ONDRAF/NIRAS
Belgian Agency for Radioactive Waste
and enriched Fissile materials

Data file

ONDRAF/NIRAS, the Belgian National Agency for Radioactive Waste and enriched Fissile Material

Organisme National des Déchets Radioactifs et des matières Fissiles enrichies (ONDRAF)

Nationale Instelling voor Radioactief Afval en verrijkte Splijtstoffen (NIRAS)

ONDRAF/NIRAS is a public institution, entrusted by the legislator under the law of August 8, 1980, amended by the law of January 11, 1991 with the management of radioactive waste generated on Belgian territory. Actually, the agency is the realisation of the authorities' wish to structure and centralise the collection and management of radioactive waste.

By granting ONDRAF/NIRAS the status of a public institution, the legislator has clearly expressed his intention to establish a radioactive waste management system in which the overriding objective is the safety of the population and the environment, and the hazards and demands of the economy are at all times subordinate.

ONDRAF/NIRAS is managing the radioactive waste so that it does not constitute any danger to the population or the environment. Moreover, ONDRAF/NIRAS is conducting intensive investigations into solutions allowing to finally isolate the radioactive waste from the biosphere, so that no danger is involved for future generations either.

ONDRAF/NIRAS is seeing its mission as follows: to protect man and the environment, for the present and future, against the potential hazards arising from radioactive waste, without thereby imposing any excessive obligations on future generations.

Radioactive waste in Belgium

Waste products are part of any human activity. Nuclear activities, whether in the industrial or medical field, are no exception to this rule, and thus also generate waste products. Some of these waste products are radioactive and hence require a specific approach.

The producers of the radioactive waste

The major producers of radioactive waste belong to the nuclear power generation sector (the nuclear power stations of Doel and Tihange). The manufacturers of nuclear fuel elements, Belgonucléaire and FBFC International (Franco-Belge de Fabrication de Combustibles International) located at Dessel, the SCK•CEN (national nuclear energy research centre) at Mol, and the IRE (Institute for Radio-elements) at Fleurus are considered as medium-sized producers. Also belonging to the nuclear fuel cycle operations, is the waste originating from the reprocessing abroad of spent nuclear fuel from the power stations, and the waste from the decommissioning of Belgian nuclear facilities.

Radioactive waste is also generated by the use of radioactivity's properties and/or radionuclides in the medical sector, for cancer treatment, diagnosis, etc., in various industrial sectors and in agriculture. Finally, the operation of many appliances being part of the man's daily life is based on the action of radioactive elements. Consequently, when they are no longer used, they are considered as radioactive waste.

The radioactive waste producers

- Nuclear power stations: the majority of the waste generated by nuclear power stations is originating from the operation of the nuclear reactors.
  Among others, this waste comprises filters, purification products, protective material, such as gloves and clothing.
- Reprocessing plants: the uranium and plutonium remaining in the spent fuel is separated from the fission products. Reprocessing is carried out abroad. Uranium and plutonium are recovered. The fission products (the waste) are conditioned in glass in view of their storage.
- Fuel fabrication plants: here the nuclear fuel is prepared for use.
- Radio-isotope fabrication plants: Radio-isotopes are radioactive elements which are used in various applications, in agriculture, in medicine and in industry.
- Decommissioning of disused nuclear facilities and in particular, the nuclear "liability programmes", which are the former EUROCHEMIC reprocessing plant, the first European Pressurised Water Reactor BR3, the former waste treatment and storage site of the SCK•CEN.
- Universities, hospitals, research centres and various industries.

The costs of radioactive waste management are borne by those producing the waste, according to objective criteria and distribution codes determined on the basis of each producer's share in the total waste volume.

The producers involved also constitute funds to cover the management costs in the future. These funds will be gathered in a fund for the financing of the long-term costs, managed by ONDRAF/NIRAS, and should allow the agency to fulfil its future obligations. This fund is now being established.

