KINGDOM OF BELGIUM

Eighth meeting of the Contracting Parties to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management

National Report of Belgium

–

August 2024

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SECTION A INTRODUCTION

A.1 General context

On 8 December 1997 Belgium signed the Joint Convention. The Belgian legislator has expressed its consent with the obligations resulting from the Convention by the Law of 2 August 2002. The ratification followed on 5 September 2002. The Convention became effective on 4 December 2002, i.e. 90 days following ratification.

Belgium belongs to the group of Contracting Parties having at least one operational nuclear power plant on their territory. Belgium has since the 1970s developed a nuclear energy programme that included 7 operational PWR reactors on 2 sites with a net electric capacity of approx. 6000 MW_e.

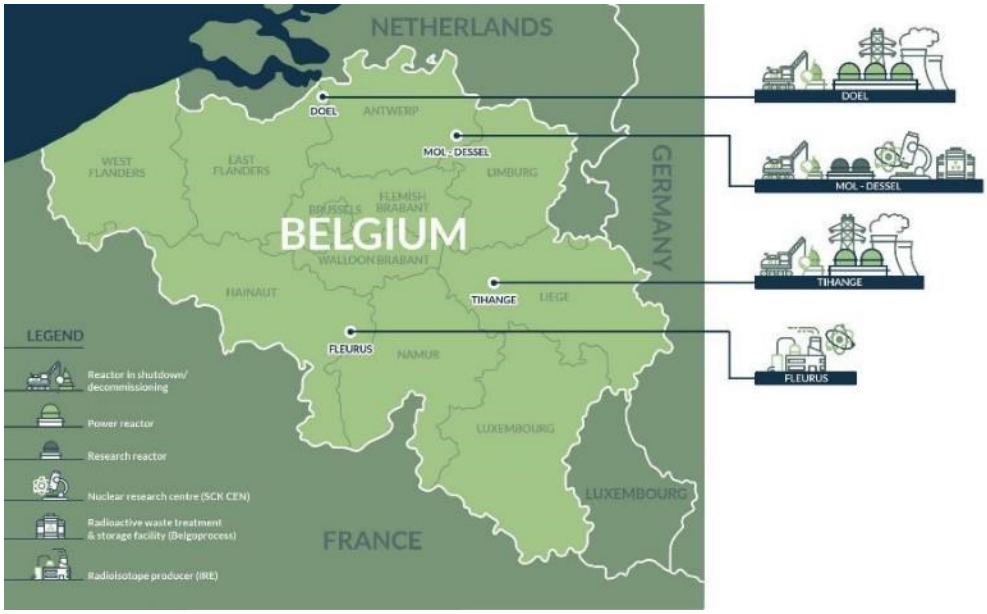


Figure 1: Nuclear sites in Belgium

The Doel and Tihange power plants (figure 1) are operated by ENGIE Electrabel, a member of the ENGIE group that was created after the merger in 2008 of 2 groups "Gaz de France" and "Suez". The share of nuclear energy in electricity generating capacity in Belgium amounts to around 41% in 2023.

The **Law of 31 January 2003 on the gradual phase-out from nuclear energy for industrial electricity production** limited the operational lifetime of the Belgian NPPs to 40 years. However, to ensure the electricity supply of Belgium, the government and the parliament already modified article 4 of this law in 2012 and in 2015, to allow a long-term operation of the units Tihange 1 and Doel 1 & 2, respectively, by 10 years. In application of this Law, two reactors have already been definitively shut down, i.e. Doel 3 and Tihange 2. Those were affected by flaw indications in their pressure vessels[1].

In 2023 the Belgian government reached an agreement with ENGIE Electrabel for 10 years extended operation of Tihange 3 and Doel 4. The Law of 31 January 2003 has been modified accordingly (see also item "*Preparation of Long-term operation of Doel 4 and Tihange 3 units*", under § A.2.3 – Other Developments). The construction of new NPPs in Belgium is still prohibited by this Law (Article 3). The legal shut-down dates of the Belgian reactors, as of 31 December 2023 (before the changes in the wake of LTO) and as of 1st July 2024, are reported in Table 1.

[1] See the Belgian national reports for the Convention on Nuclear Safety, 2014 and subsequent editions.

Table 1 Shut-down dates of the Belgian reactors, as of 31 December 2023 and 1st July 2024 (then accounting for the LTO restart period).

	As of 31 December 2023	As of 1st July 2024
Doel 1	15 February 2025	(unchanged)
Doel 2	1 December 2025	(unchanged)
Doel 3	1 October 2022	(unchanged)
Doel 4	1 July 2025	31 December 2037 (at the latest[2])
Tihange 1	1 October 2025	(unchanged)
Tihange 2	1 February 2023	(unchanged)
Tihange 3	1 September 2025	31 December 2037 (at the latest)

In the past, there were in Belgium also other nuclear activities and facilities in the field of the nuclear fuel cycle:

- a pilot reprocessing plant EUROCHEMIC
- fuel fabrication facilities (Belgonucléaire and FBFC International).

All these activities have stopped, and the facilities have been decommissioned or are being decommissioned.

In addition to waste generated by the use of nuclear energy, radioactive waste is generated by industrial, medical and research activities.

The historical radium and uranium production at the Olen site (UMICORE) and the NORM (naturally occurring radioactive materials) industries are moreover the source of radium-bearing and NORM wastes. The fraction of these wastes that will have to be managed as radioactive waste is assessed by FANC and ONDRAF/NIRAS, with a view to prepare and execute site remediation activities and future policy decisions, to be taken by the Federal Government, for the long-term management of the resulting radioactive waste.

An overview of the range of activities using radioactivity, including activities relating to the nuclear fuel cycle, to research or to medical and industrial applications of radioactivity is provided in Table 2. These activities generate spent nuclear fuel and radioactive waste with highly diverse characteristics, which must be managed safely.

Regarding the long-term management of "category A" waste (short-lived low and intermediate level radioactive waste or LILW-SL), the Belgian National Agency for Radioactive Waste and enriched fissile materials (ONDRAF/NIRAS) obtained in 2023 the licence to construct and operate a surface disposal facility for category A waste in Dessel. The project entails a disposal facility, a waste post-conditioning facility and the realisation of the accompanying conditions requested by the local stakeholders.

For the long-term management of the high-level and/or long-lived waste (category B&C waste) ONDRAF/NIRAS has drafted a policy proposal for deep disposal[3] on the Belgian territory in June 2018, conform with the legal procedure for national policy decisions, as defined in the law of 3 June 2014, transposing the EC Directive 2011/70/Euratom. This policy proposal was subject of a strategic environmental assessment procedure (2019 - 2020) with consultation of institutional actors and of the public (April 2020 – June 2020). Based on the outcomes of this procedure, ONDRAF/NIRAS submitted a revised policy proposal for the development and implementation of deep geological disposal facilities on the Belgian territory for category B&C waste through a participative and reversible decision-making process. After advice from FANC, this revised proposal was adopted by the Royal Decree of 28 October 2022 (cf. § A.2.1 – Regulatory framework improvement during the period 2020-2024), thereby establishing the first part of the national policy on the deep geological disposal of category B&C.

[2] The shut-down date will be defined at a later stage, based on a set of conditions, but cannot be posterior to 31 December 2037.

[3] In this report geological disposal, deep geological disposal and deep disposal are used as synonyms.

Table 2 Principal activities generating spent fuel and radioactive waste and main associated facilities or main types of associated waste.

Principal activities	Main facilities or types of radioactive waste
Activities related to the nuclear fuel cycle	
Fuel fabrication	
FBFC International (1973–2015, Dessel), dismantled and decommissioned since 2 May 2022	Fabrication facilities for UO_2 fuel and fuel assemblies from enriched UO_2 and fuel assembly facilities for MOX from rods of MOX fuel
Belgonucleaire (1973–2006, Dessel), dismantled and decommissioned in 2019	Fabrication facility for MOX (mixed UO_2 and PuO_2) fuel rods
Electricity production	
ENGIE Electrabel (Doel and Tihange) (SYNATOM owns the fuel)	5 PWR reactors in operation (net installed capacity, industrial commissioning date and operational end date stipulated by the law of 31 January 2003 (as amended) to phase out nuclear energy) Doel 1 (433 MWe) Doel 2 (433 MWe) Doel 4 (1039 MWe) Tihange 1 (962 MWe) Tihange 3 (1046 MWe) Radioactive waste treatment, conditioning, and storage facilities, including storage facilities for spent fuel 2 PWR reactors permanently shut-down after 40 years of operations, currently in post-operational phase and preparation for dismantling. The operator will apply for the dismantling licence soon: Doel 3 (1006 MWe) Tihange 2 (1008 MWe)
Activities related to radioactive waste management	
Belgoprocess	Various facilities for the processing and storage of radioactive waste Dismantling of former EUROCHEMIC reprocessing plant
Research	
Belgian Nuclear Research Centre (SCK CEN, Mol)	4 research reactors: BR1, BR2 (operational), BR3 (being dismantled) and VENUS, laboratories
Institute for Reference Materials and Measurements of the Joint Research Centre of the European Commission (JRC), Geel	2 linear accelerators, laboratories
Belgian universities	12 cyclotrons (including 4 attached to university hospitals), 4 linear accelerators
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	6 cyclotrons (of which 4 put out of service)
Radium and uranium production (from 1922 to 1977)	
Umicore (formerly Union Minière, Olen)	Three storage facilities (UMTRAP, Bankloop and LRA storage), subject to nuclear licences and containing radioactive substances and radioactive waste Radioactively contaminated industrial landfills and diffuse radioactive contamination, likely to require remediation
Activities of certain NORM industries	Radioactive waste from the operation and dismantling of the facilities of certain NORM industries Radioactively contaminated industrial landfills and diffuse radioactive contamination, likely to require remediation
Old domestic devices	Ionising smoke detectors, lightening conductors, etc.

A.1.1 Structure and content of the report

This national report, submitted to the eighth review meeting of the contracting parties to the Joint Convention, is established pursuant article 32 of the Convention.

This report generally aims at describing the situation on 31 December 2023, while taking account as much as possible the important evolutions of early 2024 in terms of legislative and policy changes. In particular, at the time of writing of this report, the contractual and legislative dispositions of the agreement between the Belgian Government and the NPP operator, ENGIE Electrabel, for 10 years extension of operations of the Doel 4 and Tihange 3 reactors were not fully implemented. The first legislative changes (adoption of several Laws, see "*Preparation of Long-term operation of Doel 4 and Tihange 3 units*", under § A.2.3 – Other Developments) have been adopted on 26 April 2024 (Belgian Official Gazette of 5 June 2024). The further implementation of the legislative changes may/will proceed further in the near future; an updated picture will be given in the national presentation.

The structure of this report conforms to the guidelines INFCIRC/604/Rev.4; the recommendations of the 5th Extraordinary Meeting on the reporting of Good Practices, which are not yet formally translated in guidelines, have also been taken into account.

An overview of the main developments since the 7th Review Meeting is reported in § A.2.

A follow-up of the 7th Review meeting, addressing the suggestions and challenges identified for Belgium is reported in Section K (§ K.1 – Measures taken to address suggestions and challenges identified for Belgium at the 7th review meeting of the Joint Convention (2022)). Overarching Issues identified for reporting at the 7th Review Meeting are addressed in § K.2.

Section § K.3 reports on Future Challenges and planned measures to improve safety (§ K.3.1), Areas of Good Performance (§ K.3.2) and Good Practices (§ K.3.2) for Belgium.

The following actors have participated in the drafting and review of the report:

- ONDRAF/NIRAS, the Belgian National Agency for Radioactive Waste and Enriched Fissile Materials, in charge of the management of radioactive waste,
- FANC, the Federal Agency for Nuclear Control, the nuclear safety authority, responsible for the coordination of the report,
- Bel V, the technical subsidiary of the FANC,
- ENGIE Electrabel, the licensee of the seven nuclear power plants who is also responsible for the interim storage on site of the spent fuel,
- SCK CEN, the Belgian Nuclear Research Centre, operating research reactors and laboratories, and dismantling a former PWR research reactor.

Together these actors have the legal and practical competence necessary to collect and structure the information required to elaborate the national report.

The report, as well as questions and answers from the peer review will be made available on different Belgian websites, such as www.fanc.fgov.be, www.ondraf.be, www.belv.be.

A.1.2 Summary table of current liabilities in Belgium

Table 3 Summary table of current liabilities in Belgium, at 31/12/2023[4].

Type of Liability	Current practices/ Facilities	Long-term management policy	Funding of Liabilities	Planned Facilities
Spent Fuel	- On-site wet and dry storage of spent fuel (SF) from NPPs - Dry storage (at Belgoprocess) and reprocessing of SF from research reactors	Long term management policy still to be defined: reprocessing or direct disposal	NPP operators contribute to the fund managed by SYNATOM. For spent fuel of research reactors: - Funds fed by the Belgian state for historical fuel, - provisioned by SCK CEN for fuel produced after 1988	Geological disposal (host rock and site undecided)
Nuclear fuel cycle waste	Centralised storage at Belgoprocess site of all LILW-SL, LILW-LL and HLW transferred to ONDRAF/NIRAS	LILW-SL: Near surface disposal LILW-LL and HLW: geological disposal (in both galleries and deep boreholes and does not prejudge the host formation(s) nor the site(s))	Producer pays, contribution to the ONDRAF/NIRAS long-term fund Various funds for historical liabilities fed by the Belgian State	Surface Disposal for LILW-SL at Dessel, including the disposal facility and other facilities for waste packaging for disposal. (licence for construction obtained in 2023) Storage building for the ASR non-conform waste[5] at Belgoprocess Geological disposal (host rock and site undecided)
non-reactor waste (application waste)	Centralised storage at Belgoprocess site of all LILW-SL, LILW-LL and HLW transferred to ONDRAF/NIRAS Radium waste storage at Umicore/Olen	LILW-SL: near surface disposal LILW-LL: geological disposal (in both galleries and deep boreholes and does not prejudge the host formation(s) nor the site(s)). Radium waste: policy still to be defined, shallow-depth disposal is investigated as LT management solution	Producer pays, contribution to ONDRAF/NIRAS long-term fund Insolvency fund Radium waste: Producer pays	Surface Disposal for LILW-SL at Dessel, including the disposal facility and other facilities for waste packaging for disposal. (licence for construction obtained in 2023) Geological disposal (host rock and site undecided) for LILW-LL
Decommissioning Liabilities	Present projects : Doel 3 and Tihange 2 PWR reactors BR3 Research Reactor; Eurochemic reprocessing plant; SCK CEN waste department; University of Gent (accelerators) Radio-element production facility ex- "Best Medical Belgium"	Responsibility of operator; approval of decommissioning plan by ONDRAF/NIRAS LILW-SL: near surface disposal LILW-LL : geological disposal (in both galleries and deep boreholes and does not prejudge the host formation(s) nor the site(s))	Operators contributed to the provisions; various funds for historical liabilities fed by the Belgian State; Transfer of financial means to ONDRAF/NIRAS (waste funds managed by ONDRAF/NIRAS) when waste is transferred to ONDRAF/NIRAS	Idem
Disused Sealed Sources	Return to supplier, decay storage or transfer to ONDRAF/NIRAS	Implementation of EU directive, recovery of orphan sources	If no return, holder has to set up financial guarantee	Idem

[4] At the time of writing of this report, the contractual and legislative dispositions of the agreement between the Belgian Government and the NPP operator, ENGIE Electrabel, for 10 years extension of operations of the Doel 4 and Tihange 3 reactors were not fully implemented. The first legislative changes (adoption of several Laws, see "*Preparation of Long-term operation of Doel 4 and Tihange 3 units*" under § A.2.3 – Other Developments) have been adopted on 26 April 2024 (Belgian Official Gazette of 5 June 2024). The further implementation of the legislative changes may/will proceed further in the near future; an updated picture will be given in the national presentation. The funding of liabilities for the long-term management of spent fuel and radioactive waste from commercial NPPs is planned to be transferred to HEDERA. The funds for historical liabilities, today fed by Belgian state, are also meant to be transferred to HEDERA.

[5] Alkali-silica reaction affected conditioned waste, see § K.1.1.h – Programme for long-term management of non-conform waste.

A.2 Developments since the last meeting

This section intends to highlight the main events/evolutions that have occurred since the last report.

A.2.1 Regulatory framework improvement during the period 2020-2024

Several regulatory framework changes that are relevant to this Convention have been issued during the period 2020 – 2024 and are discussed in the following subsections. With regard to other regulatory changes, for example in relation to nuclear safety and the transposition of WENRA reference levels for research reactors and nuclear power plants, the reader is invited to also consult the national report of Belgium for the 9th review meeting of the Convention on Nuclear Safety.

❖ **Laws**

- ***The Law of 7 November 2021***[6]***,*** *amending Article 179 of the Law of 8 August 1980 concerning the budgetary proposals 1979-1980*

The Law of 7 November 2021 states that the general rules for the establishment of the waste acceptance criteria have to be fixed by Royal Decree, on proposal of ONDRAF/NIRAS taking into account the binding opinion of FANC.

- ***The Law of 2 December 2021***[7]***,*** *amending the law of 15 April 1994 on the protection of the population and the environment against the dangers arising from ionising radiation and on the Federal Agency for Nuclear*

The law of 2 December 2021 clarifies the roles and responsibilities between NIRAS and the FANC to avoid that the safety decisions of the FANC are compromised by previous decisions of another public authority. In practice:

- The FANC issues a binding opinion to ONDRAF/NIRAS on its proposal for the waste "general rules" (which are the basis for the waste acceptance criteria established by ONDRAF/NIRAS) that will be set out in a Royal Decree.
- The FANC examines whether the acceptance criteria drawn up by NIRAS correspond to the general rules and to the license requirements for the applicable facilities.
- If the FANC finds, during an inspection, that the radioactive waste produced, manufactured, or possessed by an operator does not meet the acceptance criteria, the FANC shall immediately inform ONDRAF/NIRAS.

- ***The Law of 12 July 2022,*** *amending Article 179 of the Law of 8 August 1980 concerning the budgetary proposals 1979-1980 and the programme law of 30 December*

This Law of 12 July 2022 defines the financing mechanisms of specific legal tasks of ONDRAF/NIRAS related to the National Policy and effective participation of the public in the establishment of National policy proposals by ONDRAF/NIRAS, to the inventory of nuclear sites and materials, and to reporting, self-assessment and peer review obligations from the EC Directive 2011/70/Euratom.

- ***The Law of 12 July 2022,*** *strengthening the framework applicable to the provisions established for the dismantling of nuclear power plants and for the management of spent fuel and to partially abolishing and amending the law of 11 April 2003 on the provisions created for the dismantling of nuclear power plants and the management of fissile materials irradiated in these power plants*

This Law of 12 July 2022 reinforces the legal framework for the sufficiency and availability of the financial resources.

[6] This Law was issued beyond the reference date for the previous national report but have been discussed in the national presentation of Belgium at the 7th review meeting, in 2022.

[7] Same comment as footnote 6.

- ***The Law of 20 November 2022**, on management of soils contaminated by radioactive substances*

The law of 20 November 2022 lays down the principles of remediation of soil contamination in case of existing exposure situations. The law identifies the responsibilities, the process of characterization and description of the soil contamination as well as the subsequent establishment of a remediation plan and remediation project in a consultation process. It further establishes a framework for accreditation of soil experts in radioactivity. The Royal Decree for the execution of this law was adopted on 26 June 2024.

- *The four **Laws** promulgated on **26 April 2024**, in relation to the agreement between the Belgian government and the NPP operator for the long-term operations of Doel 4 and Tihange 3 reactors*

A new legislative package has been recently published (5 June 2024), in the wake of the agreement between the Belgian Government and the NPP operator, ENGIE Electrabel, in relation to the long-term operations of Doel 4 and Tihange 3 reactors. Further details are provided in § A.2.3 – Other Developments (under item "*Preparation of Long-term operation of Doel 4 and Tihange 3 units*").

❖ **Royal Decrees**

- ***The Royal Decree of 29 May 2020**[8], amending the licensing process for nuclear facilities*

The Royal Decree of 29 May 2020 amends the licensing process for nuclear facilities described in article 6 of the law of 20 July 2001 (GRR-2001), to complete the transposition of the European Directive 2014/52/EU amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment.

This update addresses:

- A clear delineation of scope of projects with EIA obligation and/or screening
- Clarification of EIA process (experts, approval of EIA report, …)
- Reshaping public enquiry process.

- ***The Royal Decree of 20 July 2020**[9], completing the transposition of the EU Directive 2013/59/EURATOM*

The Royal Decree of 20 July 2020 fully completes the transposition of the EU directive 2013/59/EURATOM into Belgian regulations, by amendment to the Royal Decree of 20 July 2001 (GRR-2001) with regard to dose limits, exemption, and clearance levels ….

- ***The Royal Decree of 28 February 2022**, on the entry into force of the law of 2 December 2021 (itself amending the law of 15 April 1994 on the protection of the population and the environment against the dangers arising from ionising radiation and on the Federal Agency for Nuclear Control)*

The Royal Decree of 28 February 2022 sets the date of the entry into force of the Law of 2 December 2021, by which FANC issues binding advice with regard to the general rules and acceptance criteria.

- ***The Royal Decree of 28 October 2022**, establishing the first part of the National Policy for the Long-Term Management of High-Level and/or Long-Lived Radioactive Waste and specifying the process for the phased establishment of the other parts of this National Policy*

The Royal Decree of 28 October 2022 establishes the first part of the national policy regarding the long-term management of category B&C waste. It puts forward the solution of deep geological disposal on Belgian territory, on one or more sites, without prejudging the disposal design (repository or deep boreholes), host formation or site. In addition, the Royal Decree states notably that the second part of the policy will provide for the reversible and participative decision-making process that will lead to the choice of the site(s) where deep disposal will be implemented.

[8] Same comment as footnote 6.

[9] Same comment as footnote 6.

- ***The Royal Decree of 17 March 2024*** *on the security of surface disposal facilities*

The Royal Decree of 17 March 2024 defines the security measures and the requirements to be complied with by the operator of surface disposal facilities for short-lived, low- and medium-activity waste, through the different phases of the lifecycle of these facilities. In particular, the Decree defines the content of the security plan and establishes the qualification procedure of the radiological security system that the operator has to put in place.

- ***The Royal Decree of 22 April 2024*** *on the licensing system for disposal facilities*

The Royal Decree of 22 April 2024 on the licensing system for disposal facilities aims at establishing a specific regulatory framework for disposal facilities of radioactive waste. Such facilities, indeed, feature two essential differences compared to other nuclear facilities: the very long periods required to bring them to their final configuration state (a closed facility offering confinement of the waste, and isolation from man and from the environment), and the absence of dismantling. The Royal Decree applies to disposal of radioactive waste resulting from a regulated practice; NORM residues and contaminated soils featuring limited radiological risks remain managed under regional environment legislation and do not fall within the scope of this Royal Decree.

- ***The Royal Decree of 25 April 2024****, amending the Royal Decree of 30 March 1981*

The Royal Decree of 25 April 2024 establishes the financing of the medium-term fund for the licensed surface disposal facility.

- ***The Royal Decree of 7 May 2024****, on the Safety Requirements for Waste Disposal Facilities*

The Royal Decree of 7 May 2024 on the Safety Requirements for Waste Disposal Facilities transposes the WENRA reference levels for waste disposal facilities (published in 2015), but is currently limited in its scope to surface disposal facilities. Safety requirements for this facility have also been defined in several FANC guides (See § H.1.2 – Safety objectives applicable for a disposal facility).The cAt surface disposal facility was licensed before the present Royal Decree and that of 22 April 2024. As part of the confirmation of the licence for creation and operation, the operator will have to update the safety file to bring it in line with the provisions of these Royal Decrees.

- ***The Royal Decree of 16 June 2024****, on the nuclear and radiological emergency plan for the Belgian territory, the territorial sea and the exclusive economic zone*

A revision of the nuclear emergency plan of 1st of March 2018 has been adopted by the Government on 16 June 2024. In view of the cut-off date of the present report, those modifications could not be described yet in § F.5 – Article 25 – Emergency Preparedness.

- ***The Royal Decree of 26 June 2024****, on the implementation of the Law of 20 November 2022 on management of soil contaminated by radioactive substances,*

The purpose of the Royal Decree of 26 June 2024 is to partially implement the Law of 20 November 2022 on management of soils contaminated by radioactive substances. It regulates the qualification of soil contamination experts, by detailing the criteria and the approval procedure.

Two Royal Decrees have recently been adopted in the wake of the agreement between the Belgian Government and the NPP operator, ENGIE Electrabel, in relation to the long-term operations of Doel 4 and Tihange 3 reactors. Further details are provided in § A.2.3 – Other Developments (under item "*Preparation of Long-term operation of Doel 4 and Tihange 3 units*"):

- ***The Royal Decree of 11 July 2024****, modifying the Royal Decree of 18 November 2002 governing the qualification of facilities for the storage, treatment, and conditioning of radioactive waste.*

- ***The Royal Decree of 11 July 2024****, on the classification of radioactive waste and spent nuclear fuel, the measuring units and consumption of volume credits, and the contractual transfer criteria.*

- *Royal Decrees in preparation*

Additionally, other Royal Decrees are in preparation, such as a Royal Decree on the general rules for the establishment of waste acceptance criteria's.

A.2.2 Peer Reviews

Peer Review missions are detailed in § K.4 – Peer reviews. Belgium has hosted an IRRS and an Artemis mission in the period 2020 – 2024. Those were organized "back-to-back", i.e. the Artemis mission following the IRRS mission within a period of 6 months:

- An IRRS mission was conducted from 19 to 30 June 2023. The report of the mission is available on the IAEA website (link) ; the main outcomes are summarized in § K.4.1 – IRRS mission of 2023.
- An IAEA ARTEMIS peer review mission was conducted from 3 to 13 December 2023. The report of the mission is available on the IAEA website (link) ; the main outcomes are summarized in § K.4.2 – ARTEMIS mission of 2023.

Also, Belgian experts participated as reviewers to several peer review missions in foreign countries.

An OSART mission was also conducted at Tihange NPP Unit 3 from 17 April to 4 May 2023.

A.2.3 Other Developments

❖ The "European stress tests" action plans

Following the Fukushima Daiichi accident, ENSREG developed a safety reassessment ('stress tests'); which was conducted for all EU nuclear power plants. In Belgium, the exercise has not only addressed nuclear power plants; all Class I facilities were asked to conduct stress tests. The operators of both nuclear power plants and the other Class I facilities have implemented and finalized the defined actions in 2020.

Two documents synthesize all activities performed in the framework of the stress-tests:

- a national report addressing the nuclear power plants; (in English)
- a national report for the other Class I facilities (in French or Dutch only).

❖ Preparation of Long-term operation of Doel 4 and Tihange 3 units

To secure electricity supply beyond 2025, the Belgian Government (BeGov) and ENGIE Electrabel have initiated discussions in 2022 to prolong the operating period of the Doel 4 and Tihange 3 reactors for ten more years. On 21 July 2023, they concluded a "Framework Agreement" which provides for an obligation of means by ENGIE Electrabel to make possible a restart of those reactors by 1st November 2025, for 10 years of long-term operation.

On 13 December 2023, BeGov and ENGIE Electrabel concluded a more detailed "Implementation Agreement" that confirms and endorses the terms and principles of the "Framework Agreement". The execution of these agreements and, more generally, the lifetime extension of the Doel 4 and Tihange 3 nuclear power plants require development of new legislation. The agreement between BeGov and ENGIE Electrabel comprises four parts:

(i) the lifetime extension of the reactors of Doel 4 and Tihange 3, as well as the support mechanisms and the changes in the structure of the organisation owning these two NPP's,

(ii) a financial cap with regard to the responsibility of the nuclear operator for the storage outside its installations and final disposal of nuclear waste and spent fuel,

(iii) a guarantee package, and monitoring of the financial situation of the nuclear operator in the light of the modified risk profile due to the agreed "cap", and

(iv) agreements regarding risk sharing in the event of legislative changes.

The new legislative package of 26 April 2024, has been published in the Belgian Official Gazette on 5 June 2024, consisting of:

- ***The Law of 26 April 2024**, amending the law of 31 January 2003 on the gradual phase-out of nuclear energy for the purposes of industrial electricity production since this law limited the lifetime of Doel 4 and Tihange 3 to 40 years of operation.*

This law allows an extension of 10 years of operation for these units, with a definitive shut-down not later than 31 December 2037. This modification was subjected in 2023 to public and transboundary consultations in the framework of an Environmental Impact Assessment procedure, in respect of relevant European Directives (2011/92/EU; 92/43/EEC; 2009/147/EC).

- ***The Law of 26 April 2024** ("Phoenix"-law), guaranteeing security of supply in the field of energy and the reform of the nuclear energy sector.*

Herewith, the Belgian State will become a 50% shareholder of "NuclearSub", a company which will house the Doel 4 and Tihange 3 reactors. This joint venture will own 90% of the reactors (as today, the remaining 10% is the ownership of the company "Luminus").
NuclearSub will benefit from a two-way Contract for Difference, i.e. a calculated reference price (strike price) is guaranteed by the Belgian State until December 31, 2037. At a higher market price, the positive difference is reimbursed by NuclearSub to the Belgian State – and vice versa at a lower market price. This mechanism will be subject to approval by the European Commission.

- ***The Law of 26 April 2024** ("Hedera"-law), relating to the creation, organization, and operation of a public body whose purpose is to manage the funds for the storage and disposal of radioactive waste and spent fuel (i.e. the financial "cap" evoked before)*

Herewith, a public body "Hedera" will be created to manage the 15 billion Euros that ENGIE will pay to the Belgian state to cover the costs of nuclear waste management (the "cap"). The nuclear operator will, after the transfer of the waste to Belgian state under the condition of conformity of the radioactive waste and spent fuel with the applicable transfer criteria, be completely and definitively (although under certain conditions) exempted from obligations relating to the management of radioactive waste and spent nuclear fuel and will no longer be financially responsible for these obligations. The financial obligations would be from that moment the responsibility of the Belgian state.
In addition, the funds to cover the clean-up of the historical (before 1988) nuclear liabilities of the Belgoprocess, SCK CEN and IRE sites will be transferred to Hedera.
Every five years, starting in 2024, ONDRAF/NIRAS will have to submit a plan to Hedera for approval, detailing the activities, resources and investments required, and their costs. Prior to approval of the plan, advice has to be asked to the Nuclear Provisions Commission (CPN). Within this five-year plan, a detailed annual plan from ONDRAF/NIRAS for the following calendar year will also need to be submitted to Hedera and approved, under a similar scheme.

- ***The Law of 26 April 2024**, relating to the creation, organization, and operation of a new administrative department with autonomous accounting within the Federal Public Service (FPS) of economy, called the BE-WATT Service.*

This Law also manages the exchange of information between the concerned actors (BE-WATT, the Operator, ONDRAF/NIRAS, FANC, Hedera, CPN, ...)

Two related Royal Decrees were published in the Belgian Official Gazette on 15 July 2024:

- ***The Royal Decree of 11 July 2024**, modifying the Royal Decree of 18 November 2002 governing the qualification of facilities for the storage, treatment, and conditioning of radioactive waste.*

- ***The Royal Decree of 11 July 2024**, on the classification of radioactive waste and spent nuclear fuel, the measuring units and consumption of volume credits, and the contractual transfer criteria.*

Under no circumstances will the Belgian State and/or a related party and/or a public authority become a nuclear operator or assume any role or responsibility related thereto. ENGIE Electrabel is and will remain the unique nuclear operator and licensee of NPPs.

The legislative dispositions of the agreement for 10 years extension of operations of the Doel 4 and Tihange 3 reactors are not yet fully implemented. Despite the adoption of a first legislative package, legislative developments will proceed to fully implement the agreement however these could not be provided at this stage in the remainder of the present national report.

❖ New spent fuel or radioactive waste storage facilities

■ *SF² buildings (Spent Fuel Facility for interim on-site storage)*

The SF² facilities are new interim spent fuel storage facilities on the nuclear sites (one facility at Doel and one at Tihange site). Together with the current interim spent fuel storage building on site (dry storage building SCG at Doel and wet storage building DE at Tihange), the additional storage facilities will allow the storage of the spent fuel elements from the nuclear units after their definitive shut-down. These facilities (SF² Doel and SF² Tihange) are designed for an operating lifetime of 80 years.

The licence for a new spent fuel storage facility (SF^2) at the NPP site in Tihange was granted by a Royal Decree in January 2020. The construction activities for Tihange were completed in 2023 and the confirmatory Royal Decree, allowing the start of operation was granted on 12 June 2024.

For the storage building at Doel the licensing application (at federal level for nuclear aspects) was introduced in 2020 and licence was granted in 2021. The construction started in 2021 and is expected to be completed by end of 2024; the start of operation is expected in 2025.

■ *New storage buildings at Belgoprocess site*

Two new buildings have recently been licensed at Belgoprocess:

- A storage facility (building 167X) dedicated to non-conform waste from NPPs[10], i.e., waste packages (potentially) affected by an alkali-silica reaction (ASR). The licence for construction and operation was issued on 16 October 2020. This storage facility 167X has a capacity of 7.350 waste drums and is designed for an operating lifetime of minimum 50 years. The facility is planned to become operational in 2024 or 2025.
- A reception and storage centre (building 165X) for non-conditioned waste that will become category A or B waste after conditioning. The licence for construction and operation was issued on 23 April 2023. This reception and storage centre will allow non-destructive characterisation measurements to be carried out to determine the activity of the non-conditioned waste. The building 165X is expected to become operational in 2028.

❖ Progress on decommissioning programmes

■ *Progress in the decommissioning at Belgoprocess site*

Details on the progress – up to 2020 – of the decommissioning programme at Belgoprocess may be found in the national report submitted for the 7th Review Meeting. This subsection addresses the latest evolution of the situation on both sites of Belgoprocess.

For site 1 of Belgoprocess the dismantling activities during the reporting period have involved:

- Building 102X: Dismantling in Solid Water Pond is finished, and the dismantling activities are ongoing in the Main Treatment Pond and the Reception Pond.
- Building 123Y: Dismantling the MAVA-cell (middle active solid waste) and the alpha-cell.

[10] See also § K.1.1.h – Programme for long-term management of non-conform waste.

In April 2020, Belgoprocess received the extension and amendment of the decommissioning licence for site 2 in Mol.

- For the pumice stone biofilters (233D and 233E), the technical preparations for the dismantling of these installations were finished in 2020 (main building) and 2023 (biofilters). The dismantling of the main building started in the second half of 2020 and the dismantling of the pumice stone biofilters will start at the earliest in 2024.
- The additional dismantling activities for the main building on site 2 (236X) are ongoing and relate mainly to decontamination activities.
- Similar decontamination activities are on-going for the buildings 234C & 234D (outside tub), 234H/B/N (Mummie) and 235A (hot).

- *Progress in the decommissioning of FBFC international*

During the period 2017-2021 all the nuclear buildings were decontaminated, unconditionally cleared, and demolished (except building 5M, which has not been demolished). The site was unconditionally released in March 2022.

- *Progress in the decommissioning of the BR3 of the Belgian Nuclear Research Centre, SCK CEN*

The dismantling and decommissioning of the BR3 reactor, the first PWR operating on the European continent that was shut-down in 1987 is still continuing. In the past, the major components of this reactor, including the pressurizer, the steam generator, the primary circuit, the reactor vessel etc., and large parts of subsidiary circuits have been fully and successfully dismantled. In the past years, most of the radioactivity has been removed from the facilities. At present, almost all activated metallic components have been dismantled. The last significantly activated metallic component i.e., the Neutron Shield Tank, has been dismantled in 2014. The fuel transfer tube is still in place, its dismantling will first require removal of concrete surrounding it.

Much effort is given to cleaning and decontaminating concrete, on optimisation of materials and waste management, including release of materials and buildings. A lot of effort was given to optimize the characterization of the infrastructure by coupling in-situ measurement with geo-statistic data. In the waste and ventilation building most of the contaminated surfaces are already treated and ready for release. In the reactor building, the dismantling of the liner of the refuelling pool was completed in 2018 allowing the detailed characterization of the biological shield by a combination of in-situ measurement and sampling. A model of the biological shield was set-up and populated with the results of the characterization. The main result is that according to the Belgian legislation, no part of the biological shield has to be considered as radioactive waste. The vertical walls of the biological have been cut into segments and removed from the reactor building. A licence has been given by FANC to conditionally free release these segments.

- *Progress in the decommissioning of the facilities of the former Best Medical Belgium (ONSF site)*

Since the bankruptcy of Best Medical Belgium S.A. (BMB) in May 2012, ONDRAF/NIRAS is in charge of clean-up and dismantling that facility located in Fleurus. ONDRAF/NIRAS became nuclear operator and licence holder for these activities, entrusted to a ONDRAF/NIRAS department named “ONSF” (ONDRAF/NIRAS site Fleurus). The facility occupied several buildings containing two cyclotrons and their irradiation vaults, laboratories containing tens of shielded cells and glove-boxes …

The final decommissioning plan for the building B14 (e.g. 2 cyclotrons) was established by ONSF and approved by ONDRAF/NIRAS in October 2018. The decommissioning licence was granted in August 2019. The dismantling operations have begun in April 2020. By the end of 2022, ONDRAF has completed the clean-up of all the buildings with the exception of Building 14. At the end of 2023, the status is as follows:

- The two cyclotrons (70 MeV CGR and 30 MeV IBA) have been dismantled.

- The dismantling of the strontium-90/yttrium-90 (Sr-90/Y-90) production labs equipment (among which two high contaminated shielded cells and gloves boxes) has been finished; shaving of the room's walls (on going) are the latest operations for finalizing the dismantling of this zone.
- The new building, necessary for the containment of the (activated) concrete cutting operations of the bunkers (where the cyclotrons and auxiliary equipment were located), was built and put into service.
- Characterization measurements aimed at locally determining the thickness of concrete to be removed were in progress, as well as the procedure aimed at choosing an operator for the cutting works.
- Studies to dismantle the 10 shielded cells of building 14 were underway.

The dismantling of these shielded cells, the cutting of the activated concrete from the bunkers, and the free release of the building constitute the main activities for the next years.

- *Progress in the decommissioning of the 2 cyclotrons of TELIX in Seneffe*

The 2 cyclotrons were removed in 2022 as-it, further dismantling is conducted off-site. The bunkers of the cyclotrons were kept, allowing reuse.

- *Progress in the decommissioning of Tihange 2 and Doel 3*

The two PWR reactors Doel 3 and Tihange 2 ended definitively their operation in September 2022 and February 2023 respectively. For each unit, a Final Decommissioning Plan has been drafted and sent to ONDRAF/NIRAS. Licence applications (including an environmental impact assessment) are in preparation and expected to be introduced by the end of 2024. Both licences are expected to be granted by 2026, which will allow to start the actual dismantling works.

Meanwhile the units are in a 'Post Operational Phase'. This phase encompasses:

- the emptying of the reactor and transfer of the fuel to the deactivation pools of the units
- the removal of the fuel assemblies from the deactivation pools to the thereto foreseen on-site interim storage buildings
- the repair of damaged fuel assemblies, the emptying of the waste and residual materials present in the pools
- the chemical decontamination (Chemical full System Decontamination or CDS) of the primary circuit
- the clean-up of operational materials and waste still present in the controlled areas
- the deconstruction of some of the non-nuclear installations and the on-site preparation of the nuclear dismantling.

During this transition period, licence applications will be introduced for the construction of Waste Management Units (WMU) in support of the dismantling. These facilities will allow the temporary storage, treatment, characterisation and clearance of the material and waste arising from the dismantling. Most of the radioactive waste will not be conditioned on-site but will be transferred to the waste handling and storage facilities of Belgoprocess in Dessel.

Three other PWR reactors, Tihange 1, Doel 1 and Doel 2 will end their operation in 2025 and will undergo a similar process.

The dismantling of the reactors will generate large amounts of conventional and radioactive waste, for which waste management routes (covering activities such as cutting, treatment, characterization, packaging, conditioning, transport) must be identified and implemented, while avoiding cross-contamination of waste streams. Those activities will require submission to ONDRAF/NIRAS of qualification files in relation to waste acceptance criteria (e.g. measurement or treatment installations)

and licence applications for new facilities (e.g. WMU), or approvals to conduct certain activities. To allow for an early identification of concerns by authorities and to ensure the acceptance – and, ultimately, the disposal – of the various waste types, early interactions have been set up between the operator, the regulatory body (FANC and Bel V) and ONDRAF/NIRAS. Those exchanges aim at facilitating the later submission of qualification files, licensing applications or work approvals.

From an administrative point of view, the separate licences for the various facilities on site (reactor units, disused steam generator storage buildings, "away from reactor" spent fuel storage facilities) have been restructured in a single, consolidated, authorization at site level. Administrative simplifications have been implemented, but no relaxation of safety requirements has been introduced. The restructured licence aims at facilitating future modifications of the licence taking into account the facilities (new or decommissioned) present on site.

❖ New developments in relation to disposal of radioactive waste

■ *Licensing of the surface disposal facility in Dessel*

In November 2019, following to a favourable advice of the Scientific Council of the FANC, the application for the licence for construction and operation was opened for public consultation. In addition, the FANC asked for advice from the municipalities within a radius of 5 kilometres from Dessel, from the provincial authorities and from the European Commission, the latter in accordance with article 37 of the Euratom-treaty. The European Commission had a few complementary questions, answered by the FANC on 28 July 2020, and issued its advice on 13 November 2020.

On the basis of the comments from the public, the various advises and answers from ONDRAF/NIRAS, the Scientific Council issued a second and final favourable advice. Based on this final advice, the King, through the Minister of home affairs issued a licence for the construction and operation of the disposal facility on 23 April 2023 (with a publication in the Belgian Official Gazette on 16 May 2023).

■ *Geological disposal*

For the long-term management of the high-level and/or long-lived waste (category B&C waste) ONDRAF/NIRAS has drafted a first policy proposal for geological disposal on the Belgian territory in June 2018, conform with the legal procedure for national policy decisions, as defined in the law of June 3, 2014, transposing the EC Directive 2011/70/Euratom. This policy proposal was subject of a strategic environmental assessment procedure (2019 - 2020) with consultation of institutional actors and of the public (April 2020 – June 2020). Based on the outcomes of this procedure, ONDRAF/NIRAS submitted a revised policy proposal for the development and implementation of deep geological disposal facilities for category B&C waste through a participative, transparent, and reversible decision-making process. After advice from the FANC, this revised proposal was adopted by the Royal Decree of 28 October 2022, thereby establishing the first part of the national policy on the deep geological disposal of category B&C.

This Royal Decree establishes the decision in principle for deep disposal on Belgian territory, without defining its implementation modalities. Upon request by the ONDRAF/NIRAS's supervising ministers, a broad societal debate was then organised in 2023-24 by the King Baudouin Foundation. This societal debate consisted of:

- an accessible website aimed at informing, raising awareness and engaging participation;
- a 'Round of Belgium' to bring the debate to citizens via dialogue evenings;
- a programme with specific teaching packages and teaching materials for the third grade of secondary education and a 'Youth Summit' to gather broad input;
- a citizens' conference, and
- interviews with experts.

The final report of the societal debate has been published in March 2024. The recommendations of the societal debate can be summarised in 7 red threads as follows:

- Act from an ethical framework;
- Create the conditions for broad and sustainable participation
- Adequate actors, distinct roles, transparent responsibilities;
- Do not allow the decision-making process to stall;
- Invest in multiple scenarios and evaluate periodically
- Initiate site identification
- Secure financing for future generations

All the outcomes of the societal debate are available on the King Baudouin Foundation website https://www.presentspourlefutur.be/resultats-du-debat-societal. The outcomes form part of the input to prepare a proposal for the second part of the national policy to the Federal Government.

- *Radium-bearing waste*

In 2020, FANC and ONDRAF/NIRAS issued a common position document with a general methodology for the management of the radiological contaminations at the Umicore site in Olen. This document proposes to separate the radium-containing substances into different fractions according to their activity level in view of their long-term management.

A road map was established in 2021 by the four main actors involved (FANC, ONDRAF/NIRAS, OVAM – the Flemish Agency for the management of waste –, and Umicore), that aims to define the steps towards the final objective, i.e. remediation of all the radium-contaminations and disposal of all the resulting radium-bearing materials. Phase two of the road map (2022 - 2024) focusses on completing the legal and regulatory framework for all the remediation and disposal projects. One of the missing elements in this framework is a National Policy for the long-term management of radium-bearing substances that need to be managed as radioactive wastes (i.e., radium-bearing waste with an activity level between 15 and 1 000 Bq/g). ONDRAF/NIRAS is currently drafting a policy proposal on the long-term management of radium-bearing substances to be managed as radioactive waste. This proposal is based on a disposal solution specific to these radium-bearing substances. The proposal will be subject to an SEA procedure and a public consultation. It is expected to be submitted to the Federal Government in 2025. This proposal does not apply to the radium-bearing waste with an activity level higher than 1 000 Bq/g, which requires it to be disposed of in a deep geological repository. It will therefore be labelled as category B waste and falls under the policy for this waste category, being deep geological disposal.

- *Waste acceptance system ONDRAF/NIRAS: analysis and verification by FANC*

With the development of a surface disposal facility ONDRAF/NIRAS realizes the ultimate step of radioactive waste management for category A waste. This also requires that the waste acceptance system and the related waste acceptance criteria (WAC) to be completed with the conformity criteria for the licensed disposal facility. Additionally, the legal changes of 2021 are being implemented in close interaction with the FANC.

