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WP 1 Review Report – Other Member States

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Integrated Waste Management Approach WP 1 Review Report – Other Member States

Executive summary

Although these four Member States have invested in nuclear reactor development the likely combined arisings of irradiated graphite represents a small proportion of the EU total quantity. Consequently information regarding graphite characteristics is sparse but may be expanded when decisions are taken to decommission the three/four demonstration reactions, some of which are still in operation.

The criteria for retrieval, possible treatment and disposal that these Member States will need to consider could have several/many synergisms with considerations other Member States will examine who have invested in graphite moderated reactors.

Revisions

Rev.	Date	Short description	Author	Internal Review	Task Leader	WP Leader
01	23/01/2009	Issue 1 draft	H Eccles (UK NNL), L Juodis, G Duškesas E Maceika (FI, Lithuania), L Petit (EDF France)	C Roth (INR, Romania)	H Eccles (UK NNL)	H Eccles (UK NNL)

02	01/04/2009	Issue 1 final version	H Eccles (UK NNL), L Juodis, G Duškesas E Maceika (FI, Lithuania), L Petit (EDF France)	C Roth (INR, Romania)	H Eccles (UK NNL)	H Eccles (UK NNL)

Chapter contents

1 Introduction

This chapter addresses nuclear reactors in Belgium, Netherlands, Romania and Switzerland with specific reference to graphite moderated reactors. The total quantity of irradiated graphite that would arise from the decommissioning of reactors in these Member States would be about 1,000 tons from test/experimental reactors as all commercial reactors built in these countries have been pressurised water reactors.

2 Belgium

2.1 Legislative and Regulatory Framework[1]

The construction and the operation of nuclear installations are regulated by the federal government. These regulations are laid down by the Royal Decree of 20 August 2001. They implement the Law of 15 April 1994 on the protection of the population and the environment against the hazards of ionising radiation and the establishment of the Federal Agency for Nuclear Control (FANC), and also to implement a number of European directives, the European Basic Safety standards (Council Directive 96/29/Euratom) being the most important one.

The regulatory function for radiological protection and nuclear safety, including waste, safety, is assumed by the Federal Agency for Nuclear Control, established by the law of 15 April 1994. It is a government agency with its own board of directors.

2.2 Policy Objectives of Decommissioning[2]

The regulation laid down by the Royal Decree of July 20, 2001 on the protection of the workers, the public and the environment against the dangers of ionizing radiation requires in the case of cessation of a licensed activity from the operator or the liquidator to inform the Federal Agency for Nuclear Control (FANC) and the Radioactive Waste management Agency (ONDRAF/NIRAS) of the intention to stop the activity.

The operator has to inform about the appropriate destination for the radioactive substances which must be elimination in the sense of final disposal, a recycling or a re-utilisation under satisfying conditions. For the major nuclear facilities, a decommissioning licence is furthermore required which defines the ultimate objectives of the decommissioning programme. The decommissioning license application, introduced by the operator, has to contain general information, the objectives to deal concerning the appropriate destination of the radioactive substances and a preliminary safety report.

For specific installations, an Environmental Impact Assessment report has to be included. The application for decommissioning, introduced to FANC, also has to be submitted to ONDRAF/NIRAS for advice.

Principle 7 of the IAEA Safety Fundamentals, i.e. "*the generation of radioactive waste shall be kept to the minimum practicable",* constitutes the basis for the material management of decommissioning programmes. Thus, the material management pathways are essentially the following:

- Re-use if possible, e.g. shielding blocks, tanks, or reuse after melting in a specialised foundry
- Recycling within the nuclear field. Nevertheless, possible applications are limited within Belgium owing to the political moratorium on the construction of new nuclear plants,
- Thorough decontamination, followed by clearance and recycling within the non-nuclear field,
- Radioactive waste circuit for the remaining material.

