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NUCLEAR ENERGY AGENCY
RADIOACTIVE WASTE MANAGEMENT COMMITTEE

NEA/RWM(2007)9
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PROCEEDINGS OF THE TOPICAL SESSION OF THE RWMC 40TH MEETING ON:

APPROACHES AND PRACTICES IN DECOMMISSIONING OF FACILITIES AND MANAGEMENT OF RADIOACTIVE WASTE FROM NON-NUCLEAR FUEL CYCLE RELATED ACTIVITIES

Held at the NEA Offices
in Issy-les-Moulineaux, France
on 14 March 2007

English - Or. English

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FOREWORD

Many activities in modern society involve the use of radioactive materials necessitating dedicated facilities for their production, application, and storage. This applies universally and, regardless of whether or not they are involved in nuclear fuel cycle related activities, all countries need frameworks for decommissioning of contaminated facilities and the construction of facilities for radioactive waste management in a manner that does not impact unduly on society in terms of safety and costs. Countries with nuclear power programmes are perhaps more likely to have in place the necessary infrastructure for dealing with non-power wastes. Nevertheless, a general concern exists about whether enough attention has been paid to small users and/or producers of radioactive materials, whether in academia, in medicine or in industry. Legacy waste is also an important issue in some countries. The exchange of the information about experiences of member countries in this area may thus be expected to have widespread benefits.

The OECD/NEA Radioactive Waste Management Committee (RWMC) organised a Topical Session to discuss these issues on 15 March 2007 in Paris, during its 40th meeting. The aim of this topical session was to explore waste management approaches and practices in decommissioning of facilities and management of radioactive waste in relation to small users and/or producers of radioactive materials from non-fuel cycle activities for educational, medical or industrial purposes. Legacy facilities and waste will be covered in a separate topical session to be organised as part of the future programme of work of the committee. Information was exchanged on:

- How countries have organized themselves (legislation, institutional arrangements etc.)?
- What approaches and practices are being implemented?
- What are the lessons to be learnt in terms of successful outcomes and difficulties experienced?

Mr. Georg Arens, BMU (German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety) served as Chair of the Topical Session.

EXECUTIVE SUMMARY

The Topical Session was devoted to the management of waste and the decommissioning of facilities associated with non nuclear fuel cycle activities, i.e. those typically in the fields of education, research, medicine and industry. National approaches in six member countries were presented orally, together with a short overview of relevant IAEA activities, after which an open discussion on relevant issues took place. In the coming months the RWMC Bureau intends to reflect on the various issues raised during the session, in order to consider what further items are appropriate for inclusion in future work programmes.

It is apparent that a variety of waste management approaches are followed in different member countries. These normally include separation of short-lived waste, which, after decay, can be managed as conventional waste. In many countries long-lived wastes are kept in storage pending the development of suitable storage facilities, though some are proceeding with development of near surface disposal facilities for certain wastes, or are planning the refurbishment of existing facilities in line with present-day regulatory standards. Some countries with waste from both power and non-power applications choose to keep separate the management routes for the two categories of waste. Highly active waste including disused sealed sources cannot usually be emplaced in near-surface disposal facilities and therefore must be kept in storage, with an associated need for security measures, e.g. to protect against terrorist activity. This is therefore a high priority issue, at both national and international levels.

Amongst the issues arising during the open discussion at the end of the session was the need to develop comprehensive waste management strategies for non-power waste, especially in member countries where no disposal route is currently available. This should include the provision of equipment properly to characterise the waste. It was noted that, in some countries, the costs of disposal of waste from small users is subsidised by the State, in recognition of the fact there is an overriding societal benefit to ensuring that such wastes are collected and safety managed. Similar considerations may apply to the costs of cleaning up sites contaminated as a result of historic practices such as radium production.

As regards decommissioning, the operators of larger nuclear facilities such as research reactors or cyclotrons are normally required to prepare (and update regularly) decommissioning plans, including providing an estimate of decommissioning costs. The funding of decommissioning of larger facilities is often borne directly by the State - with funds provided on an as-needed basis - reflecting the fact that research and educational establishments are often State-owned. In the case of smaller facilities such as laboratories the regulatory approach is more typically to require that, after closure, these are decontaminated against pre-established standards and that waste is adequately managed. The costs are normally borne directly by the facility owner. In all cases, the availability and sufficiency of funds for decommissioning and management of the resulting waste is an important consideration that could inhibit progress in this area.

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OVERVIEW OF PRESENTATIONS AND MODERATED DISCUSSIONS

The Topical Session was opened by Mr. G. Arens (BMU[1], Germany), Session Chair, who welcomed the participants. He noted that the scheduled presentations reflected a range of national situations and covered a variety of issues including, for example, funding considerations and the definition of responsibilities. On that basis, he anticipated a fruitful exchange of views.

In the first presentation Mrs. M-C. Dupuis (ANDRA) noted that the French national waste management agency (ANDRA) was responsible for the long-term management of waste both from the nuclear power generating sector and from smaller producers (including hospitals, universities and research institutes). In the latter case, ANDRA takes over control of about 200 cubic metres of waste each year. ANDRA's statutory responsibilities include waste collection, characterisation, conditioning, processing and ultimate disposal.

It was noted that adapted systems were in place for the management of two specific waste categories: diffuse nuclear waste[2] and contaminated sites. Diffuse nuclear waste includes radium needles, radioactive lightning conductors and natural radioactive salts and ore samples. A "Radium Fund" has been established by the State to help owners of materials contaminated with radium to recover the costs of disposal of these materials. Also, an "Orphan Polluted Sites Fund" has been established - from contributions from the major waste producers - for the provision of security for sites with defaulting owners.

In addition to the above special funds, ANDRA is able to subsidise the waste management tariffs charged to private individuals, making use of a special State grant (currently about €2 million per annum), in line with the public service responsibilities recently allocated to it under French Law. Under arrangements recently established, the use of the special State Grant is overseen by a National Commission on Diffuse Nuclear Waste, for which ANDRA provides the President and the Secretariat.

Mrs. Dupuis noted that special efforts had been made during the last decade to clean up radioactively contaminated sites, especially sites contaminated as a result of historical activities involving the use of radium, e.g. by the clock industry in the last century. In this case, more than 1 000 tonnes of contaminated soil were removed from historical clock industry sites during the period 1994-1998. This material is now in storage at Cadarache. She noted that the required level of decontamination was determined by the regulatory authorities on a case-by-case basis, using guidance which had been developed by IRSN, and was dependent on the intended future use of the site.

Mr. G.C. Christensen (Institute for Energy Technology, IFE) provided an overview of the system for management of non-fuel cycle related activities in Norway, noting that the country does not have a nuclear power programme. The Norwegian Radiation Protection Authority (NRPA) has defined two main categories of waste: non-nuclear waste (NORM-bearing) and nuclear waste (other radioactive

1. German Federal Ministry of the Environment, Nature Conservation and Nuclear Safety.
2 The term 'diffuse nuclear waste' is applied to waste from small waste producers outside the nuclear industry, including historical waste from these producers.

waste), each with separate disposal routes. Accordingly, a repository is being developed at Strangeneset (north of Bergen) for NORM-bearing waste (mainly LSA[3] Scale), to complement the existing repository for nuclear waste at Himdalen (southeast of Oslo). The Himdalen "Combined Storage and Disposal Facility" for LILW has been in service for some 8 years and the Strangeneset repository will enter into service in 2007. Both repositories are slightly sub-surface and both will ultimately become the responsibility of the Norwegian State.

In Norway, the Institute for Energy Technology (IFE) is the implementing body for the long-term management of all LILW nuclear waste and is the operator of the Himdalen facility. Waste producers are charged a fee for waste collection and processing, but the cost of disposal (i.e. repository operation) is borne directly by the State. Short-lived waste is allowed to decay at the site of arising and is subsequently managed as conventional waste.

The operator of the Strangeneset repository will be Wergeland-Halsvik AS. In principle, foreign NORM-bearing waste (from the oil and gas industry) can be imported and emplaced in the repository, provided both the governments of the originator country and that of Norway are in agreement.

Decommissioning plans (including cost estimates) for all significant nuclear facilities, e.g. research reactors, are in place and are regularly updated. It is intended that similar plans for small nuclear facilities will be in place within the next two years.

Mr. J-P. Minon (ONDRAF/NIRAS, Belgium) provided an overview of the Belgian approach to waste management and decommissioning of non fuel cycle waste, explaining that the national waste management organisation, ONDRAF/NIRAS, has a very wide remit which includes collection, processing, storage and disposal of waste, as well as decommissioning of nuclear facilities, when requested by the facility owner. Some major waste producers condition their own waste and then transfer the conditioned packages to ONDRAF/NIRAS for centralised storage. ONDRAF/NIRAS also maintains a comprehensive inventory of all radioactive waste on Belgian territory, including waste expected to be produced in the future, both from operating activities and from decommissioning.

Generic levels for clearance of radioactive materials have been established in Belgian legislation. As regards the release of sites (including sites contaminated because of the presence of radioactive contamination as a result of historical activities), decisions about site release are made on a case-by-case basis. Mr. Minon noted that Belgium had significant amounts of highly contaminated soil from historical activities, e.g. one site contaminated as a result of radium production activities (UMICORE) contained in the order of one million cubic metres of contaminated soil. In the latter case, progress had already been made in removal of the most highly toxic materials and it was envisaged that it will take a further 10 years to complete the clean-up activity.

In 2006 the Belgian Government decided in principle to proceed with the design and construction of a surface repository for LILW in the municipality of Dessel (east of Antwerp). When this facility comes into operation, it will accept all LILW (from power and non-power sources) that meets the relevant waste acceptance requirements.

Owners of all Belgian non fuel cycle facilities (except the Universities) are required to prepare initial decommissioning plans in accordance with a procedure developed by ONDRAF/NIRAS, and to make necessary financial provisions. Currently, such plans exist for all such facilities or are in the process of being developed. A feature of the Belgian system is that, once facilities have been

3. Low Specific Activity.

shutdown, owners have the option to relinquish responsibility for decommissioning to ONDRAF/NIRAS, who will use the funds already set aside for this purpose by the owner.

Dr. M. Mishiro (Japan Atomic Energy Agency, JAEA) presented an overview of the Japanese system for management of radioactive waste from isotopes production (RI waste) and waste from research and development facilities (research waste), both of which are managed separately from waste originating from the production of nuclear energy, and for which no disposal route currently exists. Currently, RI waste is collected, party treated, and stored by the Japan Radioisotope Association (JRIA). Research waste is managed by the relevant waste producer (research institute or educational establishment or industry) - there being one dominant producer, the Japanese Atomic Energy Agency (JAEA), the national research and development agency for nuclear research. Taking the two categories of waste together, it is currently anticipated that almost 600 000 200-litre drums will exist by 2048, of which approximately 75% will comprise JAEA waste, 20% will comprise JRIA waste and 5% will comprise waste from small producers. As of March 2005, the total amount of stored waste is equivalent to 446 000 thousand 200-litre drums.

Against this background, the Japanese Government established a Working Group to advise on future strategy in this area, which Group reported in September 2006. Their report proposed that JRIA continued to treat and store RI waste, and the JAEA should treat and store research waste, including waste generated by universities and from private research. Furthermore, the Working Group suggested that JAEA be given overall responsibility for developing and implementing a disposal solution for both categories of waste. As funds have not be set aside to cover the cost of waste disposal, the Group suggested that the Government should establish a Fund using payments from the waste producers, to enable waste disposal activities to proceed efficiently.

The Government of Japan is currently considering its response to the Working Group report. In particular, it is giving consideration to how to establish an appropriate funding scheme, taking account of the absence of existing provisions in the accounts of the research institutes, particularly the JAEA, which is Government-owned. A further topic being considered is whether it will be appropriate for JAEA, being a research organisation, to become responsible for the development of a national disposal facility for RI and research waste.

Dr. R. Hutchings (Permanent Australian Mission to the IAEA) explained the Australian approach to the management of its non-fuel cycle waste and to decommissioning its research reactors, one of which was completely recently and the other two are being decommissioned. The research reactors are operated by the Australian Nuclear Science and Technology Organisation (ANSTO). Dr. Hutchings noted that, although Australia has a substantial uranium mining industry, it does not generate power from nuclear energy. As regards the management of spent fuel from these reactors, current national policy is to send this abroad for processing, i.e. US-origin fuel is returned to the US and UK-origin fuel is currently sent to COGEMA (in France) where it is reprocessed, with the intention that residual waste will be returned to Australia in due course.

Radioactive waste from ANSTO's research activities, stored at its premises in Sydney, amount to about 1 250 cubic metres LLW (solid); 220 cubic metres ILW (solid); 195 cubic metres (thorium and uranium residues) and 6 cubic metres ILW (liquid). It is currently planned to develop a waste management facility for this waste, which will be operated by ANSTO on behalf of the Federal Government. Waste that is not owned by the Federal Government – directly or though its agencies – comes under the jurisdiction of individual States and Territories and, in line with this division of responsibilities, there is currently no comprehensive national inventory of radioactive waste in Australia. Waste under the jurisdiction of the States and Territories cannot be emplaced in the planned surface waste management facility (Common Radioactive Waste Management Facility, CRWMF) and the States will therefore need to develop their own waste management facilities.

A siting process for a near surface repository for ANSTO waste is currently in progress and, under the terms of the Commonwealth Radioactive Waste Management Act (2005), there is provision for local communities to nominate sites within their local areas for consideration. One volunteer site in the Northern Territory has already come forward and will be considered as a potential host location, together with a number of defence properties. Certain long-lived ILW waste will not be suitable for disposal in a surface repository, and will instead remain in storage above ground.

Dr. H. Selling (Dutch Ministry of Housing, Spatial Planning and the Environment (VROM)) explained that all material classified as radioactive waste in the Netherlands is collected, processed and stored at the national waste management facility operated by COVRA – with the exception of material that can be allowed to decay *in situ* because of its short half life. COVRA takes ownership of waste on delivery and acceptance and on payment of an appropriate fee. As COVRA is a State-owned agency, the State ultimately is responsible for the long-term management of the waste, including making up any shortfalls in COVRA's financial provisions. COVRA is also responsible for maintaining a national inventory of radioactive waste.

Disused sealed sources with half lives of less than 100 days are allowed to decay *in situ*; otherwise these are transferred to the national waste facility where they are conditioned in concrete and put into storage. The Netherlands has also established arrangements for management of NORM-bearing waste, which require that waste not suitable for reuse or recycling is also stored at the national waste facility and will subject to the same long-term management arrangements as waste from the nuclear fuel cycle.

As regards decommissioning of non-fuel cycle facilities, it is not planned to introduce specific regulations. Normal licence conditions require that, on shutdown of such facilities, the regulator be notified and waste, including materials contaminated by radioactivity beyond the established clearance levels, be removed from the facility.

Mr. J-M. Potier explained that IAEA had compiled a world-wide inventory of small nuclear facilities, amounting typically to thousands of small facilities in each industrial country and hundreds of facilities in each developing country. On a global scale, several thousand facilities are decommissioned each year, with a significant number of them being in developing countries. The primary focus of relevant IAEA activities is on developing countries with limited infrastructure, though most existing guidance was concerned with large nuclear facilities.

The current priority aim of the IAEA in this area is to raise awareness in developing countries to problems such as the recovery and safe storage of disused radioactive sources, and to provide guidance on best practices for decommissioning and waste management to small users of radioactive material and operators of small facilities. As well as publishing relevant guidance documents IAEA provided direct assistance through the Technical Cooperation Programme and the Nuclear Security Plan. Mr. Potier provided examples of IAEA's direct assistance programme for the recovery and storage of radium from historical applications and of high activity sources; the latter involves the use of a mobile hot cell and the provision of dual-purpose shielded containers, used both for storage and transportation.

Mr. Potier said that insufficient attention had so far been given to the decommissioning needs of small medical, industrial and research facilities, of which there were a very large number worldwide. He encouraged the development of common approaches and the provision of guidance and assistance for the implementation of these approaches. To support this objective, IAEA is proposing to establish an International Decommissioning Network later this year, with the aim of establishing a network of decommissioning projects to facilitate transfer of knowledge and exchange of personnel to gain experience in this field.

Pleanary Discussion

Mr. Arens thanked the presenters and initiated a general discussion on the issues raised in the presentations.

Amongst the issues raised by RWMC members was the lack of a comprehensive system for management of non-fuel cycle waste (including transportation, characterisation, processing, storage and disposal, as well as having in place the necessary funding arrangements), such as exists more commonly for waste from nuclear power applications. In particular, many countries lacked disposal routes for long-lived non fuel cycle waste, with waste being held in various storage facilities often in an unconditioned state. Some countries with both fuel cycle and non fuel waste maintained separate waste management infrastructures for the two waste categories, requiring some duplication of activities.

An issue of particular concern to some RWMC members was the lack of disposal routes for high activity disused radioactive sources, particularly in view of modern-day security concerns. As noted in the IAEA presentation, large numbers of sources were held in various types of storage in developed and in developing countries – in conditioned and in unconditioned states. The work already being done by the IAEA in this area, particularly for developing countries, was noted by the Committee.

The need for good characterisation of waste materials was emphasised. This issue was particularly significant in situations where waste had been in storage for many years. Often, the available information on the physical and chemical characteristics of such waste was much less comprehensive than information collected on current-day waste. It was noted also that the task of characterising waste that has been in storage for several years is often complicated by the deteriorating state of the waste packaging.

The issue of cost recovery, particularly concerning legacy waste and contaminated land, was raised by a number of RWMC members. In particular, it was noteworthy that special arrangements had been put in place in a number of member countries, to enable the cost of recovery of legacy waste to borne by the State where the original owner could not be found or was unable to cover the cost. In addition, some countries recognise that long-term waste-related costs for small users of radioactive material may sometimes be prohibitive; leading to significant risks that waste is not properly managed. In such situations, subsidies are provided by the State in order to minimise such risks. In both cases (legacy wastes and waste from small users of radioactive material), there appear to be limits to the extent to which the ‘polluter pays’ principle can be applied.

As regards the infrastructure for decommissioning of small nuclear facilities, it was suggested that many member countries had gained valuable experience from their decommissioning programmes for nuclear facilities generally. In terms of small facilities, some countries had raised issues about the timely availability of funding, reflecting the fact that many such facilities were research institutions, often State-owned, that did not have in place financial provisions for decommissioning activities. In such cases, the financing would need to come directly from the State budget.

Closing the session, Mr Arens said that several issues had been raised in the presentations and in the ensuing discussion that required further consideration by the RWMC Bureau. He expected that the

Bureau would reflect on these issues in the coming months and would consider what further work items were appropriate for inclusion in future work programmes.

The RWMC Chair also thanked the presenters and the contributors to the discussion. He noted that the Proceedings of the Topical Session would be published in due course.

APPENDIX 1

AGENDA OF THE TOPICAL SESSION ON

APPROACHES AND PRACTICES IN DECOMMISSIONING OF FACILITIES AND MANAGEMENT OF RADIOACTIVE WASTE FROM NON-NUCLEAR FUEL CYCLE-RELATED ACTIVITIES

14 March 2007

14 MARCH 2007

Topical session

Approaches and Practices in Decommissioning of Facilities and Management of Radioactive Waste from Non-nuclear Fuel Cycle-related Activities

Chair: Georg ARENS, BMU (Germany)

Background

Many activities in modern society involve the use of radioactive materials necessitating dedicated facilities for their production, application, and storage. All countries are affected. Regardless of whether or not they are involved in nuclear fuel cycle related activities, ultimately all countries will need frameworks for decommissioning of contaminated facilities and the construction of facilities for radioactive waste management in a manner that does not impact unduly on society in terms of safety and costs. Countries with nuclear power programmes are perhaps more likely to have in place the necessary infrastructure for dealing with non-power wastes. Nevertheless, a general concern exists about whether enough attention has been paid to small users and/or producers of radioactive materials, whether in academia, in medicine or in industry. Legacy waste is also an important issue in some countries. The exchange of the information about experiences of member countries in this area would be beneficial, perhaps allowing, in time, a complete overview of the radioactive waste management system to be provided to policy makers and to the public.

Objective

The aim of this topical session is to explore waste management approaches and practices in decommissioning of facilities and management of radioactive waste in relation to small users and/or producers of radioactive materials from non-fuel cycle activities, whether in academia, in medicine or in industry. Legacy facilities and waste will be covered in a separate topical session to be foreseen in the programme of work of the committee. Information will be exchanged on:

- How have countries organized themselves (legislation, institutional arrangements, etc.)?
- What approaches and practices do they implement?
- What are the lessons to be learnt in terms of successful outcomes and difficulties experienced?

As a result of the topical session an overview of the worldwide practices and approaches will be obtained. Work items for the committee may also be identified.

Process

The RWMC members are asked to provide general country information for the issues identified in the annex to this agenda, in relation to non-fuel cycle-related activities. The text needs not be exhaustive, and a brief coverage of the issues would be sufficient. A few countries will present their approaches and practices also orally to facilitate discussion amongst members. The plan is to document the information made available by member countries and the discussions associated with this topical session.

France:	M-C. Dupuis
Norway:	G. Christensen
Belgium:	C. Cosemans
Japan:	M. Mishiro
Australia:	R. Hutchings
Netherlands:	H. Selling

APPENDIX 2

QUESTIONNAIRE SUPPORTING ITEM 17 OF THE AGENDA OF THE RWMC 40TH MEETING

QUESTIONNAIRE

Issues

- **Framework:** Description of the existing financial, legal and/or regulatory framework, and its workability, for decommissioning of facilities and treatment and disposal of radioactive waste associated with non-nuclear fuel cycle activities.

- **National plan:** The national plan for decommissioning and waste management associated with non-fuel cycle activities, including description of any overlap with the infrastructure for dealing with nuclear fuel cycle waste.

- **Responsible Organisation(s)**: Organisation(s) responsible for non-fuel cycle- related waste management and decommissioning,

- **Packaging**: National technical requirements for waste packaging that are applicable to radioactive waste from non-nuclear fuel cycle-related activities.

- **Waste management treatment facilities and disposal sites**: existing and planned waste treatment facilities and waste disposal sites for waste from nuclear activities not associated with the nuclear fuel cycle.

- **Inventory of generated waste**: the volume and characteristics of the radioactive waste from non-nuclear fuel cycle activities.

- **Data management and data tracking**: Systems established for tracking data, the extent to which data are tracked, and how data reliability is assured, for radioactive waste from non-nuclear fuel cycle activities.

- **Cost estimation**: Practices for estimating the cost of decommissioning, waste treatment and disposal, and the difficulties associated with making accurate estimates, for facilities and radioactive waste associated with non-nuclear fuel cycle activities.

- **Funding**: The existence of funds, and the extent to which the responsibility is that of the state (province) or national governments, for decommissioning of facilities and treatment and disposal of radioactive waste associated with non-nuclear fuel cycle activities.