A.3 Participation in international activities

Belgium signed the main international conventions dealing with nuclear safety and is actively represented in numerous organizations and cooperation programmes.

❖ Cooperation at international organisations level

Belgium is a contracting party, among others, to the following international conventions:

- the Convention on Nuclear Safety,
- the Joint Convention on the safety of spent fuel management and on the safety of radioactive waste management,

- the Convention on assistance in the case of a nuclear accident or radiological emergency,
- the Paris convention on nuclear third-party liability and the Brussels supplementary convention, and subsequent amendments,
- the Convention on early notification of a nuclear accident,
- the Convention on physical protection of nuclear material.

The FANC, Bel V and ONDRAF/NIRAS are also actively involved in other international activities:

- Belgium actively participates in the IAEA safety standards committees involved in the development and the promotion of IAEA safety standards.
- ONDRAF/NIRAS and FANC/Bel V support the IAEA Integrated Review Service for Radioactive Waste and Spent Nuclear Fuel Management, Decommissioning and Remediation Programmes (ARTEMIS) by sending experts on request.
- FANC, Bel V and ONDRAF/NIRAS are also actively involved in the various committees and working groups of the OECD-NEA and they participate in various OECD-projects.
- ONDRAF/NIRAS participated until 2022 in the IAEA WATEC meetings as well as in IAEA projects on disposal (GEOSAF), integrated management systems and safety culture.

The SCK CEN and Belgoprocess are also actively involved in other international activities, such as the OECD NEA co-operative programme for the exchange of scientific and technical information on nuclear installation decommissioning.

❖ Cooperation at European level

At the European level, the FANC and ONDRAF/NIRAS are members of the ENSREG (European Nuclear Safety Regulators group). Belgian representatives are members of the different working groups set up by ENSREG i.e. WG1 (nuclear safety) and WG2 (waste and spent fuel management) and WG3 (transparency). The FANC and Bel V are also members of the WENRA, the Western European Nuclear Regulators' Association, and participate in the various activities and working groups (Reactor Harmonisation Working Group; Working Group on Waste and Decommissioning ...).

In addition, the FANC (with Bel V in the subgroup on emergencies) is an active member of HERCA (Heads of Radiation Protection Authorities) which brings together 49 radiation protection Authorities from 31 European countries. The FANC and Bel V are also members of the SITEX network (Sustainable network of Independent Technical EXpertise for radioactive waste Disposal).

At the bilateral level, several agreements are in force and the FANC has extended collaboration with foreign regulatory bodies, in particular with Belgium's neighbouring countries (France, the Netherlands, Luxembourg and Germany). Among others, this cooperation includes sharing of information, technical meetings, attendance at inspections on the field, and exchange of experts.

ONDRAF/NIRAS and Bel V participate in the Implementing Geological Disposal Technology Platform (IGD-TP), in the European Joint Programme on Radioactive Waste management (EURAD). ONDRAF/NIRAS also participates in the International Association for Environmentally Safe Disposal of Radioactive Materials (EDRAM). ONDRAF/NIRAS has bilateral collaboration agreements with several other radioactive waste management agencies e.g., in the Netherlands, France, Spain, UK ... In 2023, ONDRAF/NIRAS joined ERDO, a multinational working group established to study the feasibility of one or more shared geological repositories in Europe.

SECTION B POLICIES AND PRACTICES

B.1 Article 32, 1 – Policies and practices

> *ARTICLE 32. REPORTING*
>
> *1. In accordance with the provisions of Article 30, each Contracting Party shall submit a national report to each review meeting of Contracting Parties. This report shall address the measures taken to implement each of the obligations of the Convention. For each Contracting Party the report shall also address its:*
>
> *(i) spent fuel management policy;*
>
> *(ii) spent fuel management practices;*
>
> *(iii) radioactive waste management policy;*
>
> *(iv) radioactive waste management practices;*
>
> *(v) criteria used to define and categorize radioactive waste."*
>
> *2. […]*

The national programme for the Management of Spent Fuel and Radioactive Waste (hereafter the "national programme") has been established in accordance with the requirements of the 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. This directive requires Member States to implement a national programme for the management of their spent fuel and radioactive waste, from generation to disposal, to inform the European Commission of this programme for the first time by 23 August 2015 and to notify it of any subsequent significant changes. It was transposed into Belgian law by the Law of 3 June 2014 amending Article 179 of the Law of 8 August 1980 on the budgetary proposals for 1979–1980 for the purposes of transposing 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 into domestic law. The Law of 3 June 2014 was again amended in 2022 to define the financing mechanisms of specific legal tasks of ONDRAF/NIRAS related to the National Policy and effective participation, to the inventory of nuclear sites and materials, and to reporting, self-assessment and peer review obligations from the EC Directive 2011/70/Euratom.

The national programme broadly describes the status of 31 December 2014 in terms of the management of spent fuel and radioactive waste. There has been a revision of the national programme for the sake of the ARTEMIS peer review carried out in 2023. This revision integrates the significant progress made since 2015 without changing the structure or the methodology used. The update was approved by the Committee in the beginning of 2024, taking the advice of the FANC and adopted by the federal government (Council of Ministers of 19 July 2024). It includes policies for:

- the management of very short-lived radioactive waste, namely management by decay and subsequent clearance
- the short-term and medium-term management of radioactive waste which, after treatment and conditioning, becomes category A, B or C waste, namely centralized management at the site of NIRAS – Belgoprocess on the territory of the municipalities of Dessel and Mol.
- the long-term management of category A waste, namely surface disposal on the territory of the municipality of Dessel.
- the management of spent fuel from commercial nuclear power plants, namely the safe storage of spent fuel followed by its reprocessing or disposal. In SYNATOM's last reference

programme, no future reprocessing is foreseen. All spent fuel would be transferred as radioactive waste.

- the management of spent fuel from the BR2 research reactor of the Belgian Nuclear Research Centre (SCK CEN), namely reprocessing.
- the management of spent fuel from SCK CEN's BR3 research reactor, namely the safe storage of spent fuel.
- the management of spent fuel from Ghent University's Thétis research reactor, namely its declaration as radioactive waste to ONDRAF/NIRAS.
- the long-term management of B&C waste (high-level and/or long-lived waste), namely the geological disposal defined as the technical solution by the first part of the national policy, and to be developed through a reversible, transparent, and participative decisional process as part two of the national policy.
- the disposal of radium-bearing radioactive waste *(development of the national policy ongoing, to be submitted to the federal government in 2025, 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. This policy proposal is subjected to a Strategic Environmental Assessment procedure with a national consultation planned by the end of 2024).*

B.2 Waste categorisation and criteria

For the long-term management of radioactive waste, ONDRAF/NIRAS has adopted a classification consisting of three categories[11], in which waste is classified according to its activity and half-life.

- **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 people and the environment for several hundreds of years. It can be considered for surface or near-surface disposal. It corresponds to low-level waste in the IAEA 2009 classification. The radiological and physico-chemical criteria and limits for the category A waste are defined in the safety report and licensing conditions for the surface disposal facility in Dessel.
- **Category B waste** is low-level and intermediate-level conditioned waste contaminated with such quantities of long-lived radionuclides that it poses a risk to people and the environment for several tens to several hundreds of thousands of years in some cases[12]. Its thermal power is potentially significant at the time of its conditioning, but after the storage period, the thermal power is too low to be classified as category C waste. It corresponds to intermediate-level waste in the IAEA 2009 classification.
- **Category C waste** is high-level conditioned waste containing large quantities of long-lived radionuclides and which, like category B waste, poses a risk for several hundreds of thousands of years or even a period of the order of one million years. It emits heat to such an extent that it has to be accounted for in the design of the disposal facility. It corresponds to high-level waste in the IAEA 2009 classification.

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 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.

[11] These categories do not cover the radioactive radium-bearing substances contained in Umicore's licensed storage facilities in Olen.

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

NORM substances and radium-bearing substances containing activity levels below a certain threshold should not be managed as radioactive waste. These thresholds for NORM are defined in the regulatory framework (GRR-2001) and as a result almost all NORM residues that were or are still being produced in Belgium do not have to be managed as radioactive waste.

For the radium-bearing substances present on the Umicore site in Olen and its surroundings, the activity threshold levels above which these substances have to be defined as radioactive waste were defined in the common position document of FANC and ONDRAF/NIRAS. For this radium-bearing radioactive waste a specific national policy proposal for its long-term management is being prepared. When this national policy would be adopted, a specific waste category for radioactive radium-bearing waste will be integrated into the waste classification system.

B.3 Spent fuel management policy

B.3.1 Policy for the management of spent fuel from commercial nuclear power plants

The national policy regarding spent fuel is currently the safe storage followed by reprocessing or direct disposal.

The reference programmes[13] of SYNATOM (the present owner of the commercial spent fuel) for the commercial spent fuel have been evolving through time, taking into account the application of the reprocessing policy up to governmental decision of 1993:

- Reprocessing policy up to governmental decision of 1993 (so that about 10% of the total inventory of the spent fuel has been reprocessed)
- Partial reprocessing (including MOX fuel) up to 2022
- Direct disposal (i.e. no reprocessing) in the latest and current reference programme (2023)

To allow ONDRAF/NIRAS to determine, in due time, the volumes and characteristics of waste intended for deep disposal, the status of the different types of spent fuel must be fixed by Royal Decree in the framework of the development of a complete National Policy (article 4§2 of the national policy B&C waste (Royal Decree of 22 October 2022, see § A.2.1 – Regulatory framework improvement during the period 2020-2024)).

B.3.2 Policies for the management of spent fuel from research reactors

On 31 December 2023, the national policies for the management of the spent fuel from the BR2 and BR3 research reactors of the Belgian Nuclear Research Centre (SCK CEN) and from Ghent University's Thetis decommissioned research reactor are:

- *reprocessing* for the BR2 spent fuel
- *dry storage* for the BR3 spent fuel, pending an operational solution for its long-term management
- *declaration as radioactive waste* to ONDRAF/NIRAS for the Thetis spent fuel.

The initial loading of nuclear fuel is still present in the BR1 reactor, which is still operating. No policy for the management of the spent fuel that will be discharged from this reactor in the future exists yet.

Policies for the management of the nuclear fuel from the research reactor VENUS are not yet defined.

[13] Reference programmes are introduced in the regulatory framework in 2014 which states that each producer shall draw up a reference programme containing the amounts of waste they plan to produce or that are present in its facilities and/or that it plans to deliver to ONDRAF/NIRAS as well as the corresponding schedules.

B.4 Spent fuel management practices

The situation reflected here is that on 31 December 2023[14].

Until ONDRAF/NIRAS takes charge[15] of spent fuel from commercial nuclear power plants and research reactors in the form of reprocessing waste or as radioactive waste, the spent fuel is managed by its owners[16] (figure 4), SYNATOM and SCK CEN respectively. The spent fuel from the NPPs produced after the suspension of the reprocessing contracts (see § B.3.1 – Policy for the management of spent fuel from commercial nuclear power plants) is stored at the NPP sites.

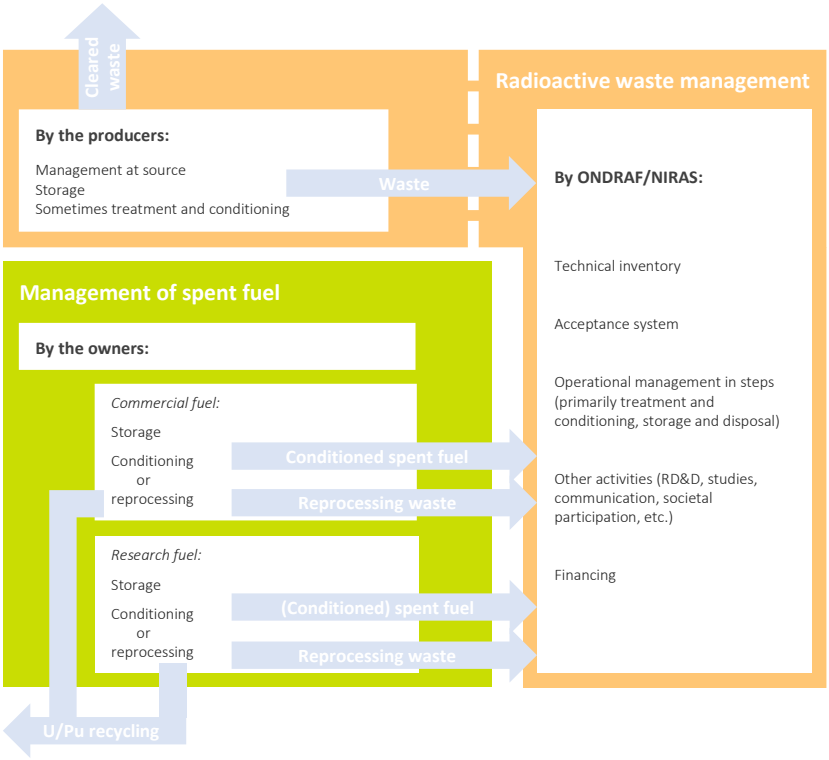


Figure 2 Organisation of the management of spent fuel and radioactive waste in Belgium, as of 31 December 2023.

B.4.1 Legal and regulatory framework

See § E.2 – Article 19 – legislative and regulatory framework, in particular § E.2.3 – Specific decisions for the management of spent fuel.

B.4.2 Management of spent fuel from commercial nuclear power plants

Pursuant to Article 179, § 1, of the Law of 8 August 1980, SYNATOM SA manages the spent fuel from commercial nuclear power plants, before ONDRAF/NIRAS takes charge of it in the form of reprocessing waste or as radioactive waste.

SYNATOM SA, a wholly owned subsidiary of ENGIE Electrabel, owns the nuclear material 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 concerning the security of energy supply 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.

[14] See also footnote 4.

[15] Taking charge: "set of technical and administrative operations necessary for the collection of radioactive waste or excess quantities from producer sites and their transfer to the facilities managed by the Organisation" (Article 1 of the Royal Decree of 30 March 1981).

[16] With the exception of the BR3 spent fuel, which is declared as waste and stored at Belgoprocess since 2002 but still owned by SCK CEN.

B.4.2.a Past reprocessing contracts

In 1976 and 1978, four contracts for the reprocessing of 672 t_{HM} (tons of Heavy Metal) spent fuel from commercial nuclear power plants were concluded by SYNATOM with the French company COGEMA (now ORANO NC). The fuel was reprocessed on the site of la Hague between 1980 and 2001.

B.4.2.b Management objectives

For the management of spent fuel from commercial nuclear power plants, namely the safe storage of spent fuel followed by its reprocessing or disposal, SYNATOM pursues the following objectives:

- to bring past reprocessing contracts to completion (now achieved),
- the safe storage of spent fuel followed by its reprocessing or disposal after conditioning,
- to conduct a safety and feasibility study for the industrial conditioning of spent fuel,
- to finance RD&D in the field of the disposal of spent fuel and reprocessing waste,
- to allocate the costs, investments and charges related to the nuclear fuel cycle fairly among electricity producers.

B.4.2.c Inventory and facilities

On 31 December 2023, 4 904 t_{HM} of spent fuel, including 66 t_{HM} of MOX fuel, have been definitively unloaded from the Doel and Tihange reactors since they started operating:

- 24% of this fuel is stored in the reactor's cooling ponds;
- 62% is stored in the storage facilities built at Doel and Tihange (see § L.2 – APPENDIX 2: Radioactive Waste Management and Spent Fuel Management at Nuclear Power Plants);
- 14% has been reprocessed at la Hague

The recovered uranium has been integrated into the fabrication of fresh fuel assemblies mostly loaded at Doel 1 and 2, but also at Tihange 2 and Doel 4, 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 sold to third parties.

Reprocessing waste, conditioned at la Hague, has been repatriated to Belgium and is stored at Belgoprocess, awaiting an operational solution for its long-term management. The repatriation of this reprocessing waste has been completed in 2018.

SYNATOM gathers and secures the documentation related to the irradiation history and the physico-chemical characteristics of the spent fuel assemblies.

B.4.2.d RD&D

SYNATOM conducted safety studies (workers and population) and feasibility studies for the industrial conditioning of spent fuel. SYNATOM participates in a network of international experts who address various subjects directly related to the evolution of spent fuel, including modelling of heat exchanges in dry storage, the behaviour of the structure materials of fuel assemblies or determining the residual heat of the fuel after its unloading.

SYNATOM has developed a process for encapsulating and drying leaking fuel rods, which has been successfully applied to the leaking fuel rods at Doel 1 and Doel 2. With a view to optimisation, SYNATOM is currently evaluating an alternative drying and encapsulation solution.

Furthermore, SYNATOM keeps abreast of the research and new advances applied in the design of new-generation casks, for example, in terms of materials designed for shielding and maintaining confinement. It also follows the research focused on the evolution of the physical properties of the materials subject to radiation and the assemblies stored in the casks.

B.4.2.e Transparency and participation

SYNATOM sends the inventory of the quantities of spent fuel present in the facilities at the Doel and Tihange sites on 31 December of the previous year to the OECD, the IAEA and Euratom, annually and at their request.

Furthermore, SYNATOM holds regular consultation and information meetings with the FANC during which all the subjects concerning the progress of projects and outstanding issues related to the management of spent fuel are addressed and analysed. SYNATOM also keeps the FANC informed about any problem that may emerge from the management of spent fuel on the power plant sites.

Through its annual report, SYNATOM communicates more broadly about the management of its spent fuel, within the limits of commercial and legal obligations (classification and categorisation of documents).

B.4.3 Management of spent fuel from research reactors

B.4.3.a Management objectives and inventory

The situation on 31 December 2023 is as follows:

- The *BR1 reactor* is still using its first fuel load. There is not yet a policy for its management. The expected inventory of BR1 fuel amounts to 29 t_{HM}.
- The spent fuel from the *BR2 reactor*, for which there were reprocessing solutions, is subject to a reprocessing policy.
    - In 1993, SCK CEN signed a contract with UKAEA Dounreay (which became DSRL) for the reprocessing of 240 spent fuel assemblies from BR2. This fuel was reprocessed, and the contract has ended. The reprocessing waste were repatriated in 2012-2014.
    - In 1998, SCK CEN signed a contract with COGEMA (now ORANO NC) for the reprocessing at la Hague of the spent fuel that will be generated until BR2 stops operating. This was however suspended in 2006 and its continuation required a bilateral agreement between France and Belgium, signed on signed 25 April 2013 and ratified in 2014. It provides, in particular, for the transfer of ownership of the residual quantities of uranium and plutonium to AREVA NC (now ORANO NC) and for the repatriation of reprocessing waste before the end of 2030. Within this framework and its addenda, 1695 fuel elements have transported for reprocessing to date. Also, waste coming from the reprocessing of 1172 fuel elements were repatriated.
- Medium-level and high-level radioactive waste generated so far by the reprocessing of spent fuel from BR2 has been conditioned on the reprocessing facilities, repatriated to Belgium, and taken charge of by ONDRAF/NIRAS. It is stored in building 136 at Belgoprocess.
- The spent fuel from the *BR3 reactor*, is declared as radioactive waste to ONDRAF/NIRAS by SCK CEN. This fuel, which amounts to 2.4 t_{HM}, is stored in 7 dual purpose transport and storage casks (CASTOR) in building 156 at Belgoprocess since 2002. This fuel is still the property of SCK CEN. In accordance with the terms of the agreement between ONDRAF/NIRAS and SCK CEN, ONDRAF/NIRAS provides storage for a maximum duration of 50 years, pending an operational solution for the fuel long-term management.
- The LWR-type fuel used in the *VENUS zero-power reactor* until 2008, when the reactor was transformed into VENUS-F, is stored at SCK CEN.
- The fuel currently used in the *VENUS-F reactor* of the GUINEVERE subcritical reactor project does not belong to SCK CEN. It is supplied by the *Commissariat à l'énergie atomique et aux énergies alternatives* (Alternative Energies and Atomic Energy Commission) (France).
- The spent fuel from the Thetis reactor was declared as radioactive waste to ONDRAF/NIRAS by Ghent University and conditioned by Belgoprocess. It is stored in building 155 at Belgoprocess.

B.5 Radioactive waste management policy

On 31 December 2023, there were national policies for:

- the management of very short-lived radioactive waste, namely management by *decay and subsequent clearance*;
- the short-term and medium-term management of radioactive waste which, after treatment and conditioning, becomes category A, B or C waste, namely *centralised management at the Belgoprocess site in Mol–Dessel*;
- the long-term management of category A waste, namely *surface disposal on the territory of the municipality of Dessel*. Two decisions by the Council of Ministers (in 1998 and 2006)[17] are establishing the national policy in terms of the long-term management of category A waste.
- the long-term management of B&C waste (high-level and/or long-lived waste) according to which the deep disposal is defined as the technical solution to be developed through a reversible, transparent, and participative decisional process. However, only the first part of the national policy is established, and the main challenges are the establishment of the other parts of the national policy on the long-term management of B&C waste and the establishment of the national policy on the long-term management of radium-bearing substances to be managed as radioactive waste (see section K).

  The first part of the national policy on the long-term management of B&C waste, being established with the Royal Decree of 28 October 2022, defines geological disposal on Belgian territory on one or more sites as the long-term management solution, and also states that the national policy is composed of various parts, to be established in steps. Geological disposal designates geological disposal in both galleries and deep boreholes and does not prejudge the host formation(s) nor the site(s).
- The need for a specific 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 to be managed as radioactive waste is very low.

The national policies currently in preparation are:

- The second part of the national policy on the long-term management of B&C waste, which is focusing on the decisional process for the implementation of geological disposal. A societal debate was organized by the King Baudouin Foundation on behalf of ONDRAF/NIRAS in the period Spring 2023 – Spring 2024, to obtain the input for a proposal of decisional process by ONDRAF/NIRAS to the Federal Government. On the basis of the outcomes of the Societal Debate ONDRAF/NIRAS will prepare a proposal for the second part of the national policy to the Federal Government.
- A specific national policy proposal for the long-term management of radium-bearing radioactive waste. Currently a shallow-depth disposal is being envisaged and investigated.

B.6 Radioactive waste management practices

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. ONDRAF/NIRAS is supervised by the ministers responsible for Energy and the Economy. It presents an annual activity report to the Parliament.

[17] The history of these decisions is detailed in the 7th national report of Belgium for the Joint Convention.

B.6.1 Legal and regulatory framework

See § E.2.2 – Applicable national requirements for the safe management of radioactive waste and spent fuel.

B.6.2 Management of radioactive waste by producers

Radioactive waste producers manage their radioactive waste under their responsibility. They 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 qualified by ONDRAF/NIRAS. But disposal of radioactive waste can only be realised by ONDRAF/NIRAS. Producers who wish to have their waste treated and conditioned abroad must take the necessary steps to ensure that the waste that returns to Belgium will comply with ONDRAF/NIRAS' acceptance criteria. Producers finance the management of their waste (see also § F.2 – Article 22 – Human and financial resources).

The management of very short-lived waste and the management by Umicore of its radium-bearing substances in licensed storage facilities are two special cases of radioactive waste management by waste producers.

B.6.2.a Management of radioactive waste by producers in general

Radioactive waste producers endeavour to limit their radioactive waste generation at the source. Their efforts rely on optimising industrial practices and limiting volumes of materials that meet the definition of radioactive waste, for example by improving decontamination techniques, optimising dismantling techniques for nuclear equipment and facilities that have been put out of service, or by considering reuse, recycling, and clearance options, in accordance with the applicable regulations.

This is a general practice for all decommissioning programmes. As an example, for the remediation of the SCK CEN site, and in particular for the decommissioning of the BR3 reactor, SCK CEN has invested in metal decontamination techniques. In particular, these techniques made it possible to entirely clear or recycle by melting the primary circuit. As for radioactive waste from buildings, this is minimised through SCK CEN's use of advanced decontamination and characterisation techniques for concrete with a view to its clearance after treatment.

Radioactive waste producers are required to sort their waste according to its physical, chemical, and radiological characteristics and each batch of waste that they are asking ONDRAF/NIRAS to take charge of, must be accompanied by a detailed approval and characterisation file demonstrating that the waste complies with the ONDRAF/NIRAS acceptance criteria that are applicable to it.

Producers generally store their radioactive waste in non-conditioned form on their sites until ONDRAF/NIRAS takes charge of it, at the producers' request. Some producers (mainly ENGIE Electrabel, which operates the commercial nuclear reactors) do however carry out their own treatment and conditioning of some of their radioactive waste, which they then store until transfer to ONDRAF/NIRAS. The treatment, conditioning, and storage of radioactive waste by producers are subject to the provisions of the nuclear licences issued by the safety authority and of the qualification issued by ONDRAF/NIRAS, with a view to ensuring that the generated waste will comply with the acceptance criteria for its future management. Finally, some producers subcontract treatment operations abroad, with a view to the partial recycling of metals in foundries, and then recover the corresponding radioactive waste.

Radioactive waste producers are required to avoid any excessive accumulation of radioactive waste on their sites. Inspections carried out jointly or independently by FANC, in its capacity as control authority, and by ONDRAF/NIRAS help to identify potential accumulations. ONDRAF/NIRAS has the right to access producer facilities and sites under its mission designed to prevent the creation of new nuclear liabilities and the power to inspect under its competences regarding the approval of equipment. ONDRAF/NIRAS informs FANC of situations where it finds an excessive accumulation of radioactive waste. The law of 15 April 1994 also enables FANC to order, at the cost of the entity responsible, the removal of radioactive substances that pose a problem for the safety of workers and

the public, and their subsequent management as radioactive waste by ONDRAF/NIRAS. The GRR-2001 also enables FANC to order the removal of substances that had no usage in the previous five years and for which no usage is foreseen by the producer.

B.6.2.b Management of very short-lived radioactive waste

Almost all very short-lived radioactive waste comes from hospitals and medical research laboratories that use radioactive substances for therapeutic or diagnosis purposes. Given that the general regulations for radiation protection allow the clearance of waste when its activity level is sufficiently low, management by decay and subsequent clearance is a management policy for the potentially concerned waste.

Through the appropriate FANC licences, hospitals and medical research laboratories manage their own very short-lived radioactive waste and store it in dedicated premises where it remains from a few weeks to several years, until its activity has decreased enough to be cleared into the conventional, non-radioactive waste management system, in accordance with the approved procedures and the requirements of the GRR-2001. The cleared waste does therefore not end up in ONDRAF/NIRAS' management system: it is then managed as conventional medical waste.

B.6.2.c Umicore's management of its radioactive radium-bearing substances in licensed storage facilities

The activities of the radium and uranium extraction plant, operated by the former Union Minière (which became Umicore in 2001) between 1922 and 1977, and then dismantled, have led to highly heterogeneous radiological contaminations in the municipality of Olen: radium-bearing substances from dismantling and remediation operations in licensed interim storage facilities and also radium contaminations concentrated in landfill sites and diffuse radium contamination.

Umicore manages, under its responsibility, at its Olen site, three licensed storage facilities that contain radioactive radium-bearing substances.

- **The UMTRAP storage facility**, built in the 1980s by Union Minière, which was licensed for an indefinite period in 1991 by the safety authority at the time (Minister of Health), contains approximately 55 000 m^3 of low-level and intermediate-level, long-lived non-conditioned radioactive substances, including Ra-sources.
- **The Bankloop storage facility**, first licensed by FANC in 2006, contains approximately 30 000 m^3 very low-level and low-level, long-lived non-conditioned radioactive substances.
- **The storage facility "LRA",** first licensed by FANC in 2016, has a capacity of 11 000 m^3. An extension for an additional capacity of 6 200 m^3 has been licensed by FANC on 20 March 2019. It is intended for long-lived, very low-level, and low-level non-conditioned radioactively contaminated soils and substances from remediation works on the Umicore site. It already contains more than 9 000 m^3 of these soils and substances.

On 7 March 2024, in view of administrative simplification, FANC issued a single licence for the Bankloop and the LRA storage facilities. It replaces previous licenses and is valid until 15/03/2039.

These storage facilities are subject of the road map agreed by FANC and ONDRAF/NIRAS with OVAM and Umicore for the remediation of all radium-bearing contaminations at the Umicore Olen site and for the disposal of all radium-bearing wastes (see § K.3.1.e – Long-term management of radioactive radium-bearing waste, for details).

The long-term management by disposal of the radium-bearing radioactive waste stored in Umicore's licensed storage facilities will be the subject of a specific national policy.

B.6.3 Management of radioactive waste by ONDRAF/NIRAS

Since the early 1980s, ONDRAF/NIRAS has gradually developed and implemented a consistent management system aimed at protecting people and the environment from the risks presented by the radioactive waste that it takes charge of. This system is comprised of a sequence of technical

steps and these steps are connected together through an acceptance system for the waste and connected through an integral management system. The entire system relies on a good knowledge of the technical inventory of radioactive waste to be managed. Other activities, that cut across the entire management system or that are specific to a given step, complete the system, whose costs are covered by various mechanisms.

ONDRAF/NIRAS may conduct its radioactive waste management mission and its other missions using its own resources or allow them to be carried out by third parties under its responsibility. In practice,

- it entrusts the transport of radioactive waste outside the sites of the waste producers to specialized transport companies;
- it entrusts industrial activities to third parties, in particular to Belgoprocess, its industrial subsidiary based in Dessel: Belgoprocess conducts treatment and conditioning activities for non-conditioned radioactive waste taken charge of by ONDRAF/NIRAS, as well as the storage activities and remediation and dismantling activities;
- it entrusts the studies and RD&D activities to third parties; in particular, it entrusts many RD&D activities to SCK CEN and EURIDICE (Economic Interest grouping of SCK CEN and ONDRAF/NIRAS) in Mol.

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

Long-term management, for which ONDRAF/NIRAS is solely responsible, guides all the previous steps in the management system.

B.6.3.a Technical inventory

In accordance with its missions, ONDRAF/NIRAS draws up an inventory of all the existing and future radioactive waste that it has to manage and keeps this updated. This deals with the waste quantities, their radiological characteristics, as well as their physico-chemical properties. It is based on the knowledge of waste stored in buildings at Belgoprocess and declarations from producers regarding their total future generation of spent fuel that will be declared as waste and radioactive waste from operating, dismantling and reprocessing operations.

B.6.3.b Operational management in steps

- **Short-term management**

The short-term management of non-conditioned radioactive waste includes its collection, treatment, and conditioning. Treatment and conditioning are a series of mechanical, chemical, and physical operations designed to convert non-conditioned radioactive waste into packages that satisfy the operational requirements for handling, transport, storage, and disposal.

Waste treatment aims to concentrate the radioactivity as much as possible in order to reduce the volumes of materials to be considered as radioactive waste and to bring these materials in a suitable physical and chemical state for conditioning. Treatment is generally performed by incineration, super-compaction or cutting for solid waste and by flocculation or evaporation for liquid waste.

The conditioning of treated waste is generally performed by immobilising the waste in a matrix of glass, concrete, or bitumen, usually in cylindrical metal packaging. Vitrification and bituminization were applied in Belgium until 1991 and 2004 respectively.

ONDRAF/NIRAS subcontracts the treatment and conditioning activities for the radioactive waste of which it has taken charge, to Belgoprocess, but retains responsibility for these activities.

❖ Medium-term management

Medium-term management includes the storage of conditioned waste packages, pending a safe solution for their long-term management, and monitoring over time. This monitoring aims to control whether the conditioned waste packages remain compliant with the acceptance criteria that were applicable when they were accepted and remain compatible with their reference final destination (disposal). The first monitoring control of selected accepted packages must take place three years after their acceptance and subsequent controls at least every ten years during the storage period.

The storage buildings are located on Belgoprocess' site 1 and operated by Belgoprocess on behalf of ONDRAF/NIRAS.

❖ Long-term management

The Belgian legal and regulatory framework defines the national responsibility to manage its own radioactive waste and stipulates that long-term management solutions must be such that they offer a final destination for waste, in line with the International and European stipulations. In other words, and as stated by Directive 2011/70/Euratom and the Law of 3 June 2014 that transposes this Directive in Belgian law and modifies the ONDRAF/NIRAS Law, waste must, eventually, be placed in a disposal facility, i.e. without the intention to retrieve it. The Law of 3 June 2014 stipulates however that national policies in terms of radioactive waste management must contain the methods for reversibility and retrievability during a period to be defined, taking account of the need to ensure the safety of the disposal facility by passive means.

The design and development of repositories are based on a systemic approach: these facilities, and their engineered barriers in particular, are designed according to the characteristics of the site and the waste to be isolated and confined so that the combination "site + engineered barriers + waste" as a whole can passively protect people and the environment, i.e. in such a way that the long-term safety after complete closure of the facility is assured without requiring human intervention.

❖ Disposal of category A waste

The national policy in terms of the long-term management of category A waste is surface disposal on the territory of the municipality of Dessel. This solution is designed to ensure long-term passive safety. In other words, once the repository is completely closed and after release from regulatory control, the system created by the facility on its site will be able to ensure protection of people and the environment without requiring human intervention. Post-closure surveillance and monitoring of the facility for a period commensurate to the radiological source term in the repository is foreseen as part of the strategy for long-term safety.

Figure 3 Projected category A waste disposal facility.

The integrated surface disposal project includes the disposal project itself and five associated components presenting socio-economic benefits for the region.

The disposal project itself comprises mainly:

- the modular repository, composed of adjoining modules in reinforced concrete designed to receive monoliths, in other words concrete caissons in which waste packages or bulk waste have been immobilised in mortar.
    - The modules are connected with a central inspection gallery and there is an inspection room and a drainage system beneath each one for the timely detection of any fissures or water infiltration. The modules are constructed on a multi-layer embankment almost three metres thick to ensure that they are always above the water level, even in the case of very heavy rain or flooding.
    - Once a module is filled with monoliths, the gaps remaining between monoliths are filled with fine gravel, so that the retrieval of the monoliths remains possible if necessary, and the module is then closed with a concrete slab.
    - Each module is covered by a temporary steel roof during the actual disposal operations. This roof is designed to be replaced, when all modules have been filled, by a permanent multi-layer cover comprised of various natural and artificial layers aimed at protecting the underlying cementitious structures and reducing the potential for water infiltration, thus forming a tumulus.
    - Following several decades of monitoring and surveillance inside the facility (by means of the drainage system and inspection rooms), the repository is fully closed by backfilling the inspection rooms and the inspection gallery. The facility is then brought into its final configuration.
- an access road and a transfer dock along the Bocholt-Herentals canal in order to limit local road traffic due to the construction and the operation of the repository as far as possible; this infrastructure should also benefit companies on the neighbouring industrial estate;
- a caisson plant, i.e. a non-nuclear facility for the fabrication of the concrete caissons for waste disposal;
- a monolith production facility, i.e. a nuclear facility for the emplacement of waste packages (typically standard 400 ℓ drums) in concrete caissons and filling them with mortar to form a monolith;
- a DT/NDT (destructive test / non-destructive test) facility to demonstrate compliance of the waste with the conformity criteria.

The associated components presenting socio-economic benefits for the region are as follows:

- Tabloo, a visitor and meeting centre close to the disposal site which, specifically, constitutes a hub for information about radioactive waste management and features multi-purpose premises available to the local communities.
- a so-called “local” fund to support or finance projects and activities with an added value for the local population over the short, medium, and long terms;
- continued consultation and participation of the public throughout the entire life of the project;
- the development of employment and maintenance of nuclear knowledge in the region;
- a project to monitor the health of the region’s inhabitants.

ONDRAF/NIRAS thus conducted the detailed studies for the integrated surface disposal project in Dessel in close consultation with the local populations concerned through the STORA (formerly STOLA-Dessel) partnership in Dessel and the MONA partnership in Mol.

In April 2023, the nuclear construction and operating licence was granted by Royal Decree (see also § A.2.3 – Other Developments).

The ongoing and future RD&D and studies are structured around the following themes in particular:

- long-term safety;
- the long-term behaviour of concrete (disposal monoliths and modules);
- a programme on disposability of waste to provide solutions for specific waste streams with issues on (chemical) waste conformity criteria. The programme includes the development of the associated requests of modification of the safety report. It also comprises a project on further developing specific DT/NDT techniques for controlling the wastes before their disposal;
- the monitoring and study over several decades of the behaviour of a test cover representative of the planned multi-layer cover;
- long-term knowledge management;
- the methods for continued societal participation.

Maintaining transparency and participation is an integral part of the integrated disposal project.

Participation is ensured through the partnership's methodology, underway since 1998:

- co-development of (preliminary) integrated disposal projects with ONDRAF/NIRAS;
- close consultation with ONDRAF/NIRAS for the implementation of the integrated project.

Transparency is ensured through:

- ONDRAF/NIRAS' dedicated website, ONDRAF/NIRAS' electronic newsletter, visits, and public information events at the communication centre Tabloo, websites of the STORA and MONA partnerships and Belgoprocess and Euridice, surface disposal project (cAt) leaflets, open days, etc.;
- the FANC website.

❖ Disposal of category B&C waste

For over 40 years, SCK-CEN and ONDRAF/NIRAS have been studying geological disposal in poorly indurated clay as a solution for the long-term management of high-level waste and low- and intermediate-level waste, long-lived (HLW/LILW-LL or category B&C waste or B&C waste). In line with international practice, ONDRAF/NIRAS plans its geological disposal facility – or repository – for category B&C waste and its implementation in a cautious, stepwise process, punctuated by the submission of key documents to the government and/or authorities such as the SAFIR2 documents submitted in 2001 and the Waste Plan submitted in 2011. In 2013, ONDRAF/NIRAS drafted a state-of-the-art report called the "RD&D Plan" in order to compile in a concise way the most recent outcomes and achievements, as well as future RD&D priorities. The RD&D programme on geological disposal of B&C waste in poorly indurated clay has been conducted so far with very encouraging outcomes. In 2019-2020, ONDRAF/NIRAS produced a roadmap of the programme for geological disposal of the B&C waste. In line with the reference scenario of obtaining a licence in 2050 it describes the broad lines of actions needed in the time frame 2021-2050. Exact timings will depend on different milestones that typically coincide with decisions that need to be taken by the government.

ONDRAF/NIRAS proposed the basis of a national policy for B&C waste to its supervising authority in May 2015; this proposal was based on the technical solution recommended in the Waste Plan, namely geological disposal in poorly-indurated clay on a single site. In November 2016, ONDRAF/NIRAS was entrusted by its supervising authority to adapt its proposal according to the following principles:

- to be established on the basis of a geological disposal in Belgium, without any precision regarding the host rock type;
- to develop the decisional stepwise process which will lead to the final choice of the disposal site, each stage of such a process being properly documented;
- to frame the development of the geological disposal solution in an integrative manner which means that the engineered barriers, the host rock, and its geological environment contribute together to the overall safety;
- to ensure that the choice of the future site will be based not only on scientific criteria but also on societal and economic aspects.

On this basis, ONDRAF/NIRAS has submitted an adapted policy proposal for geological disposal on the Belgian territory in June 2018, conform the legal procedure for national policy decisions, as defined in the law of 3 June 2014, transposing the EC Directive 2011/70/Euratom. This policy proposal is subject of a strategic environmental assessment procedure (2019 – 2020) with consultation of institutional actors and of the public. The consultation period was from April 2020 till June 2020. Based on the outcomes of this procedure, ONDRAF/NIRAS submitted a revised policy proposal for the development and implementation of deep geological disposal facilities for category B&C waste through a participative and reversible decision-making process. After advice from FANC, this revised proposal was adopted by the Royal Decree of 28 October 2022, thereby establishing the first part of the national policy on the deep geological disposal of category B&C.

SECTION C SCOPE OF APPLICATION

C.1 Article 3 – Scope of Application

ARTICLE 3. SCOPE OF APPLICATION

1. This Convention shall apply to the safety of spent fuel management when the spent fuel results from the operation of civilian nuclear reactors. Spent fuel held at reprocessing facilities as part of a reprocessing activity is not covered in the scope of this Convention unless the Contracting Party declares reprocessing to be part of spent fuel management.

2. This Convention shall also apply to the safety of radioactive waste management when the radioactive waste results from civilian applications. However, this Convention shall not apply to waste that contains only naturally occurring radioactive materials and that does not originate from the nuclear fuel cycle, unless it constitutes a disused sealed source or it is declared as radioactive waste for the purposes of this Convention by the Contracting Party.

3. This Convention shall not apply to the safety of management of spent fuel or radioactive waste within military or defence programmes, unless declared as spent fuel or radioactive waste for the purposes of this Convention by the Contracting Party. However, this Convention shall apply to the safety of management of spent fuel and radioactive waste from military or defence programmes if and when such materials are transferred permanently to and managed within exclusively civilian programmes.

4. This Convention shall also apply to discharges as provided for in Articles 4, 7, 11, 14, 24 and 26.

- All Belgian spent fuel, whether from commercial nuclear power plants or from research reactors, that is or would be present at reprocessing facilities as part of a reprocessing activity is or would be so in execution of a national policy and, as a consequence, falls or would fall within the scope of the convention.
- In practice, ONDRAF/NIRAS has taken and still takes charge of very small quantities of naturally occurring radioactive materials (NORM) that originate from the past and current operation of non-nuclear facilities and have been declared as radioactive waste. In the future, ONDRAF/NIRAS may have to take charge of other NORM declared as radioactive waste: NORM from the dismantling of certain facilities where NORM were involved. This NORM, declared as radioactive waste, falls within the scope of the convention. At present, this represents only a very small fraction of the existing and still to be produced NORM waste in Belgium.
- The only radioactive waste from military origin that falls within the scope of the convention is that declared, in very limited quantities, as radioactive waste to ONDRAF/NIRAS by one military site. This waste is taken charge of by ONDRAF/NIRAS according to its waste acceptance procedure. It becomes category A waste or category B waste after conditioning. The Belgian armed forces have no nuclear fuel, either fresh or spent.

SECTION D INVENTORIES AND LISTS

D.1 Article 32, 2 – Inventories and Lists

ARTICLE 32. REPORTING

1. […]

2. This report shall also include:

(i) a list of the spent fuel management facilities subject to this Convention, their location, main purpose and essential features;

(ii) an inventory of spent fuel that is subject to this Convention and that is being held in storage and of that which has been disposed of. This inventory shall contain a description of the material and, if available, give information on its mass and its total activity;

(iii) a list of the radioactive waste management facilities subject to this Convention, their location, main purpose and essential features;

(iv) an inventory of radioactive waste that is subject to this Convention that:

a) is being held in storage at radioactive waste management and nuclear fuel cycle facilities;

b) has been disposed of; or

c) has resulted from past practices.

This inventory shall contain a description of the material and other appropriate information available, such as volume or mass, activity and specific radionuclides;

(v) a list of nuclear facilities in the process of being decommissioned and the status of decommissioning activities at those facilities.

D.1.1 Spent fuel: management facilities and existing inventory

D.1.1.a Spent fuel from NPP

The spent fuel from the commercial nuclear power plants of Doel and Tihange that was not reprocessed in the frame of the four reprocessing contracts concluded in the period 1976–1978 is currently stored on the plant's sites: in cooling ponds, and in the dedicated centralized storage facility in Doel (two dry storage systems, the second one being in construction) and Tihange (one wet storage system (pool) and one dry storage system that will enter in operation).

The spent fuel inventory from commercial reactors has already been described in § B.4.2.c – Inventory and facilities. The spent fuel storage facilities are also described in more details in § L.2 – APPENDIX 2: Radioactive Waste Management and Spent Fuel Management at Nuclear Power Plants.

D.1.1.b Spent fuel from research reactors

The only non-reprocessed spent fuel from research reactors currently in storage that has not been declared as radioactive waste to ONDRAF/NIRAS is part of SCK CEN's spent fuel:

- the BR2 spent fuel stored in the cooling pond of the BR2 reactor prior to its reprocessing;
- the VENUS spent fuel, that awaits in storage further use.

See also § L.4 – APPENDIX 4 : Description of the installations of SCK CEN : BR2 for more information.

D.1.2 Radioactive waste: management facilities and inventories

The majority of radioactive waste treatment and conditioning facilities and of storage facilities for conditioned waste are concentrated on five sites:

- the Belgoprocess sites 1 and 2, respectively in Dessel and Mol;
- the Doel and Tihange nuclear power plants sites;
- the Umicore site in Olen

In addition,

- the Institute for Radioelements (IRE) provided services for ONDRAF/NIRAS between 1993 and 2017 for the dismantling of radioactive sealed sources and ionization smoke detectors. Since 2018, 20 x 30 ℓ drums containing dismantled ionization smoke detectors and 12 x 30 ℓ drums containing dismantled sources have been transported to Belgoprocess for treatment, conditioning, and storage.
  The following inventory is still present at the IRE site (status December 2023), transfer to Belgoprocess is ongoing:
  - 9x 30 ℓ drums containing dismantled Am-241 smoke detectors
  - 3x 220 ℓ drums containing dismantled Am-241 smoke detectors
  - 30x 30 ℓ drums containing non-dismantled Ra-226 smoke detectors
  - 4x 220 ℓ drums containing dismantled sealed sources
  - 1x 9TBq Cs-137 source
  - 13x 30 ℓ drums with various sources still to be sorted.
- some universities, hospitals and large companies store their own very short-lived radioactive waste in dedicated buildings until its activity has decreased enough for it to be cleared and released as conventional waste. The inventory of this radioactive waste is therefore not provided.

