Kingdom of Belgium

National report on the implementation of Council Directive 2011/70/Euratom establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste

Third edition, August 2021

This report meets the requirement of Article 14.1 of Council Directive 2011/70/Euratom of 19 July 2011 establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste. Pursuant to Article 8 of the Law of 3 June 2014 transposing the directive and modifying Article 179 of the Law of 8 August 1980, it has been written under the coordination of the Belgian Agency for Radioactive Waste and Enriched Fissile Materials (ONDRAF/NIRAS), in collaboration with the main relevant institutional actors: the Federal Agency for Nuclear Control (FANC), the Directorate General for Energy of the Federal Public Service Economy, SMEs, Self-Employed and Energy, and the Commission for Nuclear Provisions. Other actors were consulted on an *ad hoc* basis. This report has been notified to the European Commission by the Ministers in charge of Energy and Economy.

This report describes the situation at 31 December 2020, while taking account as much as possible of important evolutions in early 2021. It is available on www.ondraf.be, www.niras.be, and www.cpnpc.be (website of the National Programme Committee). It will be translated into French and Dutch.

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A. Introduction

Belgium had and still has an extensive range of activities using radioactivity on its territory, including activities relating to the nuclear fuel cycle, to research, and to medical and industrial applications of radioactivity (Table 1). These activities generate(d) spent nuclear fuel and radioactive waste, with highly diverse characteristics, which must be managed safely. The historical radium and uranium production generated considerable volumes of radium-bearing substances with a broad spectrum of activity levels. The industries using naturally occurring radioactive materials (NORM) also face issues linked to radioactive waste management.

Table 1 – Main activities that generate(d) spent fuel and radioactive waste and main associated facilities or main types of associated waste (situation at 31 December 2020). The main past activities and the main facilities awaiting dismantling, being dismantled, or decommissioned are grouped in the second half of the table.

Main current activities (excluding decommissioning and remediation) and main associated facilities or types of radioactive waste	
Electricity production	
Electrabel (Doel and Tihange) (Synatom owns the fuel)	7 PWR reactors (net installed capacity); the industrial commissioning date and deactivation date are those stipulated by the Law of 31 January 2003 (as amended) to phase out nuclear energy) [Belgian Official Journal 2003a] Doel 1 (445 MWe): 15 February 1975 – 15 February 2025 Doel 2 (445 MWe): 1 December 1975 – 1 December 2025 Doel 3 (1006 MWe): 1 October 1982 – 1 October 2022 Doel 4 (1038 MWe): 1 July 1985 – 1 July 2025 Tihange 1 (962 MWe): 1 October 1975 – 1 October 2025 Tihange 2 (1008 MWe): 1 February 1983 – 1 February 2023 Tihange 3 (1038 MWe): 1 September 1985 – 1 September 2025 Treatment, conditioning, and storage facilities, including storage facilities for spent fuel, on the sites of the nuclear power plants
Activities related to centralised radioactive waste management	
Belgoprocess	Various facilities for the treatment, conditioning, and storage of radioactive waste
Research	
Belgian Nuclear Research Centre (SCK CEN, Mol)	BR1, BR2, and VENUS-F (formerly VENUS) reactors, laboratories
Joint Research Centre Geel of the European Commission	2 linear accelerators, laboratories
Belgian universities and university hospitals	10 cyclotrons (including 4 attached to university hospitals), 1 linear accelerator
Radioisotope production for medical and industrial use	
National Radioelements Institute (IRE, Fleurus)	Radioisotope production facilities
SCK CEN (Mol)	Radioisotope production in the BR2 reactor
Private companies	2 cyclotrons
Use of sealed sources in industry and hospitals	Disused high- and low-level sealed sources
Activities of certain industries using naturally occurring radioactive materials (NORM)	Small quantities of radioactive waste from the operation and dismantling of the facilities of certain industries using NORM (Radioactively contaminated industrial landfills and diffuse radioactive contamination are managed as non-radioactive waste)
Main past activities, with main facilities decommissioned, being dismantled, or awaiting dismantling, or main types of radioactive waste	
Fuel reprocessing	
Eurochemic (1966–1974, Dessel)	Pilot reprocessing plant (built as part of an OECD project) (end of dismantling of the main building in 2018)
Fuel fabrication	
Belgonucleaire (1973–2006, Dessel)	Fabrication facility for MOX fuel rods with UO_2 and PuO_2 (decommissioned in 2019)
FBFC International (1973–2015, Dessel)	Fabrication facility for UO_2 fuel assemblies from enriched UO_2 and fuel assembly facility for MOX fuel rods (end of dismantling foreseen in 2021)
Research	
Belgian Nuclear Research Centre (SCK CEN, Mol)	BR02 reactor (dismantled), BR3 reactor (being dismantled)
Ghent university	Thetis reactor (decommissioned in 2015); 1 cyclotron and 2 linear accelerators put out of service (start of dismantling in 2021)

Radioisotope production for medical and industrial use	
Best Medical Belgium (bankrupt in 2012)	2 cyclotrons put out of service (dismantling ongoing)
Telix Pharmaceuticals	2 cyclotrons put out of service (dismantling of one of them in preparation)
Radium and uranium production (from 1922 to 1977)	
Umicore (formerly Union Minière, Olen)	Three storage facilities (UMTRAP, Bankloop, and Storage facility 2016), subject to nuclear licences and containing substances of which part is radioactive Radioactively contaminated industrial landfills and diffuse radioactive contamination
Production of domestic devices containing a radioactive source	Ionising smoke detectors, lightening conductors, etc.

The Federal State has exclusive jurisdiction over all nuclear issues, including the nuclear fuel cycle, radioactive waste management, radiation protection, and research, development and demonstration programmes (RD&D) in these fields.

A.1 Main actors and responsibilities

Spent fuel and radioactive waste management involve five main (groups of) actors (Figure 1):

- the owners of the spent fuel (Section A.1.2);
- the radioactive waste producers (Section A.1.1);
- the Belgian Agency for Radioactive Waste and Enriched Fissile Materials (ONDRAF/NIRAS) and its subsidiary Belgoprocess (Section A.1.1);
- the Federal Agency for Nuclear Control (FANC) and its subsidiary Bel V (Section A.1.3);
- the Federal Government and its administrations (Section A.1.4).

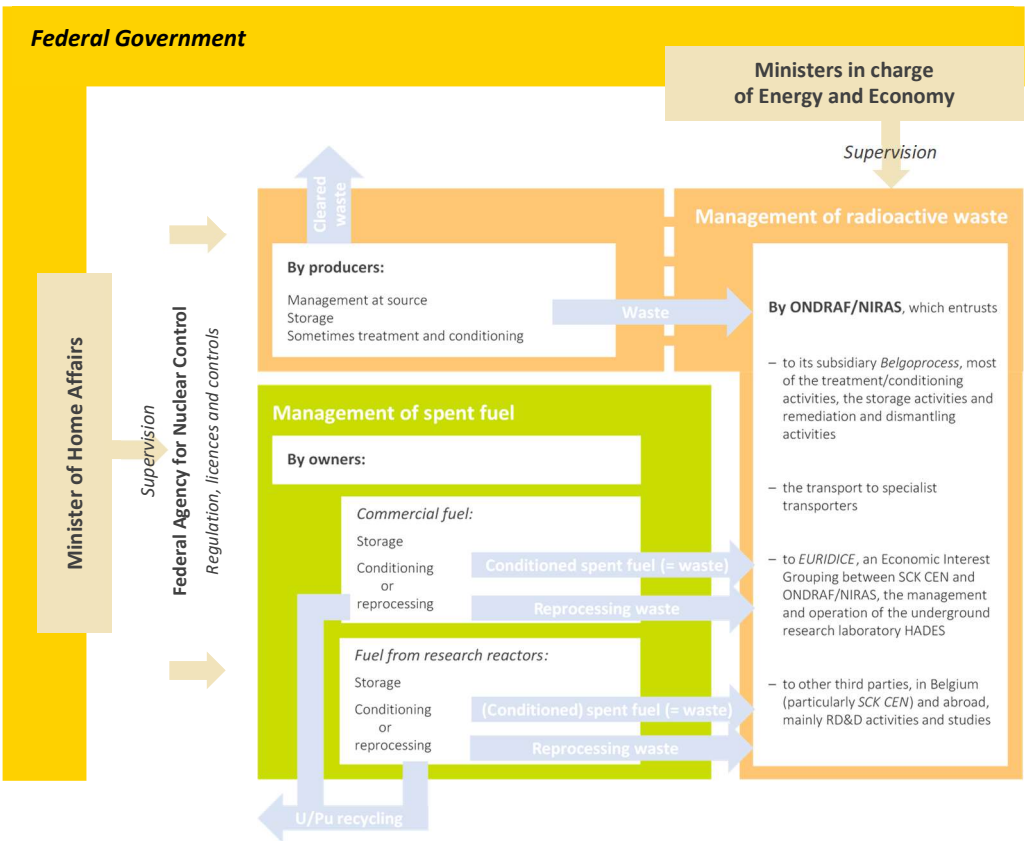

Figure 1 – Main actors in the management of spent fuel and radioactive waste.

ONDRAF/NIRAS is the organisation responsible for managing radioactive waste in Belgium, and FANC is the competent regulatory authority. Both are independent public bodies. The formal interactions between FANC and ONDRAF/NIRAS are defined in the legal and regulatory framework and in a bilateral agreement defining the modalities of collaboration and consultation between the two bodies on topics of mutual importance in the field of management of radioactive waste. Since it was recognised that their roles and responsibilities should be better defined and separated in some domains of interaction to ensure FANC's independence, their roles and responsibilities in these domains are being clarified (Section B.2.2.1).

A.1.1 Radioactive waste management

ONDRAF/NIRAS, which was given responsibility for the management of radioactive waste by the legislature, is a public body with legal personality. Its missions and functioning rules are set out by Article 179, § 2, of the Law of 8 August 1980 and the Royal Decree of 30 March 1981 (Section E.1–Article 5(1)(b)). ONDRAF/NIRAS is supervised by the Ministers in charge of Energy and Economy.

ONDRAF/NIRAS may conduct its radioactive waste management mission and its other missions using its own resources or allow some of these missions to be carried out by third parties under its responsibility. The radioactive waste management system comprises a series of steps that can be grouped into short-term (primarily waste acceptance, treatment, and conditioning), medium-term (primarily storage), and long-term (primarily disposal) management activities. Whereas waste producers are legally allowed, under well-defined conditions, to treat, condition, and store (temporarily) their own waste, ONDRAF/NIRAS is the only actor legally appointed to ensure the disposal of radioactive waste.

ONDRAF/NIRAS is in charge of the general coordination of the necessary industrial activities and RD&D activities for the long-term management of radioactive waste and ensures the continuity and integration of knowledge. ONDRAF/NIRAS can also act as a nuclear operator[1]. In that case, it is controlled by FANC as any other nuclear operator.

In accordance with the provisions of the Law of 8 August 1980, ONDRAF/NIRAS must charge its costs to the beneficiaries of its services, namely the radioactive waste producers and financially liable institutional entities (Federal State, Walloon Region, and European Commission), in proportion to those services.

ONDRAF/NIRAS is the parent company of the limited company Belgoprocess, which operates the nuclear sites Belgoprocess 1 (BP1, Dessel) and Belgoprocess 2 (BP2, Mol) and acts as ONDRAF/NIRAS' industrial branch in the framework of multi-annual agreements.

The radioactive waste producers are not required to ask ONDRAF/NIRAS to take charge of their waste immediately after its generation. They can treat, condition, and (temporarily) store their waste on their site, subject to their facilities being licensed by FANC and their equipment for treating, conditioning, and characterising radioactive waste being qualified by ONDRAF/NIRAS, in the framework of the waste acceptance system. These qualifications must ensure that the generated waste will comply with ONDRAF/NIRAS' acceptance criteria for its future management. Furthermore, producers who wish to have waste treated and conditioned abroad must take the necessary steps to ensure that the radioactive waste that returns to Belgium will comply with ONDRAF/NIRAS' acceptance criteria. In practice, the limited company Electrabel (Electrabel SA, or

[1] ONDRAF/NIRAS is since October 2012 the nuclear operator of the facilities of the former Best Medical Belgium (bankrupt in May 2012) that were not transferred to NTP Radioisotopes (Europe). It is in charge of their remediation and decommissioning.

Electrabel for short), which operates the seven Belgian commercial nuclear reactors, treats and conditions some of its own operational waste on the sites of the nuclear power plants, and some producers have certain treatment operations carried out abroad. Hospitals and medical research laboratories store their very short-lived radioactive waste in their facilities for clearance after decay, in accordance with the requirements of the general regulations for radiation protection or GRR-2001 (Section E.1–Article 5(1)(b)), the cleared waste being then managed as conventional industrial waste. The long-term management of radium-bearing and NORM substances is a distinct issue in that it involves very large amounts of substances to be divided into radioactive waste streams and waste streams not to be managed as radioactive waste ('non-radioactive waste').

A.1.2 Spent fuel management

Spent fuel from nuclear power plants and research reactors is managed by its owners.

Spent fuel from nuclear power plants Pursuant to Article 179, § 1, of the Law of 8 August 1980 (Section E.1–Article 5(1)(b)), the limited company Synatom (Synatom SA, or Synatom for short) manages the spent fuel from nuclear power plants before ONDRAF/NIRAS takes charge of it, in the form of reprocessing waste or as radioactive waste if it was declared as such.

Synatom, a wholly owned subsidiary of Electrabel, owns the nuclear materials throughout the entire fuel cycle, including while in the reactors of the nuclear power plants at Doel and Tihange. The Federal State has a golden share in Synatom giving it certain special rights within Synatom's Board of Directors and General Assembly.

Synatom can conduct its mission to manage spent fuel using its own resources or allow it to be carried out by third parties under its responsibility. The spent fuel is stored by Electrabel on the sites of the nuclear power plants.

Spent fuel from research reactors[2] The Belgian Nuclear Research Centre (SCK CEN), a foundation of public utility supervised by the Ministers in charge of Energy and Economy, manages spent fuel from research reactors before ONDRAF/NIRAS takes charge of it, in the form of reprocessing waste or as radioactive waste if it was declared as such.

A.1.3 Regulation, licences, and controls

Created by the Law of 15 April 1994, FANC is the public institution with legal personality responsible for protecting the population, workers, and the environment against the dangers arising from ionising radiation (see also Section F). Its missions and functioning rules are set out by the same law and its implementing royal decrees (Section E.1–Article 5(1)(b)). FANC is supervised by the Minister of Home Affairs.

FANC is specifically responsible for proposing regulations in terms of radiation protection and safety that comply with international recommendations and European directives, and to ensure their application. It grants construction and operation licences for nuclear facilities as well as dismantling licences, except for construction and operation licences and dismantling licences for class I nuclear facilities (Section E.1–Article 5(1)(c)), which are issued by royal decree, on FANC's proposal to its supervisory minister, after a positive opinion from the Scientific Council for ionising radiation, an

[2] From 1967 to the end of 2003, the Ghent University operated the Thetis research reactor. Its end of decommissioning was acknowledged by royal decree on 25 November 2015. Its spent fuel was declared as radioactive waste to ONDRAF/NIRAS by the Ghent University.

independent body in charge of giving opinions to FANC and its supervisory minister and whose members are appointed by royal decree. FANC also grants nuclear transport licences to transport companies of radioactive materials. It inspects nuclear facilities, controls compliance with the licence provisions and, more generally, compliance with the provisions of the legal and regulatory framework for radiation protection, nuclear safety, and nuclear security. If necessary, licences can be suspended or withdrawn by the authorities that have issued them. FANC also assesses the radiological risks of all work activities using naturally occurring sources of ionising radiation (NORM issue).

FANC's costs are covered by taxes and fees that it charges to the beneficiaries of its services, primarily licence holders, in accordance with the Law of 15 April 1994 and the relevant implementing royal decrees.

In September 2007, FANC created a subsidiary, called Bel V, in the form of a foundation of private law. Bel V, FANC's technical support organisation, performs regulatory missions delegated by FANC, such as inspections in the nuclear power plants and certain other facilities and assessments of safety reports submitted to FANC (see also Section F).

A.1.4 Overall supervision

The Federal Government has several important functions in relation to the responsible and safe management of radioactive waste and spent fuel in Belgium. In particular,

- it supervises ONDRAF/NIRAS and FANC through, respectively, the Ministers in charge of Energy and Economy, and the Minister of Home Affairs;
- it supervises the Commission for Nuclear Provisions through the Minister in charge of Energy;
- it determines the national policies on the management of radioactive waste and spent fuel — which are proposed by ONDRAF/NIRAS — before they are established by royal decree, taking FANC's opinion into account;
- it adopts the national programme, which is established by the National Programme Committee, created by law and composed of the Directorate General for Energy of the Federal Public Service in charge of Economy, SMEs, Self-Employed and Energy (chair), ONDRAF/NIRAS (secretary), and Synatom;
- it invites periodically, and at least every 10 years, an international peer review of the national framework, the competent regulatory authority FANC, and/or the national programme.

A.2 Opening remarks

This third edition of the national report on the implementation of Council Directive 2011/70/Euratom establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste (hereafter the 'national report') meets the requirement of Article 14.1 of the directive. Pursuant to Article 8 of the Law of 3 June 2014 transposing the directive and modifying Article 179 of the Law of 8 August 1980 [Belgian Official Journal 2014b], it has been written under the coordination of ONDRAF/NIRAS, in collaboration with the main relevant institutional actors: FANC and its subsidiary Bel V, the Directorate General for Energy of the Federal Public Service Economy, SMEs, Self-Employed and Energy, and the Commission for Nuclear Provisions. Other actors were consulted on an *ad hoc* basis. Together, these actors possess the legal and technical competences covering the topics to be dealt with in the national report. After it was notified to the European Commission by the Ministers in charge of Energy and Economy, the

national report was uploaded on www.ondraf.be and www.niras.be and on the website of the National Programme Committee (www.cpnpc.be) (Section E.1–Article 5(1)(a)).

This national report describes the situation at 31 December 2020, while taking account as much as possible of important evolutions in early 2021.

The report follows for its structure and content the guidelines established in January 2018 by the European Nuclear Safety Regulators Group (www.ensreg.eu/documents): the general introduction and the overview of the recent developments and main challenges are followed by an article-by-article approach and the report ends with future plans to improve safe and responsible management of spent fuel and radioactive waste, followed by a list of acronyms and bibliographic references. The report uses information in the national programme ('national programme 2015') [Belgian Official Journal 2017] and in the seventh report established in the framework of the Joint Convention on the safety of spent fuel management and on the safety of radioactive waste management [Kingdom of Belgium 2020].

Throughout the text, the national report adopts the following conventions:

- the designation 'radioactive waste' encompasses spent fuel regarded as waste;
- the designation 'owners of spent fuel' refers to the holders of the rights referred to in Article 87 of the Euratom Treaty;
- the designation 'nuclear facilities' refers to all licensed facilities, namely all class I, II, and III facilities (Section E.1–Articles 5(1)(b) and 5(1)(c));
- the translations of titles of official sources such as laws, royal decrees, or resolutions as well as the translations of the quoted extracts are non-certified translations. Only the original texts in French and Dutch are authentic;
- bibliographic references are limited to national references.

Major elements on national policies and the national programme are provided in Sections D.1 and K, respectively.

B. Main developments since 31 December 2017 and main challenges

The main developments since 31 December 2017 (reference date of the second edition of the national report or 'national report 2018' [Kingdom of Belgium 2018]) listed below are limited to key topics for which there have been significant final or intermediate results in that period. They are grouped into main developments regarding national policies (Section B.1), national framework (Section B.2), and national programme (Section B.3). Main challenges for implementing the national programme are also identified.

B.1 National policies

According to Article 179, § 6, of the Law of 8 August 1980, national policies on the management of radioactive waste and spent fuel are to be established and maintained by royal decree, debated in the Federal Council of Ministers, on ONDRAF/NIRAS' proposal and after FANC's opinion. In addition, the owners of spent fuel must propose hypotheses regarding the further use of their spent fuel (reprocessing or not) with a view to the later integration of the accepted hypotheses in the national policies, thereby establishing the status of the fuel (resource or waste), after consultation with ONDRAF/NIRAS and FANC.

The situation regarding national policies on spent fuel and radioactive waste management (Section D.1) is formally unchanged since 31 December 2017. More precisely, it is formally unchanged since the first edition of the national programme, in 2015 (Table 4 in Section D.1).

The main challenges as far as national policies are concerned are the establishment of the bases of the national policy on the long-term management of B&C waste (high-level and/or long-lived radioactive waste — see Section C.1 for the Belgian waste classification) and the establishment of the policy on the long-term management of radium-bearing substances to be managed as radioactive waste. In addition, Synatom, as owner of the spent fuel from the commercial nuclear reactors, and SCK CEN, as owner of spent fuel from research reactors, must, according to Article 179, § 6, of the Law of 8 August 1980, propose hypotheses regarding the further use of their spent fuel — except for the spent fuel of the BR2 research reactor, for which there is a national policy of reprocessing —, with a view to the later integration of the accepted hypotheses in the national policies.

The need for a national policy dedicated to the long-term management of NORM substances to be managed as radioactive waste has been assessed by FANC and ONDRAF/NIRAS. They concluded that no such specific policy will be needed since the expected volume of these substances is very low. (Sections B.3.1.7 and M.1.4).

Recent developments and challenges are as follows (see also Sections K.3 and M.1 for some milestones and timeframes):

- The basis of the future national policy on the long-term management of B&C waste, namely geological disposal on Belgian territory, was submitted by ONDRAF/NIRAS to its supervisory ministers in 2018.

  Pursuant to the Law of 13 February 2006 [Belgian Official Journal 2006a], the policy proposal of 2018 was the subject of a strategic environmental assessment procedure in 2019–2020, with consultation of institutional actors and the public in the period April to June 2020. ONDRAF/NIRAS submitted in September 2020 a revised policy proposal to its supervisory

ministers, taking account of the procedure's outcome, and submitted in April 2021 a slightly adapted version, taking account of the remarks of the supervisory ministers.

The current proposal, in the line of the 2018 proposal, states that the national policy is composed of various parts, to be established in steps. It puts forward the solution of geological disposal on Belgian territory, on one or more sites, as basis of the national policy, where geological disposal designates geological disposal in both galleries and deep boreholes and does not prejudge the host formation(s) nor the site(s).

The proposal defines the next step in the establishment of the policy as being the establishment of the decision-making process. Two other identified steps will be, on the one hand, the terms and conditions of reversibility of one or more parts of the national policy and of retrievability of the waste and, on the other hand, the choice of one or more disposal sites.