APPENDIX 3

TOPICAL SESSION ON

APPROACHES AND PRACTICES IN DECOMMISSIONING OF FACILITIES AND MANAGEMENT OF RADIOACTIVE WASTE FROM NON-NUCLEAR FUEL CYCLE-RELATED ACTIVITIES

CONTRIBUTED PAPERS

AUSTRALIA


Australian Government
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Australian Nuclear Science and Technology Organisation
Australia: Managing radioactive wastes and preparing for research reactor decommissioning
Presented by: Dr Ron Hutchings,
Counsellor (Nuclear), Australian Embassy and Permanent Mission to the UN, Vienna
OECD NEA Radioactive Waste Management Committee
14-16 March 2007

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Outline of presentation

- Brief overview of Australia, its nuclear activities and regulatory systems
- Management of spent fuel and radioactive waste
  - ➢Research reactors and their spent fuel
  - ➢Management of radioactive waste
  - ➢Development of waste store and repository
- Approach to future decommissioning of the HIFAR research reactor

Australian Government ansto

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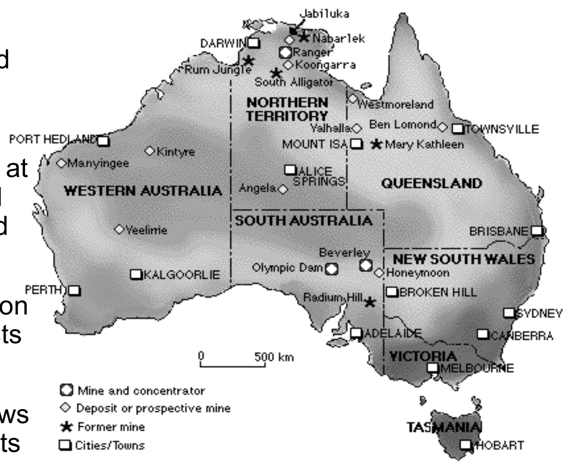
Australia: Overview

- Australia is a **federation** comprising **six states** and **two** self governing **territories**
- Nuclear activities centred at the ANSTO (Sydney) and various past, present (and possibly future) U-mines
- Responsibility for regulation of radiation protection rests with each jurisdiction
- No one set of common laws with common requirements exists



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Regulatory systems

The Australian Government prohibits
- *dealing with controlled material*, or
- *conduct relating to a controlled facility* without a licence.
  - controlled facilities include a nuclear research reactor, a nuclear waste store and a nuclear waste disposal facility.

States and Territories:
- prohibit use of non-exempt radioactive material (including radioactive waste) without a licence, and
- require material and premises to be registered

Australian Government

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Nuclear Reactors and Spent Fuel

Australia has:
- no nuclear power reactors
- 3 research reactors
  - HIFAR – a 10 MW DIDO-type reactor, currently undergoing shutdown
  - Moata – a small Argonaut reactor, shutdown in 1995
  - OPAL – a 20 MW pool reactor, currently undergoing commissioning

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HIFAR

HIgh Flux Australian Reactor

- Heavy Water Cooled and Moderated Tank Reactor

- First Criticality on January 26th 1958
- 10MW (thermal) operation achieved 1960
- 15 year initial design life
- Major refurbishment in late1980's
- Shutdown initiated 30th January 2007

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OPAL

Open Pool Australian Light water reactor

- Multi-purpose research reactor
- Construction licence granted 5 April 2002
- Fuel loading commenced 11 August 2006
- Full operating power, 20MW(th), achieved 3 November 2006

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Spent Fuel Management

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Overview of spent fuel responsibilities

- Australia's research reactors are under the control of an Australian Government* agency, ANSTO
  (Australian Nuclear Science &Technology Organisation)
- Spent fuel management is the responsibility of the Australian Government*
  (*sometimes called the Commonwealth Government)
- Commonwealth facilities are regulated by ARPANSA
  (Australian Radiation Protection & Nuclear Safety Agency)

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Spent Fuel Management Policy

- The Commonwealth is the only jurisdiction that has a requirement to manage spent fuel
- Commonwealth policy is to send spent fuel overseas for processing
  - US-origin fuel returned to the US under the FRR-SNF policy, now extended for fuel irradiated before 13 May 2016
  - UK-origin spent fuel sent to Dounreay (UK) or COGEMA (France) for reprocessing, with waste to be returned to Australia

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HIFAR spent fuel

- Two shipments of spent fuel to Dounreay, UK
- Two shipments to the US
- Four shipments to COGEMA
- Total of 2122 HIFAR fuel elements shipped to date

also

- spent fuel from the Moata reactor, shutdown in 1995, returned to the US as part of the 2006 shipment

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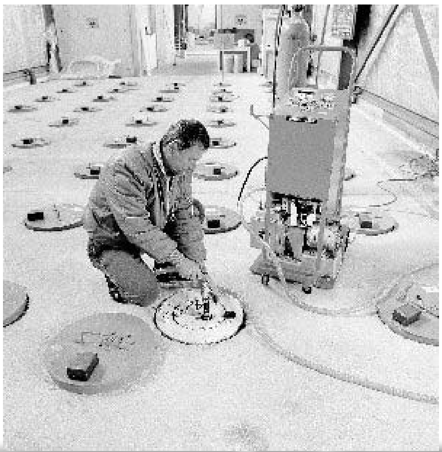
Research Reactor Spent Fuel Management Facilities



Australian Government

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OPAL Research Reactor Spent Fuel Management Strategy

US-origin fuel accepted by the US under the FRR-SNF policy extended for fuel irradiated before 13 May 2016

Fuel irradiated after 12 May 2016, contracts are in place to enable spent fuel to be sent to France for reprocessing

Australian Government

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Radioactive Waste Management

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Radioactive Waste Inventory

Waste stored at ANSTO

Type	Volume	Rate
Low Level Solid	1,249m^3	30m^3/y
Intermediate Solid	221m^3	2m^3/y
Th + U residues	165m^3	- .
Intermediate Liquid	5.7m^3	0.5m^3/y

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Waste Strategy pre-July 2004

- Planned national repository for LILW-SL
  - for use by all government and private sector waste producers
  - site selected, EIS completed
- Planned national store for ILW-LL
  - for use by Commonwealth and, by negotiation, other waste producers
- Successful legal action by South Australian Government stopped repository

Australian Government

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Waste Strategy post-July 2004

- Waste management facility to be developed for Commonwealth use only
  - to be constructed on existing Commonwealth land
  - known as the Commonwealth Radioactive Waste Management Facility, or CRWMF
- States and Territories expected to implement appropriate arrangements for waste within their own jurisdictions

Australian Government

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Commonwealth Radioactive Waste Management Act 2005

- Legislation enacted to override any existing or future Northern Territory laws that could prevent siting or development of CRWMF
- To avoid unnecessary delays due to legal challenges based upon them, Territory laws purporting to ban or regulate the Facility have been disallowed
- All Commonwealth regulatory processes must still be followed
- The legislation enables a community to nominate a volunteer site in its own local area

Australian Government

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Commonwealth Radioactive Waste Management Facility

- Three Defence properties identified in the Northern Territory
- ILW-LL to be stored above ground
- LILW-SL to be disposed of, if a site proves suitable, otherwise also stored
- Site characterisation studies commenced to determine type of facility that may be constructed at each of the three properties
- A volunteer site has also been put forward

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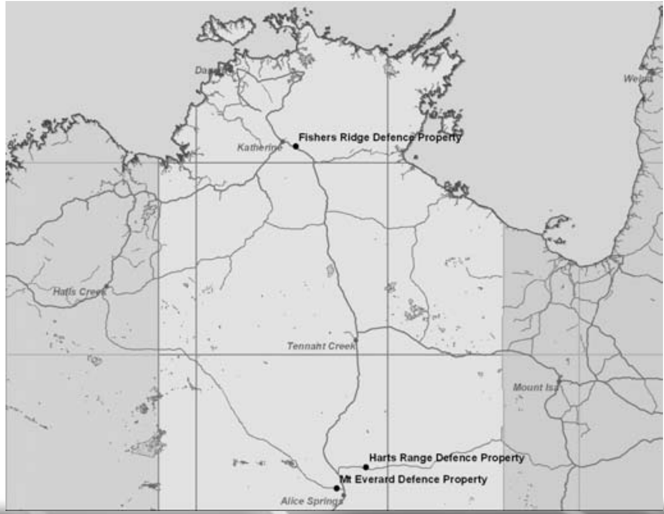
Northern Territory: possible CRWMF Sites



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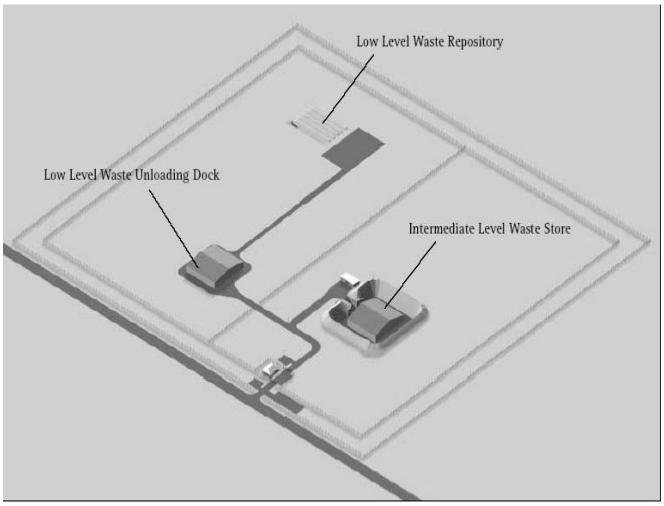
CRWMF repository/store concept



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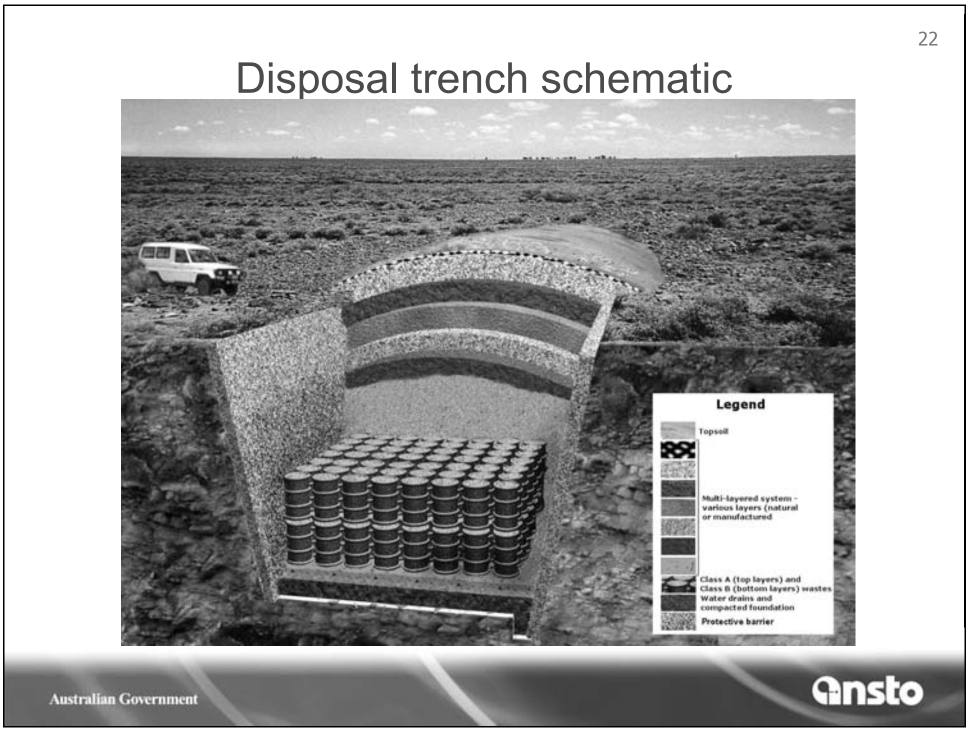
22
Disposal trench schematic
Legend
Topsoil
Multi-layered system - various layers (natural or manufactured
Class A (top layers) and Class B (bottom layers) wastes
Water drains and compacted foundation
Protective barrier
Australian Government
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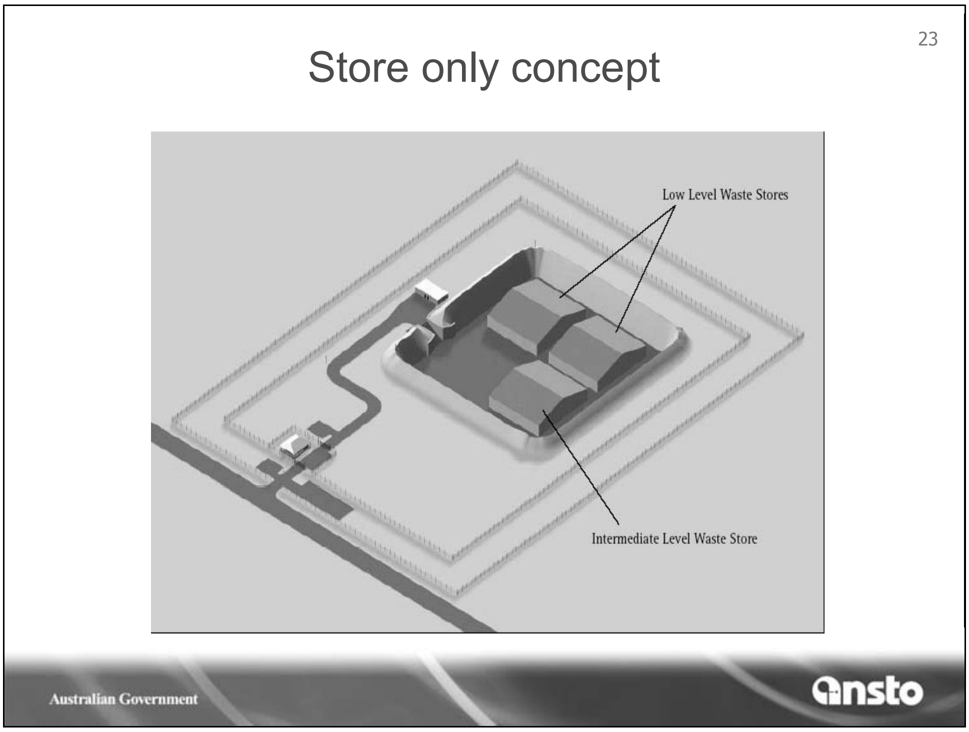
23
Store only concept
Low Level Waste Stores
Intermediate Level Waste Store
Australian Government
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Steps towards establishing the CRWMF

- Contractors have commenced specific site studies
- ANSTO is providing design advice to DEST*, in line with ARPANSA Regulatory Guidance on siting
- Site studies will provide the basis for an EIS
- Site studies will identify aspects of the site that may need to be addressed in the detailed design
- Sites will be ranked in about 12 months
- Detailed design will be developed
- EIS will be prepared
- ARPANSA licensing process will be initiated

*Dept of Education, Science and Tourism

Facility anticipated to be operational by around 2011/12

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Decommissioning

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HIFAR Decommissioning

Preferred strategy:

- Undertake prompt removal of the fuel and heavy water coolant
- Place HIFAR under care and maintenance while detailed planning for the licensing and ultimate demolition is carried out, and
- Dismantle and demolish HIFAR when the CRWF is available and a decay period of approximately ten years has elapsed after de-fuelling.

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Commencing the planning process

- January 2005 working party established to address "Decommissioning at ANSTO"
- Terms of Reference were agreed
- Representatives drawn from across the Organisation
  - Reactor Operations and Waste Operations
  - Technical Services and Facilities Management
  - Safety & Radiation Services, Security, and
  - Executive (incl. external relations specialists)
- Focus on planning the decommissioning of HIFAR

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Preparatory steps

- Determine site requirements for decommissioning
- Collect operating information
- Learn from decommissioning experiences in other countries, especially for similar reactors
- Liaise with other groups with interest in decommissioning, such as:
  - ARPANSA (nuclear safety and radiation protection regulator)
  - Dept of Environment and Water Resource
  - NSW Government bodies and corporations e.g. Dept of Environment and Conservation

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Current best practice
(in accordance with IAEA guidance)

- ***Stage 1.*** Fuel is removed, fluids are drained from the facility and external systems disconnected and removed e.g. the control room and cooling towers
- ***Stage 2.*** Care and maintenance stage, where a regime of monitoring and maintenance remains in place until arrangements completed and a decommissioning licence is issued
- ***Stage 3.*** Decommissioning itself, covering the process of removal of all radioactive and other wastes
- ***Stage 4.*** The final stage, remediation leading to the site being permitted to return to use for other purposes.

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PLAN

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The ANSTO Board has agreed to a three phase approach

Phase A:. Conducted under existing Operating Licence

- Removal of the fuel, CCA's and heavy water
- Preparation for Possess and Control Licence

Phase B: Conducted under the Possess and Control Licence

- Removal of light water cooling circuitry, all electrical circuits and all non-active equipment inside and outside the shell
- Preparation for Decommissioning Licence

Phase C: Conducted under the Decommissioning Licence

- Removal of the reactor block and core.
- Removal of the building (or shell)

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HIFAR Shell (Non nuclear)

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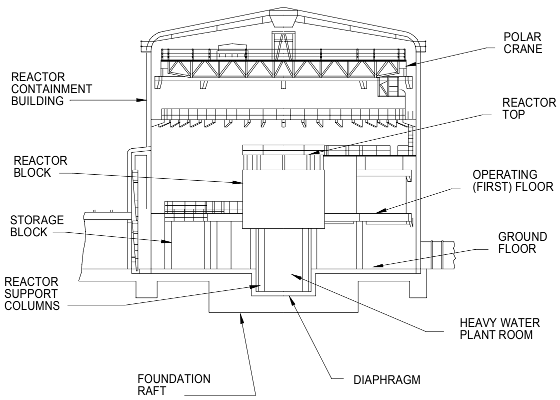

FIGURE 1.1-2 REACTOR STRUCTURE

- Strip out all electrical & instrumentation wiring
- Strip out all light water pipework
- Install AC
- Remove SCS & ductwork
- Removal all non-active material

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Resources and costs

Closure (reactor and storage blocks remain)

- Closure Team (20 people)
- Closure Term (2 yrs) 2007 & 8

Decommissioning 2014+

- Decommissioning Team (20 people)
- Specialist contractors

Data To greenfield site

- ANSTO estimate AUD 50M
- UKAEA £23 million (actual) (AUD 57M)
- Denmark DnK300million (est) (AUD 50M)

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HIFAR status

- Defuelling completed
- Planning well in hand (full time planner)
- Number of minor projects (currently being planned prior to implementation under Possess and Control Licence)
  - Fire detection
  - Radiation monitoring
  - Replacement air conditioning plant
  - Overhaul existing active ventilation system
  - New light and power circuits
- Projects to plan plant dismantling commenced
- Four contract engineers engaged (full time)

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BELGIUM

Policies and practices

Radioactive Waste Management

The foundation of ONDRAF/NIRAS (Belgian Agency for Radioactive Waste and Fissile Materials) on 8 August 1980 is the result of a decision of the Belgian authorities to entrust the management of radioactive waste to one single institution under public control. This was done in order to ensure that the public interest would prevail in all decisions on the subject. This law was modified by the law of 11 January 1991, which also slightly changed the name of the institution to 'Belgian National Agency for Radioactive Waste and Enriched Fissile Materials'.

The tasks and modes of operation of ONDRAF/NIRAS were laid down by the Royal Decree of 30 March 1981 and supplemented by the Royal Decree of 16 October 1991.

In general terms, ONDRAF/NIRAS is responsible for the management of all radioactive waste present on Belgian territory. Its mission is to outline a policy for a coherent and safe management of radioactive waste covering the following aspects:

1) Compiling an inventory of radioactive materials (and enriched fissile materials) and of all sites containing radioactive materials, and assessing the decommissioning and remediation costs of all sites containing radioactive materials (inventory of nuclear liabilities);
2) Compiling an inventory of all radioactive waste streams;
3) Collection and transport of the waste;
4) Processing and conditioning of the waste;
5) Interim storage of all conditioned waste;
6) Long-term management (disposal being the option under investigation);
7) Tasks relating to the management of enriched fissile materials.

ONDRAF/NIRAS has a centralized waste management policy, by making use of processing and conditioning facilities and interim storage facilities centralized on the Belgoprocess sites in Dessel and Mol. Some waste producers have their own processing and conditioning facilities and transfer their conditioned waste to Belgoprocess for interim storage.

More specific tasks assigned to ONDRAF/NIRAS are the following:

- In the Royal Decree of 16 October 1991 one of the missions entrusted to ONDRAF/NIRAS was the qualification of installations for processing and conditioning of radioactive waste. Some issues regarding the practical implementation of the qualification of processing and conditioning installations and of the storage buildings, are laid down in a recent Royal Decree of 18 November 2002.

- Another mission of ONDRAF/NIRAS laid down in the Royal Decree of 16 October 1991 was the establishment of acceptance criteria for conditioned and non-conditioned radioactive waste based on General Rules to be approved by the safety authorities. The set of General Rules was established by ONDRAF/NIRAS, approved by its Board of Directors and by the competent minister, and came into force by ministerial letter dated 10 February 1999.

Concerning the policy of long-term management of low and intermediate-level short-lived radioactive waste, the decision of the Council of Ministers of 16 January 1998 gave ONDRAF/NIRAS the following mission, which consists of five items:

- Limiting the siting activities to nuclear or non-nuclear volunteering sites;
- Finalizing the design studies on surface disposal;
- Finalizing the feasibility studies for deep disposal;
- Developing methods of interaction with different local stakeholders;
- Collaboration with the federal safety authorities (FANC) on safety aspects as well as on the environmental impact.

The decision by the Belgian government in favour of the construction of a surface repository was obtained mid-2006.

For the high-level and long-lived waste, ONDRAF/NIRAS is currently studying deep disposal in a clay layer as the reference option.

As the agency responsible for radioactive waste management, ONDRAF/NIRAS is in charge of all matters relating to the safety of waste management and the protection of the environment in close cooperation with FANC, which is the licensing authority for nuclear installations. A formal agreement organizing all the legal interfaces between the two agencies was signed in 2003 by the Boards of Directors of both agencies and is in force since September 2003. A Commission with members of both agencies and with a rotating chairmanship was created; this Commission coordinates all activities and interactions covered by this agreement.

Management of the decommissioning and dismantling of nuclear facilities

Legal framework

Some aspects concerning the decommissioning of nuclear installations were also entrusted to ONDRAF/NIRAS by the Royal Decree of 16 October 1991, namely the collection and evaluation of decommissioning data in order to establish programs for the resulting waste, the approval of the decommissioning program and the execution of the decommissioning program on the operator’s request or in case of incapacity of the latter.

This mission of ONDRAF/NIRAS was extended with the law of 12 December 1997, by entrusting ONDRAF/NIRAS with the establishment of an inventory of all nuclear installations and sites containing radioactive materials, and with the assessment of their decommissioning and remediation costs.

Policies

Each owner or operator of a nuclear installation is responsible for the future dismantling of his installations, once they have been definitely decommissioned. ONDRAF/NIRAS verifies that the owner/operator takes timely the necessary steps to carry out the dismantling program; the owner/operator must submit his decommissioning program to ONDRAF/NIRAS for approval. The radioactive waste resulting from dismantling is managed by ONDRAF/NIRAS according to the same principles as the waste of other origins. Furthermore, it is part of the missions of ONDRAF/NIRAS to follow up the evolution of the dismantling methodologies and technologies.

From a regulatory point of view, FANC requires early guarantees that appropriate measures are taken for proper waste management. Indeed, the operation license application must include an estimate of the waste quantities that will be produced during dismantling of the installations.

It also requests information on the management of the waste before being transferred to ONDRAF/NIRAS.

When the installation ceases its activities and is to be dismantled, the full procedure for obtaining the required licenses is applicable.

On a legal basis, ONDRAF/NIRAS has to formulate an advice on the aspects within its competence on the license demand for authorization for decommissioning, which is then transferred to FANC by the owner/operator of nuclear installations relating to non-nuclear fuel cycle activities.

If the owner/operator chooses to renounce dismantling ONDRAF/NIRAS can be asked to perform these operations. The ONDRAF/NIRAS legislation has been adapted in 1991.

ONDRAF/NIRAS sees to it that the owners/operators create the necessary provisions for the financing of the future dismantling program.

In 1997, the legal missions of ONDRAF/NIRAS were extended to making an inventory of all nuclear installations and sites where radioactive substances are present. The purpose of this inventory is to map all potential nuclear liabilities in order to detect the occurrence of such liabilities in time and – if possible – prevent them. This inventory is updated every 5 years.

Practices – implementation of the legal requirements

- Decommissioning planning

  To fulfil its legal assignments relating to the collection and evaluation of decommissioning programs of nuclear plants in Belgium, ONDRAF/NIRAS defined and implemented the structure of decommissioning plans, based on the recommendations of the IAEA. This is applicable to the nuclear installations relating to non-nuclear fuel cycle activities.

