately, multinational repositories must function as a complement to those repositories that are being developed strictly on a national basis. All Member States have the right to develop purely national facilities. However, there are clearly countries that do not have the necessary resources to undertake the development of a repository project entirely on their own, or that would prefer to collaborate in shared initiatives because of their economic advantages. In such cases it may be appropriate for these countries to engage in a multinational collaborative effort to ensure that they have access to a common repository, in order that they can fulfil their responsibilities for their managing wastes safely. The principal objectives of making state of the art disposal facilities available to all countries with radioactive wastes are to increase global environmental safety and security.

This report attempts to define the concepts involved in the creation of multinational repositories, to explore the likely scenarios, to examine the conditions for successful

implementation, and to point out the benefits and challenges inherent to multinational repositories. In essence, it attempts to define a framework dealing with institutional and other aspects (called "infrastructural") of repository development that could be employed for the establishment of multinational repositories. The potential role of international organizations in assisting countries with the realization of a multinational venture is also considered, with emphasis on the roles that the IAEA could play.

The report deals with multinational disposal of all kinds of radioactive wastes; these include spent fuel and radioactive waste resulting from nuclear energy and application programmes, and also spent radiation sources. The wastes include low and intermediate level as well as high level wastes with both short and long lived radionuclides. The considerations are valid for all internationally accepted disposal options, i.e. both near surface and geological repositories are taken into account. However, the issue of deep geological disposal of spent fuel and high level waste disposal is most challenging and will be emphasized. Consideration is given to ensure compatibility between proposals for shared interim storage facilities (which are also being examined by the IAEA) and multinational repositories, in view of the complementary nature of those systems and common requirements.

In other sectors of economy that generate hazardous waste, such as chemical and non-ferrous industries, transfers and exchanges of waste among countries are current commercial practice for selected, even highly hazardous materials. These practices aim at the optimal use of disposal opportunities in certain countries and are regulated by The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal [3]. By the same token, similar multinational initiatives should also be possible in the case of radioactive waste, as all necessary conditions would likewise be satisfied for this kind of waste.

Although it is recognised that the issue of multinational approach for waste disposal is a sensitive issue, the potential of such an approach has been put forward in several General Conferences and Board of Governors' Meetings of the IAEA as a result of interest expressed in the concept by Member States. One should be aware of the many political and public acceptance issues that may arise in opposition to the multinational disposal concept for radioactive waste. The successful implementation of repository programmes on the national level, increased transparency in radioactive waste management programmes, and demonstrated adherence to international instruments such as the Joint Convention [2] could significantly contribute to the acceptance of multinational concepts for the disposal of radioactive waste.

At the General Conference of the IAEA in 2003, the IAEA Director General re-emphasized the IAEA's interest in this area

"Our consideration should also include the merits of multinational approaches to the management and disposal of spent fuel and radioactive waste. Not all countries have the appropriate conditions for geologic disposal — and, for many countries with small nuclear programmes for electricity generation or for research, the financial and human resource investments required for research, construction and operation of a geologic disposal facility are daunting. Considerable economic, safety, security and non-proliferation advantages may therefore accrue from international cooperation on the construction and operation of international waste repositories. In my view, the merits and feasibility of these and other approaches to the design and management of the nuclear fuel cycle should be given in-depth consideration. The convening of an Agency group of experts could be a useful first step."

1.2. OBJECTIVES

The objectives of the report are:

(1) to serve as reference publication for the Member States potentially interested in multinational repository concepts as hosting, partner or third party countries.
(2) to provide an overview of the past history and the current status of multinational cooperation on repositories.
(3) to describe different scenarios of cooperation that may be encountered for the implementation of multinational repositories, and discuss their benefits and challenges.
(4) to identify the benefits that multinational repositories could bring to some Member States, but also to record the potential drawbacks and the challenges to be faced.
(5) to define the requirements that should be followed by interested Member States as hosting, partner and third party countries for pursuing such a cooperative effort.
(6) to examine the potential role of international organizations in multinational repository development
(7) to propose further studies that could clarify open technical and institutional questions.
(8) to formulate recommendations on how work in this area might proceed further.

1.3. SCOPE

The report deals with spent fuel and radioactive waste resulting from nuclear energy and other applications of nuclear technologies, including spent radiation sources. These include low and intermediate level as well as high level wastes with both short and long lived radionuclides. Because of the higher requirements for safety and security, the issue of spent fuel and high level waste disposal is most challenging and will be of main concern. Attention is drawn also to spent sealed radioactive sources, since the proper management of these is an urgent environmental and security issue.

The issues treated are, in principle, relevant for all internationally accepted disposal options; both near surface and geological repositories, including shallow and also deep borehole concepts are considered. Although final disposal of wastes is the aim of the concepts described, consideration is given to ensuring compatibility between regional storage and multinational repositories in view of complementary nature of those systems and the common requirements.

The scenarios developed for multinational repository implementation cover the interests of hosting, partner or third party countries, irrespective of the level of nuclear activity. They should therefore be relevant for all Member States with or without nuclear power programmes.

1.4. STRUCTURE

The topics corresponding to the stated objectives 2 to 8 are dealt with sequentially in Chapters 3 to 9 of the report, with detailed suggestion on the IAEA roles collected in Appendix A.

2. THE MULTINATIONAL REPOSITORY CONCEPT

There have been several initiatives in the past between countries with the objective of cooperation in the management and eventual disposal of radioactive waste. Different terms have been used to describe the underlying concepts, such as “regional repository concept”, “multinational repository concept” and “international repository concept”, with slightly different meanings for each of these terms.

The term “multinational repository concept”, used throughout this report assumes that waste originating from more than one country is being disposed in a common repository. The country in which the repository is located (“host country”) accepts waste from one or more other countries (“partner countries”). The latter have also been referred to as “customer country” or “client country” and these terms are assumed to have the same meaning as “partner country”. Apart from the host and partner countries other countries (“third party countries”) may also have an interest in the multinational repository system. For example, a third party country may be a transit country for the shipment of the waste from the partner country to the host country or a country having certain rights in terms of international agreements that stipulate prior consent rights for the transfer of spent nuclear fuel to the host country.

The term “regional repository concept” is applied to multinational concepts in which the host country and the partner countries are located in the same region of the world. The multinational repository concept, in contrast suggests that any country regardless of geographical location may participate in such a collaborative scheme. The term “international repository concept” as used in this report, implies that the waste disposal is organised under the authority of a supra-national body such as the United Nations for instance.

The term “repository” as used in this report, implies that all the material, including spent nuclear fuel, that is emplaced in the disposal system is considered a waste and is treated accordingly. In line with the standard IAEA definition, this means that there is no intent to retrieve the waste — although retrievability may remain technically feasible. If spent nuclear fuel is treated as a resource material to be reprocessed at a later stage, it is stored separately.

3. HISTORICAL PERSPECTIVE: EXAMPLES

3.1. CASE HISTORIES OF TRANSBOUNDARY WASTE TRANSFERS

Wastes have been transferred from one country to another in the past without any great problems arising and this chapter summarises some of these cases. Not documented here — although they are also of relevance in this context — are the numerous transfers of chemo-toxic waste occurring each year between countries. Large quantities of such wastes are transferred with the full consent of such partners, if the final solution arrived at guarantees better protection of the environment. For example, Germany imports toxic wastes from many countries for safe disposal in disused salt mines, i.e. Germany provides an environmentally sound disposal option not available to all nations. Of course, there have also been examples of toxic waste transfers motivated only by the wish to reduce costs and taking little heed of environmental issues. This situation should be ruled out for both toxic and radioactive wastes by appropriate legal measures and strict controls. In the following text, we confine ourselves to examples of radioactive waste transfers.

The three categories of wastes that have been transferred, as summarised in Table I, are reprocessing waste, research reactor fuels and specific other waste types whose transfer can be beneficial. When reprocessing of foreign fuels began in France, the UK and the Russian Federation, there was no thought of returning wastes. Each of these countries had a large nuclear programme requiring it to implement disposal facilities for national wastes. It seemed obvious that repackaging radioactive wastes and transporting these back over large distances was a less good environmental solution than co-disposal with host country wastes. Faced with the intensive public debate on nuclear issues, however, reprocessor countries like the UK and France introduced new contracting conditions requiring the customer nations to agree to return of all wastes.

The resulting course of action would imply shipment not only of the relatively small quantities of vitrified high level wastes, but also of the larger volumes of cemented low and intermediate level wastes. This is obviously extremely inefficient so that the reprocessors then proposed an arrangement under which the L/ILW may be retained and a smaller quantity of additional HLW returned. Exercising a degree of common sense thus results in a better global environmental option.

The same argument — a better global solution — applies to the mechanisms to allow return of spent research reactor fuel to the supplying country, most often the USA or the Russian Federation. In this case the arguments are not based only on radiological safety, but also on security. Many research reactors are fuelled with highly enriched uranium that could be misused in nuclear devices. Primarily for the latter reason, the USA has agreed to repatriate all such fuel originally supplied by the USA.

The shipment of specific waste types — as part of a commercial arrangement or an exchange agreement — can also be environmentally beneficial. For example, when Sweden decided to dispose directly of spent fuel it was faced with the prospect of having to implement a more complex repository that would also handle vitrified wastes, since some part of Swedish fuel (57 tons) had already been contracted for reprocessing. At the same time, Germany needed a place to store its first MOX fuel and recognised that the Swedish CLAB facility was suitable. A sensible arrangement was made to exchange the Swedish reprocessing

Table I. Examples of transfers of radioactive materials between countries

When	Type	Description
from 1950 on (to the late 1970's in France and the UK and later in the Russian Federation)	Reprocessing with no return of wastes	UK and French reprocessors dealt with customers (Germany, Italy, Netherlands, Japan, Sweden, Switzerland, and Belgium) with no requirement to return wastes. After 1976, there were no further contracts without a waste return option.
		Belgian reprocessing & storage at Eurochemic with no return of wastes. Eurochemic was decommissioned after a short operating period.
		The Soviet Union delivered fuel to its satellite countries and accepted returned fuel for reprocessing and disposal. Since the break up of the Soviet Union, the Russian Federation has to offer this service on a commercial basis. For example, in 1998/9, 132 damaged fuel elements were removed from Slovakia.
1976–	Reprocessing with substitution	UK and French reprocessors agreed with their customers that various wastes from reprocessing can be substituted, resulting in exchanges of specific radionuclides with equal activity or toxicity.
ongoing	Shipment of research reactor fuels	The USA has agreed to repatriate spent fuel supplied to research reactors. Transfers have already occurred from many countries to the USA and also to the Russian Federation.
1986	Bilateral exchange agreement	Germany and Sweden agreed that the former would take up unused reprocessing contracts and that Sweden would accept spent MOX fuel from Germany.
2000	Acceptance of specific waste streams	Radium containing LLW that did not meet the Spanish acceptance conditions at El Cabril was shipped to Hanford in the USA for disposal.
ongoing	Sealed sources	Sealed radiation sources were delivered to customer countries for many years with no requirement for accepting the spent sources back into the country of origin. Recently, efforts have been made to encourage return, to ensure better traceability and environmentally proper disposal.
ongoing	Uranium processing	Depleted uranium residues that arise in enrichment plants and the wastes from fuel fabrication are not returned to countries requesting these services.

contract for the German MOX fuel elements and most of the 24 tons of MOX was shipped to CLAB on the Swedish transport ship *Sigyn* [4].

Another example of waste transfer concerns only LLW, but it illustrates the utility of specialised repositories. A shipment of LLW, including industrial residues — and radium needles used for chemotherapy, was shipped from Spain to Hanford in the USA [5]. Although only small quantities of radium were included, the long half-life of this material made the wastes unsuited for disposal in the Spanish surface facility at El Cabril. The Hanford disposal facility, on the other hand, routinely accepts similar wastes from the USA. Another case of a larger programme accepting minor quantities of waste from a small producer is illustrated by the on-going shipment of radioactive residues from Luxembourg to Belgium.

A final example in which transfer of radioactive material, or seeking a common disposal solution, is recognised as being beneficial, concerns the disposal of spent sealed radiation sources. These sources can often still be strongly radioactive and, in some cases, long lived, when they are no longer usable for their original industrial or medical application. Sources are extensively used in less developed countries where no suitable disposal (or even storage) facilities are available. One solution that is being implemented is to compel the supplying high-tech country to take back the spent sources. Another is for countries with this common problem to develop jointly a solution.