There are no operating disposal facilities for radioactive waste on Belgian territory yet. A construction and operation licence has, however, been issued for a surface disposal facility of the waste of category A, whose construction is planned to begin in 2025.

D.1.2.a The Belgoprocess sites 1 and 2: current situation

ONDRAF/NIRAS has subcontracted the industrial aspects of radioactive waste management to its 100% subsidiary company, Belgoprocess. Belgoprocess operates in Mol (site 2) and Dessel (site 1) radioactive waste treatment and conditioning facilities (see Table 4) and dedicated storage buildings (see Table 5 ; a more detailed description is also provided in § L.3 – APPENDIX 3: Description of the main waste management facilities at the ONDRAF/NIRAS and Belgoprocess site). The processing facilities make it possible to process most of the radioactive waste produced and to be produced in Belgium (solid or liquid, low, intermediate, or high-level waste).

Table 4 Treatment and conditioning facilities at Belgoprocess

Name	Site	Commissioned	Incoming waste	Type of T&C	Comments
MUMMIE	2	late 60's	low-level sludges	bituminization	Preparation of decommissioning started
EUROBITUM	1	1978	low- and intermediate-level sludge and evaporator concentrates	bituminization	No further bituminization foreseen in the facility
BRE	2	1980	low-level liquid waste	flocculation	Preparation of decommissioning to start in 2023
HRA-Solarium	2		intermediate-level solid and liquid waste and radium-bearing waste	compaction followed by cementation	
PAMELA	1	1985	until 1991: liquid high-level waste after 1991: solid intermediate and high-level waste 2007: alpha-contaminated solid waste and intermediate and high-level solid waste	until 1991: vitrification after 1991: cementation 2007: cutting or super-compaction followed by cementation	Vitrification installation was decommissioned
CILVA	1	1994	solid low-level waste (unconditioned waste in carbon steel drums) and liquid low-level waste	cutting, pre-compaction and super-compaction of solid waste; incineration of solid and liquid waste; cementation	
Pyrolysis installation	2	1999	alpha-contaminated organic effluents	thermal decomposition followed by cementation of the remaining solid waste	Partially decommissioned
Building 110X	1	2005	alpha-contaminated solid low-level waste	sorting and separation of the waste with a view to its conditioning in the PAMELA facility from 2006 on	put out of operation in 2008 after having dealt with the foreseen sorting operations
ALPHA-ROOM	2	2013	low-level radium-bearing waste	sorting and compaction welding of drums	Operations ended in 2018. Decommissioning in preparation since 2019

Table 5 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 as of 31 December 2023.

Buildings	Commis-sioned	Type of conditioned waste	Waste categories	Capacity (m^3)	Filling rate (%)	Volume (m^3)	Activity (Bq) α	Activity (Bq) B, γ
127	1976	Bituminised and cemented intermediate-level waste (mainly category B waste, 220 ℓ and 400 ℓ packages) mostly (76%) from the Eurochemic reprocessing plant	A + mainly B	4 700	84	3 913	$3.4\ 10^{14}$	$4.6\ 10^{16}$
129	1985	Conditioned high-level waste (60 and 150 litre packages) from the vitrification, in PAMELA, of the 860 m^3 Eurochemic liquid waste and cemented high and intermediate-level waste 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	High-level waste from the reprocessing of commercial spent fuel by COGEMA/AREVA	C	106 (590 canisters)	66	70 (vitrified)	$8.1\ 10^{16}$	$5.9\ 10^{18}$
136-Zone D	2009	Intermediate-level waste from the reprocessing of spent fuel, high level sources	B	478	32	154	$2.1\ 10^{14}$	$4.6\ 10^{16}$
150	1986	Low-level waste (400, 500, 1000, 1200, 1500, 1600, and 2200 ℓ packages) (mainly category A) from the Doel and Tihange nuclear power plants (filters, concentrates, resins …) and the former SCK CEN Waste department	A + B	1 922	98	1 880	$1.9\ 10^{12}$	$1.3\ 10^{15}$
151	1988	Same types of waste and origins as in building 150	A + B	15 117	99	15 013	$2.2\ 10^{13}$	$1.3\ 10^{15}$
151E	2020	Category A-waste	A	2 080	40	832	$1.6\ 10^{11}$	$8.7\ 10^{11}$
155	2006	Alpha- and radium-contaminated waste and conditioned Thétis spent fuel	B (+ Ra, A)	4 531	92.5	4 189	$2.0\ 10^{15}$	$1.8\ 10^{16}$
156	2002	Spent fuel from the BR3 reactor	C	8 castors	88	7 castors	$2.0\ 10^{15}$	$1.0\ 10^{17}$
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.	35	$7.8\ 10^{11}$	$5.0\ 10^{11}$

D.1.2.b The sites of the Doel and Tihange nuclear power plants: current situation

Since 2000, the production of conditioned waste at NPPs remained in the range of 4 to 6 m^3/TWh. The waste conditioned by ENGIE Electrabel is stored in dedicated buildings on the plant's sites until ONDRAF/NIRAS takes charge of it on request of ENGIE Electrabel, and transfers the waste to dedicated buildings (151 or 127) operated by Belgoprocess[18].

On 31 December 2023, the conditioned waste inventory on the Doel site totalled 274 m^3 and on the Tihange site 190 m^3.

The Tihange and Doel nuclear power plants have their own processing installations and conditioning processes which require qualification by ONDRAF/NIRAS. The types of waste conditioned on site are waste such as filters from the primary circuit and diverse waste with a dose rate on contact higher than 2 mSv/h. At Doel, the ONDRAF/NIRAS qualification for the processing and conditioning for ion exchange resins and evaporator concentrate wastes was withdrawn in 2015 following the detection of alkali-silica reactions in a number of waste packages. The qualification was withdrawn at Tihange in 2020 also following the discovery of fractures in the cemented matrix. Consequently, unconditioned waste concentrates and resins are currently stored at the NPP sites. Alternative conditioning methods are currently under investigation (see § K.1.1.h – Programme for long-term management of non-conform waste).

D.1.2.c The Umicore site in Olen: current situation

According to the inventory of the main contaminated sites that could require radiological remediation and of Umicore's licensed storage facilities, the total volume of radioactively contaminated substances on the Umicore site in Olen and in its vicinity amounts to approximatively 1 500 000 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, and LRA facilities).
    - The *UMTRAP* storage facility, built in the 1980's by Union Minière and contains approximately 55 000 m^3 of low-level or intermediate-level, long-lived non-conditioned radioactive substances, with a specific radium-226 activity ranging from 20 Bq/g to 30 000 Bq/g. Total activity is estimated at 38 000 GBq (see Table 6). UMTRAP is composed of concrete bunkers, covered by a copper confinement, for storage of the radium sources, tailings, and radium-rich substances, and of silos between the bunkers for the lower-activity radium-contaminated substances. Various residues and contaminated soils occupy the spaces between the silos and the bunkers. All this is covered by a multilayer consisting of clay, sand, and gravel.

Table 6 Inventory of the radioactive radium-bearing substances in the UMTRAP facility

Description	Mass [tonnes]	Radium-226 activity [Bq]	Radium 226 [g]
Radium sources	n.a.	$7.26\ 10^{12}$	195.4
Tailings	2 012	$2.56\ 10^{13}$	691.8
Radium-rich substances	529	$2.17\ 10^{12}$	58.7
Radium-poor substances	7 739	$1.16\ 10^{12}$	31.4
Various residues	5 656	$8.07\ 10^{11}$	21.8
Contaminated soils	58 500	$8.88\ 10^{11}$	24.0
Total	**74 436**	**$3.79\ 10^{13}$**	**1 023.1**

[18] see also § L.3 – APPENDIX 3: Description of the main waste management facilities at the ONDRAF/NIRAS and Belgoprocess site

    - The *Bankloop* storage facility contains approximately 30 000 m³ very low-level and low-level, long-lived non-conditioned substances from the remediation in 2007–2008 of a small brook, the Bankloop, and a band of contaminated land along both sides of it. This waste has a specific (homogeneous) radium-226 activity of 3.2 Bq/g and represents a total activity of 140 GBq.
    - The *LRA storage facility*, licensed in 2016, is intended for long-lived, very low-level, and low-level non-conditioned radioactively contaminated soils and substances from works, in particular infrastructure works, on the Umicore site. At present, it contains almost 9 000 m³ of such soils and substances.
- about 400 000 m³ of radium-bearing substances present in landfills;
- about 1 000 000 m³ as diffuse contamination on the Umicore site and in its vicinity.

The volume of substances to be managed as radioactive waste is further separated into two fractions depending on the activity concentration and, consequently, their final disposal destination.

- About 2 000 m³ of radioactive substances stored in UMTRAP are identified as radioactive waste with activity concentration higher than 1 000 Bq/g and shall be therefore considered as Category B waste and fall into the scope of B&C national policy for geological disposal;
- About 30 000 m³ are identified as radioactive waste with activity concentration between 15 Bq/g and 1 000 Bq/g, originating from various installations including UMTRAP and contaminated sites ; their long-term management is included in the radium-bearing waste national policy in preparation. The proposed solution is a shallow-depth disposal.

The rest of the radioactive substances, which constitutes the larger fraction by far, is not to be managed as radioactive waste but as contaminated residues. They can be disposed of in conventional landfills.

The long-term management of the radioactive materials and radioactive waste in Umicore's licensed storage facilities will be the subject of future policy decisions, as specified in the law of 3 June 2014, transposing the EC Directive 2011/70/Euratom. In preparation of these policy decisions, FANC and ONDRAF/NIRAS have developed an assessment methodology to be applied to all sites with radium contamination from historical activities (Olen) and to NORM.

This methodology is the basis for discussions with UMICORE in view of preparing concrete plans for site remediation projects and for long-term management of the resulting non-radioactive and radioactive waste. This process was accepted by UMICORE and has been presented to the authorities of the Flemish Region for the non-radiological, environmental aspects.

D.1.2.d Total inventory of existing and planned conditioned waste

The technical inventory of radioactive waste, which ONDRAF/NIRAS updates every year, aims primarily at identifying all existing and future conditioned waste (up to a certain time horizon beyond which waste production can be considered to be negligible or inexistent), their quantities, their radiological characteristics, and their physico-chemical composition. Non-conditioned waste is inventoried with a view to its future treatment and conditioning, in order to enable the corresponding future quantities of conditioned waste to be calculated.

The current inventory 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), with the assumption that each of the seven commercial nuclear reactors will be operated according to the Law of 31 January 2003 (as of 31 December 2023), is as follows (volumes of conditioned waste for disposal, not including the disposal container external volume):

- **category A waste**: 30 600 m³ packaged wastes (mostly 400 ℓ drums) and 27000 m³ bulk conditioned waste. The latter is calculated on the basis of the net internal volume of the disposal containers (monoliths);

- **category B waste**: 10 100 m^3 (according to the currently foreseen management of commercial spent fuel), including radioactive radium-bearing waste in storage at Belgoprocess, but excluding radioactive radium-bearing substances in the Umicore licensed storage facilities in Olen;
- **category C waste**: 2800 m^3 (according to the currently foreseen management of commercial spent fuel) of which 70 m^3 is vitrified waste coming from previous reprocessing contracts.
- **Radioactive radium-bearing waste:** currently being estimated at about 30 000 m^3 of non-conditioned waste.

D.1.3 Nuclear facilities being decommissioned

The main facilities that are currently in the process of being decommissioned are:

- Some facilities on the BP1 site and some buildings on the BP2 site;
- SCK CEN's BR3 research reactor and its building;
- The University of Gent (UGent) and the University of Brussels (VUB) accelerators;
- the facilities of the former Best Medical Belgium SA company that were not taken over by NTP Europe when the company went bankrupt, in 2012, and whose remediation, cleaning and decommissioning have been entrusted to ONDRAF/NIRAS (two cyclotrons and many hot cells and laboratories).
- the Tihange 2 and Doel 3 PWR reactors (permanently shut down and in preparation for dismantling)

The current status of these main decommissioning programmes is given in § A.2.3 – Other Developments.

SECTION E LEGISLATIVE AND REGULATORY SYSTEM

E.1 Article 18 – implementing measures

> *ARTICLE 18. IMPLEMENTING MEASURES*
>
> *Each Contracting Party shall take, within the framework of its national law, the legislative, regulatory and administrative measures and other steps necessary for implementing its obligations under this Convention.*

Belgium signed the Joint Convention on 8 December 1997. With the Law of 2 August 2002, the Belgian legislator has expressed its consent with the obligations resulting from this Convention. The ratification process was completed on 5 September 2002 by the deposition of the instrument of ratification to the IAEA. The Convention became effective 90 days later, on 4 December 2002.

Belgium participated in all Review Meetings of the Joint Convention.

E.2 Article 19 – legislative and regulatory framework

> *ARTICLE 19. LEGISLATIVE AND REGULATORY FRAMEWORK*
>
> *1. Each Contracting Party shall establish and maintain a legislative and regulatory framework to govern the safety of spent fuel and radioactive waste management.*
>
> *2. This legislative and regulatory framework shall provide for:*
>
> *(i) the establishment of applicable national safety requirements and regulations for radiation safety;*
>
> *(ii) a system of licensing of spent fuel and radioactive waste management activities;*
>
> *(iii) a system of prohibition of the operation of a spent fuel or radioactive waste management facility without a licence;*
>
> *(iv) a system of appropriate institutional control, regulatory inspection and documentation and reporting;*
>
> *(v) the enforcement of applicable regulations and of the terms of the licences;*
>
> *(vi) a clear allocation of responsibilities of the bodies involved in the different steps of spent fuel and of radioactive waste management.*
>
> *3. When considering whether to regulate radioactive materials as radioactive waste, Contracting Parties shall take due account of the objectives of this Convention.*

The safety of the management of spent fuel and radioactive waste in Belgium complies

- with the requirements of the international and European conventions, treaties and protocols to which Belgium is a signatory and the requirements of European directives, regulations, and decisions;
- with internationally recommended principles and standards.

Belgium is a federal state. Certain competences such as the protection of the population and of the environment against the hazards of ionising radiation are exercised exclusively at the federal (centralized) level, while other (non-nuclear) competences are exercised at a decentralised (regional) policy level, constituted by the Flemish Region, the Walloon Region, and the Brussels-Capital Region. The management of radioactive waste on the Belgian territory is also organised at the federal level.

For the safety of spent fuel and radioactive waste management, the main stakeholders are :

- the owners of the spent fuel
- the radioactive waste owners and generators
- FANC, the safety authority responsible for protecting people and the environment against the risks of ionising radiation, and its subsidiary Bel V
- ONDRAF/NIRAS, the organisation responsible for the safe management of radioactive waste, and its subsidiary Belgoprocess

The description of the following legislative and regulatory elements is to be understood as referring to their consolidated versions – i.e., including their subsequent amendments.

E.2.1 Applicable national requirements for safety and radiation protection

- ***The Law of 15 April 1994**, on the protection of the population and the environment against the dangers arising from ionising radiation and on the Federal Agency for Nuclear Control,*

which, in particular,

- establishes the Federal Agency for Nuclear Control and
- defines its missions, including that of proposing draft Royal Decrees implementing the FANC Law.

- ***The 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),*

which, in particular,

- 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 repositories (Article 6);
- 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 or solid radioactive waste (Article 18);
- describes the concept of "work activity" (i.e. use of Naturally Occurring Radioactive Materials – NORM), lists work activities and requires that these are declared to FANC (NORM issue).

The Royal Decree of 20 July 2001 has been brought in line with the new European radiation protection directive (Basic Safety Standards – Directive 2013/59/Euratom).

- ***The Royal Decree of 24 March 2009**, regulating the import, transit, and export of radioactive substances.*

- ***The Royal Decree of 30 November 2011**, on the safety requirements for nuclear facilities (hereafter referenced as "SRNI-2011").*

This Royal Decree incorporates all the WENRA RHWG (Reactor Harmonization Working Group) reference levels into the Belgian regulations. This Royal Decree has a wider scope than the NPPs, as some generic reference levels are applicable to other nuclear facilities (for example, the obligation to proceed to periodic safety reviews, to maintain a Safety Analysis Report, to have an integrated Management system, …) including waste management and disposal facilities. A section for decommissioning of nuclear installations requirements is included.

A specific chapter, based on the WENRA – WGWD work, on the safety requirements for waste and spent fuel storage facilities has been added on 29 May 2018. Another chapter dealing with the safety requirements for surface disposal facilities was added on 7 May 2024.

- ***The Royal Decree of 1st of March 2018,*** *establishing the nuclear and radiological emergency plan for the Belgian territory*

Emergency preparedness & response is a competence belonging to the Federal Minister of Home Affairs and his administrative services (Federal Public Service Home Affairs - FOD Binnenlandse Zaken, General Directorate Civil Security and National Crisis Centre). For a nuclear or radiological crisis, its organisation and the role of the various intervening instances is prescribed in this Royal Decree – see article 25, section F.5 of this report.

The complete set of Belgian regulations in relation with radiation protection and nuclear safety can be found on http://www.jurion.fanc.fgov.be/. An overview of the structure of the Law of 15 April 1994, the Royal Decree of 20 July 2001 and the Royal Decree of 30 November 2011 is given in § L.1 – APPENDIX 1 : Legal framework for safety and radiation protection.

E.2.2 Applicable national requirements for the safe management of radioactive waste and spent fuel

In addition to the safety regulations mentioned above, the management of radioactive waste and enriched fissile materials is subject to a specific legal framework, specifying the competences and the tasks of the Belgian Agency for Radioactive Waste and Enriched Fissile Materials (ONDRAF/NIRAS).

❖ Creation and missions of ONDRAF/NIRAS

ONDRAF/NIRAS was created by the law of 8 August 1980. The Belgian authorities took the decision to entrust the management of radioactive waste to a single body under public control to ensure that the public interest prevails in all the decisions taken in this field.

- ***The Article 179 of the Law of 8 August 1980,*** *on the budgetary proposals for 1979–1980,*

which, in particular, creates ONDRAF/NIRAS and assigns it various missions (in its § 2), in particular the following ones:

- **in relation to radioactive waste**: the missions include transport outside the facilities, treatment and conditioning for producers who do not have facilities qualified by ONDRAF/NIRAS for this purpose, storage, and disposal, along with the collection and assessment of all the information needed to perform the aforementioned missions. Furthermore, ONDRAF/NIRAS is entitled to take any action or measure intended to create and maintain the necessary societal support to ensure the integration of a radioactive waste repository in a local community.
- **in relation to enriched fissile materials, plutonium-bearing materials and irradiated fuel**: the missions are transport, outside the facilities, of the enriched fissile and plutonium-bearing materials in quantities and enrichment rates exceeding the limits defined by Royal Decree, storage of plutonium-bearing materials that are in excess, storage of irradiated fuel or fresh fuel for which the holder has no planned use, as well as the collection and assessment of all the information needed to perform the aforementioned missions.
- **in relation to decommissioning**: the missions include the collection and assessment of all the information needed to enable ONDRAF/NIRAS to set up the management programmes for the resulting waste, the approval of the decommissioning programme of nuclear facilities and the execution of this programme on the operator's request or in case the operator is defaulting.

Article 179 of the Law of 8 August 1980 also transposes Directive 2011/70/Euratom into Belgian law (§ 2 and § 5 to 11) and, in particular, stipulates that a Royal decree establishes and maintains national policies for the management of radioactive waste and spent fuel by decree debated in the Council of Ministers, on ONDRAF/NIRAS' proposal and after FANC's advice.

- ***The Royal Decree of 30 March 1981,*** *determining the missions and setting out the functioning rules for the public body for the management of radioactive waste and enriched fissile materials (hereafter the "ONDRAF/NIRAS Royal Decree"),*

which implements the ONDRAF/NIRAS Law, specifies in article 2 that ONDRAF/NIRAS must in particular:

- establish and update the inventory of existing radioactive waste and forecasts for waste production;
- establish and update a general long-term management programme for radioactive waste, including a technical and economic description of the actions it envisages for the programme;
- based on the general rules proposed to and approved by the competent authorities, establish acceptance criteria for conditioned and non-conditioned waste that it must take charge of;
- qualify the facilities intended for treatment and conditioning of radioactive waste;
- verify the compliance of the quality of the conditioned or non-conditioned radioactive waste with the acceptance criteria, and ensure final acceptance of the waste.

❖ **Long-term management of Radioactive Waste (also applies to Spent Fuel declared as waste)**

- ***The Law of 20 December 1984,*** *approving the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, the Annexes, Addendum and Appendix, signed in London, Mexico, Moscow, and Washington on 29 December 1972 and amended in London on 12 October 1978, 1st of December 1978 and 1st of December 1980.*

- ***The Decision of the Council of Ministers of 16 January 1998,***

through which, in particular, it

- opts for a solution that is definitive or can become definitive, and one that is progressive, flexible, and reversible, for the management of short-lived, low-level, and intermediate-level waste (category A waste);
- orders ONDRAF/NIRAS' supervisory authority to give ONDRAF/NIRAS the mission to limit itself, in its exploratory activities, to existing nuclear zones and to sites where the local authorities show an interest.

- ***The Cooperation agreement of 17 October 2002,*** *between the Federal State and the Regions relating to the management of cleared waste.*

- ***The Decision of the Council of Ministers of 23 June 2006,***

through which, in particular, it decides 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.

- ***The Law of 10 March 2019*** *giving assent to the Agreement between the Kingdom of Belgium and the Grand Duchy of Luxembourg on the management and final disposal of radioactive waste from the Grand Duchy of Luxembourg on the territory of the Kingdom of Belgium, done at Luxembourg on 4 July 2016*

The law of 10 March 2019 ratifies the agreement from 1994 between the Kingdom of Belgium and the Grand Duchy of Luxembourg whereby Belgium agrees to treat, condition, store and dispose of

Luxembourg's radioactive waste on the territory of the Kingdom of Belgium. It also lays down the technical and financial framework for this agreement.

In 2022, a Royal Decree establishing the first part of the national policy regarding the deep geological disposal of category B&C waste, has been adopted.

- ***The Royal Decree of 28 October 2022**, establishing the first part of the National Policy for the Long-Term Management of High-Level and/or Long-Lived Radioactive Waste and specifying the process for the phased establishment of the other parts of this National Policy.*

Finally, in 2023, a Royal Decree granting the licence to construct and operate the surface disposal facility in Dessel has been adopted:

- ***The Royal Decree of 23 April 2023**, granting authorisation for the creation and operation of a surface repository for low- and intermediate-level short-lived radioactive waste in Dessel, Belgian Official Gazette of 16 May 2023.*

❖ **Storage, treatment, and conditioning of radioactive waste**

- ***The Royal Decree of 18 November 2002**, governing the qualification of facilities for the storage, treatment, and conditioning of radioactive waste,*

where this approval is given by ONDRAF/NIRAS and also concerns the facilities for radiological characterisation of radioactive waste. Modifications of this Royal Decree must still to be issued to complete the legal and regulatory framework for the waste acceptance system.

At the end of 2021, the Article 179 of the Law of 8 August 1980 and the Law of 15 April 1994 were amended to clarify the responsibilities of both agencies with regard to establishing the waste acceptance criteria and to create the legal basis for establishing the general rules by Royal Decree:

- ***The Law of 7 November 2021**, amending article 179 of the Law of 8 August 1980 on budget proposals 1979-1980*
- ***The Law of 2 December 2021**, amending the Law of 15 April 1994 on the protection of the public and the environment against the dangers arising from ionising radiation and on the FANC*

This gives FANC the competences to examine if the waste acceptance criteria proposed by ONDRAF/NIRAS comply with the general rules and with the relevant nuclear licences. This compliance check will lead to an advice of the FANC which is binding for ONDRAF/NIRAS.

In order to strengthen the waste acceptance system, the general rules for establishing waste acceptance criteria will be issued by Royal Decree, on proposal of ONDRAF/NIRAS and taking the advice of FANC. This Royal Decree is in the legal process of approval and publication.

- ***The Royal Decree of 28 February 2022**, on the entry into force of the Act of 2 December 2021 amending the Act of 15 April 1994 on the protection of the public and the environment against the dangers arising from ionizing radiation and on the Federal Agency for Nuclear Control, with regard to the powers of this Agency in respect of the general rules and acceptance criteria referred to in Article 179(2)(4) of the Act of 8 August 1980 on the budget proposals for 1979-1980.*
- ***The Royal Decree of 26 June 2024**, on the implementation of the Law of 20 November 2022 on management of soil contaminated by radioactive substances,*

The purpose of the Royal Decree of 26 June 2024 is to partially implement the law of 20 November 2022 on management of soil contaminated by radioactive substances. It regulates the qualification of soil contamination experts, by determining the criteria and detailing the procedure for approval.

E.2.3 Specific decisions for the management of spent fuel

The management strategy for the spent fuel has been subject to several changes since the construction and start of operation of nuclear reactors in Belgium. The present report focuses on the present situation; historical details on the policy changes in the 1990's can be found in the 7th national report of Belgium for the Joint Convention.

- ***Article 179 of the Law of 8 August 1980,*** *on the budgetary proposals for 1979–1980,*

which, in particular,

- orders SYNATOM to manage activities relating to the nuclear fuel cycle, with the exception of those assigned to ONDRAF/NIRAS (§ 1)
- stipulates that "*The reprocessing of fissile materials in Belgium may not start until after the legislative Chambers have decided on its principle*." (§ 4)

- ***Law of 5 May 2014****, containing assent to the Agreement between the Government of the Kingdom of Belgium and the Government of the French Republic on the treatment of Belgian spent fuel in la Hague, signed in Paris on 25 April 2013,*

which authorises SCK CEN to have the spent fuel from the BR2 research reactor reprocessed by AREVA NC (now ORANO NC) in la Hague and defines the obligations regarding the return of the generated waste. The bilateral agreement between Belgium and France on the reprocessing of spent fuel from BR2 at AREVA NC (now ORANO NC) La Hague was subject to debate in the Belgian Parliament, the report of which is available on the Chamber and Senate websites.

- ***The Law of 3 June 2014****, modifying the Article 179 of the Law of 8 August 1980 in view of the transposition of Directive 2011/70/Euratom of 19 July 2011,*

which, in particular, transposes Directive 2011/70/Euratom into Belgian law (§ 2 and § 5 to 11) and stipulates that national policies for the management of radioactive waste and spent fuel are based on at least six general principles, including the principle according to which the generation of radioactive waste shall be kept to the minimum which is reasonably practicable by means of various measures, including reprocessing, it also stipulates that any future use of spent fuel will have to be defined in national policies, in conformity with the legal procedure for the establishment of national policies as defined in the law of 3 June 2014.

E.2.4 System of licensing of spent fuel and radioactive waste management activities

Figure *4* below shows the licensing process for the nuclear installations, categorised as "Class I" in Belgium, as defined in article 6 of GRR-2001. This licensing process has been updated for the last time on 29 May 2020 to complete the transposition of the European Directive 2014/52/EU amending Directive 2011/92/EU *on the assessment of the effects of certain public and private projects on the environment*. Nuclear facilities are licensed according to article 6 of GRR-2001. The licence application contains several parts:

- The first part consists mainly of administrative information, defining, among others, responsibilities, names, and legal status of the applicant …
- The second part of the application consists of an environmental impact assessment report, in accordance with the European directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment (as amended by European directive 2014/52/EU).
- The third part is the "waste and decommissioning files" giving the expected quantities of waste and their foreseen management, including those related to the dismantling, and preliminary plans for the future decommissioning.
- The last part consists of a preliminary safety analysis report containing preliminary data in accordance with the SRNI-2011 and GRR-2001 requirements;

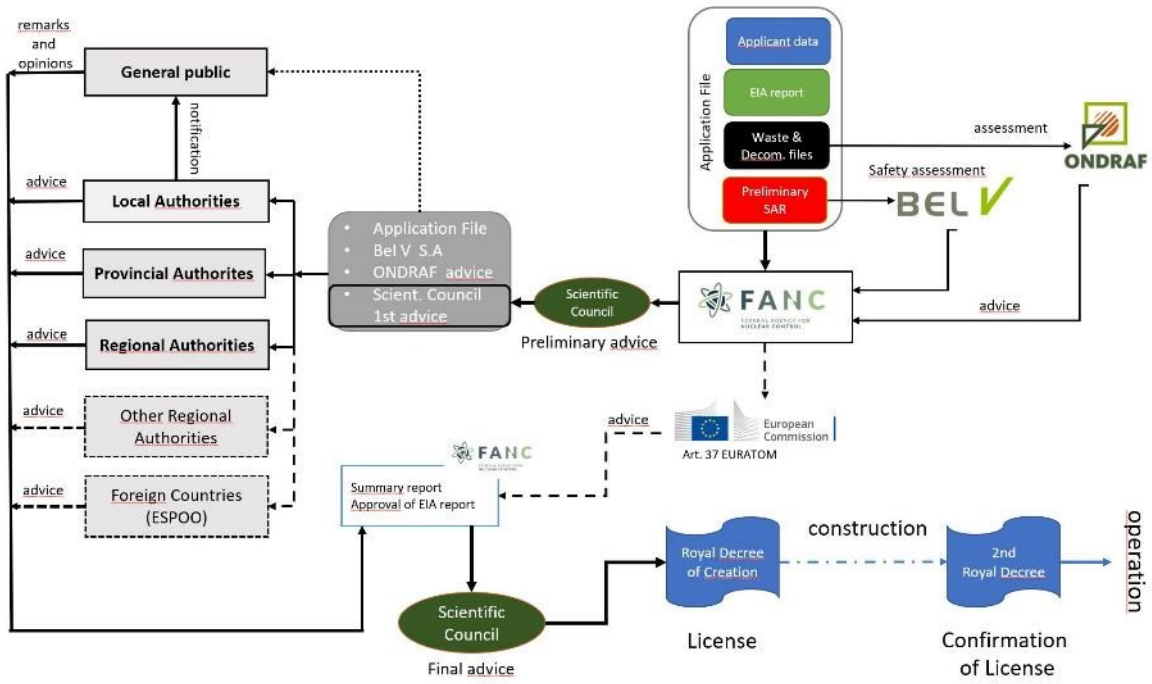


Figure 4 Licensing system for Class I facilities (2020).

Belgium is a federal state composed of three Regions being legally competent for environmental protection on their territory (radiological aspects excluded) and thus also for the granting of related environmental licences. To coordinate the process and ensure the coherency of the application files, cooperation exists between the FANC and the competent regional authorities.

The licence application is examined by the FANC. Bel V is in charge of performing the safety assessment of the (preliminary) safety analysis report. The advice of ONDRAF/NIRAS is requested on the waste and future dismantling of the facility aspects (waste and decommissioning files). The application file is then presented for advice to the Scientific Council for Ionizing Radiation. A mandatory consultation (application of Article 37 of the Euratom Treaty on the transboundary impact) or a voluntary consultation of the European Commission may take place. Following the advice of the Scientific Council, the application file is submitted to a public enquiry. Municipalities within a radius of 5km of the projected facility issue a notice of public enquiry. The application file is available in the offices of the municipality where the project is located and in the FANC's offices and on the FANC's web site. In parallel, other authorities are requested to give their advice:

- Municipal authorities (municipalities within a radius of 5 km of the projected facility)
- Provincial authorities (province(s) within a radius of 5 km of the projected facility)
- Regional authorities (of the region(s) within a radius of 5 km of the projected facility)

The FANC collects the advice, remarks and opinions of the public and the advice from the consulted authorities. The FANC then also approves the EIA report. The completed file is sent back to the Scientific Council for final advice. The Scientific Council can propose particular conditions to be attached to the licence, also related to the commissioning of the installations or in view of ensuring the safety and the wholesomeness of the future installation. The construction and operation licence allow the applicant to build the installations in conformity with the licence.

The second phase addresses the confirmation of the construction and operation licence. The licensee's Health Physics Department is primarily in charge of the acceptance of the new installations. This acceptance has to verify that the constructed facility is fully compliant with:

- the regulations (GRR-2001 and SRNI-2011),

- the licence and the conditions attached to,
- the Safety Analysis Report

Bel V acting on behalf of the FANC verifies the acceptance of the installations before operation. A similar confirmation process exists for higher risk Class II facilities (so called "Class IIA").

From the point of view of radioactive waste management, a distinction can be made between different types of facilities:

❖ Facilities for processing or storage of radioactive waste

Facilities for radioactive waste processing or storage, provided these activities are the main activities of the company, are categorized as Class I facilities. In case the waste processing or storage installation is part of a nuclear facility, it is subject to the licensing procedure for this type of facility.

The most important waste processing and storage facilities are located at the Belgoprocess sites and comprise the sites BP1 and BP2, respectively in Dessel and Mol.

❖ Facilities for disposal of radioactive waste

Facilities for radioactive waste disposal are also categorized as Class I facilities.

A specific licensing procedure for disposal facilities has been developed by the FANC (see also § A.2.1 – Regulatory framework improvement during the period 2020-2024, under "*The Royal Decree of 22 April 2024 on the licensing system for disposal facilities*"). This licensing procedure takes over the general modalities of other Class I facilities, while taking into account the specificities of disposal facilities: modular "construction", phased approach, closure, long term regulatory surveillance and monitoring, no dismantling.

❖ Facilities where irradiated fissile materials are generated and facilities for storage and treatment of irradiated fissile material or for the conditioning or disposal of enriched fissile material

All facilities generating, processing, or storing irradiated fissile material are also classified into the highest risk category (Class I); these are: nuclear reactors, facilities where the amount of fissile material used or stored is higher than half of the minimal critical mass, facilities for reprocessing of enriched or non-enriched irradiated fissile material.

The most important operational facilities of this type are:

- The power reactors of ENGIE Electrabel and their deactivation pools for spent fuel;
- The research reactors of SCK CEN;
- The facilities for interim storage of spent fuel on the sites of nuclear power plants (wet and dry storage);
- The facilities for the processing of irradiated fissile materials (hot cells of SCK CEN, IRE).

❖ Facilities generating radioactive waste

With the exception of facilities using exclusively X-ray devices, all facilities (categorized into Class I, II or III according to the GRR-2001) and NORM activities that are subject to a licence, are considered as potential producers of radioactive waste.

The licence application has to include information on the treatment techniques applied to the waste and the temporary storage before discharge, clearance, or transfer to ONDRAF/NIRAS.

ONDRAF/NIRAS receives systematically a notification of every issued licence. By this way, ONDRAF/NIRAS is informed of the identity of the potential waste producers.

If the FANC approves the use of devices containing small quantities of radioactive material but exceeding the exemption levels determined, it will determine the conditions for the removal of these devices.

E.2.5 Qualification of installations for storage, processing, and conditioning of radioactive waste

The **qualification of the installations for storage, processing and conditioning of radioactive waste** as laid down by the Royal Decree of 18 November 2002, guarantee the conformity of the radioactive waste with the Waste Acceptance Criteria issued by ONDRAF/NIRAS. This qualification is one of the conditions for acceptance by ONDRAF/NIRAS of radioactive waste produced by an Operator. It is schematically illustrated in Figure 5.

Each Belgian facility in which radioactive waste of Belgian origin is processed, conditioned, or stored, falls within the scope of this Royal Decree of 18 November 2002 (Article 2). As for facilities located abroad and contracted by a Belgian owner of radioactive waste in view of processing, conditioning or storage of his waste, Article 10 of the Royal Decree specifies that "*any contract concluded between a Belgian owner of radioactive waste and a foreign operator for processing, conditioning and storage of his radioactive waste must be approved beforehand by ONDRAF/NIRAS in view of the future acceptance of this waste by the ONDRAF/NIRAS. This article mainly focuses on the quality management system applicable to the technical equipment in order to guarantee the conformity of the waste with the acceptance criteria*" [translated [19]]

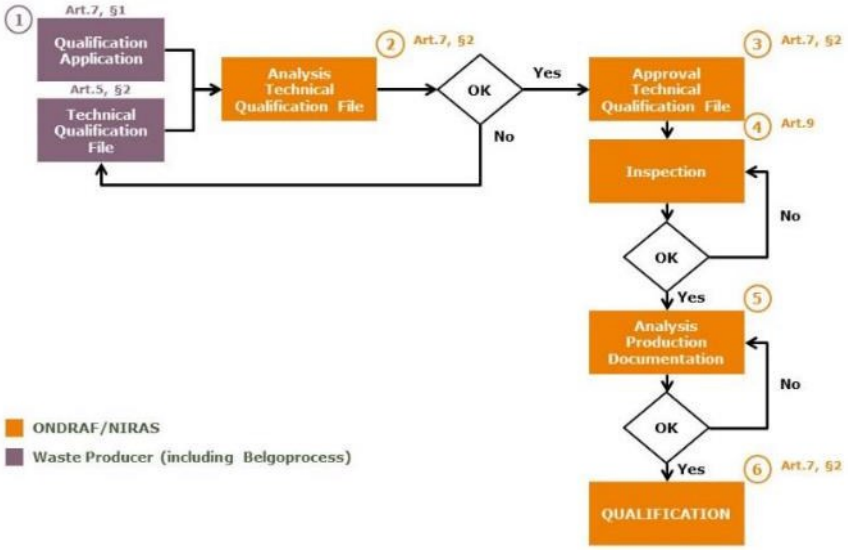


Figure 5 Generic outline of the qualification procedure for conditioned process with references to the appropriate articles of the Royal Decree of 18 November 2002.

ONDRAF/NIRAS imposes via the Belgian owner of radioactive waste upon a foreign operator the practical terms of the qualification process similar to those that are applicable to Belgian operators by way of the contract concluded between both parties. As such, the requirements of the Royal Decree of 18 November 2002 will be respected. For conditioned waste packages, the qualification procedure consists of four items:

1. the qualification of the radioactive waste processing and conditioning process for Conditioned Waste Packages (CWP);
2. the qualification of the empty waste package with its internal structures;
3. the qualification of the radiological characterization methodology for CWP's, including the qualification of the measuring equipment.
4. the qualification of the interim storage facility for CWP's

[19] Article 10: " *Tout contrat conclu entre un propriétaire belge de déchets radioactifs et un exploitant étranger pour le traitement, le conditionnement et l'entreposage de ses déchets radioactifs doit être approuvé au préalable par l'ONDRAF en vue de la prise en charge ultérieure de ces déchets par l'Organisme et en particulier sur système de qualité d'application à l'équipement technique afin de garantir la conformité des déchets avec les critères d'acceptation* " [original French text taken from the Royal Decree]

According to Article 7, § 2, the qualifications may be granted to the [Belgian] Operator for a maximum duration of five years. In case of a foreign Operator and in line with Article 7, § 2, the qualifications will also be granted to the Belgian owner for a maximum duration of 5 years.

As a general rule, this Qualification Procedure follows a step-by-step approach:

1. the drawing up of the applicable Waste Acceptance Criteria by ONDRAF/NIRAS on the basis of the general rules,
2. the drawing up of the Technical Qualification Files (TQF's) for each of the four components of the Qualification Procedure (Radioactive Waste Processing and Conditioning Process, Primary Package, the Radiological Characterization Methodology and the radiological measurement installations) by the Operator,
3. the approval by ONDRAF/NIRAS of the TQF's from Step 2,
4. the performance, by ONDRAF/NIRAS, of a Technical Audit pertaining to the Radioactive Waste Processing and Conditioning Process and the Primary Package and the equipment used for the radiological characterization of the CWP's,
5. the approval by ONDRAF/NIRAS of a First Production Documentation File pertaining to the Radioactive Waste Processing and Conditioning Process, the Primary Package and the equipment used for the radiological characterization of the CWP's,
6. the drawing up of an Application for Qualification for each of the four components of the Qualification Procedure by the Operator or, in case of a foreign Operator, by the Belgian owner of radioactive waste
7. the deliverance of the Qualifications by ONDRAF/NIRAS when the requirements of Steps 3, 4, 5 and 6 are met.

For **non-conditioned waste packages**, the qualification procedure consists of two components:

- the qualification of the methodology that guarantees the conformity of the non-conditioned waste packages with the applicable waste acceptance criteria, and
- the qualification of the radiological characterization methodology for non-conditioned waste packages, including the qualification of the measuring equipment.

The qualification procedure for non-conditioned waste packages proceeds according to the same method as described for the conditioned waste packages.

The Royal Decree of the 18 November 2002 is currently under review: main topics include a comprehensive procedure to withdraw a qualification when non-conformities are detected and a more detailed description of interim storage facilities.

E.2.6 System of prohibition of the operation of a spent fuel or radioactive waste management facility without a licence

No one may operate a nuclear facility without a licence (FANC-law, art. 16; GRR-2001, art. 5.1). The operator has to take the necessary measures to fulfil the conditions of the licence (GRR-2001, art. 5.2). ONDRAF/NIRAS can withdraw a qualification in case of non-conformity.

E.2.7 System of appropriate institutional control, regulatory inspection and documentation and reporting

FANC inspects nuclear facilities, verifies 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.

During the lifetime of a high-risk facility (Class I and Class IIA), a supervision scheme with 3 levels[20] (see Figure 6) is in place. The first level of supervision is carried out by the licensee's Health Physics Department (HPD), which has to ensure the availability and the effectiveness of the necessary measures to guarantee the nuclear safety and the radiological protection of the workers, the public and the environment.

The second level of supervision is provided by Bel V to which FANC delegates certain inspection and safety assessment tasks. The missions of Bel V are, among others, to verify the well-functioning of the HPD, to verify the commissioning of new or modified installations, to approve some of the HPD's decisions related to safety or radiological protection as defined in article 23 of GRR-2001, etc… To perform these missions in an effective way, Bel V dedicates at least one specific expert to each nuclear site or one to each reactor for the NPP-sites, who is in charge of the operational supervision of that specific site or reactor. This expert is assisted by a back office of several specialized experts with thorough knowledge and expertise in various domains such as safety analysis, criticality, emergency planning, fire protection, systems, and components.

The third level of supervision is performed by the FANC, that also verifies the well-functioning of Bel V. The prerogatives of the FANC nuclear inspectors are larger than those of the Bel V inspectors/experts as only FANC nuclear inspectors have enforcement powers and legal competencies to take the necessary and urgent measures for the protection of the workers, the public and the environment.

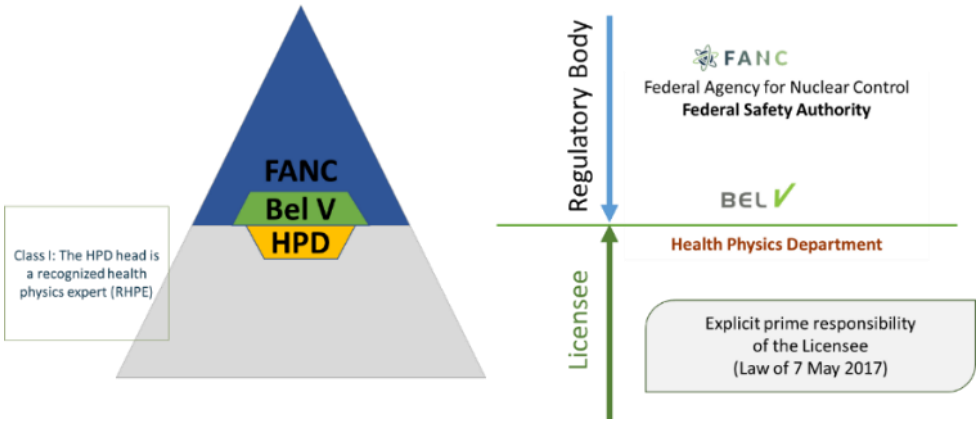


Figure 6 Schematic view of Regulatory Oversight of Class I and IIA Facilities.

E.2.8 Enforcement of applicable regulations and of the terms of the licences

The procedures used in the enforcement of regulatory requirements are based on the mandate of the FANC given in the legislation. The enforcement tools and measures are provided in the following legal documents:

- the Law of 15 April 1994;
- the GRR-2001;
- the Royal Decrees of 20 December 2007 related to administrative fines.

Coercive measures are used to reinforce FANC's orders. Two types of sanctions are foreseen in the FANC-law (articles 50 to 64): legal penalties (requiring a legal procedure by the Court) or administrative fines (nevertheless requiring an information to and a decision by the Prosecutor for the standard procedure). The FANC nuclear inspectors are nominated by Royal Decree. They have the powers of enforcement inspectors; they can also intervene on the request of Bel V inspectors. The FANC inspectors can take any measure they consider necessary to reduce or eliminate hazards for workers, the public and the environment. These measures can include warnings or requests for corrective actions within a defined delay.

[20] For low-risk facilities (Class II and Class III) the supervision is only ensured by the FANC.

The choice of the enforcement measures is based primarily on the safety significance of the infraction or situation where corrective measure is required, applying the principle of graded approach. The enforcement policy is presented in the FANC management system.

The nuclear inspectors have to take any necessary and urgent measures to avoid or eliminate a risk. Examples of those measures are:

- impose technical modifications to the installation (additional shielding, installation of additional detection device);
- proceed to the seizure or evacuation of radioactive sources, contaminated material or devices that present ionising radiation;
- impose an administrative modification (as far as procedures, instructions or operating modes are concerned) or an organisational modification (obligation of additional personnel in relation to safety and/or radiological protection);

In extreme cases and if a practice may result in a specific danger (e.g. detriment of health), the nuclear inspector has the power to interrupt the activity.