  An initial decommissioning plan is set up by the licensees for new facilities and facilities in operation for which the end of activities is not planned in the short term. This plan must be reviewed every five years or more frequently in the case of major modifications to the nuclear facility. The final decommissioning plan is submitted to ONDRAF/NIRAS three years before the planned final shutdown of the facility or part of the facility.

Every owner/operator of a nuclear installation relating to non-nuclear fuel cycle activities, excluding the Universities, is currently establishing or has established a decommissioning plan (to be) approved by ONDRAF/NIRAS.

They also concluded an agreement with ONDRAF/NIRAS regarding the legal requirements of the establishment of a decommissioning plan based on the recommendations of ONDRAF/NIRAS.

- Decommissioning programs

  The operator or owner of a nuclear facility may call upon ONDRAF/NIRAS for the execution of his decommissioning program. In this case, ONDRAF/NIRAS concludes an agreement with the operator or owner covering the technical and financial aspects of decommissioning.

Concerned nuclear installations

Description of the Belgian facilities relating to the non-nuclear fuel cycle

The "SCK•CEN" site in Mol, operated by SCK•CEN

SCK•CEN, a foundation under the supervision of the Secretary of State for Energy, is responsible for research and development and the activities of services focused mainly on nuclear safety and radiation protection, on the medical and industrial applications of radiation, and on the end of the nuclear fuel cycle. It has five main installations.

- The "*Laboratory for High and Medium Level Activity*" complex consists of infrastructures for research and physical, chemical, metallographic and mechanical investigations on radioactive materials. It consists of the main building, which includes the laboratories themselves, whose principal major equipment is shielded cells and glove compartments, and additional buildings (ventilation, waste, storage).
- The "*Chemistry*" complex essentially consists of the chemistry and radiochemistry laboratories.
- The Belgian Reactor 1 or "*BR1*", operating since 1957, is mainly a graphite moderated and air cooled reactor, using natural uranium as fuel. The BR1-complex also comprises the VENUS-reactor, a zero power, water moderated reactor using PWR-type pins (UO_2 and MOX) as fuel. VENUS is operational since 1964.
- The Belgian Reactor 2 or "*BR2*", operating since 1963, is a high-flux material testing reactor. Pressurized water moderates and cools the reactor and highly enriched uranium (> 90%) is being used as fuel. The thermal output can reach 125 MW.
- The Belgian Reactor 3 or "*BR3*" was Europe's first operational pressurized water reactor. In 1962, BR3 was connected to the grid. Definitive shut-down took place in 1987 and decommissioning started in 1990 – 1991 with the chemical decontamination of the primary loop.

The "IRE" site in Fleurus, operated by the National Institute for Radioisotopes

IRE, a non-profit company located in the industrial area of Fleurus, comprises several installations of varying importance whose main objectives are the production and processing of radioisotopes for medical and industrial use, as well as the control of the environment.

The "IRMM" site in Geel, operated by the Institute for Reference Materials and Measurements

IRMM is one of the scientific institutes that constitute the "Joint Research Center" of the European Commission. It provides independent scientific and technical advice to the Commission, the European Parliament, the Council of Ministers and the Member States of the European Union. Founded in 1957 within the framework of the Treaty of Rome, IRMM opened its doors in 1960. It is composed of 10 buildings located on a 42 hectares site in Geel and includes five scientific research units and two support groups.

IRMM has the following infrastructure and equipment at its site in Geel:

- a main installation for the production of reference materials in the environmental, biological, clinical, agricultural and industrial fields;
- isotopic mass spectrometers for environmental and nuclear measurements;
- a sterile chemistry laboratory;
- a laboratory for the metrology of radioisotopes;
- a 150 MeV linear accelerator;
- a 7 MeV Van de Graaff particle accelerator.

The installations are the main building, the chemistry building, the mass spectrometry building, the Van de Graaff building, the linear accelerator building, as well as the central water drainage system, which connects the buildings to the central waste water tanks and whose internal surfaces could be contaminated following the activities carried out in the controlled zones of the various buildings.

Other facilities

- **The "NORDION" site in Fleurus, operated by NORDION EUROPE SA**

  NORDION EUROPE SA, a Canadian company with several establishments in Europe, produces radioisotopes for medical use. Since 1990 it has occupied part of the IRE installations, which was leased to it by contract for 30 years, and shares some other installations with the IRE.

- **The "KUL" sites in Heverlee, Kortrijk, Leuven and Louvain-la-Neuve, operated by the Catholic University of Leuven**

  The KUL operates four sites which are to be considered: a site in Heverlee, one in Kortrijk, one in Leuven and one in Louvain-la-Neuve. The site in Leuven comprises in particular two teaching hospitals which belong within the scope: Sint-Raphaël and Gasthuisberg. At the site in Louvain-la-Neuve, KUL operates an installation that uses the beam of one of the UCL cyclotrons.

- **The "UCL" sites in Louvain-la-Neuve and Woluwe, operated by the Catholic University of Louvain-la Neuve**

  UCL operates three sites that are to be considered: one in Louvain-la-Neuve and two in Woluwe; its principal installation being the Cyclotron Research Center at the Louvain-la-Neuve site, which comprises three cyclotrons.

- **The"Erasme Hospital" site in Anderlecht, operated by the Free University of Brussels (French Community)**

  ULB, to which the Erasme Hospital in Anderlecht belongs, operates a cyclotron and several laboratories for nuclear medicine.

- **The "Sart-Tilman" site in Liege, operated by the University of Liege**

  The University of Liège (ULg) operates only one nuclear site, namely Sart-Tilman. On this site, ULg operates two cyclotrons.

- **The "VUB" sites in Anderlecht, Etterbeek, Jette and Rhode-Saint-Genèse, operated by the Free University of Brussels (Flemish Community)**

  VUB operates five sites that are to be considered: one in Anderlecht, one in Etterbeek, two in Jette (of which one of the teaching hospital) and one in Sint-Genesius-Rode.

- **The "IBt" site in Seneffe, operated by International Brachytherapy SA**

  International Brachytherapy SA, which started its activities in 1999, operates a site in Seneffe. IBt manufactures implants for the treatment of cancer of the prostate. This radioisotope is produced in two cyclotrons. IBt also produces Iodine for medical purposes.

- **The "IBA" site in Fleurus, operated by Ionising Beam Applications - RadioIsotopes SA**

  IBA started its activities in 2001 and operates a site with a cyclotron in Fleurus. The IBA site will be converted to a research and development center.

- **The "INW" site in Ghent, operated by the University of Ghent**

  The Institute for Nuclear Sciences (INW) operated a small research reactor, designated as "Thetis". This pool-type reactor started operating in 1967 and the final shut-down dates from 2004. Its main objectives were the production of isotopes and research on the field of activation analysis. Thetis is part of a complex of radiochemical and nuclear laboratories, which also operates a cyclotron and linear accelerators.

Activation models of cyclotrons

The main part of the nuclear installations relating to non-nuclear fuel cycle activities other than those of the SCK•CEN, IRE and IRMM, concerns cyclotrons.

In this respect ONDRAF/NIRAS has validated the determination of cyclotrons concrete activation levels. This is often evaluated on the basis of partial operation records and with a minimum of actual radiological measurements. It is checked with the NORDION and VUB cyclotrons values.

Inventories and lists

As laid down by the Royal Decree of 16 October 1991, one of ONDRAF/NIRAS' main activities is to make up and maintain a qualitative and quantitative inventory of all radioactive waste on Belgian territory. This inventory not only deals with existing waste quantities, but also with future waste, conditioned or non-conditioned, expected to be produced until the end of the Belgian nuclear program. Both operational and decommissioning waste is covered by this inventory. It not only focuses on waste quantities as such, but also on the radiological and chemical characteristics of the waste. Until now, naturally occurring radioactive materials (NORM), technical enhanced NORM (TE-NORM), discharges to the environment, depleted uranium and special fissionable materials considered to be a resource (e.g. plutonium) are excluded from the inventory.

Methodology

The methodology is based on two key elements, namely a waste stream and a questionnaire.

1) Waste stream — A waste stream is a homogeneous waste entity, distinguished by its nuclide content and, to a lesser extent, by its physical and chemical properties. As such, a waste stream is defined by the type of raw waste, its radioisotopic content and its material composition.
2) Questionnaire — As the waste producer represents the main source of all data required by the inventory, ONDRAF/NIRAS developed a questionnaire. The structure of this questionnaire mirrors the layout of the inventory, covering following aspects:
   - general information and waste quantities, including waste type, type of package, physical components and a forecast of future waste production,
   - physical and chemical characteristics of the waste, including density, material content and chemical composition, and
   - radiological characteristics of the waste, focusing on dose rates and radio-isotopic content.

   The waste producers are requested to complete one questionnaire for each waste stream. This questionnaire is available as a computer program, functioning in a Windows environment, and providing a detailed explanation of the answers required.

   Waste streams are the basic elements of the ONDRAF/NIRAS waste classification system. The classification system for conditioned waste consists of four hierarchic levels, each level offering an increasing degree of details regarding the properties of the waste.

1) The “first and top level” consists of two groups which are directly related to the disposal options.
   - The “open group” includes conditioned radioactive waste containing radioisotopes in sufficiently low activity concentrations and with sufficiently short half-lives so that alternative solutions to geological disposal may be considered. Radioactive decay allows this waste to attain a radiological level considered to be insignificant over a period of time compatible with the institutional control of a surface repository (200 to 300 years). This group therefore contains waste for which the

long-term strategic and technical management options (i.e. surface or deep disposal) are open, hence its name.

- The "geological" group includes conditioned radioactive waste containing radioisotopes in such activity concentrations that their permanent isolation from the biosphere is imperative, and therefore constitutes the only ultimate disposal solution. This permanent isolation is currently regarded as achievable by disposal in deep and stable geological formations.

2) The "second level" is made up of "three categories", namely A, B and C. Category A belongs solely to the open group whereas Categories B and C fall under the geological group. Radioactive waste belonging to Category B is defined by exclusion; it does not meet the criteria to belong to Category A, and Category B waste only generates negligible amounts of heat, contrary to the waste of Category C.

3) On the "third level", conditioned waste with similar packaging, storage and potential disposal methods is assigned to "twenty classes" for technical and financial management purposes.

4) Finally, on the "fourth level", the conditioned waste packages are assigned to "waste streams".

As the collection of data requires a systematic and uniform approach, this operation is planned in five stages, using both key elements:

- identification of waste streams by the waste producer,
- completion of a questionnaire for each waste stream by the waste producer,
- evaluation of the information on completeness, coherence and correctness by ONDRAF/NIRAS,
- transformation of data concerning non-conditioned waste streams into results applicable to corresponding conditioned waste streams by ONDRAF/NIRAS, and
- transfer of resulting data into an ONDRAF/NIRAS-database.

All calculations concerning future waste production are based on a number of assumptions, giving rise to the "reference scenario". These assumptions consider the following aspects:

- the fleet of nuclear installations, comprising not only operational facilities and those under decommissioning, but also future installations,
- the operational lifespan of these installations and the duration of the respective decommissioning phases, and
- environmental parameters (i.e. evolution of technical parameters and legal aspects, strategic decisions, etc.)

ONDRAF/NIRAS completed a first data collection cycle in 1998 and a second one in 2003. All results shown below are from this second cycle.

Results

This paragraph shows an overview of some key results from the second data collection cycle for the aforementioned waste producers. The sample data focus on Category A waste, the Category destined for surface disposal.

Volumes

Calculations based on the assumptions used in developing the reference scenario, lead to a cumulative volume of 9.765 m³ of conditioned waste of Category A (Table I).

Table I. **Reference volume of conditioned waste of Category A for the Belgian non nuclear fuel cycle related activities**

	OPERATIONAL [m³]	DECOMMISSIONING [m³]
CEN•SCK	469	5.556
IRE	602	157
IRMM	136	689
OTHERS	632	1.524
TOTAL	**1.839**	**7.926**
	9.765	

This reference volume includes waste in stock on 1st January 2001 and waste forecast to arise after that date until 2070.

Chemical composition

The assessment of the chemical composition is carried out on basis of an analysis of the components of a waste package, i.e. the raw waste, the immobilizing matrix and the primary containment. Results are available on a component level as well as on an elemental level. On the component level, the chemical composition is specified by the material name and the corresponding mass. A material is designated by either an explicit or ambiguous name or a chemical formula. On the elemental level, all materials are broken down into their elementary compositions.

Calculations show that seven components contribute more than 93% to the total mass of the reference volume of Category A waste (Table II).

Table II. **Chemical composition of the reference volume of Category A waste for the Belgian non nuclear fuel cycle related activities (blank = zero or less then 1 ton)**

COMPONENT	OPERATIONAL [ton]				DECOMMISSIONING [ton]				TOTAL [ton]
	CEN●SCK	IRE	IRMM	OTHERS	CEN●SCK	IRE	IRMM	OTHERS	
Concrete	1	0	60	0	4.561	21	860	3.060	**8.564**
Sand	237	314	72	328	2.773	81	344	576	**4.726**
Carbon Steel	111	150	48	119	2.123	81	273	87	**2.993**
Cements	121	160	37	167	1.327	41	175	293	**2.321**
Water	44	59	14	61	486	15	64	107	**850**
Unknown	372	1	50	793	329	23	26	12	**1.605**
Stainless Steel	51	130	6	0	502	27	7	56	**780**
Other Components	89	486	7	16	1.531	84	122	236	**2.571**
TOTAL	1.027	1.299	294	1.484	13.632	375	1.871	4.427	24.409

Concrete, sand and cement account for the bulk of the total mass of Category A waste. This can be explained by following facts:

- A major fraction of Category a waste is generated during the decommissioning phase and concrete is a major component of a nuclear facility,
- The immobilizing matrices consist mainly of concrete and cement.

Radiological contents

The radiological contents of conditioned radioactive waste (i.e. the radio-isotopes and their respective activity concentrations) is a key element in performance assessments and safety evaluations which are carried out for a repository. The inventory of radioactive waste is able to provide these data (Tables III and IV).

Table III. **Radio-isotopic content of Category A waste on 1st January 2001, 1st January 2070 and 1st January 2370 (blank = negligible activity) for the SCK•CEN**

Isotope	2001 [Bq]	2070 [Bq]	2370 [Bq]	Isotope	2001 [Bq]	2070 [Bq]	2370 [Bq]
Am-241	2,0E+09	1,3E+11		Nb-94	1,3E+09	1,3E+10	1,3E+10
Am-243	3,2E+07	3,4E+08		Ni-59	9,7E+13	1,0E+15	1,0E+15
C-14	4,0E+11	4,1E+12	4,0E+12	Ni-63	1,1E+15	7,8E+15	9,8E+14
Cl-36	2,1E+06	2,1E+07	2,1E+07	Np-237	1,9E+07	2,0E+08	2,1E+08
Cm-244	1,4E+10	1,9E+10	2,0E+05	Pu-238	6,2E+09	4,2E+10	4,0E+09
Co-58	8,4E+11			Pu-239	1,1E+09	1,1E+10	1,1E+10
Co-60	3,1E+13	4,7E+11		Pu-240	1,7E+09	1,8E+10	1,7E+10
Cs-134	4,4E+12	1,0E+07		Pu-241	3,6E+11	3,0E+11	2,5E+08
Cs-135	5,2E+10	5,4E+11	5,4E+11	Pu-242	1,9E+06	2,0E+07	2,0E+07
Cs-137	2,7E+12	8,3E+12	8,4E+09	Sr-90	9,1E+10	2,6E+11	1,8E+08
Fe-55	3,0E+12	1,9E+08		Tc-99	2,1E+10	2,2E+11	2,2E+11
H-3	3,9E+15	2,2E+15	9,6E+07	U-234	5,7E+07	6,1E+08	6,2E+08
I-129	8,0E+05	8,3E+06	8,3E+06	U-235	3,9E+05	4,1E+06	4,1E+06
Mn-54	1,7E+12			U-238	1,1E+07	1,1E+08	1,1E+08

Table IV. **Radio-isotopic content of Category A waste on 1st January 2001, 1st January 2070 and 1st January 2370 (blank = negligible activity) for the Belgian non-nuclear fuel-cycle related activities, other than those of the SCK•CEN**

Isotope	2001 [Bq]	2070 [Bq]	2370 [Bq]
C-14	2,5E+11	1,0E+12	1,0E+12
Cl-36	2,9E+10	1,2E+11	1,2E+11
Cs-137	9,7E+09	1,3E+10	1,3E+07
H-3	4,8E+06	1,3E+06	
I-129	9,3E+09	3,9E+10	3,8E+10
Np-237	3,2E+09	1,3E+10	1,3E+10
Sr-90	4,1E+11	5,0E+11	3,5E+08
Tc-99	2,0E+10	8,2E+10	8,2E+10
U-235	3,6E+08	1,5E+09	1,5E+09

The reference date during the second data collection cycle for the Belgian radioactive waste inventory was 1st January 2001, while 1st January 2070 marks the end of the Belgian nuclear program. The year 2370 marks the estimated end of the institutional control phase of the surface repository. The calculations leading to this radio-isotopic content do not only take the radioactive decay of the radio-isotopes into consideration, but also the waste quantities that are produced annually. As such, total activities in 2001 may be smaller than their counterparts in 2070 as the cumulative waste volume increases as a function of time.

The presence of fission products and plutonium- and uranium- isotopes in the radio-isotopic inventory of the waste generated by the SCK•CEN can be explained by the presence of operational research reactors and plutonium-laboratories on the SCK•CEN's site. These installations produce radioactive waste that can be contaminated by alpha-emitters and fission products.

The radio-isotopic inventory of the category A-waste generated by other non-nuclear fuel cycle-related activities than the SCK•CEN also contain such alpha-emitters as ^{235}U and ^{237}Np. This is mainly due to the fact that the IRE-site uses irradiated ^{235}U-targets during the production of radio-isotope generators.

CANADA

Nuclear Power Reactor Sites

Eighteen of Canada's 22 commercial nuclear power reactors are operational, two are beginning refurbished and are scheduled to be restarted in 2009 and 2010, and the remaining two are being prepared for safe storage. Three prototype power reactors (NPD, Douglas Point and Gentilly-1) have been partially decommissioned and put into a safe storage-with-surveillance state pending final decommissioning. These three reactors are owned and managed by Atomic Energy of Canada Limited (AECL), under licences from the regulatory body, the Canadian Nuclear Safety Commission (CNSC). The Douglas Point and Gentilly-1 reactors are located at sites with operational, commercial nuclear power reactors.

Atomic Energy of Canada Limited (AECL) Research Facilities

AECL, which is a Government of Canada Crown Corporation, has conducted nuclear R&D on behalf of the federal government over the past 50 years, resulting in significant legacy waste and decommissioning liabilities at its two research laboratories: Chalk River Laboratories (CRL) in Chalk River, Ontario and Whiteshell Laboratories (WL) in Pinawa, Manitoba. These nuclear legacy liabilities include accumulated waste (buried and stored) and contaminated buildings and land. CRL is operational, whereas WL is shutdown and undergoing active decommissioning.

Regarding WL, the site-wide decommissioning plan was subjected to an environmental assessment under the *Canadian Environmental Assessment Act* (CEAA). The environmental assessment addressed the partially decommissioned WR-1 research reactor and all buildings, infrastructure, waste management areas and affected lands. It was completed in March 2002, and following public hearings in September and November 2002, the CNSC issued a decommissioning licence in December 2002 for a 6-year term. The licence was intended to cover Phase 1 of a three-phase decommissioning plan for the site, and AECL is on track to completing the work by the end of the licence term (December 2008).

At CRL, approximately 20 buildings are shutdown and in various states of decommissioning, including the former NRX research reactor. Some shutdown buildings have been decommissioned and dismantled, whereas other buildings have been decontaminated and made available for other uses. AECL is currently seeking the CNSC's approval to carry out decommissioning work on the former fuel bays associated with the NRX reactor, a heavy water upgrading plant, some facilities formerly associated with plutonium extraction, a wastewater processing plant and a small research reactor. AECL also submitted a site-wide preliminary decommissioning plan for CRL to the CNSC for approval. The plan was considered at public hearings on the renewal of AECL's operating licence for CRL in April 2006 and June 2006. In renewing the licence, the CNSC tribunal stated (in its reasons for decision dated September 2006) that the plan was acceptable, recognizing that the plan will continue to evolve throughout the operating life of the site, and that uncertainties will diminish with each revision to the plan.

In 2006, the Government of Canada reviewed its long-term strategy for dealing with its nuclear legacy liabilities at AECL sites, specifically CRL, WL and the three prototype reactors. A 70-year strategy has been developed that is estimated to cost about $7 billion (2005 Canadian dollars), with a net present value of about $3 billion. On June 2, 2006, the Minister of Natural Resources announced that the Government of Canada had committed $520 million to fund the 5-year, start-up phase of the long-term strategy. The funds will be used to address health, safety and environmental priorities at the sites, including the construction of new, replacement storage facilities for high-hazard wastes and a fourth groundwater treatment facility, accelerate the decommissioning of shutdown buildings and affected lands, and continue required care and maintenance activities. Also, activities to lay the groundwork for future phases of the strategy will be completed, such as the construction of waste characterization facilities and siting and design studies for the necessary waste management facilities. Natural Resources Canada (NRCan), the lead government department for the development and implementation of Government of Canada policy on radioactive waste management, will oversee AECL's implementation of the 5-year plan.

The Minister also announced that public consultations would be carried out, starting in 2007, on the further development of the long-term, 70 year strategy. NRCan and AECL will jointly conduct the public consultations, with NRCan taking the lead role.

Uranium Mining Facilities

Canadian uranium mining companies use environmentally sustainable mining practices, have developed new technologies to manage uranium mill tailings and have successfully decommissioned a number of closed uranium mine sites. For example, Cameco Corporation has developed state-of-the-art, high-tech methods to safely mine the large, high-grade uranium deposits at McArthur River and Cigar Lake. The McClean Lake Mill, operated by Areva Resources Canada, is a state-of-the-art facility that is setting new standards for the entire spectrum of mine waste management, in particular the treatment and underground disposal of uranium mill tailings. In addition to the new technologies employed to improve safety and reduce environmental impacts, the volumes of tailings generated are significantly less than from past mining operations in Canada due to the high grades of the ore bodies.

Uranium mining facility owners are responsible for decommissioning and restoring their mine and mill sites after operations cease. In this regard, Rio Algom and Denison Mines have successfully decommissioned and remediated the extensive Elliot Lake, Ontario uranium-mining facilities that were the centre of Canada's uranium mining industry from the 1950s through to the early 1980s. The mines are licensed and are under active management. Other, smaller historic mine sites in Ontario, Saskatchewan and the Northwest Territories have also been decommissioned. All sites remain under the regulatory control of the CNSC.

All operating uranium mines in Canada are located in Northern Saskatchewan, and are licensed by the CNSC. The Cluff Lake mine site is the first of the current generation to move into decommissioning. Areva Resources Canada received a decommissioning licence for the site from the CNSC in July 2004, and plans to complete active decommissioning work in 2006.

In instances where remedial actions are required at uranium-mine and mill-tailings facilities where the owner no longer exists, the Government of Canada and provincial governments ensure that the sites are safely decommissioned. In Ontario, home of the former Elliot Lake uranium mining complex, the governments of Canada and Ontario have entered into a Memorandum of Agreement outlining their roles in the management of “abandoned” uranium mine and mill tailings. Best efforts are made to identify the uranium producer or property owner of the site. Where such an owner cannot be identified, the governments have agreed to share costs, including a 50/50 sharing of costs associated with any necessary remediation. To date, these arrangements have not been necessary as all Ontario sites have owners that are complying with their responsibilities.