3.2. SPECIFIC INITIATIVES FOR INTERNATIONAL STORAGE/ DISPOSAL

Over the past 30 years, there have been numerous initiatives to promote shared storage facilities or repositories. Some of these have originated from international organizations, some nationally and some from private initiatives. Table II summarises the proposals and in the following, some further details are given on the more interesting cases. Much of the information in this chapter has been taken from [6] and [7]; the early initiatives are described in [8].

3.2.1. Early initiatives (1970s and 1980s)

(a) Regional Nuclear Fuel Cycle Centres (RFCC) (1975–77)

In 1975, the IAEA launched a study project to examine the economic, safety, safeguards and security aspects of a multinational approach to nuclear fuel cycle facilities. For the purposes of the study, RFCCs were envisaged to include spent fuel storage, fuel reprocessing, plutonium fuel fabrication and waste disposal. The study group reported in 1977 with very encouraging results, arguing that from many perspectives considerable advantages could be expected from the RFCC concept. Firstly, the intergovernmental agreements envisaged for RFCCs would bring non-proliferation advantages. These agreements would lead to enhanced safeguards and physical protection, and improved siting of facilities. Secondly, the study argued that economic and operational advantages in geological disposal could also be expected, although the report argued that repositories would probably not be co-located with reprocessing and fuel fabrication plants. Although the study was well received by many countries, no concrete steps were taken to develop the concept further.

Table II. Past and present proposals for shared multinational waste management facilities

When	Proposals	Partners/proposer	Description
1970s and 1980s	Regional Fuel Cycle Centres (RFCC)	IAEA	Study group examined the economic, safety, safeguards and security aspects of a multinational approach to nuclear fuel cycle facilities. Ran from 1975–77. [31]
	International Spent Fuel Management (ISFM)	IAEA	Expert group discussed the key elements of the international agreements which would need to be drawn up for an international spent fuel venture. Ran from 1979–82. [7]

When	Proposals	Partners/proposer	Description
	International Plutonium Storage (IPS)	IAEA	Expert group proposed that all separated plutonium in excess of current requirements would be stored under international control. [10]
	Austrian fuel to China or the Russian Federation	Austrian Verbundgesellschaft (responsible for planned Zwentendorf reactor)	Contracts were signed with China and also with the Russian Federation for the acceptance of all wastes for Austrian power plants. With the cancellation of Zwentendorf and the Austrian decision not to open the plant, these became irrelevant.
1990s	Spent fuel & plutonium storage (IMRSS)	German and US	German and US institutions initiating concept; International Monitored Retrievable Storage (IMRSS) for SNF and plutonium. Discussed at international conferences; no actual negotiations [32]
	Disposal of spent fuel and waste; revenues to be used for nuclear test site remediation.	Marshall Islands to host; customers	Strong opposition from Pacific countries and US; feasibility study started. Initiative terminated in 1999. [17]
	Non-proliferation; SNF and plutonium storage; fuel leasing	US Fuel and Security (private) as host, including Russian partner	Proposed storage of SNF & excess plutonium on Palmyra and later Wake Island. Strongly opposed by US Government; supported by Minatom (the Russian Federation); abandoned in favour of Non-Proliferation Trust (NPT) [18]
	International storage and disposal of SNF	IAEA and then an International Working Group	IAEA started initiative. Work continued by experts from South Africa, Germany, Australia, China and Switzerland Feasibility report published [15]. IAEA Report appeared later [1]
	Storage of SNF and waste in East Asian region	Taiwan, South Korea and Japan	Various concepts discussed but no formal initiative [6]
		China a potential host to Taiwanese SNF	Letter of intent but no formal agreement. [6]
		North Korea to store Taiwanese LLW	Agreement to accept. Abandoned due to political opposition [6]
	Proposals for the Russian Federation to	A. Suzuki, Global Peace Initiative	Storage and disposal in the Russian Federation, Australia or Canada [33]

When	Proposals	Partners/proposer	Description
	Federation to host SNF/HLW	Suzuki, Bunn Norwark	Storage in Far East of the Russian Federation [34]
		Kurchatov Institute	Emphasis on storage in Krasnoyarsk [35]
	Multinational disposal of SNF and HLW	Pangea: commercial initiative	Studied best geological regions world wide. Western Australia identified as preferred region. Operations ceased 2000. [19, 20, 21]
	Disarmament, non-proliferation and remediation	Russian Federation as host; Subject to US-based Trust (NPT) - no reprocessing allowed	Russian support to continue exploration of idea initiative ongoing [22, 23]
Current	Storage and return of spent fuel, or storage and SNF reprocessing without return of plutonium and HLW	Russian Federation as host Minatom	Official Russian government policy; enabling Russian legislation. Russian offer to customers. SNF reprocessing plans. US law requires a U.S. Government consent agreement for import of U.S.-origin spent nuclear fuel by a third party country. US opposed to reprocessing of U.S.-origin fuel transferred under such a consent agreement.
	Fuel leasing	Russian initiative Minatom	Proposed fabrication of excess plutonium into fuel in the Russian Federation. Lease fuel and take back SNF to the Russian Federation. Initiative ongoing [30]
	Develop framework for multinational disposal	IAEA	Working group met 3 times with representatives from Czech Republic, Hungary, Germany, Slovenia, South Africa, Switzerland, USA. This was followed by a Technical Committee meeting to review the draft of the present TECDOC
	Promotion of multinational storage disposal of radioactive waste	Arius (Belgium, Bulgaria, Hungary, Japan, Italy and Switzerland)	Promoting concepts for international or regional solutions to the disposal of long lived radioactive waste. Ongoing initiative [24, 25]
	LLW storage and disposal	Kazakhstan Government	Proposal to dispose in disused uranium mine; Kazakhstan Government in favour; debate in parliament [28]

(b) International Spent Fuel Management Group (1975/1982)

This grew out of International Fuel Cycle Evaluation (INFCE) study of the IAEA [9]. The group was convened in 1979 and also reported in 1982. Its brief was to investigate whether there were economic, logistical or strategic reasons for developing international arrangements for spent fuel storage, and how these arrangements might be set up. The report did not include much discussion about the disposal of fuel in the host country. Under the main scenarios studied, spent fuel would be returned to the customer country after a number of years, either in its original form or following some further conditioning. However, it was argued that international arrangements would be most attractive to customer countries in the future if they included *"...an overall solution to their need to close the back-end of the fuel cycle (including radioactive waste disposal)."* The report argued that countries most suitable as a host for an international spent fuel store would be those with a nuclear energy programme and with previous experience of handling spent fuel. International fuel stores were expected to deliver savings for those national programmes generating less than 5000 tonnes of fuel. The report also contained some discussion of the key elements of the international agreements which would need to be drawn up for an international spent fuel venture. It concluded that in the short term, no demand for international arrangements existed.

(c) International Plutonium Storage (IPS) 1980

The expert group on IPS was set up to develop ideas for how the IAEA could act upon the rights provided for in article XII.A.5 of its 1957 statute, which allows for it to implement international storage facilities for excess plutonium. The group set out a number of concepts for an IPS. The study was based on the assumption that, under an IPS agreement, all separated plutonium in excess of current requirements for safeguarded use in reactors, fuel production and research would be stored under international control [10]. Stored plutonium would be released according to rules to be agreed. Three problems that were encountered were the definition of 'excess' plutonium; the conditions for release; and the location of plutonium stores. The idea was effectively dropped until around 1993 when further international controls on fissile materials were again discussed at the IAEA General Conference. Two new concerns had arisen in the intervening years. First, nuclear weapons disarmament meant that large stockpiles of special fissionable materials — plutonium and highly enriched uranium (HEU) — were expected to be recovered from dismantled weapons. Second, stocks of separated civil plutonium were seen to be growing and these also need transparent safeguarding. These concerns (expanded upon in [11]) have led to the ongoing efforts described below to develop international repository concepts in countries like the Russian Federation.

(d) OECD/NEA Study (1987)

The Radioactive Waste Management Committee (RWMC) of the Nuclear Energy Agency published a preliminary study on possible international approaches to radioactive waste disposal in 1987 [12]. The report was not widely publicised, and attracted little attention from national governments. The report concluded that there were two basic approaches to international waste repositories: an international project, or the extension of a national project, on a commercial basis, to accept additional material from other countries. The creation of an international repository through the commercial extension of national programmes was judged to be a more credible route than the formation of an international project. The study concluded that there were no apparently insurmountable safety, technical, economic or institutional obstacles to serious consideration of the concept. Nevertheless,

because of slow progress in the development of national repositories, the committee did not believe that the time was right in 1987 to embark on a comprehensive generic study.

(e) Chinese Initiatives (began early 80's)

In the 1980s, there were proposals for international disposal in the Chinese Gobi desert. Some of the discussions were initiated by the Austrian utility seeking a backend solution for spent fuel from the planned Zwentendorf reactor. The proposals were negatively received in some countries that were suggested as possible customers. Recently China has again being showing interest in waste import (e.g. a letter of intent with was signed with Taiwan in 2000) and is running a national programme that "*could be technically easily extended to include foreign wastes*" [13].

(f) Synroc Study Group in Australia (mid-1980s)

In 1983, the Australian government commissioned a report from the Australian Science and Technology Council on Australia's role in the nuclear fuel cycle. The report [14] recommended not only proceeding with uranium mining, but also becoming involved with other stages of the fuel cycle such as enrichment. It also flagged the *"particular need for international collaboration in developing (high level) waste management programs"* and the desirability of enabling access to high quality geological sites for disposal of those wastes. Later in 1998 the Synroc Study Group was set up by the Australian government to study the commercial potential for Synroc (a high quality waste form) in a global context. It was conducted by four leading Australian resource companies, assisted by ANSTO and the Australian National University, and advised by SKB Sweden. The study considered also the option of Australia hosting an international repository. It led on to the Pangea Project described below.

3.2.2. Proposals and studies from the 1990s on

(a) IAEA Expert Groups (1994/95, 2001/02)

The IAEA set up a consultant group on multinational repositories in the early 1990s and this worked until 1995, although the final report, IAEA-TECDOC-1021, was published only later [1]. In 2001 the topic was taken up again by the IAEA and a working group was established to prepare the present publication.

(b) International Working Group (late 1990s)

When the above mentioned IAEA Expert Group was wound up in 1995, work continued in an ad hoc group sponsored by the Atomic Energy Corporation of South Africa (AEC) and Germany's Gesellschaft für Nuklear-Service (GNS). This group had a wider remit, being concerned with international approaches to all radioactive wastes, other than milling and mining waste. The group produced an overview publication which can be used by national governments in their own considerations of proposals for regional repositories [15]. Included are some basic criteria for identifying potential host countries: a) the country must have an established nuclear and radioactive waste management infrastructure; b) the country must have existing technical and regulatory infrastructures for handling radioactive waste; and c) country must have a suitable land mass (referring to a preference for a large continental country). The group published a list of countries it believed would be prime targets to seek a home for spent their relatively small fuel inventories [16].

(c) Marshall Islands (1995–97)

The President of the Marshall Islands proposed hosting a storage and disposal facility, with the revenues being used in part to clean up contamination from earlier bomb testing [17]. The Government amended the law in 1995 to allow import of wastes. However there was strong opposition from Pacific states and from the US Government. As a result the project was "frozen" and a subsequent change of Government led to its being dropped.

(d) Wake Island/Palmyra Island (mid 1990s)

A USA based group, US Fuel and Security, initiated a scheme with the support of Minatom of the Russian Federation, involving storage and fuel leasing based on a Pacific island. The initial proposal was for Wake Island; later the target was Palmyra Island which was US privately owned at the time. In 1996 there was an attempt to purchase Palmyra Island from its private owner; this failed and in 2000 Palmyra Island was bought by US Nature Conservancy. In 1997, a request for using Wake Island was filed by US Fuel and Security with the US Government [18]. There was strong opposition from the US Administration, however, and the proponents turned their attention to the Russian Federation, initiating the Non-proliferation Trust idea described below.

(e) Pangea (1997–2002)

The project was initiated by individuals that had been involved in the work of the Synroc study group in Australia. The technical concept was based on a particular "high isolation" concept [19] and various regions of the world possessing especially favourable geologies were identified [20]. The main emphasis was on Australia and a commercial approach to implementing an international repository was developed in detail [21]. The original funders of the project were organizations from Canada, the USA, the UK and Switzerland, with the largest part of the financing coming from BNFL in the UK. The project raised the profile of the global debate on international repositories. It received solid support in scientific and business circles worldwide and in Australia. However, due in part to the premature leaking to the media of an explanatory video on the project, political opposition in Australia and in West Australia was strong from the initial announcement. The concept has a continuing support base but Pangea's Australian office has closed and the European Head Office has ceased operations.