2.3 Decommissioning of Nuclear Reactors – Current Situation

The BR1 (Figure 1) was the first reactor to be built in Belgium; it went critical in May 1956. This air cooled graphite moderated reactor was mostly used for research in reactor and neutron physics, but also used for the production of medical isotopes. The reactor now only operates on request. The fuel is natural metallic uranium and the current fuel is still the original. The reactor comprises of 14,500 graphite blocks (approximately 500 tons), surrounded by a concrete construction of 2 m thick. There are 829 channels (50 x 50 mm diameter) for nuclear fuel, of which only 569 are loaded. Next to these fuel channels there are about 70 channels intended for experimental purposes. These channels are of various dimensions; rectangulatr ones 10 x 10 cm, 24 x 24 cm and round ones of 8 cm in diameter.

The reactor has two thermal columns that extend up to the concrete.

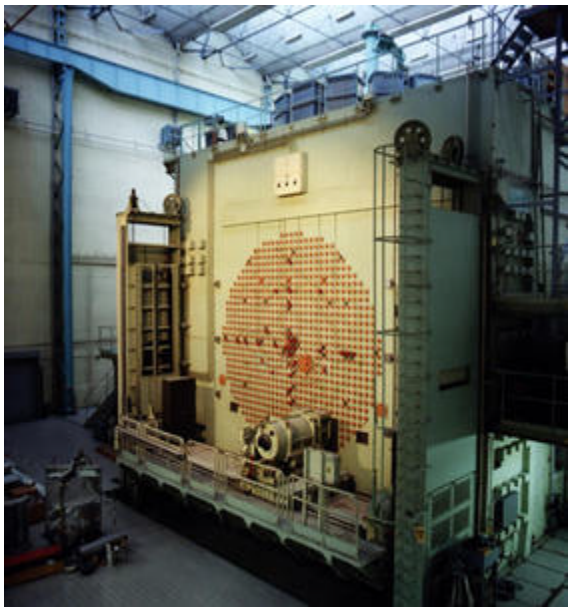

Figure 1: BR-1 Reactor[3]

The BR2 reactor (Figure 2) was first operated in January 1963. This Materials Testing Reactor is SCK•CEN's most important nuclear facility. It was operated during the past forty years within the framework of many international programmes concerning the development of structural materials and nuclear fuels for various types of nuclear fission reactors as well as for fusion reactor research.

Figure 2: BR-2 reactor[4]

The BR3 reactor (Figure 3) was the first PWR (pressurised water reactor) in Western Europe and it is also the first to be decommissioned. BR3 was a demonstration unit of an industrial

power station and served as a test reactor for prototype nuclear fuels. It was also an education centre for the operating personnel of the nuclear power plants expected at that time in Belgium. BR3 became critical for the first time on 19 August 1962 on 25 October BR3 was connected to the electricity grid. On 30 June 1987, the BR3 reactor was the first pressurised water reactor in Europe to be shut down.

Within the framework of the European five-year programme for research and technological development for the decommissioning of nuclear installations, BR3 was chosen, next to three other European installations, as a pilot project for the demonstration of the decommissioning of PWR plants. These projects aim to develop the necessary scientific and technical knowledge for decommissioning projects in real conditions.

According to plan, the plant will be completely decommissioned by the end of 2011.

Figure 3: BR-3 Reactor[5]

3 Netherlands

3.1 Legislative and Regulatory Framework[6]

In the Netherlands, basic legislation governing nuclear activities is contained in the Nuclear Energy Act of 1963, which has been amended on several occasions. Detailed information concerning the legislative and regulatory framework can be found in.

The Central Organization for Radioactive Waste (COVRA) is entrusted with the treatment and storage of all categories of radioactive waste produced in the Netherlands.