In June 2005, the Government of Canada announced that it would share the costs of remediating certain cold war era uranium mine sites, principally Gunnar and Lorado, in northern Saskatchewan with the Government of Saskatchewan. The companies that operated these mines in the 1950s and 1960s no longer exist, and the regulatory framework in place at the time they were closed was not sufficient to ensure adequate treatment and containment of the waste. The project will be carried out in three phases. Phase 1 will last a minimum of two years and consists of an environmental assessment under the CEAA and an application to the CNSC for a project licence. Phase 2, which will last at least three years, involves the actual site clean-up. Phase 3 consists of monitoring the site to ensure the waste produced as a result of the mining activity is properly treated and managed.
A Memorandum of Agreement is being developed between the two governments to define roles and responsibilities in the remediation of these legacy uranium mining and milling sites. Although the private sector companies that operated the mines no longer exist, a private land owner of a portion of the Lorado site will contribute to the clean-up costs.

Other Facilities

A former research laboratory at Tunney’s Pasture in Ottawa has been decommissioned, and the site has been released for unrestricted use. The University of Toronto has completed decommissioning of its sub-critical assembly, and the facility is no longer licensed. In addition, the University’s SLOWPOKE II research reactor has been decommissioned, and the building that housed the reactor has been decontaminated to levels permitting unrestricted use.

There are five SLOWPOKE reactors in operation in Canada. During the past year, the operator of the Dalhousie University (Nova Scotia) SLOWPOKE reactor approached the CNSC to discuss the process for decommissioning the facility. However, the formal process for decommissioning, including an environmental assessment under the CEAA and a licence application, has not yet been initiated.

The Bruce Heavy Water Plant was demolished by Ontario Power Generation between 2004 and early 2006. It was subjected to a comprehensive environmental assessment under the CEAA, and the work was performed under a CNSC Decommissioning Licence and a Detailed Decommissioning Plan. Approximately 97% of the materials arising from the demolition were metals sent for recycling. Pre-demolition and demolition-phase environmental monitoring indicated no adverse environmental impacts from the decommissioning project.

Purpose/Objectives of D&D

Under the *Nuclear Safety and Control Act*, licensees are required to develop decommissioning plans for their nuclear facilities. The licensee proposes when decommissioning should start and end, and the planned end state after the completion of decommissioning activities. The CNSC has the authority to either accept these proposals, or require their modification prior to licensing, subject to the requirements for environmental assessment under the CEAA. Depending on the licensee's proposal and supporting comprehensive safety case, the strategies that could be permitted by the CNSC include immediate dismantling, deferred dismantling, safe enclosure, or any combination of these. The time scales for planned safe storage intervals at nuclear facilities in Canada are generally in the range of a few decades.

The proposed end state of decommissioning varies from site to site. Some sites, notably most uranium mine sites and some other waste management sites, will be under permanent institutional control. That is, it will never be possible to release these sites for unrestricted use, and they may be regarded as indefinite safe storage sites. The projected decommissioning plans for many other large nuclear facilities are based on a planned end state of use for conventional industrial purposes. Some smaller facilities, including research reactors at locations such as universities, have been or will be cleared for unrestricted use.

Social and Environmental Impacts

The social and environmental issues that are of most interest to communities in the locality of decommissioning sites can vary considerably. Nevertheless, there are several issues that are common to a variety of such situations.

Among the issues of common concern are health impacts of releases and effluents, both during and subsequent to the decommissioning activity. In addition to such routine releases, the risks from possible accidents, both during and after decommissioning, are also of great interest to the community. Environmental impacts of interest include effects on water quality and effects on wildlife, such as fish in water bodies that might receive runoff from the decommissioned site.

Communities where nuclear facilities are located may be willing to accept that wastes and other remnants of the former facility remain in the community after the facility ceases to operate, but they are often unwilling to accept wastes from other locations. In some cases communities have expressed concern about the perceived stigma associated with the storage of radioactive waste near their communities, and any residual contamination from past operations and activities, and the potential impacts on property values. In some communities, ways are sought to make positive use of the sites of former facilities, for example for recreational purposes. An example of this might be the proposed use of the former head frame from a mine as a tourist attraction.

Employment is another issue, both in terms of the loss of employment after the original facility shuts down, and employment opportunities during the decommissioning work.

Competent Bodies and Roles

The nuclear fuel cycle industry is primarily composed of four utilities (Hydro-Québec, Bruce Power, Ontario Power Generation, New Brunswick Power), the Nuclear Waste Management

Organization, and uranium processing companies including uranium mining and milling (Cameco Corporation and Areva Resources Canada), refining (Cameco Corporation) and fuel fabrication (Canada General Electric and Zircatec Precision Industries). Atomic Energy of Canada Limited (AECL) is a Crown Corporation that designs, markets, sells and builds Canadian-designed CANDU power reactors, MAPLE research reactors, and MACSTOR waste storage modules. In addition, AECL has ongoing research and development programs that support operating CANDU stations.

With the exception of some legacy sites whose use predated the current regulatory system and for which an owner no longer exists, the organization responsible for decommissioning is the operator/owner of the facility. In cases of deferred decommissioning, the original operator, or a successor organization, continues to hold a licence for the facility and be responsible for meeting regulatory requirements, including those for financial guarantees. In the event that an operator becomes unable to meet its financial commitments for decommissioning, the regulator may draw upon a financial guarantee established by the operator to maintain safety and to complete the decommissioning process.

The Government of Canada recognizes the important contribution of the nuclear industry as well as the need to ensure safety, security, public health and the protection of the environment. Against this background, policies, legislation and regulations have been put in place in order to provide appropriate direction and oversight of decommissioning and radioactive waste management in Canada. Natural Resources Canada is responsible for the development and implementation of Canadian government policy on uranium, nuclear energy and radioactive waste management issues. The CNSC is the federal body for the regulation and oversight of all life-cycle stages of nuclear facilities, including decommissioning, as well as for other uses of radioactive materials. Natural Resources Canada also provides oversight, particularly through its Nuclear Fuel Waste Bureau, which administers the *Nuclear Fuel Waste Act*. Environment Canada, Health Canada, and Transport Canada also contribute to federal oversight. The federal agent charged to carry out clean-up operations for historic waste is the Low-Level Radioactive Waste Management Office (LLRWMO).

The CNSC operates under the terms of the *Nuclear Safety and Control Act*. The Commission consists of a seven person Tribunal which conducts public hearings for applicants and licensees to present information to the Tribunal for consideration and decision-making. The Tribunal also receives recommendations and information from CNSC staff as well as submissions from external interveners.

The CNSC makes regulations and issues licences for the siting, construction, operation, decommissioning and abandonment of nuclear facilities. This licensing process is comprehensive and is based on the licensee making a safety case for its intended activities, including requirements to maintain resulting effects on the environment and humans as low as reasonably achievable. The CNSC also coordinates the input of various other federal and provincial regulatory agencies with relevant/applicable requirements in establishing the licensing conditions for operations at and decommissioning of nuclear facilities.

The conditions for licence termination (licence to abandon) will be established by the CNSC on a licensee/site-specific basis. The CNSC has the responsibility to approve the conditions for release and/or continued control. The conditions for release may in some cases include arrangements for the establishment and funding of institutional controls under the auspices of a provincial or other level of government.

Funding arrangments

The responsibility for paying for the costs of construction, operation and decommissioning of any nuclear facility rests with the licensee (owner/operator). In order to ensure that the costs of decommissioning will be funded, the CNSC has the power to require financial guarantees of its licensees. The CNSC exercises this power for any licensed activities where the expected cost of decommissioning is considered high enough to warrant requiring a guarantee. A prerequisite to establishing a financial guarantee is establishment of the amount of that guarantee, which in turn is based on an estimate of decommissioning costs. This estimate is part of the preliminary decommissioning plan required in support of a licence application for any nuclear facility. As these plans are received, they are reviewed and cost estimates agreed upon. Subsequently, the licensee is requested to propose financial guarantee arrangements to cover the full amount of the accepted decommissioning cost estimates. Once these arrangements are acceptable to the Commission, they are referenced in the construction or operating licence.

CNSC regulations require information to be submitted on decommissioning plans and financial guarantees. The decommissioning plans need to clearly present the proposed decommissioning strategy and final end-state objectives. The CNSC's expectations on these matters are presented in Regulatory Guidance Documents. Two key documents, both issued in June 2000, are G-219, "Decommissioning Planning for Licensed Activities" and G-206, "Financial Guarantees for the Decommissioning of Licensed Activities". These guides as well as other regulatory documents and information can be found at the CNSC's web site: http://www.nuclearsafety.gc.ca.

The creation of a financial guarantee does not relieve the operator of its responsibility to pay for the entire cost of decommissioning its facility. The power of the regulator, to use the proceeds of a financial guarantee to pay for the cost of decommissioning by a third party, would be used only in the event that the licence holder became unable to meet its financial obligations.

Decommissioning Techniques and Inspection

Prospective licensees for decommissioning projects in Canada are free to propose the techniques they consider to be most appropriate for their particular situation. Techniques and equipment used for decommissioning, decontamination and dismantlement are regulated in the same way as techniques and equipment used during operations. The use of new technologies could be permitted by a licensee after review and acceptance by the CNSC of the proposed technology in the overall final safety/decommissioning plan. If the technology was not mentioned in the plan, the licensee would be required to make a safety case for its approval by the CNSC. A licence amendment might be required if the changes to approved activities were significant.

The CNSC has a comprehensive compliance program in place. This program includes, as appropriate, periodic inspections of all licensed activities. Such inspections are conducted and would be conducted during all periods/phases of the licensed process, including decommissioning and safe storage. The comprehensive CNSC inspection program and the various radiation protection, quality assurance and contingency programs implemented by the licensee and modified with approval by the CNSC as required, are intended to ensure that the risks associated with the decommissioning process are managed appropriately.

The CNSC establishes through an audit inspection by its own staff whether the site has met the agreed criteria and consequently whether it can be released for restricted or unrestricted use. After the release of the licensee from responsibility for the site/activity, the records required by the regulator would be kept using appropriate government archive mechanisms.

Radioactive Waste Management

In July 1996, the Government of Canada announced its *Radioactive Waste Policy Framework*. The Framework sets the stage for the further development of institutional and financial arrangements to implement long-term management of radioactive waste in a safe, environmentally-sound, comprehensive, cost-effective and integrated manner. The federal government has the responsibility to develop policy, to regulate, and to oversee radioactive waste producers and owners in order that they meet their operational and funding responsibilities in accordance with approved long-term waste management plans. It is recognized that there will be variations in the general approach for the different waste types, i.e., nuclear fuel waste, low-level radioactive waste and uranium mine and mill tailings.

Health, safety, security and environment aspects of all radioactive waste, whether ongoing or historic, are regulated under the *Nuclear Safety and Control Act* as administered by the federal regulator, the Canadian Nuclear Safety Commission (CNSC). The CNSC's Regulatory Policy entitled *Managing Radioactive Waste* (July 2004) expresses the philosophy and principles used by the CNSC in regulating radioactive waste, and is fully consistent with the Government's *Radioactive Waste Policy Framework*. All radioactive wastes, except for those discharged to the environment under the terms of licence conditions relating to authorized releases, are stored and managed under conditions permitted by a licence issued by the CNSC. Waste materials resulting from decommissioning may also be released for unrestricted use, conventional disposal, recycling, etc.; in each case pursuant to licence conditions set by the CNSC.

The CNSC is currently developing an integrated approach to the assessment of proposals by licensees to release materials via all routes and pathways from licensed activities. This integrated approach will take into consideration current proposals and practices for clearance criteria under discussion internationally.

Nuclear Fuel Waste

In Canada, irradiated fuel taken out of nuclear reactors at the end of its useful life is considered as waste. There are no plans to reprocess and recycle this fuel, so current plans are based on direct long-term management of the nuclear fuel waste.

Nuclear fuel waste includes the irradiated fuel bundles that come from the 22 CANDU reactors in Canada: 20 owned by OPG, and the other two owned by Hydro-Québec and New Brunswick Power. In addition, AECL produces a small amount of waste from its prototype and research reactors. OPG owns about 90 % of the total amount of waste, the other two nuclear utilities about 4 % each, and AECL 2 %. Other waste owners, e.g., universities, produce a much smaller quantity of nuclear fuel waste.

In total, about 1.5 million bundles of nuclear fuel waste are currently in safe storage at the reactor sites, where it can be kept for decades, in pools or in dry concrete canisters. Canada's entire nuclear power program produces about 60 000 bundles annually.

In 2002, Parliament passed the Nuclear Fuel Waste (NFW) Act which established the legal framework for the long-term management of nuclear fuel waste in Canada. The Act requires nuclear utilities to form and maintain a Nuclear Waste Management Organization (NWMO) with a mandate to propose to the Government of Canada approaches for the long-term management of nuclear fuel waste, and to implement the approach that is selected by the Government. The NFW Act also requires the utilities and AECL to establish trust funds to finance the implementation of the selected long-term nuclear fuel waste management approach.

The NFW Act requires the NWMO to submit to the Government by November 15, 2005 a study setting out its proposed approaches for the long-term management of nuclear fuel waste, and its recommendation on which proposed approach should be adopted. The NFW Act requires the NWMO to include in the study approaches based on both storage (on-site or centralized) and disposal. In carrying out the study, the NWMO must consult with the general public on each of the proposed approaches. The NWMO must also create an Advisory Council whose role is to examine and provide written comments on the NWMO's program activities. The Advisory Council's membership must reflect technical and social sciences expertise and, once the Government of Canada has selected the general approach, representation from affected local and regional governments and Aboriginal organizations.

On November 3, 2005, the NWMO submitted its study to the Minister of Natural Resources. The government is carefully reviewing the study of recommendations and expects to make a decision in the best interests of Canadians.

Low-Level Radioactive Waste

All low-level radioactive waste in Canada is presently stored. AECL provides a waste storage facility for small producers on a fee-for-service basis. To date there has been no pressing need for early disposal; volumes are small and the waste is being safely stored on an interim basis.

The major nuclear utility in Canada, OPG, and AECL together produce about 70% of the annual volume of low-level radioactive waste in Canada. OPG's low-level radioactive waste is safely stored on an interim basis at the Western Waste Management Facility at the Bruce Nuclear Power Development (BNPD). In April, 2002, OPG and the Municipality of Kincardine signed a Memorandum of Understanding (MoU) to jointly study options for the long-term management of the wastes at the BNPD site. The MoU led to a decision by the municipality to host, under the terms of an agreement with OPG, a deep geological repository for OPG's current and future low-level and intermediate- level radioactive waste from its 20 power reactors, including the waste that will be generated when those reactors are decommissioned. The proposal will undergo environmental assessment and regulatory reviews. OPG's targets are to commence construction of the deep geologic repository in 2013, with the first waste being emplaced in 2017.

The other major ongoing producer of low-level radioactive waste, AECL, stores the waste it generates in in-ground and above-ground structures. NRCan and AECL have jointly compiled an inventory of radioactive waste and decommissioning liabilities and developed a comprehensive and proactive strategy to decommission and restore AECL's research sites over a 70 year period. The strategy includes the construction and operation of the infrastructure required to characterize, treat and manage over the long-term all of AECL's low-level radioactive waste. The Government of Canada has recognized the net present value (about $3 billion) of the estimated cost of the strategy in the Public Accounts of Canada, and announced the initiation of the 5-year, $520 million start-up phase on June 2, 2006.

The bulk of historic low-level radioactive waste in Canada is located in the area of Port Hope in Ontario. In March 2001, the Government of Canada and the local municipalities where the historic wastes are located entered into an agreement, the Port Hope Area Initiative (PHAI), for the clean-up and long-term management of these wastes. Canada's agent for the management of historic waste, the Low-Level Radioactive Waste Management Office (LLRWMO) which was established in 1982, is the proponent for environmental assessment and review of the PHAI and is responsible for its implementation.

The PHAI will involve the cleanup and consolidation of the wastes and long-term management in newly constructed above-ground mounds in the local communities. The project will take roughly twelve years to complete. The first phase of the PHAI is an environmental assessment and regulatory review that is expected to be completed in 2008. Ongoing public consultation remains a priority and municipal consent will be necessary to move into the next phase. Cleanup, waste facility construction and waste emplacement would take place in the following five years, after which the facilities would continue to be monitored and maintained over the long-term.

Uranium Mine and Mill Tailings

At present, all active uranium mining sites are situated in northern Saskatchewan. With respect to inactive sites, most are found in the Elliot Lake area of northern Ontario which was the major uranium mining center in Canada for over 40 years. Since the last facility closed in 1996, uranium mining companies have committed over $75 million to decommission all mines, mills and waste management areas.

The CNSC continues to oversee a program to bring all inactive sites in Canada under regulatory control where appropriate and necessary.

Public Information

In Canada, public participation in decision-making processes continues to be a high priority. All major stakeholders carry out public affairs programs. Various pieces of legislation at the federal level incorporate mandatory public participation processes. The body of legislation is recognizing the increasing role of the public in decision-making processes, especially with respect to social and ethical considerations. For more information, Web sites of main stakeholders are listed below.

Uranium and Nuclear Industry:

Hydro-Québec: www.hydroquebec.com

Ontario Power Generation: www.opg.com

New Brunswick Power: www.nbpower.com

Bruce Power: www.brucepower.com

Atomic Energy of Canada Limited: www.aecl.ca

Nuclear Waste Management Organization: www.nwmo.ca

Cameco Corporation (uranium mining): www.cameco.com

Areva Resources Canada (uranium mining): www.cogema.ca

General Electric Canada: www.ge.com/canada

Zircatec Precision Industries: www.zircatec.ca

Canadian Nuclear Association: www.cna.ca

Federal Government Bodies:

Canadian Nuclear Safety Commission: http://www.nuclearsafety.gc.ca

Nuclear Fuel Waste Bureau: www.nfwbureau.gc.ca

Natural Resources Canada: www.nrcan.gc.ca and http://nuclear.nrcan.gc.ca

Low-Level Radioactive Waste Management Office: www.llrwmo.org

Canadian Environmental Assessment Agency: www.ceaa.gc.ca

Environnement Canada: www.ec.gc.ca

Health Canada: www.hc-sc.gc.ca

Transport Canada - Transport Dangerous Goods Directorate: www.tc.gc.ca/tdg/menu.htm

CZECH REPUBLIC

Issues

Framework

Description of the existing financial, legal and/or regulatory framework, and its workability, for decommissioning of facilities and treatment and disposal of radioactive waste associated with non-nuclear fuel cycle activities.

The legal framework for decommissioning of facilities and treatment and disposal of radioactive waste associated with non-nuclear fuel cycle activities is given by the Act No. 18/1997 Coll., "on Peaceful Utilization of Nuclear Energy and Ionizing Radiation (the Atomic Act)", as amended, and its implementing regulations, issued by the State Office for Nuclear Safety.

The Atomic Act stipulates the general provisions concerning nuclear safety, radiation protection; duties of licensees, institutional framework, etc., while the detailed requirements are defined in the implementing regulations. The act and the regulations contain also the provisions on assuring financing of waste management and disposal, as well as for decommissioning of the facilities.

The most important implementing regulations for above mentioned field are:

- Decree No. 307/2002 Coll., "on Radiation Protection",
- Decree No. 185/2003 Coll., "on Decommissioning of Nuclear Installations or Category III. or IV. Workplaces", and
- Decree No. 224/1997 Coll., "on Payments of Radioactive Waste Producers to the Nuclear Account".

National plan

The national plan for decommissioning and waste management associated with non-fuel cycle activities, including description of any overlap with the infrastructure for dealing with nuclear fuel cycle waste.

The Czech Government, in May 2002, has approved the "Concept of Radioactive Waste and Spent Nuclear Fuel Management that is a fundamental document formulating government and state authority strategy for the period up to approximately 2025 (affecting policy up to the end of the 21st century), concerning the organizations which generate radioactive waste and spent nuclear fuel. The Concept covers all waste regardless they are generated from nuclear cycle facilities or institutions out of the cycle. It concerns also waste from decommissioning, but does not include the decommissioning itself.

Responsible Organisation(s)

Organisation(s) responsible for non-fuel cycle- related waste management and decommissioning,

The facility owner (operator) is responsible for:

- the waste collection, treatment, conditioning and their financing, including financing of its disposal, and
- planning, preparation, realization and financing of decommissioning.

Conditioning of waste could provide only person with the particular license.

Disposal of all radioactive waste, generated in the Czech Republic, is in the responsibility of RAWRA.

Packaging

National technical requirements for waste packaging that are applicable to radioactive waste from non-nuclear fuel cycle-related activities.

The technical requirements for waste packaging concerning transport are laid down in the regulation No. 317/2002 Coll., on Type Approval of Packaging Assemblies for Transport, Storage and Disposal of Nuclear Materials and Radioactive Substances, on Type Approval of Ionizing Radiation Sources and on Transport of Nuclear Materials and Specified Radioactive Substances. Technical requirements concerning conditioning and packaging before the waste package disposal, is defined in acceptance criteria for the particular repository proposed by RAWRA and approved by SONS.

Waste management treatment facilities and disposal sites

Existing and planned waste treatment facilities and waste disposal sites for waste from nuclear activities not associated with the nuclear fuel cycle.

There is not any official centralized treatment facility established. Some of the waste generators have a license for treatment,, conditioning and/or transport of RW, and they provide services for the waste generators, which do not have the relevant license, on a commercial basis. The disposal of RW is in responsibility of RAWRA, which operates three LILW repositories; i.e. Richard and Bratrství for the institutional waste and Dukovany for both, the operational waste from NPP and waste from institutions out of nuclear fuel cycle (like hospitals, etc.).

Inventory of generated waste

The volume and characteristics of the radioactive waste from non-nuclear fuel cycle activities.

The waste are divided in three categories:

- LILW that are in compliance with the acceptance criteria for the repositories Richard or Dukovany (except of limitation of alpha emitters they have limited content also of some critical radio-nuclides, e.g. H^{3}, C^{14}, Cl^{36}, Sr^{90}, Tc^{99}, I^{129}, Cs^{137}) – this waste is disposed at the relevant repositories. Annual production of that waste is approximately 60 m^3. This waste contains laboratory waste, contaminated material from dismantling of equipment an disused sealed sources.

- LILW that are not in compliance with the acceptance criteria are accepted for storage at the Richard repository with intention of its future disposal in deep geological repository. Majority of this category waste are disused sealed sources or waste containing nuclear material that is under surveillance. Annual production of that category is in average 10 waste packages.
- LILW – LL that contains solely naturally occurring radio-nuclides, i.e. Ra, U, Th, limited in acceptance criteria for the Bratrství repository. Annual production varies from 1 – 10 m3.

Data management and data tracking

Systems established for tracking data, the extent to which data are tracked, and how data reliability is assured, for radioactive waste from non-nuclear fuel cycle activities.

Each transfer of waste among the waste generators is registered using so called waste package passport, at which contains all important data concerning waste (i.e. radio-nuclide content, surface contamination, surface exposure rate, type of waste, etc). RAWRA operates a database where all records of accepted waste packages are stored. Recently there is in final stage of development an on line electronic Waste Tracking System that will allow more detailed tracking on waste generated and transferred from one waste generator to the another.

Cost estimation

Practices for estimating the cost of decommissioning, waste treatment and disposal, and the difficulties associated with making accurate estimates, for facilities and radioactive waste associated with non-nuclear fuel cycle activities.

According the Atomic Act and decree on decommissioning, each relevant licensee is obliged to prepare a plan for decommissioning of its facility with cost estimation. The cost estimation is subject of review and approval by RAWRA. The plan for decommissioning approves the State Office for Nuclear Safety. In general in the case of the Czech Republic there are no difficulties with making the estimates, as majority of the facilities is very simple. Concerning the waste, RAWRA issues annually updated fees for disposal of the waste, depending on the waste type.

Funding

The existence of funds, and the extent to which the responsibility is that of the state (province) or national governments, for decommissioning of facilities and treatment and disposal of radioactive waste associated with non-nuclear fuel cycle activities.