Reversibility of the national policy implies for ONDRAF/NIRAS to follow relevant evolutions regarding geological disposal and advanced nuclear technologies, to assess the feasibility of sharing a geological disposal facility with other countries, and to consider possible future alternatives to geological disposal that are safe.

In its coalition agreement of September 2020, the Government committed itself to establishing the national policy on the long-term management of B&C waste.

- A national policy proposal for the disposal of radium-bearing radioactive waste will be developed in the next years (Section M.1.3), in accordance with the roadmap for the remediation of the Umicore site in Olen and in its vicinity and the disposal of the resulting radium-bearing radioactive waste and of the radium-bearing waste to be managed as non-radioactive waste.
- Regarding the status of spent fuel,
  - Synatom announces every three years in its reference programme to ONDRAF/NIRAS provisional quantities regarding the future reprocessing of part of its spent fuel, this as a basis for RD&D related to the design and operation of a future geological disposal facility and for costs calculations.
  - SCK CEN is currently examining the industrial feasibility of reprocessing or treating and conditioning the spent fuel that it owns and whose status has not yet been clarified, namely the spent fuel from the BR3 and VENUS reactors, and the future spent fuel from the BR1 reactor (Section M.3.1). The hypotheses to be proposed regarding the further use of this spent fuel will depend on the outcome of the studies. If proved feasible, the reprocessing or treatment and conditioning of this fuel would facilitate its proposed geological disposal.

B.2 National framework

The national framework has seen different kinds of developments since 31 December 2017 (Section B.2.1). The main challenges are those related to the implementation, in the legal and regulatory framework, of proposals aimed at clarifying the roles and responsibilities of FANC and ONDRAF/NIRAS and at improving the coverage of management costs (Section B.2.2).

B.2.1 Main developments

B.2.1.1 Ratification of the agreement between Belgium and Luxembourg on radioactive waste

To take account of the new obligations imposed by Directive 2011/70/Euratom, the Belgian and Luxembourg Governments agreed to formalise in a bilateral agreement the 1994 arrangement by which ONDRAF/NIRAS was authorised by the then Minister in charge of Economy to treat and condition a quantity of radioactive waste (mostly B, or intermediate-level, medical waste and sealed sources) from the Grand Duchy of Luxembourg every year as long as the annual waste volume after conditioning did not exceed 0,1 m^3.

The formal agreement between both countries was signed in July 2016 and was ratified by the Grand Duchy of Luxembourg and by Belgium in June 2018 and March 2019 respectively [Luxembourg Official Journal 2018; Belgian Official Journal 2019]. It establishes the technical and financial framework for the management and the disposal by Belgium of Luxembourg radioactive waste.

B.2.1.2 New royal decrees

Four royal decrees in particular can be mentioned as main developments of the national framework (see also Section E.1–Article 5(1)(b)).

- The Royal Decree of 29 May 2018 amending the Royal Decree of 20 July 2001 relating to the general regulations for radiation protection and aiming at avoiding situations that can give rise to liabilities related to radioactive waste and facilities to be dismantled [Belgian Official Journal 2018a]. This decree addresses certain recommendations of the mission of the Integrated Regulatory Review Service of the IAEA, or IRRS mission, conducted in Belgium in December 2013 and aims at increasing the accountability of operators for their radioactive waste and dismantling liabilities. It focuses also on the transfer of licences for facilities and activities and, in particular, requires licensees to maintain a full inventory of all radioactive substances present in their facilities and allows FANC to order the evacuation of radioactive substances that have not been used for five years and for which no further use in the facility is planned and justified.
- The Royal Decree of 29 May 2018 related to the safety of storage facilities for spent fuel and radioactive waste, completing the Royal Decree of 30 November 2011 on the safety requirements for nuclear facilities (hereafter the 'SRNI-2011') [Belgian Official Journal 2018b]. The 2018 decree introduces the WENRA (Western European Nuclear Regulators Association) safety reference levels for the storage of radioactive waste and spent fuel into the Belgian regulation.
- The Royal Decree of 29 May 2020 amending the Royal Decree of 20 July 2001 with regard to the licensing system for class I facilities, to align it with the transposition, in the Law of 15 April 1994, of Directive 2014/52/EU amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment [Belgian Official Journal 2020a].
- The Royal Decree of 20 July 2020 amending the Royal Decree of 20 July 2001 and transposing part of Directive 2013/59/Euratom laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation [Belgian Official Journal 2020b].

B.2.2 Main challenges

B.2.2.1 Clarification of the roles and responsibilities of FANC and ONDRAF/NIRAS

The Federal Council of Ministers entrusted in November 2016 a task force with the mission to propose improvements or modifications at the legal and regulatory levels to follow up on recommendation No. 7 of the 2013 IRRS mission. This recommendation emphasised the need for a clear separation of the roles and responsibilities of FANC and ONDRAF/NIRAS to ensure that FANC decisions are not unduly influenced by prior governmental or ONDRAF/NIRAS decisions.

The task force identified all interfaces between FANC and ONDRAF/NIRAS and the domains where roles and responsibilities were either not clearly separated or not allocated and then submitted proposals for improvement on the following four topics:

- Topic 1: the acceptance system for radioactive waste, managed by ONDRAF/NIRAS;
- Topic 2: the interdependencies between the successive waste management steps and the transfer of waste to ONDRAF/NIRAS;
- Topic 3: national policies on radioactive waste disposal and their implementation through the national programme;
- Topic 4: interventions and site remediation.

The Federal Council of Ministers instructed in July 2017 the supervisory ministers of FANC and ONDRAF/NIRAS to propose, each within the boundaries of his or her competences, the draft laws and royal decrees to implement the four proposals in the national framework [Council of Ministers 2017]. This work is ongoing (see also Section M.2):

- Topic 1: clarifications of the laws defining the competences of FANC and ONDRAF/NIRAS in relation to the general rules for the definition of the waste acceptance criteria were submitted in March 2021 to their supervisory ministers and follow now the legislative path.
- Topic 2: actions other than those under Topic 1, related to the waste acceptance system, must still be taken.
- Topic 3: ONDRAF/NIRAS submitted its policy proposal of 2018 for the long-term management of B&C waste to a strategic environmental assessment procedure and submitted revised policy proposals to its supervisory ministers in September 2020 and April 2021 (see also Section B.1).
- Topic 4: FANC and ONDRAF/NIRAS issued in January 2020 a common vision document with a general methodological approach for remediation of the radium-contaminated sites in Olen and the long-term management of the resulting radioactive waste and the waste to be managed as non-radioactive waste; a roadmap for the related site remediation and disposal projects was agreed upon in May 2021 [FANC *et al.* 2021] (see also Sections B.3.1.7 and M.1.3).

B.2.2.2 Measures to improve the coverage of management costs

Ensuring the coverage of the costs of managing spent fuel and radioactive waste and the costs of decommissioning operations, referred to globally as ‘management costs’, by the liable entities through strengthening the legal and regulatory framework is a necessity — and a major challenge — that has been repeatedly acknowledged at various levels. More specifically, the necessity to ensure the existence and sufficiency of the provisions (to be) established by the financially liable entities and the availability in due time of the corresponding financial resources has been stressed, in particular:

- by ONDRAF/NIRAS in the successive inventory reports on nuclear liabilities, and especially in the last report, published in February 2018 [ONDRAF/NIRAS 2018] (Sections I.2 and I.3.1); the 2018 recommendations led to the decision by the current Federal Government to create a task force bringing together representatives of the institutional actors (Section M.2); this task force will be in charge of examining how to ensure continuity of the financing in a context where waste producers progressively stop their activities and of making proposals to improve the legal and regulatory framework;
- by the Commission for Nuclear Provisions, a commission responsible for advising and supervising the establishment and management of the provisions for the costs of dismantling the nuclear power plants and managing the spent fuel from these plants, in its annual activity reports 2017, 2018, and 2019 [CNP 2017, 2018, 2019] (Sections E.1–Article 5(1)(h) and I.3.2). In this respect, the Commission submitted in 2018 to the former Minister in charge of Energy a proposal to revise the Law of 11 April 2003 in order to improve the existence, the sufficiency, and the availability of the provisions. This proposal was discussed by the former Federal Council of Ministers but was not adopted. The current Federal Government announced, in the coalition agreement of September 2020, its intention to strengthen the legal framework related to the nuclear provisions, upon proposal of the Commission for Nuclear Provisions (Section M.2). At the end of 2020, the current Minister in charge of Energy asked for an advice from the Commission for Nuclear Provisions, to propose a revision of the Law of 11 April 2003.

B.3 National programme

There have been no new policies, no changes to existing ones, and no major modifications or evolutions with respect to the national programme 2015. Therefore, it has not been updated.

The ongoing efforts to establish the bases of the national policy on the long-term management of B&C waste will lead to a programme update once this policy has been established. This update will also specify other elements required for Belgium to comply with the obligations of Directive 2011/70/Euratom and pointed out in the infringement procedure initiated by the European Commission: the preparation of a decision on the status of commercial spent fuel and the preparation, on the basis of current RD&D, of a decision on the status of the research spent fuel, as well as an estimate of the costs of the national programme (see also Section K.2) [EC 2019; FPS Economy 2020a].

The main developments (Section B.3.1) regarding implementation of the national programme since 31 December 2017 and the main challenges (Section B.3.2) are summarised hereafter.

B.3.1 Main developments

B.3.1.1 Update of the radiological and physico-chemical inventory

ONDRAF/NIRAS has updated the radiological and physico-chemical inventory of existing and planned conditioned waste in Belgium at 31 December 2020. It includes the waste production forecasts up to when this production has decreased to zero or can be considered to be negligible [ONDRAF/NIRAS 2021a] (Section C.2.3).

B.3.1.2 Progress related to the construction of the SF² (Spent Fuel Storage Facility) buildings

The two new facilities for the on-site dry interim storage of spent fuel (Spent Fuel Storage Facility or SF²) planned respectively on the Tihange and Doel nuclear sites must, together with the existing interim spent fuel storage facilities (wet storage in Tihange and dry storage in Doel), allow for the storage of all spent fuel from the seven commercial nuclear reactors after their final shutdown. These new facilities are designed to have an operating lifetime of 80 years.

- The nuclear licence application for the creation and operation of SF² Tihange was submitted by Electrabel in May 2018. The licensing process (review and consultation of the public and of advisory bodies) took place in 2019. The licence was granted by Royal Decree on 26 January 2020. Construction began in May 2020. Operation is expected to begin in 2023.
- The nuclear licence application for the creation and operation of SF² Doel was submitted by Electrabel in January 2020. Construction is planned from 2021 on, after obtaining the required nuclear licence (royal decree) and the permit. Operation is expected to begin in 2025.

B.3.1.3 End of the production of radioactive decommissioning waste from the former fuel-fabrication facilities

The production of radioactive waste from the decommissioning of the two fuel-fabrication facilities, Belgonucleaire and FBFC International, that were located on Belgian territory is terminated.

- Belgonucleaire was dismantled between 2009 and 2019, the last buildings being cleared and demolished in 2019. The site was unconditionally released from regulatory control after a final radiological characterisation, and the decommissioning was acknowledged by Royal Decree in December 2019.
- The decontamination, clearance, and demolition of the remaining nuclear buildings of FBFC International, whose dismantling started in 2011, and the unconditional release of the site are expected by the end of 2021.

B.3.1.4 Preparation of the final shutdown and the decommissioning of the nuclear power plants

In 2018, FANC started discussions with Electrabel to clarify strategic decisions related to the future decommissioning of Electrabel's seven nuclear power reactors, after their deactivation in the period 2022–2025: the duration of the 'post-operational period', the preparation of the dismantling licences, and the basic design of possible new facilities needed on site for the dismantling operations and radioactive waste management activities.

Electrabel and ONDRAF/NIRAS are developing and making operational all the waste management routes, from dismantling of the nuclear reactors to surface disposal of the resulting category A waste (short-lived, low-level and intermediate-level conditioned waste) (Section B.3.1.6) and to the storage at Belgoprocess of the resulting category B waste.

Tripartite meetings with Electrabel, FANC (and Bel V), and ONDRAF/NIRAS are organised to ensure the coherence of the management of decommissioning waste. This also includes the extension of the waste acceptance system to disposal of this waste.

B.3.1.5 Improvement of the inspection programme on the management of radioactive waste by producers

The inspection programme on the management of radioactive waste by producers has been recently improved as a result of the clarification, in a common position document from 2019, of the respective roles and responsibilities of FANC/Bel V and ONDRAF/NIRAS during the joint inspections carried out on the sites of waste producers operating class I and class II facilities. According to this document, the joint inspections are twofold:

- inspections carried out by ONDRAF/NIRAS that focus on the qualification of the methods and equipment used by the waste producer to ensure the conformity of its radioactive waste with the waste acceptance criteria established by ONDRAF/NIRAS — both FANC and Bel V can participate in these inspections as observers;
- inspections carried out by FANC and Bel V that focus on the operational safety and all other aspects within the legal framework of the competent regulatory authority, and in which ONDRAF/NIRAS participates as an observer.

The joint inspections ensure coherence between the ONDRAF/NIRAS and the FANC/Bel V inspection programmes.

B.3.1.6 Progress in the licensing process for the surface disposal facility for category A waste

ONDRAF/NIRAS submitted the licence application for the surface disposal facility for category A waste in Dessel to FANC in January 2013. FANC and Bel V then conducted a detailed review of the application that resulted in a series of questions to ONDRAF/NIRAS. FANC declared in December 2017 that all the questions that needed answering prior to the next step in the licensing process had been answered. ONDRAF/NIRAS reworked the licence application in 2018, taking into account its answers to FANC's questions. The reworked application was sent to FANC in February 2019, and the reworked environmental impact assessment followed in July 2019. FANC declared the licence application complete in September 2019.

In October 2019, the Scientific Council for ionising radiation issued a preliminary — positive — opinion on the application, but requested certain topics to be developed further, among others the QA/QC process during construction, the description of the integrated management system, an update of the hydro-geological model, an analysis of barrier performances, and the necessary instrumentation and control of the disposal facility.

The application was submitted in December 2019 to a public enquiry and to the opinion of both the municipalities within a radius of 5 kilometres around the disposal site and the provincial authorities. The European Commission was asked for its opinion in accordance with Articles 37 and 41 of the Euratom Treaty.

ONDRAF/NIRAS is working on the information still to be provided to the Scientific Council and plans to complete this work by the end of 2022. The Council will then evaluate this information, the comments from the public, and the various opinions, and issue its final opinion, which might include specific conditions. That opinion is expected in 2023. The licence should be granted thereafter.

B.3.1.7 Assessment of the volumes of radium-bearing and NORM substances to be managed as radioactive waste and development of a methodology in relation to disposal solutions

FANC and ONDRAF/NIRAS finalised in 2018 an inventory of the main sites contaminated by radium-bearing and NORM substances that could require radiological remediation, including their relevant characteristics, and of Umicore's licensed storage facilities and their contents [FANC and ONDRAF/NIRAS 2018] (Sections C.2.4 and C.2.5). This was with a view to preparing regulatory decisions and policy proposals for the long-term management of the fraction of those substances to be managed as radioactive waste.

In 2020, FANC and ONDRAF/NIRAS issued a common vision document with a general methodology for managing the radiological and non-radiological contaminations on the Umicore site in Olen and in its vicinity. This document proposes to separate the radium-bearing substances into several fractions in function of their activity level with a view to their long-term management: clearance, management as non-radioactive waste in a landfill but with radiological monitoring, management as radioactive waste in a near-surface disposal facility, or management as radioactive waste in a geological disposal facility [FANC and ONDRAF/NIRAS 2020].

Umicore, FANC, ONDRAF/NIRAS, and the Flemish agency for the management of non-radioactive waste OVAM agreed in May 2021 on a roadmap for the site remediation and for the disposal of the resulting radioactive waste and waste to be managed as non-radioactive waste on the basis of the proposed methodology [FANC *et al.* 2021]. This roadmap, with objectives, milestones, and timeframes, excludes, in a first phase, Umicore's UMTRAP licensed storage facility, which will be the subject of a separate decisional process. The national policy proposal of ONDRAF/NIRAS for the long-term management of B&C waste (Section B.1) covers the fraction of radium-bearing waste that would have to be disposed of in a geological disposal facility.

According to the preliminary assessment by FANC and ONDRAF/NIRAS, the radiological characteristics of the industrial landfills contaminated by NORM and of the diffuse NORM contamination present in certain zones are such that most NORM waste will not have to be managed as radioactive waste. This preliminary conclusion must be confirmed through the formalisation in the legal and regulatory framework of the proposed activity thresholds (Sections C.1 and M.1.4). If this is confirmed eventually, there will be no need for a national policy dedicated to the long-term management of NORM radioactive waste. The very limited amounts of NORM waste to be managed as radioactive waste coming from the dismantling of certain facilities using NORM should indeed enter the category B waste and are thus covered by the proposal for the bases of the national policy on the long-term management of B&C waste.

B.3.1.8 Update of the inventory of nuclear liabilities

The fourth inventory report on nuclear liabilities [ONDRAF/NIRAS 2018] gives an update, at 31 December 2015, of the situation regarding the quality of the coverage of the management costs. In other words, it provides an extensive assessment of the existence and sufficiency of the provisions established (or not) by the financially liable entities to cover their management costs and of the availability in due time of the corresponding financial resources. To do so, the report first assesses the costs of all *existing* financial obligations in terms of spent fuel and radioactive waste management and in terms of decommissioning operations (Section K.3–Article 12(1)(h)).

B.3.1.9 Implementation of the guiding principles for the financing of the long-term fund

Pursuant to the provisions of the Royal Decree of 25 April 2014 [Belgian Official Journal 2014a] amending the Royal Decree of 30 March 1981 (ONDRAF/NIRAS royal decree), ONDRAF/NIRAS has implemented the so-called 'guiding principles', which are new principles for the financing of the long-term fund that will in particular provide for a stricter application of the polluter pays principle. This required a thorough revision of all medium- and long-term management fees (for storage and disposal, respectively) and the revision of all related contracts, with the so-called 'main' radioactive waste producers, with effect as of 1 January 2019.

B.3.2 Main challenges

Two challenges, in addition to those specifically related to the main developments listed above, have been identified as key to the implementation of the part of the national programme related to the operation of the future surface disposal facility in Dessel:

- the management of the large volumes of non-conform conditioned waste, and in particular of the waste packages (potentially) affected by an alkali-silica reaction (ASR), including the necessary RD&D on the physico-chemical phenomena causing these non-conformities, adequate interim storage solutions, and the development and implementation of appropriate measures with a view to safe disposal;
- the extension of the present waste acceptance system to:
  - integrate the revised waste acceptance criteria necessary to ensure compliance of the waste intended for surface disposal with the requirements of the nuclear licence for the future surface disposal facility;
  - take into account new waste management facilities, that is, the installation for the production of monoliths (IPM) and the facility for the production of the concrete containers used by the IPM;
  - broaden the scope of the inspections towards the supply chain used by the operators of waste conditioning facilities.

  This extension will have to be in accordance with the clarifications brought to the laws defining the competences of FANC and ONDRAF/NIRAS (Section B.2.2.1).

Since these topics are ongoing work, they are not reported in this section, but in Sections K.3–Article 12(1)(f) and D.3, respectively.

C. Articles 2 and 12(1)(c) — Scope and inventory

According to the Law of 3 June 2014 transposing Directive 2011/70/Euratom, radioactive waste is *"radioactive material in gaseous, liquid or solid form for which no further use is foreseen or considered by the State or by a legal or natural person whose decision is accepted through the approval of a national policy related to that material, as referred to in § 6 and § 7 of this article, and which is regulated as radioactive waste by the competent regulatory authority or if this material must be considered as radioactive waste on the basis of a legislative or regulatory provision"*.

C.1 Classification system and scope

> Article 2(1) *This Directive shall apply to all stages of:*
>
> *(a) spent fuel management when the spent fuel results from civilian activities;*
>
> *(b) radioactive waste management, from generation to disposal, when the radioactive waste results from civilian activities.*
>
> Article 2(2) *This Directive shall not apply to:*
>
> *(a) waste from extractive industries which may be radioactive and which falls within the scope of Directive 2006/21/EC;*
>
> *(b) authorised releases.*
>
> Article 2(3) *Article 4(4) of this Directive shall not apply to:*
>
> *(a) repatriation of disused sealed sources to a supplier or manufacturer;*
>
> *(b) shipment of spent fuel of research reactors to a country where research reactor fuels are supplied or manufactured, taking into account applicable international agreements;*
>
> *(c) […]*
>
> Article 2(4) *This Directive shall not affect the right of a Member State or an undertaking in that Member State to return radioactive waste after processing to its country of origin where:*
>
> *(a) the radioactive waste is to be shipped to that Member State or undertaking for processing; or*
>
> *(b) other material is to be shipped to that Member State or undertaking with the purpose of recovering the radioactive waste.*
>
> *This Directive shall not affect the right of a Member State or an undertaking in that Member State to which spent fuel is to be shipped for treatment or reprocessing to return to its country of origin radioactive waste recovered from the treatment or reprocessing operation, or an agreed equivalent.*

For the long-term management of conditioned radioactive waste (see Table 1 in Section A for an overview of its origins), ONDRAF/NIRAS has adopted a classification in three categories, defined in accordance with the classification proposed in 1994 by the IAEA and then revised in 2009: waste is classified according to its activity and half-life. This classification could need to be refined or complemented to take account of the future national policy on the long-term management of radium-bearing waste.

- Category A waste is short-lived, low-level and intermediate-level conditioned waste containing limited quantities of long-lived radionuclides. It poses a risk to man and the environment for several hundreds of years. It can be considered for surface or near-surface disposal. It corresponds to low-level waste (LLW) in the IAEA 2009 classification. The radiological criteria and limits for category A waste will be defined in the safety report and licensing conditions for the planned surface disposal facility in Dessel (licensing process ongoing). ONDRAF/NIRAS considers short-lived, very low-level waste (VLLW) that cannot be cleared as category A waste.

- Category B waste is long-lived, low-level and intermediate-level conditioned waste. It contains long-lived radionuclides in such quantities that it poses a risk during a very long time and must be isolated from man and the environment for several tens to several hundreds of thousands of years[3]. It emits no or little heat. It corresponds to intermediate-level waste (ILW) in the IAEA 2009 classification.
- Category C waste is high-level conditioned waste. It contains large quantities of long-lived radionuclides and, like category B waste, poses a risk during a very long time and must be isolated from man and the environment for several hundreds of thousands of years or even for a period of the order of one million years. It emits a large amount of heat. It corresponds to high-level waste (HLW) in the IAEA 2009 classification. Category C waste includes vitrified waste from the reprocessing of spent fuel from commercial nuclear reactors and from the BR2 research reactor and spent fuel declared as waste, except for the fuel from research reactors that belongs to category B because of its low thermal power.