3.2.3. Recent specific initiatives

(a) Non Proliferation Trust (NPT) (1998–)

The US based Non-proliferation Trust and the Minatom Development Trust have proposed implementing international storage and disposal facilities in the Russian Federation, beginning with 10000 tonnes of non-US origin fuel. [22,23] The substantial revenues are to be used for remedial action in the Russian Federation, for job creation and for charitable purposes. Although the initiative is supported by distinguished persons and groups, there are significant outstanding problems to be solved. The NPT is vehemently against reprocessing, whereas Minatom favours this option. US consent would be needed to transfer much of the foreseen inventory to the Russian Federation and this will not be granted without conditions being met on reprocessing and on Russia's nuclear cooperation with Iran. The control of the funding is controversial, with the US partners insisting that international confidence will be obtainable only if the funding is controlled by an off-shore USA trust. The motivation for Minatom to pursue the NPT proposal rather than progressing the purely Russian proposals described below does not seem obvious.

(b) Arius (2002–)

This is currently a small group of organizations from six countries cooperating in a new association to support the concept of sharing facilities for storage and disposal of all types of long lived radioactive wastes. Arius (Association for Regional and International Underground Storage), is an organization without commercial goals [24, 25]. The mission of the association is to promote concepts for socially acceptable, international and regional solutions for environmentally safe, secure and economic storage and disposal of long lived radioactive wastes. A key objective is to explore ways of making provision for shared storage and disposal facilities for smaller users, who may seek to optimize in an economic or safety sense, or who may not have the resources to develop facilities of their own. Consequently, the initial membership of the Arius Association is predominantly from countries with smaller nuclear programmes, although it also includes industrial organizations that are interested in promoting the international disposal concept. The founding members are from Belgium, Bulgaria, Hungary, Italy Japan and Switzerland.

(c) Russian proposals (2001–)

Minatom has been involved in several of the proposals mentioned above. Over the past few years the Russian Federation has become increasingly serious about spent fuel import and is the only country publicly supporting this at government level. Approaches have been made to various countries in parallel with initiation of steps to make the necessary changes in Russian law. The proposal has significant support in the Russian parliament but public reaction is negative in the Russian Federation. In some other countries public reactions are also primarily negative. However, support in US official circles appears to be increasing [26] and this could have an important influence on the chances of success. One currently favoured location for storing imported fuel is at Zheleznogorsk (Krasnoyarsk-26). A further potential host region in the Russian Federation for an international repository is the Chita region in Eastern Siberia. Scientists from the Russian Academy of Sciences, together with representatives of the mining and chemical industry in Krasnokamensk, have pointed out that the local environmental and geological conditions and the attitude of the local population are both favourable for the implementation of a national or international repository [27].

(d) Kazakhstan proposals (2001, 2002)

The most recent proposals for a multinational repository concern the declared intention of the Government of Kazakhstan to host a repository for LLW in the Mangistan region [28]. The concept is to utilize a very extensive, disused open-cast uranium mine and to construct a state of the art LLW disposal facility therein. The recommendation of the Government to approve the agreement and change legislation as required is currently before the Kazakhstan parliament. Public opposition to the proposal has led to the concept being put on hold.

(e) SAPIERR project (2003–)

In the scope of the 6th Framework Programme of the European Commission (EC), a project has been initiated aimed at coordination of European interests in regional repository concepts. The project (SAPIERR Support Action on Pilot Investigations on European Regional Repositories) is managed by organizations based in Slovakia and Switzerland and has the support of around a dozen countries that are in the present EU or will be in the enlarged EU [24]. The first phase does not involve any considerations of potential repository hosting countries.

(f) Regional storage and disposal of spent sealed sources (2003–)

The IAEA has a continuing project on the technology for the management of spent sealed sources [29]. In 2003, a special conference was held in Vienna on *Security of Radioactive Sources* — with the primary driver being the security concerns raised by the widespread availability around the globe. The secretary of Energy of the USA on that occasion announced that the USA is *"prepared to work with other countries to locate, consolidate, secure, and dispose of high-risk, orphan radiological sources by developing a system of national and regional repositories to consolidate and securely store these sources"*.

3.3. THE IMPORTANCE OF FUEL LEASING CONCEPTS

One promising approach that would allow all countries, even those with small electricity programmes, to benefit from nuclear power without being faced with the challenge of managing the spent fuel itself involves fuel leasing, which bundles front-end and back-end services provided to reactor operators. In this concept the uranium producer and/or the fuel fabricant do not transfer title of the fuel when it is delivered to the user. Instead the fuel is leased to be returned when unloaded from the reactor. To provide such a fuel leasing service, the fuel supplier must be in a country that will accept spent fuel from other countries, i.e. in an international repository host country, or else the fuel supplier must have access to a multinational repository in a third country.

In the supplying country this procedure may be more acceptable than acceptance of foreign fuel originating elsewhere. In fact, fuel leasing was effectively practiced between the former Soviet Union and its East European satellite states. If the leasing system can be expanded, the fuel provider can obviously charge a premium above fuel prices of suppliers not offering this option, since the user is saved expensive disposal costs. Of course if no parallel arrangement can be made for an existing backlog of spent fuel — so that the user country must in any case find a disposal route — then paying a premium price is much less attractive.

Leasing has, however, a further attraction beyond the purely commercial potential benefits. If all fuel, both fresh and spent, becomes the property of only a few fuel supplying countries, then safeguards and non-proliferation measures should be more easily applied. This concept of restricting fuel ownership to fewer countries could be particularly important point when the fresh fuel supplied is MOX fuel with its plutonium content. If the leasing concept does give the ability to utilize MOX more freely, this could represent a global security benefit since it implies that the stocks of surplus plutonium from weapons' dismantling could be used up more quickly.

Recently different groups have been working on the concept of fuel leasing based on MOX fuel fabricated using excess weapons plutonium. This type of scheme has the advantages of reducing proliferation risks, accelerating the utilization of separated plutonium, bringing finance to the Russian Federation and solving disposal problems for small countries. It should be noted, however, that this last advantage can be realised only if these countries also have a disposal route from existing spent fuel that was not obtained under a leasing agreement. A full description of one proposal prepared by a German-Russian group called the Nuclear Disarmament Forum is in Reference [30]. British groups are also working in this concept but their analyses are largely proprietary.

4. SCENARIOS FOR DEVELOPING MULTINATIONAL REPOSITORIES

Various different considerations for developing and implementing multinational repositories have been discussed in the past and are still subject to an ongoing debate. However, multinational repositories for radioactive waste and spent nuclear fuel have not yet been developed by any group of countries worldwide and in addition firm multinational agreements for such type of international cooperation are not in place. Thus, currently practical experience is extremely limited and it is difficult to judge which conditions might be most suitable for developing and implementing multinational repositories.

The interest in shared repositories has not led to great progress in the area, due primarily to the lack of potential and capable countries willing to host multinational repositories but also to the reservations expressed by some national programmes. Consequently, it is expected that scenarios for developing and implementing multinational repositories will depend significantly on the specific circumstances in potential hosting countries and that these circumstances may change with time.

It is, however, already feasible to propose scenarios that could credibly lead to the development of multinational repositories, provided that the necessary political support can be obtained. These could be classified according to various criteria, e.g. according to the waste management capabilities of potential hosting countries and of countries interested to dispose of their waste abroad or according to the main incentives to create a multinational repository. Economy of scale, improvement of physical security and improvement of global nuclear and environmental safety are examples of major incentives. The three main scenarios below are classified according to the degree of self-sufficiency and independence of the repository host country.

The degree of self-sufficiency of the national repository programme in the potential hosting country would have a major impact on the intensity and nature of the multinational cooperation for developing and implementing a repository. Self-sufficiency of the national programme in the hosting country implies that the necessary infrastructural framework, the technical capability and the financial resources for developing and implementing the repository type in question can be provided without essential assistance from abroad. In contrast to this, full multinational cooperation is indispensable if the host country cannot by itself provide the necessary technical and financial framework. Even if a hosting country could make available all necessary resources and capabilities at a national level, a cooperative model may also be chosen, if all parties prefer to share the risks and benefits resulting from multinational cooperation in developing and implementing a nuclear repository. In the following text, we define broad scenario types that could describe a possible end situation in which multinational repositories operate. Thereafter, mechanisms whereby these end scenarios might be reached are discussed.

4.1. ADD-ON SCENARIO

> *Scenario Type I: This is titled the "ADD-ON-Scenario": the host country offers to complement its national inventory of wastes for disposal by wastes imported from other countries.*

This scenario is characterised by the availability of all necessary resources and capabilities in the hosting country. It is possible that, in this case, a national repository

programme would first be developed and implemented and then at a later stage disposal services might be offered to potential partner countries. It requires that the hosting country have the political will, the technical and financial resources and the natural conditions (geology) to develop a repository. Its motivation can have various sources: straightforward business initiative; a desire to share repository development costs; willingness to help neighbours (in the context of a regional repository scenario); an interest in reducing global security risks; a commitment to reduce the number of disposal sites worldwide; an opportunity to trade its offer to take radioactive waste from its partners for some other national goal to which all partner countries can contribute. An example for the last type of motivation could be the offer of countries with highly developed nuclear capabilities to combine the delivery of equipment for nuclear power plants with fuel leasing agreements, as it was exercised by the former Soviet Union with east European countries. In practice, in this add-on scenario, the repository remains effectively a national repository, but with a part of the waste inventory coming from abroad. However, the national infrastructural framework would have to be amended to enable the acceptance of foreign radioactive waste. In particular, the specification of the interfaces between the waste management systems of the involved countries will be required. It is also conceivable that partner countries delivering waste to a host might place specific requirements on the repository system. The Swiss nuclear law, for example, has such provisions [36]. Nevertheless it is expected that emphasis will be on the technical and institutional infrastructure available in the hosting country.

4.2. COOPERATION SCENARIOS

In the case where multinational cooperation is, by necessity or choice, an indispensable element of repository development and implementation, the scenario types are referred to as *Type II "Cooperation scenarios"*. They are characterised by the participation of other (partner) countries in developing a repository programme jointly together with the potential hosting country or countries. In this case one or more other countries interested to dispose their waste in the potential hosting country or countries will be involved directly in an early stage of repository development and implementation. It is conceivable also that countries can initially come together to discuss the advantages and drawbacks of a shared repository — without, however, defining at the outset potential host or hosts. This is similar to the "compact" system under which different groupings of states in the USA sought a common LLW repository. It is also the basis of the SAPIERR project described earlier. The contribution of the partner countries will logically depend on the capabilities and demands of the hosting country and on their own capabilities. Potential contributions could include technical assistance (including regulatory assistance), advance funding or political support.

The *"Cooperation scenarios"* provide the more complex challenge with regard to multinational repositories, since they involve full-scale multinational cooperation as an indispensable prerequisite. There are various scenarios that can be included in this category; some are outlined below, others might also be feasible.

Scenario II-a: Several industrialised countries with relatively small nuclear energy programmes decide to cooperate for the disposal of their radioactive waste in a host country satisfying all necessary technical requirements

The prospective countries in such group would be attracted to the multinational concept because of the prospect of reducing the number of waste sites and saving resources by not developing individual repositories and by benefiting from economies of scale. Candidate

countries for such a group are those with small but mature nuclear programmes and extensive national experience, e.g. Belgium, Italy, Netherlands, Switzerland etc.

Scenario II-b: Countries with small quantities of radioactive wastes and in varying stages of development seek assistance from each other and cooperate to ensure that one of their number acquires all necessary technology and institutional structures.

This scenario could be exemplified by cooperation between the significant numbers of member states that operate only research reactors and/or one or very few nuclear power reactors. These countries might all be faced with similar difficulties in implementing a self-sufficient national disposal concept for all types of radioactive waste and particular for high level waste and spent nuclear fuel. Thus, multinational cooperation seems to be a logical consequence. The partners would cooperate to ensure that the finally chosen host or hosts will, by the time of implementation, satisfy all technical and institutional requirements. In addition this scenario could be typical for countries whose sole use of nuclear materials is in the industrial, research reactors and medical area. An example, which is assisted by the IAEA, is the development of borehole disposal of spent nuclear sources from several developing countries in a multinational facility. While a repository solely dedicated to the disposal of non-fuel cycle waste could be constructed, it may be preferable to handle these materials as part of a larger programme. It is also conceivable that a country with no significant quantities of its own wastes, but with especially suitable conditions for disposal, could offer to host a multinational repository for commercial reasons.