3.1.1 Main National Laws and Regulations in nuclear power

- 1963 Nuclear Energy Act and Implementing Regulations, as amended by the 1979 Environmental Protection Act and its 1992 and 2000 amendments.
- 1999 Royal Decree on the Transfer of Responsibility for the Implementation of the Nuclear Energy Act.
- Establishment of the new General Inspectorate for Housing, Spatial Planning and the Environment in 2002.
- 1986 Decree on Radiation Protection and its 1988 and 1996 amendments.
- 1979 Act on Nuclear Third Party Liability. The 1984 and 1987 General Administrative Orders to increase the liability amount and the 1991 Amendment of the Act. 1993 and 1997 Royal Decrees to increase the liability amount.

3.2 Policy Objectives of Decommissioning[7]

All activities relative to the import, transport, use, storage, disposal and export of radioactive material are subject to the provisions of the Nuclear Energy Act, last revised in 2005)1. This includes the construction and operation of nuclear power plants as well as the decommissioning of these facilities.

According to the adopted waste management strategy, the conditioned waste is kept in an engineered intermediate storage facility for an extended period of time (at least 100 years). The storage facility for high-level waste was commissioned 30 September 2003. The latter storage facility is designed to accommodate reprocessed and vitrified spent fuel from the nuclear power stations, conditioned spent fuel from the research reactors as well as other types of high level waste.

The government has formulated a policy on radioactive waste governing long-term (approximately 100 years) interim surface storage and the conditions for permanent disposal. The government has decided that the disposal of radioactive material in an underground repository should ultimately be reversible, and that both salt formations and clay layers should be studied as possible geological matrices for such storage.

Although the current radioactive waste management policy envisages no disposal in the near future, research on the suitability of deep underground rock formations in the Netherlands has been continued over the last few years. The commission on radioactive waste (CORA) has been established to co-ordinate this research programme.

3.3 Decommissioning of Nuclear reactors –Current situation[8]

As of the start of 2003 only one of the two reactors in the Netherlands was connected to the grid. The first reactor, Dodewaard, a 55 MWe BWR (Figure 4) was operational in 1968. The main purpose of this reactor was to conduct nuclear experiments for commercial applications.

In 1997 the Dodewaard Nuclear Power Plant (BWR, 58MWe) was shut down after 28 years of operation. The plant had been built primarily as a means of gaining experience with nuclear energy and was never meant to operate economically. In a liberalised electricity market this NPP is a non-economic liability. Since 1997 the plant is in a state of decommissioning.
The license for the decommissioning of the Dodewaard NPP has been granted in 2002. The Environmental Protection Act requires that prior to the actual dismantling of a nuclear facility an Environmental Impact Assessment (EIA) is performed, describing alternative decommissioning options. The EIA report for the decommissioning of Dodewaard NPP was submitted as a supporting document in the licensing procedure. Comparison of the three options considered in the EIA for Dodewaard (see strategy hereafter) led to results which are not discriminating with respect to radiation protection and general safety, but showed substantial cost differences.

All spent fuel has been removed from the reactor and shipped to the UK for reprocessing. Since mid 2005 the plant is in the phase of safe enclosure. This phase is foreseen to last for 40 years.

In 1973 the Borssele reactor (PWR, 450 MWe) [Figure 5] was connected to the grid, it has a licence to operate until 2034. The decision to extend the licence was taken in 2006 in relation to investments in renewable energy systems and in relation to requirements according to the Kyoto protocol.

Figure 4: Dodewaard Nuclear Power Plant[9]

Figure 5: Borssele Nuclear Power Plant[10]

4 Romania

4.1 Legislative and Regulatory Framework[11]

In Romania there are many organizations involved in the nuclear field with different attributions:

- National Commission for Nuclear Activities Control(CNCAN) is responsible for enforcing the regulatory requirements in the nuclear field; regulates the development, application and use of nuclear energy for peaceful purposes in Romania and is reporting to the Ministry of Waters and Environment;
- National Nuclear Company SC "Nuclearelectrica" SA is responsible for the engineering, construction and operation of CANDU power reactors and is reporting to the Ministry of Economy;
- Autonomous Company for Nuclear Activities (RAAN) is responsible for design and research in nuclear fields and heavy water production and is reporting to the Ministry of Economy;