For the processing of non-conditioned waste and the storage of conditioned waste, ONDRAF/NIRAS uses a more detailed classification system, based on the physico-chemical and radiological characteristics of the waste. This system determines the waste management route for the various waste types: the treatment (evaporation, incineration, (super)compaction, solidification, etc.) and conditioning processes, the appropriate storage facility, and the reference disposal solution.

According to the FANC and ONDRAF/NIRAS vision document (Section B.3.1.7), radium-bearing substances and NORM substances with activity levels below a certain threshold should not be managed as radioactive waste, subject to confirmation in the legal and regulatory framework. This concerns an as yet undetermined fraction of the radium-bearing substances in Olen (long-lived very low-level, low-level, or intermediate-level substances). It also concerns the very large quantities of NORM substances that were and are still being produced in Belgium, mainly by the phosphate industry. These NORM substances are and will continue to be managed as non-radioactive waste according to the provisions of the regional environmental protection framework, with appropriate control of the residual radiological risks by FANC, for instance during operational activities, site remediation activities, and post-remediation site surveillance.

As a corollary, and also subject to confirmation in the legal and regulatory framework, the radium-bearing substances and small volumes of NORM substances with activity levels above the threshold should be managed as radioactive waste.

C.2 Inventory

> Article 12(1)(c) *an inventory of all spent fuel and radioactive waste and estimates for future quantities, including those from decommissioning, clearly indicating the location and amount of the radioactive waste and spent fuel in accordance with appropriate classification of the radioactive waste;*

[3] Sealed sources that must be managed as radioactive waste end up in category B after treatment and conditioning.

C.2.1 Existing spent fuel

Spent fuel from nuclear power plants

Until the Parliamentary Resolution and the decision of the Federal Council of Ministers of December 1993 [Council of Ministers 1993], the spent fuel from the Belgian nuclear power plants was sent to France for reprocessing. Four contracts were concluded by Synatom with COGEMA (which became AREVA NC in 2006, and then Orano Cycle in January 2018) for the reprocessing of 672 tHM spent fuel. This fuel was reprocessed on the site of la Hague (France) between 1980 and 2001.

At 31 December 2020, 4 627 tHM of spent fuel, including 66 tHM of MOX fuel, had been definitively unloaded from the Doel and Tihange reactors since they started operating:

- 24,8% of this fuel is stored in the reactors' cooling ponds;
- 60,7% is stored in the storage facilities built at Doel (dry storage in metal casks) and Tihange (wet storage) (see also Section M.3.4);
- 14,5% has been reprocessed at la Hague:
  - The recovered uranium has been integrated into the fabrication of fuel assemblies for Belgian commercial nuclear reactors between 1994 and 2009.
  - The recovered plutonium has been integrated into the fabrication of MOX fuel assemblies for Doel 3 and Tihange 2 between 1995 and 2010, or transferred to third parties.
  - Reprocessing waste, conditioned at la Hague, has been entirely repatriated to Belgium and is stored in building 136 at Belgoprocess, awaiting a solution for its long-term management. The last transport took place in July 2018.

Spent fuel from research reactors

At 31 December 2020, the inventory of existing spent fuel from research reactors was as follows[4]:

[4] The BR1 reactor is still using its first fuel load.

Except for the fuel from the BR2 reactor awaiting reprocessing in the reactor's cooling pond and for the fuel from the VENUS zero-power reactor, the fuel that was definitively unloaded from research reactors does not have the status of spent fuel anymore, since it was reconditioned, reprocessed, or declared as radioactive waste.

- The spent fuel from the BR02 zero-power reactor was reconditioned to form new assemblies for the BR2 reactor.
- The spent fuel from the BR2 reactor is considered a resource and, hence, is subject to reprocessing. The intermediate-level and high-level reprocessing waste generated so far has been conditioned abroad, on the sites of the reprocessing facilities, repatriated to Belgium, and taken charge of by ONDRAF/NIRAS. It is stored in ONDRAF/NIRAS' building 136 at Belgoprocess. The contract with COGEMA (now Orano Cycle), signed in 1997, required a bilateral agreement between France and Belgium, which was ratified in 2014 [Belgian Official Journal 2014c]. It provides for the reprocessing of the BR2 spent fuel delivered at la Hague by 31 December 2025 and for the repatriation of the corresponding reprocessing waste before the end of 2030. It also provides for the transfer of ownership of the residual quantities of uranium and plutonium to Orano Cycle.
- The spent fuel from the BR3 reactor declared as radioactive waste to ONDRAF/NIRAS by SCK CEN has been dry stored in seven CASTOR casks in ONDRAF/NIRAS' building 156 at Belgoprocess since 2002. It is still the property of SCK CEN. In accordance with the terms of the agreement between ONDRAF/NIRAS and SCK CEN, ONDRAF/NIRAS provides safe storage for a maximum duration of 50 years, pending an operational solution for the fuel long-term management. Nevertheless, SCK CEN is currently investigating whether the BR3 spent fuel could be reprocessed or treated and conditioned. If it were eventually to be reprocessed, this spent fuel would not be considered as waste anymore, but as a resource.

- the spent fuel from SCK CEN's BR2 reactor that is stored in the reactor's cooling pond prior to its reprocessing;
- the fuel from SCK CEN's VENUS zero-power reactor, which was unloaded in 2008 when the reactor was transformed into VENUS-F and which is stored at SCK CEN, awaiting further use.

C.2.2 Existing radioactive waste

The inventory of conditioned radioactive waste stored at Belgoprocess at 31 December 2020 is given in Table 2 [ONDRAF/NIRAS 2021a].

No radioactive waste had been disposed of in a final repository in Belgium at 31 December 2020.

Table 2 – Main characteristics of the storage buildings for conditioned waste at Belgoprocess (all on site 1, except the buffer facility) in terms of capacity and the waste they contain at 31 December 2020 (disused sealed sources included).

Buildings	Commissioned	Type of conditioned waste	Waste categories	Capacity (m^3)	Filling rate (%)	Volume (m^3)	Activity (Bq)	
							α	β-γ
127	1976	Bituminised and cemented ILW (mainly category B waste, 220 and 400 litre packages) mostly (76%) from the Eurochemic reprocessing plant	A + mainly B	4 700	83	3 907	$3,4\ 10^{14}$	$4,6\ 10^{16}$
129	1985	Conditioned ILW (60 and 150 litre packages) from the vitrification, in PAMELA, of the 860 m^3 Eurochemic liquid waste and cemented ILW from the BR2 and BR3 reactors and from the partial dismantling of the PAMELA vitrification facility	B	250	86	215	$1,7\ 10^{15}$	$3,7\ 10^{17}$
136-Zone C	2000	HLW from the reprocessing of commercial spent fuel by COGEMA/Orano Cycle	C	106 (590 packages)	66	70 (vitrified)	$8,1\ 10^{16}$	$5,9\ 10^{18}$
136-Zone D	2009	ILW from the reprocessing of commercial spent fuel by COGEMA/Orano Cycle	B	600	26	154	$2,1\ 10^{14}$	$4,6\ 10^{16}$
150	1986	LLW (400, 500, 1000, 1200, 1500, 1600, and 2200 litre packages) (mainly category A) from the Doel and Tihange nuclear power plants (filters, concentrates, resins, etc.) and the former SCK CEN Waste department	A + B	1900	100	1900	$2,0\ 10^{12}$	$1,3\ 10^{15}$
151	1988	Same types of waste and origins as in building 150	A + B	14 700	102	15 020	$2,5\ 10^{13}$	$1,4\ 10^{15}$
151 E	2020	LLW (400 litre packages)	A	2000	0,1	2	$1,3\ 10^{7}$	$3,4\ 10^{8}$
155	2006	Alpha- and radium-contaminated waste and conditioned Thetis spent fuel	B	4 221	98	4 130	$2,0\ 10^{15}$	$1,8\ 10^{16}$
156	2002	Spent fuel from the BR3 reactor (non-conditioned)	C	8 CASTOR	88	7 CASTOR [1]	$2,0\ 10^{15}$	$1,0\ 10^{17}$
270 (buffer facility)		Packages that must be transferred to building 155, if necessary after reconditioning. These are mainly conditioned radium-bearing waste packages and conditioned waste packages (under characterisation) from the former SCK CEN Waste department	A + B	temporary buffer	n.a.	36	$4,5\ 10^{10}$	$5,4\ 10^{10}$

[1] The spent fuel from the BR3 reactor amounts to 2,4 tHM.

The fuel from the VENUS-F reactor of the GUINEVERE subcritical reactor project does not belong to SCK CEN. It is supplied by the French *Commissariat à l'énergie atomique et aux énergies alternatives* (Alternative Energies and Atomic Energy Commission) and will be returned to France in due time.

C.2.3 Estimates of the total future inventory of radioactive waste

The estimated total inventory of existing and planned conditioned waste is updated periodically by ONDRAF/NIRAS on the basis of, on the one hand, its knowledge of existing waste and spent fuel and of the estimated waste from the decommissioning of existing nuclear facilities and, on the other hand, the waste producers' reference programmes, containing their estimates of the waste they intend to transfer to ONDRAF/NIRAS.

The estimated inventory, at 31 December 2020, of existing and planned conditioned waste (over a realistic period, variable depending on the (type of) waste producer, but that may exceed 50 years in some cases) [ONDRAF/NIRAS 2021a], is provided in Table 3. The inventory considers:

- in accordance with the provisions of the Law of 31 January 2003 on nuclear phase out, that the Doel 1 and 2 and the Tihange 1 commercial nuclear reactors will be operated for 50 years and the four other reactors will be operated for 40 years;
- Synatom's reference programme of September 2019, according to which part of the spent fuel from commercial nuclear reactors will still be reprocessed, in addition to the 672 tHM UOX that have already been reprocessed in the past.

The inventory includes

- the decommissioning waste from all existing nuclear facilities;
- the limited amounts of radioactive waste currently abroad and to be repatriated;
- the disused sealed sources;
- the (maximum) 30 m^3 of category B and A waste (approximate ratio 90/10) from the Grand-Duchy of Luxembourg that Belgium agreed to take charge of by 2049 (Section B.2.1.1);
- the limited amounts of conditioned NORM radioactive waste already transferred to ONDRAF/NIRAS.

It does not include

- the operational and decommissioning waste from future facilities;
- the radium-bearing substances in Umicore's licensed storage facilities and from future remediation operations to be managed as radioactive waste, which are covered in Section C.2.4;
- the NORM substances to be managed as category B waste and not yet transferred to ONDRAF/NIRAS, which are covered in Section C.2.5.

Table 3 – Estimated total inventory of existing and planned conditioned waste (rounded figures) at 31 December 2020, based on the nuclear phase-out law and the 2019 reference programme of Synatom.

Waste category	Number of packages, monoliths or assemblies	Waste volumes or tHM
Category A		
Packaged wastes [1]	66 100 packages	27 100 m^3
Bulk conditioning	8 800 monoliths	26 400 m^3 [2]
Category B		
Packaged wastes	31 700 packages	8 700 m^3
Category C		
Packages of vitrified wastes	770 packages	140 m^3
Spent fuel from nuclear power plants	9 800 assemblies	4 100 tHM

[1] The category A waste packages are mostly 400-litre drums.

[2] Calculated on the basis of the net internal volume of the disposal containers (monoliths).

C.2.4 Radium-bearing substances to be managed as radioactive waste

According to the inventory of the main contaminated sites that could require radiological remediation and of Umicore's licensed storage facilities [FANC and ONDRAF/NIRAS 2018], the total volume of radioactively contaminated substances on the Umicore site in Olen and in its vicinity amounts to maximum 300 000 m^3. It can be divided as follows:

- about 95 000 m^3 of non-conditioned radium-bearing substances in three licensed storage facilities on the site of Umicore (UMTRAP, Bankloop storage facility, and Storage facility 2016);
- about 205 000 m^3 of radium-bearing substances present in landfills and as diffuse contamination on the Umicore site and in its vicinity.

An initial estimate of the volumes of substances to be managed respectively as radioactive and non-radioactive waste (not considering the UMTRAP storage facility, which will be the subject of a separate decisional process) will be made at the end of 2021, on the basis of the methodology developed by FANC and ONDRAF/NIRAS in their vision document (Section B.3.1.7) and of all available information on the radiological characteristics of the contaminated sites and radioactive substances in storage.

In addition, Umicore, FANC, ONDRAF/NIRAS, and OVAM agreed in May 2021 on a roadmap for the site remediation and for the disposal of the radioactive waste and of the waste to be managed as non-radioactive waste. This roadmap provides for the establishment by ONDRAF/NIRAS of a national policy proposal for the low- and intermediate-level radium-bearing waste in case another disposal solution could be developed than geological disposal as category B waste (Section M.1.3).

C.2.5 NORM substances to be managed as radioactive waste

Based on the inventory of the main contaminated sites that could require radiological remediation and on the methodology developed by FANC and ONDRAF/NIRAS [FANC and ONDRAF/NIRAS 2018], the fraction of NORM substances that will have to be managed as category B waste by ONDRAF/NIRAS in the long term will be limited to a small volume of NORM radioactive waste from the dismantling of certain facilities using NORM (see also Section B.3.1.7).

D. Article 4 — General principles and policies

D.1 National policies

> Article 4(1) *Member States shall establish and maintain national policies on spent fuel and radioactive waste management. Without prejudice to Article 2(3), each Member State shall have ultimate responsibility for management of the spent fuel and radioactive waste generated in it.*

At 31 December 2020, the national policies on spent fuel and radioactive waste management were unchanged with respect to the situation presented in the national programme 2015. They were as follows (Table 4):

for radioactive waste:

- management by decay and subsequent clearance of very short-lived radioactive waste;
- centralised short-term and medium-term management on the BP1 and BP2 sites in Mol–Dessel of radioactive waste that, after treatment and conditioning, becomes category A, B, or C waste (de facto policy resulting from a succession of historical choices and events);
- surface disposal in Dessel for the long-term management of category A waste (policy decisions by the Federal Council of Ministers, in 1998 and 2006 — Section E.1–Article 5(1)(b)).

for spent fuel:

- safe storage followed by reprocessing or disposal for the spent fuel from commercial nuclear reactors;
- reprocessing for the spent fuel from SCK CEN's BR2 research reactor (ratification in 2014 by law of the 2013 bilateral agreement between Belgium and France related to the reprocessing contract signed in 1998 with COGEMA (now Orano Cycle)) [Belgian Official Journal 2014c];
- safe dry storage for the spent fuel from SCK CEN's BR3 research reactor pending an operational solution for its long-term management.

As a corollary, and considering that a national policy dedicated to the long-term management of NORM radioactive waste will probably not be necessary, the following national policies were still to be established at 31 December 2020 (see Section M.1 for information on the plans to establish the missing policies and confirming that there is no need for a dedicated NORM policy):

- the policy on the long-term management of category B&C waste;
- the policy on the long-term management of radium-bearing substances to be managed as radioactive waste.

In addition, Synatom, as owner of the spent fuel from the commercial nuclear reactors, and SCK CEN, as owner of the spent fuel from the BR1, BR3, and VENUS reactors, must propose hypotheses regarding the further use of their spent fuel (reprocessing or not), with a view to the later integration of the accepted hypotheses in the national policies, thereby establishing the status of the fuel (resource or waste), after consultation with ONDRAF/NIRAS and FANC (Article 179, § 6, of the Law of 8 August 1980).

Table 4 – Overview of the existence of national policies on the management of spent fuel and radioactive waste, at 31 December 2020. The situation is unchanged compared with that presented in the national programme 2015 [✓: yes; ✗: no].

	NATIONAL POLICIES ON THE MANAGEMENT BY PRODUCERS / OWNERS	TRANSFER OF WASTE	NATIONAL POLICIES ON THE MANAGEMENT BY ONDRAF/NIRAS	
			SHORT AND MEDIUM TERMS (treatment, conditioning and storage)	LONG TERM (disposal)
Very short-lived waste	✓	not app.	not applicable	not applicable
Category A waste	not applicable [1]	⇒	✓	✓
Category B waste	not applicable [1]	⇒	✓	✗
Category C waste (reprocessing waste)	not applicable	[2]	✓	✗
Category C waste (spent fuel)	not applicable		✓	✗
Spent fuel from Synatom	✓ [3]		not applicable	not applicable
Spent fuel from SCK CEN	✓		not applicable	not applicable
Ra-bearing substances in Umicore's licensed storage facilities	not applicable	⇒	✗	✗
Ra-bearing substances to be managed as radioactive waste by ONDRAF/NIRAS	not applicable	⇒	✗	✗
NORM substances to be managed as radioactive waste by ONDRAF/NIRAS	not applicable	⇒	✗ [4]	✗ [4]

[1] The management of radioactive waste by producers must comply with a set of principles and obligations, but is not subject to an actual national policy.

[2] Decisions on the future of spent fuel will have to be made before it is transferred to ONDRAF/NIRAS.

[3] Policy for the management of spent fuel from Synatom: safe storage followed by reprocessing or disposal.

[4] The NORM substances to be managed as radioactive waste will probably be limited to NORM from dismantling (Section B.3.1.7), which will follow the management route of similar types of waste already covered by the waste management system and that end up in category B.

D.2 Ultimate responsibility

> Article 4(2) *Where radioactive waste or spent fuel is shipped for processing or reprocessing to a Member State or a third country, the ultimate responsibility for the safe and responsible disposal of those materials, including any waste as a by-product, shall remain with the Member State or third country from which the radioactive material was shipped.*

If radioactive waste or spent fuel is transferred to a foreign country for treatment or reprocessing, the final responsibility for safe disposal of these substances, including any waste created as a by-product, remains with the Belgian State (Article 179, § 7, of the Law of 8 August 1980, inserted by Article 4 of the Law of 3 June 2014).

D.3 Principles

> Article 4(3) *National policies shall be based on all of the following principles:*
>
> *(a) the generation of radioactive waste shall be kept to the minimum which is reasonably practicable, both in terms of activity and volume, by means of appropriate design measures and of operating and decommissioning practices, including the recycling and reuse of materials;*
>
> *(b) the interdependencies between all steps in spent fuel and radioactive waste generation and management shall be taken into account;*
>
> *(c) spent fuel and radioactive waste shall be safely managed, including in the long term with passive safety features;*
>
> *(d) implementation of measures shall follow a graded approach;*
>
> *(e) the costs for the management of spent fuel and radioactive waste shall be borne by those who generated those materials;*
>
> *(f) an evidence-based and documented decision-making process shall be applied with regard to all stages of the management of spent fuel and radioactive waste.*

Table 5 provides an overview of how national policies on radioactive waste management implement the general principles.

Table 5 – Overview of how national policies on radioactive waste management implement the general principles.

GENERAL PRINCIPLES ON WHICH POLICIES MUST BE BASED					
(a) Minimisation of radioactive waste	(b) Interdependencies	(c) Safe management / Passive safety features for the long term	(d) Graded approach	(e) 'Polluter pays' principle	(f) Evidence-based and documented decision-making process
Very short-lived waste: management through decay followed by clearance					
The waste never gets declared as radioactive waste to ONDRAF/NIRAS	n.a. (one management step only)	Nuclear licensing according to GRR-2001 [1] Clearance according to GRR-2001 Passive features: n.a.	Solution proportionate to risks	Section I	Nuclear licensing process
Category A, B and C waste, short and medium term: centralised management					
Reduction in the number of facilities and, hence, in decommissioning waste	Based on ONDRAF/NIRAS' acceptance system + IMS Consideration of logistic interdependencies is favoured by centralisation	Nuclear licensing according to GRR-2001 Centralisation of controls, competences, etc. Storage can be safe for decennia Passive features: n.a.	Processes and facilities designed in function of the physical, chemical, and radiological characteristics of the waste	Section I	Nuclear licensing process Qualification process Respect of the environmental regulations
Category A waste, long term: surface disposal in Dessel					
n.a.	Based on ONDRAF/NIRAS' acceptance system + IMS	Nuclear licensing according to GRR-2001 Passivity of the disposal system inherent to the system as a result of its design	Solution designed in function of the physical, chemical, and radiological characteristics of the waste Solution different than that proposed for B&C waste (geological disposal)	Section I	Participation through partnerships Nuclear licensing process

[1] Royal Decree of 20 July 2001 relating to the general regulations for the protection of the population, workers, and the environment against the dangers arising from ionising radiation, also known as 'general regulations for radiation protection'.

Radioactive waste producers endeavour to limit their radioactive waste generation at source. These efforts rely on optimising industrial practices and limiting volumes of radioactive waste, for example by improving decontamination techniques, optimising dismantling techniques for nuclear equipment and facilities that have been put out of service, and using recycling and reuse options as

well as clearance possibilities, in accordance with the applicable regulations. This is a general practice for all decommissioning programmes.

ONDRAF/NIRAS is implementing an integrated management system for all the steps in the management of radioactive waste (Figure 2) to ensure interdependencies (operational and long-term safety, management of radioactive waste streams, logistics, roles and responsibilities, etc.) between the different steps of the management of radioactive waste as best as possible and specifically to guarantee that all requirements arising from the need to ensure long-term safety are passed on across the previous management steps. This system is based on the IAEA recommendations and on the legislation (SRNI-2011 — Section E.1–Article 5(1)(b)).

The backbone of the integrated management system is the waste acceptance system, which aims to ensure that at each step in the management chain, the radiological and physico-chemical characteristics of the radioactive waste comply with the requirements arising from the subsequent steps in its management. It includes in particular the establishment, by ONDRAF/NIRAS, of the acceptance criteria that non-conditioned and conditioned waste must satisfy for ONDRAF/NIRAS to take charge of it. These criteria are based on the general rules approved by the competent regulatory authority and take into account the requirements of the nuclear licences for the transport of radioactive waste and for the treatment, conditioning, and storage of this waste. When a disposal facility becomes operational, the waste acceptance criteria for disposal will be integrated in the waste acceptance system. In the meantime, the waste acceptance system is based on provisional generic requirements for disposal.

ONDRAF/NIRAS is currently extending the waste acceptance system to include the surface disposal activities. This extension will include the facilities to produce the concrete containers that will receive the waste and the monoliths (IPM), as well as the surface disposal facility itself. This must be done in accordance with the clarifications brought to the laws defining the competences of FANC and ONDRAF/NIRAS (Section B.2.2.1) and take due consideration of the FANC recommendations and of the lessons learnt during the management of non-conform conditioned waste.