Scenario II-c: Specializing of repositories for specific types of waste, possibly combined with arrangements for international exchanges

In a process of optimization, it could be judged as useful if certain countries were to specialize in the disposal of specific types of waste. They could accept wastes of this type from other countries either as part of a commercial arrangement or, conceivably, as part of an agreement involving exchange of waste types. Examples could be the collection of spent sealed sources for disposal in only a few countries, the exchange of heat generating waste against non-heat generating transuranic waste (TRU) or of L/ILW against HLW. Such exchanges would require agreement among parties on waste equivalence and on measures for waste characterization, quality assurance and quality control. Waste exchanges of this sort are foreseen in the return of reprocessing wastes to customer countries and in the past some such exchanges with full transfer of titles have been reported from various European countries. However, they did not have any significant impact on the development and implementation of repositories as a joint multinational effort. Nevertheless, they illustrate the viability of multinational cooperation as a pre-stage for the development of multinational repositories. They could also lead to the development and implementation of specialised repositories as a multinational cooperative effort.

4.3. INTERNATIONAL OR SUPRANATIONAL SCENARIO

A final type of scenario is

Scenario III "Full international or supranational scenarios" in which a higher level of control and supervision is implemented.

It has been suggested that global acceptance of a multinational repository might be enhanced if the operation were fully in the hands of an international body. The host country

would, in this scenario, effectively cede control of the necessary siting area to the international body. This scenario seems unlikely in the foreseeable future because such transfer of sovereignty is likely to be of extreme political sensitivity. It may also be less appropriate because international agencies, such as the IAEA are more suited to an oversight role than to assuming hands-on operational responsibilities. In this latter case, the question would also arise as to which body could then assume the control and supervisory role over the operator.

4.4. DISCUSSION

The above mentioned scenarios should be recognised as representative only. Similar or other constellations, or combinations of the above, may also be feasible. Scenarios which receive attention in future will depend on the needs and interests of potential hosting countries and on the capabilities of partner countries to respond to this demands appropriately. Due to the very limited experience to date it hard to predict in this respect, which of the indicated or other scenarios might be the most promising.

The scenarios sketched are end-point scenarios. It is interesting to speculate on how these situations might arise. What mechanisms could lead to the successful development of each scenario?

The add-on scenario is host country driven. It requires only one potential host to achieve the necessary level of national agreement and then to make an offer to partner countries. History has documented that there are countries that would react positively to such an offer, provided that public and political sentiment in the partner country was in favour and that the potential host was recognised internationally as suitable. The most obvious candidates for hosts in the add on scenario are large countries with significant national waste inventories. the Russian Federation is an example of a country where direct interest in becoming the host in an add-on scenario has been expressed at government level, and the large potential economic advantages may lead others also to consider this option. An important additional driver for such potential hosts with a nuclear history, giving rise to legacy wastes, can be the availability of funding to enable remediation efforts to progress. The obvious partners in the add-on scenario are those with small nuclear waste inventories and/or complex geological environments; typical examples are nuclear power nations such as Taiwan and Switzerland or countries with only research reactor fuel, e.g. Australia, Norway, Denmark, and many others.

The Type II scenarios are more partner country driven. A group of countries may get together, without, in the first instance, identifying potential hosts. These countries can work on agreeing a transparent and equitable framework for a multinational approach and thereafter seek potential hosting offers — either from within their own group or from third countries. Should the potential host initially be outside the group, and be a country wishing or requiring participation of the partners in the repository development, it seems likely that it would subsequently become a member. An interesting possibility in the partner-driven scenario is that “a reverse auction” scenario might take place. This approach involves the “buyers”, i.e. the potential repository users, making open offers of financial and other benefits in the hope of attracting a potential host. If first iterations fail to do so, the benefits offered are progressively raised until one (or more) hosting offers is received. This development scenario would ensure that the key acceptance issues were settled before investing the time and resources needed for development of a state of the art, safe repository. It is predicated on the assumption that there could conceivably be actual competition between potential hosts — but this is a situation that is not at present the case.

For Type III supra-national repositories, the most plausible driver might be the global drive to contain terrorism and thus to ensure that radioactive materials are as inaccessible as possible.

In conclusion it is again stressed that the above mechanisms describe only some conceivable approaches that might bring interested countries together in order to discharge their national responsibility for the proper management and disposal of radioactive waste in collaborative manner. The Joint Convention on Spent Fuel and Radioactive Waste makes clear that every State is ultimately responsible for the safe management of these materials, even if they are not disposed of nationally. Thus, cooperative development scenarios may require the partners to interact through all the phases of repository development. The complex issues involved in allocation of responsibilities and liabilities though all phases are addressed in Chapters 5 and 6. In principle, the phases for the development and implementation of a multinational repository are identical with those for a national disposal facility. Major phases to be considered are:

- *Conceptual phase* (establishing an expected waste inventory, developing generic repository designs for potential host rock formations)
- *Site selection and characterization* (screening of potentially suitable sites, site investigation and confirmation of its suitability)
- *Repository planning and licensing* (developing the repository design, performing safety assessments and licensing of the facility)
- *Facility construction*
- *Facility operation*
- *Facility closure*

Each of these phases offers various opportunities for cooperation between hosting and partner countries. Which of them will be chosen will depend on the regulatory framework implemented in the hosting country and on the capabilities and interests of the involved countries. However, it is to be expected that the main responsibilities (in particular for the final site selection, licensing, operation and closure of the facility) rest with the hosting country, with partner countries providing assistance as mutually agreed between the parties.

In addition, one must consider the fact that the development and implementation of a nuclear repository is a sophisticated and time-consuming process, which lasts usually a few decades. In such timeframes, interests of involved countries and the relation between the countries might change. Thus, it is hard to predict in detail how scenarios for developing and implementing multinational repositories will develop. It is nevertheless important that the involved parties develop as early as possible a strategic plan that can be revised at appropriate intervals, taking into account new technical, regulatory or political developments.

5. BENEFITS AND CHALLENGES

A multinational repository project has the potential to benefit the host and partner countries in many ways. It also presents them with potential risks and requires them to face the associated challenges of successfully responding to those risks. Important benefits and challenges for countries contemplating a multinational repository programme are in areas related to security, environmental safety, non-proliferation, economics, institutional requirements, and public acceptance and support. Many of the benefits and challenges parallel closely those that are relevant for a particular host region or host site within a national disposal initiative, so that they have already been addressed by various member states. Without doubt, the most important aspects are those concerning safety and security. If any proposed multinational repository would not meet the accepted high standards for radioactive waste disposal, then it should clearly not be implemented.

5.1. SECURITY AND ENVIRONMENTAL SAFETY

The concept of multinational repositories offers the opportunity of safe and secure radioactive waste disposal to countries that are not able for various reasons to implement a national repository project in a timely fashion. It has been argued that real prospects of success for a multinational approach will appear only after successful implementation of a national deep geological repository. Nevertheless, the expected global security and safety benefits provide major arguments for supporting the concept of multinational repositories and for encouraging potential host countries to offer their cooperation to interested partner countries. It is important to note that the improvements in safety and security that are expected are at a global scale. It is not intended to imply that a specific multinational repository will be safer or more secure than a properly implemented national repository. The global benefit results from making a proper disposal facility accessible also to countries that may not be in a position to implement a state of the art national repository.

5.1.1. Non-proliferation and Physical Protection

Compared with surface storage of nuclear materials, emplacement in a geological repository provides a higher level of security because of the lower accessibility of the waste material. The emplacement of SNF deep underground inside a facility that is highly monitored, with numerous engineered and administrative controls, can enhance both physical security and safeguards relative to most surface storage facilities. Even after closure, the risk of clandestine human intrusion is highly unlikely in a properly sited, designed, and operated repository because of the long time required for the assembly and operation of the mining and drilling equipment necessary for entry, and because of the detectable signals and indicators associated with those activities.

Conditions for security of a multinational repository relate to measures necessary to guarantee the non-proliferation and physical protection. Non-proliferation is traditionally associated with actions that deter and prevent the diversion of fissile materials or equipment that can be used in nuclear weapons. Prior to the terrorist attacks on the USA in September 2001, non-proliferation of weapons-grade nuclear material was arguably the primary security concern associated with nuclear facilities. However, since then, the threat of terrorist attacks against nuclear facilities that could result in the release of radioactive debris into the atmosphere and the unauthorised removal of dangerous radioactive material that could be used in radioactive dispersal devices has greatly expanded security concerns. Today, security

includes actions that deter and prevent terrorist attacks, or acts of sabotage, against reactors, repositories, at-reactor or away-from-reactor spent fuel storage facilities, or spent fuel storage containers during transport.

Multinational repositories could make the security and safeguards benefits of geological disposal available to more countries and could therefore enhance global security. Provided that the host country, most likely in agreement with the partner countries, takes the appropriate measures, a highly transparent, safeguarded and well protected multinational repository could greatly reduce the risk of proliferation through theft or diversion of the material in the repository. A multinational repository could be specifically sited, designed and constructed to create high levels of security [37].

Multinational repositories may also increase some security risks, however. The accumulation of larger volumes of nuclear materials might attract various subversive attacks and increase the potential consequences resulting from them. Also, a multinational repository will involve transport between the partner and host country over longer distances. This could result in increased risks of theft or diversion of nuclear material during actual transport or temporary storage during transport.

5.1.2. Environmental Issues

Safety and environmental aspects to be considered include both radiological and conventional issues. Radiological safety will not be a major issue, provided that the multinational repository conforms to the same international norms that national facilities must satisfy. The following text therefore focuses on conventional environmental benefits and challenges.

(a) Potential for global environmental benefits

Because many countries with nuclear programmes are not planning to develop a repository for many decades, a multinational repository approach offers the potential for them to dispose more quickly of the radioactive waste currently held in surface storage in those countries. It follows that the development of a multinational repository to serve those countries could reduce environmental concerns associated with continued, decades-long periods of surface storage. In addition, a multinational repository approach has the potential to reduce on a global basis the total number of future repository sites that would otherwise be needed. This creates the potential to avoid the environmental impacts that would have been incurred as a result of the construction and operation of the numerous repositories that would be needed in the absence of a multinational approach.

Multinational repositories will have to fulfil the same criteria and meet the same requirements and standards as national repositories. Nonetheless, a multinational repository approach could be useful in further reducing the environmental impacts for small countries with limited resources. This would result from the broader choices of potentially suitable sites and geological settings that would be available for consideration; from the ability to reduce the total number of nuclear facilities (e.g. surface stores, waste packaging plants, repositories) that would be necessary if each partner country had decided to develop its own national disposal system; and from the ability to avoid the environmental risks associated with under-funded or marginally-funded repositories that might otherwise result.

(b) Potential environmental impacts for the host country

Implementation of a multinational repository could have positive environmental consequences in the host country, if some of the revenues from users were to be used for carrying out improvements. Several of the suggested projects for importation of foreign wastes to countries that have existing problems with contamination have included proposals for funding remediation of the sites. In other cases, although the environmental and particularly the radiological impacts associated with state of the art repositories will be low, there is the potential for the host country to incur an negative incremental long term environmental impact because it will become the disposal site also for radioactive material generated by partner countries.

Such additional impacts may result from larger construction volumes for larger facilities and from higher doses gathered from the handling of larger waste volumes. The host country also incurs an incremental near term environmental risk because waste from partner countries will be transported through the host country. In addition there will be conventional environmental impacts at some level associated with the construction and operation of the new and potentially more extensive road or rail infrastructure in the host country.

Such potentially greater environmental impacts raise the question of environmental equity for the host country. To ensure that the benefits of cooperation are equitably shared between host and partners, the fees paid to the host by partners could be significant. As mentioned above, the funds created by these fees could be used for environmental compensation e.g. for cleanup of nuclear contamination in the host country, for environmental restoration of non-nuclear contamination, or for creating other environmental improvements in the host country or in the host community.

5.2. ECONOMICS AND FINANCE

5.2.1. Economic and Financial Benefits

Disposal facilities and in particular geologic repositories involve high levels of fixed costs that are independent — to a degree — of the quantity of waste to be emplaced. Examples include capital costs such as site characterization, underground and surface facility design and construction, infrastructure (roads, rail, and utilities) construction, procurement of capital equipment and materials, and licensing costs. Fixed operating expenses include security, maintenance of facilities and equipment, and administration. For a single repository these costs could be in the billions of US dollars. These liabilities are a serious concern for radioactive waste producers in any country, especially because the repository costs may be associated with major uncertainties that make long term financial planning difficult.