According the regulations – each licensee creates, during the operational period, its own fund for the future facility decommissioning. RAWRA inspects the creation of the funds of each licensee.

DENMARK

Non-nuclear waste

Non-nuclear waste generated in Denmark is divided into two types;

- Industrial waste consisting of disused sources from industry, medical use and research including orphan sources.
- Naturally Occurring Radioactive Material (NORM) from the oil and gas production in the Danish sector of the North Sea.

Industrial waste

The route for disposal of sealed sources is regulated in the Order on the use of industrial radiography and in the Order on use of sealed radioactive sources. The Orders list two ways to dispose of sources; storage at the waste management plant at Danish Decommissioning or returning of the sources to the manufacturer.

Waste from the use of unsealed sources from laboratories and hospitals are regulated through the Order on the use of unsealed radioactive sources. Solid waste can be combusted at an incinerator plant if such waste fulfil certain requirements regarding maximal activity and can be packed and transported to the plant as expected packages. Liquid waste from laboratories and hospitals where the concentration does not exceed 0.1 MBq/l can be disposed of through the sewerage. Liquid waste that does not fulfil these requirements must be disposed of at Danish Decommissioning.

Denmark is in the process of establishing a national repository for low and intermediate level waste and all waste that is stored at Danish Decommissioning will eventually go to this national repository.

Orphan sources

There have been a few incidents with orphan sources in Denmark over the last years. All incidents have been in the recycling industry and at scrap yards. None of these incidents have been severe. Larger scrap yards have on voluntary basis installed portal detectors and/or handheld radiation monitoring instruments.

Cases with radioactive sources in scrap are dealt with on a case by case basis. If the National Institute of Radiation Hygiene (NIRH) estimates that there is no immediately health risk by storing or handling the radioactive item, scrap dealers are asked to dispose of the item themselves. This can be done if the radioactive item is already known by NIRH or if the scrap dealers have already measured a dose rate from the item. If NIRH is not certain that there is no immediately radiation hazard, we will make an inspection as soon as possible. NIRH can be reached at all times on the 24-hour emergency telephone service. The health physicist on duty is equipped with hand held radiation monitoring instruments, shielding, and various radiation protection equipments.

Disposal of orphan sources can only be done by sending them to the waste management plant at Danish Decommissioning. If the owner can not be located, or if no one else can be made responsible for the source, the State guaranties for safe handling and storage of orphan sources.

Problems with orphan sources

Until now all orphan sources in Denmark have been found by the recycling industry and at scrap yards. The main problem is that not all companies that deal with recycling of metal are able to screen for radioactivity. Small yards normally sell to larger yards or smelters. This makes it more difficult to locate the original owner of radioactive items. In each incident NIRH do as much as possible to locate the original owner of orphan sources.

NORM

NORM mostly originates from the oil and gas production in the Danish sector of the North Sea. The waste occurs in two main forms;

1. As mineral scales and sludge of particulate scale containing mainly radium and its decay products.
2. As thin coatings in gas and condensate processing equipment, mainly containing decay products of Rn-220 as Pb-210 and Po-210.

The waste is handled by the operators of the oil-production fields or by subcontractors.

There are three ways the waste has been dealt with so far. There is no final solution for NORM waste in Denmark.

1. NORM from cleaning of gas pipes is received at the waste management plant at Danish Decommissioning. This waste is only a small amount of the combined NORM production. Danish Decommissioning is at the moment not able to receive larger amounts of scale and sludge.
2. Sludge and scale from oil- and gas production have in two cases been re- injected into abandoned wells at the same production facility as the waste has been produced. Re-injection of NORM requires a licence from NIRH.
3. The remaining NORM that has been brought on land is stored at temporary storage sites. These sites are maintained by the oil companies or con- tractors and licensed by NIRH.

Problems with NORM

The main problem with storage of NORM is that there is no national facility for handling and disposal of waste.

FRANCE

Management of diffuse nuclear waste[1] in France

France's National Agency for Radioactive Waste Management (ANDRA) fulfils a multi-faceted mission within the framework of the policy governing radioactive waste management defined by the public authorities. This mission and especially the public service mission has just been made subject to Planning Act of Parliament No 2006-739 of 28 June 2006 stipulating the programme governing sustainable management of radioactive material and waste.

Within the whole picture, distinction can be made between the situations of the various radioactive waste producer categories which cover very different conditions in technical and economic terms and the function of waste holders.

1. Nuclear industry – a system in place

The waste produced by the nuclear industry (EDF, the CEA and AREVA) accounting for most of the volume and radioactivity of the waste produced is disposed of within the framework of a system of technical specifications and tests in order to produce waste packages controlled by producer-operators. This industrial mission does not come under Andra's general interest mission as stipulated by the Act of Parliament of 28 June 2006[2].

2. Small-sized producers – contrasting situations

Andra disposes of 200 m^3 of waste produced by the hospital-university and research sectors on an annual basis. The disposal is still financed by the producers. However, unlike for the nuclear industry, Andra disposal covers "the settlement of every account", and thus Andra manages this waste from A to Z: collection, characterisation, conditioning, treatment and disposal of ultimate waste. This activity, which is more decentralised, does not come under the public service mission as the producers are professionals fully aware of the radioactive nature of the items held and ensuing restrictions.

However, there are two more scattered sectors accounting for low volumes which require the setting up of appropriate management solutions and funding:

- family or proximity nuclear waste where members of the public who are totally foreign to the use of radioactivity find themselves with radioactive items in their possession (for example, by inheritance) and are sometimes unaware of the radioactive nature of these items (for example items containing radium, needles and fountains),

1. Waste from small waste producers outside the nuclear industry, including historical waste
2. Article 14 1° and 6° and article 15

- Sites contaminated by radioactive substances, especially those involved in the former radium industry, which have often gone bankrupt.

The last two sectors come under Andra's public service mission.

3. Family nuclear waste: technical storage solutions but with dissuasive collection costs

In technical terms, temporary storage solutions pending the setting up of elimination outlets for the waste in the last two sectors have been implemented by Andra. These resulted in storage authorisation for the Socatri facility in June 2003 (under the basic nuclear installation scheme) and the drawing up of an agreement with the CEA in July 2005 (Saclay and Cadarache, under the schemes governing facilities classified for environmental protection and basic nuclear installations).

However, the ability to store collected radioactive waste is one matter and the ability to collect waste is an entirely different thing.

The costs for family nuclear waste disposal are high due to the restrictions and precautions related to the collection and storage activity. The disposal costs amount to an average of 1 000 € excluding VAT for colleted waste with significant variations:

- 600 € excluding VAT for naturally radioactive salts and mineral ore samples;
- 4 000 € for radium items especially those for medical purposes;
- 1 500 € for radioactive lightning conductors.

Such disposal prices mainly borne by private individuals who have not actually purchased these items and which are sometime not labelled radioactive (radioactive salts) can appear dissuasive. The polluter pays principle has reached its limits in this case and by blocking disposal incurs health risks for the holders.

Up to now, Andra has tried to implement solutions for private individuals by exceptionally operating modified tariffs and using its own resources.

Article 15 of the Act of Parliament of 28 June 2006 stipulates the principle of State subsidy contributing to the financing of general interest mission entrusted to the Agency in compliance with provisions 1° and 6° of article 14 of the Act (cf. §5/).

By granting disposal of items free of charge or significantly assisted, this subsidy constitutes a real opportunity for the management of this radioactive waste. However, the principles for using this subsidy need to be clearly defined and justified. The corresponding policy must thus be validated by the future National Commission on Diffuse Nuclear Waste (NCDNW) (cf. § 6/).

According to the current state of reflection, subsidised disposal should benefit:

- Private individuals.
- The public health and safety response services (SDIS, Gendarmerie and Ademe acting on bankrupt sites, etc).
- In certain cases, local councils (especially if they hold waste for safety reasons, due to retrieval from the highways for example).
- Certain public companies.

It should especially rule out producers of items, holders using or purchasing items for their radioactive properties or for purposes of industrial and commercial activities, particularly operators of basic nuclear installations and facilities classified for environmental protection. Spent sealed sources subject to a retrieval system are also excluded as they are managed by other mechanisms.

In technical terms, it should focus on the following types of items:

- Minerals, mainly in the case of mineralogical collections (autunite, etc),
- Naturally radioactive salts (radium and thorium),
- Radium items (especially medical devices containing radium),
- Lightning conductors depending on the holder's capacity.

The case of ionisation smoke detectors is the subject of discussions for the implementation of a management solution.

4. Contaminated sites: few sites but high treatment costs – often bankrupt companies

Around twenty sites must be cleaned up due to radioactive contamination. The inventory is limited and very often very old mainly involving radium-contaminated sites, for which contamination normally dates back several tens of years.

In most cases, the current owners did not cause the contamination of which they consider themselves the victim, as the owners responsible are either deceased a long time ago or are bankrupt.

This therefore mainly involves environmental liability of limited size compared to chemically polluted sites.

Although large-scale operations have so far been carried out, the provision of a public allowance enables the cleaning up of this environmental liability to be envisaged in a few years time, at least concerning the old sites with bankrupt owners.

Treatment costs are nonetheless very high compared to chemically polluted sites.

Moreover, the lack of a final outlet for radium-contaminated soil mainly requires the use of Socatri and the CEA's storage solutions. Although these storage facilities, which also concern lightning conductors and radium bearing items, provide a satisfactory technical response for the transition period, they involve high annual costs which are borne by public subsidy (around 470 K€).

For example, the Bayard plant site (clock-making industry) in Saint-Nicolas d'Aliermont (Seine-Maritime) was cleaned up by Andra between 1994 and 1998 for several million euros. This treatment generated 1 050 tonnes of radium-contaminated soil currently stored at Cadarache. The cost of retrieval and disposal of this soil is currently estimated at 5.5 million euros excluding VAT borne by public funds due to bankruptcy of the owners.

Other sites are still to be subject to expensive treatments such as those of Isotopchim at Ganagobie (company in receivership formerly manufacturing marked molecules) and the site in the district of the petite Coudraie at Gif-sur-Yvette where, depending on the houses, treatment costs range from a few tens of K€ to several hundreds of K€ for the purchase of housing.

The public service subsidy really comes into its own in terms of protection of members of the public, as one of the particularities of contaminated sites is that a lot of the former workshops have been converted into dwellings and are currently occupied.

The subsidy replaces previous funding methods which were mainly based on voluntary contribution from the nuclear industry and by transfer of credits from Ademe. Even if these methods were able to fund large-scale operations (Bayard and Orflam), they could not face up to all challenges due to their temporary nature and the limit of their scope.

However, the use of this public subsidy for the purposes of treating sites must be validated by the future National Commission on Diffuse Nuclear Waste both concerning the financial aspects and site treatment strategies.

5. Andra's public service mission

This mission sought by the Nuclear Safety Authority as early as 2003, stipulated in article 4.6 of the State-Andra contract, and confirmed by article 14 (1° and 6°) of the Act of Parliament of 28 June 2006, focuses on 3 objectives:

- Compilation of the inventory of radioactive material and waste – Andra's original mission.
- Disposal of family nuclear waste.
- Cleanup of sites contaminated by radioactive substances whose owner is bankrupt and disposal of waste produced.

Article 15 of the Act of Parliament laid down the principle of a State subsidy contributing to the funding of these general interest missions and amounting to around 2 million euros. The Agency has already embarked on applying this mission. The public service mission was created within the Agency on 1 January 2007 and the ministerial circulars are currently being drafted. They will mainly define the role of the NCDNW.

6. The National Commission on Diffuse Nuclear Waste (NCDNW)

The study of the decision-making process for files qualifying for public subsidy has been completed and approved by the supervisory bodies. In April 2007, it is planned to propose the setting up of a National Committee for Assistance in the Radioactive Field to Andra's Board of Directors placed under its aegis. This commission will rule on priorities for granting subsidy funds, disposal of certain types of scattered nuclear waste and the strategy and amounts for treating contaminated sites with bankrupt owners. The draft composition of this commission includes representatives of the public authorities, public technical bodies, associations, elected officials and qualified experts. Its operating principles are as follows:

- Committee operating mode (debates),
- Referral by the public authorities and Andra,
- Secretariat and Andra presentation reports.

Internal commission organisational documents incorporating these principles are currently being drafted.

HUNGARY

Hungarian Practice

The Hungarian Act CXVI on Atomic Energy of 1996 regulates among others the basic aspects of radioactive waste management. The Act requires that a licence for the application of atomic energy shall be granted only if the safe storage, i.e., interim storage or final disposal, of the radioactive waste and spent fuel generated by the licensed activity can be assured in accordance with the most recent proven results of science, internationally accepted norms, as well as experience.

According to the Act on Atomic Energy and the Governmental Decree 240/1997. (XII.18.) Korm. the Central Nuclear Financial Fund has been set up on 1 January 1998 to finance radioactive waste disposal, interim storage and disposal of spent fuel as well as decommissioning of nuclear facilities. As required by the Act, the government authorised the Director General of the Hungarian Atomic Energy Authority (HAEA) to establish the Public Agency for Radioactive Waste Management (PURAM), now in operation since 2 June 1998. The Minister supervising the HAEA has jurisdiction over the Fund, while HAEA is responsible for its administration.

PURAM performs – among others – the tasks related to the final disposal of radioactive waste including waste from non-nuclear fuel cycle facilities. The Minister of Health, through the National Public Health and Medical Officer Service (NPHMOS) performs the regulatory tasks with respect to radiation safety. NPHMOS is the responsible regulatory body for licensing and controlling the siting, construction, commissioning, operation, modification and closure of a radioactive waste disposal facility.

All practices involving radioactive materials, including sealed radioactive sources, are subject to licensing as required by Decree 16/2000. (VI. 8.) of the Minister of Health in order to ensure safety. The Decree regulates, among others, the licensing of non-nuclear facilities and equipment, including their decommissioning. At present decommissioning of non-nuclear facilities is not on the agenda in Hungary.

In 1976, a radioactive waste treatment and disposal facility at Püspökszilágy was commissioned to condition and dispose of institutional LILW waste. The Radioactive Waste Treatment and Disposal Facility is a near-surface type repository with concrete trenches and disposal wells.

According to the Act CXVI of 1996 on Atomic Energy nuclear facilities are liable to cover the costs of the radioactive waste and spent fuel management by payments into the Fund. The institutes disposing of radioactive waste in the Radioactive Waste Treatment and Disposal Facility are also liable to contribute to the Fund in accordance with the official price list contained in a ministerial order.

The small-scale or non fuel-cycle producers - including hospitals, laboratories and industrial companies - generate about 20-30 m^3 LLW/ILW and 1 000-3 000 spent radiation sources per year. The Radioactive Waste Treatment and Disposal Facility has a capacity of 5 040 m^3. Now the repository is full. By the end of 2004, according to the currently available best estimate, the total activity of the radioactive waste disposed of in the repository was 950 TBq. Most radioactive wastes, including spent sealed sources, are generated in medical, industrial and research applications. The two most widely used radionuclides with significant inventories are ^{60}Co and ^{192}Ir, used in medical and industrial radiography.

According to the plans of the operator, the Public Agency for Radioactive Waste Management, the repository should be operational for additional 40-50 years by accommodating radioactive waste from the small-scale producers of the country. Bearing this approach in mind, measures are to be taken to provide additional disposal capacity within the site. The removal of certain long-lived and high activity spent sources from the vaults in the framework of a safety enhancement programme provides a good opportunity for this undertaking.

A recent achievement in the facility is the conversion of the existing treatment building into a centralised interim store that can serve as a ‘buffer storage’ until new disposal capacity is available in the repository. The renovated building is also designed and licensed for the interim storage of long lived radioactive waste, sealed sources, until a high level waste repository will be available.

In Hungary all radioactive sources are recorded in a central registry, under the responsibility of the Hungarian Atomic Energy Authority. The central registry system has been in operation since the end of the 1960’s, and it provides for the regulatory control of radioactive sources throughout their full life-time. This registration system was recently upgraded. The present unified computerised local and central registry system is based on regular electronic reports of inventory changes and annual inventories, and a passport identifying each sealed source which contains all relevant technical data as well as details of the legal owner of the source. The new system has strengthened the regulatory control, and greatly improved its efficiency.

IAEA

Background

Most of existing technical literature on decommissioning addresses technological and other aspects in decontamination and dismantling of large nuclear facilities such as nuclear power plants, reprocessing plants and relatively large prototype, research and test reactors. It should however be noted that most nuclear facilities are smaller - in size and complexity- and may present a lower radiological risk in decommissioning than those quoted above. Such facilities e.g. critical assemblies, biological and medical laboratories, factories manufacturing radioactive products etc. - are often located in developing countries where decommissioning is often perceived as a low priority activity. The risk here is that even minimum requirements and strategies be disregarded in decommissioning of these facilities resulting in unnecessary costs, delays, and possibly safety concerns e.g. loss of radiation sources and contaminated materials.

IAEA Publications

Safety Guide WS-G-2.2 on "Decommissioning of Medical, Industrial and Research Facilities"

The objective of this Safety Guide is to provide guidance to national authorities, including regulatory bodies, and operators to ensure that the decommissioning process for medical, industrial and research facilities where radioactive materials and sources are produced, received, used and stored is managed in a safe and environmentally acceptable manner.

TRS No. 414 on "Decommissioning of Small Medical, Research and Industrial Facilities"

The objective of this report is to provide information which will be useful in planning and managing the decommissioning of small nuclear facilities, such as:

- Medical facilities with radiography and radiotherapy units and those radioisotopes.
- Industrial facilities such as those producing radioisotopes, using irradiation and radiography devices, and manufacturing products incorporating radioactive materials.
- Research facilities such as those associated with the nuclear industry e.g. critical assemblies or zero-power reactors, pharmaceutical and medicine.
- Teaching and research laboratories in universities and hospitals.

Major aspects covered include, among others:

- the need for and contents of early planning for decommissioning;
- access to decontamination and dismantling technology as needed;
- the need for, qualifications, and training of a dedicated decommissioning team;
- project budget, cost control, cash flow;
- sequencing of operations, scheduling, milestones;
- quality assurance, including monitoring of activities and record -keeping;

and how all the above-listed factors would change from plant operation until decommissioning, and throughout decommissioning stages up to achievement of unrestricted release conditions.

TECDOC-1145 on "Handling, Conditioning and Storage of Spent Sealed Radioactive Sources"

The report provides reference material, guidance and know-how on handling, conditioning and storage of spent SRS to both users of sealed sources and operators of waste management facilities.

TECDOC-1183 on "Management of Radioactive Waste from the Use of Radionuclides in Medicine"

The main objective of this publication is to review the different options and provide practical guidance on the management of biomedical radioactive waste that may arise in health care facilities, clinics, laboratories and other associated medical institutions. It outlines the advanced practices used in different facilities around the world that handle radionuclides for biomedical applications and therefore deal with management of the associated waste.

TECDOC-644 on "Guidance on Radioactive Waste Management Legislation for Application to Users of Radioactive Materials in Medicine, Research and Industry"

The main aim of this document is to give guidance on legislation required for safe handling, treatment, conditioning and release or disposal of radioactive waste. It covers all steps from the production or import of radioactive material, through use, treatment, storage and transport, to the release or disposal of the waste either as exempted material or in special repositories.

TRS No. 402 on "Handling and Processing of Radioactive Waste from Nuclear Applications"

The main objective of this report is to provide technical information and reference material on the different steps and components of radioactive waste management for staff in establishments that use radionuclides and in research centres in Member States. It provides technical information on the safe handling, treatment, conditioning and storage of waste arising from the various activities associated with the production and application of radioisotopes in medical, industrial, educational and research facilities.

TECDOC-776 on "Reference Design for a Centralized Waste Processing and Storage Facility"

The objective of this report is to present the generic reference design of a centralized waste processing and storage facility (WPSF) intended for countries producing small but significant quantities of liquid and solid radioactive wastes. These wastes are generated through the use of radionuclides for research, medical, industrial and other institutional activities in IAEA Member States that have not yet developed the infrastructure for a complete nuclear fuel cycle.

TECDOC-1371 on "Reference Design for a Centralized Spent Sealed Sources Facility"

The objective of this report is to provide Member States, their responsible organizations and personnel with guidance on practical steps needed to select appropriate and efficient technologies for processing and storage of radioactive waste from different nuclear applications. The report addresses practical considerations for the selection of a particular waste management scheme based on the critical review of the related technical and non-technical factors affecting this selection, and taking into account radiological safety of workers, the public and protection of the environment.

TRS on "Decommissioning of Research Reactors and Other Small Nuclear Facilities by Making Optimal Use of Limited Resources" (ready for publication)

This TRS is intended to facilitate timely and efficient completion of decommissioning project for research reactors and other small nuclear facilities in that it highlights cost-effective technologies and planning methodologies and suggests ways to simplify and optimize the decommissioning process without compromising safety. This is particularly critical in MSs or institutions short of technical, financial and human resources at disposal of a decommissioning project. Addressing the decision - making process in such difficult circumstances is the focus of this TRS.

TRS on "Hands-on Decontamination and Dismantling Techniques for Small Medical, Industrial and Research Facilities" (under development)

The objective of this report is to highlight first-aid, practical guidance in selection and implementation of decontamination and dismantling techniques for small nuclear facilities for guidance to nuclear operators and decommissioning implementers. This is particularly relevant to MSs having limited experience/expertise in decommissioning.

TECDOC on "Nature and Magnitude of the Problem of Sealed radioactive Sources" (under development)

The document is intended to provide insights into the problems associated to sealed radioactive sources and to support the Agency's programme to improve the management of sealed radioactive sources throughout the world, especially in developing countries. The document will be useful as a reference to competent national authorities and others concerned with the safe management of sealed radioactive sources.

Safety Assessment Projects in RWM and Decommissioning

In 2006, the intercomparison of safety assessment methodologies programme has continued. This programme started as international projects on radioecological assessment and modelling that were aimed at refining existing information and to improve models to be applied for the purposes of radiation protection of the public and the environment. With the same idea and to promote safety assessment methodologies, the IAEA launched, in 1997, a project on Improving Long Term Safety Assessment Methodologies for Near Surface Radioactive Waste Disposal Facilities (ISAM). Since then, the Waste Safety Section has built a coherent structure of intercomparison projects on safety assessment methodologies and models. The Agency's project, Safety Assessment Driving Radioactive Waste

Management Solutions (SADRWMS) is an international programme of work to examine international approaches to safety assessment in aspects of predisposal radioactive waste management, including waste conditioning and storage. A complementary project to ISAM on Application of Safety Assessment Methodologies for Near-Surface Radioactive Waste Disposal Facilities (ASAM) has been launched in 2002. The project on Evaluation and Demonstration of the Safety of Decommissioning of Nuclear Facilities (DESA) aims to develop a harmonized methodology for evaluating and demonstrating safety during decommissioning and to produce model safety assessments for selected nuclear facilities by applying this methodology. DESA started in November 2004.

Direct Assistance to Member States

In the radioactive waste management and decommissioning areas, direct assistance is being provided to Member States through the IAEA's Technical Cooperation (TC) Programme and the IAEA's Nuclear Security Plan. The main general objective is to strengthen the safe and secure management of radioactive materials, in particular disused sealed radioactive sources, in Member States.

Management of Disused Radioactive Sources

The build up of infrastructure and national capabilities in the area of management of sealed radioactive sources is an important factor to make the direct assistance programme effective and sustainable in developing Member States. In this respect regional capabilities in the form of qualified teams to provide the needed assistance and render sources safe and secure including the required tools and equipment has been put in place by the Agency. This infrastructure is set as mobile systems that can be taken by the various teams to conduct source recovery and conditioning work in the third countries.

Radium sources

Over the last 10 years, over 13,000 individual Radium sources (needles, applicators and tubes) have been collected, conditioned and stored in more than 50 Member States. Several additional specialized national teams have been trained in several regions world-wide and have solved the problem in their own countries. Tool kits have been developed and are being used for the radium source conditioning operations.