- Nuclear Agency (AN) is responsible for promoting nuclear energy and is reporting to the Ministry of Economy;
- National Agency for Radioactive Waste (ANDRAD) is responsible for national; coordination of spent fuel and radioactive waste management, including final disposal and is responding to the Ministry of Economy;
- National Agency for Export Import Control for Strategic Products (ANCESIAC) licences export and import for strategic products including nuclear material, non nuclear material and equipment and is reporting to the Ministry of Foreign Affaires.

4.2 Policy Objectives of Decommissioning

The Romania government as with all Member States recognise and support the European commission's decommissioning directives.

European Commission[12] initiatives in the field of decommissioning nuclear installations are based on chapter 3 (article 37 et al) of the "EURATOM Treaty" and on the following Resolutions and Directives of the Council:

- Council Resolution of 15 June 1992 concerning the "Community Action Plan within the European Union in the field of radioactive waste";
- Council Resolution of 12 December 1994 concerning the management of radioactive waste within the European Union;
- Council Directive of 27 June 1985 amended by the directive 97/11/CE of 3 March 1997 concerning the assessment of the effects of certain public and private projects on the environment;
- Council EURATOM Directive 96/29 of 13 May 1996 establishing revised basic health and safety standards (revision of Directive 80/836 EURATOM of 15 July 1980).

4.3 Decommissioning of Nuclear Reactors – Current Situation[13]

Today in Romania, only two research reactors are operational: the 14 MWe TRIGA steady-state reactor and the ACPR TRIGA pulsed reactor, operated by the Institute of Nuclear Research (INR) Pitesti (Figure 6). The VVR – S reactor from Bucharest is currently shut-down and will be decommissioned.

There are currently two commercial power reactors in operation, Cernavoda – Units 1 and 2 (700 MWe CANDU type power plants).

Figure 6: INR Pitesi TRIGA Reactors

It is estimated that the total quantity of irradiated graphite from these research reactors is less than 10 tons, most is still within operational reactors.

The VVR – S Bucharest reactor owned by the National Institute for Research & Development for Physics and Nuclear Engineering was designed to provide experimental activities for research and radioisotopes production. The 2 MW reactor was fuelled by enriched uranium (4.5 Kg). The thermal column contains about 4.5 tons of graphite that is now contaminated with neutron activated products and contaminants H-3, C-14, Eu-152, Eu-154.

The TRIGA Reactor thermal column is a graphite block (1716x1144x710 mm) formed by 98 rectangular graphite cells (12 rows x 8 bricks) in aluminium cladding placed in the reactor pool, on the North side of the steady state core (Figure 7). A number of graphite cells are already removed from the thermal column and stored.

Information relevant to the management and subsequent disposal of TRIGA reactor graphite has been measured/recorded:

- Sintered graphite blocks, aluminum cladding
- Density: 1.6 g/cm^3
- Graphite blocks manufactured in UK
- Impurities and concentrations not available

- Radioactivity:
  - Co-60 (300 Bq/g) andEu-152 (10 Bq/g) activities measured in i-graphite sample arising from irradiation devices, after a few months of irradiation and 10 years cooling – no information about the neutron fluency;
  - Production rate for C-14 in the TRIGA Reactor thermal column - estimated by MCNP computation: 13 kBq/MWday.