In addition, ONDRAF/NIRAS must revise the waste acceptance criteria pertaining to radioactive waste destined for the surface disposal facility. These revisions must ensure coherence of the waste acceptance criteria with the disposal criteria proposed in the safety report for acceptance of the waste for the surface disposal facility.

According to the provisions of the Royal Decree of 18 November 2002, all facilities in Belgium in which radioactive waste of Belgian origin is treated, conditioned, stored, or characterised must be qualified by ONDRAF/NIRAS to ensure compliance of the corresponding waste with ONDRAF/NIRAS' acceptance criteria. As for facilities located abroad and contracted by a Belgian owner of radioactive waste with a view to treatment, conditioning, or storage of its waste, the royal decree specifies that *"any contract concluded between a Belgian owner of radioactive waste and a foreign operator for treatment, conditioning, and storage of its radioactive waste must be approved beforehand by ONDRAF/NIRAS with a view to ONDRAF/NIRAS taking charge of this waste at a later stage and in particular with a view to the quality system applicable to the technical equipment in order to guarantee the conformity of the waste with the acceptance criteria"*.

The radiological and physico-chemical inventory of existing and planned waste (characteristics, volumes, and production forecasts) (Sections C.2.2 to C.2.5) is another key element for managing waste streams and associated facilities.

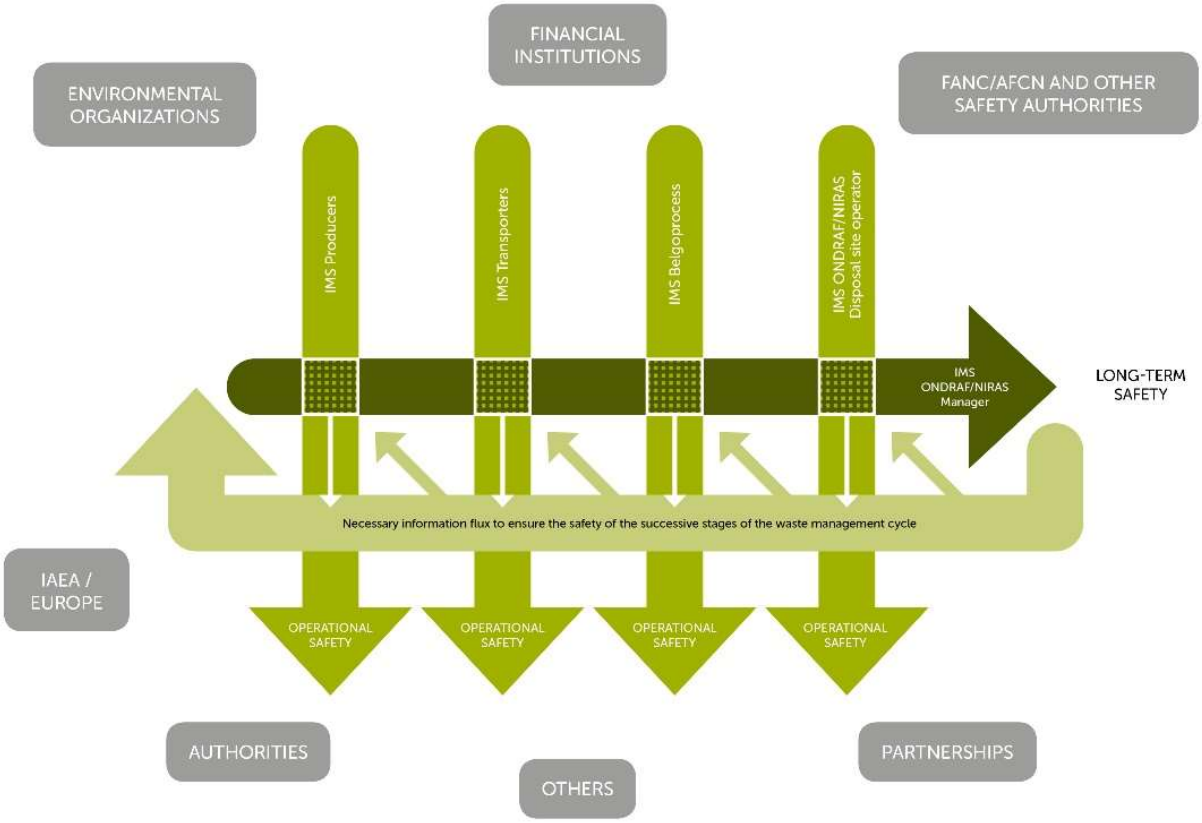

Figure 2 – ONDRAF/NIRAS' integrated management system (IMS) and waste acceptance system as tools to ensure interdependencies between the successive steps in radioactive waste management.

D.4 Disposal of waste in other Member States or in third countries

> Article 4(4) *Radioactive waste shall be disposed of in the Member State in which it was generated, unless at the time of shipment an agreement, taking into account the criteria established by the Commission in accordance with Article 16(2) of Directive 2006/117/Euratom, has entered into force between the Member State concerned and another Member State or a third country to use a disposal facility in one of them.*
>
> *Prior to a shipment to a third country, the exporting Member State shall inform the Commission of the content of any such agreement and take reasonable measures to be assured that:*
>
> *(a) the country of destination has concluded an agreement with the Community covering spent fuel and radioactive waste management or is a party to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management ('the Joint Convention');*
>
> *(b) the country of destination has radioactive waste management and disposal programmes with objectives representing a high level of safety equivalent to those established by this Directive; and*
>
> *(c) the disposal facility in the country of destination is authorised for the radioactive waste to be shipped, is operating prior to the shipment, and is managed in accordance with the requirements set down in the radioactive waste management and disposal programme of that country of destination.*

Article 4(4) of Directive 2011/70/Euratom has been transposed by Article 4 of the Law of 3 June 2014.

Belgium is not exporting radioactive waste to other countries for disposal.

E. Article 5 — National framework

E.1 Legislative, regulatory, and organisational framework

> Article 5(1) *Member States shall establish and maintain a national legislative, regulatory and organisational framework ('national framework') for spent fuel and radioactive waste management that allocates responsibility and provides for coordination between relevant competent bodies. The national framework shall provide for all of the following:*

National programme

> Article 5(1)(a) *a national programme for the implementation of spent fuel and radioactive waste management policy;*

The first edition of the *National Programme for the Management of Spent Fuel and Radioactive Waste* or 'national programme 2015' was drafted by the National Programme Committee (*Comité du Programme national* / *Comité van het Nationale Programma* or CPNPC) created by Article 6 of the Law of 3 June 2014 modifying Article 179 of the Law of 8 August 1980 (see below, under Article 5(1)(b)) to transpose Council Directive 2011/70/Euratom of 19 July 2011. The National Programme Committee is composed of representatives of the Federal Public Service in charge of Energy (chair), ONDRAF/NIRAS (secretary), and Synatom.

The National Programme Committee decided to limit the national programme 2015 to a description of the existing situation at 31 December 2014 in terms of national policies, the implementation of these policies, and the national framework for this implementation, without new normative content.

The national programme 2015 was adopted by the Federal Council of Ministers on 30 June 2016 and notified to the European Commission on 5 August 2016. It was sanctioned by ministerial decree on 3 October 2016 and published in the Belgian Official Journal on 15 June 2017 [Belgian Official Journal 2017]. The French and Dutch versions, as well as the English courtesy translation, are available on a dedicated website of the Federal Government: www.cpnpc.be.

National arrangements for the safety of spent fuel and radioactive waste management

> Article 5(1)(b) *national arrangements for the safety of spent fuel and radioactive waste management. The determination of how those arrangements are to be adopted and through which instrument they are to be applied rests within the competence of the Member States;*

The complete set of Belgian, European, and international regulations in relation with spent fuel and radioactive waste management can be found on www.jurion.fanc.fgov.be.

Main texts related to nuclear safety and radiation protection

Law of 15 April 1994 *on the protection of the population and the environment against the dangers arising from ionising radiation and on FANC* (hereafter the 'FANC law') [Belgian Official Journal 1994b], which, in particular,

- establishes FANC;
- defines its missions, including that of proposing draft royal decrees implementing the FANC law;
- states that licence holders are responsible, in all circumstances, for ensuring the protection of the population, workers, and the environment against the hazards or health inconveniences that could arise from their practices and that this responsibility cannot be delegated.

Royal Decree of 20 July 2001 *relating to the general regulations for the protection of the population, workers and the environment against the dangers arising from ionising radiation* (hereafter the 'general regulations for radiation protection' or 'GRR-2001') [Belgian Official Journal 2001], which implements the FANC law and, in particular,

- organises the facilities in which activities are performed that involve the use of radioactive substances or ionising radiation in four classes, ranging from I to IV, with class I facilities being the highest risk facilities (Article 3). Class I facilities include the following radioactive waste and spent fuel management facilities:
  - the facilities where radioactive waste is collected, treated, conditioned, stored, or handled, provided these activities are the main activities of the company;
  - the facilities for radioactive waste disposal;
  - the facilities where the amount of fissile materials used or held is higher than half of the minimal critical mass, thus facilities where (irradiated) fissile materials are processed, stored, or disposed of;
- establishes that licence applications for class I, II, and III facilities must contain a 'Radioactive Waste file' and a 'Decommissioning file', where the Radioactive Waste file describes the organisational and technical measures taken to manage the generated waste and the Decommissioning file describes notably the expected volumes of radioactive waste from dismantling (Article 5.8, introduced by the Royal Decree of 29 May 2018);
- establishes the licensing system for class I treatment, conditioning, and storage facilities for radioactive waste and establishes the general provisions for the licensing system for disposal facilities (Article 6, as replaced by the Royal Decree of 29 May 2020);
- establishes the basic standards regarding protection against exposure to ionising radiation (Chapter III, Section I);
- contains various articles relating to radioactive waste (Chapter III, Section IV);
- provides the possibility for operators to request authorisation from FANC for the discharge, disposal, recycling, or reuse of liquid and solid radioactive waste (Article 18);
- requires licensees to maintain an inventory of all radioactive substances present in their facilities, whereby the inventory of sealed sources and radioactive waste must be accurate and updated on a continuous basis (Article 27.bis, introduced by the Royal Decree of 29 May 2018);
- describes the concept of 'work activity' (use of NORM), lists work activities, and requires them to be declared to FANC.

The Royal Decree of 20 July 2001 has been fully brought into line with the European radiation protection directive 2013/59/Euratom by the Royal Decree of 20 July 2020.

Royal Decree of 30 November 2011 *on the safety requirements for nuclear facilities* (hereafter the 'SRNI-2011') [Belgian Official Journal 2011], which is the result of the WENRA harmonisation activities with respect to regulations, providing for a wide range of obligations, among which the obligations for the holders of a class I licence to

- document their organisational structure and adopt a graded approach for nuclear safety management to ensure a safe operation of the facility by sufficiently qualified people (Article 4);
- establish, implement, assess, and improve on a continuous basis an integrated management system giving priority to safety; this system must cover all the activities and processes that can have an impact on the nuclear safety of the facilities, including the activities carried out by subcontractors or suppliers, with licence holders having to determine and allocate the necessary resources (financial resources, sufficient and sufficiently qualified human resources, etc.) (Article 5);
- establish and maintain a safety report (Article 13);
- proceed to periodic safety reviews (Article 14);
- ensure that storage facilities for spent fuel and radioactive waste meet the specific safety requirements transposed from the WENRA safety reference levels on spent fuel and waste storage (Chapter 4, introduced by the Royal Decree of 29 May 2018).

Main texts related to the management of radioactive waste and spent fuel

Law of 8 August 1980 (Article 179) *on the budgetary proposals for 1979–1980* [Belgian Official Journal 1980], which, in particular,

- entrusts Synatom with the management of activities relating to the nuclear fuel cycle, with the exception of those assigned to ONDRAF/NIRAS (§ 1);
- creates ONDRAF/NIRAS (§ 2 — hereafter the 'ONDRAF/NIRAS law');
- assigns various missions to ONDRAF/NIRAS (in particular, the inventory and management of radioactive waste, including spent fuel declared as waste, and missions relating to decommissioning) (§ 2);
- recognises the need for societal integration of a disposal facility at the local level and allows ONDRAF/NIRAS to create a fund for covering the societal costs of such integration, called 'medium-term fund' (§ 2);
- stipulates that national policies on the management of radioactive waste and spent fuel are to be established and maintained by royal decree, debated in the Federal Council of Ministers, on ONDRAF/NIRAS' proposal and after FANC's opinion (§ 6).

Royal Decree of 30 March 1981 *determining the missions and setting out the functioning rules for ONDRAF/NIRAS* (hereafter the 'ONDRAF/NIRAS royal decree') [Belgian Official Journal 1981], which implements the ONDRAF/NIRAS law.

Parliamentary resolution of 22 December 1993, confirmed by the Federal Council of Ministers the same year [Council of Ministers 1993], which, in particular, ordered the Government, in the future, to prioritise no longer the reprocessing strategy compared with the conditioning and direct disposal strategy (once through cycle). The Government could therefore no longer consider reprocessing as the obvious reference strategy. It had to create the conditions to allow the conditioning and direct disposal strategy to be developed as an alternative. This was reconfirmed by the Federal Council of Ministers on 4 December 1998.

Decision of the Federal Council of Ministers of 16 January 1998 [Council of Ministers 1998] through which, in particular, it

- opted for a solution that is definitive or can become definitive, and one that is progressive, flexible, and reversible, for the long-term management of short-lived, low-level and intermediate-level waste (category A waste);
- ordered the Minister in charge of Economy to give ONDRAF/NIRAS the mission to limit itself, in its exploratory activities, to existing nuclear zones and to sites where the local authorities showed an interest.

Ministerial letter of 10 February 1999 [Van den Bossche 1999] concerning the General Rules for the establishment of acceptance criteria by ONDRAF/NIRAS for conditioned and non-conditioned waste.

Law of 2 August 2002 *containing assent to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, signed in Vienna on 5 September 1997* [Belgian Official Journal 2002b].

Royal Decree of 18 November 2002 *governing the qualification of facilities for the storage, treatment, and conditioning of radioactive waste* by ONDRAF/NIRAS [Belgian Official Journal 2002a] and also concerning the facilities and equipment (including methodologies) for radiological characterisation of radioactive waste, which, in particular,

- requires licensees to establish a quality management system for their waste storage and treatment facilities (Article 5, § 1);
- sets out requirements for this quality management system (Article 5, § 2).

Decision of the Federal Council of Ministers of 23 June 2006 [Council of Ministers 2006] determining in particular that the long-term management method for category A waste will be surface disposal on the territory of the municipality of Dessel, as part of a project incorporating the technical and societal aspects and developed through a participative process.

Description of the responsibilities allocated by the national framework to the various actors

See Section A.1.

Licensing system (FANC)

> **Article 5(1)(c)** *a system of licensing of spent fuel and radioactive waste management activities, facilities or both, including the prohibition of spent fuel or radioactive waste management activities, of the operation of a spent fuel or radioactive waste management facility without a licence or both and, if appropriate, prescribing conditions for further management of the activity, facility or both;*

All facilities in which an activity is performed that involves the use of radioactive substances or ionising radiation, except the facilities holding radioactive substances in quantities or concentrations under the exemption levels set in the GRR-2001, are subject to a licensing procedure described in the GRR-2001.

The licensing procedure varies with the class of the facility. In particular, licence applications for class I facilities, namely the class to which radioactive waste and spent fuel management facilities belong, must be accompanied by an environmental impact assessment, drawn up in agreement with Directive 2014/52/EU amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment (Figure 3).

Licence applications for the creation and operation of facilities are submitted to FANC, for nuclear safety verification by Bel V or FANC. Depending on the class of the facility, they are also submitted to certain other authorities, such as the local authorities (municipality and province levels), the Scientific Council for ionising radiation, and the European Commission, for their opinion. Creation and operation licences are granted by FANC, except for licences for class I facilities, which are granted by royal decree.

To avoid situations that can give rise to liabilities, licence application files must include a 'Radioactive Waste file' and a 'Decommissioning file' (Article 5.8, introduced by the Royal Decree of 29 May 2018). These documents, which deal with the expected production of operational radioactive waste and of decommissioning waste, are submitted to ONDRAF/NIRAS' opinion in the framework of the licensing procedure.

After construction, a facility can only be put into operation after its conformity with the conditions attached to the licence has been verified. For class I facilities, this verification is conducted by Bel V or/and FANC and entails checking compliance with the licence conditions, with the regulation in force (in particular the SRNI-2011), and with the safety report. A positive verification leads to the confirmation of the initial licence by a royal decree called 'confirmation decree' and allows the facility to be operated.

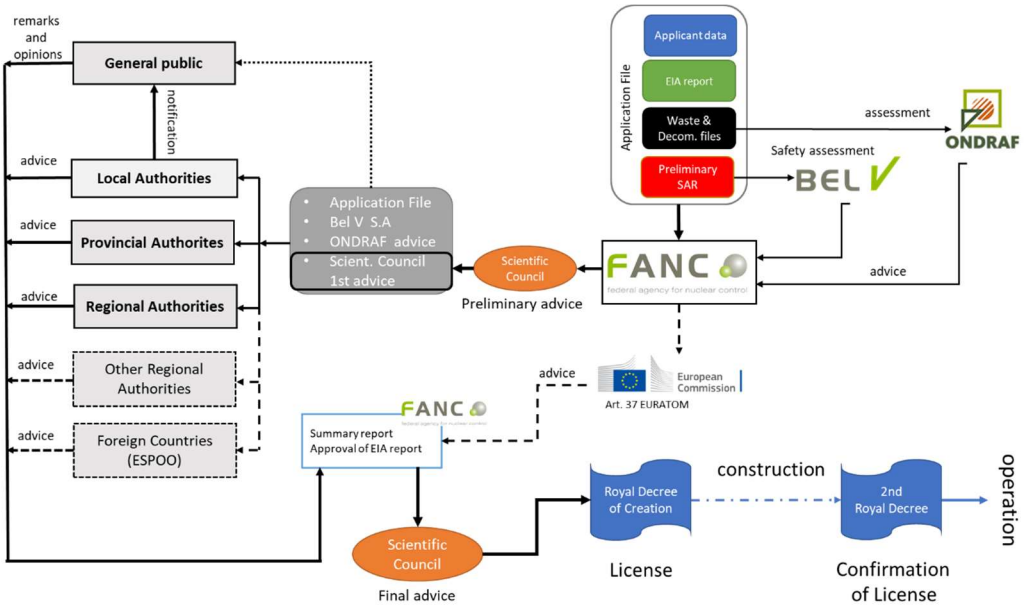

Figure 3 – Licensing procedure for class I facilities.

Institutional control, regulatory inspections, documentation, and reporting (FANC)

> Article 5(1)(d) *a system of appropriate control, a management system, regulatory inspections, documentation and reporting obligations for radioactive waste and spent fuel management activities, facilities or both, including appropriate measures for the post-closure periods of disposal facilities;*

FANC is responsible for the supervision and control of all activities concerning radiological protection and nuclear safety.

Since March 2019, Bel V is legally delegated by FANC to perform technical safety assessments and regular on-site inspections in the class I facilities and in high-risk class II facilities.

On the basis of their large inspection experience and their well-established know-how in collecting and interpreting operational feedback data, FANC and Bel V have over the years developed an inspection and safety assessment strategy aimed at assessing how licensees manage safety, with specific emphasis on the implementation of the GRR-2001, the SRNI-2011, and the conditions attached to the licences of the facilities. This strategy includes a permanent monitoring of the licensees, conformity checks of the facilities, and an inspection programme with various types of inspections. This strategy is evolving with time and safety concerns (for example, human and organisational performances) and is supported by strong programmes of initial expert training and retraining, of operational experience data collection and analysis, and of specific research and development activities.

During the operational period of class I facilities, a three-level control scheme is in place.

- The first level of control is ensured by the licensee's *Health Physics Department* (HPD): the HPD ensures the existence and effectiveness of the measures to guarantee nuclear safety and the radiological protection of the workers, the public, and the environment. It examines and approves projects for modifications in facilities.
- The second level of control is ensured by *Bel V*: among other tasks, Bel V verifies the proper functioning of the HPD and approves some of the HPD's decisions related to safety or radiation protection, in particular those related to the commissioning of new or modified facilities. Bel V has the power to make recommendations to operators, but has no enforcement power. If an operator violates the conditions attached to the licence and fails to correct the situation, or if the operation evolves towards an unsafe situation, Bel V reports the situation to FANC.
- The third level of control is ensured by *FANC*, which also verifies the proper functioning of Bel V. The FANC nuclear inspectors are legally entitled to take the necessary and urgent measures for protecting the workers, the public, and the environment.

Licensees are required to report regularly to FANC the inventory of radioactive substances, including radioactive waste, present in their facilities (Article 27.bis of the GRR-2001, introduced by the Royal Decree of 29 May 2018) or that were removed from them (Article 23.1.6 of the GRR-2001), as well as the inventory of liquid and gaseous radioactive effluents (Article 23.1.6 of the GRR-2001).

Enforcement actions (FANC)

> **Article 5(1)(e)** *enforcement actions, including the suspension of activities and the modification, expiration or revocation of a licence together with requirements, if appropriate, for alternative solutions that lead to improved safety;*

The procedures for enforcing regulatory requirements are based on FANC's legal framework. The enforcement tools and measures are provided in the following legal texts:

- the FANC law;
- the GRR-2001;
- the Royal Decree of 20 December 2007 related to administrative fines.

The FANC nuclear inspectors are nominated by royal decree. They have the powers of enforcement inspectors and can take any measure they consider necessary to reduce or eliminate hazards for the

workers, the public, and the environment. These measures are chosen primarily on the basis of the significance for safety of the infraction or situation, applying the principle of graded approach. They can include warnings and requests for corrective actions within six months (Articles 9 and 9bis of the FANC law). In extreme cases and if a practice may result in a specific danger, such as a detriment to health, nuclear inspectors have the power to suspend the activity. They can intervene at the request of Bel V inspectors.

In addition, the Scientific Council for ionising radiation and the FANC services in charge of the controls can, on their own initiative and at any moment, propose additional conditions to be included in the licence to improve safety (Article 13 of the GRR-2001).

Finally, if the licensee does not comply with the regulations or with its licence, the licence can be suspended or withdrawn, by royal decree after opinion of the Scientific Council for ionising radiation for class I facilities, and by FANC for the other licensed facilities (Article 16 of the GRR-2001).

Two types of sanctions can be used to reinforce FANC's orders: legal penalties or administrative fines (Articles 50 to 64 of the FANC law).

Allocation of responsibilities to the bodies involved

> Article 5(1)(f) *the allocation of responsibility to the bodies involved in the different steps of spent fuel and radioactive waste management; in particular, the national framework shall give primary responsibility for the spent fuel and radioactive waste to their generators or, under specific circumstances, to a licence holder to whom this responsibility has been entrusted by competent bodies;*

See Sections A.1, F.1, and G.1.