Radioactive waste categorisation

ONDRAF/NIRAS classifies radioactive waste on the basis of the importance of the risk. In all, three categories are distinguished. On account of the overriding importance of safety, each category is managed in a specific way.

The waste categories are based on two criteria:

1. *The amount of radioactive substances contained in the waste* (which broadly corresponds to the intensity and type of radiation). This criterion is expressed as radiation activity of the waste (high-, medium-, and low-level).
2. *The duration of the risk* (or the life of the radiation), which depends on the decrease of radioactivity with time, and is expressed as half-life (short-, or long-lived). The half-life is the time it takes for any radioactive substance to lose half of its radioactivity. It is different for each radioactive substance, and may vary from seconds to thousands of years. The half-life does not express the time it takes for any radioactive substance to become non-radioactive, but actually indicates the decay rate of the radioactivity in any substance.

The measures with respect to protection against radiation and contamination are proportional to the activity level and the duration of the risk of the radioactive

substances. Consequently, the categorisation of radioactive waste is in accordance with very precise protection measures.

Category A: low- or medium-level short-lived waste

This category comprises low- and medium-level waste having half-lives of less than 30 years.
This waste originates from the operation of nuclear power stations and facilities using or manufacturing radio-elements. It mainly includes used materials or products (filters, purification products, protective material, such as clothing and gloves) which might have been in contact with radioactive substances.
This waste may contain long-lived radio-elements, but only in such a negligible amount that they do not involve any danger. (These radio-elements generally emit alpha radiation.)

Category B: low- or medium-level long-lived waste

This category comprises waste contaminated by long-lived radio-elements, in such large amounts that it cannot be classified in category A.
This waste mainly originates from facilities manufacturing fuel elements for nuclear power stations, and from facilities reprocessing irradiated fuel.

Category C: high-level and very high-level waste

This category comprises large amounts of beta and alpha emitting radio-elements having short or long half-lives. They are highly heat-generating.
This waste arises from the reprocessing of irradiated nuclear fuel. Spent fuel that is not reprocessed also belongs to this category.

Amounts

At present, ONDRAF/NIRAS is managing (figures as of December, 1998):

- 10,845 m³ of conditioned low-level waste (Category A waste)
- 3,715 m³ of conditioned medium-level waste (Category B waste)
- 215 m³ of conditioned high-level waste (Category C waste).

These wastes are in safe interim storage at Belgoprocess, the industrial subsidiary of ONDRAF/NIRAS, located at Mol-Dessel.

ONDRAF/NIRAS estimates that by the year 2050, the following overall amounts of conditioned waste have to be managed:

- 60,000 m³ of conditioned low-level waste (Category A waste)
- 8,000 m³ of conditioned medium-level waste (Category B waste)
- 2,500 m³ of conditioned high-level waste (Category C waste).

In this assessment, it is assumed that the current programme of nuclear generation of electricity is completed (7 nuclear reactors) and that radio-isotopes and sources of radiation will further be used in industry and medicine.

Radioactive waste management

The principles underlying the management of radioactive waste are in fact exactly the same as those governing the management of household and industrial wastes: sorting at the point of generation, volume reduction, recycling and recovery. However, the safety rules and regulations are adapted to the specific nature of the materials to be managed, and together with appropriate plant and equipment they provide the required protection from radiation and contamination.

Management starts as soon as the waste arises in the facilities using radioactive substances and materials. The main objective is to protect man and the environment, for the present and future, from the possible detrimental effects of radiation.

In order to achieve this goal, the primary heterogeneous and multiform wastes are converted, through a series of treatment and conditioning processes, into an homogeneous, compact and chemically stable final product. This final product should be limited in volume and confine the radio-isotopes present, so that they cannot cause any damage to man or the environment.

The management of radioactive waste comprises various stages:

1. At the point of generation

ONDRAF/NIRAS imposes a number of rules and waste specifications to be met by the producers. Wastes must be sorted and the packaging must clearly show the kind of radioactive substances it contains. Besides, the producers must limit waste arising as much as possible.