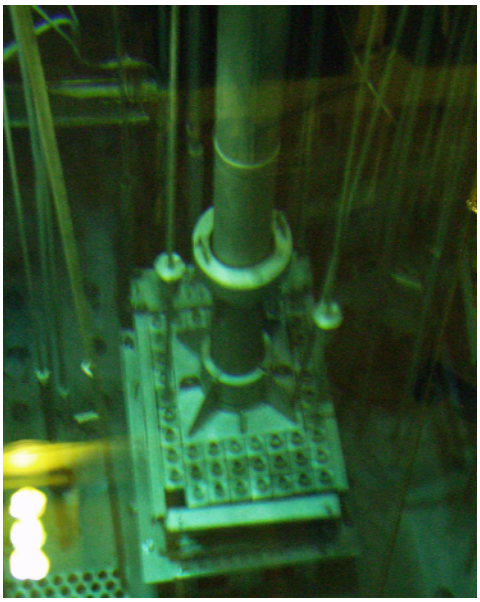

Figure 7: TRIGA-SSR thermal column

5 Switzerland

5.1 The legislative and Regulatory Framework[14]

The Federal Department of Environment, Transport, Energy and Communication (UVEK) reports to the Federal Council. The Federal Office of Energy (BFE), a regulatory body, reports to the Federal Department of Environment, Transports, Energy and Communication. The Swiss Federal Nuclear Safety Inspectorate (HSK) is part of the Federal Office of Energy. The Commission for the Safety of Atomic Installation reports to the Federal Council via the Federal Office of Energy.

After a two-year consultation phase, the Federal Act on Nuclear Energy was adopted by parliament in March 2003, and entered into force on 1 February 2005 at the same time as its

implementing ordinance. The revision process on the 1959 Federal Acts on Atomic Energy and on the 1978 Federal Decree on the atomic energy act, which lasted for the past 30 years, were therefore terminated.

From now on, the construction and operation of nuclear facilities and any changes in their purpose, nature or size requires a general licence prior to the granting of technical licenses. The general licence delivered by the Federal Council determines the site and the main features of the project.

The application for a general licence must be particularly accompanied by:

- a concept for the decommissioning of the installation or for the monitoring and the closure of the deep geological depository;
- the demonstration of feasibility of disposal of the radioactive waste produced in this nuclear installation; and
- the demonstration of the suitability of the site for deep geological depositories.

The Federal Council transmits the application for consultation to the Cantons, federal authorities and neighbour countries concerned. It also arranges for various expert reports to be prepared, mainly by the Swiss Federal Nuclear Safety Inspectorate. The application, the statements and experts' reports are made available to the public along with any supporting documents. Anyone may then submit written objections to the Federal Chancellery concerning the granting of the general license.

The site Canton, neighbouring Cantons and countries enjoy extended participation rights, as they must be involved in the general licence granting procedure. Their concerns need to be considered as far as they do not unproportionally restrict the project. Finally, after having examined the application, the opinions given during the consultations, the experts' reports and any objection made, the Federal Council reaches a positive or negative decision; the granting of a general license must also be approved by the Federal Assembly. A referendum can be held against the approval, by the Federal Government: 50 000 voters can demand a public vote on

the project. If the Swiss electorate ratifies the project, the application for a construction licence may be submitted.

Licences for constructing, operating, modifying or decommissioning a nuclear installation as well as licences for geological investigations with regard to the construction of a deep geological depository are primarily of a technical nature since the main requirements relate to nuclear safety. The new provision is that all other procedures for non-nuclear licenses necessary for the realisation of the project, will be integrated in the same procedure (namely, Cantonal licenses concerning construction and land use planning and the protection of workers). Thus, there will be only one single licence granted by the Federal Department of Environment, Transport, Energy and Communication. The application for a license for constructing, operating or modifying a nuclear installation must be particularly accompanied by a technical report (safety analysis report). All further documentation must be submitted according to the respective non-nuclear laws.

The documents necessary for the license will be published for public consultation. The concerned parties according to the administrative procedure have the possibility to appeal. The Canton where the installation is to be located will also be consulted. If the Canton rejects the application and if the Federal Department wants to grant the license, the Canton can appeal against this decision.

5.1.1 Main national laws and regulations governing nuclear power

Note: Reference to the original publication is given in parenthesis: (RO 732. 0).