Thus, a large-capacity, multinational repository could offer an economic advantage in that the host and partners could achieve substantial economies of scale by pooling resources and sharing the fixed capital costs and also the operating costs, as well as the associated financial risks. Doing this could allow the host and partner countries to achieve a lower unit cost than would otherwise be the case for a national programme undertaken by either the host or partner countries acting alone [38].

The host country could negotiate additional economic benefits or other advantages. The negotiating advantage for the host arises because it is agreeing to host the repository and in so doing to provide a substantial safety, environmental, economic and security benefit to the

partners. As a consequence, the host country could, for example, negotiate a reduction of its share of the repository costs or it could negotiate an annual fee for discretionary or non-discretionary uses such as environmental cleanup, education, and social programmes. Other potential economic benefits for the host country could include creation of employment opportunities (including high-tech jobs), infrastructure improvements, and increased taxes from contractor private companies. In addition, the education, training, and experience acquired by its citizens in the course of their work on the multinational repository could potentially be used to stimulate new businesses.

5.2.2. Potential for added costs

Potential added costs could arise from the longer transport distances involved in shipping between partner countries and the host, and from the more complex modes of transport that might involve combinations of sea, road and rail transport through host, partner or other countries. Additional administrative costs could be created as a result of the host/partner, partner/partner, and third party/host/partner legal and financial arrangements needed for the project. There would almost certainly be added costs created by the differences in the legal, regulatory, and financial systems among the host, partner and third-party countries. Potentially, as in the case of national repository programmes, a trust fund could be created as another means to cover added costs.

5.2.3. Economic and financial risks

Developing a multinational repository is a decades-long undertaking; therefore, for all involved countries, there is are decades-long economic risks associated with failure or significant delays, including those that could result from changes in the political systems in the host or partner countries. These risks may result in dramatic increases of disposal costs or in case of total failure of the project in the loss of the invested funds. Due to the decades long life cycle from the first steps of site investigation until the final closure of the repository, such projects are also extremely sensitive to inflation. In addition changes of regulatory requirements may become a major cost driver that cannot be predicted easily.

All of the above issues are equally relevant for national or multinational repositories. However, due to the variety of countries involved, the economic and financial consequences arising from such risks can be more complex for a multinational repository project than for a strictly national approach. e.g. one or several countries can lose the interest or the capability to contribute to the project. Differences in the economic development, in the national policy for securing funds over long periods and different inflation of the national currencies may cause additional financial burdens for the involved countries. Mutually agreed-upon approaches should be developed to reduce the overall economic risks for all involved countries and for allocating the economic risks between host and partner countries. Commercial arrangements should be developed based on risk allocation arrangements.

Host country economic risks can be reduced by developing arrangements to assure that funds are received on schedule and spent as planned. If this does not occur, possible impacts on the host country include loss of jobs, schedule slippages, excessive costs, and loss of public and institutional support. In addition, if this does not occur, the result for both the host and partner countries could be delays in shipments of waste from storage sites in host or partner countries, or the prospect that waste would not be shipped, ever.

5.3. TECHNICAL ISSUES

From a technical point of view, the same requirements apply to a multinational repository as to national one and the same technical principles should be followed in designing the facility. Technical advantages can result from collaborating on repository implementation. More expertise is available; more funding can be made available for developing robust engineered systems; a wider choice of siting may be possible. There are also additional technical challenges.

One potential technical challenge arising from the larger scale of a multinational disposal facility is that there may be a greater variety of waste sources. In this context, the waste acceptance criteria might be more complex due to differences in the nationally employed conditioning technologies and waste packaging and a greater variety of waste handling equipment might be required.

A very specific issue is quality assurance of the waste packages to be disposed of in a multinational repository. Usually the waste producers are involved to a great extent in the quality assurance of the waste packages. If they follow different national systems it might be difficult to maintain compatibility. The situation may become worse if historic waste is involved, since this may be poorly documented in national systems. In some cases, reconditioning and/or repackaging of waste might even be needed.

5.4. LEGAL AND INSTITUTIONAL ISSUES

A decision to enter into a multinational repository agreement would result in a need for the host and partner countries to compare and contrast different elements of the institutional framework for radioactive waste management in each country. This institutional framework would include, for example, environmental regulations, entities and processes for establishing funding; the technical and legal infrastructure, organizational responsibilities, and public participation. The result of the exercise could lead to greater levels of shared knowledge of the institutional framework in each country among all of the countries, and perhaps even to a benchmarking of elements of the institutional framework in each country. It is reasonable to expect that areas would be identified in the infrastructural framework of one country that could be considered for adoption by other countries for purposes of modification of their own infrastructural framework, should the need arise.

A possible institutional challenge could develop as a result of the long operating life of the multinational repository, which extends through closure and sealing of the subsurface facility and through decommissioning of the surface facilities. The operating life of a multinational repository could therefore extend beyond the life of the critical institutions in the host and partner countries. Treaties at national levels would most likely be needed.

New and specific questions might arise in the context of transboundary movement of the waste, associated with transfer of title. Particularly in case of the execution of a retrievability option for the repository and in case of intervention measures that involve waste retrieval, the question of waste possession should be clearly addressed. Rather than full and immediate transfer of title, a possibly long period of shared responsibility might be agreed. Partner countries may be prepared to continue to carry a share of the responsibility, even for potential retrieval, since the alternative is to carry the full responsibility in their national programmes. A detailed study of these liability issues would be useful; they are complex in a

national context and will be more so for multinational repositories, although the difficulties should not be insurmountable.

5.5. SOCIO-POLITICAL ISSUES

For repository projects in general and especially for international projects, sustained public support is necessary and is an enabling function. A sufficient level of public acceptance is necessary in both the host and partner countries. Past history shows clearly that public acceptance is difficult to achieve, but, once achieved and sustained, public acceptance and support can lead to the sustained political support that is essential for multinational repository concepts. Continuity of political support during the lifetime of a multinational repository project is important. Political support could also facilitate making changes in laws or regulations that might be needed in the host or partner countries in order to develop a multinational repository. A challenge would develop if circumstances led to decisions by political incumbents, or challengers, to oppose the multinational repository because of a perceived political advantage. Political support is also important in third party countries. If a potential host is recognised by the international community as providing a needed environmental service in a responsible manner, then there will be a greater chance of hosts volunteering.

For nuclear projects such as a multinational repository project, public acceptance and support must be carefully and deliberately sought, and continuously nurtured through all phases of the project. Once gained, it will be fragile and could be easily lost with the prospect of never being able to regain it to former levels. Great breadth and depth of transparency and the absence of real or perceived secrecy will facilitate public acceptance and support. An effective public and stakeholder outreach programme, ensuring that the public is informed with balanced views and complete information, could provide enormous benefit to a multinational repository project. The benefits – and the challenges – of achieving public and political support may well be the issues of overriding importance.

Public support for multinational repositories will be difficult to achieve for reasons that apply also to national repositories, e.g. the linkage to nuclear power, the general distaste for waste and the specific fear of radioactivity. The additional challenge of motivating a localised host community to accept wastes from further afield is also a key issue in national disposal programmes. All of these aspects are magnified in the multinational context. This has been recognised in various countries by interest groups which have attempted to strengthen opposition against national repositories by asserting that they might lead to later import of foreign wastes. This tactic has been used by anti-nuclear groups even in countries like Sweden and Argentina that have laws forbidding waste import.

It is important to recognize that at least three types of “publics” exist: the global public, the public in the partner counties, and the public in the host country. In addition, the public in the host country must be differentiated; reactions may be different in the public in the local region of the multinational repository and the public elsewhere in the host country.

For public perception and for stable public and political support, it is important that the arrangements for a multinational repository are based on a fair and equitable sharing of benefits and challenges between the host and partner countries. Neglecting the internationally agreed high safety standards for the disposal of radioactive waste would, correctly, be recognised as shifting an undue burden to another country. Similarly, if the only motivation for joining a multinational repository project is internal political opposition or lack of public

support for a national solution, then this would not provide favourable ethical basis for waste export. Only if the driving forces are recognised to be safety, security and economic optimization, and only if the benefits from sharing the repository are equitably distributed between host and partners, can one hope for sufficient political and public support.

6. CONDITIONS FOR IMPLEMENTATION

The previous chapter examined the advantages and the problems that can arise from multinational repository projects. The present section addresses the conditions that a host country, partner country or third party should fulfil if the advantages are judged to outweigh the drawbacks so that the goal becomes successful development of multinational repositories. It also addresses conditions that a host country, partner country or third parties might impose as necessary for successful development. Many of the conditions addressed in this chapter relate to the benefits and challenges discussed in the previous chapter. The important conditions are

- Security and Environmental Safety
- Economics and Financial Arrangements
- Technical
- Legal and Institutional
- Socio-political.

Before moving to specific requirements in these areas, it is valuable to consider the ethical issues related to multinational repositories, even though these are not conditions to be satisfied in the same sense. Rather, ethical considerations are overarching matters that should be the concern of all parties involved, and are effectively the same for all parties since the participation of each party in a multinational repository project presumes that they subscribe to the importance of honouring ethical values related to all parties. For example, it would not be ethical for a partner country or third part to deliberately target and seek to team with a host country for a multinational repository because of the perception that the host country has less stringent regulations and safety standards, an insufficient legal system, or a government that can disregard public concerns. Similarly, it would not be ethical for a host country to prematurely offer itself as a multinational repository site until governing authorities had ensured that the regulations, safety standards, legal system and mechanisms for public input were adequate.

As a related ethical matter, there is a consensus that each country bears ultimate responsibility for its own radioactive wastes. However, this does not imply from an ethical standpoint that disposal must be on the national territory of the country that generated the waste (see e.g. [2, 39, 40]). The host county, the partners and the international community could agree that if there has been equitable treatment of all parties, then there are no ethical grounds ruling out a given proposal for a multinational repositories. This can be best appreciated by looking at past experience of radioactive waste transfers between willing partners (see Section 3) and also by comparison with transfers of other toxic wastes to host countries that are better equipped than the sending countries to ensure safe and economic disposal (e.g. import by Germany of chemotoxic wastes for disposal in disused salt mines). A specific ethical issue included in the IAEA Safety Principles [39] and relevant for multinational repositories is that repository host countries may not impose on others burden greater than those acceptable in the host country itself.

Another relevant factor influencing the decision of any country to concentrate on a national or multinational repository concept concerns the timing of this decision and the investment of resources prior to the decision. At the outset of any waste management programme, it can be prudent and easily feasible to keep both options open. However, if a

large fraction of the resources needed for a national repository has already been expended, a cost comparison may show that it is unreasonable for economic reasons to move to a multinational solution in another country. Of course, the option of the national facility becoming multinational in an add-on scenario would still be open. In practice, the difficulty in deriving dependable cost estimates for either type of repository makes the necessary cost comparison difficult. Obviously, if national policy requires a solution to be implemented by some fixed deadline and if no multinational solutions are available or in sight, then a national approach must be followed.

6.1. SECURITY AND ENVIRONMENTAL SAFETY REQUIREMENTS

6.1.1. Non Proliferation and Physical Protection

An important condition for hosts, partners and third parties is to site, design, and operate multinational repositories to take advantage of the inherent ability of repositories to enhance the physical security and safeguards for the emplaced waste.

Subsequent to the first signing of the Non-Proliferation Treaty in 1970 [41], the IAEA implemented a verification mechanism known as the IAEA Safeguards System (Safeguards). The purpose of IAEA safeguards is to verify that nuclear material or equipment is not being diverted from peaceful nuclear activities to develop or produce nuclear weapons. The IAEA is identifying issues and developing policy and technology such that safeguards can be applied to national repositories [42]. The IAEA program, Development of Safeguards for Final Disposal of Spent Fuel in Geologic Repositories (SAGOR), is intended to optimize existing technologies and foster advanced technologies that will enable safeguards objectives to be met and still meet repository environmental and safety objectives [43].

Host, partner and third parties should expect that an IAEA safeguards regime will be required for a multinational repository containing spent nuclear fuel or other forms of nuclear material subject to safeguards. The safeguards regime for a multinational repository must be recognised by all parties to be of equivalent — or perhaps greater — strength than the safeguards regime required for national repositories.

The overall objective of safeguards applied to national or multinational repositories is to verify that nuclear materials have not been diverted and that no undeclared activities have occurred. Different administrative and technical means are used to achieve this objective. Examples of means that would be expected to be applied to repositories include rigorous control over access to repository facilities, surface and subsurface, and local and remote surveillance designed to detect undeclared surface or subsurface activities at the repository and in the vicinity.