2. Transportation

ONDRAF/NIRAS organises the collection of most of the primary wastes at the various producers' sites. An inventory of these wastes is drawn up, and the wastes are transported to the processing and conditioning facilities of Belgoprocess, the subsidiary of ONDRAF/NIRAS, at Mol-Dessel.

Some waste producers have their own facilities for processing a major part of their waste themselves. In that case, the final products are transferred to the central storage facilities of Belgoprocess at Mol-Dessel.

No special safety measures are required for the transportation of low-level waste. This waste can be transported with a common truck, without requiring special equipment. However, the carrier must have a special licence. The transportation of the other wastes requires appropriate transport means, since the environment must be protected from radiation and dispersion of radio-isotopes. For this purpose, ONDRAF/NIRAS uses specialised carriers, among which Transnubel and Transrad, who have the required vehicles and equipment, and transport licences issued by the competent authority (Ministry of Public Health).

3. Volume reduction, stabilisation and confinement of radioactive wastes

Volume reduction

Different techniques are applied to reduce the volume of radioactive waste.

- *Liquid radioactive wastes* are treated chemically or thermally. In a chemical treatment, chemicals are added to the liquid wastes, forming flocks to which the radioactive compounds are bound. Those flocks settle and form a sludge layer, which is filtered and dried. The purified water may be released after control, in compliance with the discharge licences issued by the competent authorities. In a thermal treatment, the water is boiled down to a radioactive sludge. The condensed water vapour is released after control.
- *Solid combustible radioactive wastes* are incinerated at a temperature of 900 °C and reduced to ashes in an industrial incinerator. The flue gases are filtered and released.
- *Solid non-combustible radioactive wastes*, providing they are compressible, are collected in steel drums and compacted under very high pressure (2,000 t). The result is a cake approximately 25 cm thick. Non-compressible wastes are cut up, so that they can be collected in standard drums.

Stabilisation and confinement of radioactive waste

The intermediate treatment products (sludge, ashes, cakes, ...) are embedded in cement or bitumen so that a solid block is formed inside a metal drum, and radio-isotopes are thus prevented from dispersing. The assembly of treated waste, embedding in cement or bitumen and packaging in a metal drum is called a waste package. This mode of operation also aims at facilitating handling in subsequent stages of the waste management. Each waste package is provided with identification, so that at any time, the nature and origin of the waste contained by the package can be checked.

High-level waste mainly comprises waste arising from the reprocessing of irradiated nuclear fuel elements. These are presently reprocessed in the facilities of Cogéma at La Hague, France. The heat-generating waste is incorporated into molten glass and immediately poured into stainless steel canisters. Upon cooling, this glass structure ensures a very stable confinement of the radioactive material.

4. Storage

The waste packages resulting from the treatment and conditioning are stored in specially designed storage buildings, located on the site of Belgoprocess, awaiting their further long-term management.

The drums containing conditioned low-level waste are stored in a building, provided with remotely controlled handling equipment, in order to reduce the already low radiation exposures of the workers even further (application of the ALARA principle - as low as reasonably achievable).

The drums containing conditioned medium-level waste are stored in facilities provided with remotely controlled handling equipment. These facilities are shielded in order to ensure an optimal protection of the environment.

The vitrified, highly radioactive and heat-generating waste is stored in facilities specially equipped for this purpose, under forced ventilation, where it will remain in storage for 50 years, until it is sufficiently cooled to allow its disposal.

5. Long-term management

In this respect, a distinction is made between the long-term management of low-level and short-lived waste, and the long-term management of high-level and long-lived waste. The duration of the risk plays an important role.

a) the long-term management of low-level and short-lived waste

In June of 1997, ONDRAF/NIRAS has published a report on the technical options for the long-term management of low-level and short-lived waste (NIROND 97-04). This report emphasised the need for society to reflect on the long term. Does Belgium choose long-term storage or disposal ? That was the strategic knot to be cut.