Bel V is delegated by the FANC to permanently supervise whether the operator complies with the regulations in force and with the conditions attached to the licence, but only has the power to make recommendations. Should the operator violate the conditions set in the licence and fail to correct that situation, or should the operation evolve towards an unsafe situation, this would be referred to the FANC who will proceed to enforcement measures.

Another possibility to strengthen safety is foreseen in article 13 of the GRR-2001: The Scientific Council for Ionizing Radiation and the FANC services in charge of the supervision can, on their own initiative and at any moment, propose additional conditions to be attached to the licence with the aim of improving safety.

Finally, if the licensee does not comply with the regulations or with its licence, a process described in article 16 of GRR-2001 allows the FANC to propose the suspension or the withdrawal of the licence, after advice of its Scientific Council for Class I facilities.

E.3 Allocation of responsibilities of the bodies involved in the different steps of spent fuel and of radioactive waste management

Four main groups of stakeholders are essentially involved in spent fuel and radioactive waste management :

- the owners of the spent fuel;
- the radioactive waste holders and/or producers ;
- ONDRAF/NIRAS, the organisation responsible for the safe management of radioactive waste, and its subsidiary Belgoprocess ;
- the regulatory body : the FANC and its subsidiary Bel V.

E.3.1 ONDRAF/NIRAS

ONDRAF/NIRAS is a public body governed by a board of directors, whose members are appointed by the federal government. ONDRAF/NIRAS is supervised by the federal Ministers responsible for energy and economy ; who are represented at the board by a Commissioner. ONDRAF/NIRAS submits annually an activity report to the Belgian Parliament.

ONDRAF/NIRAS may conduct its radioactive waste management mission and its other missions using its own resources or allow some of them to be carried out by third parties under its responsibility. Nevertheless, ONDRAF/NIRAS is the only actor appointed to ensure the long-term management of radioactive waste.

ONDRAF/NIRAS handles the general coordination of all the aforementioned industrial and RD&D activities and ensures the durability and integration of knowledge. Its role of radioactive waste manager is separate from its role of nuclear operator. When it acts as a nuclear operator, ONDRAF/NIRAS is controlled by FANC as any other nuclear operator.

Additionally, since 2023 ONDRAF/NIRAS is also responsible for the exploitation of the site NIRAS – Site Dessel (NISD), the entity in charge of the exploitation of the surface disposal facility.

ONDRAF/NIRAS becomes the owner of radioactive waste with the transfer of management responsibility in the waste acceptance process. Through its 100% subsidiary NV Belgoprocess SA, who is the operator of two nuclear sites (BP1 and BP2 located at Dessel and Mol respectively), ONDRAF/NIRAS is also involved in the processing and storage of radioactive waste. Belgoprocess is holder of the operating licences for the processing and storage facilities on its site. ONDRAF/NIRAS is responsible for the construction of new installations on these sites, which needs to be licensed through the FANC. ONDRAF/NIRAS is responsible for the decommissioning of installations on these sites, which ceased their activities. The agreements between ONDRAF/NIRAS and Belgoprocess are laid down in long-term agreements. The members of the Board of Belgoprocess are appointed by the Board of ONDRAF/NIRAS. A government Representative, appointed by the federal Minister responsible for the energy policy, attends the meetings of the Board. More information can be found on www.belgoprocess.be and www.ondraf.be

In 2012, the company Best Medical Belgium went bankrupt. Part of the installations were taken over by the South-African company NTP Radioisotopes SOC Ltd after the bankruptcy; ONDRAF/NIRAS then became responsible for all remediation and decommissioning activities on the remaining fraction. The site is now called "ONSF" (ONDRAF/NIRAS Site Fleurus). ONDRAF/NIRAS became, as such, a nuclear operator. The relations with the FANC for these activities are the same as for all other nuclear operators.

The organisational structure of ONDRAF/NIRAS can be found on www.ondraf.be/structure-interne and is given in Figure 7 below.

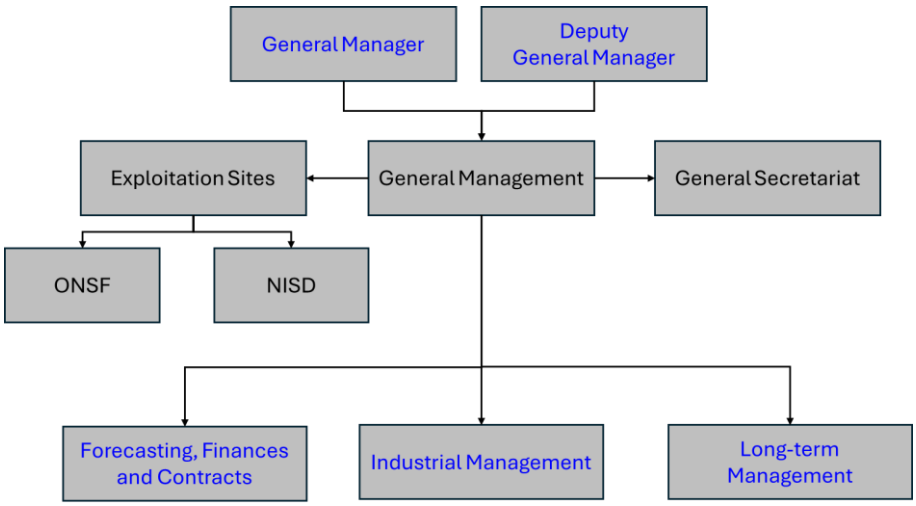


Figure 7: ONDRAF/NIRAS Organizational structure.

E.3.2 Relations between ONDRAF/NIRAS and the FANC

With regard to the management of radioactive waste, the FANC and ONDRAF/NIRAS have been entrusted by the legislator with a legal mission, with the same main objective, namely the protection of the public and the environment against the hazards of ionizing radiation, in particular in relation to the presence of radioactive materials and radioactive waste. However, the instruments used by those agencies in order to achieve this objective, are different.

The role of ONDRAF/NIRAS should not be confused with that of the FANC. Both Agencies have a complementary role to play. The FANC is the Safety Authority, who sets the operation conditions in the licences. ONDRAF/NIRAS as a waste management agency qualifies the waste storage and

processing facilities, only from a perspective of the quality of the waste and its characterisation in view of its safe long-term management. None of the missions exercised by ONDRAF/NIRAS can be regarded as missions belonging to the FANC (in conformity with art. 20, paragraph 2, of the Convention).

The distinction between the competences and responsibilities of the FANC and ONDRAF/NIRAS are formalized because the supervision and political responsibility of these public institutions is exercised by different members of the federal government. This does not prevent both public institutions from concluding privileged relations with one another. In implementation of the GRR-2001, both institutions have concluded an agreement in view of the mutual exchange of information and mutual consultation concerning several aspects of radioactive waste management (breakdown into so-called addenda). This agreement which organises the legal interfaces between the two agencies has been signed in 2003. The interactions between the two agencies are organised by and structured in three-yearly programmes of work, defining the thematic priorities, objectives, deliverables, and planning of work. The programme of work is periodically reviewed. A Commission with members of both organisations and with a rotating chair was created; this Commission coordinates all activities and interactions that are covered by the agreement. In 2023, a new addendum related to "pre-licensing" was added to the agreement. This addendum addresses the needs of specific dialogue between ONDRAF-NIRAS and FANC regarding the way of implementing disposal before the grant of a licence. Figure 8 gives a schematic view of the relationships between ONDRAF/NIRAS and the FANC.

Before 2018, the nuclear waste management inspections on sites operated by the waste producers, were conducted by nuclear safety inspectors. A dedicated inspection campaign in 2017, comprising the Class I facilities, has shown that special care should be taken towards interdependencies, that more concertation between waste producers has to be established, that FANC/Bel V and ONDRAF/NIRAS should avoid conflicting requirements during inspections carried out by both organizations autonomously, and that follow up of the inspections should be more frequent. Since 2018, inspections in relation to radioactive waste management in waste producers' facilities are conducted by FANC dedicated staff. Experts from ONDRAF/NIRAS are invited to join the inspection team. At the same time, experts from FANC are invited to participate in audits conducted by ONDRAF/NIRAS during the qualification of equipment used by waste producers for treatment, processing, characterization, and storage of radioactive waste. The collaboration is now supported by a specific inspection guide and a common position document which clarifies the roles, responsibilities, and scope of the respective inspections.

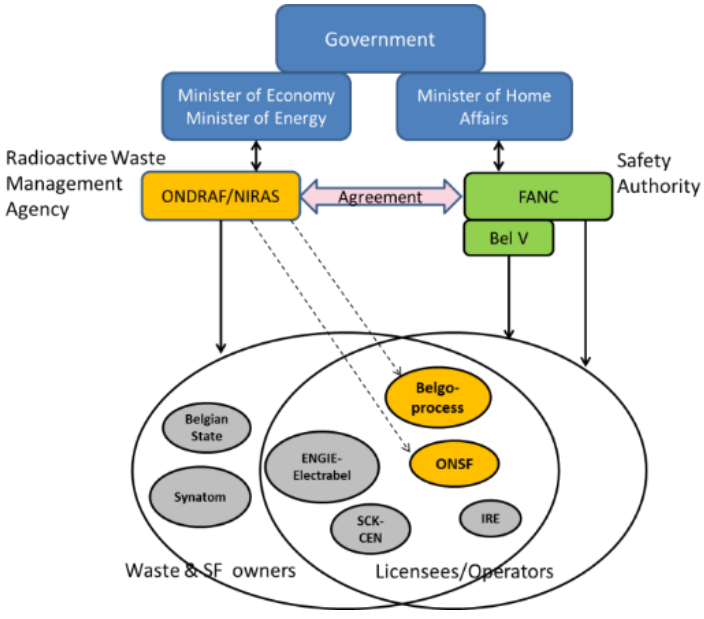


Figure 8 Organisational Structure of the Relationships between the radioactive waste management Agency, the operators and the owners of radioactive waste and the Safety Authority.

E.4 Article 20 – Regulatory body

ARTICLE 20. REGULATORY BODY

1. Each Contracting Party shall establish or designate a regulatory body entrusted with the implementation of the legislative and regulatory framework referred to in Article 19, and provided with adequate authority, competence and financial and human resources to fulfil its assigned responsibilities.

2. Each Contracting Party, in accordance with its legislative and regulatory framework, shall take the appropriate steps to ensure the effective independence of the regulatory functions from other functions where organizations are involved in both spent fuel or radioactive waste management and in their regulation.

Since 1st of September 2001, the supervision of nuclear activities is the responsibility of the Federal Agency for Nuclear Control (FANC), which constitutes the Safety Authority. This mission has been entrusted to the FANC by the Law of 15 April 1994. According to articles 14ter of this law (as amended by the law of 7 May 2017), the FANC can create legal entities to assist it in the execution of its missions. The FANC has made use of this provision and created Bel V in September 2007, a subsidiary with the statute of a so-called 'foundation' as defined in Belgian law. The FANC delegates several regulatory tasks to Bel V, among others, on-site routine inspections – albeit without associated enforcement powers – and independent safety assessments. Only Class I facilities (including NPPs and Research Reactors) and certain higher risk Class II facilities – the so-called Class IIA – are supervised by Bel V.

It is through the association of the FANC on one side, and Bel V on the other that the function of regulatory body as stipulated in article 20, is ensured.

E.4.1 The FANC

The Federal Agency for Nuclear Control (FANC) is an autonomous public institution with legal personality. The Agency is directed by a 14-headed Board of Directors; its members are appointed by the Federal Government on the basis of their particular scientific or professional qualities. In order to guarantee the independence of these directors, their mandate is incompatible with holding certain other responsibilities within the nuclear sector and within the public sector. The Board of Directors delegates the management of the FANC to the General Manager. The FANC submits annually an activity report to Parliament.

In order to perform certain tasks, the FANC is advised by the Scientific Council for Ionizing Radiation; the composition and the competences of this Council are determined by Royal Decree. The Council consists of high-level experts within the field of radiation protection, nuclear energy, and nuclear safety.

The FANC exercises its authority with regard to the nuclear operators through one-sided administrative legal acts (the consent of the persons involved is not required) such as the granting, refusal, modification, suspension and withdrawal of licences, recognitions, or approvals. It organises inspections to verify the compliance with the conditions stipulated in these licences and with the applicable regulations. The FANC can claim documents in whatever form, from the facilities and companies under its supervision. Infractions with regard to the decisions of the FANC can be sanctioned.

The operation of the FANC is entirely and directly financed by the companies, organisations, or persons to whom it renders services. In practice this is done through non-recurrent fees, and annual taxes at the expense of the applicants or holders of licences or recognitions. The amount of the taxes is set in article 30bis of the law of 15 April 1994, the amount of the fees is fixed by Royal Decree, as

foreseen in article 30quater of the law of 15 April 1994. The receipts and expenditures of the FANC have to be in equilibrium. The above-mentioned statute confers to the FANC the indispensable independence to enable it to impartially exercise its responsibilities as regulator of the nuclear activities.

Within the Board of Directors, an audit Committee and a strategy Committee have been set up to prepare certain decisions. Below the General Manager, the FANC is organized in four departments: the Department "Facilities and Waste", the Department "Security and Transport", the Department "Health and Environment" and the Department "Support" (see Figure 11). The FANC organisation chart, as from 1st of March 2024, is reported in Figure 9.

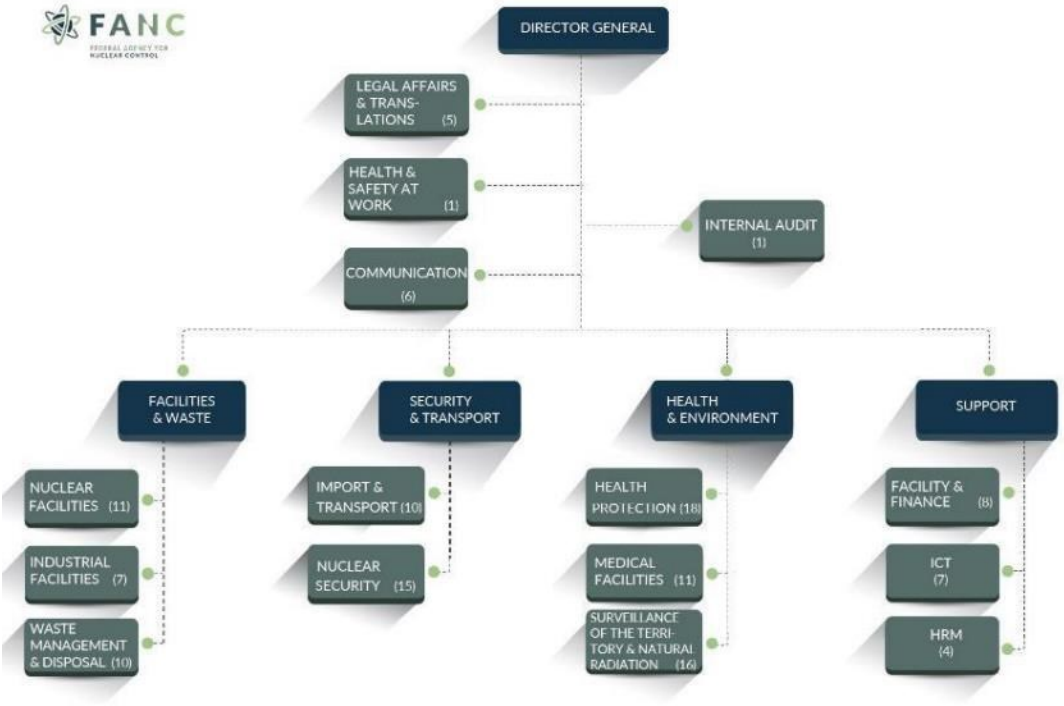


Figure 9 Organisational chart (with staffing) of the FANC, as of 1st of April 2023.

The missions of the **department 'Facilities & Waste'** relate to nuclear and industrial facilities, radioactive waste facilities, and recognition of qualified experts in Health Physics.

- The first mission includes the collection, the analysis, and the evaluation of licence applications. This mission consists of ensuring that ionizing radiation can be used safely and that a licence can be granted.
- The second mission involves the surveillance, the inspections and the investigations that ensure that the activities carried out comply with the licence and its conditions, and, in a more general way, with the regulations in force. In addition, the department must also track down any illegal activity carried out without authorization. Synergy between these two missions mainly aims at improving: 1) the safety in general, and 2) the protection of the workers, the public and the environment against the hazards of ionizing radiation.
- The third mission includes the contribution to a regulatory framework for the disposal of radioactive waste of different categories, as well as the licensing of disposal facilities.
- Finally, the department makes regulation proposals in its field of activities and develops the related technical regulations (binding) and guidance (non-binding).

The **department `Security & Transport'** is responsible for the physical protection of nuclear and radioactive material, and for the regulation of transport, import, transit, and export of radioactive material. Here also, the licensing activity as well as the surveillance of a specific activity have been

integrated in the same pillar, with the objective of optimizing the exchange of information and setting up a more effective surveillance policy.

The **department `Health & Environment'** is in charge of the activities relating to man and his environment (including the radiological monitoring network TELERAD). This operational entity is directed towards the protection of the public, the workers, and the environment in all fields, namely the medical applications, the natural radiation sources, the radiological surveillance of the territory, the national nuclear emergency plan, and the clean-up/restoration of contaminated sites.

The **department `Support'** is in charge of the activities at the organizational level and activities involving several departments (horizontal activities):

- human resources management at the FANC level;
- follow-up of FANC projects;
- coordination of international activities;
- finances and Information Technology.

At present, the personnel of the FANC consists of about 150 persons. This figure is stable for about 10 years. More than 60 % of them are university graduates in different fields of science (physics, chemistry, biology, medicine), engineering, law, economics, social sciences, and communication.

E.4.2 Bel V and its relations with the FANC

Bel V is a non-profit 'foundation', created in 2007 by the FANC, in view of delegating them some surveillance functions. Bel V performs activities that are, at the international regulation level, within the competences of the regulatory bodies for nuclear safety. Bel V has adopted the guiding principles for the activities of such organizations, as described in the IAEA safety standards concerning legal and governmental infrastructure.

Within the scope of the Belgian legislation and of its own authority, Bel V also applies the fundamental safety principles of the IAEA.

❖ Delegation of regulatory functions to Bel V

The list of regulatory tasks that can be delegated by the FANC to Bel V is fixed in article 38.1 of the GRR-2001. These tasks consist, for Class I and high-risk Class II (so-called Class IIA) facilities, of:

- Regular on-site inspections, for the permanent supervision of the good performance (including approbation of some decisions) of the licensee's Health Physics Department. This permanent supervision in practice consists of systematic, thematic, and specific inspections devoted to defined subjects (operation, periodic tests, chemical control, radiological protection …) and specific items follow-up inspections, examination of modifications and incident analysis.
- Safety assessments of licence applications for and of acceptance of new installations and of modifications
- Safety assessments and on-site inspections of other licensee's projects – e.g. Periodic Safety Reviews (PSR), Licensee's action plans.
- Safety assessments of the files and safety analyses related to the SRNI-2011 that are submitted by the licensee.

The Board of Administrators of the FANC formally delegated those tasks to Bel V on 1st of March 2019. Those tasks are annually identified in an inspection and safety assessment programme, which is approved by the FANC and communicated to the licensees.

Bel V's inspections reports are written following each inspection and are also sent to the FANC. Bel V discusses its findings with the FANC on a regular basis. In addition, any situation that may have an impact on the public, the workers or the environment is immediately communicated to the FANC. Each year, Bel V makes an evaluation of the safety of the installations it inspects and draws up the lessons learnt.

The FANC is in charge to monitor the good performance of Bel V, its subsidiary, according to the Law of 15 April 1994 and to article 38 of GRR-2001.

Bel V is retributed by the licensee, for the on-site controls and safety assessments it performs as foreseen in the approved annual inspection and safety assessment programme, and on the basis of a pre-defined average hourly tariff. This tariff is fixed in article 38 of the GRR-2001, as modified by the Royal Decree of 6 December 2018. Due to Bel V being a non-profit organization, its financial resources are used for the payment of its personnel and related costs, for the participation in national or international working groups, for personnel training, for its research and development activities, for the maintenance of technical and regulatory documentation.

Bel V's technical personnel is composed of some 80 full-time equivalent university graduates (engineers and scientists), and recruitment is in line with the foreseeable workload. The organization chart of Bel V is given in Figure 10.

Bel V inspectors have to be recognized experts according to article 73 of the GRR-2001, requiring, amongst others, at least three years of experience in the nuclear field before obtaining expert certification. Bel V's staff training budget amounts to about 10 % of its overall budget.

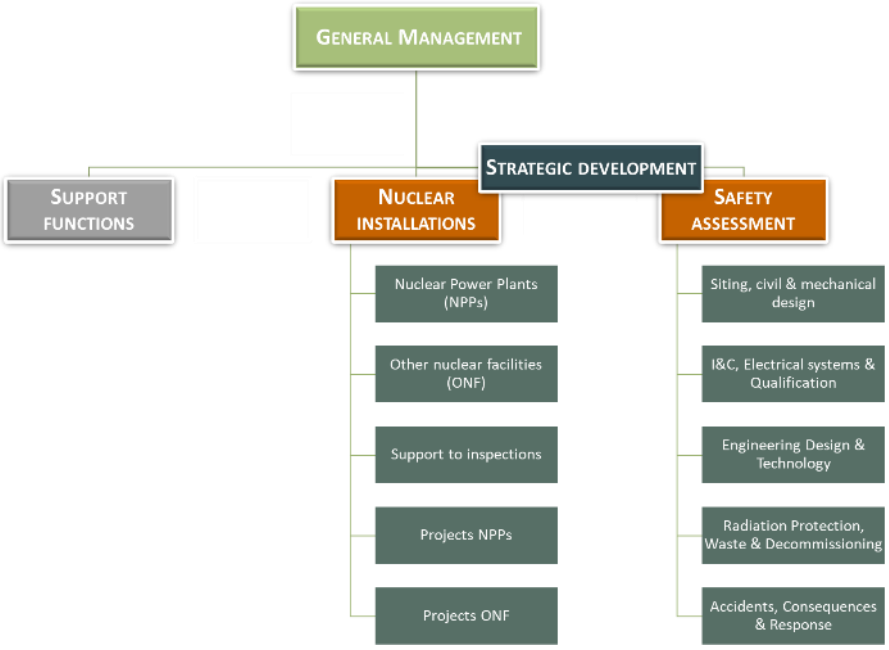


Figure 10 Organisational structure of Bel V.

E.4.3 Independence of the regulatory body

The law of 15 April 1994 defines the statute, the missions of the FANC, as well as some requirements about its internal administration. The Federal Agency for Nuclear Control (the FANC) is an autonomous public institution with legal personality.

The FANC is institutionally and financially independent. The FANC is under the supervision of the Minister of Home Affairs. A Government commissioner attends the meetings of the Board of Directors to verify that the FANC fulfils its legal missions. The members of the Board of Directors are appointed by Royal Decree, on the proposal of the Council of Ministers. The Governance charter of the Board of Directors is published on the FANC web site. The Board of Directors, which meets approximately six times per year, focuses on:

- the overall strategy at long and short term, with the approval of the mid-term and annual operational plan;
- the staffing and personnel employment conditions of the FANC;
- the financing of the FANC.

The Board approves the annual budget and the staffing of the FANC. It nominates and evaluates the senior management. The Board delegates the management of the FANC to the General Manager, who is appointed by Royal Decree for a fixed term of 6 years.

The FANC, as a public body, reports to Parliament via the Minister of Home Affairs, thus ensuring a legal independence with respect to other governmental bodies and Ministries that promote the use of ionizing radiation for various purposes. The FANC has no link with the private sector dealing with the use of nuclear energy or involved in the use of radiation sources.

Bel V is a non-profit 'foundation' created by the FANC. It establishes a quarterly report and also publishes an annual activity report of activities to be submitted to its Board. This report is referred to in FANC's annual report and can also be presented to the Parliament.

The Belgian public organisations dealing with questions related to the use of nuclear energy, such as the Nuclear Research Centre (SCK CEN) in Mol, or the Belgian Agency for Radioactive Waste and Enriched Fissile Materials (ONDRAF/NIRAS), the Institute for Radioelements (IRE) report to the Ministers responsible for Economic Affairs and for Energy.

The regulatory body plays no part in nuclear energy promotion. The FANC also has the mission to "stimulate and co-ordinate research and development" in its domains of competence. It establishes privileged relationships with the public organisations working in the nuclear field, with the scientific research networks and with the relevant international organisations." (Art. 23 of the FANC-law).

The Belgian parliament has set up a permanent sub-commission on nuclear safety, which from time to time requests the FANC to report and to be questioned. This sub-commission also discusses the annual report of the FANC.

E.4.4 Transparency

Public consultation is legally foreseen in licensing procedures for nuclear facilities. Access by the public to environmental information and consultation of the public in environmental impact assessment procedures are also part of the legal and regulatory framework, transposing the European directives and international conventions on these matters.

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.
- **Law of 11 April 1994,** *on access to public sector information*
- **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*
- **Law of 5 August 2006,** *on public access to environmental information*, which transposes Directive 2003/4/EC.

The participation process in the environmental impact assessment related to plans and programmes (including foreign parties) is regulated by the laws here below listed:

- **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.
- **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 »], which transposes Directive 2001/42/EC and Directive 2003/35/EC, the latter amending the Council Directives 85/337/EEC and 96/61/EC.

The FANC is in charge of disseminating objective and neutral information about radiation risks, according to article 26 of the Law of 15 April 1994. Communication with interested parties is one of the core processes of the FANC. The document COM of the FANC management system describes the FANC communication policy, which explicitly refers to the IAEA GSG-6 guide.

Interested parties that are informed by the FANC comprise:

- the general public and the media:
  - the FANC and Bel V have their own web sites. The FANC web site allows the general public to contact and ask questions to the FANC and the communication service takes care of answering them;
  - the FANC also uses its own social media channels to engage with general public;
  - the media are informed by the FANC management and the FANC communication office. Important events give rise to press releases and conferences;
  - laws and regulations are published in the Belgian Official Gazette ("Belgish Staatsblad-Moniteur Belge"), as well as notification of decisions (licensing of Class I facilities, recognition of experts in health physics ...). A consolidated version of the regulations is available on the FANC web site (http://www.jurion.fanc.fgov.be). Search and filtering functions makes the information easily accessible to the various stakeholders involved;
  - the local, regional competent authorities and the general public are consulted ("public inquiry") in the frame of the licensing process of high-risk facilities (Class I and some Class II), with the possibility to attend information meetings organized by the FANC. In specific cases, international consultations are organized (EU neighbours, ESPOO), according to the EU directives and/or EURATOM treaty (art. 33). Advice and concerns are taken into account in the licensing process.
- the supervising Minister and the Parliament through:
  - the answers proposed by the FANC to questions that are addressed by the Parliament's members to the Minister;
  - the government commissioner who attends the meetings of the Board of Directors;
  - the annual report submitted to the parliament;
  - the follow-up by the parliamentary commission of Home Affairs and by the parliamentary sub-commission on nuclear safety.
- the licensees
  - several formal and informal communication mechanisms are in place;
- other interested parties
  - The GRR-2001 foresees that other parties are notified of the FANC decisions: For example, article 6.8 prescribes notification of the granted licences to local authorities, to some federal administrations, to the civil security, to ONDRAF/NIRAS, to the European commission and other European countries when relevant.

The government and the public are also informed by the annual report of the FANC. This report is published on the FANC web site, together with the Bel V annual report. Parliament members can also ask questions to the FANC supervising minister.

The main communication tool of the FANC is its web site www.fanc.fgov.be. It is comprehensive and contains information for the general public as well as for professionals. Several reports, information files about the radiation risk of different facilities and activities or about particular subjects are available.

Public enquiries related to licence applications are also performed through the FANC web site.

The results of the measurements performed by the TELERAD network are available on the FANC web site as well, at www.telerad.be.

All events related to nuclear activities and radiation protection are rated on the INES-scale (International Nuclear and Radiological Event Scale). The FANC has set up a convention with the licensees of Class I facilities and of highest risk Class II facilities to use INES as a communication tool to the public. This convention is on a voluntary basis, and all the concerned licensees participate to it.

Finally, since 2012, the radioactive releases from all Belgian nuclear and waste facilities with their calculated radiological impact are published annually on the FANC web site (in French).

The active participation of the stakeholders of local communities concerned by the radioactive waste disposal is regulated by the ONDRAF/NIRAS law and decree:

- **Article 179, § 2, of the Law of 8 August 1980** (ONDRAF/NIRAS Law), which, in particular, 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 repository.
- **Royal Decree of 30 March 1981** (ONDRAF/NIRAS Royal Decree), which requires ONDRAF/NIRAS to establish and implement an information and communication programme covering all its activities

Besides, ONDRAF/NIRAS goes even beyond legal obligations by developing a policy of (pro-)active and transparent communication on all the aspects of radioactive waste management in Belgium. For instance, consultation of / and dialogue with the public is a key element of the partnerships between ONDRAF/NIRAS and localities that were created for the category A disposal programme.

SECTION F OTHER GENERAL SAFETY PROVISIONS

F.1 Article 21 – Responsibility of the licensee

> *ARTICLE 21. RESPONSIBILITY OF THE LICENSEE*
>
> *1. Each Contracting Party shall ensure that prime responsibility for the safety of spent fuel or radioactive waste management rests with the holder of the relevant licence and shall take the appropriate steps to ensure that each such licence holder meets its responsibility.*
>
> *2. If there is no such licence holder or other responsible party, the responsibility rests with the Contracting Party which has jurisdiction over the spent fuel or over the radioactive waste.*

The Law of 15 April 1994 clearly states the prime responsibility of the licence holder:

> *"Art. 28. § 1.*
>
> *The license holder is responsible, in all circumstances, to ensure the protection of the workers, the population and the environment against the hazards or health detriment which could arise from the exercise of its practice. This responsibility cannot be delegated." :*

In addition, the licensee has to comply with the regulations in force dealing with nuclear safety and radiation protection. The regulatory framework expresses in several statements the prime responsibility of the operator for safety:

- Article 5.2 of the GRR-2001 also indicates that the licensee is responsible for complying with the conditions set in the licence. For the nuclear Class I facilities, the licence requires conformity with the Safety Analysis Report. Moreover, the operator must commit himself in the licence application to register with ONDRAF/NIRAS and to conclude with this organisation an agreement on radioactive waste management.
- The operator must also conclude a civil liability insurance (Article 6.2.5 of the GRR-2001); the law of 22 July 1985, which makes the conventions of Paris and Brussels and their additional protocols applicable, and the law of 13 November 2011 set the maximum amount of the operator's liability for the damage at some Euro 1.2 billion per site and per nuclear accident. Some operators have obtained a derogation that limits their civil liability to about 75 million euros.

If waste or spent fuel is transferred to a foreign country for treatment or reprocessing, the final responsibility for safe disposal of these substances remains with the Belgian State (article 179 of the Law of 8 August 1980 amended by article 4 §7 of the law of 3 June 2014 transposing the European Directive 2011/70/EURATOM).

F.2 Article 22 – Human and financial resources

ARTICLE 22. HUMAN AND FINANCIAL RESSOURCES

Each Contracting Party shall take the appropriate steps to ensure that:

(i) qualified staff are available as needed for safety-related activities during the operating lifetime of a spent fuel and a radioactive waste management facility;

(ii) adequate financial resources are available to support the safety of facilities for spent fuel and radioactive waste management during their operating lifetime and for decommissioning;

(iii) financial provision is made which will enable the appropriate institutional controls and monitoring arrangements to be continued for the period deemed necessary following the closure of a disposal facility.

F.2.1 Human resources

F.2.1.a Legal framework

The legal and regulatory framework contains several provisions on the expertise and skills different actors should have or develop:

- Holders of a nuclear licence must make arrangements for education and training, as well as research activities, to acquire, maintain and further develop the necessary expertise and competences to meet the needs of the National Programme (Article 5 of the Law of 3 June 2014.);
- ONDRAF/NIRAS must define RD&D programmes that are necessary for the execution of its missions ;
- Class 1 licensees must meet a series of requirements in terms of skills and expertise for their staff and ensure that subcontractors have the necessary skills and work according to the appropriate standards

The main actors in spent fuel and radioactive waste management are involved in international networks and initiatives to share best practices, knowledge and resources on issues related to spent fuel and radioactive waste management. Examples are the “European Joint Programme on Radioactive Waste Management (EURAD), the “Implementing Geological Disposal of radioactive waste Technology Platform (IGD-TP)”, the “European Nuclear Safety Regulators Group (ENSREG)”, the ERDO working on shared solutions for radioactive waste, NEA Expert Groups, and IAEA Networks. These international collaborations and initiatives cover a wide range of topics, such as deep geological disposal, integrated management systems, safety culture, radiation protection, preservation of records, knowledge, and memory.

ONDRAF/NIRAS and FANC have bilateral agreements with other radioactive waste management agencies and regulatory bodies abroad. ONDRAF/NIRAS is a member of the “International Association for Environmentally Safe Disposal of Radioactive Materials”, in short EDRAM. EDRAM is an association of twelve waste management organisations from eleven countries (Belgium, Germany, Finland, France, the United Kingdom, Japan, Canada, Sweden, Switzerland, Spain, and the USA). The Members meet twice a year to discuss the progress of work worldwide and recent developments in the different member countries. FANC participates in research projects in the Mont Terri rock laboratory in Switzerland and the Tournemire experimental station in France, and is a member of the international SITEX-network (Sustainable network for Independent Technical EXpertise on radioactive waste management). This contributes to maintaining and expanding FANC's expertise in areas such as the deep geological disposal of radioactive waste.

ONDRAF/NIRAS’ RD&D programmes contribute to capacity building in the field of spent fuel and radioactive waste management. These RD&D activities have been on-going for several decades. The

HADES underground research laboratory in Mol, for example, was constructed in the early 1980s and has been used since then for in-situ research and long-term confirmation and demonstration experiments as part of ONDRAF/NIRAS' RD&D programme on the deep geological disposal of category B&C waste.

In 2020, SCK CEN and ONDRAF/NIRAS signed a public-public cooperation agreement to strengthen their collaboration on RD&D required for the safe management of radioactive waste. This cooperation focuses on developing and maintaining the scientific knowledge and competences related to safe methods for the management of radioactive waste. More specifically, the cooperation agreement is intended to:

- guarantee continuity of knowledge and key expertise within Belgium;
- cover all aspects in the radioactive waste management chain, namely treatment, conditioning, storage, and disposal;
- focus on strategic domains of the National Programme;
- ensure a robust cooperation framework; and
- make a more efficient use of public money.

FANC and Bel V conduct independent R&D related to radioactive waste management to develop and retain the expertise necessary for the independent review of the safety reports for disposal facilities developed by ONDRAF/NIRAS. FANC and Bel V also collaborate in several international initiatives to further develop their high-level expertise in safe radioactive waste management. Finally, both parties have developed a programme called "Strategic Research Needs — Strategic Issues Underlying the Development of Expertise and Skills of FANC/Bel V in Geological Disposal". This programme is regularly updated to keep it in line with the national waste management policies and strategies.

In addition, ONDRAF/NIRAS, FANC, SCK CEN and Bel V continuously invest in education and training of their own personnel and other actors involved in spent fuel and radioactive waste management. Examples of such education and training activities are:

- ONDRAF/NIRAS and Belgoprocess stimulate their staff to regularly attend trainings in specific technical fields (radiation protection, waste conditioning techniques, disposal of radioactive waste, etc.).
- The different types of experts of FANC/Bel V are subject to a formal internal recognition procedure in accordance with the requirements applicable to health physics experts[21]. This sets high demands in terms of training and competence. The inspections carried out by Bel V, on the sites of the Class 1 and high-risk Class 2 facilities, must be carried out by recognized experts in health physics.
- 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 includes a course on the nuclear fuel cycle, radiochemistry, dismantling, radioactive waste management and disposal. This programme includes contributions from ONDRAF/NIRAS, FANC and SCK CEN. BNEN acts as a catalyst for networking between academic institutions, research centres, industry and other stakeholders within the nuclear domain and aims to develop and maintain high-quality expertise in the field of nuclear engineering.
- The University of Hasselt offers a post-academic curriculum of one year to obtain a postgraduate degree as Radiation Protection Expert. The study meets the requirements of the Royal Decree of 20 July 2001 and has been designed for everyone who wishes to become officially accredited as a Radiation Protection Expert. This course is developed in collaboration with the SCK CEN Academy.

[21] Article 73 of the Royal Decree of 20 July 2001

- 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 to share experience and identify good practices with regard to their joint activities (e.g., joint inspections);
- ONDRAF/NIRAS, SCK CEN and EURIDICE organise exchange meetings (called PPS-talks) to share information about their research activities in the fields of surface and deep geological disposal.

F.2.1.b ONDRAF/NIRAS – Belgoprocess

As of 31 October 2023, ONDRAF/NIRAS had 197 permanent employees.

There is a steady increase in number of staff over the last years, because of additional tasks for ONDRAF/NIRAS (e.g. taking over responsibilities for the ONDRAF/NIRAS site in Fleurus) and because of the organisational preparation of the construction, the building and operation of the first disposal facility in Belgium.

Belgoprocess, which is in charge of the industrial management of the processing and storage of radioactive waste, whereas ONDRAF/NIRAS is responsible for the overall and administrative management and research, employs about 360 people.

Both organizations stimulate their workforce to attend regular training in specific technical fields (radiological protection, waste conditioning techniques, disposal of radioactive waste …). They are also largely involved in working groups set up by international organisations (IAEA, NEA, European Commission, …) in the field of spent fuel and radioactive waste management.

F.2.1.c About NPP's – ENGIE Electrabel

ENGIE Electrabel is the licensee of 7 NPP in Doel and Tihange. Their total capacity represents 5 913 MW. ENGIE Electrabel owns 100% of the units 1 and 2 of Doel, 89,8% of the units 3 and 4 of Doel and 2 and 3 of Tihange, and 50% of Tihange 1. The quantity of electricity produced by the seven nuclear plants went up to 50% of the electricity consumed in Belgium; in 2023, in view of the permanent shut-down of Doel 3 and Tihange 2 reactors, it summed up to 43% of that value.

Among ENGIE Electrabel's total Belgian workforce of around 4000 employees, about 2050 people, of which 200 at corporate level, are devoted to nuclear power station operation. The ENGIE group, of which ENGIE Electrabel is a part, also has an Engineering division, Tractebel ENGIE, which is the Architect-Engineer of the Belgian nuclear power stations (and of most of the fossil fuel fired plants) and which houses the know-how accumulated over fifty years of nuclear technology, which started with the construction of the research reactors at the SCK CEN Research Centre.

❖ **Organisation**

Nuclear activities within ENGIE Electrabel are managed on a three-level structure:

- Corporate level
- Nuclear Power Plant level
- Health Physics Department

■ *The **corporate level** includes, under the General Management, following organisations:*

- The **Technical Directorate** is in charge of the following activities:
  - Manages the evaluations, design, studies, modifications, and projects of the nuclear fleet
  - Under the responsibility of a dedicated Decommissioning Program Manager, the preparation of the decommissioning of the units, including the application for final shut-down of nuclear activities, drawing up the dismantling plan and the application file for the decommissioning permit.

- **The Decommissioning Strategy and Policy Manager** is responsible for the central management of the Decommissioning Strategy and Policy, including the further professionalisation and coordination of interactions with government agencies (ONDRAF/NIRAS, FANC, Bel V).
- The **Human Resources Department**
- **The Communication and Stakeholder Engagement Department**
- **The Financial Department**

- *At the **Nuclear Power Plant** level, the organisation includes the following departments and sections:*

- The **Operations department** is in charge of the safe conduct of the generation process and of the installations.
- The **Maintenance department** is in charge of ensuring the short- and long-term availability of the installations and equipment. It is also responsible for the management of contractors.
- The site **Decommissioning Program** department is responsible for managing the decommissioning program at site level, in conjunction with the corporate decommissioning manager.
- The **section Continuous improvement** is in charge of Human Factors and operational Experience activities.
- The **section Nuclear Fuel** is in charge of all the fuel handling operations.
- The **CARE department** is in charge of surveillance in radioprotection, measurements, protection of the workers (industrial safety), fire protection, environment, and safety of the installations (including the setting up and the management of the emergency planning and preparedness). This department is the local section of the centralized Corporate Health Physics Department (as required by the GRR-2001) and has the appropriate delegation from this department to perform the formal approvals required by the regulations. It ensures also the local independent nuclear safety oversight of the site by e.g. the execution of independent technical checks.

- *The **Health Physics Department** (HPD) is headed by the Chief HSSE & Nuclear Safety.*

Besides the Local Health Physics Departments on sites (CARE), there is also the Corporate Health Physics Department.

The Corporate HPD department is

- in charge of supporting the increase of the effectiveness of the management of nuclear safety for the nuclear fleet.
- responsible for the Corporate Independent Nuclear Safety Oversight. In this perspective it's performing independent audits and assessments and delivers the operational line – up to the board of Directors – with a current perspective of the Nuclear Safety performance of the nuclear fleet.
- responsible for the governance, oversight, and support for the Radiation Protection in Doel and Tihange

Chapter 13 of the Safety Analysis Report describes the structure of that organisation which has been approved by the Belgian Safety Authorities.

❖ Training

The Chapter 13 of the Safety Analysis Report of a NPP deals with personnel qualification, training, and re-training. Qualification of the personnel is inspired from the ANS 3.1 standard, though adapted to the Belgian educational system. The Safety Analysis Report defines the level of qualification corresponding to each of the safety related functions. It does not state the individual qualifications

of each person in the organisational chart. However, demonstration of qualification of all the operating personnel is available to Bel V and the FANC.

The training programmes are defined in the Safety Analysis Report, which includes a "function-programme" correlation chart. Chapter 13 of the Safety Analysis Report exhaustively lists all posts for which a licence is required. This licence is granted on the basis of the positive opinion expressed by an Assessment Committee – Bel V being member of this Committee, with veto right – which assesses the operator's knowledge.

Some knowledge–re-training programme for all qualified personnel is set up in function of the occupied position. The content of this programme is discussed with Bel V, is essentially operation-focused and includes, amongst others, a refresher course regarding the theoretical and practical knowledge (two weeks per year), training on the full-scope simulator (two weeks every two years) and, in teams, a review of the descriptions of the different systems (two weeks per year).

Similar attention is given to the maintenance personnel (department "Maintenance").

For all the personnel of the plant, training and retraining programmes are organised, adapted to the duties of the personnel. Note that the Royal Decree of 20 July 2001 requires an annual retraining of the whole personnel on the basic rules of radiological protection, including the good practices for an efficient protection and a reminder of the emergency procedures at the site. The Instructors who give the training are qualified for the particular subjects that they teach and possess a formal instructor certification.

Subcontractors are responsible for the training of their own personnel; moreover, training in radiological protection is legally required and is made specific to the site where they will work. They must pass an examination at the site before they are allowed to the workplace.

Since 2007, all the personnel and subcontractors operating in the plant have to follow a new basic training in nuclear safety and nuclear safety culture.

In addition to the individual training, great care is given to master the knowledge existing in the nuclear domain. The design bases of the plants, i.e. the knowledge of the design of the plants and the reasons of the choices made are an important part of the knowledge.

With the closure of the Doel 3 and Tihange 2 NPP's, extra training effort is focussed on the post operational period (POP). The training programs & staff qualification of operations personnel was reviewed accordingly by Bel V and FANC. The impact of the new configuration of the nuclear island on maintenance staff and others is minor, and there is less qualified equipment to maintain.

ENGIE Electrabel is member of the World Association of Nuclear Operators (WANO) whose objective is to reach higher standards for the safety and reliability of the operating nuclear units through permanent information exchange, peer reviews, good practice programmes, mutual assistance. ENGIE Electrabel is also member of FORATOM.

F.2.2 Financial resources

As indicated in "*Preparation of Long-term operation of Doel 4 and Tihange 3 units*" (under § A.2.3 – Other Developments): at the time of writing of this report, the contractual and legislative dispositions of the agreement between the Belgian Government and the NPP operator, ENGIE Electrabel, for 10 years extension of operations of the Doel 4 and Tihange 3 reactors are not implemented. That agreement includes changes in the funding scheme, the management of financial provisions, and the accountability in relation to spent fuel and radioactive waste management, not only for NPPs, but also for historical liabilities borne by the Belgian state.

The situation described in the present section and subsections reflects the status as of 31 December 2023. It may be subject to significant changes in the future; an updated picture will be shared in due time.

F.2.2.a NPP's

❖ Belgian legal context

The legal basis regulating the responsibility for the dismantling of the nuclear power plants and the back-end of the nuclear fuel cycle is the law of 11 April 2003 (as amended by the law of 12 July 2022). This law stipulates that SYNATOM is responsible for the coverage of decommissioning costs and costs related to the management of irradiated fissile materials and for the management of the funds necessary for that coverage, including the related radioactive waste, on behalf of ENGIE Electrabel and LUMINUS. The law addresses, among others, the following topics:

- the installation of an oversight committee named CPN ("Commission des provisions nucléaires") and its responsibilities;
- the development of a revised methodology for the calculation of nuclear liabilities;
- the transfer of existing funds from ENGIE Electrabel and LUMINUS to SYNATOM;
- the percentage of the funds that can be lent to ENGIE Electrabel and LUMINUS;
- the management of the funds.