Neutron Sources

Neutron source recovery, conditioning and repatriation operations have been for the first time carried out on the international level in November 2005. The consolidation of neutron sources from multiple countries into one shipment to the country of origin were shipped from South Africa to the USA. The USA and IAEA have agreed that such operations will continue in Africa and will be expanded to Latin America.

High Activity Sources (SHARS)

While the development of technical capabilities for direct assistance for recovery and conditioning of high activity sources is continuing, the option to return sources to suppliers is taken with every opportunity. The successful repatriation of sources to countries of origin has contributed to reducing the sealed source inventory in several developing countries from the African and Latin American regions. In many cases, sources with high activity are problematic to either store them or ship them to a recipient country for re-use. This has been particularly difficult for sources that have lost their special for certificate. In order to manage these sources properly their recovery, re-encapsulation and certification as sealed is important for proper management. A SHARS Installation (a mobile hot cell) has been designed and manufactured to allow such work to be carried out in least developing countries. The first of it kind has been designed and manufactured in South Africa. The license for the installation has been granted for the first pilot operation to take place in March 2007.

Training in decommissioning

Assistance for the decommissioning of small facilities in countries with limited capabilities and resources has been provided for years through the IAEA's TC Programme. Training of local experts in Decommissioning and Radioactive Waste Management is one of the main priorities. One of the recommendations of the recent Athens Conference on Decommissioning was to encourage the IAEA to pursue its efforts to enhance international co-operation through information exchange and experience sharing, with the objective of assisting countries in the development of infrastructure and capacity, particularly developing Member States. The Agency's initiative to establish an International Network of Decommissioning Centres was positively received.

Following a review of how the IAEA fulfils its role in the decommissioning area, the Agency decided to enhance its arrangements for working with decommissioning organizations. A network of organizations with particular experience and excellence in nuclear decommissioning is being established- the IAEA International Decommissioning Network (IDN). This approach was strongly supported at the recent Athens conference. The functions of IDN are to provide:

a. opportunities to support nuclear facilities or Member States, particularly those with less developed decommissioning industries, by providing access to decommissioning skills, knowledge and projects;

b. a forum in which to provide specialist advice and technical guidance on the Agency's programme in the area of decommissioning;

c. a mechanism whereby decommissioning organizations may exchange information under the aegis of the Agency to pursue the promulgation of good practices and the longer term retention of knowledge in support of deferred dismantling.

ITALY

Framework

The present Italian legislative and regulatory framework related to nuclear and radiation safety is the result of an evolution of rules and standards that begun in the early 60ties with the experience of licensing and operation of NPPs and other nuclear fuel cycle installations. This framework covers also the safety of decommissioning of facilities and treatment and disposal of radioactive waste associated with non-nuclear fuel cycle activities.

It must be recalled here that the European Union Member States share common directives and regulations that have been inspiring many relevant aspects of the national regulatory system. It is to be noted here that Italy, as contracting party of the Joint Convention on the Safety of Spent Fuel and on the Safety of Radioactive Waste Management, at the article 3 has declared that "This Convention applies to the radioactive wastes arising from the past operation of nuclear fuel cycle installations and to the waste derived from the application of radioisotopes in industry, agriculture, research and medicine or arising as a result of past activities, incidents and accidents involving radioactive materials" (First Italian National Report, April 2006).

The Italian regulatory system is made up of three types of rules of different legal force depending on their origin:

Legislation and Ministerial Decrees

In the Italian system the source of legally binding rules must be either an act of Parliament or a Legislative Decree; the Government can issue governmental or ministerial decrees binding in law.

The main corpus making up the Italian system is itemised below:

- Act no. 1860 of 31 December 1962, as amended by the President's Decree no. 1704 of 30 December 1965 and by the President's Decree no. 519 of 10 May 1975.
- Presidential Decree no. 1450 (1971), which contains Requirements and procedure for the acquisition of the operational personnel.
- Legislative Decree no. 230 of 17 March 1995, in force in Italy since January 1st 1996, implements six EURATOM Directives on radiation protection (EURATOM 80/836, 84/467, 84/466, 89/618, 90/641 and 92/3). It needs a series of Government and Ministerial Decrees, which have not been all issued yet.
- Legislative Decree no. 241 of 26th May 2000, which has transposed EU directive 96/29/Euratom laying down basic safety standards for the radiation protection of workers and the public. Decree no. 241 has modified and integrated Legislative Decree no. 230 of 1995.

- Legislative Decree no. 257 of 9th May 2001 was promulgated to modify certain details in Legislative Decree no. 241 of 2 000 concerning requirements for notification and authorisation of non nuclear installations where ionising radiation is used for industrial, research and medical purposes.
- The process to incorporate the requirements of the Council Directive 2003/122/Euratom on the Control of the High Activity Sealed Radioactive Sources and Orphan Sources into the National regulation is in advanced progress; a legislative decree on this matter is now to be published.
- A new decree is in progress for a more specific regulation of the matter related with the management of radioactive waste associated with non-nuclear fuel cycle activities, including the coverage of the associated costs.

Technical guides

The issuing of technical guides is assigned in Law to the National Agency for the Protection of the Environment and Technical Services (APAT) by the Legislative Decree no. 230/1995. Technical guides contain recommendations and are a tool to implement rules of good practice. In addition, the existing international recommendations, such as IAEA and ICRP publications; has been largely made use of in the Italian system.

Technical Guides N°26 (1987) is related to safe management of radioactive waste. There is a plan to update this guide in the near future according with the more recent international standards.

Technical Standards

These standards are mainly published by UNI, the Italian National Standards Body. Some standards are related to decommissioning and to waste management. Standards documents are developed within an Expert Group and approved by the Technical Committees. They represent a broad consensus of the experts (industry, research, and sometimes regulatory Agencies) in the field who were involved in the development of the standard itself; thus, they are thought to stand for good practice.

The key regulatory functions related to nuclear safety and radiation protection matters, including the safe management of radioactive waste, are exploited in Italy by the following main bodies:

- MSE (Ministry of Economic Development, former Ministry of Industry) is the Licensing Body, with the authority to grant the license/authorization for nuclear activities and for major practices involving the use of ionising radiations. Authorizations are granted on the bases of the technical advise provided by the Regulatory Body (APAT), on the bases of the environmental assessment provided by the Ministry of the Environment, when applicable, and on the bases of the advice provided by the Ministries for the Interior, Labour and Social Affairs, Health and by the Region where the installation is located.
- APAT (National Agency for Environmental Protection and Technical Services), is entitled with the role of Regulatory Body. APAT supervises the compliance with the requirements established in the law and in the Ministerial authorization throughout its

inspection activity. APAT is also entitled to support the Governmental rule-making function in the field of nuclear safety and radiation protection.

- The “Technical Committee on Nuclear Safety and Radiation Protection”, entitled to formulate an independent technical advice during the assessment process connected to the granting of licenses and authorizations. The advice is asked by and provided to APAT. The Technical Committee is composed of experts designated by various Ministries (Interior, Health, Environment and Territory, Productive Activities, Transport and Infrastructure), by APAT and ENEA (National Agency for New Technologies, Energy and the Environment) and by the Regions where the nuclear activities are exploited.

For industrial and research installations of a less important character the Prefect of the province has administrative competence to issue authorisations after seeking the advice of regional technical bodies and of the Fire Corps; the authorisation required for installations where ionising radiation is used for medical purposes is issued by the Regions, which are responsible for health in the Italian system. The “less important character” is defined in a technical annex to Legislative Decree 241/2000 lays down thresholds in order to determine which installations are authorised by the Ministry of Industry and which one by local authorities; thresholds are set in terms of values of activity, activity concentration and neutron yield for radioactive sources, and of energy and neutron yield for accelerators. The same Annex also lays down the technical features of the radiation sources and of the installation which must be specified in the application.

National plan

There isn’t a national plan for decommissioning and waste management associated with non-fuel cycle activities.

Responsible Organization(s)

Decommissioning of facilities and treatment and disposal of radioactive waste associated with non-nuclear fuel cycle activities are responsibility of the licensees.

Nevertheless ENEA (National Agency for New Technologies, Energy and the Environment) has been entrusted by the Government with the management of the radioactive waste coming from small producers, which accept this role on a voluntary basis. For such a management ENEA has organized a special technical-operative service, called “Integrated Service”, in which ENEA is in charge of guidance, supervision and control for the whole cycle of waste management. ENEA has entitled Nucleco S.p.A. (Nuclear Ecology Company) with the operative and commercial task. Created in 1980, Nucleco is a waste management company, owned by SOGIN (60%) and ENEA (40%). SOGIN (Società Gestione Impianti Nucleari) is the company entitled, since 1999, for the decommissioning of the NPPs and the fuel cycle facilities.

Packaging

Even if a final disposal site is not yet available, the reference technical guide concerning the radioactive waste management is the Technical Guide n° 26, issued by APAT, which defines waste classification as well as technical requirements for the waste forms and the waste packages for disposal. Other international standards are used for specific purposes (i.e. IAEA regulations for transport).

Waste management treatment facilities and disposal sites

A near surface repository for radioactive waste, including those waste from nuclear activities not associated with the nuclear fuel cycle, is to be opened in Italy. The site has not been selected yet, but the decision to realize a national LLW repository has been taken at governamental level. Interim storage facilities are sited in the existing nuclear installations (NPPs, fuel cycle facilities and research centres).

Waiting for the national repository, there are a few authorised commercial operators for the management of industrial, medical and research radioactive waste, (e.g. Nucleco, Protex, Campoverde, Sicurad, Sorim and MIT). Among them Nucleco is the only one with on site capabilities for treatment, volume reduction, conditioning and interim storage (using the facilities which are property of ENEA). Nucleco is then the main Italian commercial operator for collection, transportation, interim storage, characterization, treatment (mainly by supercompaction) and conditioning of mainly VLLW and LLW waste produced by the industrial, medical and research processes in the context of the Integrated Service coordinated by ENEA since 1985. The other Italian operators only provide regional services of collection, transportation and interim storage, sometimes release for waste with short life radionuclides, after their radioactivity decay.

The “Integrated Service” is a technical and commercial service that ENEA offers to small producers of noNPPs radioactive waste (medicine, industry, agriculture, research and education); Nucleco has been entrusted with the operative and commercial task, using the ENEA’s waste management facilities and storage infrastructures, located in the “Casaccia Research Centre” (near Rome). ENEA and Nucleco drew up a special agreement describing mutual duties and responsibilities. With the Integrated Service, ENEA becomes owner of the collected radioactive waste, leaving the waste producers free of any responsibility, and takes care of the final disposal, together with the radioactive waste produced by ENEA itself within the radiochemical research laboratories and research reactors. Integrated Service has also collected disused sealed radioactive sources with Cs-137 and Co-60 and Ra-226 no longer used in medical therapy.

ENEA makes the Integrated Service available also to the above private regional operators, which do not have treatment facilities. ENEA provides qualification for these operators and gives them specific technical-operational procedures for packaging and transport, according with international standards.

The described services include the collection of disused sealed sources, the dismantling of equipment containing sources, processing of sources and transfer of the processed material to the interim store, waiting for the final disposal route, not yet available.

Inventory of generated waste

The large part of the radioactive waste existing in Italy has been produced in the past during the operation of the nuclear installations connected to the national nuclear power programme, shut down in 1987 and currently under decommissioning. The radioactive waste produced by R&D, medical and industrial applications represents a minor fraction to be managed.

The overall national inventory of the radioactive waste, including the radioactive waste from non-nuclear fuel cycle activities, is currently updated by APAT. The Data Base is able to present the data in terms of volumes, mass, activity and physical status. The present inventory of the Italian radioactive waste coming from non-nuclear fuel cycle activities (medical, industrial and research applications) is: about 9 300 m3 of VLLW-LLW (about 8 600 GBq activity), 160 m3 of ILW-HLW (about 8 800 GBq) and spent sources with about 1 000 000 GB activity.

Data management and data tracking

Nucleco has in place a system for data management and tracking according with QA procedures.

Cost estimation

Practices for estimating the cost of waste management are in place within the Integrated Service to establish the fees for the small producers or operators, but estimate of the interim storage and of the final disposal is not very accurate because there isn't a final repository and it isn't known when it will be available.

Funding

In principles, licensees have the responsibilities for decommissioning of facilities and treatment and disposal of radioactive waste associated with non-nuclear fuel cycle activities. When the radioactive waste is collected and treated by Nucleco, ENEA becomes owner of the packages and responsible for interim storage and final disposal; the estimated cost for the final disposal is in charge to the producer as a part of the overall fee for the services. As reported above, a new legislation is in progress to better regulate the matter in terms of responsibility and financial provision.

JAPAN

National policy on radioactive waste management and decommissioning (the Atomic Energy Commission)

The Atomic Energy Commission formulated the Framework for Nuclear Energy Policy on October 11, 2005. Based on the framework, the national policy on nuclear energy was decided by the cabinet of the government. The points of the policy for radioactive waste management and decommissioning are as follows.

- Radioactive waste has to be appropriately classified and safely treated and disposed of for each classification under the principles of 1) the liability of waste producers, 2) minimization of the amount of radioactive waste, 3) rational treatment and disposal, and 4) implementation based on public understanding and acceptance.
- As for radioactive waste from RI (radioisotopes) usage (called RI waste hereafter), preparations for enactment of specific provisions are under way based on the amended "Law Concerning the Prevention from Radiation Hazards due to Radioisotopes and Others." In dealing with waste from research and development facilities (called research waste hereafter), discussions on safety regulations have been undertaken step by step, and relevant parties should work on the implementation of disposal in line with the progress of the preparations for the safety regulations.
- As for the decommissioning, it is important to undertake the activities relevant to decommissioning of nuclear facilities, such as commercial power reactors, test and research reactors and nuclear fuel cycle facilities, with the first priority on the safety assurance, under the responsibility of the installer, according to the amended Nuclear Reactor Regulation Law and the safety regulations of the Government, while promoting the understanding and cooperation of the local community.

Existing framework of law and regulation for disposal of RI and research wastes

- Basic concept of safety regulation concerning near-surface disposal for RI waste was provided in January 2004. It is planned to develop upper limits of radioactivity concentrations for disposal and safety review guideline in the future.
- As for the research waste, the basic concept was provided in April 2006 in a similar way. Upper limits of radioactivity concentrations for disposal and safety review guideline for research waste will be also developed in a similar way as for the RI waste.

Status of RI and research wastes management

Systematic discussions were undertaken by the government (MEXT) on the process of disposal implementation focusing on radioactive waste classified for near-surface disposal, and were summarized as follows. (Report of the working group, September 2006)

Current status

Currently, RI waste is collected, partly treated, and stored by Japan Radioisotope Association (JRIA), however a disposal facility has not been constructed. Most of the research waste is stored by the producers. JAEA which is a dominant contributor to generate research waste in Japan is storing the waste, a part of which has been treated for volume reduction. The total amount of stored RI and research waste in Japan is about 446 thousands of 200-liter drums as of March 2005. Part of waste is under treatment for volume reduction, however the waste after this process is not appropriate in its form for disposal and should be further treated.

Discussion of the framework by the government (MEXT) how to promote the disposal of RI and research wastes

Focused discussions were undertaken by the government (MEXT) on the framework of near-surface disposal. Main points of the discussions are summarized as follows.

Treatment and storage of RI and research wastes

Regarding RI waste, JRIA continues to collect, store, and treat it. JAEA also continues to store, and treat its own research waste. For research waste generated from universities and private research institutes, it is necessary to establish rational measures because of small amount of the waste. As for treatment of research waste generated from facilities other than JAEA, it is considered that JAEA would treat such waste by utilizing its treatment facility for disposal packaging if acceptance and economical conditions for treatment could be arranged.

Measures to secure financing for development of a disposal facility

a) Estimation of disposal cost

The total cost of disposal is estimated as 227.9 Billion yen. The estimated disposal cost for a 200-liter drum is then 700 and 130 thousands yen for concrete pit disposal and trench type disposal, respectively. The conditions postulated in the estimate are as follows.

i) Amount of waste generated

The amounts of waste packages which will be produced up to 2048 is estimated about 259 and 360 thousands of 200-liter drums for the near-surface disposal of concrete pit and the trench type, respectively.

ii) Disposal schedule

It is estimated that the construction period from site selection to completion of construction is necessary about 8 years, and operation period of the disposal facilities is supposed to be 50 and institutional control periods after closure are 50 years for trench type disposal and 300 years for concrete pit disposal, respectively.

b) Securing of financing for developing disposal facility

The principle is that waste producers pay cost based on the principle of "the liability of waste producers." The working group report said that the government should develop a system of securing of financing so that the cost burden of waste producers is to be conducted steadily and disposal activities are executed efficiently. It is also said that cost burden to the producers is to be conducted steadily for the past produced waste by fixing the period of paying the cost. A possible funding system is that the disposal organization (see the next section c)) will commit the fund management to an outside independent organization and extract according to the requirement. On the other side, "The reserve fund" system can also considered in which each waste generator will commit fund management directory to the outside independent organization and pay the disposal cost to the disposal organization putting disposal in execution.

c) Organisational structure for implementing waste disposal

As for disposal of RI and research wastes, conducting disposal activity in an intensive and centralized way is more reasonable and efficient than each producer will dispose separately. Therefore such an implementation system is desired as an organization having economic foundation and high technical capabilities to conduct it. It is also necessary that the organization has management capabilities as a disposal implementing entity in order to gain the trust of the public.

JAEA is considered to be an organization having the above conditions, as JAEA is the only integrated nuclear research and development agency in Japan, and at the same time generates large portion of waste. It is appropriate that JAEA will conduct and promote disposal activity for all RI and research wastes in cooperation with the government, other waste generators, conducting also other R&D activities.

Items to be taken into account in developing disposal facility

There are RI and research wastes produced from the national research organization such as JAEA, National Institute of Radiological Science (NIRS), etc. These wastes are generated as a result of conducting the national policy. The RI and research wastes are also generated by commercial activities in the private sectors. Due to their variety of sources and purposes of activities, a contribution or a funding system for RI and research wastes has not been established as that for the commercial power plants, and this should be a liability issue if current problem would be put off till the next generation. In the light of the current status, it is necessary for the government to play a role in developing a disposal facility and to arrange conditions to promote disposal as soon as possible.

Further issues for disposal of RI and research wastes - Discussion points

- Which funding scheme is appropriate to develop the disposal facility?
- JAEA is an R&D organization, and it is questionable whether such R&D organization could secure additional fund for treatment and disposal of waste within the existing budget.
- What is the desirable scheme for relationship and coexistence with the local community?
- How should the fund be established for construction and operation of waste treatment facility for packaging and decommissioning in academia and R&D institutes?
- Are there any specific issues to be addressed in developing safety regulations on disposal of RI and research wastes?

The NETHERLANDS

Introduction

The Netherlands has a small nuclear energy programme, with 1 nuclear power plant in operation (Borssele NPP), 1 shut down and put in a safe enclosure for the next 40 years (Dodewaard NPP) and 3 research reactors (HFR and LFR in Petten and the HOR in Delft). Also related to the nuclear fuel cycle is the uranium enrichment facility of Urenco in Almelo.

The non-nuclear fuel cycle-related activities include 1 commercial manufacturer of radiopharmaceuticals, about 5 large research centres or industrial sites using radioactive materials and about 200 licensed users of varying quantities of radioactive materials or sources in hospitals, universities and industries. All these activities generate radioactive waste that has to be managed. In addition, substantial quantities of low level radioactive waste from natural origin arise as residues from processing raw materials or during oil and gas production (NORM wastes).

Radioactive waste management policy

The national policy on radioactive waste management, laid down in a position document in 1984 and endorsed by the parliament, envisaged the institution of a single organization responsible for the removal, processing and storage of all radioactive wastes, ranging from NORM waste to vitrified high level waste and spent fuel. As a result COVRA, the Central Organization for Radioactive Waste, founded in 1982, was charged with the implementation of this decision. COVRA is located at a site in the south-west of the country near the Borssele NPP. It was also decided that dedicated surface storage facilities be constructed for each waste category with sufficient capacity to accommodate all radioactive wastes generated in a period of about 100 years. The storage facility is now in full operation since the commissioning in 2003 of HABOG, the store for high level waste.

This centralized approach chosen for the management of radioactive waste aimed to limit local storage of radioactive waste to a practical minimum. COVRA periodically collects the radioactive waste from licensees. Only radioactive waste with a half-life of less than 100 days is allowed to decay on the site where it is generated.

Radioactive waste inventory

The inventories (data December 2004) of the different categories of radioactive waste are given in Table 1.

Table 1. Inventory of radioactive waste in the Netherlands

Facility	Waste form	Total inventory (m^3)
COVRA, Borssele		
LOG	LILW	8552
VOG	LILW, depleted U	416
COG	NORM	1850
HABOG	HLW	5
NRG, Petten	HLW, unconditioned	~1500 drums

A first observation that can be made with respect to the figures in this table is that the total amounts are relatively small. Although more HLW will be returned to the Netherlands after reprocessing of the spent fuel from the NPP's, the total amounts are not expected to exceed 100 m^3. This is actually the major reason why long term storage was the preferred option as compared to geological disposal. More radioactive waste has to be accumulated to justify the costs for the construction of a repository.

A second observation is that roughly half of the amount of LILW can be attributed to institutional waste (non fuel cycle-related).

A third remark is that COVRA accepts for storage only NORM waste, whose activity concentration by far exceeds the national exemption/clearance levels and for the use of which a license based on the Nuclear Energy Act is required. NORM waste with a lower activity concentration will either be disposed of at a disposal site for chemical wastes or it will be reused or recycled for selected applications.

Data management and data tracking

One of the challenges associated with the long term storage of radioactive waste is to keep record of the characteristics of individual packages.

For practical purposes the waste package identification procedures for management steps of relatively short duration, such as treatment are different from those applicable during the long storage period.

After receipt of a batch of radioactive waste packages, but before conditioning each package is provided with a bar code sticker, containing information on its origin (name and address of the generator) and its contents (radionuclides present and the activity of each of the radionuclides).

After conditioning of the radioactive waste, during which usually many packages are combined into one conditioned waste package, the relevant data are recorded in a database and the packages are identified both by a unique number and their position in the storage racks. The data records are kept in more than one safe place and are updated as necessary. A quality management programme ensures that the data are always available on the a suitable and preferably sustainable storage medium.

Financial resources for radioactive waste management

One of the basic principles governing radioactive waste management and also adhered to in the Netherlands is *the polluter pays principle*. This principle requires that all costs associated with radioactive waste management are borne by the persons or institutes responsible for the generation of this waste. These costs, which include costs for removal, transport, treatment, conditioning, storage and disposal are charged by COVRA to its customers. According to its statutes COVRA is set up as a non-profit organisation which works on the basis of full cost recovery. In that respect COVRA is in practice a monopolist, because it is the only recognised radioactive waste management agency. On the other hand COVRA has a legal obligation to accept the waste offered for removal by license holders provided that it meets the acceptance criteria, set by COVRA.

For LILW there are fixed tariffs for specified categories of radioactive waste which take into account all management costs as explained before. Once the transfer of the waste has been accomplished the customer is exempted from further liability for the waste. No surcharges can be made to make up for exploitation losses by COVRA and no waste can be returned to the customers. While the tariffs are annually adjusted with the price index, every five years the tariff structure is evaluated with the aim to reconsider the need for any structural adjustment. However, the utmost restraint is exercised to any proposal for an increase of the tariffs, in order to prevent the temptation of environmentally irresponsible behaviour with the waste by the customer.

Legacy waste

1 500 Drums of waste are stored at the NRG Waste Storage Facility at Petten. This waste, resulting from some four decades of nuclear research at that facility, includes highly active waste containing fuel material residues, some highly active wastes not including fuel material (fission and activation products) as well as long-lived institutional waste. The wastes are stored in metal drums placed inside concrete-lined pipes (“storage tubes”).