Provisions for public information and participation

> Article 5(1)(g) *national requirements for public information and participation;*

The right of the public to access information is regulated by the following legal provisions:

- Article 32 of the Constitution, which gives everyone the right to consult any administrative document and to obtain a copy of it, allowing for exceptions;
- the Law of 11 April 1994 *on public access to information in the administrative sector* [Belgian Official Journal 1994a];
- the Law of 17 December 2002 *containing assent to the Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters and Annexes I and II, signed in Aarhus on 25 June 1998* [Belgian Official Journal 2003b];
- the Law of 5 August 2006 *on public access to environmental information* [Belgian Official Journal 2006b], which transposes Directive 2003/4/EC.

The participation process in the environmental impact assessments related to plans and programmes (including foreign parties) is regulated by the following laws:

- the Law of 9 June 1999 *containing assent to the Convention on Environmental Impact Assessment in a Transboundary Context and Appendices I, II, III, IV, V, VI and VII, signed in Espoo on 25 February 1991* [Belgian Official Journal 1999b];

- the Law of 13 February 2006 *on the assessment of the effects of certain plans and programmes on the environment and on public participation in respect of the drawing up of certain plans and programmes relating to the environment* (the so-called 'SEA law') [Belgian Official Journal 2006a], which transposes Directive 2001/42/EC and Directive 2003/35/EC, the latter amending the Council Directives 85/337/EEC and 96/61/EC.

In addition, FANC, ONDRAF/NIRAS, and the Commission for Nuclear Provisions must comply with specific legal and regulatory provisions:

- the Royal Decree of 30 March 1981 (ONDRAF/NIRAS royal decree) requires ONDRAF/NIRAS to establish and implement an information and communication programme covering all its activities;
- the Law of 15 April 1994 (FANC law) requires FANC to disseminate neutral and objective information in the nuclear domain;
- Article 179, § 2, of the Law of 8 August 1980 (ONDRAF/NIRAS law) foresees in the possibility of public participation in disposal projects, since it allows ONDRAF/NIRAS to create a 'medium-term fund' to cover the costs incurred in creating and maintaining the required societal support to ensure the integration of a disposal project into a local community, particularly costs related to the activities and projects of the local community which, through a participative process, ensures the continuity of societal support for the disposal facility (surface or geological);
- Article 179, § 6, of the Law of 8 August 1980 stipulates that the national policies fall within the scope of the Law of 13 February 2006;
- the Royal Decree of 20 July 2001 (general regulations for radiation protection or GRR-2001), which establishes the licensing system for class I, II, and III facilities, contains provisions for the compulsory consultation of the public by FANC in the framework of the licensing process of the class I facilities and of the high-risk class II facilities and for public participation in decision-making processes through the environmental assessments that are compulsory for the licensing of class I facilities;
- the Law of 11 April 2003 *on the provisions established for the dismantling of nuclear power plants and the management of fissile materials irradiated in these power plants* [Belgian Official Journal 2003c], which, in particular, requires the Commission for Nuclear Provisions to submit an annual activity report to the Minister in charge of Energy, who hands it over to Parliament and ensures that it receives adequate publicity.

Financing provisions

> Article 5(1)(h) *the financing scheme(s) for spent fuel and radioactive waste management in accordance with Article 9.*

The legal and regulatory framework concerning the coverage of the costs of managing spent fuel and radioactive waste and the costs of decommissioning operations, referred to globally as 'management costs', is currently composed of the different regulations that organise the financing of these activities, as well as of the general elements of law (civil law, accounting law, administrative law, tax law, company law, etc.) and of provisions relating to specific cases where the Federal State has already been held financially liable.

The main texts specifically related to the financing of spent fuel and radioactive waste management are listed below.

Article 179, § 2, of the Law of 8 August 1980 (ONDRAF/NIRAS law), which, in particular,

- stipulates that the costs of ONDRAF/NIRAS' activities, including RD&D costs, are charged to the beneficiaries of its services;
- allows ONDRAF/NIRAS to create a 'long-term fund' to finance radioactive waste storage and disposal;
- allows ONDRAF/NIRAS to create a 'medium-term fund' to cover the costs of integrating disposal projects into the local communities concerned;
- allows ONDRAF/NIRAS to create an 'insolvency fund' mainly intended to compensate for the potential bankruptcy or insolvency of waste producers and licence holders;
- gives ONDRAF/NIRAS the mission of evaluating every five years the existence and sufficiency of the provisions established by nuclear facilities operators and the holders of radioactive substances to finance their decommissioning costs, including the costs of managing spent fuel and radioactive waste, and their remediation costs ('inventory of nuclear liabilities').

Royal Decree of 30 March 1981 (ONDRAF/NIRAS royal decree), which

- implements the ONDRAF/NIRAS law and, in particular,
- stipulates the obligation for radioactive waste producers to sign an agreement with ONDRAF/NIRAS focusing, among other things, on the financial terms for taking charge of their waste, and
- establishes a range of principles, called 'guiding principles', which improve the financing of the long-term fund since 1 January 2019.

Royal Decree of 16 October 1991 *on the regulations for the control and method of subsidising the Belgian Nuclear Research Centre and amending the statutes of this centre* [Belgian Official Journal 1991a], which, in particular,

- defines the technical (or nuclear) liabilities of SCK CEN as being *"the obligations resulting from the decommissioning of facilities, as well as the treatment, conditioning, storage, and discharge or disposal of radioactive waste arising from the decommissioning of facilities, related to the Centre's nuclear activities up to 31 December 1988"* and
- stipulates that the Federal State is responsible for financing this liability.

Royal Decree of 16 October 1991 *establishing the regulations for the control and method of subsidising the National Radioelements Institute and amending the statutes of this institute* [Belgian Official Journal 1991b], which, in particular,

- defines the technical (or nuclear) liabilities of the IRE as being *"the obligations resulting from the decommissioning of facilities, as well as the treatment, conditioning, storage, and discharge or disposal of accumulated radioactive waste, including radioactive waste arising from the decommissioning of facilities, related to the Institute's nuclear activities"* and
- stipulates that the Federal State is responsible for financing this liability.

Law of 29 April 1999 *on the organisation of the electricity market* [Belgian Official Journal 1999a], which, in particular,

- structures the financing, through a federal contribution, of the obligations resulting from the decommissioning of the BP1 site (former pilot reprocessing plant Eurochemic), or BP1 liabilities, and BP2 site (former SCK CEN Waste department), or BP2 liabilities, and from the management of radioactive waste, including radioactive waste from decommissioning.

Law of 11 April 2003 *on the provisions established for the dismantling of nuclear power plants and the management of fissile materials irradiated in these power plants* [Belgian Official Journal 2003c], which, in particular,

- makes Synatom responsible for ensuring coverage of the costs of dismantling the nuclear power plants and managing the spent fuel from these power plants;
- requires Synatom to establish dismantling provisions and provisions for the management of spent fuel in its accounts and requires the nuclear operator (Electrabel) and holders of a share in nuclear production to pay Synatom the amounts corresponding to the requested provisions;
- regulates Synatom's management of the financial resources that represent the equivalent value of the established provisions;
- assigns control over the establishment and management of the provisions for the dismantling of nuclear power plants and the management of the spent fuel to a commission called the Commission for Nuclear Provisions.

E.2 Improvement of the national framework

> Article 5(2) *Member States shall ensure that the national framework is improved where appropriate, taking into account operating experience, insights gained from the decision-making process referred to in Article 4(3)(f), and the development of relevant technology and research.*

See Sections B.2 and M.2.

F. Article 6 — Competent regulatory authority

F.1 Competent regulatory authority

> Article 6(1) *Each Member State shall establish and maintain a competent regulatory authority in the field of safety of spent fuel and radioactive waste management.*

Created by the Law of 15 April 1994 and operational since 1 September 2001 (Section E.1–Article 5(1)(b)), FANC is the regulatory authority in the field of safety of spent fuel and radioactive waste management: it must ensure that the population, the workers, and the environment are efficiently protected against the dangers arising from ionising radiation. It is endowed with wide competences.

According to Article 14ter of the FANC law, FANC can create legal entities to assist it in its missions. It created in September 2007 a subsidiary called Bel V, in the form of a foundation of private law. Bel V, FANC's technical support organisation, performs regulatory missions delegated by FANC, in particular on site routine inspections — albeit without associated enforcement powers — and independent safety assessments.

FANC's regulatory functions that are relevant in the framework of Directive 2011/70/Euratom are listed hereafter. The list of regulatory tasks that its Board of Directors can delegate to Bel V is fixed, since December 2018, in Article 38.1 of the GRR-2001. They were formally delegated to Bel V in March 2019.

- function 'Development of regulations and guides': allocated exclusively to FANC, which must propose new regulations to the Government. Since 2017, FANC can also issue binding technical regulations in cases foreseen in a royal decree.
- function 'Licensing': ensured by FANC. For the class I facilities, the Government is the competent authority to issue licences. FANC investigates the licence applications and drafts the licences and conditions attached to them.
- function 'Safety assessment': allocated to FANC, which delegates the main part of it to Bel V for the class I facilities.
- function 'Inspection': allocated to FANC, which delegates the main part of it to Bel V for the class I facilities.
- function 'Enforcement': allocated exclusively to FANC.

Additional functions are allocated to FANC, with possible support from Bel V:

- the radiological surveillance of the Belgian territory,
- participation in the national nuclear emergency planning and response,
- communication to the public and the political authorities.

F.2 Functional separation

> Article 6(2) *Member States shall ensure that the competent regulatory authority is functionally separate from any other body or organisation concerned with the promotion or utilisation of nuclear energy or radioactive material, including electricity production and radioisotope applications, or with the management of spent fuel and radioactive waste, in order to ensure effective independence from undue influence on its regulatory function.*

FANC is an autonomous public institution with legal personality, institutionally independent (see Section F.3.2 for financial independence).

FANC is placed under the supervision of the Minister of Home Affairs and reports annually to Parliament through its supervisory Minister. This ensures its independence from the Ministries and public organisations connected with the uses of nuclear energy or radioactive materials and with the management of spent fuel and radioactive waste. The public organisations dealing with questions related to nuclear energy and radioactive materials, namely SCK CEN and IRE, and ONDRAF/NIRAS, which is responsible for the management of radioactive waste, are indeed under the supervision of the Ministers in charge of Energy and Economy. FANC has no connections with the private sector.

Although FANC plays no part in nuclear energy promotion, it must *"stimulate and co-ordinate research and development"* and *"[establish] privileged relationships with the public organisations working in the nuclear field, with the scientific research networks, and with the relevant international organisations."* (Article 23 of the FANC law).

The 14 members of FANC's Board of Directors, who are appointed by royal decree for a fixed term of six years, on the basis of their particular scientific or professional qualities, are forbidden to take on certain other responsibilities within the public sector or in entities that are under FANC's control for the duration of their mandate and until the end of the year following the year during which their mandate ended. They meet approximately six times per year, in the presence of a Government commissioner also appointed by royal decree. They can be dismissed by royal decree.

The Board delegates the management of FANC to the General Manager, who is appointed by royal decree for six years, it nominates and evaluates the senior management, and it approves the annual budget.

FANC can be advised by the Scientific Council for ionising radiation on its control policy, more specifically as far as licence applications and renewals of licences are concerned. The Council's composition — high-level experts in the fields of radiation protection, nuclear energy, and nuclear safety — and competences are determined by royal decree.

FANC exercises its authority regarding the nuclear operators through unilateral administrative legal acts such as the granting, refusal, modification, suspension, and withdrawal of licences, qualifications, or approvals. It organises inspections to verify compliance with the conditions stipulated in these acts and with the applicable regulations. FANC can claim documents in whatever form from the companies and organisations it controls.

F.3 Legal powers and human and financial resources

> Article 6(3) *Member States shall ensure that the competent regulatory authority is given the legal powers and human and financial resources necessary to fulfil its obligations in connection with the national framework as described in Article 5(1)(b), (c), (d) and (e).*

F.3.1 Legal powers

See Section E.1–Articles 5(1)(d) and 5(1)(e).

F.3.2 Human and financial resources

FANC's staff level is around 150 persons. More than 60% of them are university graduates in different fields of science (physics, chemistry, biology, medicine, etc.), engineering, law, economics, social sciences, and communication. Bel V employs around 70 university graduates in technical functions, and recruitment is in line with the foreseeable workload.

FANC's operation is entirely and directly financed by the companies, organisations, or persons to whom it renders services. In practice, this is done through annual taxes charged to the holders of licences and qualifications and through non-recurrent fees charged to the applicants of licences and qualifications or approvals. The amount of the taxes is set in Article 30bis/1 of the FANC law; the amount of the fees is fixed by royal decree, as provided for in Article 30quater of the same law. In case of an unexpected additional workload, Article 31, § 3, of the FANC law allows FANC to charge its additional costs to the licensee concerned, at an hourly fee fixed in the Royal Decree of 16 October 2009 [Belgian Official Journal 2009].

The taxes and fees enable FANC to be independent from licence holders. Indeed, whatever the sanction imposed by FANC on a licence holder, it does not affect the tax owed and, hence, the financing of FANC. The temporary shutdown of a nuclear facility does not influence FANC's revenues either, which enables it to rule on cases with complete independence.

Bel V is financed by the licensees, through an hourly fee fixed in Article 38 of the GRR-2001. Every year, Bel V prepares with FANC an annual inspection and safety assessment programme for the next year, of which the relevant part(s) is(are) then sent to the various licensees before formal approval by FANC. The licensees are periodically invoiced for Bel V's inspections and safety assessments.

G. Article 7 — Licence holders

G.1 Prime responsibility for safety

> Article 7(1) *Member States shall ensure that the prime responsibility for the safety of spent fuel and radioactive waste management facilities and/or activities rest with the licence holder. That responsibility can not be delegated.*

Article 28, § 1, of the FANC law states explicitly the prime responsibility of licence holders for the safety of spent fuel and radioactive waste management (Section E.1–Article 5(1)(b)).

In addition, licensees must comply with the regulation in force dealing with nuclear safety and radiation protection. The regulatory framework expresses the prime responsibility of operators for safety in several statements.

G.2 Regular assessment, verification, and improvement of safety of existing facilities or activities

> Article 7(2) *Member States shall ensure that the national framework in place require licence holders, under the regulatory control of the competent regulatory authority, to regularly assess, verify and continuously improve, as far as is reasonably achievable, the safety of the radioactive waste and spent fuel management facility or activity in a systematic and verifiable manner. This shall be achieved through an appropriate safety assessment, other arguments and evidence.*

Safety assessments during operation

Modifications during the operational lifetime of a facility are subject to safety assessments. Depending on their safety significance, the proposals are classified into one of the following three categories, to which different measures are attached:

- major modifications changing the basic characteristics of the unit, which are subject to a licence according to the provisions of Article 12 of the GRR-2001;
- minor modifications having a potential impact on safety; commissioning the modification is subject to a positive acceptance report from the licensee's HPD and then to a final approval by Bel V allowing implementation of the modification when all the files, the procedures, and the safety report have been adequately updated;
- modifications without impact on safety, which must be approved by the HPD only, without formal involvement of Bel V.

Periodic safety reviews

According to Article 14 of the SRNI-2011, all class I facilities are subject to ten-yearly periodic safety reviews.

The general objectives of the periodic safety reviews are as follows:

- to demonstrate that the facility has at least the same level of safety as it had when the licence to operate was granted, or since its latest periodic safety review;

- to inspect the condition of the facility, devoting particular attention to ageing and wear and to other factors that may affect its safe operation during the next ten years;
- to justify the facility's current level of safety, considering the most recent safety regulations and practices and, if necessary, to propose appropriate improvements.

The most recent periodic safety reviews for the BP1 and BP2 sites were submitted to FANC respectively at the end of June 2018 and at the end of June 2016. The ongoing resulting action plan aims at enhancing further the safety level of the sites. Some of the noteworthy actions include the planned renewal of the water treatment facility and a complete update of the existing safety reports. The preparation of the next periodic safety reviews is scheduled to begin respectively at the end of 2025 and 2023 for the BP1 and BP2 sites.

Other safety improvements

Additional safety improvements (action plans) result from non-recurrent situations:

- safety improvements resulting from experience feedback;
- safety improvements resulting from the European stress tests;
- safety improvements driven by new regulation proposed by FANC (for example, to comply with WENRA requirements);
- safety improvements resulting from European and international peer reviews.

In particular, following the Fukushima Daiichi accident, all class I facilities were asked to conduct stress tests. These tests included topics such as safety functions, earthquake, flooding, extreme weather conditions, forest fire, explosive gas and shock wave, cyber-attack, loss of electrical power and loss of ultimate heat sink, and severe accident management.

The action plans following the stress tests of the class I facilities were approved by FANC in July 2013. Belgoprocess plans to complete the last remaining action by the end of 2021, and Electrabel completed its action plans for the sites of Doel and Tihange by mid-2020.

G.3 Safety demonstration and prevention of accidents for planned facilities or activities

> Article 7(3) *As part of the licensing of a facility or activity the safety demonstration shall cover the development and operation of an activity and the development, operation and decommissioning of a facility or closure of a disposal facility as well as the post-closure phase of a disposal facility. The extent of the safety demonstration shall be commensurate with the complexity of the operation and the magnitude of the hazards associated with the radioactive waste and spent fuel, and the facility or activity. The licensing process shall contribute to safety in the facility or activity during normal operating conditions, anticipated operational occurrences and design basis accidents. It shall provide the required assurance of safety in the facility or activity. Measures shall be in place to prevent accidents and mitigate the consequences of accidents, including verification of physical barriers and the licence holder's administrative protection procedures that would have to fail before workers and the general public would be significantly affected by ionising radiation. That approach shall identify and reduce uncertainties.*

According to the provisions of Articles 6 and 7 of the GRR-2001, the licence application files for class I facilities and the high-risk class II facilities must include a safety report. For class I facilities, this report must comply with the provisions of Article 13 of the SRNI-2011. In other words, it must contain information on the design of the facility and its operation that is sufficiently accurate for FANC to be able to assess the nuclear safety.

In practice, the safety assessment is performed by Bel V, a founding member of ETSON (European Technical Safety Organisations Network), by delegation of FANC.

Several future class I facilities are currently in the licensing process (Sections K.3 and M.3.4), mainly

- the spent fuel storage facilities (SF^2) in Tihange and Doel;
- the reception and storage centre for non-conditioned waste at Belgoprocess;
- the storage facility dedicated to the (potentially) ASR-affected waste packages at Belgoprocess;
- the surface disposal facility for category A waste in Dessel.

The respective licence application files contain a safety report.

The royal decree in preparation on the licensing system of disposal facilities includes provisions for all the licensing steps, also including the closure of disposal facilities and their post-closure phase.

G.4 Integrated management systems

> Article 7(4) *Member States shall ensure that the national framework require licence holders to establish and implement integrated management systems, including quality assurance, which give due priority for overall management of spent fuel and radioactive waste to safety and are regularly verified by the competent regulatory authority.*

Article 5 of the SRNI-2011 requires the licensees of class I facilities *"[to establish, implement, assess, and improve on a continuous basis] an integrated management system giving priority to nuclear safety. […] This management system shall cover all the activities and processes that can have an impact on the nuclear safety of the facility, including the activities carried out by subcontractors or suppliers."* Article 5 also contains requirements for safety culture in the management system (introduced by the Royal Decree of 9 October 2018, transposing partially Directive 2014/87/-Euratom [Belgian Official Journal 2018c]).

The description of the management system is part of the safety report.

Thematic inspections by FANC/Bel V focus on licensees' management systems.

ONDRAF/NIRAS developed an integrated management system as an instrument meant to contribute to ONDRAF/NIRAS meeting its objectives as waste management organisation. ONDRAF/NIRAS has been further implementing it to ensure that interdependencies between the different steps of the management of radioactive waste are considered as best as possible (see also Section D.3).

In addition, Article 5 of the Royal Decree of 18 November 2002 governing the qualification of facilities for the storage, treatment, and conditioning of radioactive waste by ONDRAF/NIRAS [Belgian Official Journal 2002a] requires licensees to establish a quality management system for their waste storage and treatment facilities and sets out requirements for this system (Section E.1–Article 5(1)(b)).

G.5 Licence holders' financial and human resources

Article 7(5) *Member States shall ensure that the national framework require licence holders to provide for and maintain adequate financial and human resources to fulfil their obligations with respect to the safety of spent fuel and radioactive waste management as laid down in paragraphs 1 to 4.*

See Sections H and I.

H. Article 8 — Expertise and skills

> Article 8 *Member States shall ensure that the national framework require all parties to make arrangements for education and training for their staff, as well as research and development activities to cover the needs of the national programme for spent fuel and radioactive waste management in order to obtain, maintain and to further develop necessary expertise and skills.*

The acquisition, maintenance, and development of the necessary expertise and skills are concerns that are considered by all actors. The existing provisions of the legal and regulatory framework transposing Article 8 of Directive 2011/70/Euratom are not yet fully applicable, because the implementing rules of Article 5 of the Law of 3 June 2014 have not yet been established by royal decree.

The existing legal and regulatory framework contains however provisions that are specific to the various (groups of) actors:

- the FANC nuclear inspectors must comply with the regulatory requirements that apply to recognised experts in health physics (GRR-2001, Article 73);
- ONDRAF/NIRAS must define, in collaboration with the operators, the applied research and development programmes necessary for the accomplishment of its missions (ONDRAF/NIRAS royal decree, Article 2);
- class I licensees must comply with a series of requirements in terms of skills and expertise for their staff and make sure that subcontractors have the necessary skills and work to the appropriate standards (SRNI-2011, Article 6).

The main actors in the management of spent fuel and radioactive waste are involved at the international (IAEA and OECD/NEA) and European levels to share best practices, knowledge, and resources on all kinds of issues related to spent fuel and radioactive waste management, such as geological disposal, integrated management systems, safety culture, radiation protection, preservation of records, knowledge, and memory, and update of existing standards and development of new ones. The Belgian contributions is these various fields are valued abroad. In addition, ONDRAF/NIRAS and FANC/Bel V have bilateral agreements with, respectively, foreign radioactive waste management agencies and regulatory bodies.

The IAEA offers online learning courses on spent fuel and radioactive waste management and, like all partners in the European Joint Programme on Radioactive Waste Management (EURAD), SCK CEN, ONDRAF/NIRAS, and Bel V contribute to training and knowledge management courses.