ENGIE Electrabel and LUMINUS remain liable for all costs regarding the future dismantling of the nuclear power plants, including eventual cost overruns.

❖ Dismantling funding system

The main characteristics of the applied methodology are the following:

- the net present value of all future decommissioning costs must be assessed, and the associated funding must be available, when necessary,
- the amount of funds is discounted until their use for the dismantling activities.

The current technical scenario to evaluate the dismantling cost is based on the immediate dismantling of all units in sequence, and the decommissioning of the common facilities after the decommissioning of the last unit on each site. This scenario is based on a study performed by an independent engineering company, by the engineering company Tractebel ENGIE, and by ENGIE Electrabel.

For this technical scenario, a bottom-up approach is considered, based upon real plant specific material data (physical, chemical, radiological database present in the power plant). A scenario considering techniques (dismantling, decontamination, clearance) applied to each material is developed. Based on efficiencies values, timing, and unit cost for each technique, and based on a set of boundary conditions, the cost is evaluated by an addition of all the tasks.

Two types of operating experience (OE) are taken into account:

- OE from real decommissioning activities of large NPPs among others, in Germany (similar to the Belgian ones);
- OE from Belgian experiences (nuclear facilities and R&D reactors) is used to take into account the Belgian regulatory framework.

The technical scenario with its boundary conditions included in the preliminary decommissioning plan of ENGIE Electrabel NPP's and the related cost evaluation are updated every 3 years to take the present economic conditions into account, the last one in 2022.

The law of 11 April 2003 (as amended by the law of 12 July 2022) stipulates a three-yearly review and a formal approval by the CPN of any changes in methodology, funding, or investment policy. The CPN formulates its advice with respect to the sufficiency of financial funding, taking into consideration the advice of ONDRAF/NIRAS for technical and costing matters and FANC for matters related to safety, security, and safeguards. The CPN advice is binding for SYNATOM.

❖ Funding system for the management of spent fuel

The applied methodology ensures that appropriate measures are made to cover the costs associated with the management of irradiated nuclear fuel and its nuclear waste, up to and including their final disposal. The estimate has been based on the future costs for all spent nuclear fuel during the total operating lifetime of the 7 nuclear power plants in Belgium as from 1986 onwards (the spent fuel used before 1986 has been reprocessed and the corresponding future costs have also been provisioned). Those costs cover, but are not limited to the intermediate spent fuel storage until a solution for its treatment is defined (reprocessing or conditioning in view of direct disposal), spent fuel reprocessing or spent fuel conditioning, waste storage and final disposal.

In order to limit the risks associated with the future availability of sufficient financial means, several realistic technical scenarios for reprocessing or direct disposal or a mix between-scenario have been identified and their related cost duly evaluated following the same methodology. The amount of funds is currently determined by mixed scenario with a part of reprocessing of spent nuclear fuels and a part of direct disposal.

Also for this fund, there is an update every 3 years with a binding advice from the CPN similar as for decommissioning.

F.2.2.b Research Reactors

The SCK CEN, the Belgian Nuclear Research Centre is a "Foundation of Public Utility " (FPU) with a legal status according to private law, set up according to the law on non-profit organisations, under the supervision of the Belgian Federal Minister in charge of Energy.

❖ Financing of decommissioning

The future cost for dismantling is covered by funds. With respect to these technical liabilities, the following rules for funding apply. All dismantling costs for installations built and in operation before 1989 are covered by a special "Technical Liabilities Fund", which is secured by the Federal State and managed by ONDRAF/NIRAS. All new technical liabilities after January 1989 are financed by the SCK CEN by means of setting up the necessary provisions. The total liabilities are reassessed yearly, and total amounts will be available at the moment of dismantling and decontamination. The necessary financial means are funded by means of annual government grant and by revenues from contract research and services to third parties.

❖ Financing of the management of spent fuel

The Federal State is responsible, through the SCK CEN technical liabilities fund, managed by ONDRAF/NIRAS, for fuel loaded into the reactors prior to 1st of January 1989. SCK CEN is responsible for financing the management of its spent fuel from the research reactors for fuel loaded into the reactors after 1st of January 1989. SCK CEN makes the necessary provisions to cover the end-of-cycle costs for its fuel.

These provisions are audited annually, and ONDRAF/NIRAS evaluates them every five years as part of its nuclear liabilities inventory mission.

F.2.2.c Financing of ONDRAF/NIRAS activities

The coverage of the costs of managing spent fuel and radioactive waste and the costs of decommissioning, in this context referred to the generic term "management costs", is based on the provisions of the legal and regulatory framework. With the acceptance process, ONDRAF/NIRAS takes charge of the radioactive waste from producers against payment by these producers of a tariff intended to cover the cost of short-term, medium-term, and long-term management of the transferred waste. For their part, in principle, producers make provisions to cover their future decommissioning costs, including the cost for ONDRAF/NIRAS to manage the radioactive waste from dismantling, while owners of the spent fuel make provisions in particular for ONDRAF/NIRAS to manage their reprocessing waste and/or spent fuel declared as waste.

As part of its legal mission to produce a five-yearly inventory of nuclear liabilities(last version published in March 2024), ONDRAF/NIRAS makes recommendations to the supervising Ministers on organising coverage for these management costs.

❖ Legal and regulatory framework

The legal and regulatory framework concerning the coverage of management costs is currently composed of different regulations as well as general elements of law (civil law, accounting law, administrative law, tax law, company law, etc.) and provisions relating to specific cases where various institutional entities have already been held financially liable.

- ***The Article 179, § 2, of the Law of 8 August 1980*** *(ONDRAF/NIRAS Law),*

which, in particular,

- stipulates that the costs related to 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 its long-term missions (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" to compensate for the potential bankruptcy or insolvency of a waste owner or producer;
- 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.

- ***The 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 on, among other things, the financial terms for taking charge of their waste.

- ***The 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,*

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.

- ***The 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,*

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.

- ***The Law of 29 April 1999**, on the organisation of the electricity market,*

which, in particular, structures the financing for the obligations resulting from the decommissioning of the BP1 (former pilot reprocessing plant Eurochemic or BP1 liability) and BP2 (former Waste department of SCK CEN or BP2 liability) sites.

- ***The Law of 11 April 2003**, on the provisions created for the dismantling of nuclear power plants and the management of fissile materials irradiated in these power plants*

This law was previously the law defining the control over nuclear provisions. These dispositions have been abrogated by the law of 12 July 2022 (see hereunder).

- ***The Law of 12 July 2022** amending Article 179 of the Law of 8 August 1980 concerning the budgetary proposals 1979-1980 and the programme law of 30 December 2001,*

which defines the financing mechanisms of specific legal tasks of ONDRAF/NIRAS related to the National Policy and effective participation, to the inventory of nuclear sites and materials, and to reporting, self-assessment and peer review obligations from the EC Directive 2011/70/Euratom.

- ***The Law of 12 July 2022** strengthening the framework applicable to the provisions established for the dismantling of nuclear power plants and for the management of spent fuel and to partially abolishing and amending the law of 11 April 2003 on the provisions created for the dismantling of nuclear power plants and the management of fissile materials irradiated in these power plants,*

which reinforces the legal framework for the sufficiency and availability of the financial resources.

❖ Mechanisms set up by ONDRAF/NIRAS

- *Financing of **short-term management activities***

Financing for the treatment and conditioning of radioactive waste is provided via two different mechanisms:

- The “main” radioactive waste producers finance the treatment and conditioning of their waste in accordance with the provisions of the agreements between them and ONDRAF/NIRAS, on the basis of an agreed fraction of the fixed costs for the treatment and conditioning facilities at Belgoprocess, and the payment of the variable operating costs for the management of its waste.
- The “small” radioactive waste producers finance the treatment and conditioning of their waste through so-called “all-in” tariff payments that cover the treatment, conditioning, storage, long-term management, and general activities.

- *Financing of **medium-term and long-term management activities***

Financing for the medium-term and long-term management of radioactive waste must cover the cost of technical activities and the cost of so-called “associated” conditions which accompany the implementation of disposal projects. Indeed, local populations who agree to the disposal of radioactive waste on their territory and the related detriment serve the public interest, which justifies some kind of compensation. Technical costs are covered by tariff payments made by waste producers into a centralised fund, the long-term fund. The costs of associated conditions will be covered by the medium-term fund.

The *long-term fund*, created in accordance with the ONDRAF/NIRAS Law and operational since early 1999, is ONDRAF/NIRAS’ responsibility. Its mechanism is based on a capitalisation system. It is provisioned by radioactive waste producers every time they transfer radioactive waste to ONDRAF/NIRAS, according to a funding mechanism which, in principle, ensures that ONDRAF/NIRAS will eventually be able to cover its fixed costs and enables it to cover its variable costs as they arise. It does not cover the cost of potentially retrieving the disposed waste.

In the past, the long-term fund mechanism was such that tariff increases were carried forward on waste still to be taken charge of by ONDRAF/NIRAS from the revision date of the tariffs. This meant that the very last producer delivering waste to ONDRAF/NIRAS would potentially have to cover the management cost for the radioactive waste from all other producers that they would not have covered. This system has changed with the provisions of the Royal Decree of 25 April 2014, which amends the ONDRAF/NIRAS Royal Decree. This new decree, which specifies the guiding principles for provisioning the long-term fund, stipulates that tariff increases are passed onto producers based on their full programme for generating radioactive waste, in other words, both the waste that they have already transferred to ONDRAF/NIRAS and the waste still to be transferred.

The *medium-term fund* is designed to cover the costs of implementing the conditions associated with a disposal project, so that the project taken as a whole — or integrated project — presents added value for the local populations concerned. In accordance with the provisions of the ONDRAF/NIRAS Law, the medium-term fund will be financed by a so-called "integration" contribution levied against the radioactive waste producers and calculated based on the total capacity of the repository and the respective total waste quantities from the producers that are intended to be disposed of within it. The financing of the medium-term fund is set by the Royal Decree of 25 April 2024 , which amends the Royal Decree of 30 March 1981 that determines the missions of ONDRAF/NIRAS (see § E.2.2 – Applicable national requirements for the safe management of radioactive waste and spent fuel). The amount of the medium-term fund for surface disposal is set by the ONDRAF/NIRAS Law at 130 million EUR_{2010} to be indexed. The obligation for producers to contribute to the medium-term fund begins as soon as the repository has been the subject of a nuclear construction and operation licence and the necessary non-nuclear permits. The medium-term fund must be fully established no later than three months after the confirmation licence, which allows its commissioning and operation, is issued.

- **Financing of the technical inventory, acceptance system and other activities, particularly RD&D**

The technical inventory, acceptance system and other activities are financed based on the terms set out in the bilateral agreements with waste producers. These usually provide for quarterly advance payments with settlement based on the closure of ONDRAF/NIRAS' annual accounts.

- **Insolvency fund**

The *insolvency fund*, implemented in 1992, 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 cost of managing sources declared by FANC as orphan and waste. It does not cover services resulting from the bankruptcy or insolvency of entities that are financially liable for radioactive radium-bearing waste from old radium extraction activities and radioactive NORM waste.

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

- **Provisions made by the producers and ONDRAF/NIRAS' nuclear liabilities inventory mission**

As part of its legal missions, every five years, ONDRAF/NIRAS draws up an inventory of the nuclear facilities and sites containing radioactive substances, estimates the management cost, i.e. all the costs for decommissioning, remediation, radioactive waste management and, if necessary, managing spent fuel, to be charged to each financially liable entity and evaluates the existence and sufficiency of the provisions made to cover the costs. This mission, called the "nuclear liabilities inventory", is financed by fees charged to nuclear facilities operators and holders of radioactive substances or, failing this, their owners.

The last nuclear liability report covering the period 2018-2022 has been published beginning of 2024. The nuclear liabilities inventory is primarily a financial exercise, which should enable ONDRAF/NIRAS' supervising Ministers to ensure that every financially liable entity plans in time the necessary resources to cover the costs for dismantling and for the management of radioactive waste (either present on site or arising from the dismantling) or, if this is not the case, should enable it to impose the necessary corrective measures in a timely fashion. This inventory also contains recommendations on organising coverage for the costs of managing spent fuel and radioactive waste.

The recommendations in the report of 2018 led to the decision by the current Federal Government to create a task force bringing together representatives of the institutional actors; this task force has been charged of examining how to ensure continuity of the financing in a context where waste producers progressively stop their activities. The task force concluded its mandate by making proposals to improve the legal and regulatory framework.

F.2.2.d Summary table of financial responsibilities for management costs

Table 7 below gives a summary, drawn up from the fifth nuclear liabilities inventory report by ONDRAF/NIRAS, of the (main) financially liable entities responsible for covering the management costs associated with a selection of significant sites in Belgium and the main financing mechanisms established by these entities, and similar information for several specific waste groups (orphan sources and radium-bearing and NORM wastes that would be declared as radioactive waste to ONDRAF/NIRAS.

Table 7 Summary table of financial responsibilities for management costs.

Sites (or groups of waste)	Financially liable entities (main)	Main financing mechanisms
ENGIE 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)	Operational waste : SCK CEN Technical liabilities before 1989: Federal State New technical liabilities, starting from 1989: SCK CEN	Annual budget External fund, without separate legal personality, with additional measures 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
IRE (Fleurus)	Liabilities: Federal State	External fund, without separate legal personality, with additional measures
Private radioisotope production companies	The companies concerned	Accounting provisions
BMB (Fleurus) – bankruptcy	Special case of BMB, declared bankrupt and no longer having financial resources (2012): – financing by the Walloon Region through an internal fund for the management costs referred to in agreements prior to the bankruptcy; – for the management costs not referred to in these agreements, financing through the insolvency fund	
Belgoprocess (Mol and Dessel)	Excluding liabilities: ONDRAF/NIRAS Liabilities: Federal State	Internal funds with additional measures External fund, without separate legal personality, with additional measures
Umicore authorised storage facilities and radium-bearing waste to be managed as radioactive waste (Olen)	Umicore	Accounting provisions
Orphan sources	—	Insolvency fund
NORM waste that would have to be managed as radioactive waste	Site operator, user, or owner	Environmental accounting provisions, not specific to potential costs for management of NORM waste as radioactive waste

F.3 Article 23 – Quality Assurance

ARTICLE 23. QUALITY ASSURANCE

Each Contracting Party shall take the necessary steps to ensure that appropriate quality assurance programmes concerning the safety of spent fuel and radioactive waste management are established and implemented.

F.3.1 Legal and regulatory framework

Article 6 §4 of the European Directive 2011/70 (transposed in Belgian law by the law of 3 June 2014) requires 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 6 (d) of the European Directive 2009/71 (amended by 2014/87) requires licence holders to establish and implement management systems which give due priority to nuclear safety.

Art. 5 of the Royal Decree of 30 November 2011 (SRNI-2011) requires licensees to establish, implement, assess, and improve on a continuous basis an integrated management system giving priority to safety. This management system shall cover all the activities and processes which can have an impact on the nuclear safety of the facility, including the activities carried out by the subcontractors or suppliers.

Art. 4 of the same SRNI-2011 states that the organisational structure of the licensee has to be documented and that nuclear safety management should follow a graded approach to ensure a safe operation of the facility by sufficiently qualified people. The human resources management must take into account the long-term objectives as well as retirement and other cutbacks.

Art. 5 §1 of the Royal Decree of 18 November 2002 governing the qualification of facilities for the storage, treatment and conditioning of radioactive waste requires licensee to establish a quality management system for their waste storage and treatment installations. Art. 5 §2 sets out requirements for this quality management system.

F.3.2 Quality Management system of ONDRAF/NIRAS

F.3.2.a Integrated management system

ONDRAF/NIRAS' radioactive waste management system comprises a series of steps that can be grouped into short-term (treatment and conditioning), medium-term (storage) and long-term (disposal) management activities. The short-term and medium-term management activities are part of a policy of centralised, safe management at Belgoprocess. Developments on disposal of radioactive waste are at very different stages of progress.

In order to ensure interdependencies between the different steps for the management of radioactive waste and specifically to guarantee that all requirements ensuing from the need to ensure long-term safety are passed on across the previous management steps, ONDRAF/NIRAS has implemented an integrated management system for all the steps in the management of radioactive waste and for its activities as operator. This system is based on the legal requirements and the IAEA recommendations. Its backbone is the waste acceptance system.

F.3.2.b Quality Management certification of ONDRAF/NIRAS and Belgoprocess

The "Waste Acceptance system" of ONDRAF/NIRAS is ISO 9001 certified since 2002. The Waste Acceptance System constitutes the central point around which most activities of ONDRAF/NIRAS revolve.

ONDRAF/NIRAS integrated the Quality Management System in an Integrated Management System. After adaptations of the process model, a process 'management systems' was defined.

ONDRAF/NIRAS has taken in the last few years different steps towards the further adoption of an Integrated Management System (including safety, environmental, quality, economic, human-and-organisational-factor, … elements) in line with the IAEA Safety Requirements and Safety Guides concerning Integrated Management Systems. The management system is based on the Plan-Do-Check-Act cycle.

Efforts have been made on different levels. The most important evolutions are:

- The implementation of a structured internal control system at three levels (Three lines of defence-model), more specifically self-assessments of the processes, assessments in the context of audits, external audit, and management reviews;
- In this context, the continuous follow up of defined risks and measures since the development of a structured risk management system (define scope, identify risks, describe risks and consequences, evaluate risks, propose measurements, and do the follow-up) suitable at every level of the organisation;
- To document and describe all the processes (using the graded approach) in a process modelling tool with the focus on the interaction between the processes, the roles and responsibilities and the interaction with Belgoprocess and other stakeholders, following the graded approach. It was necessary to describe several processes in detail;
- The review of the safety policy (in line with the revision of GS-R-3 in GSR part 2), the development of an action plan and the ongoing implementation of several activities and training sessions with the main goal to improve and optimize the safety culture;
- Digital monitoring of incidents related to safety, environment, quality, health … and related measures or suggestions for improvement;
- To develop a policy and management cycle to ensure the follow-op of different strategic activities
- The ongoing elaboration of end-to-end processes, focusing on interactions between processes;
- The ongoing improvement of alignment of the management systems of ONDRAF/NIRAS and Belgoprocess.

Belgoprocess has implemented for its activities in a quality management system which complies with the ISO 9001, ISO 14001, and ISO 45001 standard, and with the IAEA safety standard GS-R-3 (now GSR part 2).

Since safety and environmental protection are imperious conditions for nuclear activities, Belgoprocess works continuously towards a total integration of quality, safety, and environmental protection issues into one management system. The global certification ISO-9001, ISO-14001 and OHSAS-18001 has been obtained since 2007.

F.3.2.c Waste acceptance system

The acceptance system (see Figure 11) guarantees that the interdependencies between the successive steps in the management of radioactive waste and related to the radiological and physico-chemical characteristics of such waste are taken into account in ONDRAF/NIRAS' management system. This system aims to ensure that at each step in the management chain, the radioactive waste has characteristics that are deemed compatible with the requirements ensuing from the subsequent steps in its management

There are three parts to the acceptance system:

- The establishment, by ONDRAF/NIRAS, of the acceptance criteria which non-conditioned and conditioned waste must satisfy for ONDRAF/NIRAS to take charge of it, as well as the

establishment of the terms for transferring the ownership of this waste from the producers to ONDRAF/NIRAS. The acceptance criteria have been established based on the general rules drawn up by ONDRAF/NIRAS in accordance with the provisions of the ONDRAF/NIRAS Royal Decree and approved by the competent authority on 10 February 1999. These also take into account the provisions of the nuclear licences for the transport of radioactive waste and the operation of treatment, conditioning, and storage facilities for this waste. Once the long-term management solutions for category A, B and C waste are well established, the acceptance criteria will be adapted to take into account the requirements specific to the disposal facilities and, subsequently, the provisions of the nuclear licences for the construction and operation .

- The qualification, by ONDRAF/NIRAS, in accordance with the provisions of the Royal Decree of 18 November 2002, of the treatment and conditioning equipment and processes, including the primary packages of conditioned waste (i.e. the confirmation that these facilities, processes and packages are suitable for producing waste that complies with the applicable acceptance criteria), the qualification of the methods and equipment for determining the radiological content and physico-chemical characteristics of non-conditioned and conditioned waste, and the qualification of the storage buildings.
- The acceptance, by ONDRAF/NIRAS, of the conditioned or non-conditioned waste packages delivered by producers, after the administrative and technical verification of their compliance with the applicable acceptance criteria. This acceptance is accompanied by payment by the waste producers of a tariff intended to cover the cost of the waste's short-term, medium-term, and long-term management and by the transfer of ownership of the waste to ONDRAF/NIRAS. In the case of delivery of non-conditioned waste, the waste is also subject to a technical acceptance by ONDRAF/NIRAS, after its conditioning by Belgoprocess.

The acceptance system is applicable to waste treated and conditioned in Belgium, as well as to waste from the reprocessing of Belgian spent fuel abroad which is then treated and conditioned on site before being returned to Belgium. This waste comes from the reprocessing of SYNATOM's spent fuel at la Hague and the reprocessing of spent fuel from SCK CEN's BR2 research reactor at la Hague and Dounreay.

Radioactive waste from the treatment of contaminated equipment and materials of Belgian origin abroad, which is returned to Belgium, must be accompanied by detailed characterisation files demonstrating that it complies with ONDRAF/NIRAS' waste acceptance criteria.

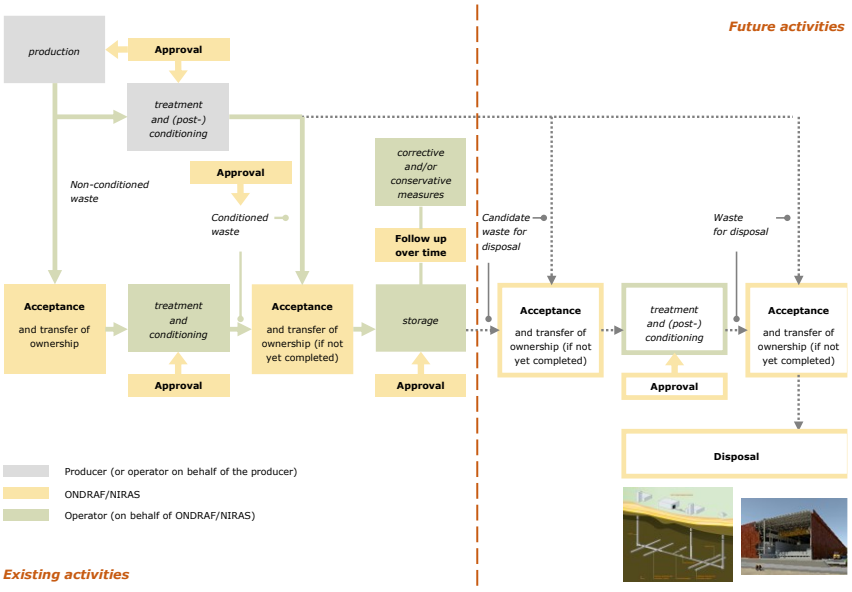


Figure 11 Simplified diagram of the ONDRAF/NIRAS acceptance system for radioactive waste. The system currently in force for the acceptance of non-conditioned and conditioned waste is being extended to waste for disposal.

As for the category A surface disposal, ONDRAF/NIRAS is also preparing the verifications of the waste before its disposal. On the one hand, waste conformity files confirming the conformity of groups of waste with the surface disposal facility in Dessel are being established, verified, independently assessed by the HDP, and after approval of the HDP submitted to Bel V and the FANC for assessment and approval. On the other hand, a programme on disposability of waste is conducted. The disposability programme comprises various projects related to changes to monoliths or conformity criteria for specific waste streams with issues on (chemical) waste conformity criteria. It also comprises a project on further developing specific DT/NDT techniques for controlling the wastes before their disposal.

F.3.3 Quality Management system of ENGIE Electrabel / SYNATOM

The responsibility for applying the quality assurance (QA) programme is assumed by ENGIE Electrabel, who subcontracts the related tasks to Tractebel-ENGIE, his Architect-Engineer during the design and construction phases of the power stations, up to and including the commissioning tests.

As regard the spent fuel casks owned by SYNATOM, the process is similar. The responsibility for applying the quality assurance (QA) programme is assumed by SYNATOM, who subcontracts these tasks to Tractebel-ENGIE during the design and construction phases of the casks, up to and including the commissioning tests.

During the operation lifetime of the casks, the quality assurance programme is managed by ENGIE Electrabel.

The management system for nuclear safety is described in chapter 17 of the Safety Analysis Report which deals with the design and construction phases, followed by the operation period. As there is no unit under construction at present in Belgium, emphasis is put on how the integrated management system is applied during operation.

F.3.3.a ENGIE Electrabel's global approach

The principal goal of ENGIE Electrabel's management system is to ensure and to improve safety at Doel and Tihange power stations through a common approach and via plant-specific approaches.

To fulfil its mission and achieve its objectives, ENGIE Electrabel establishes, implements, assesses, and continually improves a management system that meets the following basics:

- Nuclear Safety is the overriding priority within the management system, taking precedence over all other considerations;
- It fosters the development of, and promotes the improvement of, a strong Nuclear Safety culture by improving behaviour and attitudes both among individual workers and line management;
- It identifies and integrates coherently all requirements that are applicable to its activities and processes, especially about Nuclear Safety, Quality, Nuclear Security, Health and Safety, Environmental protection, and Economic considerations.
- It is based on the identification, development, implementation, assessment, and continuous improvement of the processes needed to achieve the goals and meet all requirements applicable to ENGIE Electrabel.
- To deploy appropriately its resources, ENGIE Electrabel implements the requirements of its management system following a graded approach.

The implementation of this management system allows ENGIE Electrabel to:

- Improve its Nuclear Safety performance through the planning, monitoring, and control of its safety-related activities;

- Ensure that Quality, Nuclear Security, Health and Safety, Environmental protection requirements and Economic considerations are not considered separately from Nuclear Safety, to help preclude their possible negative impact on Nuclear Safety
- Describe the planned and systematic actions necessary to provide adequate confidence that it conforms to all its applicable requirements;
- Allocate appropriate resources to carry out its activities and provide the countermeasures to be put in place in order to offset any process or activity failures.

The effectiveness of the management system is monitored and measured to confirm the ability of the processes to achieve the intended results and to identify opportunities for improvement.

Opportunities for the improvement of the management system are identified and actions to improve the processes are selected, planned, and recorded. Improvement plans include plans for the provision of adequate resources. Actions for improvement are monitored through to their completion and the effectiveness of the improvement is checked.

F.3.3.b Applicability

The integrated management system applies to any safety-related Structures, Systems, Components as well as to activities or processes affecting nuclear safety, e.g. human performance, organisational performance, safety culture, radiological protection, radioactive waste management, fire detection and protection, environmental monitoring, nuclear fuel management, emergency intervention and site security.

F.3.3.c Key documents

ENGIE Electrabel's management system for Nuclear Safety is described in a number of documents that move downwards from broad principles towards technical specifications and daily practices:

- Chapter 17.2 of the FSAR
- The Policy Manual of the Nuclear Generation Management System Reference Book
- Governance Nuclear Activities ENGIE Electrabel
- Execution documents

❖ **The "Reference Book" and the "Governance Nuclear Activities ENGIE Electrabel"**

The "Reference Book" is the cornerstone of the ENGIE Electrabel internal governance regarding Nuclear Safety and describes the Nuclear Safety Management System of the Nuclear Production of ENGIE Electrabel (NGMS). Through the management system, ENGIE Electrabel guarantees and continuously improves its nuclear safety performance based on standards and expectations, evolving with changing regulatory requirements and performance enhancing decisions.

Internal governance means « the needed organizational structures, policies, processes and programs to establish high standards for executing the nuclear activities of ENGIE Electrabel, including the operation, maintenance and organizational support of the nuclear power plants. »

The NGMS is structured by grouping these activities & processes in a number of Functional Areas (FA), in which processes important to Nuclear Safety are clearly identified.

The standards & expectations for each of those FA's integrate all (regulatory) requirements related to nuclear safety and other specific (regulatory) requirements that could interact and could have a negative impact on nuclear safety during operation of the NPP, coming from industrial safety (OHSAS 18001), environment (ISO 14001) or any other governance applying to the FA.

The NGMS reference book is built up in compliance with regulatory requirements and includes:

- the company's policy statements on Nuclear Safety, H&S, Security and Environment
- the organizational structure of the nuclear activities
- a description of the management system NGMS and its Functional Areas (FA)

- a description of the method used to measure, assess, and improve performance in the different FAs (including NGMS as a management system)
- functional responsibilities and responsibilities of Senior and Line Management
- a description how all related documentation is structured and managed
- an identification of the interactions with requirements other than Nuclear Safety related that apply to the operator (e.g. OHSAS18001, ISO 14001 …).
- the standards & expectations per FA.

The standards and expectations per Functional Area, are described and kept up to date in the "Governance Nuclear Activities ENGIE Electrabel" document.

❖ **Competence development**

A general training is given regarding the quality assurance objectives and the means for achieving these, to all personnel in charge of safety-related activities or processes in the various services. This training is maintained and updated when necessary.

F.3.3.d Evaluation

Quality assurance is integrated directly in the different processes and procedures, important for the nuclear safety. Basics elements are the necessity to perform self-checks and peer-checks during the execution of the tasks, and to execute tests, inspections, and verifications to provide evidence that a structure, system, or component will perform satisfactorily in service.

❖ **Nuclear safety oversight**

Corporate oversight and monitoring are used to strengthen Nuclear Safety and improve performance. Plant safety and reliability are under constant scrutiny through techniques such as assessments, performance indicators, and periodic management meetings.

❖ **Self-assessment (Management Reviews and Functional Area Health Reviews)**

Management at all levels (Line Management and Functional Area Management) carry out self-assessments with the objectives to:

- Evaluate the performance of work;
- Verify compliance with all aspects of the management system (legal and performing enhancing requirements);
- Prevent, identify, and correct weaknesses that hinder the achievement of ENGIE Electrabel's objectives;
- Improve the management system;
- Enhance the Nuclear Safety culture and the effectiveness of processes and activities.

❖ **Management System Review**

A management system review is conducted at planned intervals at to ensure the continuing suitability and effectiveness of the management system and its ability to enable the objectives set for ENGIE Electrabel to be accomplished and the Nuclear Safety policy to be met.

❖ **Independent Nuclear Safety Oversight**

The Health Physics Department ("Service de Contrôle Physique/Dienst voor Fysische Controle") is established with the responsibility for conducting these independent assessments. It has sufficient authority to discharge its responsibilities, and has direct access to the Senior Management. Within the Health Physics Department , the roles, and responsibilities of the Care departments and the ENGIE Electrabel Corporate Nuclear Safety Department are clearly defined. Independent oversight provides the ENGIE Electrabel Senior Management with an ongoing perspective of performance at

the nuclear stations and in the corporate organization compared to the industry, with a principal focus on Nuclear Safety, plant reliability, and emergency response effectiveness.

The Independent Nuclear Safety Oversight embodies a comprehensive system of planned and periodic audits and assessments, to verify compliance with the different aspects of the management system.

❖ **Nuclear Safety Committees**

Within ENGIE Electrabel, Nuclear Safety Committees are defined at different level. Their objectives are to evaluate and continuously improve the Nuclear Safety performance and the Safety Culture of ENGIE Electrabel:

- The Plant Operating Review Committees (PORC, plant level),
- the Site Operating Review Committees (SORC, site level),
- The Independent Nuclear Safety Committee (INSC, fleet level), and
- Nuclear Safety Committee (CSN, Board level).

❖ **Regulatory control activities**

As regards the regulatory control activities, FANC and Bel V verify the practical implementation of the various regulations during operation. As regards pressure vessels for which the ASME code or the conventional Belgian regulations (RGPT) are applicable, the intervention of an Authorised Inspection Agency (AIA) is required as an independent inspection organisation, and FANC and Bel V take into account the results of those inspections.

F.3.4 Quality Management system of the regulatory body

F.3.4.a The Federal Agency for Nuclear Control

Both the FANC and Bel V have their own management systems, that are connected to each other when useful.

The FANC management system consists of:

- a governance document “Management system policy” which describes how missions and responsibilities entrusted to the FANC by the Law of 15 April 1994 are discharged through the different FANC departments;
- the “Strategic plan” which is established on a timeframe of 9 years. This strategic plan is translated in a 3-year operational plan and finally in an annual operational plan including the assigned resources;
- FANC policies, developed in accordance with the FANC missions and the Strategic plan and validated by the senior management. They have committed themselves to follow the quality policy requirements and request every FANC employee to do the same.
- procedures described in the FANC management system are derived from the legislation and the FANC policies.

The processes include licensing, inspections, incident and accident management, environmental surveillance, security, enforcement, development of regulations and guides, international relations, projects and development, human and financial resource management, communication, ICT management, legal affairs, and record and information management.

The concept of continuous improvement is being applied to the FANC organization, to the management system, and to the individual workers at FANC.

An annual Management Review is conducted on the quality aspects, including results of internal/external quality audits, corrective/preventive actions, non-conformities, complaints, and customer satisfaction surveys and financial aspects.

F.3.4.b Bel V

At the end of 2006, in view of ISO-certification, a process-oriented organisation has been implemented. Among these processes, the most important ones from a safety point of view are to manage projects/missions (manage safety assessment projects and inspection projects), to perform inspections, to provide and to manage expert services (perform safety assessment activities), to manage expertise and technical quality, to manage and to develop human resources. Process managers who are accountable for the realisation of goals manage these processes as well as the quality of the activities performed in the process they are in charge of.

The follow-up of all national and international projects linked to the operation of the installations is performed in the framework of the process "Technical Management of the projects/missions". Recent examples are the periodic safety reviews, the long-term operation of NPPs, the preparation of decommissioning and dismantling for the units in definitive shut-down, the licensing process of new on-site interim spent fuel storage facilities for the Doel and Tihange sites, the licensing of a waste disposal facility.

Safety assessment is performed in the framework of the process "provide and manage expert services". It covers support to inspection activities, the analysis of significant modifications, and analysis having a more general character such as generic studies valid for all nuclear power plants, probabilistic safety assessment, etc…

Bel V's technical staff, regardless of which main process they belong to, is attached to "Technical Responsibility Centres" (TRC), or "horizontal" cells in charge of exercising nuclear safety and radiation protection expertise and of maintaining the knowledge in the various technical specialities. The management of all TRCs is also performed within the process "provide and manage expert services".

The process "perform the inspections during operation" covers inspections in all nuclear installations supervised by Bel V. The activities performed in this process also include inspections in installations other than nuclear power plants, namely other Class I facilities, including Belgoprocess, as well as in some high-risk Class II facilities. Besides, this process includes Bel V activities in the frame of its participation in the national emergency preparedness & response plan. The "Operating Experience Feedback Committee" belongs also to this process.

Research and Development activities in which Bel V participates (own developments in Bel V, bilateral and international projects) are managed in the framework of the process "manage expertise and technical quality".

These processes are managed by directors who are accountable for the realisation of goals and the quality of the activities performed in the process they are in charge of.

Bel V MS is aligned with the requirements of GSR part 2. Furthermore, Bel V has been certified ISO 9001:2008 in 2009 and ISO 9001:2015 in 2018 and 2021.

F.4 Article 24 – Operational Radiation Protection

ARTICLE 24 OPERATIONAL RADIATION PROTECTION

1. Each Contracting Party shall take the appropriate steps to ensure that during the operating lifetime of a spent fuel or radioactive waste management facility:

(i) the radiation exposure of the workers and the public caused by the facility shall be kept as low as reasonably achievable, economic and social factors being taken into account;

(ii) no individual shall be exposed, in normal situations, to radiation doses which exceed national prescriptions for dose limitation which have due regard to internationally endorsed standards on radiation protection; and

(iii) measures are taken to prevent unplanned and uncontrolled releases of radioactive materials into the environment.

2. Each Contracting Party shall take appropriate steps to ensure that discharges shall be limited:

(i) to keep exposure to radiation as low as reasonably achievable, economic and social factors being taken into account; and

(ii) so that no individual shall be exposed, in normal situations, to radiation doses which exceed national prescriptions for dose limitation which have due regard to internationally endorsed standards on radiation protection.

3. Each Contracting Party shall take appropriate steps to ensure that during the operating lifetime of a regulated nuclear facility, in the event that an unplanned or uncontrolled release of radioactive materials into the environment occurs, appropriate corrective measures are implemented to control the release and mitigate its effects.

F.4.1 Legal and regulatory framework

The GRR-2001 provides the basic nuclear safety and radiological protection regulations. Amendments are regularly proposed by the FANC in order to take account of scientific and technical developments, to transpose the European directives (e.g. Basic Safety Standards 2013/59/Euratom…)

Chapter III "General Protection" of GRR-2001 specifically deals with radiological protection and ALARA-policy. Amongst others:

- Article 20 sets among others the three basic radiological protection principles: justification of the practice, optimisation of protection and dose limits for both workers and members of the public.
- Article 23 describes the key role of the Health Physics Department (HPD). This department is, in a general way and amongst other duties, responsible for the organisation and the supervision of the necessary means for occupational radiation protection. The head of the HPD in nuclear facilities (Class I) must be a qualified expert of Class I, recognized as such by the FANC. Assessments and findings of the Health Physics Department must be recorded, including the dose registration. The individual doses, including doses due to the internal contaminations and accidents are reported to the medical service. Each year the licensee has to send the recorded doses to the centralized registration system at the FANC. The registers of the HPD are stored for at least 30 years.
- Art. 24 to 26 deal with the medical surveillance of workers and with the requirements with respect to their training and obligations of the workers to comply with instructions and regulations

- Art. 27 to 32 deal with the general protection equipment and arrangements, including individual protection equipment, dosimetry, and the use of warning signs.
- Art. 33 to 37 deal with radioactive waste (solid, liquid, and gaseous) and discharges

The GRR-2001 also introduce the concept of clearance and strict rules concerning the reuse and the recycling of very low-level solid waste.

The book V, title 5 of the Code on well-being at work on the protection of workers against the risks of ionizing radiation stipulates amongst others the modalities of the medical surveillance of the exposed workers by a recognized health physician, depending on the radiological risks at the installations.

Article 7 of SRNI-2011 sets the requirements related to the design basis of the facility. These requirements comprise among others, safety functions, the defence in depth concept, the identification of normal operating conditions, anticipated operational occurrences as well as accidents from postulated initiating events (internal and external), fail safe principle …

F.4.2 Implementation

Different means are used for the ALARA-application: development, approval, and implementation of a working plan; optimisation of working methodology during the receipt, transfer, and storage operations; use of software tools for evaluation of the individual and collective doses before the operations are performed.

F.4.2.a Dose limits

For specific operations, exposed workers are equipped with individual neutron and gamma dose rate meters for a strict follow-up of the dose. Operational dosimetry is used for ALARA purposes only, with immediate warning in case of significant dose or dose rate.

For official occupational dose registration, dosimeters recognized by the FANC have to be used. They typically integrate the dose over an extended period of time (e.g. 1 month) and are not suitable for ALARA.

For substantial or unusual works, there is a specific safety/radiological protection preparation of the work, through consultation between the Head of the Health Physics Department (HPD) and the work supervisor, well ahead of the planned date of the work. Where possible, operations are performed remotely (use of manipulators or use of automatic sequences, etc…).

At the design, radiation zones are defined with a limitation of the dose rate in function of the exposure time.

For the waste storage buildings at Belgoprocess the dose rate outside the recent buildings (in contact with the walls) is limited to 10 µSv/h. For the storage building of the used steam generators of the Tihange plant, this limit is set at 7.5 µSv/h. In practice the measured dose rate values are far below these limits. The areas that are accessible by the public are located at several hundreds of meters from the storage buildings. The design of these buildings is such that the impact for the public (including sky shine effects) is only a small fraction of 1 mSv/year.

Shielding is systematically installed at various locations during operations. Specific shields are also installed when dictated by the type of the work (e.g. detecting hot spots). Warning signs indicating the hot spots and the ambient dose rates informs the workers about the ambient radiological conditions; access to certain locations is only allowed with specific authorisation of the Health Physics Department; specific ALARA warning signs are present; signals indicate to the worker the location of very low dose rate areas (“green” area) that may be used as falling-back station. On a voluntary basis, facilities apply a dose constraint for the individual dose. In practice, for all nuclear facilities, this is about half the of the legal dose limit (20 mSv per 12 consecutive months, in accordance with the GRR-2001).

F.4.2.b Contaminations

The contaminations are excluded or limited by the multiple barriers (confinement of radioactive materials, ventilation (depression cascade, rate of air renewal, installation parts for collection of leakages, etc…).

Licensees have to check periodically storage conditions of conditioned and unconditioned waste and spent fuel in order to verify the integrity of the packages. Reporting is done to ONDRAF/NIRAS and FANC.

For the storage facilities at Belgoprocess a systematic inspection programme is implemented to verify the conformity of the stored waste packages with the waste acceptance criteria that apply. As defined in the general rules for the waste acceptance criteria this inspection is executed within the first three years of storage and then every ten years. ONDRAF/NIRAS reports the results of this inspection programme to its supervising Ministers.

Systematic measurements are performed for surface and air contamination (continuous air monitoring is also foreseen if required) in representative locations. Immediate action is taken should a problem be detected (decontamination of the surfaces).

The degree of the contamination has to be below prescribed surface contamination levels for dry storage of spent fuel.

F.4.2.c Discharges

Discharges are defined as authorised and controlled releases into the environment, within limits set by the regulation (GRR-2001) or by the licence. In addition, there are operational release limits (limiting the release on time-based assumptions), linked with a scheme to notify the operators, the HPD, Bel V, and the FANC. The results of the monitoring of the atmospheric releases and the liquid discharges (routine releases) are periodically sent to Bel V and to the FANC for an additional check. An annual report about the discharges and the estimation of their radiological impact on the population is produced by each licensee and sent to the FANC.

Since 2012, the radioactive releases of all Belgian nuclear and waste facilities with their calculated radiological impact are published annually on the FANC web site (in French).

The radiological impact for the most exposed individual of the public, due to releases from the Belgian Class I facilities is reported in Table 8.

The operator of a nuclear facility has to establish and to keep up to date an inventory of the gaseous and liquid radioactive discharges and of the radioactive waste stored on the site and of the cleared materials. This inventory is permanently available to the FANC and ONDRAF.

F.4.2.d Monitoring

Each licensee is responsible for on-site radiological monitoring (monitoring and recording of the radioactive effluents discharges, radioactive contamination, and monitoring of the doses on the site).

At the NPPs and at Belgoprocess, the liquid effluents are released via a single pipe that is monitored for compliance check with the discharge limits. Casks in which spent fuel elements are stored are equipped with a continuous monitoring of the leak-tightness.

Offsite environmental monitoring programmes (e.g. at SCK CEN and Belgoprocess: emission, immission, dose rate, contamination, etc…) are established in agreement with the FANC to assess the impact on the environment. These results are evaluated by the HPD and the FANC.

The Belgium's TELERAD network for automatic radiological monitoring aims at measuring routinely the radioactivity in air and water on the Belgian territory (See article 25 hereafter).

Table 8 radiological impact for the most exposed individual of the public, due to releases from the Belgian Class I facilities.

Site or Facility	Annual exposure to the most exposed individual resulting from average actual releases			
	Gaseous	Liquid	Total (maximum)	Period
SCK CEN	0.86 µSv	-	0.86 µSv	2020-2023
FBFC	< 0.1 µSv	-	< 0.1 µSv	2020-2023
~~**Belgonucleaire**~~				
Belgoprocess	5 µSv	0.56 µSv	5.57 µSv	2020-2022
JRC (Geel)	< 0.1 µSv	-	< 0.1 µSv	2020-2023
total MOL – Dessel site	5.9 µSv	0.56uSv	6.4 µSv	2020-2023
IRE site	7.12 µSv	0.27 µSv	7.39 µSv	2020-2023
Tihange site (3 NPPs)	25.92 µSv	1.58 µSv	27.5 µSv	2020-2022
Doel site (4 NPPs)	21.57 µSv	0.65µSv	22.2 µSv	2020-2022

F.4.3 International exchanges

The regulatory body and the Belgian licensees participate actively since 1992 in the ISOE (Information System on Occupational Exposure) programme of the OECD Nuclear Energy Agency (NEA).

In addition, the FANC is an active member of HERCA (Heads of Radiation Protection Authorities) which brings together radiation protection Authorities from 31 European countries.

Belgium also participates in the relevant working groups set up by the European Commission, the NEA, UNSCEAR and the IAEA and occasionally shares experiences during cross inspections (exchange of practices) with foreign authorities.

Finally, bilateral contacts are established with safety authorities of neighbouring countries.

F.5 Article 25 – Emergency Preparedness

ARTICLE 25. EMERGENCY PREPAREDNESS

Each Contracting Party shall ensure that before and during operation of a spent fuel or radioactive waste management facility there are appropriate on-site and, if necessary, off-site emergency plans. Such emergency plans should be tested at an appropriate frequency.

Each Contracting Party shall take the appropriate steps for the preparation and testing of emergency plans for its territory insofar as it is likely to be affected in the event of a radiological emergency at a spent fuel or radioactive waste management facility in the vicinity of its territory.