In the course of a two-year campaign between 1999 and 2001 the waste was inspected and levels of activity were determined. The inspection revealed evidence of corrosion in drums containing highly active mixed waste, due to the presence of PVC. It is intended that those drums containing PVC, about 300 in total, will be conditioned by cement grouting and repacked using a hot cell facility currently under development at the Petten site. Recently an Environmental Impact Assessment for the hot cell facility has started. Prior to the inspection campaign, the potential implications of packaging highly active waste together with PVC were unknown. After this learning experience the practice of using PVC for wrapping up radioactive waste samples is discontinued.

All other containers in the pipe storage will also be treated, repackaged and transferred to COVRA. It is intended that all legacy waste from the Waste Storage Facility at Petten will have been removed within the next five years.

(TE)NORM waste

The national legislation contains some provisions which are specific to radioactive waste from natural origin. This includes both waste from raw materials such as ores, containing naturally occurring radioactivity in a basically unmodified form (NORM) and residues in which the concentrations of natural radioactive have increased as a result of chemical or physical steps during industrial processing (TENORM). The definition excludes waste from raw materials which are destined for nuclear fuel cycle applications, such as uranium ores. (TE)NORM is generally characterized by large volumes and low radioactivity concentrations. From the perspective of the fundamental principle that generation of radioactive waste should be kept to the minimum practicable, reuse or recycling is a preferred management option. This is only considered acceptable if the radiation doses to exposed persons can be kept sufficiently low.

Therefore a graded system was introduced for radioactive waste from natural origin as presented in Table 2.

Table 2. Graded system for radioactive waste of natural origin

	Activity	Activity concentration
No requirements	< EL/CL[6] < EL/CL > EL/CL	< EL/CL > EL/CL < EL/CL
Notification	> EL/CL	> EL/CL but < 10*EL/CL
Licensing	> EL/CL	> 10*EL/CL

EL = Exemption level CL = Clearance level

Reuse or recycling of radioactive waste from natural origin is limited to wastes for which notification is required or no requirements apply. If the radioactivity concentration is enhanced to an extent that a license is required, reuse or recycling is not allowed. However, in order to encourage to the extent possible reuse and recycling of materials, it is explicitly allowed to mix radioactive waste with non-radioactive or less radioactive components arising in the process.

In the case that waste from ores – and other raw materials – generated in processing industries, have natural radioactivity concentrations far in excess of the exemption or clearance levels as specified in the aforementioned graded approach, these wastes have to be collected and managed by COVRA.

These wastes are stored in large freight containers in a building specifically build for this purpose. At the end of 2005 a total of 86 containers was kept in storage in the container storage building.

Disused sealed sources

If a sealed radioactive source is declared disused, transfer of the source may occur in three different ways:

1. The preferred option is return of the sources to the manufacturer. This is a common solution in the case that a source is replaced by a newer one or that the user is a good customer with respect to other products.
2. Transfer to another legal or natural person who is in possession of a valid license for that source or, if no further use is foreseen.

6. In the Netherlands the clearance levels have been set equal to the exemption levels

3. Transfer to the recognized organization for radioactive waste management (COVRA). COVRA takes title of the spent sealed sources, after which they are treated as appropriate, conditioned and kept in storage.

As already mentioned, for short lived sources, with a half-life of less than 100 days, on-site decay is usually practiced.

For orphan sources a mechanism exists which enables transfer to one of three institutes which have officially been appointed as collection points for such sources, without further costs to the finder. Orphan sources are occasionally found during routine monitoring at the entrance of scrap yards.

Decommissioning of facilities

The focus of regulatory requirements for decommissioning is clearly on nuclear power plants. Presently a modification of the national legislation is under preparation, which requires operators of the NPP to:

- submit a decommissioning plan and update it every five years;
- provide financial assurance for decommissioning where the bottom line is that the funds for decommissioning should be available when needed;
- legally separate the decommissioning funds from the operational assets and liabilities;
- for new nuclear power stations to make provisions that enable immediate dismantling after shut down.

There are no legal requirements for the decommissioning of non fuel cycle-related facilities. However, the license conditions for those facilities stipulate that at closure of a facility the regulatory body should be notified, radioactive materials be disposed of or transferred to a third party with a valid license and any residual radioactive contamination be removed. After the licensee has demonstrated compliance with the license conditions, clearance of the facility is obtained from the regulatory body.

NORWAY

Introduction

This report gives a short description of the management of radioactive waste originating from activities not being a part of the nuclear fuel cycle. In Norway this means all radioactive waste not resulting from the operation of the two nuclear research reactors at the Institute for Energy Technology.

The report is based on a presentation given at the 40th meeting of NEA's Radioactive Waste Management Committee as a part of the Topical Session on Decommissioning and management of waste from non-nuclear fuel cycle activities.

Legislative and Regulatory Systems

The Radiation Protection Act of 12 May 2000 regulates the use of ionising and non-ionising radiation, radiation protection requirements, medical use of radiation, contingency planning, waste management and discharges to the environment. The Act itself establishes the framework, which is spelled out in further details by the Regulations on Radiation Protection and Use of Radiation of 21 November 2003.

The Working Environment Act of 4 February 1977 regulates all aspects of the working environment and protection of workers and has regulations regarding HSE (health, safety, environment).

The Atomic Energy Act of 12 May 1972 regulates the licensing regime, general requirements for licences, inspection regime and the legal basis for the regulatory body concerning nuclear energy activities, nuclear fuels and radioactive substances.

Responsible organizations

The Ministry of Health and Care Services is responsible for the granting of licences for e.g. IFE's nuclear facilities and the Himdalen repository for low and intermediate level radioactive waste (LILW).

The Ministry of Trade and Industry provides financial resources for the operation of IFE's nuclear facilities and the Himdalen LILW repository.

The Norwegian Radiation Protection Authority (NRPA) is the competent authority and regulatory body in radiation protection, radioactive waste management, nuclear safety and security, and nuclear emergency preparedness.

The Directorate of Public Construction and Property (Statsbygg) is a Directorate under the Ministry of Government Administration and Reform and is builder and owner of the Himdalen facility.

The Institute for Energy Technology (IFE) is the implementing body of LILW management (except NORM-waste).

General description of radioactive waste management in Norway

Exempt sources and practices

The NRPA has decided that the following items and practices are exempt from regulatory control:

- Smoke detectors containing less than 40 kBq Am-241.
- Welding electrodes containing thorium.
- Depleted uranium used as balance weights and shielding material.
- Sealed radioactive sources of strength less than 1 MBq used in education, demonstration, and/or testing.

In addition, the Regulations on Radiation Protection and Use of Radiation have defined exempt levels for open sources handled in classified and approved laboratories.

The Norwegian definition of non-nuclear and nuclear radioactive waste

During the process leading to the construction of the repository for LILW in Himdalen (about 50 km east of Oslo), NRPA defined naturally occurring radioactive materials (NORM) as “non-nuclear” radioactive waste. This was done in order to avoid disposal of large quantities of low specific activity (LSA) scale from the Norwegian petroleum industry in this repository.

Consequently, all types of national LILW except NORM-waste, no matter of origin, are considered as “nuclear” radioactive waste and thus allowed to be disposed of in the Himdalen repository, if compliant to the safety regulations of the facility.

IFE’s role in the Norwegian radioactive waste management (RWM) system

IFE has been granted licence for operation of its Radioactive Waste Treatment Plant at Kjeller and the national repository for LILW in Himdalen. The plant is the national facility for conditioning of all LILW generated in Norway, except NORM-waste.

General RWM practices

NRPA may establish clearance levels for radionuclides or radioactive materials. Any discharge of radioactive materials needs a permit from the NRPA.

Materials containing short-lived radionuclides may be disposed of as non-radioactive when the radionuclides have been allowed to decay below given clearance level(s). The external users have to send longer-lived radionuclides to IFE for treatment as radioactive waste.

NORM-bearing waste (LSA scale, etc.) cannot be disposed of in the Himdalen repository, but in a designated NORM-repository. Such a repository is now under construction and is described below.

Decommissioning

Plans for total decommissioning of the production facilities for medical isotopes at IFE will be made in 1-2 year's time, similar to the plans for IFE's nuclear facilities. IFE has recently updated its plans for partly decommissioning of its nuclear facilities (costs included) and will in 2007 extend the plans to include total decommissioning (green field).

Decommissioning of the hot laboratory of the Nuclear Chemistry Department of the University of Oslo is now being performed under supervision of RP personnel from IFE. The facility will be rebuilt as a hot laboratory after clearance.

Other decommissioning plans or activities regarding non-nuclear activities are not known.

Details of radioactive waste management – non-NORM materials

Medical isotopes

Norway has about 25 hospitals and other main users of medical isotopes. IFE's Isotope Laboratories are the national pharmacy for medical radioisotopes, and are as such authorised to handle all domestic sales. The Laboratories produce now only small amounts of R&D-related radioisotopes.

GE Healthcare has its laboratories at IFE's premises and is the only national producer of medical radioisotopes. It produces mainly I-131 and Tc-99m (Mo/Tc-generators).

The major radionuclides and annual domestic sales (including domestic production and imported radioisotopes) are:

	No. of units	MBq
Mo-99 (Tc-99m)	1 335	26 270
I-131	1 426	1 866
F-18	176	276
I-123	765	137
In-111	305	37

The Mo/Tc generators are returned to IFE after decay of Mo-99. The other isotopes can be treated as non-radioactive after sufficient decay, or be discharged (if liquid), or sent to IFE. The waste owner has to pay for the conditioning of the waste at IFE. Any discharge exceeding given clearance levels requires a permit from the NRPA, even "discharge" from patients.

Research and development

Open sources are used in nuclear research, development of radiochemical analyses, petroleum well studies, etc., in laboratories at e.g. universities and research establishments. Such laboratories must be classified (A, B, and C laboratories) according to the activity quantities to be handled. Laboratories of type A must apply to the NRPA for a permit, whereas laboratories of type B and C shall only have to report to the NRPA of their use of radioactivity.

Short-lived radionuclides are allowed to decay, while longer-lived radionuclides are discharged (if liquid), or sent to IFE for treatment as radioactive waste. The waste owner has to pay for the conditioning of the waste at IFE. Any discharge of radioactive materials needs a permit from the NRPA, which also may establish clearance levels.

Industrial sources

Industrial sealed sources are used in petroleum well logging, as level watches, as band weights, for military purposes, etc. An overview of the number of such sources in use in Norway (including off-shore facilities) is given below:

Nuclide	No. of sources	Total activity (TBq)
Am-241	260	8
Co-60	970	2 400
Cs-137	1 520	590
H-3	25 200	500
Other beta	800	220
Total	29 000	3 700

Spent (disused) short-lived sources are allowed to decay, while longer-lived sources are sent to IFE for treatment as radioactive waste. The waste owner has to pay for the conditioning of the waste at IFE. The NRPA has decided that all sources bought as from 2004 shall be returned to the producer.

Details of radioactive waste management – NORM materials

Mineral exploration tailings

Several Norwegian mines have tailings that contain enhanced levels of NORM, mainly thorium and uranium and their daughter products. Two of the mines will be mentioned here. Figure 1 shows the location of the two mines.

Figure 1. **The location of the former mines at Søve and Einerkilen**

The Søve niobium mine

The production of niobium from the mine took place in the years 1953-1965. The region contains a major part of Norway's thorium resources, which in total is estimated to be about 13 % of the world's resources of this element.

A radiological survey performed by IFE in 2006 shows that the dose rate 1 m above the tailings resulting from ore processing varied between 0.1 and 4 μSv/h. The radiation is due to elevated levels of both thorium and uranium. The tailings – covering about 3 300 m2 – are regarded as a potential radiological risk area, and the NRPA is now considering if any action should be taken. A photo of the former niobium ore treatment facility is shown in Figure 2.

Figure 2. **Photo from the former niobium ore treatment facility at Søve (left) and the former Einerkilen uranium mine (right)**

The Einerkilen uranium mine

Institute for Atomic Energy (IFA, IFE since 1980) was established early 1948 to construct a national atomic research reactor. Norway possessed a sufficient quantity of heavy water, but needed uranium. A pegmatite deposit at Einerkilen was expected to contain in average 100 g natural uranium per ton, and might contain the necessary uranium quantity for construction of the planned reactor.

Building of the ore treatment plant and other facilities at Einerkilen started later in 1948, and the exploration started in November 1950. The ore contained however much less uranium than expected, and the operation was therefore stopped already in July 1951.

In the meantime an agreement was signed with the Netherlands, which possessed a sufficient quantity of uranium. Thus, the construction of the reactor JEEP (Joint Establishment Experimental Pile) was started, and it went critical in July 1951.

The buildings of the mine were removed short time after closure, but the concrete foundations still remain – now mostly hidden by vegetation. IFA/IFE has constructed fences in the area to avoid people falling down the steep rock walls surrounding the open mine. The tailings are regarded not to represent any threat to the public and the environment. A photo of the mine area is shown in Figure 2.

Magnesium production

The seawater contains a relatively high concentration of magnesium, and electrolysis of seawater is a way to produce this metal. Norway's largest producer of magnesium has used this process until the production was stopped five years ago. The cathode deposits and sludge from the process are slightly radioactive, mainly because of uranium. In 2004 the deposit/sludge was classified by IFE with reference to the clearance level of 5 Bq U-238 per gram of material given by the NRPA. The same clearance level was established for Th-232. About 25 tons of NORM-bearing sludge exceeding the clearance level are temporarily stored at the premises of the producer. The rest of the sludge has been disposed of in a special, large repository for industrial toxic waste. Deposits on about 300 cathodes remain to be classified.

LSA scale and produced water

LSA scale (Low Specific Activity scale) is a radioactive deposit inside pipelines and other production equipment and consists of carbonates and sulphates of Ca, Ba and co-precipitated Ra. The salts were dissolved in the reservoir itself in a mixture of original formation water and injected seawater. When transported to the surface together with the oil, the pressure and temperature drops, and the salts are deposited. Figure 3 shows an example of serious deposit inside a pipeline.

Figure 3. **Cross-section of a pipeline with deposited LSA scale**

Produced water is the formation water of the reservoir brought to the surface together with the oil. It contains about 1 000 times more radium than the seawater. If complex-binders are added to the water, the salts will not precipitate, and the water may be discharged to the sea.

The NRPA has for LSA scale established a clearance level that is 10 Bq Ra-226 or Ra-228 or Pb-210 per gram of LSA scale.

The annual production of LSA scale at Norwegian facilities is at present about 20-30 tons and is expected to increase to more than 100 tons within few years, as the production increases with increasing age of the oil fields. About 500 tons of radioactive scale, sludge, etc., are presently stored at different Norwegian coastal bases.

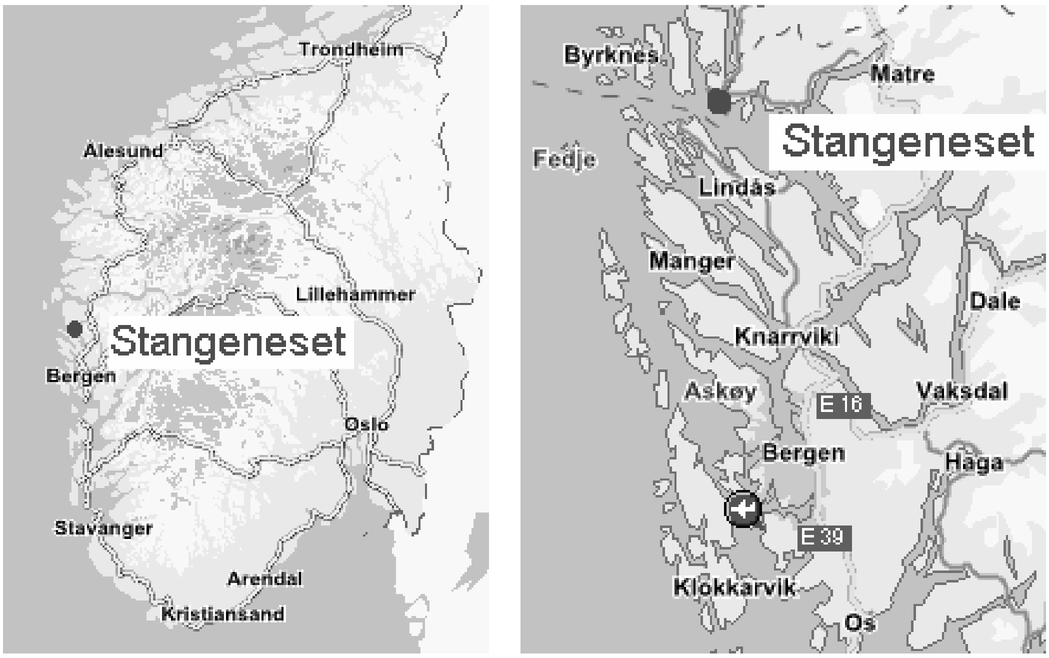
The annual production of produced water at Norwegian off-shore installations is about 200 million std. m3 containing 500 GBq of Ra-226 and 400 GBq of Ra-228.

The new Stangeneset Repository for NORM

The repository is designed for safe disposal of NORM-bearing waste, primarily LSA scale from the oil and gas industry. It is presently under construction and will start its operation already in 2007. Its location at the western coast of Norway is shown in Figure 4. The operator will be the local company Wergeland-Halsvik AS. The company Norse Decom AS, which is a subsidiary of IFE, will be responsible for client relations, quality assurance, environmental monitoring and radiation protection.

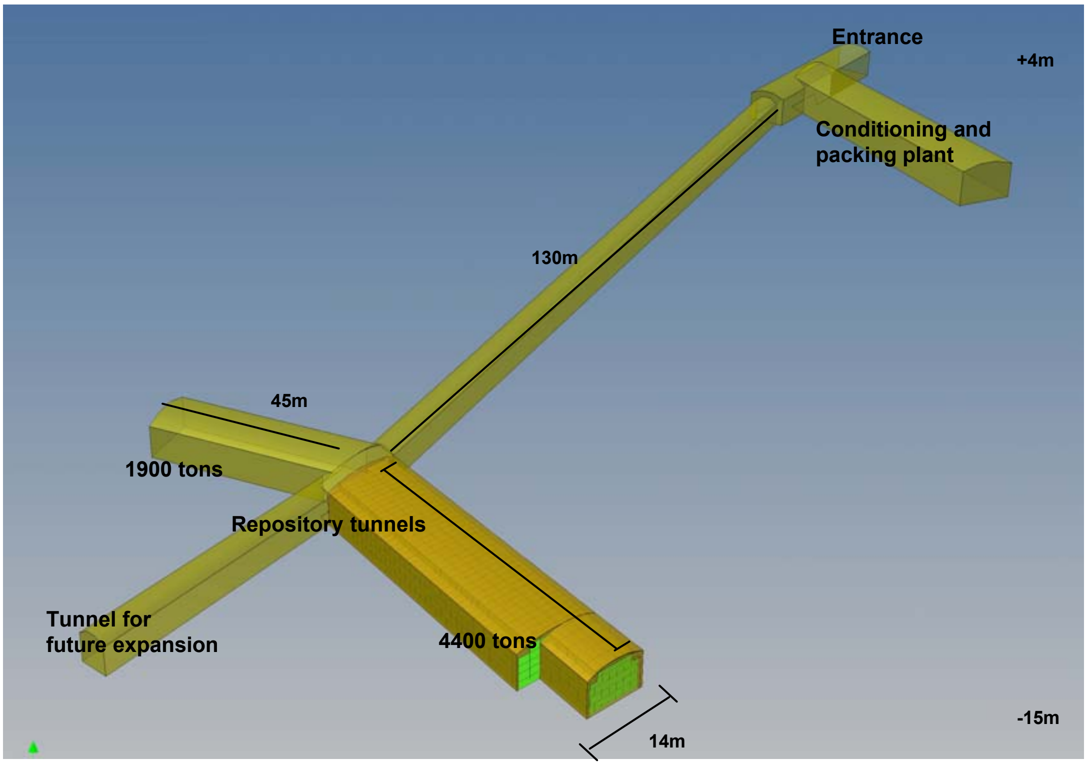
The Norwegian Government has given State Fund Guarantee for the repository and thereby approved it. It is expected that the Licence to Operate will be granted within the first half of 2007.

Figure 4. **Location of the Stangeneset repository for NORM**



A drawing of the repository is shown in Figure 5. It will receive untreated LSA scale and dispose it in underground rock caverns after conditioning and packing in HDPE-lined concrete containers. The repository will initially have a capacity of 6 300 tons of LSA scale, but the capacity can be extended to meet any future demand.

Figure 5. **Drawing of the Stangeneset repository**



The LSA scale producer is also the scale owner, which in practice means the actual licence holding petroleum company. All Norwegian producers have the right to establish contracts with the Repository for delivery of scale for disposal.

The country of origin defines the LSA scale “nationality”. Foreign LSA scale may under certain conditions be exported from other countries for final disposal at Stangeneset repository. However, to do so requires approval from the relevant authorities in both the exporting and the importing country.

SLOVAK REPUBLIC

Decommissioning of facilities

Until now none practices concerning decommissioning of non-fuel cycle facilities have been performed in Slovakia. All licensed facilities are under operation.

Management of radioactive waste from non-fuel cycle related activities

According to definition non-fuel cycle radwaste is that arising from using of ionising radiation sources in medicine, industry and research, i.e. institutional radwaste. management of that kind of waste consists of its collection, segregation, storage, treatment, conditioning and disposal.

Radiation protection regulatory body under Ministry if health is responsible for supervision of collection, segregation and storage of institutional radwaste. Nuclear regulatory authority is responsible for supervision of treatment, conditioning and disposal of that waste.

Current practices of management of institutional radwaste are based on its temporary storage within the place of using, respectively on safe collection and segregation of spent sealed sources and their centralised storage.

As far as concern open (non-sealed) sources this kind of waste is treated, conditioned and disposed of together with fuel cycle operational or decommissioning waste, if they are fulfilling waste acceptance criteria for existing near surface disposal facility in Slovakia. For higher level activity sealed sources no treatment and conditioning method is available nor disposal option is available. At present the project of so called integral long term storage facility is under preparation for this particular kind of institutional radwaste as well as for other waste waiting for deep geological disposal.

SPAIN

Issues

Framework: Description of the existing financial, legal and/or regulatory framework, and its workability, for decommissioning of facilities and treatment and disposal of radioactive waste associated with non- nuclear fuel cycle activities.

Spanish Legal Framework does not establish specific legislation for each "radioactive waste" category. Promoting for the development of a regulatory framework is one of the key objectives of Nuclear Safety Council (CSN).

The Regulatory system in place in Spain includes a set of regulations related to the different aspects associated to the radioactive waste management and disposal as a whole, this means that generally does not establish specific regulations related to the origin of the waste (waste producer) while it focus its attention on the significant characteristics of the waste for its further management to prevent the inherent risk associated to these materials.

The basic regulation for the licensing, operation and decommissioning of nuclear and radioactive installations comes through the *Regulation on Nuclear and Radioactive Installations (Approved by Royal Decree 1836/1999, of 3rd December)*[7]. Therefore its Title III is dedicated specifically to the radioactive installation while Chapter I is dedicated to "Definitions, classification and authorisations". Furthermore the Chapter III is on "Radioactive installations for research, medical, agricultural, commercial or industrial purposes". Its articles are as follows:

Article 38. *Request for operating.*
Article 39. *Authorisation granting.*
Article 40. *Changes and modifications.*
Article 41. *Decommissioning and closure.*
Article 42. *Closure statement.*

The last developments in the Spanish legislation pay specific attention to the issues related to the radioactive sources in those aspects not covered by the regulated handling and use of these materials in the corresponding and authorised installations. A specific case is been developed by the *Royal Decree 229/2006, of February 24th, on the control of high level encapsulated radioactive sources and orphan sources* that transposes to the Spanish system the European Council *Directive 2003/122/EURATOM, of December 22nd 2003, on the control of high activity sealed radioactive sources and stray sources is to prevent workers and the public from being exposed to ionising radiations as a result of inadequate control of high level encapsulated radioactive sources and the possible existence of orphan sources.*

7. Mentioned in Legal Framework, related Laws, Decrees, safety regulations and other materials, pg. 10

Thereafter it is also accepted the existence of certain marginal risk caused by beneficial activities, once it has been limited by all reasonable resources. In this context, it is establish a set of concepts (exemption and clearance) which use is fundamental in the whole Radiological Protection System and, by the way, affects to the use of radioactive material, including the management of the radioactive waste produced.