H.1 Education and training

Examples of education and training activities related to the management of spent fuel and radioactive waste are as follows:

- ONDRAF/NIRAS and Belgoprocess stimulate their staff to attend regular training in specific technical fields (radiation protection, waste conditioning techniques, disposal of radioactive waste, etc.);
- FANC's various types of experts are subject to formal internal recognition according to the requirements applicable to health physics experts, as described in Article 73 of the GRR-2001. This de facto sets high demands in terms of training and competence. The inspections carried

out by Bel V, on the sites of the class I and high-risk class II facilities, must be carried out by class I health physics experts, recognised according to the provisions of the same article;

- the Belgian Nuclear Higher Education Network (BNEN), a consortium of six Belgian universities and SCK CEN, organises a post-graduate qualification in nuclear engineering, which comprises in particular a course on the nuclear fuel cycle and a course on MOX and thorium fuel, radiochemistry, and dismantling; this programme involves contributions from ONDRAF/NIRAS and FANC, in addition to SCK CEN;
- the 'SCK CEN Academy' organises courses in all SCK CEN's RD&D fields, including radioactive waste management and disposal;
- FANC and ONDRAF/NIRAS organise information meetings on specific topics for their staff (waste acceptance system, on-site inspections of spent fuel and waste management activities, etc.);
- FANC and ONDRAF/NIRAS organise regular meetings on return of experience to share experience and define good practices regarding their common activities (for example, common inspections);
- ONDRAF/NIRAS, SCK CEN, and EURIDICE organise exchange meetings to share information about their research activities in the fields of surface and geological disposal;
- FANC had planned a second training course on waste management in collaboration with ONDRAF/NIRAS and the SCK CEN Academy in 2020. It had to be postponed because of the covid-19 pandemic and is now scheduled for the end of September 2021.

In addition, the preservation of the nuclear knowledge in the Mol–Dessel area is a condition set by the local communities for constructing the surface disposal facility for category A waste in Dessel. In this context, ONDRAF/NIRAS started a collaboration with the Thomas More University College and the KU Leuven University, called LIBRA. LIBRA organises study days and collaborative projects during which students familiarise themselves with radioactive waste and its management.

H.2 Research and development

RD&D in terms of the management of spent fuel and radioactive waste is essentially that conducted by or on behalf of the following actors:

- Synatom follows the research and new advances related to the safe storage of spent fuel with the collaboration of Tractebel and has studies carried out on its behalf.
- Electrabel conducts R&D on treatment and conditioning processes of resins and concentrates with Laborelec. These new processes are to replace the ones for which ONDRAF/NIRAS withdrew Electrabel's qualifications, after the discovery of non-conformities in conditioned waste packages produced in Electrabel's conditioning facilities.
- ONDRAF/NIRAS is directly involved in RD&D in various fields, such as safety, technology, and ethics, and has RD&D carried out on its behalf, mostly by SCK CEN, but also by universities, research centres, and industries worldwide. SCK CEN's pioneering role in RD&D for radioactive waste management, and in particular long-term management, dates back to the 1960s, namely before the first commercial nuclear reactors were commissioned. Since its creation, ONDRAF/NIRAS has played a major role in the organisation of the RD&D in radioactive waste management. ONDRAF/NIRAS and SCK CEN created in 1995 the Economic Interest Grouping PRACLAY, which became the EIG EURIDICE (European Underground Research Infrastructure for Disposal of Nuclear Waste in Clay Environment), primarily to manage the HADES

underground research laboratory, recognised by the IAEA as a centre of excellence for disposal technologies and training of scientists (see also Section K.3–Article 12(1)(f)).

- SCK CEN conducts innovative research on several key domains in radioactive waste management, including RD&D on the management of its own (future) wastes (related to existing and planned nuclear facilities). Since the late 1990s, SCK CEN has also been developing the MYRRHA project, a nuclear research infrastructure designed notably to allow the continuation, in association with Belgian and international universities and research centres, of fundamental nuclear research. MYRRHA could offer an opportunity to optimise geological disposal through transmutation of the minor actinides, which are long-lived radioactive substances, into less toxic, shorter-lived radioactive substances. It is considered a priority European research infrastructure. In this respect, SCK CEN develops capabilities in partitioning & conditioning (P&C) and partitioning & transmutation (P&T) strategies through the ASOF project (Energy Transition Fund).
- SCK CEN and ONDRAF/NIRAS signed in December 2020 a public-public cooperation agreement aimed at strengthening their collaboration on scientific research and the technical-scientific support needed for the safe management of radioactive waste in the short, medium, and long term. This cooperation focuses on developing and maintaining the scientific knowledge and competences with respect to safe management methods of radioactive waste with minimal impact on man and the environment, taking the societal context into account.

  More specifically, the cooperation agreement is intended to
  - guarantee continuity of knowledge and anchor expertise within Belgium;
  - cover all aspects in the radioactive waste management chain, namely treatment, conditioning, storage, and disposal;
  - focus on strategic domains for the Belgian national programme;
  - ensure a robust cooperation framework, in line with the legal context;
  - make a more efficient use of public money.
- SCK CEN, ONDRAF/NIRAS, and Bel V participate in various European R&D projects related to radioactive waste management, including projects under the auspices of the European Joint Programme EURAD.
- Belgoprocess conducts applied RD&D to develop further treatment and conditioning techniques, notably on plasma technology and pyrolysis.
- FANC and Bel V conduct independent R&D related to radioactive waste management to establish the tools and knowledge necessary for the independent review of the (preliminary) safety reports for disposal facilities set up by ONDRAF/NIRAS and to develop and retain expertise in this field. In this framework, FANC and Bel V have developed a programme called SRN, that is Strategic Research Needs — Strategic Issues Underlying the Development of Expertise and Skills of FANC/Bel V in Geological Disposal [FANC and Bel V 2020]. This programme is implemented through a deployment plan that is regularly updated and brought into line with the (proposals of) national policies of ONDRAF/NIRAS.

  FANC and Bel V are also partnering in various international initiatives in order to develop further and maintain their high-level expertise in safe radioactive waste management.
- Every year, the Belgian Government funds projects to improve nuclear safety in the countries of Central and Eastern Europe and the Commonwealth of Independent States (CIS), carried out by Belgian institutions and companies, in the following areas: radiological protection for medical applications, dosimetry, management and storage of disused sealed radioactive sources, processing, characterisation, packaging, storage, and disposal of radioactive waste, as well as radiological control of the territory and remediation and decommissioning of nuclear installations.

I. Article 9 — Financial resources

> Article 9 *Member States shall ensure that the national framework require that adequate financial resources be available when needed for the implementation of national programmes referred to in Article 11, especially for the management of spent fuel and radioactive waste, taking due account of the responsibility of spent fuel and radioactive waste generators.*

The coverage of the costs of managing spent fuel and radioactive waste and the costs of decommissioning operations, referred to globally as 'management costs', can be divided into two parts: the financing mechanisms set up by ONDRAF/NIRAS for managing the waste transferred by waste producers to ONDRAF/NIRAS (Section I.1) and the financing mechanisms used by radioactive waste producers and spent fuel owners to cover the costs of managing their waste or spent fuel before transfer to ONDRAF/NIRAS, the costs of their decommissioning operations, and the costs of transferring their waste to ONDRAF/NIRAS (Section I.2). The existence and the sufficiency of the established and planned provisions to cover the management costs are assessed every five years by ONDRAF/NIRAS in the framework of its legal mission to draw up the 'inventory of nuclear liabilities' (Sections I.2 and I.3). In addition, ONDRAF/NIRAS assesses the availability of the corresponding financial resources (Section I.3). In parallel, a dedicated commission, the Commission for Nuclear Provisions, is responsible for advising and supervising the establishment and management of the provisions for the dismantling of the nuclear power plants and the management of the spent fuel from these plants (Sections I.2 and I.3). The competence of this commission relates to the existence, the sufficiency, and the availability of provisions.

The main texts of the legal and regulatory framework related to financial resources are listed in Section E.1–Article 5(1)(h).

I.1 Financing mechanisms for radioactive waste management set up by ONDRAF/NIRAS

ONDRAF/NIRAS takes charge of radioactive waste from producers after acceptance and against payment of a fee intended to cover the costs of managing the transferred waste. In accordance with the provisions of the ONDRAF/NIRAS law, ONDRAF/NIRAS must charge its costs to the beneficiaries of its services, namely the radioactive waste producers and the financially liable institutional entities, in proportion to those services. The allocation of responsibilities between ONDRAF/NIRAS and the producers is set out in the contracts between them.

The costs of managing radioactive waste can be divided into three main areas, which are financed using separate methods:

- short-term management activities (Section I.1.1),
- medium-term and long-term management activities (Section I.1.2),
- other services, particularly RD&D (Section I.1.3).

Additionally, an insolvency fund has been created to cover financial obligations regarding decommissioning and radioactive waste management of defaulting producers and licence holders, which are implicitly identified as being the holders of class II and III licences (Section I.1.4).

I.1.1 Financing of short-term management activities

Schematically, financing of the treatment and conditioning of radioactive waste is provided via two different mechanisms.

- The so-called 'main' radioactive waste producers concerned by treatment and conditioning, namely Electrabel, FBFC International, Belgonucleaire (until 2023), IRE, and SCK CEN on the one hand and the Federal State as the financially liable entity for historical nuclear liabilities on the other hand, finance the treatment and conditioning of their waste in accordance with the provisions of the contractual agreements between them and ONDRAF/NIRAS. Since 1996, these agreements have been based on a capacity reservation system that stipulates that each 'main' producer guarantees the payment to ONDRAF/NIRAS of an agreed fraction of the fixed costs of the treatment and conditioning facilities and the payment of the variable operating costs of the management of its waste as it is accepted by and transferred to ONDRAF/NIRAS. In practice, the 'main' producers pay their share of the fixed costs according to a contractual schedule and pay the fees corresponding to the variable portion of the costs of the treatment and conditioning of their non-conditioned waste as ONDRAF/NIRAS takes charge of it. Pursuant to the provisions of the agreements, these fees can be revised every five years.
- The 'small' radioactive waste producers finance the treatment and conditioning of their waste through so-called 'all-in' fees that cover ONDRAF/NIRAS' services (treatment, conditioning, storage, disposal, transport, RD&D, etc.).

I.1.2 Financing of medium-term and long-term management activities

Financing of the medium-term and long-term management of radioactive waste must cover the costs of the technical activities and the costs of the 'associated' projects that accompany the implementation of disposal projects. Local communities who agree to the disposal of radioactive waste on their territory and to the related consequences are indeed given the opportunity, as a compensation, to develop projects with an added value for their region.

In accordance with the ONDRAF/NIRAS law, technical costs are covered by fees paid by waste producers into a centralised fund, the long-term fund, and the costs of associated projects will be covered by contributions from the producers to the medium-term fund.

Long-term fund The mechanism of the long-term fund is based on a capitalisation system. The fund is financed by producers every time they transfer radioactive waste to ONDRAF/NIRAS in application of the polluter pays principle, according to a mechanism that should ensure that ONDRAF/NIRAS will be able to cover the fixed costs of storage and disposal and that enables it to cover the variable costs as they arise.

Pursuant to the provisions of the Royal Decree of 25 April 2014 [Belgian Official Journal 2014a], amending the ONDRAF/NIRAS royal decree, ONDRAF/NIRAS has indeed implemented in the contracts with the 'main' radioactive waste producers the so-called 'guiding principles' for financing the long-term fund, with effect as of 1 January 2019. These principles stipulate that, from then on, fee increases will be passed onto producers based on their full radioactive waste production programme, in other words, both the waste they have already transferred to ONDRAF/NIRAS and the waste still to be transferred. Prior to that, fee increases were passed onto producers on the sole basis of the waste still to be transferred to ONDRAF/NIRAS.

The management of the long-term fund is ONDRAF/NIRAS' responsibility.

Medium-term fund The medium-term fund will be financed by contributions from the producers, calculated on the basis of the total volumetric capacity of the disposal facility (surface or geological)

and the total waste quantities from each producer that are intended to be disposed of within the facility. The obligation for producers to contribute to the fund begins as soon as the disposal facility has received its nuclear construction and operation licence and the necessary non-nuclear permits. The amount set by law must have been fully established no later than three months after the disposal facility has been authorised to start operation.

I.1.3 Financing of other services, particularly RD&D

Other services (RD&D, acceptance system, transport, radiological and physico-chemical inventory, communication, etc.) are financed based on the terms set out in bilateral agreements between ONDRAF/NIRAS and the waste producers. These agreements typically cover a period of several years.

I.1.4 Insolvency fund

The insolvency fund is, in accordance with the provisions of the ONDRAF/NIRAS law, mainly intended to finance services for the management of radioactive waste and the decommissioning of nuclear facilities that are not covered following the bankruptcy or insolvency of the financially liable entities, which are implicitly identified as not including the financially liable entities for class I nuclear facilities. The insolvency fund also covers the costs of managing sources declared by FANC as orphan sources and radioactive waste. It does not cover services resulting from the bankruptcy or insolvency of entities that are financially liable for radium-bearing waste from old radium extraction activities and for NORM waste to be managed as radioactive waste.

The insolvency fund is financed by invoicing producers a reserve of 5% calculated on the costs of the transport, treatment, conditioning, storage, and, since 2020, disposal services provided by ONDRAF/NIRAS.

I.2 Financing mechanisms used by producers in general and specific financing mechanisms

Four types of financing mechanisms, with different degrees of availability of the financial resources, are used in Belgium to cover the management costs [ONDRAF/NIRAS 2018]:

- annual budget: the relatively immediate nature of an annual budget gives the financial resources a high level of availability;
- budget plan over several years: the inconsistency between the use of this short-term financing mechanism and the aim of covering medium- or long-term commitments gives the financial resources an insufficient or even almost zero availability;
- establishment of accounting provisions: this mechanism, which is the most frequently used, gives the financial resources an almost zero availability. One or more additional measures can however be associated with the establishment of the provisions, for example in the form of conditions on the management of financial resources, which increase the availability of these resources;
- establishment of an internal or external fund: this mechanism gives the financial resources a low to high availability, depending on its characteristics. One or more additional measures can also be associated with the establishment of a fund, which increase the availability of these resources.

Although there are no *general* provisions in the legal and regulatory framework ensuring the *existence*, the *sufficiency*, and the *availability* of financial resources to cover the management costs, some specific legislation and regulation exist, principally

- the Law of 11 April 2003 on the provisions established for the dismantling of nuclear power plants and the management of spent fuel, which makes Synatom responsible for ensuring coverage of the costs of dismantling the nuclear power plants, including the costs of managing the resulting radioactive waste, and of managing the spent fuel, and which assigns control over the establishment and management of the corresponding provisions to the Commission for Nuclear Provisions (Section E.1–Article 5(1)(h));
- laws and royal decrees relating to the three historical nuclear liabilities to be borne by the Federal State (Section E.1–Article 5(1)(h)):
  - Belgoprocess The nuclear liabilities cover all historical obligations associated with the BP1 site, or BP1 liabilities, and the BP2 site, or BP2 liabilities: management of historical waste, decommissioning of facilities, and sites remediation.
  - SCK CEN The nuclear liabilities cover all obligations related to SCK CEN's nuclear activities up to 31 December 1988.
  - IRE The nuclear liabilities cover all obligations related to IRE's nuclear activities, without any limitation in time, and cover thus also the management of operational radioactive waste.

The financing of the three historical nuclear liabilities to be borne by the State is ensured through the creation of three separate funds within ONDRAF/NIRAS, which manages them.

I.3 Existence, sufficiency, and availability of the provisions

ONDRAF/NIRAS assesses periodically the provisions established (or not) by all financially liable entities to cover their management costs (Section I.3.1), whereas the Commission for Nuclear Provisions does a similar, but more thorough exercise dedicated to the provisions for the costs of the dismantling of the nuclear power plants and the management of the spent fuel from these plants (Section I.3.2).

I.3.1 All nuclear facilities and sites: evaluations by ONDRAF/NIRAS

As part of its legal missions, ONDRAF/NIRAS draws up every five years an inventory of all nuclear facilities and sites containing radioactive substances, estimates the management costs that will have to be borne by each financially liable entity, and evaluates the existence and sufficiency of the provisions established to cover these costs (see Table 6 for a summary of key elements of the report 2013–2017) [ONDRAF/NIRAS 2018]. In addition, it evaluates the availability of the corresponding financial resources.

The inventory report 2013–2017, which ONDRAF/NIRAS submitted to its supervisory ministers in February 2018, does not reveal significant changes with respect to the previous inventory report.

- Overall, the total estimated management costs (Section K.3–Article 12(1)(h)) appeared to be sufficiently covered by provisions, with a total coverage rate of 99% (taking account of both the existing and planned provisions). This percentage, however, must be taken with caution, in particular because of the many uncertainties that affect the costs estimates and the sometimes rapid evolutions of the financial markets and the long-term interest rates.

- According to ONDRAF/NIRAS' assessment, and considering the financing mechanisms used, the availability of almost three quarters of the financial resources corresponding to the established provisions was insufficient or even close to zero.

Table 6 – Summary, drawn up from the inventory report 2013–2017 on nuclear liabilities, of the (main) entities responsible for covering the management costs associated with a selection of significant sites in Belgium and the main financing mechanisms they have established, and similar information for several specific waste groups (update of Table 3 of the national programme 2015).

Sites (or groups of waste)	Financially liable entities (main)	Main financing mechanisms
Sites for which there are no historical nuclear liabilities or for which there are historical nuclear liabilities for part of the costs only		
Electrabel (Doel and Tihange)	Operational waste: Electrabel Spent fuel and dismantling: Synatom	Annual budget 'External' accounting provisions with additional measures
FBFC International (Dessel)	FBFC International	Accounting provisions with additional measures
Belgonucleaire (Dessel)	Belgonucleaire	Accounting provisions with additional measures
SCK CEN (Mol)	SCK CEN (for part of the management costs)	Accounting provisions with additional measures
JRC Geel	European Commission	Budget planning
Universities and university hospitals	(The associated) Universities	Accounting provisions, annual budget, or none depending on who is responsible
Private radioisotope production companies	The companies concerned	Accounting provisions
Belgoprocess (Mol and Dessel)	ONDRAF/NIRAS (for part of the management costs)	Internal funds with additional measures
Best Medical Belgium (Fleurus), declared bankrupt (2012) and no longer having financial resources	Walloon Region (for the management costs referred to in agreements prior to the bankruptcy)	External fund with additional measures
Umicore's authorised storage facilities and radium-bearing substances to be managed as radioactive waste (Olen)	Umicore	Accounting provisions
Orphan sources	—	Insolvency fund
NORM substances that will have to be managed as radioactive waste	Site operator, user, or owner	Environmental accounting provisions, not specific to potential costs for the management of NORM substances as radioactive waste
Sites where management costs are, in part or in full, historical nuclear liabilities		
Belgoprocess (Mol and Dessel)	Federal State (for part of the management costs)	External fund, without separate legal personality, with additional measures
SCK CEN (Mol)	Federal State (for part of the management costs)	External fund, without separate legal personality, with additional measures
IRE (Fleurus)	Federal State	External fund, without separate legal personality, with additional measures
Best Medical Belgium (Fleurus), declared bankrupt (2012) and no longer having financial resources	—	Insolvency fund (for the management costs not referred to in the agreements with the Walloon Region prior to the bankruptcy)

ONDRAF/NIRAS made recommendations to its supervisory ministers to improve the existence, the sufficiency, and the availability of the provisions, with special emphasis on the issues associated with the end of the economic activities of nuclear operators such as Belgonucleaire and FBFC International.

More specifically, to improve the coverage of management costs, ONDRAF/NIRAS recommended mainly to:

- introduce a general obligation to establish sufficient provisions to cover management costs, including for the particular case of high-activity sealed sources;
- introduce rules guaranteeing the availability of financial resources corresponding to the established nuclear provisions;
- introduce mechanisms that ensure the continued financing of radioactive waste management until its end, in other words over a timeframe that may appear incompatible with the decision of private companies to cease their activities;
- improve the Law of 11 April 2003 with regard to the general recommendations regarding the coverage of management costs, in particular the availability of financial resources.

These recommendations have not been introduced into the legal and regulatory framework (see also Section M.2), but led to the decision by the current Federal Government to create a task force bringing together representatives of the institutional actors; this task force will be in charge of examining how to ensure continuity of the financing of radioactive waste management in a context where waste producers progressively stop their activities and of making proposals to improve the legal and regulatory framework.

I.3.2 Nuclear power plants and spent fuel: control by the Commission for Nuclear Provisions

Pursuant to the Law of 11 April 2003, the Commission for Nuclear Provisions advises and supervises the establishment and management of the provisions for the dismantling of nuclear power plants and the management of the spent fuel from these plants. The Commission's advice on the triennial review of the nuclear provisions by Synatom, of which the last one was given at the end of 2019, takes the compulsory opinion of ONDRAF/NIRAS on the existence and sufficiency of these provisions into account. The Commission's advice is binding for Synatom: if requested to do so, Synatom must recalculate its provisions according to the recommendations of the Commission and adapt the corresponding financial resources accordingly. At 31 December 2020, the nuclear provisions established pursuant to the Law of 11 April 2003 and in accordance with the Commission's requirements amounted to EUR_{2020} 13 836 million, namely EUR_{2020} 6 085 million for dismantling and EUR_{2020} 7 751 million for the management of spent fuel (https://economie.fgov.be/fr/themes/energie/competences-federales/comites-et-commissions/commission-des-provisions).

The Commission for Nuclear Provisions submitted in 2018 to the former Minister in charge of Energy a proposal to revise the Law of 11 April 2003 in order to ensure the prudential control by the State — through the Commission — of the existence, the sufficiency, and the availability of the provisions [CNP 2018]. This would be done in particular by guaranteeing the payback of Synatom's loans by Electrabel and by strengthening the competences of the Commission. The proposal has not been adopted by Parliament. At the end of 2020, the current Minister in charge of Energy asked for an advice from the Commission for Nuclear Provisions, in order to propose a revision of the Law of 11 April 2003 (see also Section M.2).

Meanwhile, Electrabel agreed to pay back gradually its loan for the compartment *'spent fuel management'*. At the end of 2020, Synatom established an institutional SICAV *(société d'investissement à capital variable)* under Belgian right, which will eventually house most, if not all, of the assets related to the nuclear provisions. This is considered a step forward, since it increases the availability of the provisions and reduces the risk. Further improvements are expected once the Law of 11 April 2003 has been revised.

J. Article 10 — Transparency

In addition to the general provisions regarding public information and participation, and in particular the applicability of the SEA law to the national policies, the legal and regulatory framework imposes specific obligations in these fields to FANC, ONDRAF/NIRAS, and the Commission for Nuclear Provisions (Section E.1–Article 5(1)(g)). Pursuant to its statutes, SCK CEN is tasked with information and documentation activities. Electrabel and Synatom, as key stakeholders in the management of spent fuel and radioactive waste, also provide information to the general public. Finally, the National Programme Committee publishes the successive editions of the national programme and national report.