F.5.1 Regulatory Framework

- The GRR-2001 in its Article 72 requires an emergency plan for the regulated installations potentially presenting a serious radiological risk.
- Article 16 of the Royal Decree of 30 November 2011 requires each licensee of a Class I facility to set up an internal Emergency plan. This article specifies the objectives, the preparation, and organisational issues. Arrangements with external organisations (fire rescue, hospitals, police ...) have to be concluded. It also states that adequate on-site emergency infrastructure needs to be provided and that the internal emergency plan needs to be exercised at least once per year.
- The Royal Decree of 1st of March 2018 defines a nuclear and radiological emergency plan (NEP) for the Belgian territory. This Royal Decree has been updated very recently (16 June 2024); those modifications could not be reported yet.

F.5.2 Implementation of Emergency Organisation in the Event of an Emergency

F.5.2.a Classification of Emergency

The Royal Decree of 1st of March 2018 defines three levels for the notification of emergencies according to the classification systems of GSR-7, which are in ascending order of seriousness Facility Emergency, Site Area Emergency and General Emergency, which the operator must use when warning the National Crisis Centre (the NCCN in below, previously CGCCR)[22] which assembles under the authority of the Minister of Home Affairs. In addition, a fourth notification level (General Emergency in 'reflex' mode) has been considered to cope with events with fast kinetics. In case an emergency situation is quickly developing (fast kinetics) and might lead within 4 hours to a radiation exposure of the population above an intervention reference level, immediate protective actions for the off-site population – without any assessment – are taken by the local authorities (Governor of the Province), waiting for the full activation of the emergency cells. The "automatic" protective actions taken under this "reflex"-phase are essentially limited to **warning**, **sheltering** and **keep listening** within a predefined **reflex zone**. Once the crisis cells and committees are installed and operational, the Emergency Director of the authorities will decide to cancel the reflex phase and to replace it by the proper emergency level. In such case the governor of the province hosting the nuclear site is immediately notified in parallel to the warning message to the National Crisis Centre. For each of these 4 notification levels (Facility Emergency, Site Area Emergency, General Emergency and General Emergency in 'reflex' mode) the notification criteria are defined in the Royal Decree of 1st of March 2018. In addition, for each nuclear installation concerned, a set of particular types of events is established for each of the notification levels. In the specific case of the General Emergency in 'reflex' mode notification level, the activation criteria are based on predefined scenarios.

[22] NCCN is one of the Directorates of the Home Affairs Federal Public Service (FPS).

For example, the criterion associated with the Facility Emergency level is defined as follows: "Event which implies a potential or real degradation of the safety level of the installation, and which could further degenerate with important radiological consequences for the environment of the site. Radioactive releases, if any, are still limited and there is no immediate off-site threat (no action requested to protect the population, the food chain or drinking water). Actions to protect workers and visitors on site might be necessary."

Each of these 4 notification levels (Facility Emergency, Site Area Emergency, General Emergency and General Emergency in 'reflex' mode) activates the federal emergency plan. In addition to these four levels, an "Alert" level is defined for notifying the Authorities in case of a serious enough operational anomaly that request an evaluation by the regulatory body (concertation between FANC and Bel V) to decide whether or not it is worth activating the emergency plan. Other minor operational anomalies and situations that could raise public interest (such as any intervention of emergency services on site) must be communicated to the authorities, immediately or on the first next working day according to criteria for "Declaration" stated by the regulatory body.

All emergencies (Facility Emergency, Site Area Emergency, General Emergency and General Emergency in 'reflex' mode) have to be notified to the NCCN. This permanently manned centre alerts and mobilizes the cells involved in the crisis management at the federal level (Management Cell Federal Coordination Committee, Evaluation Cell, Measurement Cell, Information Cell) and houses these cells during the crisis situation as well.

In the case of General Emergency in 'reflex' mode, the Governor of the province hosting the nuclear site immediately takes the 'reflex' protective actions (warning, sheltering and keep listening) in a pre-defined 'reflex' zone around the affected site. As soon as all the National Crisis Centre's cells are in place and operational, the General Emergency in 'reflex' mode level will be later converted to an appropriate emergency level (Facility Emergency, Site Area Emergency or General Emergency) by the emergency director of the authority according to the evaluation of the situation and possible consequences. At that time the responsibility of the conduct of the operations returns to the Federal Minister of Home Affairs (or his representative).

F.5.2.b Environment monitoring

The data received through Belgium's TELERAD network for automatic radiological monitoring can also be accessed by the National Crisis Centre and internationally through EURDEP and IRMIS. TELERAD is a network with the principal aim to measure routinely the radioactivity and to make measurements in case of an accident occurring in a Belgian nuclear site or abroad. The monitoring of the territory consists in a measurement network having a 20 km mesh (GM detectors), measurement stations in the vicinity of the Belgian nuclear installations and along the Belgian border in the vicinity of nuclear power plants in neighbouring countries. Around the Belgian nuclear sites, the network is arranged in two rings: the first ring (NaI scintillators) is on the site border and measures ambient radioactivity around the site, the second ring (GM detectors) covers the near residential zone, between 3 and 8 km from the site, depending on the direction. The monitoring network has 226 stations for the measurement of the ambient dose rate in air, 7 stations for the measurement of iodine and β/γ in aerosols and 11 stations for the measurement of radiation in river water; 13 stations are complemented with a meteorological mast.

Next to the fixed measuring station network, 24 mobile measuring devices (GM detectors) are available to be positioned where needed e.g. to fill up gaps between fixed stations. Figure 12 below depicts the TELERAD network. The data can be consulted through a dedicated website.

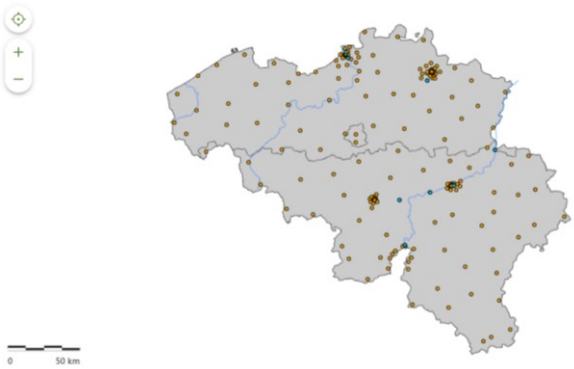


Figure 12 TELERAD Network – location of the measuring stations.

F.5.2.c National Master Plan for Organisation in the Event of Emergencies

The NCCN is composed of the "Federal Co-ordination Committee" chaired by the Emergency Director of the Authorities, of the evaluation cell, of the measurement cell, and of the information cell, as indicated in the figure below.

In case of an accident abroad, the NCCN, as National Warning Point (NWP), is informed by the Ministry of Foreign Affairs, the IAEA (through quick information exchange system USIE), the European Commission through the European Commission Urgent Radiological Information Exchange system (ECURIE) or other reliable sources. The "Emergency Director" of the Authorities as National Competent Authority for accidents Abroad (NCA-A) could also be informed by the IAEA and/or the EC. This information channel provides possible redundancy. In case of an accident in a Belgian installation, the operator's "Emergency Director" informs the NCCN and supplies all the information that becomes known to him as the accident evolves.

The Federal Management Cell, together with the Federal Coordination Committee, is the official leader of the conduct of the operation in case of an emergency. It defines the general strategy to deal with the emergency, takes the basic decisions (need and extent of direct protective actions for the population and/or for the food chain or the drinking water supply) and assumes the political responsibilities. The Management cell leans notably on the advice of the Evaluation cell on radiological aspects and on the relevant crisis cells of ministerial departments for the socio-economic aspects. The decisions taken are then transmitted for practical implementation and execution to the Provincial Crisis Centre, managing all the multidisciplinary intervention teams (fire brigades, civil protection, police, medical emergency services...).

The evaluation cell is composed of representatives of the relevant departments (in particular the FANC which chairs the cell), the Federal Agency for the Safety of the Food Chain, the Royal Institute of Meteorology, and of experts of the SCK CEN, the "Institut des Radioéléments", and of Bel V that supervises these installations, as well as of a representative of the operator of the facility. This cell gathers and evaluates all information received from the affected installation, the off-site radiological measurement results received from the Measurement Cell and information from institutions represented in the evaluation cell. It evaluates the installation status and its estimated time evolution in order to assess the real or potential impact of the event. Then, it advises the decision cell on protective actions for the protection of the population and the environment. This advice is elaborated on the basis of intervention criteria provided in the NEP. The evaluation cell is also responsible for the preparation of the relevant information to be communicated to neighbouring countries and to the international organisations (European Commission, IAEA) in accordance with the Convention on Early Notification of a nuclear Accident and the "ECURIE" convention.

The measurement cell co-ordinates all the activities related to the gathering of field radiological information (external radiation in the air and from the deposits, samples measurements ...) transmitted either by the automatic radiological measurements network, TELERAD, or by the field teams. The measurement cell then transmits the collected and validated information to the evaluation cell.

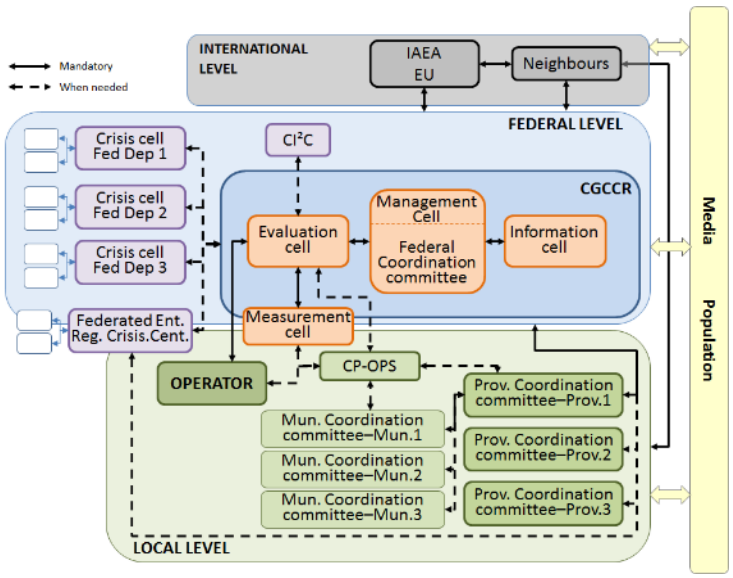


Figure 13 EP&R organisation for Belgium.

The information cell is in charge of communications with the media and the population as well as with the neighbouring countries and specific target groups.

The relevant crisis cells of ministerial departments advise the Federal Coordination Committee on the feasibility and economic and social consequences of their decisions; it informs the Federal Coordination Committee about the follow-up and ensure the management of the post-accidental phase and an as prompt as possible return to normal life.

Depending on the scope, the cells which compose the NCCN (Emergency and Coordination Committee, Evaluation Cell, Measurement Cell, and Information Cell) participate in exercises of the emergency plans at the relevant facilities.

The Royal Decree of 1st of March 2018 defines the emergency planning zones relative to the direct actions to protect the population (evacuation, sheltering, and iodine prophylaxis). The evacuation planning zones extend to a 10 km radius around the nuclear plants; the sheltering and ITB planning zones extend to 20 km around the nuclear plants.

The intervention criteria levels are set in the NEP. They are 5 mSv expected total effective dose integrated over 24 hours e.g. taking into account all direct exposure pathways (cloud shine, inhalation, and ground shine) for sheltering, 50 mSv expected total effective dose integrated over 7 days (1 week), i.e. by taking into account all direct exposure pathways (cloud shine, inhalation, and ground shine) for evacuation. For intake of stable iodine, the intervention reference levels are 10 mSv thyroid equivalent dose for children less than 18 years and pregnant or breastfeeding women and 50 mSv for adults.

For off-site radiological calculations, focusing on the urgent protective actions, the licensee has to implement a radiological assessment model. For that purpose, a dose/dispersion model developed by the Belgian Nuclear Research Centre (SCK CEN) is used. The model is a segmented Gaussian plume model, based on the Belgian (also called Bultynck-Malet or SCK CEN) turbulence typing scheme and the associated dispersion ('sigma') parameters[23]. These parameters were obtained using extended tracer experiments on each site during the sixties/seventies. The calculation domain extends up to 50 km around the release point. For the Tihange site empirical correction factors were introduced to take the more complex topography into account. Calculations are done per time step of 10 minutes, extrapolations (projections) over time can be made as well. In addition to the dispersion model, a set of standard scenarios has been developed in order to perform quick assessments at early stages. In

[23] H. Bultynck and L.M. Malet, Evaluation of atmospheric dilution factors for effluents diffused from an elevated continuous point source, TELLUS Vol 24, N°5 (1972).

the latest version of the diffusion model[24], the parameters associated with the standard scenarios have been stored in a database allowing rapid projections for any of the pre-defined scenarios. In addition, simplified and user-friendly tools and models are available to the evaluation cell and FANC-Bel V for cross-check validations and/or specific projections.

The exposure pathways considered for urgent protective actions are cloud shine dose, inhalation dose and ground shine dose (instantaneous and integrated up to one day and two weeks). Ingestion pathway would be covered by implementing measures on the food chain (food ban...). Effective doses for adults and thyroid doses for adults and children are calculated. Deposition of iodine (limited to I-131) and caesium (limited to Cs-137) are also calculated. Related to forecasts, the total doses as well as the projected doses are calculated.

The National Emergency Plan is continuously evolving and is worked on a permanent basis. This effort incorporates lessons learned from emergency exercises and aims at a steady progress in the development of standardized working procedures and tools for diagnostic purposes, radiation monitoring strategy and decision making.

F.5.2.d Internal and External Emergency Plans for Nuclear Installations, Training and Exercises, International Agreements

The emergency plan of each Belgian Class I facility is described in its Safety Analysis Report. In particular, an "internal emergency plan" details the instructions for all the actors.

The nuclear power plants conduct internal exercises several times a year, and the NCCN organise one internal and one external exercise annually for each nuclear power plant and every two years for other sites.

Consistent with the intended objectives, the NCCN involves as often as possible the various disciplines (fire brigade, medical help, police force, civil protection, measurement teams ...) in these exercises.

The operator is requested to draw up a scenario with which the objectives can be tested.

Regarding independent evaluation in the event of an emergency, Bel V sends representatives to the affected site and to the evaluation cell of the National Crisis Centre to contribute, based on the collected technical information and data, to the technical and radiological assessments used to support the issue of advice and recommendations of protective actions.

F.5.2.e Information of the public

The GRR-2001 specifies in its Article 72 all the obligations regarding training and information of the public pursuant to the Directive 2013/59/EURATOM. During the accident itself, information is supplied to the media by the information cell of the NCCN. At local level the provincial emergency plan includes the ways to inform the population (BE-Alert system[25], police equipped with megaphones, radio, and television) and following-up the instructions given to the population (iodine tablets, sheltering, evacuation, etc.).

[24] A. Sohier, Expérience et évaluation des codes de calcul de doses actuels utilisés en temps de crise nucléaire, Annales de l'Association belge de Radioprotection, Vol 24, N° 4 (1999).

[25] The Government's alert system, sending messages via text, e-mail, or voice call.

F.6 Article 26 – Decommissioning

ARTICLE 26. DECOMMISSIONING

Each Contracting Party shall take the appropriate steps to ensure the safety of decommissioning of a nuclear facility. Such steps shall ensure that:

(i) qualified staff and adequate financial resources are available;

(ii) the provisions of Article 24 with respect to operational radiation protection, discharges and

unplanned and uncontrolled releases are applied;

(iii) the provisions of Article 25 with respect to emergency preparedness are applied; and

(iv) *records of information important to decommissioning are kept.*

F.6.1 Legal and regulatory framework for decommissioning

The provisions of the generic part (Chapter 2) of the Royal Decree of 30 November 2011 on the Safety Requirements for Nuclear Installations (SRNI-2011), as amended by the Royal Decree of 15 August 2015 on Safety Requirements for Decommissioning, are fully applicable for decommissioning activities. Organisational aspects (article 4), staff training and qualification (articles 4 & 6), management system and record-keeping (article 5), on site emergency planning (article 16) are dealt with in this chapter.

A specific section dealing with decommissioning (including dismantling) fully implements the WENRA Safety Reference levels related to decommissioning and includes the following :

- Art. 17/1 is related to the notification of cessation of nuclear activities. It also lists the documents and information that must be sent to the FANC;
- Art. 17/2 is related to safety measures and justification of deferred dismantling;
- Art. 17/3 sets out requirements about maintaining and adapting the SSCs and the OLCs during the dismantling of the installations;
- Art. 17/4 is related to the preliminary qualification of new dismantling techniques;
- Art. 17/5 sets out requirements for radioactive waste from dismantling and for (on-site) waste storage;
- Art 17/6 sets outs requirements about the management of documents and inventories;
- Art 17/7 requires an experience feedback management process (from Belgium and from abroad);
- Art. 17/8 sets out requirements about the update of the surveillance and maintenance programmes;
- Art. 17/9 sets out requirements about the update of the on-site emergency plan;
- Art 17/10 gives the tables of content of the Safety Report for Dismantling;
- Art 17/11 deals with Periodic Safety Reviews during the dismantling of installations;
- Art 17/12 deals with the radiological characterisation of the final state and measures to be taken if this state cannot be reached. It also requests the licensee to establish a final dismantling report.

All requirements related to radioprotection (dose limits, discharges, clearance, …), imposed by GRR-2001, remain applicable during decommissioning.

The dismantling of a Class I facility is a practice that requires prior approval via a **dismantling licence** (article 17.2 of the GRR-2001). The contents of this dismantling licence application are described in

the same article. The application for a dismantling licence shall include at least proposals from the licensee on the following matters:

- the process for dismantling of the installations;
- the disposal and destination of activated or contaminated materials, radioactive substances or devices containing such substances and, if applicable, the information specified in article 18.2 of GRR-2001;
- the final state of the site;
- any other provisions that would guarantee the health and safety of workers and the general public as well as protection of the environment, both during and after dismantling and preparatory operations;
- for Class I facilities, the Safety Analysis Report for Dismantling;
- an environmental impact assessment report or a screening note for certain dismantling projects (NPPs, …).

A Safety Report for Dismantling (SRD) is thus an essential part of the dismantling licence application for Class I facilities and should include a detailed safety assessment of the dismantling project. This report (content detailed in article 17/10 of SRNI-2011) includes topics such as estimation of source term (initial characterization), dismantling techniques, criteria for clearance of radioactive materials, removal and destination of radioactive waste, organization and training, use of subcontractors, radiological impact on the workers, the public and the environment.

As part of this licensing process, ONDRAF/NIRAS has to give its advice on matters under his responsibility. Operators must submit two documents before they can begin dismantling – the Final Dismantling Plan (PFD) for NIRAS/ONDRAF and the SRD for FANC. Legal assignments regarding the management of decommissioning and related liabilities have been entrusted since 1991 by Royal Decree to ONDRAF/NIRAS. The responsibilities involve:

- the approval of final dismantling plans;
- the elaboration of mechanisms for building up financial funds for the execution of programmes, in agreement with the operator or the owner of the facilities, except the NPP decommissioning and spent fuel back-end management which is covered by the Law of 11 April 2003 (as amended by the law of 12 July 2022);
- the execution of decommissioning programmes as requested by the owner or in case of failure.

F.6.2 Implementation of the legal requirements

F.6.2.a Decommissioning planning

To fulfil its legal assignments related to the collection and evaluation of decommissioning programmes of nuclear plants in Belgium, ONDRAF/NIRAS defined and implemented the structure of the *decommissioning plans*, based on the recommendations of the IAEA.

A dismantling plan is a tool that evolves in three phases. When starting up a facility, the operator prepares an initial decommissioning plan in which the decommissioning costs and the provisions necessary to ensure its financing are assessed. These assessments provide the basis for the decommissioning funds to be set up by the operator.

During operation, the operator revises the decommissioning plan every five years to allow for the evolution of the facility itself and of the decommissioning and waste processing techniques, methods, and costs. The operator is required to provide the final decommissioning plan three years before the final shut-down. It contains a definitive decommissioning strategy, after it has been established that the available financial means are sufficient to execute the whole program.

F.6.2.b Decommissioning programmes

The operator or the owner of a nuclear facility can call upon ONDRAF/NIRAS for the execution of a decommissioning programme. In this case, ONDRAF/NIRAS has to conclude a convention with the operator or owner covering the technical and financial aspects of the decommissioning.

Up to now, the Belgian government has entrusted ONDRAF/NIRAS by conventions with the management of the nuclear liability funds SCK CEN, Belgoprocess site 1 (BP1), Belgoprocess site 2 (BP2) and IRE.

An assessment was made of the costs incurred in the period 1989-2020 for the remediation of decommissioned nuclear facilities at these three sites (Belgoprocess, SCK CEN and IRE Fleurus). This so-called *spending review* also examined the financial resources still available in each fund, estimated future expenditure related to these liabilities and suggested ways to optimise future costs and provide budgetary control.

❖ Liability fund SCK CEN

Annual endowments for decommissioning all nuclear facilities existing on the SCK CEN site in Mol before 1989 are spread over the period 1989 – 2019 but an adaptation of the financing mechanism is being prepared in order to spread the annual endowments in line with the annual programmes until final decommissioning of the installations.

The SCK CEN nuclear liability fund covers the following facilities:

- the BR1 complex with a graphite moderated research reactor and the VENUS zero-power reactor.
- the BR2 complex, a material testing reactor;
- the BR3 reactor, a pilot PWR shut down in 1987 and currently being decommissioned;
- the laboratory buildings containing mainly hot-cells and glove boxes,
- a farm and pastures, where experiments with radioactive tracers were performed in the past.

The decommissioning activities are executed mainly by the SCK CEN staff following 5 years programmes and annual budgets which must be approved by ONDRAF/NIRAS and the Belgian State. These activities are in line with the decommissioning plans which were elaborated by SCK CEN and approved by ONDRAF/NIRAS and by the Steering Committee liability SCK CEN, chaired by the Belgian State.

❖ Liability funds BP1 & BP2

The BP1 & BP2 liability funds were raised in 1989 to finance the decommissioning and the remediation of respectively the former EUROCHEMIC reprocessing plant and its associated activities in Dessel (located on site BP1), and the former waste processing installations of the Nuclear Research Centre SCK CEN in Mol (located on site BP2).

The former EUROCHEMIC facilities cover:

- the reprocessing plant which is being decommissioned since 1986;
- the vitrification plant PAMELA. As the last vitrification operation took place in September 1991, this installation has been adapted for the treatment and conditioning of alpha bearing waste and medium active waste.
- the bituminisation plant EUROBITUMEN for which no further use is foreseen, and which is in operational stand-by;
- waste storage buildings containing medium- and high-level waste conditioned during and after the reprocessing activities.

The former installations of the BP2 site cover waste storage and processing facilities.

The law of 24 March 2003 guarantees the financing of the BP1 and BP2 liabilities till the completion of the corresponding dismantling and waste conditioning activities. According to this law, the decommissioning activities are executed by the Belgoprocess staff following 5 years programmes and annual budgets which have to be approved by ONDRAF/NIRAS and by the Steering/Surveillance Committee liability Belgoprocess, chaired by the Belgian State.

- **Liability fund IRE**

The IRE liability fund was raised in 1991 to finance the management of waste and irradiated uranium respectively produced and used during the operation of the Institut National des Radioéléments (IRE), a nuclear facility producing mainly radioisotopes for nuclear medicine. The Belgian state is financially responsible for 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.

- **Settlement of liabilities funding during operation**

One of the main tasks of ONDRAF/NIRAS is to verify the existence and the sufficiency of funds to be set up by the operator or the owner of nuclear facilities and contaminated sites (article 9 of the Programme Law of 12 December 1997). Nevertheless, the legal responsibility for building up sufficient nuclear liabilities funding remains with the operator or the owner.

Decommissioning and remediation costs as well as the annual financial funding level are periodically re-evaluated. The annual funds level is calculated based on the best estimates of the decommissioning and remediation costs for the year of the evaluation. The final objective is to constitute the total amount of financial means at the final shut-down of the facility. This way, the funds level is raised during the operating lifetime when the facility is still providing revenues.

F.6.2.c Actual status of the main decommissioning activities

The current status of the main decommissioning activities is given in "*Progress on decommissioning programmes*", under § A.2.3 – Other Developments.

SECTION G SAFETY OF SPENT FUEL MANAGEMENT

G.1 Legal and regulatory framework

According to Belgian regulations, spent fuel facilities and waste management facilities are both categorized as "Class I" facilities. This subsection G.1., dealing with the legal and regulatory framework for safety, is the same for both types of facilities:

As a member of the European Union, the Belgian legal and regulatory framework has also to comply with the requirements of the European Directives :

- 2013/59/ Euratom laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation, and repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom;
- 2011/70/ Euratom of 19 July 2011 establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste;
- 2009/71/ Euratom of 25 June 2009 (amended by the Directive 2014/87/ Euratom) establishing a Community framework for the nuclear safety of nuclear installations, in relation to spent fuel storage facilities, on-site waste storage and treatment facilities.

In addition to the GRR-2001 requirements, all generic safety requirements of chapter II and of chapter IV of the SRNI-2011 (Royal Decree of 30 November 2011) are also applicable to these facilities (See Section E – Legislative and Regulatory System). A specific Chapter (IV ter) applicable to surface disposal facilities has been recently included in the SRNI-2011. An overview of the content of Chapter II of the SRNI-2011 (i.e. safety requirements applicable for all Class I facilities), Chapter IV (specific safety requirements for radioactive waste and spent fuel storage facilities), Chapter IV ter (specific safety requirements for surface disposal facilities) is given in § L.1 – APPENDIX 1 : Legal framework for safety and radiation protection.

❖ Safety assessment of new facilities

Prior to the construction and the operation of new installations, a construction and operating licence application has to be submitted. A preliminary safety analysis report describing a set of applicable measures has to be annexed to the licence application (See § E.2 - Article 19 – legislative and regulatory framework). The most important safety-related information that has to be mentioned in this report concerns:

a) Introduction and context.

b) General description of the site, the installation, its normal operation and its safety, brief description of the main circuits (fluid and electrical circuits) and of the control-command system; the nature and quantities of radioactive substances used.

c) Detailed description of the site:

- a topographic survey of the region within a radius of 500 m around the facility as well as indications relating to the population density within this perimeter
- geology, seismology, hydrology, meteorology, climatology, and other relevant natural features
- economic activities, including agriculture, transportation, and other relevant aspects related to human activity.

d) General aspects of the design and fundamental safety objectives, description of defence in depth.

e) Detailed description of the safety functions and of the structures, systems, and components important for nuclear safety with their design bases and their operation in all states of the

installation (in normal operation, at standstill, in incident conditions and accidental conditions).

f) Codes and standards applicable to the installation and the structures, systems, and components important for nuclear safety;

g) Safety demonstration:

- deterministic analyses demonstrating compliance with safety criteria and radiological limits, including a description of the margins,
- preliminary probabilistic safety analyses for the facilities referred to in art. 3.1.a).1;

h) Organization of the operation and description of the management system.

i) Operational aspects, including:

- a description of the objectives of the accident management procedures,
- the principles of maintenance, tests, and inspections,

j) Staff qualification and training,

k) Principles of ageing management.

l) Main operating limits and conditions with their technical justifications.

m) Description of radiation protection, including, inter alia, the measures and means implemented to ensure compliance with the basic standards as defined in Chapter III.

n) Radioactive releases in normal and accidental situations and the planned operational limits; proposal for an on-site and off-site environmental monitoring program.

o) Preparation to emergency situations: actions at the site level and liaison / coordination with external organizations.

p) The radioactive waste sub-file and the dismantling sub-file referred to in article 5.8

Article 6.3 of the GRR-2001 requires that a safety assessment of a licence application must be performed. In practice, the safety assessment is performed by Bel V, by delegation of the FANC. Bel V is a founding member of ETSON, the European TSO Network. The ETSON Safety assessment Guide (2004) explains the objectives of the safety assessment:

> *"The basic objective of review and assessment is to determine whether the operator's submissions demonstrate that a nuclear activity complies with the stipulated safety objectives or requirements. For a nuclear facility, review, and assessment aim at checking that it complies with the safety objectives throughout its lifetime."*

As an example, for the recent SF^2 facilities (on-site dry spent fuel storage at Doel and Tihange), the specific safety requirements considered in the design are listed under article 8 – Assessment of Facilities – section G.5.3. The licence application also comprises an environmental impact assessment covering radiological and non-radiological impacts. This environmental impact assessment and the associated public consultations are in line with the *European Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment*, as amended by the Directive 2014/52/UE of 16 April 2014.

The second phase consists in the confirmation of the construction and operation licence. Before introducing radioactive materials in the installation, the Federal Agency for Nuclear Control (FANC) or Bel V acting on behalf of the FANC proceeds to the delivery of the installations before the actual start up. In particular, the Safety Analysis Report has to be up to date and to reflect the exact state of the facility and the activities that are performed within.

The commissioning of the installations aims at :

- verifying the compliance with the licence conditions
- verifying the compliance with the regulation in force (among others, the SRNI-2011);
- verifying the compliance with the Safety Analysis Report.

A fully favourable acceptance report leads to the confirmation decree allowing the operation of the Class I facility (See article 19).

❖ Periodic Safety Reviews

According to article 14 of SRNI-2011, all Class I facilities are subject to ten-yearly periodic safety reviews (PSRs). Periodic Safety Reviews of the Tihange and Doel nuclear power plants include the on-site waste treatment and storage facilities, as well as on-site spent fuel storage facilities.

The general objectives of these 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 was granted to operate, or since its latest periodic safety review;
- to inspect the condition of the unit, devoting particular attention to ageing and wear and to other factors which may affect its safe operation during the next ten years;
- to justify the unit's current level of safety, taking into account the most recent safety regulations and practices and, if necessary, to propose appropriate improvements.

Both the scope and the methodology are based on the approach adopted by the IAEA safety guide SSG-25 by the use of 14 Safety Factors, followed by a Global Assessment.

The objectives of the periodic safety review are multiple. In the review, the operator should assess the state of the installation and the organisation in relation with international legislation, standards, and good practices. Furthermore, strong points and weaknesses should be identified, as well as compensating measures in the case that some weak points cannot be modified. Finally, the assessment should show to what extent the safety requirements of the Defence in Depth (DiD) concept are fulfilled, in particular for the basic safety functions of reactivity control, heath removal and confinement of radioactive material.

The assessment identifies both Strengths and Opportunities for Improvement (OFIs). The OFIs were weighted according to a resources/safety relevance scale (in accordance with the new international standards) to select the most relevant actions to be taken.

❖ Stress test

Following the Fukushima Daiichi accident, all "Class 1" nuclear installations, including NPPs, spent fuel storage and waste storage and treatment facilities, were asked to conduct stress tests. The action plans following the stress tests of those facilities have been approved by the FANC in July 2013. As for NPPs, the stress tests for other Class I facilities 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.

❖ Dismantling plans

A preliminary dismantling plan must be established at the design stage of new installations. The objective of this decommissioning plan is to:

- assess the dismantling strategies which depend on factors such as the protection of the operators, the public and the environment, the planning, and the organisation,
- evaluate the dismantling techniques specific to the installations,
- list the waste produced during the dismantling,
- assess the costs generated by those operations,

- analyse the financial funding level that shall be available to ensure that the safety conditions are met when those operations are performed and to avoid a financial burden on future generations.

The dismantling plan must be updated during the operation of the installation, in particular for:

- the evolution of the technologies related to decontamination and dismantling;
- the evolution of the regulatory aspects such as release limits and methodologies resulting in modifications of the estimated waste quantities;
- the destination of the waste;
- the history of the installation (maintenance, intervention, incidents, accidents, …);
- the modification in quality management

❖ Safety assessments during operation

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

- major modifications changing the basic characteristics of the facility. These modifications are subject to a licence according to the provisions of Article 12 of the GRR-2001. The applied process is similar to the initial licensing process. The safety review of the application file is performed by Bel V and presented to the FANC, and an amendment to the licence (i.e. a Royal Decree) is established.
- non-important modifications having a potential impact on safety without requiring amendment of the licence. The modification file is established and is examined by the HPD. After that, it is examined by Bel V, which may result in amendments being ordered to the modification file. Commissioning the modification is subject to a positive acceptance report, issued after validation of the modification and requalification of the part of the installation that has been modified and the updating of the operation documents. Based on the positive opinion of the HPD, Bel V issues, after further checks, a final acceptance report allowing the implementation of the modification when all the files, procedures and the Safety Analysis Report have been adequately updated. This process is followed up by the FANC, which may intervene if deemed necessary.
- modifications without impact on safety, that usually do not imply modification of the Safety Analysis Report, and which comply with all the safety rules applicable to the installation. These modifications have to be approved only by the Health Physics Department of the Licensee, without formal involvement of Bel V.

❖ Operational requirements

The following articles of SRNI-2011, applicable to all Class I facilities, deal with the operation of facilities:

- Art. 9 sets requirements related to operational limits and conditions. The operational limits and conditions form an integral part of the safety report and shall be reviewed and modified when needed. The limits shall be determined in a conservative manner. In case the operational limits and conditions cannot be complied with, suitable corrective measures shall be implemented and reported to the regulatory body.
- Art. 10 deals with ageing where both the ageing (physical and economic) as well as the ageing management programme need to be addressed. This ageing management programme shall be reviewed at least during each periodic safety review.
- Art. 11 imposes the licensee to have an operational feedback process in place for collecting, analysing, and documenting events that occur in his facility as well as in other similar facilities.

This process shall also document the analysis methodologies, notification, and distribution of relevant information as well as the process for continuous improvement.

- Art. 12 sets the principles, preparation, and implementation of the maintenance-, test-, monitoring- and inspection programmes for structures, systems, and components important to safety.

The FANC and Bel V monitor and FANC enforces compliance with the regulations.

❖ Notification of incidents

Article 67 of the GRR-2001 requires the licensee to notify the FANC and the competent authorities (including the Governmental Centre for Coordination and Emergencies) any event with a potential significance on safety or on health of people and environment.

The FANC issued a technical regulation on 5 July 2019 which determines the criteria and modalities for notification of events and the use of the INES-scale as well as detailed reporting (in-depth analysis). Similar technical regulation exists for Class II-III facilities. This technical regulation specifies:

- The list of events that have to be notified to the FANC and associated criteria. This list comprises:
  - events related to the safety;
  - events related to the radiation protection;
  - events related to the environment;
  - other events;
- the practical modalities of the notification: time limit for notification, needed information, organizations to be notified, …;
- the need for an in-depth analysis to be performed by the licensee;
- the need of an INES analysis. The licensee has to perform the INES-analysis according to the latest INES manual, and the level has to be approved by Bel V and by the FANC. Depending on the INES-level, a specific notice is issued. For events of level 1 or higher, the FANC publishes a short notice on its website. For events of level 2 or higher, besides the notice on the website of the FANC, the licensee has to issue a press release about the event and the INES National Officer will notify the IAEA.

❖ Consultation of neighbouring countries

Several mechanisms exist to consult neighbouring countries in case they are likely to be affected by a new facility, and provide them, with general data relating to the facility:

- The licensing process foresees the consultation of neighbouring countries even at local level.
- Article 37 of the EURATOM treaty requires to provide the European Commission with data related to the transboundary impacts of the planned facility.
- Belgium has bilateral agreements with France, Germany, Netherlands, and Luxembourg that arrange exchange of information.

G.2 Article 4 – General safety requirements

ARTICLE 4. GENERAL SAFETY REQUIREMENTS

Each Contracting Party shall take the appropriate steps to ensure that at all stages of spent fuel management, individuals, society and the environment are adequately protected against radiological hazards.

In so doing, each Contracting Party shall take the appropriate steps to:

(i) ensure that criticality and removal of residual heat generated during spent fuel management are adequately addressed;

(ii) ensure that the generation of radioactive waste associated with spent fuel management is kept to the minimum practicable, consistent with the type of fuel cycle policy adopted;

(iii) take into account interdependencies among the different steps in spent fuel management;

(iv) provide for effective protection of individuals, society and the environment, by applying at the national level suitable protective methods as approved by the regulatory body, in the framework of its national legislation which has due regard to internationally endorsed criteria and standards;

(v) take into account the biological, chemical and other hazards that may be associated with spent fuel management;

(vi) strive to avoid actions that impose reasonably predictable impacts on future generations greater than those permitted for the current generation;

(vii) aim to avoid imposing undue burdens on future generations.

G.2.1 Doel and Tihange sites

The installations are described in § L.2 – APPENDIX 2: Radioactive Waste Management and Spent Fuel Management at Nuclear Power Plants.

Three spent fuel storage modes are currently applied :

- fuel deactivation pools in the units: The fuel deactivation pools are located in the buildings “GNH” (Doel 1/2), “SPG” (Doel 3/4), “BAN” (Tihange 1) and “BAN-D” (Tihange 2/3).
- dry storage containers in building SCG (Doel) and the future SF^2 buildings (Doel and Tihange);
- wet storage pools in building DE (Tihange).

The intermediate storage capacity of spent fuel assemblies had to be substantially improved to cope with the decision to stop reprocessing. A storage building was constructed on each site. These buildings are designed to receive, and store discharged spent fuel in pools (building DE-Tihange) or in shielded containers (‘dry storage’ -building SCG-Doel).

On both sites, additional interim dry storage facilities (SF^2 facilities) have been licensed to allow the storage of the remaining fuel after the final shut-down of the units and emptying of their pools.

G.2.1.a Spent fuel deactivation pools in the units

The spent fuel deactivation pools as well as the installations and systems integrated in these buildings have been designed and built according to the safety principles, the general design criteria, and the building standards in force at the time when the nuclear power generating units were designed and built.

These safety principles and general criteria, approved by the Belgian Safety Authorities, are mainly those in force in the American regulation and accepted on international level.

The design of these buildings complies with the provisions set out in the GRR-1963, now replaced by the GRR-2001.

The residual heat is removed by the redundant fuel pool purification system of each unit (PL at Doel and CTP at Tihange); these systems are designed to remove the residual power generated by the spent fuel assemblies. In the case of loss of external electrical power supply, the residual heat system is supplied by using emergency power supply systems.

Calculation codes, recognised by the safety authorities, were used to verify that the Keff (neutron multiplication factor) does not exceed the criteria in normal and accidental conditions. The calculations have conservatively not considered the presence of boric acid in the system. Analysis have demonstrated that the burnup credit is no longer required.

G.2.1.b Tihange site: Intermediate storage building DE

This building DE is located within the perimeter of the Tihange 3 unit and is therefore an integral part of the Tihange 3 installations.

The DE building is included in the periodic safety review that is performed every ten years. Therefore, the lifetime of the installation is periodically reassessed.

The design requirements for the safety of building DE are the same as for building BAN-D of unit 3.

The heat generated by the spent fuel assemblies is removed by three systems operating in cascade. These systems – which are physically separated – are permanently operating in normal operational conditions of the installations.

Calculation codes recognised by the regulatory body were used to verify that the k_{eff} (neutron multiplication factor) does not exceed the criteria in normal and accidental conditions. The design calculations have not considered the presence of boric acid in the pool water.

Efforts after the Fukushima-Daiichi accident have been pursued to implement improvements related to hardware, organization, and procedures, to better cope with possible accident scenarios. Modifications, mainly adaptations of procedures, have been also implemented considering the findings of the Spent Fuel Pool (SFP) studies for internal events/hazards, seism and external flooding performed in the frame of the periodic safety assessments.

G.2.1.c Doel site: Intermediate storage of containers in building SCG

At Doel, the intermediate storage safety functions are fulfilled mainly by the dual-purpose containers. The container models are approved by the FANC for transport, and comply with the IAEA transport regulations. Furthermore, the container models are approved for storage. The storage configuration of the containers is different from the transport configuration.

The design of the intermediate storage – i.e. the containers configured for the storage and the storage building itself – complies with the provisions of GRR-1963 now replaced by GRR-2001.

The storage containers are designed in such a way that the residual decay heat is removed passively by convection and thermal radiation. The thermal power removed by the container is determined to reduce as much as possible the maximum surface temperature of the fuel rods in normal storage conditions (300 to 400°C depending on the container type), in order to guarantee, the fuel integrity in the long term. The data used for the design of these containers are penalising with regard to the power history of fuel assemblies and their cooling time before being loaded in containers.

It has been verified that the containers meet requirements for sub-criticality. In particular, a keff lower than 0.95 is obtained by taking penalising hypotheses as regards the size and the nuclear characteristics of the fuel assemblies plunged into pure water.

In general, the design requirements for the intermediate storage are the same as those in force for the power units on the site.

The SCG is included in the periodic safety review that is performed every ten years.

G.2.1.d SF² facilities

The SF² buildings are the first facilities designed on the basis of a technical guidance from the FANC from 2017 (which then became a technical regulation document in 2021), addressing the safety demonstration for Class I nuclear facilities, and the concept of defence-in-depth. It defines new safety objectives – as defined in EC directive 2014/87/Euratom – for the various operating regime (normal conditions, anticipated incidents, design basis accidents, design extension accidents A and B). On the basis of those requirements, a graded approach was implemented for the SF² facilities to account for external events (man-made or natural).

Together with the current interim spent fuel storage building on site (dry storage building SCG at Doel and wet storage building DE at Tihange), this additional storage facility will allow the storage of the spent fuel elements from the nuclear units (4 units in Doel and 3 units in Tihange) after their final shut-down and the emptying of the pools in these units. These new facilities (SF² Doel and SF² Tihange) are designed for an operating lifetime of 80 years.

The spent fuel elements will be loaded in dual purpose casks (same cask technology as currently used in the SCG-building at Doel) designed for transport and storage. The cask loadings will be performed in the DE-building for Tihange and the reactor pools of the nuclear units at Doel.

The safety functions (confinement, heat removal, radiation protection, sub-criticality and retrievability) are guaranteed by the cask during transport and storage. During storage, the main storage building, and associated equipment contribute also to some safety functions (radiation protection, heat removal and retrievability).

G.2.2 SCK CEN site: BR2

Additional information on BR2 can be found in § L.4 – APPENDIX 4 : Description of the installations of SCK CEN : BR2.

G.2.2.a Spent fuel storage

BR2 standard spent fuel elements are stored under water, mainly for shielding reasons. Storage for this kind of fuel is foreseen in the containment building and in the storage canal in the machine hall. The transfer of BR2 fuel elements is allowed 100 days after their last irradiation considering the ^{131}I content and the residual power.

Due to the high heat flux involved during the irradiation time, the böhmite (a type of aluminium oxide) corrosion layer grows and thermal stresses on the cladding may cause pieces of this crust to break loose, resulting in cladding consumption. Such corrosion pits, causing fission products release, have already been observed. These lead to the release of gaseous and volatile fission products. The analyses of fission products release are routinely performed to check for defective fuel elements after each shut-down of the reactor. The quantity of fission products released from such pitting is limited and becomes rapidly neglectable if the element is no longer irradiated.

G.2.2.b Criticality considerations

Irradiated standard fuel elements are manipulated in the reactor pool or in the storage canal either single or in a transfer basket, which can contain up to 9 standard fuel elements in an annular configuration. Even in the most reactive state, fuel elements cannot reach criticality, even if they fall out of the basket. The fuel elements are locked in their basket during handling operations.

Storage racks are designed in such way that the multiplication factor remains lower than 0.9, even when an additional element approaches the rack. The subcriticality can be guaranteed by sufficient distance between the elements in the rack or by the use of neutron screens.

Originally, the fuel elements were composed of an alloy uranium/aluminium with an aluminium cladding. Currently, all elements contain a core of a dispersion of UAl_x in an aluminium matrix with an aluminium cladding. The different types of standard fuel element did not have to be considered individually, as the experimental evidence shows that the most reactive state of any BR2 standard

fuel element is the state of a fresh alloy fuel element. Criticality calculations of standard BR2 fuel assemblies are therefore conservative for fresh alloy fuel elements containing 244 g ^{235}U.

Generic studies were carried out on the storage of several kinds of fuel and to find simple rules that encompass some cases of fuel arrangements. Other fuel elements or experimental fuel rods have to comply with the preceding criteria.

G.2.2.c Cooling

The pool water circuit transfers the heat produced in the reactor pool (870 m^3) and the side-pools to the secondary cooling circuit through two heat exchangers having a total capacity of 2.9 MW. This circuit consists of the following loops:

- cooling;
- purification;
- auxiliaries.

The circulation in the cooling line of the reactor pool is maintained by 2 pumps, each with a flow of 420 m^3/h (one in service and the other in standby). A third one of 90 m^3/h is used when the reactor is stopped. The flow in the side-pools is ensured by 2 pumps of 85 m^3/h (one in service and the other in standby).

Before entering the reactor pool, the cooling water flows through the reactor shroud to ensure the cooling of the outside wall of the reactor vessel to evacuate the heat generated by the γ-heating.

When the pumps stop, the shut-down pump with a flow of 90 m^3/h starts automatically to evacuate the residual heat.

In case of loss of integrity of the dam, the water in the side-pools is kept at a minimum level of 2.2 m, enough to keep the fuel elements under water.

The main secondary water circuit evacuates into the air the heat removed from the reactor by the primary circuit and the pool circuit; afterwards, it cools down the gas condenser of the primary degasifier. This circuit consists of the following loops:

- cooling;
- purification;
- auxiliaries.

The circulation in the cooling loop is maintained by 4 pumps each with a flow of 39.2 m^3/min and a pressure head of 4 kg/cm^2. Each pump is driven in direct coupling by an electric motor of 500 HP. When the reactor is operating, 2 or 3 pumps are in service, depending on the power of the reactor, and one pump in stand-by. The fourth pump in stand-by is equipped with a progressive opening which is used when restarting the secondary circuit. This avoids shocks in the piping.