Host. As a minimum, the host country will be responsible for safeguards applied during transport of the waste within the host country, during temporary surface storage of the waste at the repository site, during emplacement, and after the repository is closed and sealed. The host country should also anticipate that safeguards will continue for the duration of the safeguards agreements. The host country should anticipate unannounced visits by IAEA safeguards inspectors, and requests for access to surface and subsurface facilities from IAEA safeguards inspectors on short notice. As pointed out earlier, in practice, it may be possible to achieve enhanced safeguarding by siting a multinational facility in a host country at a location with particularly suitable conditions for ease of surveillance. The particular situation of safeguards in a nuclear weapon state (NWS) host needs to be studied.

Partner. The partner country remains responsible for safeguards within its own borders. This will probably include safeguards during preparation for transport, and could include safeguards during transport depending on agreements between the partner countries and host country regarding responsibility for transport.

Third parties. It is possible that, for a large multinational facility an increased level of security might be result through the involvement of the international community.

6.1.2. Environmental Issues

Host. The host will be required to ensure that the disposal solution implemented is environmentally acceptable and presents no unacceptable radiological hazard. There are international standards that have to be adhered to. Those related to radiological safety are documented by, for example, the IAEA and the EC. The latter also issues Directives on environmental assessment processes. A condition that should be satisfied by the host country and is that the repository itself must be state of the art (i.e. planned and implemented following international requirements) and the safety should be checked by performance assessments involving qualitative and quantitative safety case arguments. Reviews of such work by international organizations or by third party countries are becoming a standard part of any repository programme and will be expected for the host country involved in a multinational project.

Partner. The siting of a safe repository is possible in almost all countries, given the right combination of geological conditions and engineered barriers enclosing the wastes. Nevertheless, some countries may have particular problems in locating suitable stable geological environments or may be so densely populated that unwanted environmental impacts of any major new nuclear facility, including a repository, are difficult to avoid.

Third Parties. For third parties, the most important issue is a responsibility to exercise oversight to assure that the performance assessments and related safety case analyses have been performed. Assuming that the host country has signed the Joint Convention, then the rights of third countries to be protected to at least the level in the partner countries is formally agreed.

6.2. ECONOMICS AND FINANCIAL ARRANGEMENTS

6.2.1. Economics

All over the world, SNF/HLW disposal expenses are treated as a part of nuclear power production costs and they represent a significant fraction of these costs. It is therefore widely assumed that organizations responsible for the management of SNF/HLW would pay potentially substantial disposal fees to a multinational repository. For low level wastes, the disposal costs are lower and the volumes so much higher that transport begins to play a significant role in determining costs. This reduces economic drivers for multinational LLW repositories. The potentially large revenues that can be generated by disposal of SNF/HLW have led a number of commercial entities to express interest in constructing and operating such facilities as a business venture, and have also led non-profit organizations to promote development of such facilities in the hopes that the substantial operating revenues could be applied to security and environmental remediation. The implementation of a multinational repository would have economic consequences for all parties.

Host. A requirement that the host country will obviously put on any multinational repository project is that there must be an economic advantage in offering a multinational repository site. For a large, self-sufficient host (add-on scenario), this can be through defraying some of the costs of implementing the national facility. For a smaller host (cooperation scenario), the main advantage might be in achieving a cost-sharing arrangement that allows it to take care of its own wastes in a manner that might otherwise be economically infeasible. For add-on or cooperation scenarios, the acceptance of the repository might also be looked upon as a straightforward provision of a required service so that the costs involved become regulated by normal market forces. It is entirely conceivable that, in fact, with time commercial competition between hosts could arise.

Application of revenues to other non-proliferation, environmental or social programmes in the host country is seen by many observers as an incentive to implement proposals to that effect. An example is the Non-proliferation Trust Proposal [22,23]. Potential target areas for revenue investment as part of these sorts of proposals include:

- Development, design, construction, and operation of a geological repository for a host country that may otherwise not be able to finance such an undertaking on its own;
- Improving the physical protection, control, and accounting of fissile materials or dangerous radioactive materials in host and partner countries;
- Site environmental remediation of radioactively contaminated areas in host countries;
- The opportunity to apply enhanced non-proliferation or security programmes;
- Charitable or educational programmes.

It is important to recognize that strictly commercial projects might not include direct revenue redistribution of the types described above, but could nonetheless provide the host country with significant revenues in the form of taxes or levies, and jobs for host country citizens.

Partner. The partners must be prepared to meet their share of the costs and also to compensate the host for the service provided. The ability and the readiness of partner countries to pay for disposal services provided by a host will depend upon the economic and social conditions prevailing in the partner. Rationally, the maximum price that a partner might pay is governed by the costs of the alternative of implementing a national repository. In practice, some partners may be willing to pay a premium above this in order to avoid the difficult societal problems of siting in their own country or to have a clear and early cap on their future nuclear liabilities, rather than face the uncertain costs of implementing a national repository in the far future. The financial consequences for host or partner countries have been looked at in detail in [38], using the theoretical example of Germany.

Third parties. In particular for the case that commercial competition would arise, there could be a need for external oversight ensuring that standards are not sacrificed in order to reduce costs. It is conceivable that third parties or international organizations might financially support multinational efforts, for example if global security were thus significantly enhanced.

6.2.2. Financial arrangements

The financing arrangements will normally be bilateral agreements affecting simultaneously both host and partner. One mechanism is that host and partners agree to a co-

financing scheme for the entire project development; this was done for development of internationally accessible reprocessing facilities in the UK and France. Other financing options include those used for other large scale projects, such as the issuance of bonds, to be repaid over a number of years out of operating revenues, or the issuance of stock.

Under each option for financing the multinational repository project, participating partner countries would have to make decisions about how costs would be divided among each partner country, and in negotiation with the host country how revenues would be allocated to the host country and to involved private organizations.

The most important consideration would be that financing must be secured. This involves consideration also of sharing financial risks of extra costs due to cost overruns, failure to obtain licenses or permits, or potentially expensive remediation work. An equally important consideration is that the funds must be secure to prevent theft, fraud, or for uses not agreed to by the participating parties.

6.3. TECHNICAL REQUIREMENTS

Host. As a minimum, the technical requirements for hosting a multinational repository would be similar to those required for a national repository. The requirements must be fulfilled by the host country before a multinational repository can be operated. If a potential host does not initially satisfy these requirements, then assistance may be provided by the partners or by third parties to assure that they are satisfied.

The requirements will include a suitable site, a transportation system and infrastructure, the ability to characterize a potential site, to evaluate the performance of a repository design, and to design, license, construct, operate, close and monitor such a facility. A quality assurance (QA) programme will be required for the activities of the repository operator and of the partner countries. Waste type specifications and acceptance requirements or criteria will need to be developed consistent with the QA programmes.

The type and amount of material to be disposed of needs to be determined (e.g. standard commercial spent nuclear fuel, spent MOX fuel, vitrified high level waste, research reactor fuel, immobilised Pu, or other). This will be important in determining the type of packaging and/or conditioning that will be required. This information will also be used to establish waste acceptance requirements that must be set by the host and satisfied by the partners.

Further technical requirements included in the Joint Convention [2] are to provide for adequate human and financial resources. The former implies the availability in the host of sufficient numbers of properly qualified staff; the latter is covered under the topic of financing.

Partner. Each partner country will have to assess its waste arisings, agree to condition wastes so as to meet acceptance criteria at the repository and establish a binding schedule of transfers of wastes to the host country. Partner countries must have or acquire the technology to properly condition and characterize wastes to be sent to a multinational repository. An exception might occur if a technologically advanced host or third party organization would undertake to perform such services for a less developed partner country. Appropriate oversight by national bodies in the partner country or from international bodies would still be necessary.

Third parties. International organizations, in particular the IAEA, are accustomed to providing technical support to member countries for nuclear activities. This is discussed in Section 7. Third parties might also be involved in ensuring that technical requirements are met by the host. This could be through the provision of technical know-how, e.g. through bilateral agreements between waste agencies or provision of consulting services.

6.4. LEGAL AND INSTITUTIONAL REQUIREMENTS

The Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management [2] is the broadest international agreement on the safe management, storage and disposal of spent nuclear fuel and radioactive waste. All parties will be bound by the overarching requirements in the Joint Convention. The Joint Convention commits parties to assuring safety for current and future generations, establishing proper siting procedures for facilities, performing appropriate design and assessment activities and operating facilities safely. It also requires establishment of a legislative and regulatory framework, clear allocation of responsibilities, provision of appropriate human resources, and application of quality assurance throughout the system. The requirements in the Joint Convention will affect different parties to varying degrees.

6.4.1. Structural

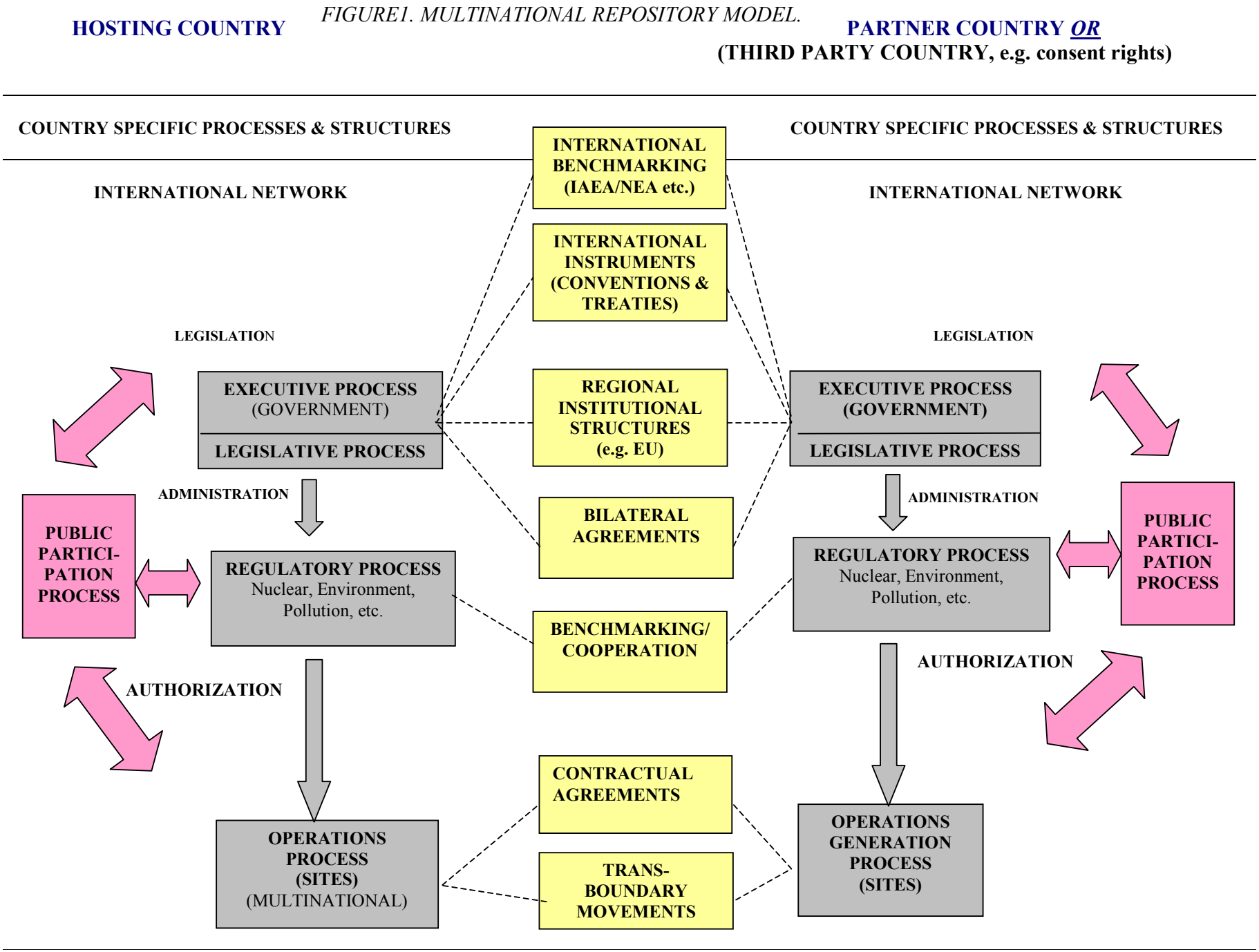
Figure 1 gives an illustrative overview of the necessary structures and the interfaces within and between host and partner countries. The figure is schematic, and is intended simply to reflect some particular points of note, e.g.