Instead of immediately entering into the debate on the different options for the long-term management of low-level waste, the report requested that the government would first take a decision with respect to the management strategy, based on two ethical principles required by the IAEA-Safety Fundamentals: first, the health effects to be expected for future generations must not exceed the levels which are acceptable today. Second: the present generation must not transfer excessive obligations to future generations.

Long-term storage offers an interim solution, in that it consists in the storage of the waste in specially designed buildings with means for inspection. The radioactive waste is accessible at all times. The buildings are resistant to exceptional conditions, such as storms, earthquakes, explosions ... This solution requires an active management and an active control of the waste in the long-term. Consequently, safety depends on the decisions taken by future generations. Moreover, this option requires the latter to put in important technical and financial efforts.

Disposal guarantees the long-term safety in a passive and robust way. During the entire implementation and filling stage of the repository - a stage which owing to the limited production of waste, will progress extremely gradually and take much time - the decision making process remains reversible, and the possibility remains to consult all parties concerned at any moment, and to integrate progress made in research. During this stage, the repository is operated as a prolonged storage facility, offering the fundamental advantage that at the appropriate time, future generations can decide to close the facility and switch to a passive management of the waste packages. Disposal offers a final solution, either at the surface, or in the underground.

Surface disposal is completely based on the principle of multiple shielding, as in the Russian dolls, where the smallest doll is protected by all the others. As soon as it is decided to close the concrete repository units, the low-level waste packages are artificially shielded by various impermeable covering layers. A control gallery is provided under each repository unit.

In an *underground repository*, the long-term safety is guaranteed by the host rock in which the repository is built. The host rock currently being studied in Belgium is clay. Clay is favourable, because it has small permeability, good absorption properties, and neutralises crack formation thanks to its plastic nature. Construction tests in the underground laboratory at Mol, at a depth of 230 m, have shown that it is possible to dig galleries with the appropriate diameter in clay, using industrial techniques. Additional research and development work is required to study the compatibility of low-level waste with the clay formation.

GOVERNMENT MAKES A STRATEGIC CHOICE

On January 16, 1998, the Cabinet decided to opt for a final solution, i.e. a solution which can be made final, but is also progressive, flexible and reversible in its implementation. As soon as possible, the Cabinet also wants to make its choice between the technical solutions of surface and underground disposal.

In order to enable the government to make the choice between surface disposal and underground disposal on a sound basis, the Minister of the Economy has entrusted ONDRAF/NIRAS with the following tasks:

- As soon as possible, ONDRAF/NIRAS should further elaborate and finalise the conceptual study of surface disposal, and especially develop the aspects of reversibility and controllability.
- As soon as possible, ONDRAF/NIRAS should further elaborate and finalise the feasibility study of underground disposal and the associated cost estimate for low-level waste.
- ONDRAF/NIRAS should develop a methodology allowing to integrate such a project on the local level. This methodology not only includes the management structure, but also consultation with all parties involved, so that both their concerns and wishes can be taken into account.
- ONDRAF/NIRAS should limit their field work to the existing nuclear areas (Doel, Fleurus, Mol-Dessel and Tihange), and to areas where the local authorities show an interest in the project.

In order to carry out these new tasks, NIRAS/ONDRAF has established a new work programme. This programme provides for the definition of concrete pre-projects of a repository that is final or intended to become final, either at the surface or in the underground, so that the Government will be able to select with full knowledge of the facts, which of the projects are to be elaborated further. “Final or intended to become final” since the disposal will remain completely reversible, at least until the closure of the site, by the year 2060, and even longer in the case of surface disposal. Integration and partnership are under discussion, according to an original socio-economic approach that is being developed by NIRAS/ONDRAF for some years already.

The complete work programme of NIRAS/ONDRAF is as follows:

- ***Stage 1:*** identification of the work areas by means of preliminary administrative investigations and fieldwork. For each area that is taken into consideration after these preliminary investigations, a local partnership is set up.