J.1 Information to the general public and workers

> Article 10(1) *Member States shall ensure that necessary information on the management of spent fuel and radioactive waste be made available to workers and the general public. This obligation includes ensuring that the competent regulatory authority inform the public in the fields of its competence. Information shall be made available to the public in accordance with national legislation and international obligations, provided that this does not jeopardise other interests such as, inter alia, security, recognised in national legislation or international obligations.*

J.1.1 FANC

FANC is required by the Law of 15 April 1994 to disseminate neutral and objective information in the nuclear domain. It informs the general public and workers through various channels:

Corporate website FANC's corporate website (www.afcn.fgov.be or www.fanc.fgov.be), respectively in French and in Dutch, is FANC's main communication tool. It is a comprehensive source of information, for both general and professional audiences, in all of FANC's areas of competences, including the aspects related to spent fuel and radioactive waste management. It contains many downloadable synthesis reports, often available in English. It is updated on a continuous basis and flash news are published regularly. A specific section, JURION, contains the entire national, European, and international legal and regulatory framework related to radiation protection. The FANC website allows the general public to ask questions to FANC and to request access to information provided it is non-classified and it does not jeopardise the general interest or the interest of a specific third party.

Public events Training sessions and workshops.

Printed information Annual report and information brochures.

Media information Press releases and conferences.

Bel V has its own website (www.belv.be) and also publishes an annual report.

Information for the general public about emergency planning in case of a nuclear accident is provided on the following website:
www.risquenucleaire.be or www.nucleairrisico.be or www.nuklearrisiko.be.

J.1.2 ONDRAF/NIRAS

ONDRAF/NIRAS is required by the Royal Decree of 30 March 1981 to establish and implement an information and communication programme covering all its activities. It informs the general public through a variety of channels, sometimes in collaboration with other actors. Examples of information channels are as follows:

Corporate website ONDRAF/NIRAS' corporate website (www.ondraf.be or www.niras.be), respectively in French and in Dutch, provides general information on ONDRAF/NIRAS' activities in radioactive waste management, including downloadable documents going from general information sheets to comprehensive reports, for example the five-yearly inventory report on nuclear liabilities.

Social media information To attract visitors to the corporate website and keep the interested public informed, ONDRAF/NIRAS publishes one to two LinkedIn messages per week, with a link to updated news on the corporate website.

Printed information

- annual report, also distributed digitally since 2016;
- bi-annual ONDRAF/NIRAS magazine (in French and in Dutch);
- quarterly 'NIRAS-Belgoprocess newspaper' (in Dutch), distributed door-to-door to the inhabitants of Dessel, where the surface disposal facility is to be built, and of the four neighbouring municipalities. This newspaper covers all of ONDRAF/NIRAS' and Belgoprocess' activities.

Visits and public information evenings

- visits to ONDRAF/NIRAS' information centre on radioactive waste management in Dessel (www.isotopolis.be): 11 000 visitors per year on average (75% from schools, 23% from associations, 2% from companies), where visits include
  - the demonstration tests of the surface disposal project;
  - for schools, the possibility to visit the EURIDICE exhibition space;
- visits to the EURIDICE exhibition space and the HADES underground research laboratory: 2 500 visitors per year on average (50% education and training, 30% technical visits, 20% associations);
- the communication centre Tabloo built on the site of the future surface disposal facility for category A waste will provide information about radioactivity, all aspects of radioactive waste management, and research on nuclear applications, notably through a large interactive exhibition. The Tabloo communication centre is developed with the partnerships STORA and MONA and in collaboration with SCK CEN. It will open to the public as from January 2022;
- local public information evenings related to various aspects of the surface disposal project.

Media information Annual encounters with the press, which contribute to building trust among this target group, complemented by dossier-related press conferences, and press releases on specific achievements or topics.

Belgoprocess, EURIDICE, and the STORA and MONA partnerships (Section J.2.2) each have their own website — respectively www.belgoprocess.be, www.euridice.be, www.stora.org, and www.monavzw.be — and provide information to the public, too, with STORA and MONA playing a key role in informing the local communities on nuclear issues, with a focus on nuclear activities in Belgium.

J.1.3 Others

Commission for Nuclear Provisions

The Commission for Nuclear Provisions is required by the Law of 11 April 2003 to submit an annual activity report to the Minister in charge of Energy, who hands it over to Parliament and ensures it receives adequate publicity. The report is published on the website of the Federal Public Service Economy: https://economie.fgov.be/fr/publications/rapports-annuels-de-la (in French) or https://economie.fgov.be/nl/publicaties/jaarverslagen-van-de-commissie (in Dutch).

National Programme Committee

The National Programme Committee publishes the national programme for the management of spent fuel and radioactive waste and the national report on the implementation of Directive 2011/70/Euratom on its website (www.cpnpc.be).

SCK CEN

Pursuant to its statutory mission to maintain a centre of excellence on nuclear energy and ionising radiations, SCK CEN, among other things, gathers, keeps up to date, and spreads scientific, technical, technological, and socially relevant documentation, acting as a centre of knowledge, and promotes the knowledge of the various nuclear sciences, techniques, and technologies among the population. It has a corporate website (www.sckcen.be) and distributes printed information (annual highlights and other (mainly scientific) publications).

Electrabel

Each year, the nuclear power plants issue an environmental declaration (https://nuclear.engie-electrabel.be), listing the various ways in which their activities, including those dealing with the production and management of radioactive waste and effluents, have affected the environment and outlining the measures taken to guarantee safety, preserve the environment, and secure the well-being of their workers. Any significant impact is covered in an action plan intended to reduce said impact.

Synatom

Synatom informs the general public through its corporate website (https://synatom.be) and printed information (annual report and other publications).

J.2 Public participation

> Article 10(2) *Member States shall ensure that the public be given the necessary opportunities to participate effectively in the decision-making process regarding spent fuel and radioactive waste management in accordance with national legislation and international obligations.*

J.2.1 FANC

FANC consults the general public ('public inquiry') in the framework of the licensing process of the class I and the high-risk class II facilities as described in the GRR-2001, offering the possibility to attend information meetings, and consults the European Commission according to the provisions of Articles 37 and 41 of the Euratom Treaty.

Public participation in decision-making processes through the public consultations organised in the framework of the licensing of the class I and high-risk class II facilities relates to the licence

application files and also, for class I facilities, the environmental impact assessment. Recent examples of such consultations are the ones that were organised with a view to the construction by ONDRAF/NIRAS of the surface disposal facility in Dessel and the construction by Electrabel of its new spent fuel storage facilities (SF^2) in Tihange and Doel.

J.2.2 ONDRAF/NIRAS

ONDRAF/NIRAS is, since December 2010, entitled by law to take the necessary initiatives intended to create and maintain the societal support that is necessary to ensure the integration of a disposal project into a local community, including through participative processes and structures (Section E.1–Article 5(1)(g)). The active participation of stakeholders of the local communities concerned by the surface disposal of category A waste has however been a reality for over 20 years already. Its continuation was explicitly requested by the Council of Ministers in 2006 [Council of Ministers 2006].

- Category A waste disposal The local partnerships STORA (in Dessel) and MONA (in Mol) continue to follow the ongoing licensing process for the disposal facility and to accompany the development of both the associated technical surface facilities and the societal projects that will bring added value to the region. The communication centre Tabloo built on the site of the future disposal facility will be both an information centre about radioactivity and radioactive waste, including a large interactive exhibition, and a community centre. Numerous spaces — such as a theatre, a temporary exhibition space, and an event area — will be available for activities by the local community. All parts of the centre are being developed with the partnerships STORA and MONA.

  To ensure continued participation in the long term, ONDRAF/NIRAS, STORA, and MONA are currently working on a joint vision on the future role of and the collaboration with the partnerships. Organising public participation over a very long period raises indeed a number of complex issues, which amount to answering the question of how to turn partnerships into flexible organisations that are ready for the future. Further collaboration and responses to the challenges will be laid down in a collaboration agreement in 2021.

- Category B&C waste disposal The 2018 proposal for the bases of a national long-term management policy was the subject of a strategic environmental assessment procedure in 2019–2020, with consultation of institutional actors and the public in the period April to June 2020. ONDRAF/NIRAS received a total of 21 569 reactions form the public, of which 64 from Belgian municipalities and 9 411 from foreign countries. The revised policy proposal submitted in September 2020 by ONDRAF/NIRAS to its supervisory ministers takes account of the procedure's outcome. A slightly adapted version, taking account of the remarks of the supervisory ministers, was submitted in April 2021.

  Some other initiatives have been taken, such as the involvement of the partnerships STORA and MONA in European projects related to geological disposal (for instance, the Modern2020 project discussing the monitoring of geological disposal during the operational phases, which ended in 2019, and the current EURAD project relating to interactions with civil society).

  In addition, ONDRAF/NIRAS' proposal for the bases of a national long-term management policy makes provisions for a decision-making process — the future second part of the policy — that, in particular, will have to be participative, fair, and transparent. According to the proposal, this process will help prepare the decisions, go beyond the legally planned consultations (for example, those provided for in the SEA law), include the civil society, and ensure an ongoing dialogue between citizens and experts. This is to create and maintain the societal support necessary to develop the proposed geological disposal solution and, in the long run, to ensure its integration at local level.

To prepare the second part of the national policy, its supervisory ministers asked ONDRAF/NIRAS to draw up a proposal for a broad participative process aiming, on the one hand, at re-evaluating and confirming that geological disposal is the best choice for the long-term management of B&C waste and, on the other hand, at defining the main lines of the decision-making process that will eventually lead to the choice of one or more disposal sites, taking into account the requirement of reversibility of the decisions. This participative process will have to consider the recommendations of a large panel of stakeholders and the informed opinions of the civil society, obtained after a thorough deliberative process with representative panels. It will aim at generating collective awareness, understanding, and involvement.

K. Articles 11 and 12 — Progress in the implementation of the national programme since 31 December 2017

K.1 Implementation

> Article 11(1) *Each Member State shall ensure the implementation of its national programme for the management of spent fuel and radioactive waste ('national programme'), covering all types of spent fuel and radioactive waste under its jurisdiction and all stages of spent fuel and radioactive waste management from generation to disposal.*

The first edition of the national programme, giving the situation at 31 December 2014, was adopted by the Federal Council of Ministers on 30 June 2016 and notified to the European Commission on 5 August 2016. The ministerial decree of 3 October 2016 sanctioning this adoption, to which the programme is attached, was published in the Belgian Official Journal on 15 June 2017 [Belgian Official Journal 2017]. The French and Dutch versions, as well as the English courtesy translation, are available on a dedicated website of the Federal Government: www.cpnpc.be.

The existing national policies are listed in Section D.1, together with those that must still be established. Table 8, in Section K.3, provides an overview of the state of progress towards implementation of the national programme 2015.

K.2 Review and update

> Article 11(2) *Each Member State shall regularly review and update its national programme, taking into account technical and scientific progress as appropriate as well as recommendations, lessons learned and good practices from peer reviews.*

According to the provisions of the Law of 3 June 2014, the national programme must be updated regularly, and whenever a national policy is established or modified. This update, whose frequency is not set, is the task of the National Programme Committee (CPNPC) created by the same law (see also Section E.1–Article 5(1)(a)). Significant changes to the national programme must be notified to the European Commission within the month following their adoption.

The methods for following up the implementation of the national policies, which, according to the Law of 3 June 2014, must be part of these policies, have not been established yet. However, the proposal for the bases of the national policy on the long-term management of B&C waste includes the establishment of a decision-making process ensuring that these follow-up methods will be included in the policy (Section B.1). The establishment of this process will form the second part of the national policy.

Belgium will organise a self-assessment and receive an international peer review mission covering the topics under Article 14(3), among which the implementation of the national programme (see Section L).

With no new national policies, modifications of existing policies, major modifications to or evolutions in the national programme to take into account, the national programme 2015 has not been updated yet.

The national programme will be updated when a significant modification or evolution occurs. This could be, for instance, the establishment of the bases of the national policy on the long-term management of B&C waste, which is expected in 2021, the licensing of the future surface disposal facility for category A waste, or the strengthening of the legal and regulatory framework on the financing of the management costs.

The first update of the national programme, expected to be the one integrating the bases of the national policy on the long-term management of B&C waste, will also specify other elements required to comply with the obligations of Directive 2011/70/Euratom and pointed out by the European Commission in the framework of the infringement procedure against Belgium: the preparation of a decision on the status of commercial spent fuel and the preparation, on the basis of current RD&D, of a decision on the status of the research spent fuel, as well as an estimate of the costs of the national programme [FPS Economy 2020a]. Such estimate was given in the national report 2018 [Kingdom of Belgium 2018], complementing the information provided in the national programme (see also Section K.3–Article 12(1)(h)). It is currently being revised in the framework of the fifth inventory report on nuclear liabilities, due in 2023.

K.3 Contents

Article 12(1) *The national programmes shall set out how the Member States intend to implement their national policies referred to in Article 4 for the responsible and safe management of spent fuel and radioactive waste to secure the aims of this Directive, and shall include all of the following:*

Article 12(1)(a) *the overall objectives of the Member State's national policy in respect of spent fuel and radioactive waste management;*

The overall objectives of Belgium's national policies on spent fuel and radioactive waste management are unchanged (Sections D.1 and D.3).

Article 12(1)(b) *the significant milestones and clear timeframes for the achievement of those milestones in light of the overarching objectives of the national programme;*

Table 7 summarises the timeframes for the achievement of the significant milestones mentioned in the national programme 2015, together with other milestones for which the programme does not announce a timeframe, and gives the current estimated timeframes.

- Priority is given to the licensing of the surface disposal facility for category A waste, now expected in 2023. Construction will begin once this milestone has been reached.
- The timeframe for the construction of a geological disposal facility once it has received its creation and operation licence can be estimated roughly. By contrast, the timeframe for the granting of this licence is difficult to establish, since it depends in particular on the time that will be necessary to establish the various parts of the policy on the long-term management of B&C waste, including the selection of one or more disposal sites. In the reference programme

2021–2025, used as a basis for RD&D and costing, the nuclear licence for the geological disposal facility is supposed to be granted in 2050 [ONDRAF/NIRAS 2021b].

- A proposal for a national policy on the long-term management of radium-bearing substances to be managed as radioactive waste is expected to be submitted to the Federal Government in the period 2023–2024. This proposal will have been the subject of a strategic environmental assessment.
- The establishment of the status of the spent fuel from the commercial nuclear reactors and from the BR1, BR3, and VENUS research reactors through integration of the accepted hypotheses regarding its future use in the national policy on the long-term management of B&C waste is planned at the latest before the establishment of the last part of this national policy [FPS Economy 2020a].

As a result of

- the delays in the implementation of surface disposal,
- the uncertainties regarding the planning of implementation of geological disposal,
- the existence of non-conform conditioned waste streams, which need to be physically separated from the conform waste streams,
- the upcoming end of life of some storage facilities,

ONDRAF/NIRAS has developed a tool aimed at monitoring the storage capacities at Belgoprocess and anticipating the needs in terms of new storage capacities. This tool takes into account a reference scenario of the evolution of the storage capacities and alternative scenarios. The reference scenario is defined on the basis of the remaining storage capacities, the waste production forecasts from the different waste producers, and the planned facilities that will increase the available storage capacities. The alternative scenarios consider variations with respect to the reference scenario, for example, delays in the implementation of a planned facility or variations in the waste production forecasts. Evaluations of the various scenarios enable timely decisions on the extension of storage capacities (see also Section M.3.4).

Table 7 – Overview of progress in the implementation of the national programme 2015.

Significant milestones			Timeframe according to the national programme 2015	Current estimated timeframe
Establishment and implementation of (parts of) national policies				
Bases of the policy on the long-term management of B&C waste			proposal to be submitted in 2015	proposal 2018 submitted to SEA procedure in 2020; revised proposal (after SEA) submitted in 2021; establishment expected in 2021
Policy on the long-term management of radium-bearing substances to be managed as radioactive waste			no timeframe set	SEA procedure and policy proposal foreseen in the period 2021–2024
Policy on the long-term management of NORM substances to be managed as radioactive waste			no timeframe set	policy probably not necessary (to be confirmed)
Hypotheses by Synatom regarding the further status (resource or waste) of its spent fuel			no timeframe set	no timeframe set
Hypotheses by SCK CEN regarding the further status (resource or waste) of its BR1, BR3, and VENUS spent fuel			no timeframe set	no timeframe set; RD&D in progress on the industrial feasibility of reprocessing or of treating and conditioning the spent fuel
Implementation of the national programme				
Management of spent fuel by its owners				
Return of the last waste from the reprocessing of Doel and Tihange spent fuel			2017	completed in 2018
Start of operation of the new spent fuel storage facilities (SF^2) in Doel and Tihange			2022	Tihange: 2023 Doel: 2025
Centralised short- and medium-term management of radioactive waste				
Start of operation of the reception and storage centre for non-conditioned waste			2018	2025
Start of operation of the storage building for ASR-affected waste packages			2018	2024
Long-term management of category A waste				
Caisson plant		start construction	T_0 [1]	done (2019)
		start operation	T_0 + 2 years	2022
Monolith production facility (IPM)		start construction	T_0	done (2018)
		start operation	T_0 + 4 years	2023
Disposal facility		nuclear licence	T_1 – 3 months	2023
		start construction	T_1	2024
		start operation	T_1 + 4 years	2027
		end operation	T_1 + 54 years	2077
		complete closure	T_1 + 104 years	2127
Communication centre Tabloo		start construction	mid-2016	done (2019)
		start operation	end 2019	2022
Long-term management of B&C waste				
	nuclear licence		T_0	T_0 [2]
	start of disposal of category B waste		T_0 + 15 years	T_0 + 20 years
	start of disposal of category C waste		T_0 + 55 years	T_0 + 60 years
	end of operation		to be decided	T_0 + 80 years
	complete closure		T_0 + 100 years minimum	to be decided

[1] T_0 = positive opinion of the Scientific Council for ionising radiation on the licence application file for the disposal facility + 3 months.

[2] T_0 is considered to be 2050 in the reference programme used as a basis for RD&D and costing. The calendar beyond T_0 is a rough estimate.

Article 12(1)(c) *an inventory of all spent fuel and radioactive waste and estimates for future quantities, including those from decommissioning, clearly indicating the location and amount of the radioactive waste and spent fuel in accordance with appropriate classification of the radioactive waste;*

See Section C.2.

Article 12(1)(d) *the concepts or plans and technical solutions for spent fuel and radioactive waste management from generation to disposal;*

The concepts or plans and technical solutions for spent fuel and radioactive waste management have remained unchanged since 31 December 2017 (see Section M.3.4 for the main progress made).

Article 12(1)(e) *the concepts or plans for the post-closure period of a disposal facility's lifetime, including the period during which appropriate controls are retained and the means to be employed to preserve knowledge of that facility in the longer term;*

A 300 year post-closure surveillance period is foreseen in the licence application for the future Dessel surface disposal facility for category A waste. Possible markers have also been the subject of a product development study and a long-term archiving strategy for important information has been fixed.

In the absence of a national policy on the long-term management of B&C waste, developing concepts or plans for the post-closure period of the future geological disposal facility for B&C waste is premature. Studies are nevertheless underway on monitoring, reversibility, and retrievability, which are legal requirements.

Article 12(1)(f) *the research, development and demonstration activities that are needed in order to implement solutions for the management of spent fuel and radioactive waste;*

The RD&D activities needed to implement solutions for the management of spent fuel and radioactive waste continue in a national, European, and international framework. Examples of key RD&D topics since 31 December 2017 or in the near future are as follows:

Short-term and medium-term management:

- development of new treatment and conditioning processes for resins and concentrates (Electrabel);
- studies on spent fuel behaviour in extended storage conditions (Synatom);
- participation in the European project 'THERAMIN' aimed at identifying and testing thermal treatment techniques for potentially problematic waste types and at evaluating their end products with respect to long-term safety (ONDRAF/NIRAS and SCK CEN — terminated);

- termination of the first R&D phase (2016–2020) on the waste packages presenting an ASR (ONDRAF/NIRAS):
  - study of the gel formation mechanisms;
  - development of non-destructive control techniques for following up gel formation;
  - assessment of the consequences for disposal;
  - development of solutions for retreatment and reconditioning;

  followed by the establishment, by the end of 2021, of a common vision of the possible options for the long-term management, with a view to establishing a new R&D programme (ONDRAF/NIRAS, FANC, and Electrabel).

Long-term management, surface disposal:

- study of the long-term behaviour of plasmaslag in a surface disposal facility (STAB-SLAK project);
- destructive and non-destructive controls of conditioned waste packages prior to surface disposal;
- verification of the local hydrogeological model;
- adaptation and/or optimisation of the current design of the surface disposal facility and of the safety report for specific waste streams that do not meet the currently proposed disposal criteria.

Long-term management, geological disposal:

- continuation of the PRACLAY heater experiment, which has been running according to plans since November 2014 and indicates so far that the properties of Boom Clay, favourable to the confinement of high-level waste, are not negatively affected by heating;
- preparation of a methodological safety and feasibility case for geological disposal, planned for 2025, which considers several depths between 200 and 600 metres in poorly-indurated clays for illustration, thereby taking advantage of ONDRAF/NIRAS' 40 years of RD&D on Boom Clay and Ypresian clays;
- at the request of FANC, studies with a view to applying the optimisation principle to the future choice of one or more host formations for geological disposal through the development of safety attributes;
- after having established, in the framework of an iterative process with independent review, a reference design for the disposal facility that takes into account long-term safety, broad aspects of operational safety, and reversibility and retrievability aspects, more detailed analysis of operational safety aspects and update of the design if necessary;
- refurbishment of the first access shaft to the HADES underground research laboratory, with a view to continued RD&D in the next decades;
- assessment of the behaviour and transfer of gaseous compounds formed in the geological disposal facility through clayey host rocks (in the framework of the EURAD RD&D Work Package on gas).

> **Article 12(1)(g)** *the responsibility for the implementation of the national programme and the key performance indicators to monitor progress towards implementation;*

Implementing the national programme is the responsibility of the various (groups of) actors involved (mainly ONDRAF/NIRAS, FANC, the spent fuel owners, and the radioactive waste producers), each within its competences, and provided the competent federal authorities establish the necessary national policies and develop the legal and regulatory framework as required. These responsibilities are unchanged and are not expected to change, but the repartition of roles and responsibilities between FANC and ONDRAF/NIRAS is being clarified (Sections B.2.2.1 and M.2).