- the legal, institutional and regulatory requirements are similar in both host and partner country;
- interactions of a political, legal and commercial nature are needed at all levels; and
- information and participation of the public in all involved countries is a key element.

Specific aspects are commented on in more detail below.

Host. The host country, after ratifying the Joint Convention, must fulfil all the requirements of the Joint Convention and also those in further IAEA Requirements and Guides documents such as that on “Legal and Governmental Infrastructure for Nuclear, Radiation, Radioactive Waste and Transport Safety” [44]. This means that the host country must have an internal organizational structure capable of managing and performing in-house or through contracts the implementation and regulatory tasks necessary for the siting, design, construction, operation, closure and decommissioning of the repository. If the host country does not have in existence the required internal organizational structure, then assistance can be obtained from capable external sources in order to develop the required structures within the host country. For example, the development of this internal organization structure may be done with assistance from partner countries, the IAEA or from other competent organizations.

FIGURE1. MULTINATIONAL REPOSITORY MODEL.



Partner. Partner countries need to have in place sufficient parts of an internal organizational structure to guarantee that it and the internal organization of the host country have clear, correlative opposite elements within their respective internal organizations. This condition is necessary in order to organize and manage the legal, economic and safety aspects related to waste acceptance, transport, and repository development and operations. A possible first step for developing correlative internal organizational structures between host and partners is to establish a series of bilateral agreements. It is also conceivable that partner countries might group together in order to assure that they have a common voice on issues of overarching importance.

Third parties. Third parties not directly involved in the multinational repository can be concerned with issues related to waste transport activities, or possibly about potential transboundary impacts. These third party countries should have appropriate bodies in their internal organization for interacting with the host and partners on such issues. The most important necessary third party structures are perhaps those involving international bodies responsible for transport, safeguards etc. (i.e. IAEA, EC, etc.). As mentioned in Section 7, it is also conceivable that an expanded role of an international body might be requested by the host state and/or the partners. Extreme scenarios up to designation of ex-territorial (not belonging to any state) status for the repository site have been suggested in the past.

6.4.2. Legal

Host. It is recognised, also by international organizations (e.g. IAEA [2], EC [45]) that no state may be compelled to accept foreign waste and that individual states can legislate against this. Some have already done so, e.g. Sweden, Finland, France, Argentina. Thus, a state that seeks to accommodate a multinational repository within its territory will have to ensure that an appropriate national legal framework is in place. It should be recognised that there is a possibility that the host government decision on importing SNF and/or HLW may bring about lawsuits demanding review of its decision.

A specific legal issue will concern the transfer of ownership of wastes from a partner to a host country. This may occur at the time of transport if both agree. It may also be postponed until repository closure or even further into the future, should the host and partners decide on some form of shared liabilities extending into the future.

Transfer of ownership of spent fuel might be more complicated, as spent fuel can also be regarded as a potential resource rather than a waste and as the transfer involves safeguards issues.

Partner. The partner country will have to satisfy its national legal requirements. Some countries have legislation forbidding export of wastes, e.g. France and Finland. A partner country might propose specific legal requirements to be met before export is allowed (e.g. Swiss case [36]). There are also international requirements to be met, in particular concerning transport. However, here it should be kept in mind that international shipment of spent fuel to reprocessing facilities is an established practice and so many of the judicial precedents may apply to shipment to a repository.

The issue of transfer of ownership or liabilities is obviously key also for the exporting (partner) country. The concept of continuing shared liabilities may be acceptable when compared to the option of retaining full liabilities, as within a national project, but it weakens the potential partner country incentive of capping definitively future liabilities.

Third parties. Many countries supplying fuel fabrication or uranium enrichment services for the international market place restrictions on future transfers of material they have fabricated or enriched. Thus, before transferring SNF to a multinational repository, in many cases, the partner country will be required to notify or obtain the consent of the country in which the SNF was originally mined, fabricated or enriched.

The United States has consent rights on approximately 33,000 metric tons of spent nuclear fuel outside the United States. This means that this SNF can be transferred only with the explicit agreement of the USA. Current United States policy in this regard continues to discourage the accumulation of separated plutonium world wide. Therefore the USA would need to be assured that the SNF was destined for disposal in a repository and would not be reprocessed. In addition, as a precondition for US approvals of the transfer of US-origin spent fuel to a multinational repository, US law requires that the United States have in force an agreement for peaceful nuclear cooperation with the country where it is proposed to build a repository facility [46].

Another issue concerns legislation governing spent fuel transit through third countries en route to the multinational repository. Agreements for transit rights will have to be negotiated, but experience to date indicates that such matters do not present insuperable judicial or political difficulties.

6.4.3 Treaties

Host, partner and third parties. An initiative to construct a multinational repository and the transport of material there would be also affected by several international agreements to which many countries are parties or which they actively support. The most directly relevant agreements are The Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management [2]; Code of Practice on the International, Transboundary Movement of Radioactive Waste [47]; and the reporting requirements of the IAEA Safeguards Agreements of the transferring States and the Supplementary Protocol to these agreements [48].

6.4.4. Regulatory

Host. The host would need a regulatory system satisfying the IAEA requirements laid out in publication [49]. The host regulator would be the primary oversight body. In addition, it is conceivable that the regulators from partner countries would demand a degree of oversight.

If a potential host does not initially have a strong, competent and independent regulator, then assistance from the partners or from international bodies can help achieve this. The costs of regulation will be passed on to the users of the facility through the host country.

Partner. In some countries, export of radioactive wastes is allowed only if the country's national regulators are satisfied that the host country repository meets the standards of the partner country.

Third parties. Depending on the constellation of host and partner countries, there may be international pressure for strengthening regulatory measures to provide independent oversight of safety and security.

6.5. SOCIO-POLITICAL REQUIREMENTS

Host. Problems in implementing even national repositories are today more of a societal than a technical nature. A sufficient degree of acceptance in a host country is necessary. How this acceptance is measured may differ widely between potential hosts, in particular the balance between political and public approval. For multinational repositories, the challenge is obviously greater. In the host country, acceptance of a multinational repository will be more likely if:

- the benefits to the host are widely recognised and accepted as being needed;
- the planned repository is recognised to be safe and secure;
- the host is acknowledged by the international community as providing a necessary service;
- financial incentives are clearly communicated;
- further advantages are seen, such as environmental remediation of regions within the host country;
- there is some familiarity with nuclear technologies.

The long and often largely unsuccessful efforts to promote acceptance of repositories at the national level indicate that a concerted effort will be needed for multinational repositories. This could involve sociological research aimed at identifying the issues thought most problematic and the paths towards societal consensus.

Partner. In the partner country, it cannot be assumed that export of the waste is the most acceptable societal solution. The advantages for the host as well as for the partners should be clearly laid out also for the public in the partner country. Some arguments that could enhance acceptance in partner countries are:

- a safer and more secure global situation is achieved;
- resources in all participating countries are used in a less wasteful fashion;
- the host country receives deserved benefits (the remediation argument may be particularly influential here);
- the arrangements are judged by the international community to be ethically and technically appropriate.

It might be thought that acceptance in partner country political circles would be easily achieved, because social unrest caused by national siting efforts might be avoided. This political attitude need not be the case. Firstly, some politicians will argue that disposal should be national. Secondly, publicly advocating an export solution may be politically more exposed than nominally supporting a national solution – especially when specific measures to progress such a solution can be postponed for long times.

Third parties. It would seem reasonable that the world community would regard any proposal for a multinational repository as being more promising if the host State has a political system that is regarded as stable.

7. THE ROLE OF THE INTERNATIONAL INSTITUTIONS

Although the responsibility for the safe management of radioactive waste remains fully on national institutions, a broad consensus exists of its international dimension. Involvement of international organizations with regional or worldwide domains may enhance and accelerate implementation of a multinational facility. The roles of some international institutions, e.g. the European Commission (EC) of the European Union (EU), the OECD Nuclear Energy Agency (NEA) and the IAEA, should be considered in this context, but a new specialized organization could also be created and entrusted to assure some of the further specified objectives.

In its Communication and Fourth Report on the Present Situation and Prospects for Radioactive Waste Management in the European Union [40], the Commission stated:

> *"The Commission repeats its plea ... for self-sufficiency of the European Union as a whole and solidarity between Member States in matters of radioactive waste disposal. ... Countries with a large radioactive waste production certainly should be able to dispose of their waste on their own territory. The possibility of voluntary cooperation between Member States however should be kept open, where, for example, a regional approach to disposal could result in improved safety and environmental benefits."*

More recently, the Commission's position has been reiterated in the Explanatory Memorandum to the proposed new Directive on the Management of Spent Nuclear Fuel and Radioactive Waste [45] in which is stated:

> *"While Member States should certainly aim to be self-sufficient in the management of their own radioactive waste, there should be greater collaboration between Member States, especially where this would help guarantee or reinforce the necessary high level of nuclear safety and environmental protection. An approach involving two or more countries could also offer advantages especially to countries that have no or limited nuclear programmes, insofar as it would provide a safe and less costly solution for all parties involved. However, no Member State should be obliged to accept imports of radioactive waste from other Member States."*

Note, however, that in the context of the single European market and the free movement of goods and services, there is a question mark over the legality of such unilateral bans by individual EU Member States[1]. To clarify the situation would require a judgement by the European Court of Justice, but until now these bans have never been legally challenged and it is not likely that they will be in the future. In fact the EC has repeatedly stressed that no country should ever be compelled to accept foreign wastes.

[1] Some countries license imports of waste for further processing, though only on the condition that the residues are re-exported back to the country of origin. Note also that in the case of Sweden and Finland restrictions on imports were in place before these countries joined the EU and derogations from EU rules were subsequently agreed during the accession negotiations.

The Explanatory Memorandum goes on to state:

"It is recognised that for certain Member States with very limited accumulation of waste, export to other countries probably represent the most viable option from the environmental, safety and economic points of views. However, these transfers can only be sanctioned providing the very strict conditions listed in the Article are respected."

This is a reference to Article 4 of the proposed Directive, which requires Member States to establish national programmes for the management of all waste under their jurisdiction — see [45] for full text. The proposals effectively permit waste exports to form part of a Member State's programme provided certain strict conditions are met. Note that the proposals are currently the subject of discussions with the EU Member States and the European Parliament and are liable to be amended before any formal adoption in EU law. Though there is no fixed timetable for this process, the Commission is pressing for agreement on the text as soon as possible and in any case before enlargement of the EU in May 2004.

The primary objective of the NEA is to promote cooperation among the governments of its participating countries. This is implemented by procedures including:

- developing exchange of scientific and technical information; and
- setting up international research and development programmes and joint undertakings.

Some considerations of possibilities for international cooperation in the exploitation of radioactive waste facilities were summarised in the 1987 NEA publication [12]. This, together with above mentioned objective of the NEA, provide a good basis for future involvement of this institution in studying multinational solutions of the disposal of radioactive wastes.

Although all these international institutions may have a role in the development and implementation of multinational repositories, the following text primarily refers to and elaborates the role of the IAEA. The IAEA, the nuclear organization with the broadest international mandate, can most naturally take a leading role in the development and promoting the idea of multinational repository. The IAEA can support by its authority and by its tools for cooperation the implementation of a project in all stages of its development. Specific support can be provided on request to a country volunteering to host an multinational facility or to any other involved country, but the IAEA may also be involved in initiating generic discussions assessing the viability of such a solution. In other words, the IAEA has demonstrated a direct interest in multinational disposal concepts and could offer assistance to both host and partner countries if they choose to take these concepts to commercial development.

The IAEA has established strong positions — either by explicit political mandates or by the content of its work — in the two key areas of relevance here, namely non-proliferation and safety. As stated in its Statute, the IAEA objectives in encouraging peaceful uses of atomic energy throughout the world involve the following:

- to encourage and assist research and to promote development and practical application in this field;
- to foster the exchange of scientific and technical information;
- to encourage the exchange of training of scientists and experts; and
- to make provision for materials, services, equipment, and facilities to meet the research need for this purpose.

In everyday practice, these goals are achieved by engaging in activities, including the following:

- issuing international consensus standards and by provision of an assistance for their application,
- providing an objective evaluation of particular national activities and programmes through international peer reviews,
- facilitating international collaboration and exchange of experience on technical and social issues,
- disseminating knowledge and suitable technology among all Member States.