- ***Stage 2:*** characterisation of the work areas by means of extensive investigations in the field, and elaboration, in close co-operation with the local partners, of a detailed pre-project, on the basis of the needs and capabilities of the region.
- ***Stage 3:*** assessment of the pre-projects by independent experts in the fields of safety, respect of the environment, and economical and social-cultural cost-effectiveness. Subsequently, the pre-projects and their experts' assessment are submitted to the government, who can then make a choice.

The most innovating element of the methodology now being followed by ONDRAF/NIRAS, is the emphasis put on the integration of the project on a local level. The agency will in doing so, of course, not neglect the security aspect or its general study on the concepts and the feasibility. It gradually came to realise over the last few years - and this was clearly confirmed in the new missions from the government - that the traditional procedures are not sufficient in this case. A method must be applied in which all concerned parties on a local level have a say in the matter at an early stage. The aim of ONDRAF/NIRAS henceforth is to set up a partnership with each municipality that wishes to do so when they fulfil at least the minimal technical conditions, and to develop with each of them an integrated disposal project that is socially acceptable and offers maximum added value to the region.

b) the long-term management of high-level and long-lived waste

Extensive research and development programmes have been set up to study the various possible options. These scientific programmes, which have frequently been the subject of close international co-operation, all proceed according to the same approach, i.e. the construction of repositories in deep, stable, substantially impermeable geological formations which have proven their isolating capacities over millions of years, or which appear to be able to effectively limit the possible dispersion of radio-isotopes to the biosphere.

The method presently being studied by ONDRAF/NIRAS for the high-level and long-lived waste assumes the construction of a repository in deep clay layers offering sufficient protection in the very long term.

The development and results of the studies in progress are submitted to the competent supervising authority (the Minister of the Economy), in the form of progress reports, so that the latter can take the required decisions with full knowledge of the facts.

Decommissioning

Nuclear facilities retired from service and their infrastructure are carefully decontaminated prior to being dismantled. In specific cases such as the dismantling and cutting of highly activated components from nuclear reactors, remote controlled robots or under water cutting are used to protect the workers against the radiation from those structures. Upon completion of the dismantling stage of the contaminated and activated components, the facilities and their infrastructure are either demolished, re-commissioned for example as a storage facility, or re-used for conventional applications.

Under the provisions of the law of January 11, 1991, the legislator assigned by law certain responsibilities in the field of decommissioning to ONDRAF-NIRAS. Among others, the agency has to collect and to evaluate information related to the decommissioning programmes of nuclear installations, to approve those programmes, and to execute decommissioning programmes at the demand of third parties or in the case of failure of an operator. Thus, initial, ongoing and final decommissioning planning following the IAEA-Safety Requirements and Guides in the field of decommissioning is a common practice. For the purposes of standardisation of decommissioning planning, ONDRAF-NIRAS issued recommendations for the elaboration of decommissioning plans.

Strategies for decommissioning and site restoration activities, as well as for the management of the resulting radioactive waste, are essentially guided by the principles of the Safety Fundamentals of the IAEA. As those activities are associated rather with "practice" than "interventions", optimisation of radiation exposures as well as dose limitation (ALARA) are required. The burden on future generations is limited as much as possible by adequate decommissioning planning, including the provision for the financing of activities in the future. This is also why the legislator furthermore assigned by law to ONDRAF-NIRAS in 1997, the elaboration of an inventory of all nuclear installations and all sites containing radioactive substances within the country, including the verification of the existence of sufficient financial provisions for the execution of decommissioning and restoration programmes. The burden on the future generations is also reduced by the recycling of materials as much as is economically possible, rather than leaving the future generation with radioactive waste which needs to be disposed of. Furthermore, recycling preserves raw material sources, and follows tendencies for waste management in general, i.e. other than radioactive waste, essentially for ecological reasons.

In this field, a broad experience has been gained, among others through the decontamination and dismantling of the facilities of the former Eurochemic reprocessing plant at Dessel and the BR3-PWR at Mol.

The decommissioning of Belgium's nuclear plants constitutes in the future the largest source of radioactive waste to be managed. It will mainly generate low-level waste.

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