G.3 Article 5 – Existing facilities

ARTICLE 5. EXISTING FACILITIES

Each Contracting Party shall take the appropriate steps to review the safety of any spent fuel management facility existing at the time the Convention enters into force for that Contracting Party and to ensure that, if necessary, all reasonably practicable improvements are made to upgrade the safety of such a facility.

G.3.1 Doel and Tihange sites

The measures to investigate and improve the safety of the spent fuel management installations are addressed below.

G.3.1.a Ten-yearly safety reviews

The operators of Class I facilities are obliged under the Royal Decree of 30 November 2011 and the provisions of their licence to conduct a Periodic Safety Review (PSR) every 10 years.

Since 2007 the FANC has required that operators perform the PSR following a methodology based on the 14 Safety Factors described in the IAEA Safety Guides NS-G-2.10 and SSG-25. FANC/Bel V oversees this process by reviewing the analysis and approving the resulting action plan.

This process has already been applied successfully for the third PSR of the Doel 3 & Tihange 2 units (2012 & 2013 respectively), the third PSR of the Doel 4 & Tihange 3 units (2015), and the fourth PSR for the Long-Term Operation of the Doel 1&2 and Tihange 1 units (2015). The PSR action plan has been implemented for Doel 3 & Tihange 2 and has largely been implemented for the other units.

The next PSR of the Doel 3 & Tihange 2 units and later of the Doel 1&2 and Tihange 1 units are prepared in the framework of final plant shutdown before dismantling and decommissioning. The next PSR of the Doel 4 and Tihange 3 units are being prepared in the framework of their long-term operation.

G.3.1.b Stress tests

See § A.2.3 – Other Developments, § G.4.1.b – Stress tests, and item "*Stress test*" under § G.1 – Legal and regulatory framework.

G.3.1.c Safety assessments

During the operation of the installations, experience feedback may lead the operator to consider some modifications to the installations.

The proposals for modifications to the installations are examined by the Health Physics Department of the operator. Modifications having potentially an important impact on the safety or that are outside the current licence imply a formal declaration to the FANC (art. 12 of GRR-2001) which can, if the FANC decide it, result in a new licensing procedure. Bel V is mandated to check the approval of the Health Physics Department.

As explained in § G.2.1.a – Spent fuel deactivation pools in the units, such assessments led to the modifications related to the reliability of the spent fuel pool cooling.

G.3.2 SCK CEN site: BR2

The steps to investigate and improve the safety of the spent fuel management installations are dealt with below.

G.3.2.a Ten-yearly safety reviews

According to article 14 of SRNI-2011, all Class I facilities are subject to ten-yearly periodic safety reviews (PSRs). Periodic Safety Reviews include the on-site waste treatment and storage facilities, as well as on-site spent fuel storage facilities. The objectives of the ten-yearly review are similar to those of the NPPs.

G.3.2.b Stress tests

See item "*Stress test*" under § G.1 – Legal and regulatory framework.

G.3.2.c Safety assessments

Operational experience might bring the operator to consider performing certain modifications to the installations.

In order to guarantee a safe and reliable operation of BR2, it is necessary to observe specific prescriptions with regard to the modifications of materials and/or installations. The aim is:

- to guarantee that the quality of the systems and components is not lost due to the modifications;
- to guarantee the compliance with the description in the licence documents;
- to guarantee a safe and reliable operation.

A standard application and modification form with regard to the installations is presented to the Committee on the Modification of Installations (CWI/CMI). After receipt of the application, a review and assessment are performed by the Committee. It is only after its advice is obtained, that the application will be submitted to the Internal Service for Prevention and Protection at Work (IDPBW/SIPPT) and the HPD.

A preliminary investigation of this modification is also necessary in order to verify whether it fits within the framework of the special licence conditions, implying that no additional or modified licence is needed.

Modifications having potentially an impact on safety and on the reactor need to be approved by the Internal Service for Prevention and Protection at Work (IDPBW/SIPPT), by the Health Physics Department and by Bel V, according to article 23 of the GRR-2001.

Modifications having potentially an important impact on the safety or that are outside the current licence imply a formal declaration to the FANC which can, if the FANC decide it, result in a new licensing procedure.

G.4 Article 6 – Siting of proposed facilities

ARTICLE 6. SITING OF PROPOSED FACILITIES

1. Each Contracting Party shall take the appropriate steps to ensure that procedures are established and implemented for a proposed spent fuel management facility:

(i) to evaluate all relevant site-related factors likely to affect the safety of such a facility during its operating lifetime;

(ii) to evaluate the likely safety impact of such a facility on individuals, society and the environment;

(iii) to make information on the safety of such a facility available to members of the public;

(iv) to consult Contracting Parties in the vicinity of such a facility, insofar as they are likely to be affected by that facility, and provide them, upon their request, with general data relating to the facility to enable them to evaluate the likely safety impact of the facility upon their territory.

2. In so doing, each Contracting Party shall take the appropriate steps to ensure that such facilities shall not have unacceptable effects on other Contracting Parties by being sited in accordance with the general safety requirements of Article 4.

The current spent fuel management installations have been sited after evaluation and consideration of the relevant factors related to the sites.

G.4.1 Doel and Tihange sites

G.4.1.a Siting

❖ **Characteristics considered for the selection of the sites**

The Doel and Tihange nuclear power plant sites were originally evaluated according to the requirements set by the US rules (Chapter 2 of the Safety Analysis Report, Standard Review Plan, 10 CFR 100). These requirements apply to the phenomena of natural origin (earthquakes, floods, extreme temperatures …) and to the phenomena of human origin (industrial environment, transports …).

With regard to the natural phenomena:

- The geological and seismic characteristics of the sites and their surrounding area were specifically investigated in order to identify the soil characteristics and the earthquake spectrums that must be considered when designing the structures and systems.
- The hydrological characteristics of the rivers Meuse and Scheldt were investigated, not only to quantify the risk of floods and possible loss of the heat sink, but also in order to develop the river flow models in order to evaluate the impact on dilution of released liquid effluent.
- Meteorological and climatic surveys made it possible to define the atmospheric diffusion and dispersion models to be used when assessing the short-term and long-term environmental impacts of atmospheric releases considering the local characteristics. These studies were complemented with demographic surveys in the vicinity of the sites.
- Concerning the population density around the sites, no detailed criterion was originally imposed. The radiological consequences of incidents or accidents are calculated for the critical group living at the site border or in any other location outside the site where the calculated consequences are the largest.

With regard to the external events of human origin: due to the population density in the vicinity of the sites, and also considering the impact that the local industrial activities may have on the power stations, specific requirements were adopted: protection against external accidents such as civil or military airplane crash, gas explosion, toxic gas cloud, major fire.

❖ **Periodic reassessment of the site's characteristics**

Reassessments are systematically performed during the periodic safety reviews of each unit.

During the periodic safety review, studies are performed and, where necessary, measures are implemented to ensure that the residual risk following external accidents remains acceptable considering the environment of the site with respect to the risks resulting from transport (including by aircraft) and from industrial activities. The implementation of WENRA 2020 reference levels in SRNI-2011 provides now a regulatory framework for external hazard studies.

G.4.1.b Stress tests

Following the Fukushima Daiichi accident, the licensee conducted stress tests. Safety evaluation reports for the Doel and Tihange sites have been established by the licensee and reviewed by the FANC and Bel V, as well as by external experts. In the frame of the stress tests, an assessment of design bases, existing margins and cliff-edge effects was performed in relation to risks related to the site characteristics like earthquake, flooding, and severe weather conditions,

An action plan was launched as a result of the assessment, including:

- A revaluation of the seismic hazard by ENGIE Electrabel (in collaboration with Royal Observatory of Belgium and external experts for peered review) to confirm the adequateness of the seismic hazard considered for the seismic design of the NPPs.
- Reinforcements of Structures, Systems and Components to improve their resistance against beyond design earthquakes;
- A site peripheral protection for Tihange, in relation to an upgraded design basis flood;
- Improvements of the protections against beyond-design-basis floods: in Doel, volumetric protections of sensitive buildings and adapted procedures; in Tihange, water supplies (involving piping, pumps, additional electrical diesel generators, etc.) to the primary circuit, the steam generators, and the spent-fuel pools, with adapted procedures and training;
- Improvements of the sewage systems for protecting the sites against rains with return periods much larger than considered in the design.

All planned improvement measures have been implemented. The action plan was finalised in 2020. The FANC confirmed the closure of the stress-tests action plan.

G.4.2 SCK CEN site: BR2

G.4.2.a Siting: Initial siting and periodic reassessment of the site's characteristics

The SCK CEN installations were sited in 1953. The selection had to comply with the regulations in force at that time for the construction and operation of the installations.

❖ Seismic analysis

During the design and construction of BR2, seismic loads were not considered, although the risk of earthquakes was considered, as the original safety report[26] indicates:

> *"11.2.7 Earthquakes*
> *The seismic index for Belgium is 0.2. This means that the average number of earthquakes per year and per 100 000 km² is 0.2. The last appreciable earthquake occurred in 1938 and was of class 7, which means that the acceleration was approximately of 100 cm/sec²."*

No special provisions have to be taken for earthquakes in the reactor building or control design. The earthquake mentioned occurred on 11 June 1938, in the massif of Brabant. The epicentre was located in Zulzeke-Nukerke (geographical co-ordinates: Lat 50.783N; Lon 3.58E). The magnitude was 5.9 and the depth of the hypocenter 24 km. The intensity at the epicentre was VII (MSK) with a macro seismic region of 340 km^2. In the region of Mol, an intensity of IV was observed.

In the operating licence, issued after the safety review of 1986, a study of the protection against earthquakes was requested. The definition of the reference earthquake had to be done according to the procedures of 10 CFR 100, Appendix A, though with the exception that the horizontal acceleration could be lower than 0.1 g.

In 1997, a seismic qualification was asked by the authorities and a dynamic calculation of the main structures of the reactor building was made. The study concluded that the fuel storage canal would provide adequate resistance to the reference 0.1 g seismic event with a minimum safety factor of 1.4.

❖ Other External events

All barriers can be damaged due to external events. The effect of an aeroplane impact, explosions, etc. is discussed in a report by Belgatom dated January 1988 "Réévaluation de la sûreté des installations du SCK CEN - Etude des agressions d'origine externe".

G.4.2.b Stress tests

In the frame of the Stress Tests, an assessment of design bases, existing margins and cliff-edge effects was performed in relation to risks related to the site characteristics like earthquake, flooding, and bad weather conditions. A graded approach was used. The FANC National report was issued on 16 April 2013. The main issues concerning siting that have been addressed are:

- A new Probabilistic seismic-hazard assessment study of the Mol-Dessel region was done by the Royal Observatory of Belgium. Following a graded approach, a return period of 1000 years (instead of 10000 years for NPP) was chosen. Despite the fact that the peak ground acceleration level was substantially increased, enough margin was found for a large part of the Structures, Systems and Components important for safety:
- Stress tests confirmed that the risk of flooding is very limited.
- A higher return period (minimum 1000 years) for rain has to be considered.
- Construction of a new seismic-qualified building for the diesel emergency power supply
- Construction a new firefighting water supply system

[26] Belgian Engineering Test Reactor BR2 - Safety and Design - Final Report - Report CEN - Blg 59 - R.1996 – 1st of May 1961.

G.5 Article 7 – Design and construction of facilities

ARTICLE 7. DESIGN AND CONSTRUCTION OF FACILITIES

Each Contracting Party shall take the appropriate steps to ensure that:

(i) the design and construction of a spent fuel management facility provide for suitable measures to limit possible radiological impacts on individuals, society and the environment, including those from discharges or uncontrolled releases;

(ii) at the design stage, conceptual plans and, as necessary, technical provisions for the decommissioning of a spent fuel management facility are taken into account;

(iii) the technologies incorporated in the design and construction of a spent fuel management facility are supported by experience, testing or analysis.

G.5.1 Doel and Tihange facilities

G.5.1.a Appropriate measures to limit radiological effects

- **Fuel deactivation pools in buildings "GNH" (Doel 1/2), "SPG" (Doel 3/4), "BAN" (Tihange 1) and "BAN-D" (Tihange 2/3)**

On each site, the spent fuel assemblies discharged from the reactors are stored in the cooling ponds of the units for radioactive decay.

The function of biological protection of the personnel handling the assemblies and operating the pools is guaranteed in the different operation modes. During the storage, the biological protection consists in an 8-metre-thick layer of water above the top of the assemblies stored in the racks. During the transfer operations between the pools and the transit operations in the transfer canal, the layer thickness of water above the top of the assemblies is at least 3-meter so that the shielding is sufficient to limit the dose rate at the level of the working desk.

To avoid emptying the pools and uncovering the spent fuel assemblies, all penetrations through the pool surface are located 3 meter above the upper level of the racks.

All pipes penetrating the pools are equipped with anti-siphoning devices to avoid untimely spent fuel drainage e.g. in case of rupture of these pipes outside the pools.

The following measures have been taken during the design of the buildings:

- use of materials avoiding the accumulation of activation and fission products.
- reduction of the pipes' length carrying radioactive fluids in the frequently accessed areas;
- use of remote-controlled valves and fittings;
- installation of removable or fixed biological shields;
- limitation of the surface and air contamination in the areas;
- accessibility to the equipment that must be regularly inspected in order to reduce the exposure time.

The external wall of the building is designed to protect the external staff and the public against the radiation of the sources present in the building in normal as well as in accidental conditions.

- **Building DE (Tihange)**

Functionally, building DE is an extension of the spent fuel storage building in unit 3 (building BAN-D). It is located within the technical perimeter of unit 3.

It is designed to handle and store under water irradiated fuel assemblies coming from units 1, 2 and 3.

The fuel is transferred from the three units to building DE by means of a transfer container designed based on the international regulations for the transport of radioactive material.

Inside building DE, the activity in the pool hall is permanently controlled by monitoring of the radiation level around the storage pools and checking indirectly if the layer of water separating the radioactive fuel from the handling areas, and monitoring of the radioactive noble gas concentration in the air of the pool hall, hereby controlling indirectly the integrity of the fuel rods. The alarms are monitored from the main control room of Tihange unit 3.

The ventilation system is composed of 6 different circuits and is designed to fulfil in the first place the following safety functions:

- keeping building DE under a slightly negative air pressure with respect to the outside air;
- releasing the air extracted from building DE through the chimney of unit 3;
- evacuate the heat generated by the pump for water flow in the pools.

❖ Building SCG (Doel)

The SCG is a separate building used only for intermediate storage. It consists of a dry storage in containers qualified for transport and storage. The containers are filled with spent fuel assemblies and are prepared and tested in the fuel building of the units before being transferred. There are no operations that could lead to discharge performed in building SCG. The potential incidents do not lead to radioactive release either. Therefore, the design of the building does not take account of the occurrence of a discharge.

The design of the containers ensures the appropriate biological protection of the staff. The containers comply with the dose rate limits set in the international transport regulation (IAEA TS-R-1), i.e. 2 mSv/h at the external surface and 0.1 mSv/h at a distance of 2 metres.

A redundant barrier has been designed in the primary lid of the container in order to prevent leaks. The leak tightness of this barrier is continuously monitored. As regards exposure of the personnel and the population, only external radiation must be considered since there are no discharges.

The external walls of the building are designed in such a way as to protect the external personnel and the general public against the radiation of the sources held in the building in normal operational conditions.

❖ SF² (spent fuel facility for interim storage on-site)

The additional SF² facilities are new interim spent fuel storage facilities built on the nuclear sites (1 facility at Doel and 1 at Tihange). Together with the current interim spent fuel storage building on site (dry storage building SCG at Doel and wet storage building DE at Tihange), these additional storage facilities will allow the storage of the spent fuel elements from the nuclear units (4 units in Doel and 3 units in Tihange) after their final shut-down and the emptying of the pools in these units. These facilities are designed for a lifetime of 80 years.

The SF² facilities at Tihange and Doel are very similar, except the number of storage positions. Their design features are described in § L.2.4.b – Interim storage of spent fuel.

G.5.1.b Decommissioning

Regarding the decommissioning aspects of the spent fuel management installations, it must be noted that the decommissioning phase should not raise any particular technical problem given the preliminary decommissioning plans already examined and the experience feedback.

G.5.2 Installations of SCK CEN: BR2

G.5.2.a Discharge of liquid waste into the environment

BR2 has no direct discharge of liquid waste into the environment. All potential contaminated wastewater is sent to Belgoprocess, where it is discharged after eventual treatment.

A number of provisions is taken to avoid the accidental release of contaminated water to the environment:

- The water of the secondary circuit, which comes in contact with the environment during the passage through the cooling towers is checked in order to detect possible contamination through leaks in the heat exchangers. Different measuring chains are installed on different locations, monitoring the 16-N activity and the β-γ-activity. Samples of the secondary water are regularly taken to be analysed by means of spectrometry.
- Radioactive wastewater is transported towards the treatment installation in a double piping with leak control.
- The piping for transfer of pool water is placed in a cellar.

G.6 Article 8 – Assessment of Safety of facilities

ARTICLE 8. ASSESSMENT OF SAFETY OF FACILITIES

Each Contracting Party shall take the appropriate steps to ensure that:(i) before construction of a spent fuel management facility, a systematic safety assessment and an environmental assessment appropriate to the hazard presented by the facility and covering its operating lifetime shall be carried out;

(ii) before the operation of a spent fuel management facility, updated and detailed versions of the safety assessment and of the environmental assessment shall be prepared when deemed necessary to complement the assessments referred to in paragraph (i).

G.6.1 Doel and Tihange facilities

The construction and the commissioning of any installation, and in particular a spent fuel management installation, are subject to a licensing process that includes a systematic safety assessment and an environmental impact assessment as described in section G.1 – Legal and regulatory framework.

For the SF² (spent fuel facility for interim storage on-site), the following list provides the existing regulatory framework for safety including radiation protection that is specific and applicable to the new facility:

- Law of 15 April 1994, as amended, on the protection of the public and the environment against the dangers of ionising radiation and on the Belgian Federal Agency for Nuclear Control (FANC), constitutes the legal basis for the FANC as regulatory body, and sets out the basic elements for protecting the workers, the public and the environment against the adverse effects of ionising radiation, repealing, and replacing the Law of 29 March 1958;
- The Royal Decree of 20 July 2001, as amended (GRR-2001), laying down the general regulations on the protection of the public, workers, and the environment against the hazards of ionizing radiation, concerns radiation protection and provides for the general principles set in the Law of 15 April 1994, replacing the Royal Decree of 28 February 1963. It implements several European Directives including Council Directive 96/29/Euratom of 13 May 1996 laying down basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionising radiation. Chapter 2 of GRR-2001 (article 6) presents the main steps of the Belgian licensing procedure for nuclear installations;
- The Royal Decree of 30 November 2011, as amended (SRNI-2011), laying down the safety requirements for nuclear installations, concerns the safety of nuclear installations and is the transposition of Council Directive 2009/71/Euratom of 25 June 2009 establishing a Community framework for the nuclear safety of nuclear installations and of the WENRA Reactor SRLs for operating (existing) reactors of January 2008 into Belgian law. In August 2015 SRNI-2011 was extended to include a section on decommissioning (Royal Decree of 10 August 2015). This section transposes the WENRA Decommissioning SRLs into Belgian law. In May 2018 SRNI-2011 was extended to include a chapter 4 on the specific safety requirements for spent nuclear fuel and radioactive waste storage facilities which are a transposition of the WENRA SRL on Waste and Spent Fuel Storage;
- The Royal Decree of 1 March 2018, defining a nuclear and radiological emergency plan for the Belgian territory, as well as notification criteria from the operators to the Government;
- The European Environmental Impact Assessment (EIA) Council Directive 85/337/EEC of 27 June 1985 which is repealed by the Directive 2011/92/EU of the European Parliament and the Council of 13 December 2011, that entered in force on 17 February 2012. The Directive 2011/92/EU is amended by Directive 2014/52/EU of the European Parliament and the Council of 14 April 2014 that has been transposed in Belgian law on 29 May 2020. For new Class I installations, the FANC (and Bel V) developed a Technical Regulation on the safety

demonstration and non-binding guidance on specific external hazards and on nuclear security. The contents of these guidance are expected by the FANC to be applied;

- The FANC Technical Regulation on the nuclear safety demonstration of new Class I nuclear installations provides expectations with respect to Defence-in-Depth (DiD), quantified safety objectives and external hazards in general.
- The FANC/Bel V guidance on specific external hazards provide expectations on how one or more hazard levels can be derived with the purpose to include these in the safety demonstration. These guidance address respectively seismic hazards accidental (unintentional) aircraft crashes and external flooding
- The FANC guidance on the management of nuclear documents contains recommendations related to the storage, the consultation, the reproduction the transmission and the destruction of nuclear documents as provided in articles 7 and 8 of the Royal Decree of 17 October 2011 on categorisation and protection of nuclear documents.
- The FANC/Bel V guidance on the application of conservative and less conservative approaches for the analysis of radiological consequences and on the methods and the hypotheses used for the calculation of the radiological consequences.

G.6.2 Installations of SCK CEN: BR2

See dedicated subsections in § G.1 to G.5.

G.7 Article 9 – Operation of facilities

ARTICLE 9. OPERATION OF FACILITIES

Each Contracting Party shall take the appropriate steps to ensure that:

(i) the licence to operate a spent fuel management facility is based upon appropriate assessments as specified in Article 8 and is conditional on the completion of a commissioning programme demonstrating that the facility, as constructed, is consistent with design and safety requirements;

(ii) operational limits and conditions derived from tests, operational experience and the assessments, as specified in Article 8, are defined and revised as necessary;

(iii) operation, maintenance, monitoring, inspection and testing of a spent fuel management facility are conducted in accordance with established procedures;

(iv) engineering and technical support in all safety-related fields are available throughout the operating lifetime of a spent fuel management facility;

(v) incidents significant to safety are reported in a timely manner by the holder of the licence to the regulatory body;

(vi) programmes to collect and analyse relevant operating experience are established and that the results are acted upon, where appropriate;

(vii) decommissioning plans for a spent fuel management facility are prepared and updated, as necessary, using information obtained during the operating lifetime of that facility, and are reviewed by the regulatory body.

G.7.1 Doel and Tihange facilities

G.7.1.a Initial licence and commissioning

The licensing process and the related safety assessment have been described in section G.1 and article 19 of this report.

The commissioning test programme is discussed and approved by Bel V, which follows-up the tests, evaluates the test results, verifies the conformity to the design and issues the successive permits that allow to proceed with the next step of the test programme. The FANC is informed and can intervene if considered necessary.

This process is complete when the final acceptance report is delivered by Bel V and, on the basis of a FANC report, a Royal Decree may allow operation.

G.7.1.b Operational limits and conditions

The Technical Specifications are referenced in the Safety Analysis Report. They specify the operational limits and conditions, the requirements with respect to the availability of the systems, the test and control conditions, and the actions to be taken if the acceptance criteria are not met. This applies to any status of the installation.

There are procedures related to the compliance with the Technical Specifications (T.S.) for maintenance activities during plant outage and plant operation. Each maintenance procedure has its own paragraph dedicated to T.S. requirements and limitations. During plant outages, safety engineers monitor the requirements of the Technical Specifications.

Each modification that may have an impact on the safety must be approved by the regulatory body before it can be implemented. In this respect, modifications to procedures, to the Technical Specifications and to the Safety Analysis Report are identified and discussed.

G.7.1.c Surveillance programmes

The Technical Specifications also list the controls and tests to be performed and their frequency. Specific programmes are established, in particular for inspections and controls, and tests. Each safety-related equipment has a qualification file that contains all the qualification test requirements and results. In this file are also recorded the results of ageing tests (based on IEEE 323 and the Arrhenius law) or experience feedback of similar equipment, defining the qualified life of the equipment. The qualified life determines the frequency of replacement of that equipment, which can be re-assessed depending on the real operational conditions and location of that equipment.

G.7.1.d Operation in accordance with the approved procedures

A general description of the procedures in force in the power plant is given in section 13.5 of the Safety Analysis Report. The completeness (form and contents) of the procedures has been investigated on the basis of the USNRC Regulatory Guide 1.33 which lists the subjects for which procedures must be established. This investigation was conducted as part of the licensing process and the acceptance of the installations by Bel V. During the commissioning tests, the relevant procedures that were used by the operators were verified for adequacy.

G.7.1.e Engineering and technology support

The organisation and know-how of the operator, dealt with in chapter 13 of the Safety Analysis Report, must be maintained throughout the operational life of the power plant, and even after its definitive shut-down as long as this new status is not covered by a new licence.

From an engineering point of view, the licensee gets the help of Tractebel ENGIE (TE) by means of a specific partnership program for a limited list of critical activities. TE has indeed the necessary knowledge of the installations as it was the Architect-Engineer during their construction. Moreover, TE has been in charge of the investigations and their implementation during the ten-yearly safety reviews, of the steam generators replacement projects and of a large part of non-important modifications projects, which allowed keeping up the competence and knowledge of the installations. TE is also consulted by the licensee when the latter wants to proceed to a modification of its installation. TE is also in charge of the follow-up of the provisioning of fuel reloads and of core management. Through its R&D projects, training actions and technological surveys, TE maintains a high competence in conformity to the state of the art. In order to reach these goals, TE is involved in many international research projects and is a member of various networks (or competence centres).

The design bases of the plants, i.e. the knowledge of the design of the plants and the reasons of the choices made in this design are an important part of the knowledge.

The operator – with the support of the Architect-Engineer – has developed a complete set of procedures to be able to cope with incidents ('I' procedures) or accidents ('A' procedures). These procedures are simulated, validated, and used for the operators' training.

G.7.1.f Notification of significant incidents

Section 16.6 of the Safety Analysis Report lists the events that must be notified to Bel V and/or to the FANC, indicating for each notification the delay within which it must be notified. The same section also specifies the cases for which incident reports must be supplied to the regulatory body, and within which delay.

For each incident, a classification with reference to the INES international scale is proposed by the operator, discussed with Bel V, and decided by the FANC.

The IRS (Incident Reporting System – IAEA) reports are established by Bel V and transferred to the operator for comments, and to the FANC before it is distributed abroad.

G.7.1.g Operational experience feedback

Operational experience feedback has always been considered essential to plant safety, both by the operators and the regulatory body. Art. 11 of the Royal Decree SNRI-2011 requires vigilance and

operational feedback (internal and external). Also, the licence conditions require that experience feedback from the Belgian and foreign units must be considered. Incident analysis includes an evaluation of the root cause, lessons learnt, and corrective actions taken.

Databases have been developed, in particular by Bel V, to systematise experience feedback and facilitate the link with the safety analysis. FANC carries out a process that complements and verifies the Bel V OEF process for nuclear facilities

G.7.1.h Decommissioning plans

The operator entrusted Tractebel ENGIE with the follow-up of the decommissioning issue for the spent fuel management installations. In particular, initial decommissioning plans for nuclear power generating units have been established, including the spent fuel storage installations. These decommissioning plans are periodically reviewed.

In concrete terms, provisions have been taken to facilitate the dismantling:

- considering dismantling aspects when modifying the storage installations, in order to facilitate these operations and to reduce as much as possible the activity level during the dismantling;
- gathering the information related to the storage buildings in order to improve the organisation of the future dismantling operations;
- implementing an efficient waste management policy throughout the normal operation.

For the Doel 3 and Tihange 2 units which have been permanently shut down in 2022 and 2023 respectively, final decommissioning plans have been elaborated and transmitted to ONDRAF/NIRAS in 2024.

G.7.2 SCK CEN installations: BR2

G.7.2.a Initial licence and commissioning

See Section E (§ E.2 – Article 19 – legislative and regulatory framework) and Section G – Safety of Spent fuel Management.

G.7.2.b Operating limits and conditions

As described before, the Technical Specifications are approved in the licence. They specify the operational limits and conditions, the requirements with respect to the availability of the systems, the test and control conditions, and the actions to be taken if the acceptance criteria are not met.

G.7.2.c Surveillance programmes

A surveillance programme is established in order to guarantee the quality of all safety-related activities in case of a shut-down, as well as during maintenance works.

The general surveillance programme is applicable to all BR2 systems and is based on the legal provisions, standards, the internal safety and quality programme and the procedures and instructions of the manufacturer.

The periodicity of the checks needs to be guaranteed, depending on the safety, the possibility of failure and the above-mentioned documents. In the absence of these documents, reference is made to the constructor's or own experience. A decrease of the frequency is only permitted if regulations or licence conditions allow to do so.

❖ Types of inspection

- *Periodical inspections*

Almost all of the inspections belong to this category. Nevertheless, the definition of periodicity can take on many forms, e.g. time interval, number of effective working hours, at the start of a new cycle … These inspections consist mainly of the following activities:

- Inspection of structures, systems, and components;
- Operational checking (quality);
- Calibrations (quantity).

- *Occasional inspections*

Non-periodical inspections are also possible, e.g. on demand of Bel V or FANC, or on the initiative of the HPD.

- *Inspections before operation*

It is ensured that the products, machines, devices, installations, equipment, etc… supplied, are not being used or processed before it is verified that they meet the safety requirements prescribed. The acceptance inspection can range from an ordinary identity control of the product supplied, based on the accompanying delivery note or order form to an extensive inspection of the compliance with the safety requirements.

G.7.2.d Operation in accordance with the approved procedures

A general description of the operation procedures is given in the Safety Analysis Report approved by the regulatory body.

G.7.2.e Engineering and technology support

The organisation and know-how of the operator must be maintained throughout the useful life of the power plant, and even after its definitive shut-down as long as this new status is not covered by a new licence.

G.7.2.f Notification of significant incidents

Each operating cycle of the BR2 is preceded by a note called “start-up” justifying the operational safety on the basis of the observations made during the previous period. These notes report, a.o. the operational incidents that occurred and form a first available database.

Since 1994, an analysis is carried out for each operational incident according to a standard format. The database was completed up to 1986 by means of the data filed in “start-up” notes.

G.7.2.g Decommissioning plans

A fund – financed by the State – has been set up to cover obligations resulting from the decommissioning of the installations involved in the nuclear activities of the SCK CEN before 31 December 1988. This fund is called “Technical Liability Fund” (*Fond du Passif technique*). The objective is to come back to green field; however, other end-states may be considered such as re-use of installations. Decommissioning of BR2 is covered by this fund. An initial decommissioning plan was worked out for BR2 and approved by ONDRAF/NIRAS and the Technical Passive Fund administrators.

G.8 Article 10 – Disposal of spent fuel

ARTICLE 10. DISPOSAL OF SPENT FUEL

If, pursuant to its own legislative and regulatory framework, a Contracting Party has designated spent fuel for disposal, the disposal of such spent fuel shall be in accordance with the obligations of Chapter 3 relating to the disposal of radioactive waste.

According to the Royal Decree of 28 October 2022 in relation to the national policy for category B & C waste, disposal has become the long-term management solution for the spent fuel that would be declared as waste. Currently only the spent fuel from the research reactor Thetis has been designated for disposal in Belgium.

SECTION H SAFETY OF RADIOACTIVE WASTE MANAGEMENT

Section H of this report provides comprehensive information on safety objectives and how they are or will be met for the following installations:

- existing facilities for temporary storage of radioactive waste (also for spent fuel considered as waste) and treatment and conditioning of radioactive waste;
- future disposal facilities for radioactive waste;
- future disposal facilities for spent fuel if considered as waste, at that time.

Similarly to spent fuel management facilities, these facilities are categorized as "Class I" facilities in the Belgian regulations. **The legal and regulatory framework described above in § G.1 (**Legal and regulatory framework**) applies.**

In addition, some elements of the regulatory framework are applicable to the radioactive waste only, i.e.,

- Law of 10 March 2019 giving assent to the Agreement between the Kingdom of Belgium and the Grand Duchy of Luxembourg on the management and final disposal of radioactive waste from the Grand Duchy of Luxembourg on the territory of the Kingdom of Belgium, done at Luxembourg on 4 July 2016

The waste treatment facilities at NPPs are presented in L.2 – APPENDIX 2: Radioactive Waste Management and Spent Fuel Management at Nuclear Power Plants.

H.1 Article 11 – General safety requirements

ARTICLE 11. GENERAL SAFETY REQUIREMENTS

"Each Contracting Party shall take the appropriate steps to ensure that at all stages of radioactive waste management individuals, society and the environment are adequately protected against radiological and other hazards.

In so doing, each Contracting Party shall take the appropriate steps to:

ensure that criticality and removal of residual heat generated during radioactive waste management are adequately addressed;

(ii) ensure that the generation of radioactive waste is kept to the minimum practicable;

(iii) take into account interdependencies among the different steps in radioactive waste management;

(iv) provide for effective protection of individuals, society and the environment, by applying at the national level suitable protective methods as approved by the regulatory body, in the framework of its national legislation which has due regard to internationally endorsed criteria and standards;

(v) take into account the biological, chemical and other hazards that may be associated with radioactive waste management;

(vi) strive to avoid actions that impose reasonably predictable impacts on future generations greater than those permitted for the current generation;

(vii) aim to avoid imposing undue burdens on future generations."

H.1.1 Safety objectives applicable for existing processing and storage facilities (Belgoprocess)

The storage facilities are described in appendix 3. A set of measures are taken in order to ensure the highest level of protection of the population, the workers and the environment during radioactive waste processing and storage operations:

- The category C waste storage buildings are designed and constructed to allow the removal, by natural convection and radiation, of the heat produced by this waste. Moreover, the mass of fissile U and Pu isotopes is limited to avoid criticality risk.
- The processing techniques are implemented in order to reduce as much as possible the quantity of primary and secondary radioactive waste resulting from those operations. Radioactive waste producers endeavour to limit their radioactive waste generation at source. These efforts rely on optimising industrial practices and limiting volumes of materials that meet the definition of radioactive waste, for example by improving decontamination techniques, optimising dismantling techniques, using recycling and reuse options as well as clearance possibilities, in accordance with the applicable regulations.
- Compliance with the safety regulations takes into account the radiological, biological, chemical, and other risks that can be linked with radioactive waste management.
- Some obligations must be complied with during the operation of the installations so that the future generations will not find themselves faced with constraints in terms of safety and financial means. That's why, from the operational phase of the installation onwards, funds are set up to finance the future decommissioning operations.

In order to guarantee interdependencies and consistency across all the management steps (see also section E), ONDRAF/NIRAS has set up or is developing various tools, such as:

- the integrated management system,
- the waste acceptance system,
- the technical inventory of radioactive waste.

H.1.2 Safety objectives applicable for a disposal facility

The safety strategy for a repository is the high-level integrated approach adopted to achieve safe disposal. It sets out in broad terms how it is foreseen that safe disposal will be achieved, taking into account the prevailing circumstances and the contextual framework. The safety strategy includes the safety principles to be applied, the strategic choices made, the safety concept adopted, the resulting high-level requirements to be met and the corresponding management strategy adopted to ensure that these requirements are satisfied, while addressing their impact on safety with respect to the entire repository system (waste, engineered barriers, natural barriers, site). Together with leading national and international research centres and specialized research consultancies, ONDRAF/NIRAS is conducting a wide range of safety studies. Their aim is to provide feedback for the development of the repository, to evaluate the safety of the designed facility and to establish the allowed quantities of long-lived radioactive substances that will be translated into acceptance criteria for the waste.

During its operation, a nuclear facility needs to be monitored in order to demonstrate the safety of the people living in the vicinity at all times. ONDRAF/NIRAS is developing a programme to monitor the surface repository and its surroundings in accordance with the regulations. This surface repository monitoring programme can also be integrated into general information about the wider nuclear site. For the geological disposal still at a generic level of development, a monitoring strategy is also developed as accompanying measures of the operational phase and as a performance confirmation mean for the inception of the long-term phase.

No matter how thorough and well thought-out the repository's safety management may be, accidents can never be ruled out during the construction and the operational phases. For this reason, ONDRAF/NIRAS is preparing an emergency plan for the surface disposal in Dessel; a script containing

the key risks at the site, including relevant strategies, plans of action, procedures, and instructions to organize help and to minimize the consequences of a possible nuclear accident for humans and the environment. ONDRAF/NIRAS will organize a health monitoring programme for the Dessel and Mol inhabitants, as well as for the municipalities in the immediate vicinity of the surface disposal of LLW. Together with leading knowledge organizations ONDRAF/NIRAS is conducting a pilot project that will establish whether human- bio-monitoring would be an appropriate method.

The FANC has developed and proposed a specific licensing system, as well as specific safety requirements for disposal facilities. Those have recently been published (Royal Decree of 22 April 2024, see § A.2.1 – Regulatory framework improvement during the period 2020-2024). Several technical guides applicable for the development of repositories are developed:

- Generic requirements (for surface disposal and geological disposal):
    - generic technical guide for radioactive waste disposal facilities;
    - post-closure safety analysis of radioactive waste disposal facilities ('Safety Analysis Requirements technical guide');
    - the consideration of the biosphere in a long-term safety assessment;
    - physical protection in the framework of nuclear safety.
- Specific requirements for geological disposal facilities:
    - integrated guide for the safety of geological disposal facilities;
    - requirements related to natural components ('SR3 technical guide').
- Specific requirements for the surface disposal:
    - general technical guide for surface disposal;
    - the aspect of human intrusions for surface waste disposal facilities;
    - the radiation protection criteria for long term safety for surface waste disposal facilities ('RPC-LT technical guide';
    - the radiation protection criteria for the operational period (with emphasis on criteria associated to the consideration of less frequent internal/external events);
    - the consideration of hydrogeology in the long-term safety assessment;
    - the consideration of earthquakes to be taken into consideration in the repository design.

These guides are based on International guidance, in particular the relevant IAEA safety standards and the WENRA Safety Reference Levels as well as best practices.

The design and development of repositories are based on a systemic approach: these facilities, and their engineered barriers in particular, are designed according to the characteristics of the host medium and the waste to be isolated and confined so that the combination "site (including host rock for the geological disposal) + engineered barriers + waste" as a whole can passively protect people and the environment in the long term, i.e. in such a way that the long-term safety after complete closure of the facility is assured without further requiring human intervention.

The protection of man has to be assessed for the operational phase and for the post-closure period by providing all the arguments that the expected radiological impact is lower than the dose constraint imposed by the regulator or more stringent than other complementary safety indicators the regulator might define or impose (see also § E.2 – Article 19 – legislative and regulatory framework) and that all reasonable efforts have been done to optimise protection (ALARA principle).

H.2 Article 12 – Existing facilities and past practices

ARTICLE 12. EXISTING FACILITIES AND PAST PRACTICES

"Each Contracting Party shall in due course take the appropriate steps to review:

(i) the safety of any radioactive waste management facility existing at the time the Convention enters into force for that Contracting Party and to ensure that, if necessary, all reasonably practicable improvements are made to upgrade the safety of such a facility;

(ii) the results of past practices in order to determine whether any intervention is needed for reasons of radiation protection bearing in mind that the reduction in detriment resulting from the reduction in dose should be sufficient to justify the harm and the costs, including the social costs, of the intervention."

H.2.1 Safety improvements to existing waste management facilities.

H.2.1.a Periodic safety reviews

All Class I facilities are subject to ten-yearly periodic safety reviews (PSR). PSR of the Tihange and Doel NPP's include the on-site waste treatment and storage facilities, as well as the on-site spent fuel storage facilities.

For the facilities at the Belgoprocess site (waste processing and storage facilities for the category A, B and C waste) the last periodic safety review was performed in 2018 (site 1) and in 2016 (site 2).

H.2.1.b Stress tests

Information concerning the current status of the Stress Tests action plans for the concerned facilities can be found in sections G.1 – Legal and regulatory framework.

H.2.1.c Past practices

The historical radium production in Belgium (1920s – 1960s) has created a radioactive legacy for which interventions have already partially been executed (construction of 3 storage facilities at the UMICORE, Olen site).

The situation and perspectives are described in sections D.2.3 and K.2.(4).

H.3 Article 13 – Siting of proposed facilities

"ARTICLE 13. SITING OF PROPOSED FACILITIES

1. Each Contracting Party shall take the appropriate steps to ensure that procedures are established and implemented for a proposed radioactive waste management facility:

(i) to evaluate all relevant site-related factors likely to affect the safety of such a facility during its operating lifetime as well as that of a disposal facility after closure;

(ii) to evaluate the likely safety impact of such a facility on individuals, society and the environment, taking into account possible evolution of the site conditions of disposal facilities after closure;

(iii) to make information on the safety of such a facility available to members of the public;

(iv) to consult Contracting Parties in the vicinity of such a facility, insofar as they are likely to be affected by that facility, and provide them, upon their request, with general data relating to the facility to enable them to evaluate the likely safety impact of the facility upon their territory.

2. In so doing, each Contracting Party shall take the appropriate steps to ensure that such facilities shall not have unacceptable effects on other Contracting Parties by being sited in accordance with the general safety requirements of Article 11."

H.3.1 Existing facilities

Almost all processing installations and storage buildings in Belgium are currently located on the Belgoprocess sites, which were formerly the SCK CEN WASTE Department (started up in 1956) and the EUROCHEMIC fuel reprocessing pilot plant (started up in 1966). All facilities were to comply with the regulations in force at that time. In the periodic safety reviews, all relevant site-related factors are taken into account. In addition to the licence for the dismantling of these former installations, changing the use of existing facilities (such as processing facilities) on the Belgoprocess sites required new licences for these changes. New licences for new treatment and storage buildings are also required. All relevant site factors and impacts have to be dealt with in this licensing process (see § H.2 – Article 12 – Existing facilities and past practices). The licensing process also requires public involvement and the consultation of neighbouring countries (application of article 37 of the Euratom Treaty).

H.3.1.a Disposal programme of category A waste

- **An integrated project for surface disposal of category A waste (the "cAt" project)**

The surface disposal facility at Dessel will provide a solution for disposal of the Belgian category A waste. This includes category A waste that is produced today and temporarily stored in the Belgoprocess buildings, as well as category A waste to be generated in the future, for instance after dismantling of the nuclear facilities. The radioactive waste involved is processed and conditioned and may contain only limited amounts of long-lived radionuclides, making it suitable for surface disposal.

This project combines a safe and technologically feasible solution for Belgian category A waste with socio-economic added value for the region: stimulating use and retention of nuclear know-how, anticipating spatial opportunities, organizing health monitoring, establishing of a Local Fund for financing socio-economic projects and activities. These added values are a fair appreciation for the solution offered by the municipalities Dessel and Mol to a problem that involves the entire Belgian population.

Integration is essential for the cAt project: a safe and effective repository that can rely on continuous support from the population. Safety and technological feasibility, sustainability, openness, transparency and "collective design", integration in the landscape and the social surroundings are key concepts in the implementation of the cAt project.

❖ The visiting and meeting centre

A visiting and meeting centre has been established at the disposal site, serving as the core of all information and communication about the cAt project, radioactive waste management and radioactivity in general.

The visitor and meeting centre consists of:

- an interactive theme park about radioactivity, including radioactive waste management: a tourist and educational activity centre for all age groups;
- a contact and reception centre on everything pertaining to the cAt project and the region's nuclear history;
- a local meeting place: an open house, in every sense, for people from the neighbourhood and further afield where activities can be organised.

H.3.2 Future disposal facilities

H.3.2.a Disposal programme of category B&C waste

The current disposal programme of ONDRAF/NIRAS for high-level and long-lived waste and spent fuel is a programme of methodological research and development. Its prime aim is to investigate whether it is feasible, both technically and financially, to design and build on Belgian territory a deep geological disposal facility for the considered waste that is safe, without prejudgment on the site where such a solution would actually be implemented. The actual siting of such a disposal facility will become a central element of a next phase of the disposal programme, after the necessary policy decisions for geological disposal (the first one was adopted in 2022 and sets forth that geological disposal is the final solution for B&C waste, without fixing any site). Proposed disposal facilities for these kinds of waste are thus in a R&D stage of development, and not yet in siting nor licensing phase.

H.3.2.b Disposal programme for Radium-bearing waste

Umicore, FANC, ONDRAF/NIRAS, and OVAM (Public Flemish Waste Authority) agreed in May 2021 on a roadmap for the site remediation and for the disposal of the radioactive waste and of contaminated residues (waste not to be managed as 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 which another disposal solution is considered alongside the deep geological disposal, namely a shallow-depth disposal, hence introducing a new waste category and preventing all the radium-bearing waste to fall into the category B waste avoiding very large volumes going into the geological disposal (costs/benefits analysis). A strategic environmental assessment (SEA) for the draft plan for the long-term management of radium-bearing waste is ongoing (2023-2024) as required by the Law of 13 February 2006 for any new national policy proposal regarding long-term management of radioactive waste. It will include a national consultation (planned for end 2024) after which the policy proposal will be submitted to the federal government in 2025.

The methodology developed by FANC and ONDRAF/NIRAS in their vision document, which is based on the separation of the radioactive substances according to their activity, allowed to establish an initial estimate of the volumes of substances to be managed respectively as radioactive waste and contaminated residues (see also § D.1.2.c – The Umicore site in Olen: current situation).