These are, therefore, the main directions in which the IAEA may assist in and support the implementation of a multinational disposal project. It may be appropriate for the IAEA to maintain its role as an international institution that is able to provide a broad and highly respected forum for exchange of information among interested countries. This role is very important in the developing and implementing the multinational repository concept and there is no international institution better suited to fulfil this role. The IAEA can advise all interested parties on how to identify requirements necessary for implementation of multinational repository concepts. Assistance to the involved parties can also include identifying and implementing the conditions stipulated by international agreements, such as the Joint Convention. Finally, the IAEA may help in resolving conflicts of interests of the countries involved in multinational waste disposal concept.

When assessing the potential role of international institutions, the creation of a new, fully integrated international entity can also be considered. This would consist of representatives of institutions/countries involved in a particular international project. Its function may be as an executive, similarly to that proposed in [50]. Such an institution could establish and enforce on its members radioactive waste management standards and execute all financial and contractual arrangements for the state hosting the multinational repository. Establishment of international advisory body, as discussed during the 3rd Scientific Forum [51], could provide a forum for unification of international opinion on particular, controversial, issues. Creation of any new institution may result in sharing the activities and roles described in Appendix A between the IAEA and this institution.

8. FUTURE STUDIES

Some of the complex interactions that are inherent in the multinational repository concept warrant further study and clarification. The most important issue in this respect is the institutional framework for a multinational repository. There are other issues concerning stakeholder involvement in a multinational repository concept. This is an area in which the international community has become increasingly interested lately and which is important to understand in order to make progress towards any repository project, be it national or multinational. In this Chapter, the capabilities of the international community to initiate a number of studies of relevance to the multinational repository concept are described. At the request of a group of Member States, these studies could be initiated in the framework of some specific projects.

8.1. SAFETY AND SECURITY

Spent nuclear fuel contains fissile and fissionable material that requires continued securing and safeguarding. Possible misuse of this material is being reassessed in the light of possible terrorist attacks. For these malicious purposes, also other radioactive waste including spent sealed sources may be used. The disposal of spent nuclear fuel and other radioactive waste can significantly reduce the potential threat of theft of these materials. However, for various reasons (financial problems, small amounts of waste, unfavourable geological conditions, lack of resources, etc.) some countries may not be capable to implement the disposal solution on reasonable timescales. This may seriously affect the safety and security not only of the particular country but globally. Multinational repository can provide safe disposal for such countries and thus reduce the danger of illegal possession of nuclear or radioactive waste. For these reasons, it would be useful to assess how the risks being imposed on the international community and on Member States might be reduced by encouraging multinational repositories. Assessment of these global risks could be carried out with and without having multinational repositories.

8.2. AGREEMENTS/LIABILITIES

The responsibility for proper waste disposal normally rests with the waste owner. In the context of a national waste repository, legislation provides for the transition points of ownership and liability, including that for future costs of waste disposal. In the case of a multinational repository project, this becomes a more complex issue and there are several possible solutions. For example, the host country may choose to accept title to the waste taken from the partner country at transfer to the repository and assume all future liabilities in respect of this waste for a prepayment of the disposal price. Alternatively, the host country can accept the wastes for transfer, whilst the partner country retains ownership and both countries share in some agreed way future liabilities with respect to the disposal of such waste. In the case of spent nuclear fuel this matter is even more complicated. Spent nuclear fuel can be viewed as resource for later use or as waste. If the fuel is later reprocessed, any arrangement between host and partner country will have to clarify who is the beneficiary of any potential future economic value contained in the spent fuel.

Research could be undertaken into possible interfaces and identify requirements in order to provide for the necessary protection of the host and the partner countries.

8.3. LEGAL AND REGULATORY ISSUES

A multinational repository project will require compatible legal systems and regulations in host and partner countries. In this respect a study could be undertaken to make an intercomparison of the legal and regulatory environment in participating countries and identify areas of divergence. Member State reports in the scope of the joint Convention will provide valuable input here.

8.4. ECONOMICS OF DISPOSAL SYSTEMS

Economic benefits are potentially an important driving force for the development of a multinational repository [38]. A systematic study could be carried out to collect information on the cost of national disposal projects and assess their cost structure (fixed cost, variable cost).

8.5. DATA ON INVENTORY AND CONDITIONING OF RADIOACTIVE WASTE

Radioactive wastes exist at many locations and in great variety of chemical forms and radioactive content. The IAEA maintains a database production and management of radioactive wastes in Member States. This database could serve as the basis for a study on wastes that are candidates for disposal in multinational repository projects.

8.6. DATA ON EXISTING RADIOACTIVE WASTE DISPOSAL PROGRAMMES

In parallel to an ongoing study in the EU, a further study could collect information on existing waste disposal systems and analyze it with respect to the regulatory environment and the funding mechanisms in support of the project. This is important basic input for any coordinated planning of disposal.

8.7. STORAGE VS. DISPOSAL AND RETRIEVABILITY ISSUES

These are contentious topics of high current interest in national disposal programmes. It would be useful to examine whether the questions being debated are influenced by including multinational repositories as a possible option.

The terms storage and disposal are defined in IAEA publications (Joint Convention, IAEA glossary). However, when considering issues of future rights and responsibilities more complex questions arise, as discussed in Reference [52]. These issues are more complex for a repository in which wastes from several countries are emplaced than they are for a national facility.

The issues of retrievability and reversibility are also much discussed [53–55]. In this publication, disposal is regarded as the emplacement of spent fuel or other waste in a repository without intention of retrieving. The different aspects of development and implementation of a multinational repository have been discussed only with this definition in mind. Retrievability of spent fuel or other waste has been introduced as an important feature of the disposal concepts of some countries. What is the implication if this also becomes the norm for a multinational repository? In such a case, some aspects addressed in this publication (e.g. transfer of title, ownership of spent fuel, liabilities) may not be sufficiently elaborated. Further examination of these issues could be initiated in an additional study. The safety

implications of retrievability/reversibility in the context of recent efforts to increase safety and security of waste management may also be addressed.

8.8. SOCIAL SCIENCE STUDIES

Radioactive waste disposal projects invariably encounter opposition from sectors of the public affected by the project. This is the case irrespective of the question of who owns the waste to be disposed of. In the case of a multinational repository project, the issue is further complicated by those aspects that result from the fact that benefits of the multinational repository are enjoyed by the participating countries, whilst the perceived risk associated with the repository is borne by the inhabitants of the host country. In order to help to mitigate these fears, studies could be initiated that clarify the nature of these fears, the importance of time horizon and the nature of perceived "adequate return" in the form of financial benefits for services rendered by a local community and a single country to a wider circle of repository users. The work carried out under the auspices of the EU in connection with the RISCOM project [56] and the Eurobarometer polling [57] should be of particular interest.

9. CONCLUSIONS AND RECOMMENDATIONS

9.1. CONCLUSIONS

This report allows one to come to a number of conclusions that are summarized below:

(1) Multinational repositories can enhance global safety and security by making timely disposal options available to a wider range of countries. For some Member States, multinational repositories are a necessity, if safe and secure final disposal of long lived radioactive waste is to replace indefinite storage in surface facilities.

(2) The global advantages of multinational repositories are clear and the benefits can be significant for all parties, if they are equitably shared. For individual countries, the balance of benefits and drawbacks resulting from participation as a host or as a partner must be weighed by the appropriate national decision making bodies.

(3) Implementation of multinational repositories will be a challenging task. However, there are a number of conceivable scenarios under which their development might take place.

(4) This report specifies some of the principal requirements to be fulfilled when implementing multinational repositories. In the future, both national and international repositories are expected to be implemented.

In addition, the current publication shares the conclusions of the earlier IAEA publication [1] on this topic:

(5) The multinational repository concept does not contradict ethical considerations.

(6) The high ratio of fixed to variable costs for a repository ensures that considerable economies of scale will apply.

(7) Transport of nuclear material is so safe that the distances resulting from a multinational repository will not have a significant impact on public health.

9.2. RECOMMENDATIONS

(1) The concept of multinational repositories should continue to receive support from all countries that have an interest in a shared disposal solution.

(2) Discussion on the advantages, drawbacks and boundary conditions for multinational concepts can be initiated by interested countries without prior definition of potential host countries.

(3) Proponents of national and multinational repository concepts should acknowledge that both types may be implemented and should try to ensure that activities undertaken in either case do not negatively impact the other.

(4) Although the issue has not been addressed directly in the scope of the present report, the potential interactions between recent proposals for nuclear fuel cycle centres [58] and for multinational repositories should be studied in more depth, in particular in connection with security and safeguards issues.

(5) The studies proposed in Chapter 8 of this report should receive consideration. An immediate practical step could be to facilitate multinational or regional disposal concepts for spent sealed sources.

Appendix A

POTENTIAL ROLES FOR THE IAEA THROUGHOUT THE DEVELOPMENT OF A MULTINATIONAL REPOSITORY

Concrete potential activities of the IAEA as listed below are linked to the particular phases of the facility implementation, but the on-going advising, mediating and coordinating functions of the IAEA are also emphasised. The sequence of the listed phases is proposed for development of a multinational facility on a green field. However, in particular projects and scenarios for their implementation some phases may be bypassed or amalgamated, according to specifics of the particular project.

Generic phase is characterised by strategic considerations, formulating problems which may arise during implementation of the multinational facility project, defining the roles of host, customer and third party States. No host countries are identified in this stage. The IAEA may enhance contacts among involved parties and initiate strategic studies. The following are typical activities to be performed in this stage:

- providing a forum for strategic discussions (technical committee meetings, seminars, workshops, round table discussions at conferences);
- stimulating the debate on international disposal strategies;
- coordinating the consistency of international storage/disposal conceptual activities;
- linking national and international institutions interested in tackling the issue;
- issuing general standards and requirements;
- promoting comparative strategic studies; and
- assessing the viability of international solutions of waste management.

Conceptual phase involves non-site specific conceptual and technical studies, although volunteering host countries may appear during this phase. The IAEA activities would concentrate on collecting and supporting the exchange of technical information among involved parties, on proposing objectives of such studies, and on coordinating formulation of collective opinions on key political and technical elements of the multinational repository project. Potential problems to be solved under the IAEA auspices in this stage are as follows, even if some of them are beyond usual IAEA scope of activities (see the last three bullets):

- issuing guidance for development of a multinational repository;
- formulating functional requirements on the particular elements of the disposal system;
- developing conceptual designs of facilities for different waste categories;
- carrying out transport and safety studies;
- evaluating safety and security and advising on the liability issues;
- studying application of the safeguard system for operation of an international facility;
- collecting and processing information about waste inventories with potential for their acceptance to the international repository;
- recommending legislative environment for implementation of the project;

- defining institutional framework required for implementation the facility;
- initiating studies aimed at public acceptance issues both in host and in partner countries;
- organizing technical meetings to promote international cooperation; and
- assessing concrete economic impacts of the international solution,
- quantifying the challenges/benefits of the international disposal concept,
- performing social science studies.

Host country selection phase consists in comparative evaluation of potential for hosting an multinational facility in countries that agree to be considered. The IAEA role is seen in organizing objective evaluation of proposed solutions and in supporting both methodically and technically those countries which declare initiatives to further investigate the implementation of multinational disposal concepts. This support may cover the activities listed below:

- assessing availability of manpower, financial and technical sources;
- providing training possibilities for the involved personnel to increase its technical capabilities;
- assisting in optimizing the technical and transport infrastructure;
- promoting harmonization of the legal and institutional background in involved countries;
- mediating contacts to foreign institutions providing services or technologies not available in the potential host state;
- organizing reviews to evaluate plans/programmes aimed at development of the facility; and
- providing forum for technical and methodological debates.

Implementation phase includes siting, design and construction of the facility and gaining proves of its radiological and nuclear safety. The IAEA assistance can be provided by *assuring* that the following tasks are addressed:

- advising in establishment of transportation/handling systems;
- mediating expert support for safety analyses of the whole system (both operational and long term);
- advising on records management (data collection, records keeping, creation of databases);
- recommending procedures for conditioning of radioactive wastes;
- establishing QA,QC systems;
- drafting standard agreements for involvement of other parties in development and operation of the international facility;
- organizing reviews to evaluate safety proves;
- organizing and assuring safeguards during the whole implementation phase; and

– providing its authority of the respected international institution to back the proposed solutions.

Operation and closure phase: is supposed to run under the supervision of the parties involved in the multinational project. The support of the IAEA can be reduced in this phase and will concentrate on assuring the safeguard requirements, on organizing peer reviews of the disposal system and, also, on collection and generalization of practical experience gained during the facility operations (lessons learned).

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