- Exemption. It is applied to the practises which radiological risk is as low that appears reasonable not to allocate specific resources through the Radiological Protection System. Thereof, the exemption consists to allow the producers to avoid certain administrative conditions when the derivate doses are trivial and its control is not justified. The "Regulations on nuclear and radioactive installations" defines this concept in Article 35 "Exemption as radioactive installation". Moreover, Table 1 of Annex 1 of such regulation offers the list by radionuclide of maximum activity and activity by unit mass bellow which its position and use does not require any authorisation.
- Clearance. As a consequence of the development of practises subjected to regulatory control, it can be generated radioactive materials, waste or reusable, which management can be done out of the regulatory control when the associated radiological risk is low enough. Such clearance is done on the basis activity levels (or activity by mass unit) that must be defined the Regulatory Authorities and that not necessary are equal to the exemption levels. In this case, furthermore, a specific authorisation issued by the competent authority will be required that will request the application of the corresponding procedures to guarantee that the release of the materials is being done in compliance to the criteria and levels defined. This "clearance option" is presented in the "Regulations on nuclear and radioactive installations", Article 76 "Release and management of radioactive materials".

In general terms, the Regulatory framework has not developed general level of reference to be used for clearance and a case by case philosophy is being used.

However, dedicated provision specifically for the MIR installations was adopted paying specific attention to the general characteristics of such waste producers. This has been developed through the Ministerial Order 1449/2003 of May 21st "On the management of solid waste material with radioactive content generated at category 2 and 3 radioactive installations where non-encapsulated radioactive isotopes are handled or stored."

From a financial point of view, the most relevant figure is the Royal Decree Law 5/2005, of 11th March 2005 modifying the Sixth Additional Provision of the Electricity Industry Act, Law 54/1997, of 27th November related to the Fund for the financing of the activities of the General Radioactive Waste Plan.

As it has been done up to now, the existing Fund will be due to finance the activities of the General Radioactive Waste Plan. Up to now, the Fund was covered by several incomes:

1. A quota on revenues via the electricity sales.
2. Invoice in advance for the RWM and decommissioning cost of the Juzbado Nuclear Fuel Manufacturing Plant.
3. Direct invoice from the operators of non-nuclear fuel cycle radioactive installations.
4. Financial yield.
5. Other minor incomes.

The new measures regulate the new prices system for the costs considered as being attributable to the operation of the NPPs from 31st March 2005 onwards. They shall be those associated with the management of radioactive wastes deposited in the plant store as from that date, as well as the proportional part of dismantling and decommissioning costs corresponding to the operating period remaining to the plant as of that date. As regards spent fuel, the costs considered as being attributable to operation following 31st March 2005 shall be those associated with the management of spent fuel resulting from the new fuel introduced into the reactor during refuelling outages concluding after that date.

- *National plan: The national plan for decommissioning and waste management associated with non-fuel cycle activities, including description of any overlap with the infrastructure for dealing with nuclear fuel cycle waste.*

The purpose of the state-owned corporation ENRESA is to provide the public service of managing radioactive waste, including spent fuel, and the dismantling and decommissioning of nuclear and radioactive facilities, produce proposals for the General Radioactive Waste Plan, implement the provisions of such Plan and manage the Fund to finance activities included in the General Radioactive Waste Plan (GRWP), all under the terms of such Plan's arrangement.

The GRWP itself is the basic reference document that clearly and concisely deals with all the strategies and actions to be undertaken in Spain in the different fields of radioactive waste management and the dismantling of facilities, along with the corresponding economic-financial study. This section also presents the main data relating to radioactive waste generation, programmes for removal, the capacity of the facilities, costs and revenues, etc., such that overall this part of the document is in itself sufficient to serve as a summary of the planning of this particular issue in Spain.

The 6th General Radioactive Waste Plan, currently in force as approved by the meeting of the Cabinet of Ministers held on June 23rd 2006, replaces the plan previously approved in July 1999 (5th GRWP) and constitutes a formal revision of that plan, in accordance with Royal Decree 1349/2003 of October 31st on the ordering of the activities performed by the radioactive waste management agency Empresa Nacional de Residuos Radiactivos, S.A (ENRESA) and their financing.

Responsible Organisation(s): Organisation(s) responsible for non-fuel cycle- related waste management and decommissioning

ENRESA is the National Agency responsible for the management of the radioactive waste being produced in Spain. In the frame of this responsibility, ENRESA is the solely organization for the management and disposal of the radioactive wastes arisen from the operation of radioactive devices in nuclear and radioactive installations for any purpose.

In addition to the before presented nuclear and radioactive installations related to the nuclear cycle, there are around 1,200 authorized nuclear and radioactive installations for medical, industrial and research (MIR) purposes in Spain.

The radioactive waste arisen from the MIR can be classified in three classes:

- Operational waste produced by the use of radioactive material in MIR applications,

- Decommissioning waste from the dismantling of the contaminated components of the radioactive installations and
- Disused/spent radioactive sources used in such installations.

The basic relations between ENRESA and the waste generators are defined by the Royal Decree 1349/2003 of 31st October on "Regulation of activities of Empresa Nacional de Residuos Radiactivos, S.A. (ENRESA), and funding thereof".

This regulation establishes that:

...

Section 3: *General provisions*

1. *The operators of nuclear and radioactive facilities working with radioactive substances are required to have special facilities for the storage, transport and handling of radioactive waste, under the provisions of section 38 of the Nuclear Energy Act 25/1964 of April 29th.*
2. *It is considered that the operators of nuclear and radioactive facilities also have facilities to which the preceding item refers when under contract or by any other means accepted by law they are able to use the services of companies, who shall be authorised by Royal Decree, and which have facilities for the storage, transport and handling of radioactive waste, even if they are owned or in the name of third parties.*
3. *These companies will provide the required services subject to requirements arising from the public interest and assurance of service provision.*

Section 4: *Authorisation for the Empresa Nacional de Residuos Radiactivos, S.A. to provide services and establishment of its roles.*

1. *Empresa Nacional de Residuos Radiactivos, S A. (ENRESA) is authorised to provide the services under section 3.2 and will have the following roles:*
   a) *Treatment and conditioning of radioactive waste.*
   b) *Site selection, design, construction and operation of centres for the storage and definitive disposal of radioactive waste.*
   c) *Establishment of systems for the collection, transfer and transport of radioactive waste.*
   d) *Adoption of measures to ensure safety in transit of radioactive waste under the terms of specific regulations governing the transport of hazardous goods and whatever the relevant authorities and agencies may specify.*
   e) *Management of the operations involved in the dismantling and decommissioning of nuclear and radioactive facilities.*
   f) *In the event of nuclear or radiological emergencies, act in support of the national civil defence system and security services, in the manner and situations required by the relevant agencies and authorities …*

Section 5: Standard-form contracts.

1. *The radioactive waste management services provided by ENRESA to nuclear and radioactive facility operators will be governed by contracts based on relevant standard-form contracts to be approved by the Ministry of Finance.* (currently, the Ministry for Industry, Tourism and Trade*)*
2. *Such contracts shall specify their term, which will last until the end of the lifetime of the facilities, to include the dismantling of nuclear facilities and, as appropriate, radioactive facilities, as well as financial consideration, where appropriate, for services to be provided, under the terms hereof.... "*

These contracts establish the contractual terms, which will extend until the end of the service lifetime of the installations, including the services related to dismantling of nuclear and radioactive facilities where appropriate and the payment to be made where applicable. This will ensure that the services are rendered in accordance with the provisions enacted by this regulation.

Due to the differences between large generators – i.e. nuclear facilities – and institutional generators regarding industrial capacities mainly, it is here defined two models that, even when responding to the same philosophy, should consider the specific industrial capacities of each type of waste generator regarding waste treatment and conditioning.

The responsibilities within the operator of the installation (waste producer) and ENRESA are defined through this figure.

For the small producers, the main text of the contract is defined by several clauses related to:

1. Definitions
2. Object
3. Obligations of each party
4. Financing
5. Duration of the contract
6. Decommissioning

In addition, the following technical annexes regarding specific points of interest to ENRESA for the subsequent waste management are included:

a. RW description sheet
b. Delivery note for waste collection
c. Waste type assignment
d. Waste Acceptance Criteria
e. Tariffs

Packaging: National technical requirements for waste packaging that are applicable to radioactive waste from non-nuclear fuel cycle-related activities.

The technical application of the standard-contract by the operator of a radioactive installation is defined through safety regulations and procedures for the functioning of the installation and the on-site management of the waste being produced.

In general terms, the producer is responsible for the waste sorting according the waste categorization and technical procedures defined by ENRESA. ENRESA has the duty to verify the application of such procedures and confirm the suitability and homogeneity of the primary packages prior to grant its acceptance for their removal and transport for further management at the El Cabril centre.

Primary packaging done by the producers has the only objective to facilitate the waste sorting and removal. For its transportation, ENRESA's staff put theses primary packages into appropriate and licensed overpack.

Waste management treatment facilities and disposal sites: existing and planned waste treatment facilities and waste disposal sites for waste from nuclear activities not associated with the nuclear fuel cycle.

The table presents the current National radioactive waste classification, taking into account as main references its specific initial activity level and semi-decay period for dominant radionuclides. It is mentioned also the ongoing management routes in Spain.

	Short and Medium lived Main radionuclides <30 years	**Long lived** Main radionuclides >30 years
Very Low (VLRW)	Ongoing project for near surface disposal	In situ stabilisation in former mining sites
Low and Intermediate (LILW)	Near surface disposal facility in operation (El Cabril)	Storage. Disposal under consideration (6^{th} General Radioactive Waste Plan)
High (HLW)	Storage. Disposal under consideration (6^{th} GRWP)	

The El Cabril LILW disposal centre is the final destination of the inventory of radioactive waste being generated at the Spanish MIR radioactive installations. Generally, they are treated and conditioned for disposal. In this case, their acceptance for disposal is conditioned to the full compliance of the Waste Acceptance Criteria (WAC) issued for the facility as result of its Safety Assessment. In some other cases, they cannot be disposed of. For this purpose, the centre is allowed to store them till a disposal route will be available.

ENRESA has the responsibility to verify, prior to the removal of the waste from the producer site that the primary packages generated by the radioactive installation comply with the basic requirements and conditions issued by the Nuclear Regulatory Body.

When ENRESA confirms the compliance of those requisites, accepts the packages and becomes the solely responsible.

These primary packages are delivered to the El Cabril centre for further handling, treatment and conditioning. ENRESA will work with them at its facilities with the final objective to generate packages for disposal that have to meet with the same conditions and requirements applied to the packages coming from the Nuclear Installation (e.g. NPPs).

In the case of non-nuclear cycle radioactive waste, treatment and conditioning is carried out at the El Cabril facilities, since given the small volume generated, the large number of producers and their different characteristics there would be no justification for each such producer having the necessary installations.

In spite of the difficulties posed by the dispersion of these producers, the problem of managing their wastes may be considered to be basically solved. However, these producers need to be continuously trained, with a view to optimising subsequent waste management.

Waste transport is performed by ENRESA, as the responsible operator. This is accomplished either using the Company’s own resources, in the case of wastes generated by Radioactive Installations (RI), or by way of specialist companies, in the case of conditioned wastes from Nuclear Installations. Until such time as the wastes are transferred to El Cabril, they are temporarily stored in the authorised installations that the producers have in their sites.

Inventory of generated waste: the volume and characteristics of the radioactive waste from non-nuclear fuel cycle activities.

Non-nuclear cycle installations which use radioactive isotopes and are therefore subject to monitoring by the regulatory authority, are generally grouped into one of the following three groups according to the type of activity they carry out:

- Medical installations
- Installations connected to industry and agriculture
- Research and teaching institutions

In 2006, a total of 1,330 RIs were authorized to operate, the majority located in the Autonomous Communities Madrid and Catalonia (261 and 260 respectively) followed by Andalusia (177), the Basque Country (119) and Valencia (112).

Although not technically RIs, non-regulated installations in the steel and metal recovery sectors are also classified as belonging to this group for inventory purposes when these installations detect metal scrap containing radioactive material within the scrap to be processed.

The characteristics of the installations in each of these three groups can be summarized as follows with regard to the generation of radioactive waste:

- Medical installations: characterized by the production of noticeable quantities of radioactive waste on a regular basis. In Spain they constitute approximately 30% of all RIs and generate some 80% of waste which is managed by Enresa.
- Installations related to industry and agriculture: these produce small quantities of waste on an occasional basis. They constitute 60% of all installations in Spain and generate approximately 5% of all managed waste.
- Research and teaching centres: their production of waste is small but is on a regular basis. They represent 10% of all RIs and generate approximately 15% of managed waste.

The greater majority of waste generated in these installations can be included in the LILW group for inventory purposes. Nevertheless, since the waste delivered to Enresa is not conditioned, classification criterion must be adopted regarding the treatment the waste must undergo when it arrives at the nuclear power plant of El Cabril facility. The following codes are used in this classification:

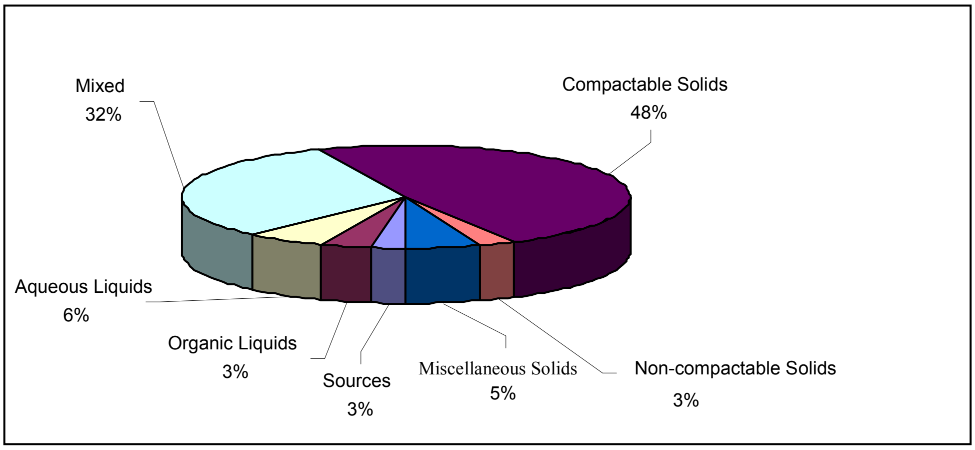
- S-01: Compactable solid waste
- S-02: Non compactable solid waste
- S-03: Animal carcasses and biological waste

- S-04: Hypodermic needles in rigid containers
- S-05: Other special solids not covered by the above codes
- M-01: Mixed waste composed of organic liquids plus vials
- M-05: Special mixed waste
- L-01: Organic liquid waste
- L-02: Aqueous liquid waste
- L-05: Special liquids
- F-01: Encapsulated sources with a radioactivity limit below that established for transport containers type A of the ADR Dangerous Goods Transport Regulation and with a volume less than 20 litres for the source and container combined.
- F-02: Encapsulated sources with the same radioactive life as F-01 but with a volume above 20 litres and below 80 litres.
- F-03: Encapsulated sources which exceed the limits of radioactivity or volumes established for the codes F-01 and F-02.

Figure bellow shows the proportion of each of these types of waste according to the current volume of waste generated annually at radioactive installations.

Depending on the type of installation in question, specific characteristics of the waste generated can be established, for example, in the case of medical installations this would comprise source, vials, hypodermic needles, aqueous liquids, biological residue and miscellaneous solids. As concerns industrial and agricultural installations this tends to be encapsulated sources, and in research and teaching institutions compactable and non compactable solids, aqueous and organic liquids, mixed waste and finally animal carcasses predominate.

Figure 1. **Types of radioactive waste in RIs**



Data management and data tracking: Systems established for tracking data, the extent to which data are tracked, and how data reliability is assured, for radioactive waste from non-nuclear fuel cycle activities.

Cost estimation: Practices for estimating the cost of decommissioning, waste treatment and disposal, and the difficulties associated with accurate estimates, for facilities and radioactive waste associated with non-nuclear fuel cycle activities.

Funding: The existence of funds, and the extent to which the responsibility is that of the state (province) or national governments, for decommissioning of facilities and treatment and disposal of radioactive waste associated with non-nuclear fuel cycle activities.

From the economic-financial point of view, there is a system that guaranties the financing of radioactive waste management costs, based in the principle of generating funds up-front, throughout the operational lifetime of the Nuclear Power Plants.

Along the years since 1984, the system has been quite stable, even it has been refined several times. In 2005 a major change happened by introducing the so-called “internalization” philosophy to the cost related to the management of the waste being produced by the Nuclear Power Plants. Here will be explained what are the legislative base and principles for the new system.

ENRESA must evaluate every year the whole life system cost of radioactive waste management. The economical appraisal is presented to the MITyC.

The final economic balance of the management performed by ENRESA should be zero. Both the incomes and the financial yield of net surpluses are set aside for the Fund. This Fund must be used only in compliance with the objectives for which ENRESA was created and therefore for financing of the costs of the General Radioactive Waste Plan (GRWP).

The supervision, control and qualification of the financial investments of the Fund are the responsibility of the Tracking and Control Committee that reports to the MITYC.

The system applicable to the licensees of non nuclear fuel cycle radioactive installations by applications in the medicine, industry, agriculture or research, is through regulated tariffs approved by the MITYC. To those all, they are directly invoiced by the services rendered when the wastes are collected.

APPENDIX 4

PARTICIPANTS LIST FOR THE 40TH SESSION OF THE RADIOACTIVE WASTE MANAGEMENT COMMITTEE

14 March 2007 - 16 March 2007

Member Country	
Australia	Mr. Jim SCOTT ARPANSA
Australia	Dr. Ron HUTCHINGS Australian Permanent Mission to the UN
Austria	Mr. Helmut FISCHER Federal Ministry of Agriculture, Forestry, Environment and Water Management
Belgium	Mr. Walter BLOMMAERT Federaal Agentschap voor Nucleaire Controle
Belgium	Mr. Jean-Paul MINON ONDRAF/NIRAS
Canada	Dr. Peter BROWN Natural Resources CANADA
Canada	Ms. Kathryn SHAVER Nuclear Waste Management Organisation
Canada	Mr. Robert LOJK Canadian Nuclear Safety Commmission
Czech Republic	Mr. Miroslav KUCERKA Radioactive Waste Repository Authority
Denmark	Mr. Tue DYEKJAER-HANSEN National Institute for Radiation Hygiene
Finland	Mr. Esko RUOKOLA Radiation and Nuclear Safety Authority
Finland	Dr. Juhani VIRA Posiva Oy
Finland	Ms. Jaana AVOLAHTI Ministry of Trade and Industry
France	Mr. Philippe BODENEZ Autorité de Sûreté Nucleaire (ASN)
France	Mrs. Marie-Claude DUPUIS Andra
France	Mr. Michel JORDA IRSN/DSDRE
France	Mr. Alain MARVY CEA/Saclay
France	Mr. Gerald OUZOUNIAN Andra
France	Mr. Cyrille VINCENT DGEMP
Germany	Mr. Georg ARENS Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU)
Germany	Mr. Tilmann ROTHFUCHS Gesellschaft für Anlagen und Reaktorsicherheit (GRS) mbH

Germany	Dr. Klaus-Juergen RÖHLIG Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) mbH
Germany	Dr. Peter BRENNECKE Bundesamt für Strahlenschutz (BfS)
Germany	Dr. Christoph SCHOLTEN Permanent Delegation
Germany	Dr. Enrique BIURRUN DEB Technology GmbH
Hungary	Mme Ildikó CZOCH Hungarian Atomic Energy Authority
Italy	Mr. Giuseppe BOLLA SOGIN
Italy	Dr. Mario DIONISI APAT
Italy	Dr. Alfredo LUCE ENEA C.R. SALUGGIA
Italy	Mr. Ivo TRIPPUTI SOGIN
Japan	Mr. Yoshio KAWAGUCHI Permanent Delegation
Japan	Mr. Kazumi KITAYAMA Nuclear Waste Management Organisation of Japan (NUMO)
Japan	Dr. Masaaki MISHIRO Japan Atomic Energy Agency (JAEA)
Japan	Mr. Hiroshi RINDO Japan Atomic Energy Agency (JAEA)
Japan	Dr. Hiroyuki UMEKI Japan Atomic Energy Agency (JAEA)
Japan	Mr. Shintaro HARA Ministry of Economy, Trade and Industry (METI)
Japan	Dr. Noriaki SASAKI Japan Nuclear Energy Safety Organization (JNES)
Korea	Mr. Jong-Won CHOI Korea Atomic Energy Research Institute (KAERI)
Korea	Dr. Sang-Hoon PARK Korea Institute of Nuclear Safety (KINS)
Korea	Mr. Youn Keun LEE Korea Institute of Nuclear Safety (KINS)
Netherlands	Mr. Henk SELLING Ministry of Housing, Spatial Planning and the Environment
Norway	Mr. Gordon CHRISTENSEN Institute for Energy Technology
Spain	Dr. Carmen RUÍZ LÓPEZ CSN
Spain	Mr. José Antonio GAGO BADENAS ENRESA
Sweden	Mme Elisabeth ANDRÉ TURLIND Swedish Nuclear Power Inspectorate (SKI)

Sweden	Ms. Taina BÄCKSTRÖM Swedish Radiation Protection Authority (SSI)
Sweden	Mrs. Monica HAMMARSTRÖM Management Company (SKB)
Sweden	Mrs. Josefin Päiviö JONSSON Swedish Nuclear Power Inspectorate
Switzerland	Mr. Piet ZUIDEMA NAGRA
United Kingdom	Mr. David BENNETT Environment Agency
United Kingdom	Dr. Alan HOOPER United Kingdom Nirex Limited
United Kingdom	Mr. Robert JACKSON Dept. for Environment, Food & Rural Affairs
United States	Ms. Margaret FEDERLINE
United States	Mr. Theodore SHERR US Nuclear Regulatory Commission
United States	Mr. Abraham VAN LUIK US Department of Energy
United States	Mr. Alan BROWNSTEIN US Department of Energy
United States	Daniel SCHULTHEISZ US Environmental Protection Agency

Non-Member Country	
Slovenia	Mr. Maksimilijan PECNIK Slovenian Nuclear Safety Administration
Slovenia	Mr. Miran VESELIC Director, Agency for Radwaste Management

Consultant to NEA	
Switzerland	Alec BAER

European Commission	
EC	Mr. Wolfgang HILDEN
EC	Dr. Michel RAYNAL

International Atomic Energy Agency	
IAEA	Mr. Jan-Marie POTIER

OECD/Nuclear Energy Agency	
OECD / NEA	Mrs. Evelyne BERTEL Administrator, Nuclear Development Division
OECD / NEA	Mr. George BROWNLESS Administrator, Radiation Protection
OECD / NEA	Ms. Elizabeth FORINASH Administrator, Radioactive Waste Management
OECD / NEA	Mr. Edward LAZO Principal Administrator, Radiation Protection
OECD / NEA	Ms. Gail MARCUS Deputy Director General
OECD / NEA	Mr. Patrick J. O'SULLIVAN Administrator, Radioactive Waste Management
OECD / NEA	Mr. Claudio PESCATORE Principal Administrator, Radioactive Waste Management
OECD / NEA	Mr. Hans RIOTTE Head, Radiation Protection and Radioactive Waste Management Division
OECD / NEA	Mr. Takanori TANAKA Deputy Director, Safety and Regulation