The following data apply to the currently applicable, most important decrees. Some of them, as mentioned above, will gradually be replaced.

5.1.1.1 General legislation

- Law on Nuclear Energy (LENu) adopted in 21 March 2003 and entered into force on 1 February 2005, and its ordinance on Nuclear Energy (OENu) entered into force on 1 February 2005.
- Act on the control of goods to be used for civil and military purposes, and of special military goods (RO 946.202)

5.1.1.2 Protection against Radiation

- Radiation Protection Act 1991 (RO 814.50)
- Radiation Protection Ordinance 1994 (RO 814.501)

- Ordinance on interventions in case of increase of radioactivity levels (RO 732.32)
- Ordinance on measures to protect the vicinity of nuclear installations in case of emergencies (RO 732.33)

5.1.1.3 Civil liability

- Act on Nuclear Third Party Liability 1983 (RO 732.441)
- Ordinance on Nuclear Third Party Liability 1983 (RO 732.44)

5.2 Policy Objectives of Decommissioning[14]

Nuclear power plant owners are responsible for funding their decommissioning. The total estimated costs of decommissioning the five units currently in operation amount to CHF 1 800 million. The Confederation manages the decommissioning that was established in 1984 to ensure that the necessary funds are available for decommissioning nuclear power plants after 40 years of operation. The nuclear utilities pay contributions to this fund on an annual basis. Currently, Switzerland has no radioactive waste disposal facilities. Until final repositories become operational, all categories of radioactive waste are held in interim storage facilities either at the nuclear power plants or at a centralised facility. In 2001, a centralised interim storage facility, located on the site of the Paul Scherrer Institute (PSI) at Würenlingen, began to accept intermediate- and high-level waste. The facility is operated by Zwischenlager Würenlingen (ZWILAG), a utility-owned organisation. A repository project for low-and intermediate-level waste had been planned at Wellenberg in central Switzerland. However, the electorate rejected a bill that would have permitted the construction of an underground test facility.

A repository for high-level waste will not be required before 2020. NAGRA is pursuing a programme based on the concept of a deep geological repository and focusing on the crystalline bedrock of northern Aargau and the opalinus clay of the Zürcher Weinland in the northern part of the Swiss plateau.

In 2002, Nagra submitted a report demonstrating how and where spent fuel, high-level and long-lived intermediate-level waste can be safely disposed of in Switzerland. The federal safety authorities are currently evaluating the report with a view to allowing the government to take a decision regarding the management of these wastes around 2006. Identification of a site will be the subject of a later general license procedure.

5.3 Compliance with International Guidelines and Regulations

The Swiss government has well-established bilateral relations with French and German authorities in the nuclear field. Within this framework, French and Swiss regulatory authorities began common inspections of their nuclear installations. In addition the Swiss recognises and complies with nuclear energy international guidelines.

5.4 Decommissioning of Nuclear Reactors – Current Situation

The Swiss have constructed five commercial nuclear stations, three PWRs and two BWRs. Although the Swiss undertake nuclear research this does not involve graphite moderated reactors.

There are few references to the decommissioning of nuclear reactors and those that address the subject have little relevance to the CARBOWASTE project.

6 References

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[5] http://www.sckcen.be/en/Our-Research/Research-facilities/BR3-Belgian-Reactor-3

[6] http://www.nea.fr/html/general/profiles/netherlands.html

[7] Decommissioning in the Netherlands, September 2004, nea web site

[8] http://www.world-nuclear.org/info/inf107.html

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[10] http://en.wikipedia.org/wiki/Borssele_nuclear_power_plant

[11] ESARDA BULLETIN, No. 37, December 2007

[12] COMMISSION DECISION C(2007)5493 of 16/11/2007

[13] World Nuclear Association web site

[14] www.nea.fr/html/general/profiles/switzerland.html#hist