The key performance indicators selected to monitor progress are as follows:

- the existence of a national policy;
- the existence of general and dedicated radiation protection and safety regulation;
- the existence of operational management;
- the existence of a financing mechanism;
- the existence of RD&D.

The values of these indicators are unchanged. They are given in Table 8.

Table 8 – Overview of the state of progress towards implementation of the national programme, at 31 December 2020, according to the key indicators used in the national programme 2015. Their values are unchanged [✓ : yes; ✖ : no; ● : interim situation].

	MANAGEMENT BY PRODUCERS / OWNERS					TRANSFER OF WASTE	MANAGEMENT BY ONDRAF/NIRAS										
							SHORT AND MEDIUM TERMS (treatment, conditioning and storage)					LONG TERM (disposal)					
	National policy?	Regulation: general?	Regulation: dedicated?	Operational management?	Financing mechanism?		National policy?	Regulation: general?	Regulation: dedicated?	Operational management?	Financing mechanism?	National policy?	Regulation: general?	Regulation: dedicated?	RD&D?	Operational management ?	Financing mechanism?
Very short-lived waste	✓	✓	✓	✓	✓	n.a.	not applicable					not applicable					
Category A waste	n.a.	✓	✓	✓	✓	⇒	✓	✓	✓	✓	✓	✓	✓	●	✓	✖	✓
Category B waste	n.a.	✓	✓	✓	✓	⇒	✓	✓	✓	✓	✓	✖	✓	●	✓	✖	✓
Category C waste (reprocessing)	not applicable						✓	✓	✓	✓	✓	✖	✓	●	✓	✖	✓
Category C waste (spent fuel)	not applicable						✓	✓	✓	✓	✓	✖	✓	●	✓	✖	✓
Spent fuel from Synatom	✓ [2]	✓	✓	✓	✓	[1]	not applicable					not applicable					
Spent fuel from SCK CEN	✓	✓	✓	✓	✓		not applicable					not applicable					
Ra-bearing substances in Umicore's licensed storage facilities	n.a.	✓	✓	✓	✓	⇒	✖	✓	✓	✖	✓	✖	✓	●	✖	✖	✓
Ra-bearing substances to be managed as radioactive waste by ONDRAF/NIRAS	n.a.	✓	●	✓	✓	⇒	✖	✓	✓	✖	✓	✖	✓	●	✖	✖	✓
NORM substances to be managed as radioactive waste by ONDRAF/NIRAS [3]	n.a.	✓	●	✓	✓	⇒	✖	✓	✓	✖	●	✖	✓	●	✖	✖	●

[1] Decisions on the future of spent fuel will have to be made before it is transferred to ONDRAF/NIRAS.

[2] Policy for the management of spent fuel from Synatom: safe storage followed by reprocessing or disposal.

[3] The NORM substances to be managed as radioactive waste will probably be limited to NORM from dismantling (Section B.3.1.7), which will follow the management route of similar types of waste already covered by the waste management system and that end up in category B.

Article 12(1)(h) *an assessment of the national programme costs and the underlying basis and hypotheses for that assessment, which must include a profile over time;*

The most comprehensive costs estimate of the full national programme 2015 is the one calculated by ONDRAF/NIRAS in the fourth inventory report on nuclear liabilities (see also Sections I.2 and I.3). However, the inventory of nuclear liabilities does not cover the costs of managing *future* operational waste and spent fuel and the costs of the decommissioning, including the decommissioning waste, of *future* nuclear facilities, whereas these costs are part of the costs of the national programme.

The inventory report on nuclear liabilities is updated every five years, which allows costs estimates to be refined iteratively as projects become better defined or concepts become clearer. The next inventory report on nuclear liabilities, due in 2023, is in preparation. It will, in particular, be based on more recent costs estimates for the surface disposal project for category A waste and for the geological disposal programme for B&C waste, taking account of modified hypotheses. It will also take account of the spent fuel generated since the previous inventory of nuclear liabilities.

The cost estimates of the fourth inventory of nuclear liabilities are based on a series of hypotheses, in particular the hypothesis that all the regulatory, technical, and economic conditions are those in place on the inventory reference date, namely 31 December 2015. Generally speaking, these estimates were produced as if all operations took place 'instantly' on that date (overnight costs). The fees applied for calculating the waste management costs are those for the 2014–2018 contractual period, established in 2013. The main hypotheses specific to the fees for storage and disposal for that period (now outdated) were as follows:

- the seven existing commercial nuclear reactors will be operated for 40 years;
- B&C waste will be disposed of in Boom Clay at 200 metres depth (financial hypothesis only);
- spent fuel from commercial reactors will be reprocessed (contractual hypothesis);
- geological disposal of category B waste will start in 2047;
- geological disposal of category C waste will take place over the period 2100–2110.

The total costs as evaluated by ONDRAF/NIRAS in the fourth inventory report, namely EUR_{2015} 15 107 million, include the following:

- the costs of managing all *existing* radioactive waste and all radioactive waste from the future decommissioning of all *existing* facilities (including the transport, treatment, conditioning, storage, and disposal costs);
- the costs of the decommissioning operations of the *existing* facilities, of which EUR_{2015} 5 403 million for the decommissioning of the nuclear power plants, assuming in particular for nuclear power plants that
  - dismantling starts (almost) immediately after reactor shutdown;
  - dismantling of a plant is managed as a unique, integrated project;
  - the decommissioning costs include the demolition of the buildings and the restoration of the site to the state of undeveloped land;
- the costs of managing all *existing* nuclear materials, of which EUR_{2015} 4 925 million for the management of spent fuel, assuming in particular for the spent fuel from commercial nuclear reactors that 22% of it will be reprocessed (financial hypothesis Synatom) and that the rest will be conditioned and declared as radioactive waste to ONDRAF/NIRAS, to be disposed of in a geological disposal facility.

Article 12(1)(i) *the financing scheme(s) in force;*

The financing schemes in force are unchanged.

However, ONDRAF/NIRAS has implemented the so-called 'guiding principles' governing the financing of the long-term fund (Section I.1.2). This required a thorough revision of all medium- and long-term management fees (for storage and disposal, respectively) and the revision of all related contracts, with the so-called 'main' radioactive waste producers, with effect as of 1 January 2019.

Article 12(1)(j) *a transparency policy or process as referred to in Article 10;*

The transparency policy and processes are unchanged. This topic does not appear to be an issue.

Article 12(1)(k) *if any, the agreement(s) concluded with a Member State or a third country on management of spent fuel or radioactive waste, including on the use of disposal facilities.*

The agreements with Member States or third countries on the management of spent fuel or radioactive waste are unchanged, except for the fact that the Government of the Grand Duchy of Luxembourg and the Belgian Government ratified, in June 2018 and March 2019 respectively, the agreement establishing the technical and financial framework for the management and the disposal by Belgium of Luxembourg radioactive waste (Section B.2.1.1) [Luxembourg Official Journal 2018; Belgian Official Journal 2019].

Bilateral talks with France aim at reaching an agreement on the reprocessing of the BR2 spent fuel that is not covered by the current bilateral agreement with France, namely the BR2 spent fuel that will not have been delivered at la Hague by 31 December 2025.

Article 12(2) *The national programme together with the national policy may be contained in a single document or in a number of documents.*

The national programme and the national policies are contained in several self-supporting documents. Indeed, pursuant to the Law of 3 June 2014, the national programme is adopted by ministerial decree, whereas the national policies are since then established by royal decree.

L. Article 14.3 — Peer reviews and self-assessments

> Article 14(3) *Member States shall periodically, and at least every 10 years, arrange for self-assessments of their national framework, competent regulatory authority, national programme and its implementation, and invite international peer review of their national framework, competent regulatory authority and/or national programme with the aim of ensuring that high safety standards are achieved in the safe management of spent fuel and radioactive waste. The outcomes of any peer review shall be reported to the Commission and the other Member States, and may be made available to the public where there is no conflict with security and proprietary information.*

Self-assessments and international peer reviews of the national framework, FANC, and the national programme (including its implementation as far as self-assessments are concerned) must be organised at least every ten years, on initiative of the competent ministers.

Belgium will receive an IRRS mission and an ARTEMIS peer review mission covering the topics under Article 14(3). These missions are planned respectively during the second and third quarters of 2023. (The last IRRS mission took place in December 2013, with a follow-up mission in November–December 2017.) Belgium will organise a self-assessment as a preparatory step to the IRRS and ARTEMIS missions.

M. Future plans to improve safe and responsible management of spent fuel and radioactive waste

The main future plans to improve safe and responsible management of spent fuel and radioactive waste involve the preparation of new (parts of) national policies (Section M.1), further developments of the national legal and regulatory framework (Section M.2), and the further implementation of the national programme (Section M.3).

M.1 National policies

M.1.1 Status of spent fuel

Synatom, as owner of the spent fuel from the commercial nuclear reactors, and SCK CEN, as owner of spent fuel from research reactors, must propose hypotheses regarding the further use of their spent fuel, with a view to the later integration of the accepted hypotheses in the national policies (Article 179, § 6, of the Law of 8 August 1980). The status of this spent fuel will be established at the latest before the establishment of the last part of the national policy on the long-term management of B&C waste [FPS Economy 2020b, 2020c].

- Synatom announces every three years in its reference programme to ONDRAF/NIRAS provisional quantities regarding the future reprocessing of part of its spent fuel, this as a basis for RD&D related to design and operation of a future geological disposal facility and for costs calculations.
- SCK CEN is currently examining the industrial feasibility of reprocessing or of treating and conditioning the spent fuel that it owns and whose status has not yet been clarified, namely the spent fuel from the BR3 reactor that was declared as waste to ONDRAF/NIRAS but is still SCK CEN's property, the spent fuel from the VENUS reactor, and the future spent fuel from the BR1 reactor (Section M.3.1). The hypotheses to be proposed regarding the further use of this spent fuel will depend on the outcome of the studies. If proved feasible, the reprocessing or treatment and conditioning of this fuel would facilitate its proposed geological disposal. The studies, however, are still at a relatively preliminary stage.

M.1.2 Long-term management of B&C waste

ONDRAF/NIRAS has submitted a revised proposal setting the bases of a national policy on the long-term management of B&C waste to its supervisory ministers in April 2021 (Section B.1).

In its coalition agreement of September 2020, the Government committed itself to establishing the national policy on the long-term management of B&C waste. After this policy has been established, in the form of a royal decree, a major focus for the coming years will be to prepare the elements that will complement these bases. Efforts will focus in particular on preparing the second part of the policy, namely the participative decision-making process that will help to ensure the phased establishment and maintenance of the national policy and that will continue through to the application for the creation and operation licence(s). To this end, and as requested by its supervisory ministers, ONDRAF/NIRAS will organise a broad participative process aiming, on the one hand, at re-evaluating and confirming that geological disposal is the best choice for the long-term management of B&C waste and, on the other hand, at defining the main lines of the decision-

making process, to be established by royal decree, that will eventually lead to the choice of one or more disposal sites (Section J.2.2).

M.1.3 Long-term management of radium-bearing substances to be managed as radioactive waste

The roadmap for the site remediation and disposal activities related to the management of the radium-bearing contaminations at the Umicore site in Olen and its vicinity, that was agreed upon in May 2021 by the four actors involved — FANC, ONDRAF/NIRAS, OVAM, and Umicore —, includes the following four phases (see also Section B.3.1.7):

- preparatory activities (2021);
- modifications, if needed, to the legal and regulatory framework and selection of a preferred remediation option (2021–2024);
- definition of the remediation and disposal projects, including the authorisation steps (beyond 2024);
- implementation of the remediation and disposal projects.

The activities in 2021 and during the following years (phases 1 and 2) will focus on:

- inventorying the available information on the contamination characteristics and assessing the fractions of radioactive waste and waste to be managed as non-radioactive waste on the basis of the threshold value set out in the FANC – ONDRAF/NIRAS vision document;
- preparing a national policy proposal for the disposal of radium-bearing radioactive waste, including the strategic environmental assessment procedure;
- identifying potentially missing regulatory elements and making proposals to complete the regulatory framework;
- defining the authorisation path, at the regional and federal levels, for all remediation and disposal activities;
- assessing the remediation options and selecting a preferred option.

The long-term management of the radium-bearing substances contained in Umicore's UMTRAP storage facility in Olen will be the subject of a separate decisional process. UMTRAP contains indeed the radium-bearing substances with the highest activity. This process will take due account of the safety of the storage facility in the medium term and of the financial provisions to be established for long-term management.

M.1.4 Long-term management of NORM substances to be managed as radioactive waste

The non-necessity of a national policy dedicated to the long-term management of NORM radioactive waste, as assessed by FANC and ONDRAF/NIRAS, will be confirmed, subject to the introduction of the necessary elements in the legal and regulatory framework.

M.2 National framework

Most plans to improve the national legal and regulatory framework are bundled together in the task force's report that was submitted in July 2017 to the Federal Council of Ministers (Section B.2.2.1), which then entrusted the supervisory ministers of FANC and ONDRAF/NIRAS with the mission to propose draft laws and draft royal decrees giving shape to the task force's proposals. (Some of these proposals have actually been under development since long before 2017.)

The regulatory projects related to FANC's competences expected to be finalised in the coming years are as follows:

- the addition in the FANC law of the mission to control the elements of the ONDRAF/NIRAS waste acceptance system related to the safety of radioactive waste management and the corresponding amendments to the GRR-2001;
- the royal decree on the safety requirements for disposal facilities;
- the royal decree on the licensing system of disposal facilities;
- the law regarding the management of existing exposure situations.

The initiatives to improve the legal and regulatory framework related to ONDRAF/NIRAS' competences expected to be finalised in the coming years are as follows:

- the clarifications of the law defining the competences of ONDRAF/NIRAS (ONDRAF/NIRAS law) in relation to the general rules for the definition of the waste acceptance criteria for conditioned and non-conditioned waste; these have been submitted in March 2021 to ONDRAF/NIRAS' supervisory ministers, together with the corresponding amendments to the law defining the competences of FANC (FANC law), and follow now the legislative path; they entail
  - the establishment of a royal decree on the general rules needed for establishing the waste acceptance criteria;
  - the establishment of a royal decree on the modalities of the waste acceptance system;
- the amendments to the royal decree on the qualification by ONDRAF/NIRAS of the facilities for the storage, treatment, and conditioning of radioactive waste to take account of the lessons learnt during 20 years of application of this decree and of the new provisions regarding the general rules;
- the royal decree laying down the bases of the national policy on the long-term management of B&C waste.

The Federal Government, in the coalition agreement of September 2020, committed itself to strengthening the legal framework to ensure the existence, sufficiency, and availability of the nuclear provisions, upon proposal of the Commission for Nuclear Provisions regarding the provisions for the costs of the dismantling of nuclear power plants and the management of the spent fuel from these plants.

In addition, the Federal Government will set up a task force, composed of representatives of the institutional actors, to examine how to ensure the continuity of the financing of radioactive waste management, considering the end of the activities of some radioactive waste producers, and to make proposals to adapt the legal and regulatory framework to this end.

M.3 National programme

Belgium will update its national programme after a significant modification or evolution has occurred.

M.3.1 RD&D

Examples of key RD&D topics to improve safe and responsible management of spent fuel and radioactive waste are as follows:

- continuation by ONDRAF/NIRAS of the adaptation and/or optimisation of the current design of the surface disposal facility and of the safety report for specific waste streams that do not meet the currently proposed disposal criteria;
- further preparation by ONDRAF/NIRAS of the methodological safety and feasibility case for geological disposal, planned for 2024–2025, which considers several depths between 200 and 600 metres in poorly-indurated clays for illustration;
- continuation by ONDRAF/NIRAS of the studies with a view to applying the optimisation principle to the future choice of one or more host formations for geological disposal;
- continuation by ONDRAF/NIRAS of the iterative revision process of the design of the geological disposal facility with a focus on operational safety issues;
- continuation by ONDRAF/NIRAS of the studies on the ethical issues related to geological disposal, for example, reversibility of the decisions and retrievability of the waste with respect to intergenerational equity, consequences of delayed decisions, etc.;
- start of the public-public cooperation agreement between ONDRAF/NIRAS and SCK CEN on the scientific research and the technical-scientific support needed for the safe management of radioactive waste in the short, medium, and long term;
- continuation by EURIDICE of the PRACLAY heater experiment;
- continuation by Electrabel of the development of some new treatment and conditioning processes for resins and concentrates; these new processes are to replace the ones for which ONDRAF/NIRAS withdrew Electrabel's qualifications;
- continuation by Synatom of
  - its follow-up of the output of international expert networks related to the long-term behaviour of spent fuel;
  - its follow-up of the R&D on dry storage solutions;
- continuation by SCK CEN of the studies on the industrial feasibility of reprocessing or of treating and conditioning the spent fuel from the BR1, BR3, and VENUS research reactors;
- further development by SCK CEN of the MYRRHA project, a nuclear research infrastructure designed, in particular, to allow the continuation, in association with Belgian and international universities and research centres, of fundamental nuclear research and research towards the transmutation of minor actinides in spent fuel, with a view to optimising the long-term management of spent fuel.

M.3.2 Waste acceptance system

ONDRAF/NIRAS will continue to extend the waste acceptance system, by taking into account the revised waste acceptance criteria necessary to ensure compliance of the waste intended for surface disposal with the requirements of the nuclear licences for the future surface disposal facility and for

the new waste management facilities, namely the installation for the production of monoliths (IPM) and the facility for the production of the concrete containers used by the IPM. The extension of the system will also take account of the addition of a new type of inspections, namely inspections pertaining to the supply chain used by the operators of waste conditioning facilities.

M.3.3 Short-term management

Examples of key issues to improve safe and responsible short-term management of radioactive waste are as follows:

Construction of a new, single, treatment facility for low- and intermediate-level effluents at Belgoprocess, to replace the current facilities on the BP1 and BP2 sites:

- studies: 2018–2021;
- investment: 2021–2026.

Modifications to the PAMELA facility to enable homogeneous cementation of chemically contaminated, intermediate-level effluents:

- implementation: 2024–2026.

M.3.4 Medium-term management

Examples of key issues to improve safe and responsible medium-term management of spent fuel and radioactive waste are as follows:

Extension of the storage capacities for spent fuel in Doel and Tihange, which were approximately 70% (number considering the locations occupied by spent fuel casks without thermal saturation) and 82% full respectively at the end of 2020, and will be saturated before complete phase out in 2025:

- concept chosen by Electrabel for the SF^2 facilities: dry storage in casks;
- licence application: submitted in 2018 for Tihange and in 2020 for Doel;
- start of construction: in 2020 in Tihange, expected in 2021 in Doel;
- start of operation: expected in 2023 in Tihange and in 2025 in Doel.

Construction at Belgoprocess of a reception and storage centre for non-conditioned waste, which can be extended to storage of conditioned waste:

- licence application: expected end 2021;
- start of construction: expected end 2022;
- start of operation: expected end 2024.

Construction at Belgoprocess of a storage facility (foreseen lifetime of 75 years) dedicated to isolating the (potentially) ASR-affected waste packages:

- licence application: submitted in 2019; licence received in 2020;
- start of construction: beginning of 2021;
- start of operation: expected in 2024.

Follow-up of the remaining available storage capacity for conditioned radioactive waste at Belgoprocess, taking account of the following key factors, and taking actions as needed:

- the expected volumes of conditioned waste, which originates mainly from nuclear power plants;
- the evolution of the projects for creating additional storage capacity at Belgoprocess, in particular the construction of the facility for the (potentially) ASR-affected waste packages;
- the planned construction of the post-conditioning facility for category A waste, where buffer capacity is foreseen;

- the expected planning for the construction and operation of the surface disposal facility for category A waste.

M.3.5 Long-term management

The licensing procedure for the surface disposal facility for category A waste will continue (see Table 7 in Section K.3 for the current estimated timeframes).

Acronyms

ARTEMIS	Integrated Review Service for Radioactive Waste and Spent Fuel Management, Decommissioning and Remediation of the IAEA
ASR	alkali-silica reaction
BP	Belgoprocess
CNP	*Commission des provisions nucléaires / Commissie voor nucleaire voorzieningen* (Commission for Nuclear Provisions)
CPNPC	*Comité du Programme national / Comité van het Nationale Programma* (National Programme Committee)
ENSREG	European Nuclear Safety Regulators Group
EURAD	European Joint Programme on Radioactive Waste Management
EURIDICE	European Underground Research Infrastructure for Disposal of Nuclear Waste in Clay Environment
FANC	*Federaal Agentschap voor Nucleaire Controle / Agence fédérale de Contrôle nucléaire* (Federal Agency for Nuclear Control)
FPS	Federal Public Service Economy, SMEs, Self-Employed and Energy
GRR-2001	Royal Decree of 20 July 2001 relating to the general regulations for the protection of the population, workers, and the environment against the dangers arising from ionising radiation, also known as 'general regulations for radiation protection'
HADES	High-Activity Disposal Experimental Site
HLW	high-level waste
HPD	Health Physics Department
IAEA	International Atomic Energy Agency (Vienna)
ILW	intermediate-level waste
IMS	integrated management system
IPM	installation for the production of monoliths
IRE	*Institut national des radioéléments* (National Radioelements Institute)
IRRS	Integrated Regulatory Review Service of the IAEA
LLW	low-level waste
MOX	mixed-oxide fuel
MYRRHA	Multipurpose hYbrid Research Reactor for High-tech Applications
NORM	naturally occurring radioactive materials
OECD/NEA	Organisation for Economic Cooperation and Development / Nuclear Energy Agency (France)
ONDRAF/NIRAS	*Organisme national des déchets radioactifs et des matières fissiles enrichies / Nationale instelling voor radioactief afval en verrijkte splijtstoffen* (Belgian Agency for Radioactive Waste and Enriched Fissile Materials)
OVAM	*Openbare Vlaamse Afvalstoffenmaatschappij* (Flemish agency for the management of non-radioactive waste)
PWR	pressurised-water reactor
RD&D	research, development and demonstration
SA	*société anonyme* (limited company)
SCK CEN	*Studiecentrum voor Kernenergie / Centre d'Etude de l'Energie Nucléaire* (Belgian Nuclear Research Centre)

SEA	strategic environmental assessment (environmental impact assessment as defined by the Law of 13 February 2006 and Directive 2001/42/EC)
SRNI-2011	Royal Decree of 30 November 2011 on the safety requirements for nuclear facilities
Synatom	*Société belge des Combustibles nucléaires Synatom / Belgische Maatschappij voor Kernbrandstoffen Synatom* (owner of the fuel of the nuclear power plants)
tHM	tonne of Heavy Metal
VLLW	very low-level waste
WENRA	Western European Nuclear Regulators Association

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