H.4 Article 14 – Design and construction of facilities

"ARTICLE 14. DESIGN AND CONSTRUCTION OF FACILITIES

Each Contracting Party shall take the appropriate steps to ensure that:

(i) the design and construction of a radioactive waste management facility provide for suitable measures to limit possible radiological impacts on individuals, society and the environment, including those from discharges or uncontrolled releases;

(ii) at the design stage, conceptual plans and, as necessary, technical provisions for the decommissioning of a radioactive waste management facility other than a disposal facility are taken into account;

(iii) at the design stage, technical provisions for the closure of a disposal facility are prepared;

(iv) the technologies incorporated in the design and construction of a radioactive waste management facility are supported by experience, testing or analysis."

According to the regulations in force, the Preliminary Safety Analysis Report that is part of the licence application file has to describe how the following points will be implemented:

- protection against potential criticality (limitation of U and Pu quantities in waste and in containers),
- protection against contamination (i.e. casks in corrosion-resistant materials),
- protection against irradiation (thickness of the cell walls calculated to remain below the dose rate limits, installation of permanent dosimeters, use of portable dosimeters during a handling or maintenance operation)
- expected levels of radioactivity released in normal and accidental situations and operational limits,
- consideration of accidental scenarios (cask fall, airplane crash, radiolysis, failure of the cooling or electric system, floods, explosion, …) and their impact on radiological safety,
- description of the monitoring programmes (on site/off site)
- Probability Safety Analyses available at the time of the application.

The levels of details of the above-mentioned points depend on the type of installations.

The licence application for a disposal facility has to cover all phases of the facility lifetime, including a description of the feasibility of its closure.

A preliminary decommissioning plan has to be established (see section G.1)

Finally, the techniques considered during the design of the processing and storage installations and used during their construction are based on the industrial experience, on tests and on analyses.

H.5 Article 15 – Assessment of safety of facilities

> *"ARTICLE 15. ASSESSMENT OF SAFETY OF FACILITIES*
>
> *Each Contracting Party shall take the appropriate steps to ensure that:*
>
> *(i) before construction of a radioactive waste management facility, a systematic safety assessment and an environmental assessment appropriate to the hazard presented by the facility and covering its operating lifetime shall be carried out;*
>
> *(ii) in addition, before construction of a disposal facility, a systematic safety assessment and an environmental assessment for the period following closure shall be carried out and the results evaluated against the criteria established by the regulatory body;*
>
> *(iii) before the operation of a radioactive waste management facility, updated and detailed versions of the safety assessment and of the environmental assessment shall be prepared when deemed necessary to complement the assessments referred to in paragraph (i)."*

H.5.1 Existing or new facilities

See § G.1 – Legal and regulatory framework.

H.5.2 Disposal facilities

Before a disposal facility can be constructed, a licence for creation and operation has to be granted by Royal Decree. A safety assessment as well as an environmental impact assessment has to be conducted and submitted to the FANC as a part of the licence application file.

❖ Categories B&C programme

The main elements (objectives, achievements, future priorities, …) of the RD&D programme for the geological disposal of category B&C waste in a poorly indurated clay host rock are described in more detail in 'ONDRAF/NIRAS Research, Development and Demonstration (RD&D) Plan for the geological disposal of high-level and/or long-lived radioactive waste including irradiated fuel if considered as waste'. The objectives, organization, and planning of the next phases of this RD&D programme will largely depend on the policy decision taken by the Federal Government in 2022 (see § A.2.1 – Regulatory framework improvement during the period 2020-2024) and the other policy decisions yet to come. In the framework of a pre-licensing process for deep underground disposal for B&C waste, ONDRAF/NIRAS is developing a methodological and non-decisional Safety Case (SFC 1) with, as reference option, a geological disposal facility (GDF) for the management of category B and C waste in the Boom Clay or the Ypresian clays at a depth between 200m and 600m so to take advantage of its 40 years' experience of research, development, and demonstration in poorly indurated clays. The main objective of such a safety case is to challenge the methodology implemented by ONDRAF/NIRAS. The independent review of the safety case by FANC is also an opportunity to assess the adequacy and completeness of the regulatory framework. Besides, in order to comply with the regulator's expectations, other host rocks are also investigated but not yet at the same level of detail, in order to verify that, based on current knowledge, there is no major obstacle for such a project.

❖ Category A programme

The safety demonstration for the surface disposal facility, documented in the safety report that constitutes the basis for the nuclear licence, is separated into two phases. A first phase concerns the safety of the facility during the operational period, up to the closure of the facility, whilst a second phase concerns the long-term safety of the facility after it has been closed. The demonstration of operational safety is rather similar to that encountered for e.g. storage facilities, but the demonstration of long-term safety is very particular for disposal facilities and relies on the development of scenarios describing the expected and possible system evolutions, including those involving human intrusion in the period after release from regulatory control. Together with this

(radiological) safety assessment, ONDRAF/NIRAS introduced an environmental impact assessment, from which the nuclear aspects were also assessed by the regulator.

The safety assessment and environmental impact assessment aimed to demonstrate that the radiological impact, both during operations as in the long term, will comply with the criteria as set by the regulator through specific guidelines.

At the request of FANC, ONDRAF/NIRAS developed an approach to optimise the design of certain SSCs. The approach consists of identifying the different design options for a given SSC and scoring these options based on a set of attributes, such as durability, robustness, demonstrability and others. The optimal option is then selected based on the score for each attribute and taking into account social and economic factors.

This approach is systematically applied for the SSCs of the surface disposal facility and will continue to be applied throughout the entire life of the facility.

FANC has developed several guides, dealing with disposal facilities, and setting amongst other dose criteria for the different scenarios and time frames:

- Guide on the consideration of human intrusions for surface waste disposal facilities:
    - This guide stipulates amongst others the differed and direct radiological impact of maximum 3 mSv/y associated to Human Intrusion Scenarios.
- Guide on the radiation protection criteria for long term safety:
    - This guide stipulates amongst other things the criteria associated to the different types of scenarios that are assessed in the long-term safety assessment (except for human intrusion). A dose constraint of 0.1 mSv/y for the normal evolution scenario, and a global risk constraint of 10^{-5}/y for altered evolutions scenarios are set, as is a reference value of 3 mSv/y under penalizing conditions to be considered at timescales over which reliable statements on repository performance can no longer be made.
- Guide on the radiation protection criteria for the operational period (with special emphasis on criteria associated to the consideration of less frequent internal/external events).
- Guide on the consideration of hydrogeology in the long-term safety assessment
- Guide on the consideration of the biosphere in a long-term safety assessment

The applying regulatory framework relating to nuclear safety and radiation protection applying to the surface repository includes these guides as well as, obviously, the general regulations on protection against ionizing radiation (Royal Decree of 20/07/2011) and the generic safety prescriptions for nuclear facilities (Royal Decree of 30/11/2011). Specific safety prescriptions for disposal facilities have been integrated in the latter Royal Decree in 2024 (see "*The Royal Decree of 22 April 2024 on the licensing system for disposal facilities*" under § A.2.3 – Other Developments). A preliminary version thereof had been published as a FANC note and was used as a guide by ONDRAF/NIRAS, for developing the licence application, and by the safety authority, for assessing the adequacy of the application/safety demonstration.

The licensing conditions stipulate that the FANC and Bel V will define a list of their "hold-points" and "witness-points" that ONDRAF/NIRAS must take into account in its construction and commissioning programme. A first hold-point is called the hold-point "ready for construction" (RFC) in which ONDRAF/NIRAS has to demonstrate to the FANC and Bel V that it is ready to start construction. This demonstration includes elements of proof that ONDRAF/NIRAS possesses an adequate organization, leadership for safety and safety culture. It also includes all procedures that are necessary before starting construction as well as an adequate QA/QC-programme by both the contractors and ONDRAF/NIRAS.

An important element of the QA/QC-programme is a risk analysis identifying the critical tasks and measures in order to obtain SSCs that fulfil all conformity criteria with regard to nuclear safety. This risk analysis will be performed by the contractors under the guidance of ONDRAF/NIRAS. It will subsequently be independently assessed by the service of physical control (DFC - 'Dienst Fysische Controle') of ONDRAF/NIRAS, and after approval of the DFC it is submitted to Bel V and the FANC for assessment and approval.

The risk analysis also serves as a tool for ONDRAF/NIRAS and its DFC to define their hold- and witness-points during the construction process and to define the contractor's construction procedures that need DFC-approval. The lifting of the hold-point ready for construction is foreseen in 2025 after which actual construction activities will take a start.

❖ Radium-bearing waste programme

A strategic environmental assessment (SEA) for the draft plan for the long-term management of radium-bearing waste is ongoing (2023-2024) as required by the Law of 13 February 2006. It will include a national consultation (planned for end 2024) after which the policy proposal will be submitted to the federal government in 2025.

H.6 Article 16 – Operation of facilities

"ARTICLE 16. OPERATION OF FACILITIES

Each Contracting Party shall take the appropriate steps to ensure that:

(i) the licence to operate a radioactive waste management facility is based upon appropriate assessments as specified in Article 15 and is conditional on the completion of a commissioning programme demonstrating that the facility, as constructed, is consistent with design and safety requirements;

(ii) operational limits and conditions, derived from tests, operational experience and the assessments as specified in Article 15 are defined and revised as necessary;

(iii) operation, maintenance, monitoring, inspection and testing of a radioactive waste management facility are conducted in accordance with established procedures. For a disposal facility the results thus obtained shall be used to verify and to review the validity of assumptions made and to update the assessments as specified in Article 15 for the period after closure;

(iv) engineering and technical support in all safety-related fields are available throughout the operating lifetime of a radioactive waste management facility;

(v) procedures for characterization and segregation of radioactive waste are applied;

(vi) incidents significant to safety are reported in a timely manner by the holder of the licence to the regulatory body;

(vii) programmes to collect and analyse relevant operating experience are established and that the results are acted upon, where appropriate;

(viii) decommissioning plans for a radioactive waste management facility ***other*** *than a disposal facility are prepared and updated, as necessary, using information obtained during the operating lifetime of that facility, and are reviewed by the regulatory body;*

(ix) plans for the closure of a disposal facility are prepared and updated, as necessary, using information obtained during the operating lifetime of that facility and are reviewed by the regulatory body."

❖ Commissioning programme

As described above, before the operation of a facility, a fully favourable acceptance report, based on a commissioning programme has to be established. Based on this acceptance report, a "confirmation decree" as Royal Decree, allows the operation of the Class I facility.

❖ Operational requirements

Operational requirements as described in G.1 – Legal and regulatory framework apply to these facilities.

❖ Decommissioning plan

See § G.1 – Legal and regulatory framework.

H.7 Article 17 – Institutional measures after closure

"ARTICLE 17. INSTITUTIONAL MEASURES AFTER CLOSURE

Each Contracting Party shall take the appropriate steps to ensure that after closure of a disposal facility:

(i) records of the location, design and inventory of that facility required by the regulatory body are preserved;

(ii) active or passive institutional controls such as monitoring or access restrictions are carried out, if required; and

(iii) if, during any period of active institutional control, an unplanned release of radioactive materials into the environment is detected, intervention measures are implemented, if necessary."

H.7.1 Legal and regulatory framework

Art. 60 of the Royal Decree on the "Safety Requirements for Disposal Facilities" (see § A.2.1 – Regulatory framework improvement during the period 2020-2024) deals with the need for a document management system to ensure long-term traceability of information and data relating to safety, and decisions in connection with the disposal facility. This information and data shall be kept up-to-date until the release of regulatory control and includes at least:

- Characterisation of the site.
- Design basis.
- Design.
- As built data.
- Operation history including events and accidents.
- Inventory and emplacement of the waste.
- State of the disposal system after closure.
- All documents relating to the safety case.

Art. 71.1 of this project deals with the development and the implementation of a monitoring programme with a view to obtaining a full and relevant set of data in order to:

- verify that regulatory requirements and licensing conditions are met;
- verify that the disposal system behaves as intended, in particular by monitoring physical and chemical parameters providing information on changes in the disposal system and its environment from the initial reference state;
- verify that the assumptions and models used when assessing safety are consistent with the conditions observed;
- support safety-related decisions;
- detect any potential releases of radionuclides into the environment and monitor their development and radiological impact.

The monitoring programme shall be reassessed periodically, and adapted, if necessary, particularly when passing from one phase in the disposal facility's lifecycle to another and in case of observing an unexpected evolution. Any change in the monitoring programme shall be approved by the FANC. Art. 71.2 of the same project deals with deviation to the safety case observed through the monitoring results. The cause of this deviation has to be identified, the implications on safety assessed and corrective measures implemented if required.

H.7.2 Disposal of category A waste

❖ Post-closure concepts

Access restrictions to the disposal site will apply until the release of regulatory control, mostly with a view towards preventing inadvertent human intrusion. The elaboration of a monitoring and surveillance programme for verification of the proper functioning of the repository is planned. This specifically includes the following elements:

- the facility's environmental impact (principally radiological monitoring of the ambient air quality, the soil and the ground and surface waters);
- follow-up of control structures;
- groundwater level measurements for supporting hydrogeological models.

Periodic safety reviews will continue in the post-closure period, with the ultimate aim of justifying the eventual release of regulatory control.

❖ RD&D

Monitoring and study over several decades of the behaviour of a test cover representative of the multi-layer cover.

❖ Timeframes

Intention to maintain monitoring and surveillance for 250 years after the complete closure of the repository. As per the periodic safety reviews, the possibility for optimization (shortening) of the duration of this period must be studied, in view of the principle to transfer lesser burdens to future generations.

❖ Transparency and participation

Maintaining transparency and participation until the end of control is an integral part of the integrated disposal project. Financing through a local fund, long after the closure of the repository, of projects improving the local quality of life will contribute to maintain memory of the repository.

H.7.3 Disposal of category B&C waste

❖ Post-closure concepts

The post-closure concept is still to be introduced into the regulations.

ONDRAF/NIRAS committed itself to:

- ensure operational reversibility and examine the measures that may facilitate the potential retrieval of the waste packages after partial or complete closure of the repository for a period to be defined in consultation with the stakeholders, including FANC;
- maintain the controls for the proper functioning of the disposal system which will be performed in addition to the regulatory controls for a period to be defined in consultation with the stakeholders, including FANC;
- make the most appropriate preparations for the transfer of knowledge about the repository and the waste it contains, to future generations.

❖ RD&D

Studies are ongoing on the controls, reversibility and retrievability.

❖ Timeframes

The definition of schedules, for RD&D and for the post-closure phase itself, is premature. However, according to ONDRAF/NIRAS provisional plan, the license for construction and operation of the GDF is assumed to be granted in 2050 and the operational and closure phases should last 85 years. The

duration of the institutional control phase (after closure) is not yet defined but should not exceed 300 years, in line with the international standards.

H.7.4 Disposal of radium-bearing waste

❖ Post-closure concepts

As already mentioned, (see § D.1.2.c – The Umicore site in Olen: current situation), 30 000 m³ of radium-bearing substances are identified as radioactive waste for which a radium-bearing waste national policy is in preparation. The proposed solution is a local shallow-depth disposal. The rest of the radioactive substances will be either considered as B-waste for the geological disposal or contaminated residues and will be disposed of in conventional landfills.

The post closure concept is still being studied.

❖ Legislative developments

Actions are undertaken at institutional level to:

- prepare a national policy proposal for the disposal of radium-bearing radioactive waste, including the strategic environmental assessment procedure;
- complete the regulatory framework based on the identified missing regulatory elements;
- define the authorisation path, at the regional and federal levels, for all remediation and disposal activities;

❖ RD&D

The current RD&D activities are:

- Finishing 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;
- assessing the remediation options and selecting a preferred option.

❖ Timeframes

The definition of schedules, for RD&D and for the post-closure phase itself, is premature.

❖ Transparency and participation

A strategic environmental assessment (SEA) for the draft plan for the long-term management of radium-bearing waste is ongoing (2023-2024) as required by the Law of 13 February 2006. It will include a national consultation (planned for end 2024) after which the policy proposal will be submitted to the federal government in 2025.

SECTION I TRANSBOUNDARY MOVEMENTS

I.1 Article 27 – Transboundary movements

ARTICLE 27. TRANSBOUNDARY MOVEMENTS

1. Each Contracting Party involved in transboundary movement shall take the appropriate steps to ensure that such movement is undertaken in a manner consistent with the provisions of this Convention and relevant binding international instruments.

In so doing:

(i) a Contracting Party which is a State of origin shall take the appropriate steps to ensure that transboundary movement is authorized and takes place only with the prior notification and consent of the State of destination;

(ii) transboundary movement through States of transit shall be subject to those international obligations which are relevant to the particular modes of transport utilized;

(iii) a Contracting Party which is a State of destination shall consent to a transboundary movement only if it has the administrative and technical capacity, as well as the regulatory structure, needed to manage the spent fuel or the radioactive waste in a manner consistent with this Convention;

(iv) a Contracting Party which is a State of origin shall authorize a transboundary movement only if it can satisfy itself in accordance with the consent of the State of destination that the requirements of subparagraph (iii) are met prior to transboundary

movement;

(v) a Contracting Party which is a State of origin shall take the appropriate steps to permit re-entry into its territory, if a transboundary movement is not or cannot be completed in conformity with this Article, unless an alternative safe arrangement can be made.

2. A Contracting Party shall not licence the shipment of its spent fuel or radioactive waste to a destination south of latitude 60 degrees South for storage or disposal.

3. Nothing in this Convention prejudices or affects:

(i) the exercise, by ships and aircraft of all States, of maritime, river and air navigation rights and freedoms, as provided for in international law;

(ii) rights of a Contracting Party to which radioactive waste is exported for processing to return, or provide for the return of, the radioactive waste and other products after treatment to the State of origin;

(iii) the right of a Contracting Party to export its spent fuel for reprocessing;

(iv) rights of a Contracting Party to which spent fuel is exported for reprocessing to return, or provide for the return of, radioactive waste and other products resulting from reprocessing operations to the State of origin.

The transport of radioactive material in Belgium is governed by the Royal Decree of 22 October 2017 on the transport of class 7 dangerous goods, modified by the Royal Decree of 3 July 2019. The transport of class 7 dangerous goods, the handling, during multimodal transport, of packages, containers or tanks containing these goods and the establishment of an interruption site may only be carried out by natural or legal persons recognized by the FANC under the provisions of this Decree.

Before a carrier can be recognized, he must have at least the following:

- a management system in accordance with the provisions of the applicable international agreements and regulations governing the transport of dangerous goods, whereby the carrier can guarantee and demonstrate that Class 7 dangerous goods are always transported safely and properly;
- a radiation protection programme in accordance with the provisions of the applicable international agreements and regulations governing the transport of dangerous goods;
- an internal emergency procedure;
- a Health Physics Department, as set out in the GRR-2001;
- third-party liability insurance.

In addition to the recognition for carriers, some shipments need to be licensed prior to shipment, among others the transport of radioactive waste and nuclear spent fuel.

With regard to the transboundary shipments of radioactive waste and spent fuel, the provisions of the article 27 of the Joint Convention are fully reflected in the European Directive 2006/117/Euratom of 20 November 2006 on the supervision and control of the shipments of radioactive waste between Member States. In the Belgian legislation, the Royal Decree of 24 March 2009 regulating import, transit and export of radioactive substances transposes these European Directive. In the licensing procedure the advice of ONDRAF/NIRAS in case of import and export of radioactive waste is foreseen. Belgium has not licensed any shipment of spent fuel or radioactive waste to a destination south of latitude 60 degrees South for storage or disposal.

Currently, there are few transboundary shipments of spent fuel and radioactive waste. Belgium has consented the transit or the import or the export and granted licences for:

- Export of spent fuel for reprocessing from the SCK CEN to ORANO La Hague, France;
- Transit of spent fuel for reprocessing from Borssele, The Netherlands to ORANO La Hague, France;
- Transit of compacted and vitrified radioactive waste from ORANO La Hague, France to the Netherlands;
- Import of spent fuel for post irradiation examination from the European Commission in Karlsruhe, Germany to the SCK CEN;
- Import of spent fuel (or in some cases, fuel samples) for experiment or analysis, from France to the SCK CEN;
- Import of radioactive waste after treatment in Germany and Sweden, to Belgium;
- Transit of radioactive material for treatment from Germany to USA;
- Export of radioactive waste after treatment at Belgoprocess, to Romania;
- Export of radioactive waste for treatment from to Sweden;
- Export of radioactive material for analysis in France;
- Export of solid and metallic radioactive waste from maintenance on primary pump engine at Westinghouse Electric Belgium to France, Spain, and UK.

A comprehensive list of those shipments is available in the 5th national report of Belgium under Council Directive 2006/117/Euratom.

SECTION J DISUSED SEALED SOURCES

J.1 Article 28 – Disused sealed sources

> *"ARTICLE 28. DISUSED SEALED SOURCES*
>
> *1. Each Contracting Party shall, in the framework of its national law, take the appropriate steps to ensure that the possession, remanufacturing or disposal of disused sealed sources takes place in a safe manner.*
>
> *2. A Contracting Party shall allow for reentry into its territory of disused sealed sources if, in the framework of its national law, it has accepted that they be returned to a manufacturer qualified to receive and possess the disused sealed sources."*

Belgium has no specific regulation with regard to disused sealed sources. The same conditions and licences are applicable to these sources as those regarding new sources: operation licences, transport licences for the carriers and import licences are required as well as the application of the ruling European regulation 1493/93 on shipments of radioactive substances between Member States.

The user/holder can either transport these sources to ONDRAF/NIRAS as declared radioactive waste or, if stipulated in the contract, he can return them to the supplier/producer.

In case a Belgian producer takes back the sources, they are subject to the same regulatory requirements as those regarding the import of new sources, including the application of regulation 1493/93. The producer is required to either store the used sources for decay storage or transfer them to ONDRAF/NIRAS.

Disused sealed sources are regulated by the European Directive 2013/59/EURATOM.

The Directive sets out the obligation for each Member State to set up a system requiring prior licence for the holder of a sealed source. The licence will only be granted if the competent authorities have imposed appropriate measures for the safe use of the source, including when it becomes disused. A financial guarantee has to be set up for the disposal and storage of the source when it becomes disused, or arrangements have to be made to return the source to the supplier or to a recognised storage facility.

The licence must cover different fields: responsibilities of the holders, staff competencies, information and training requirements for workers and people working in the vicinity of the sources, minimum equipment and packaging performance criteria, procedures to be followed in case of an accident, transfer modalities…

Each source will be identified by a standard record sheet indicating, among others, the name of the holder, the location, the transfers, the nature of the radio-isotopes and the results of regular integrity tests. The packaging and, if possible, the sources will be marked by a unique identification number. The competent authorities receive regular updates of these records.

The holder has the obligation to regularly check the location and the good state of the sources in his possession and to warn immediately the competent authority of any disappearance or accidents having led to an exposure. The competent authority can perform inspections to check that the directive is correctly applied. The holder is also to transfer forthwith every disused source to a recognised installation or to the supplier, according to the arrangements made.

❖ Retrieval of Orphan Sources

FANC, ONDRAF/NIRAS and the certified inspection body have drawn up a procedure for managing orphan sources. After detection of an orphan source, usually at a company that has been registered with FANC as a company where orphan sources are likely to be encountered (e.g. scrap metal recycling installations and waste incinerators), the source is stored in a safe storage area on site. An

inventory of radioactive sources is kept by each site and reported to FANC, who informs ONDRAF/NIRAS. Once a year, holders of orphan sources are obliged to contact a certified expert who characterizes the sources, prepares them for transport and drafts the necessary documents for ONDRAF/NIRAS, who verifies the conformity of the waste with the current acceptance criteria for waste treatment, before organizing the transport to Belgoprocess. In the event that a source with a dose rate exceeding the limits for safe local storage is encountered, the source can be transported immediately at the behest of FANC.

Organizing the transport of orphan sources on a yearly basis has several advantages with respect to the optimization of packaging and the costs for transport and waste treatment. In addition, an accumulation of radioactive sources at non-nuclear facilities is avoided.

The graph below provides an overview of the yearly number of retrieved orphan sources. The significant rise of retrieved sources over the years is explained by the specific legislation since 2011 that obliges companies where orphan sources can potentially be encountered to install detectors, and by the above-mentioned procedure which was written in 2013. Between 2014 and 2016, a historical backlog of orphan sources was retrieved, explaining in part the peak number of retrieved orphan sources in this period. The peak witnessed in 2021-2022 is possibly due to logistical difficulties during the covid-period (2020). In the long term, a steady decline in the number of encountered orphan sources is expected, as many orphan sources are historical objects no longer in production today.

The costs for the retrieval and further management of orphan sources are covered by the ONDRAF/NIRAS Insolvency Fund, as dictated in Belgian regulations by the Royal Decree of 2 June 2006, amending accordingly the Royal Decree of 30 March 1981. This fund is financed by invoicing producers of radioactive waste a reserve of 5% calculated on the cost of the transport, treatment, conditioning, and storage services provided by ONDRAF/NIRAS, and has a lower and upper limit. Upon reaching the upper limit, which is based on the maximum cost in case of bankruptcy or insolvability of the Class II and III facilities, the collection of the reserve of 5% is temporarily suspended. When the yearly evaluation of the funds indicates that the lower limit might be reached in the following year, the collection is resumed.

Figure 15 shows an overview of the different types of orphan sources retrieved as radioactive waste between 2007 and 2023. It is worth noting that only about 15% of orphan sources can be labelled as sealed sources: lightning rods (8%) and other sealed sources (7%). Other categories include radium contaminated objects (29%), contaminated metals (23%), uranium and (to a lesser extend) thorium ores (16%) and chemical products (10%).

❖ Schools/pharmacies

Many schools and pharmacies in Belgium still had historical radioactive sources in their possession that are no longer in use today. The presence of disused sources at these locations however constitutes an unnecessary safety risk, which is the main driver for having the radioactive sources removed.

Because the financial aspect of the removal of radioactive sources can form an obstacle for these institutions, ONDRAF/NIRAS and FANC decided to organise a specific removal campaign in the interest of sharing transport and waste treatment costs. The ministries of education and the APB (an organisation representing pharmacies in Belgium) informed all Belgian schools and pharmacies of the upcoming campaign, requesting them to check their inventory for the presence of any radioactive sources, and to fill in a questionnaire to provide more details on the sources in their possession. With this information, transports were organised for the removal of said sources in 2007/2008 and again in 2015.

Despite these efforts, ‘forgotten’ radioactive sources are still occasionally found by schools and pharmacies. These cases are collected for a combined yearly recovery, thereby reducing the transport costs for these institutions.

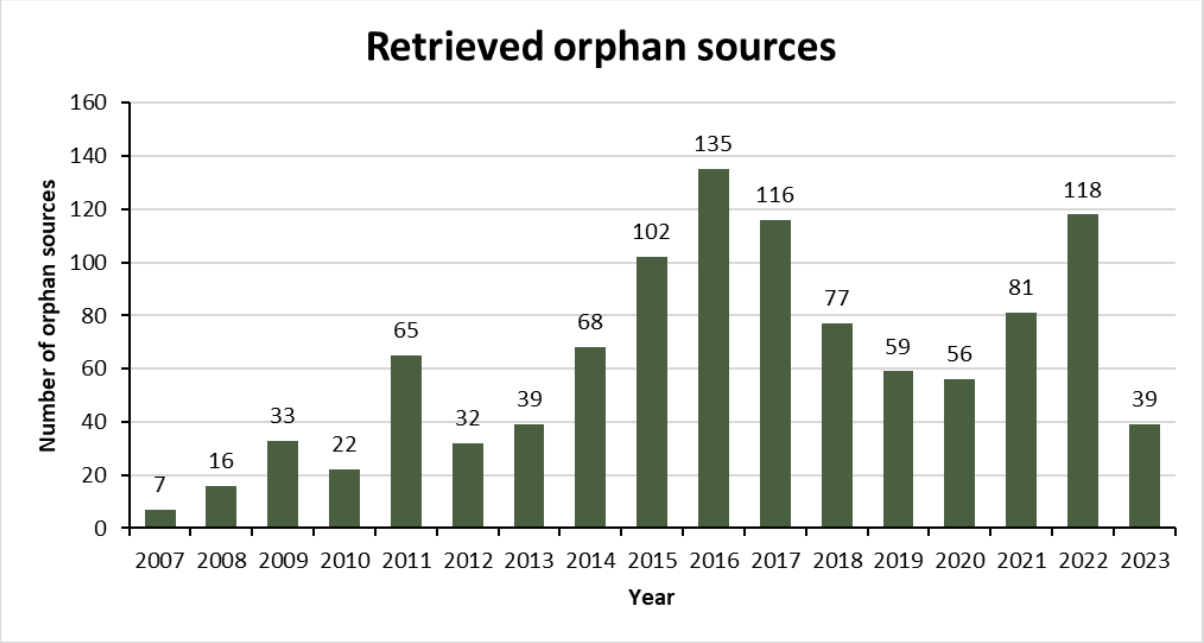


Figure 14: Yearly evolution of number of retrieved orphan sources.

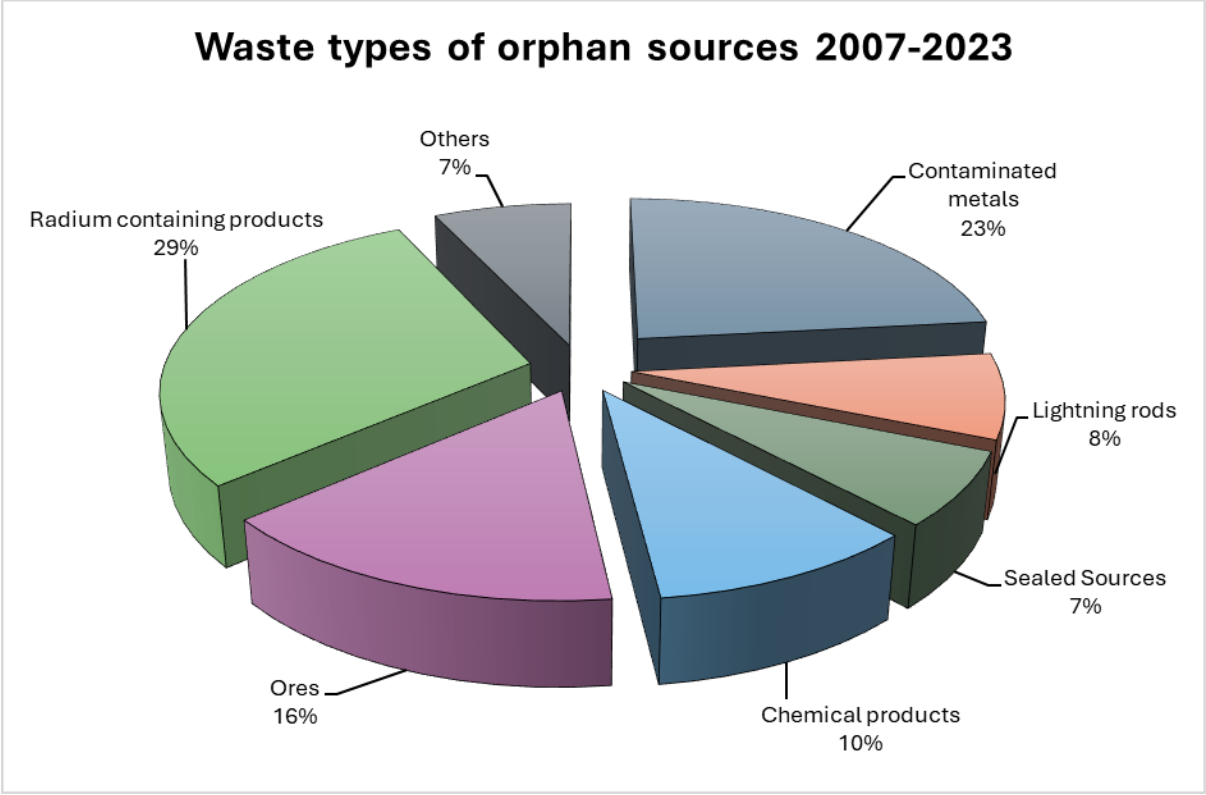


Figure 15 Orphan source types.

SECTION K GENERAL EFFORTS TO IMPROVE SAFETY

K.1 Measures taken to address suggestions and challenges identified for Belgium at the 7th review meeting of the Joint Convention (2022)

At the 7th review meeting in 2022, 8 challenges were identified. They were in line with the self-evaluation in the national report:

- Finalising construction and commissioning of new radioactive waste storage facilities at Belgoprocess ;
- Decommissioning of NPPs and other facilities ;
- Determining the status of spent fuel ;
- Establishing and implementing national policy on long-term management of HLW and long-lived wastes, including a stepwise, reversible, and participative decision process ;
- R&D programme on Partitioning and Transmutation (as an alternative management pathway for spent fuel – but not an alternative to disposal) ;
- Site remediation for radium-bearing waste at Umicore, Olen ;
- IRRS and ARTEMIS missions in 2023 ;
- Programme for long-term management of non-conform waste.

No suggestion was formulated to Belgium.

K.1.1 Challenges to improve safety identified for Belgium at the 7th review meeting

K.1.1.a Finalising construction and commissioning of new radioactive waste storage facilities at Belgoprocess

The new licensed storage facilities at Belgoprocess are discussed in § A.2.3 – Other Developments (in particular, on p. 11). Both the storage facility for non-conform waste (building 167X) and reception and storage centre for non-conditioned waste (building 165X) will become operational in the next 5 years. A new storage facility (168X) is planned to replace bunker 1, 2 and 3 of the existing building 127 for the storage of bituminised waste and a new storage facility (MESSINA) is planned to replace the last bunker, bunker 4, of the existing building 127 for the storage of mainly cemented waste. In 2024, the basic design for these two projects will be carried out to further plan the detailed design and realisation phases.

K.1.1.b Decommissioning of NPPs and other facilities

See § A.2.3 – Other Developments, and § F.6 – Article 26 – Decommissioning.

K.1.1.c Determining 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 design and operation of a future geological disposal facility and for costs calculations. The current reference program for the long-term management of spent fuel from NPP is direct disposal, without reprocessing.

SCK CEN is currently exploring the feasibility of reprocessing with industrial partners, or the treatment and conditioning of its (future) spent fuel and whose status has not yet been clarified, namely:

- the spent fuel from the BR3 reactor that was declared as waste to ONDRAF/NIRAS to allow a safe storage for a maximum of 50 years but is still SCK CEN's property pending an operational solution for the fuel long-term management;
- the used fuel from the VENUS reactor, and
- the future spent fuel from the BR1 reactor.

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.

K.1.1.d Establishing and implementing national policy on long-term management of HLW and long-lived wastes, including a stepwise, reversible, and participative decision process

According to the first part of the national policy for the long-term management of the high-level and/or long-lived waste, laid down in the Royal Decree of 28 October 2022, deep disposal (i.e., geological disposal) is the reference long-term management option for B&C waste. The first part of the national policy also specifies that the decision-making process to develop and implement such a deep geological disposal facility needs to be a participative, fair, and transparent process. The Royal Decree also sets out the reversibility of this decisional process, according to which each step of the process can be re-evaluated. Through the Royal Decree, ONDRAF/NIRAS received the mandate to make a proposal for the decision-making process, as second part of the national policy, with an indicative timeline for this process and the main milestones for implementing this policy through the National Programme. The outcomes of the ARTEMIS mission serve as an input for this proposal (see § K.4.2 – ARTEMIS mission of 2023).

Also as part of the preparation of this proposal, a national societal debate on the long-term management of radioactive waste started in 2023 and ran till March 2024. The debate initiated by ONDRAF/NIRAS was led under the auspices of the King Baudouin foundation as neutral institution. The societal debate provided recommendations for the definition of the above-mentioned reversible and participative decision-making process. The societal debate (see § A.2.3 – Other Developments ; and § K.3.1.b – Outcomes of the public consultation) confirmed the need for deep geological disposal in all conceivable scenarios and requested all institutional actors to move forward in the development of this solution.

K.1.1.e R&D programme on Partitioning and Transmutation (as an alternative management pathway for spent fuel – but not an alternative to disposal)

According to the Royal Decree of 28 October 2022, ONDRAF-NIRAS is asked to continue to monitor developments on deep disposal, including deep boreholes, and advanced nuclear technologies, i.e., Partitioning and Transmutation. Even though Partitioning and Transmutation is not considered as a potential alternative to disposal, it could optimise the future disposal facility. These technologies are the object of research by SCK-CEN in its Myrrha project.

The ARTEMIS peer review held in December 2023 recommended ONDRAF/NIRAS to focus its main resources on solutions that are technically feasible and internationally acknowledged for the long-term management of category B&C waste of the Belgian inventory.

K.1.1.f Site remediation for radium-bearing waste at Umicore, Olen

At the UMICORE site in Olen there is a legacy of historical radium-bearing waste, substances and contaminations resulting from the production of radium in the period 1922 – 1977. There are three licensed storage facilities and landfills with radium-contaminated materials.

The roadmap defined by the four involved actors, Umicore, FANC, ONDRAF/NIRAS, and OVAM, aims at the definition and implementation of all the site remediation projects and disposal projects to come to a safe long-term situation at the Olen site.

The main challenges in phase 2 of the roadmap (2022- 2024) are to come to a complete legal and regulatory framework for remediation of radiologically contaminated sites and for the disposal of the radioactive radium-bearing waste. Several legislative changes have already taken place during the current reporting period (see § A.2.1 – Regulatory framework improvement during the period 2020-2024). This roadmap provides for the establishment by ONDRAF/NIRAS of a national policy proposal for the low- and intermediate-level radium-bearing waste in which another disposal solution is considered alongside the deep geological disposal, namely a shallow-depth disposal, hence introducing a new waste category and preventing all the radium-bearing waste to fall into the category B waste. The policy proposal is planned for 2025.

K.1.1.g IRRS and ARTEMIS missions in 2023

See § K.4 – Peer reviews.

K.1.1.h Programme for long-term management of non-conform waste

Non-conform conditioned waste (400 ℓ drum packages), affected by an Alkali-Silica reaction (ASR) leading to the production of a gel, have been discovered, starting from a routine inspection in 2012 at Belgoprocess. Historical elements can be found in the previous editions of the Belgian national report for the Joint Convention (2014, 2017 and 2020). ONDRAF/NIRAS was tasked to investigate the different options for the long-term management of these non-conform drums. The first RD&D program phase (2017-2022) on the ASR-affected drums was conducted on four different aspects, being 1) the phenomenology of the gel formation, 2) the development of monitoring techniques for the gel formation, 3) assessing the consequences on the disposal system and 4) designing a full reconditioning and rehabilitation solution. Based on the results of this RD&D program two of the four abovementioned options remain: item 3) the ASR impact on the engineered barrier system is acceptable (eventually with a modified design) and item 4) the waste has to be reconditioned.

These results steer the 2nd phase of the RD&D program, which consists, for example (for option 3 mentioned above), of assessing the maximum possible volume of gel production for conditioned waste drums and evaluating the impact of humidity on the development of the ASR reaction. In the frame of reprocessing (option 4) research is ongoing on the long-term behaviour of the end-product of a plasma incineration process. With this technology very high temperatures are reached under an oxidizing environment resulting in a complete thermal decomposition and a glass composite material as an end-result. Fluxing strategies, by treating several waste streams together or by non-radioactive additives like regular glass, might be needed to obtain a good end-product, i.e. an end-product that is compatible with all conformity criteria related to the surface disposal repository.

K.2 Overarching Issues identified for reporting at the 7th Review Meeting

As reported in the Summary Report of the 7th Review Meeting:

> *The Contracting Parties agreed that National Reports for the Eighth Review Meeting should address, as appropriate, the actual measures that have been taken in implementing the following issues:*
>
> *(i) Competence and staffing linked to timetable for spent fuel and radioactive waste management programmes;*
>
> *(ii) Inclusive public engagement on radioactive waste management and on spent fuel management programmes;*
>
> *(iii) Ageing management of packages and facilities for radioactive waste and spent fuel, considering extended storage periods;*
>
> *(iv) Long term management of disused sealed sources, including sustainable options for regional as well as multinational solutions.*

Those are reported in the following subsections.

K.2.1 Competence and staffing linked to timetable for spent fuel and radioactive waste management programmes

See § F.2.1 – Human resources, and § K.3.1.i – Capacity building.

K.2.2 Inclusive public engagement on radioactive waste management and on spent fuel management programmes

See § A.2.3 – Other Developments (in particular, subsection "*New developments in relation to disposal of radioactive waste*").

K.2.3 Ageing management of packages and facilities for radioactive waste and spent fuel, considering extended storage periods

For all nuclear facilities and installations on the Belgoprocess site, there is an ageing management system up and running. Storage facilities are part of these facilities and included in this program. The facilities and installations are split into SSC's (structures, systems, and component) and depending on their safety risk profile a graded approach is applied. For these SSC, aging drivers are identified, and a maintenance program is implemented for these drivers. Additionally, maintenance logs are analysed to identify trends and eventually used to adjust the existing programs. The output from these programs is translated into specs, so new investments fit better into this approach. Safety reviews are periodically performed to assess if facilities and installations comply with the latest standards.

Related to the storage capacities, regular analyses, taking into account the forecast of incoming flow, outgoing flow, ongoing construction of new storage capacities and the remaining storage capacity are performed to identify if actions, like extra storage capacity, are needed. In this way also the 'expiration' date of a building is monitored. Additionally, a 'spare' capacity is considered to cope with unforeseen deviations.

For packages of waste, ONDRAF/NIRAS and Belgoprocess developed an approach to follow up the quality and conformity of the packages and to identify and initiate potential actions to be taken. This includes a periodic review of witness packages and global inspections of the storage facilities and the waste packages they contain. The packages are designed taking into account the conditions prevailing in the storage building and their expected lifetime in storage.

With respect to the spent fuel, it has been requested in the frame of the licensing of the temporary storages SF^2 at the Doel and Tihange sites, to establish an entry control program and a monitoring program for periodic inspections of the casks, which shall be approved by FANC and Bel V. Options for complementary controls of the spent nuclear fuel should also be evaluated. The latter is currently investigated based on the international knowledge in the field.

K.2.4 Long-term management of disused sealed sources and multinational solutions

The preferred solution for disused sealed sources is return to the source producer, as stipulated by the licences issues by FANC. This is however no legal obligation. The alternative is management as radioactive waste by ONDRAF/NIRAS. In Belgium, disused sealed sources of both low- and high-activity are excluded from surface disposal. Consequently, all disused sealed sources are considered for deep geological disposal. For the treatment and conditioning of these materials, distinction is made between the low- and high-activity disused sealed sources. The high-activity sealed sources are dismantled by removing the shielding whenever this is technically possible and justifiable from an ALARA point of view. After the dismantling the source capsules are cemented in a shielded container. If removal of the shielding is not feasible, the high-activity sealed sources are directly cemented in a 400 ℓ drum. Low-activity sealed sources are loaded in 200 ℓ drums. If possible, mainly in the case of small calibration sources, the 200 ℓ drums are super-compacted. If not, the empty space is filled with sand. The (super-compacted) 200L-drums are consequently cemented in 400 ℓ drums.

K.3 Self-evaluation

K.3.1 Future Challenges and planned measures to improve safety

K.3.1.a Preparation of dismantling of the ENGIE Electrabel PWR reactors which have been permanently shut down

With the permanent shut down of the ENGIE Electrabel Tihange 2 and Doel 3 reactors and the prospect for the shut-down of the Tihange 1 and Doel 1&2 reactors, a decommissioning organization structure has been set up with the licensee, the regulatory body, and ONDRAF/NIRAS. The emphasis is put on the safety measures and on the material and waste that will result from the dismantling.

During the post-operational phase and the dismantling phase of the units, the safety relevance of the structures, systems, and components (SSC) will change over time, and this will impact on the surveillance and maintenance program activities. A classification system will be used to identify which SSC are important to safety and should remain functional. Evolution or changes in the functional classification during the various stages of the dismantling will be identified and authorized using the change management system.

The expected dismantling material and waste streams (MWS) have been identified. Bilateral working groups have been set up the specific concerns of each MWS and to ensure the compliance with the respective acceptance criteria. The convergence, through these bilateral workgroups, to a timely and industrially feasible solution is recognised as one of the key elements allowing the selection of the dismantling approaches and ensuring the feasibility of the dismantling schedule. Efforts are further made to develop and qualify the most efficient waste characterization and clearance methodology.

In parallel Material and Waste Management Units (WMUs) are designed and will be constructed within existing buildings or in new buildings on the decommissioning sites of Doel and Tihange. They will require separate licences (separate to the dismantling licences).

The treatment of dismantling licence applications for the concerned nuclear power reactors will also be a first-of-a-kind for the regulatory body, and represent a significant challenge.

K.3.1.b Outcomes of the public consultation

The implementation modalities, not present in the first part of the National Policy on the long-term management of high-level radioactive and/or long-lived waste, will be proposed in the second part of the National Policy, on the basis of the public consultation organized in the wake of the Royal Decree of 28 October 2022 (cf. § A.2.3 – Other Developments).

K.3.1.c Surface disposal of category A waste

While the licence for construction and operation of the surface disposal facility for category A waste granted in 2023, the preparation for the start of the construction continues a.o. through the future definition by the FANC and Bel V of a list of “hold-points” and “witness-points” that ONDRAF/NIRAS must take into account in its construction and commissioning programme.

The plan for the filling of the first four disposal modules based on the conformity files approved by the FANC and Bel V will be set up and taken into account in the commissioning phase. The planned start of operation of disposal activities is 2029. The waste acceptance system will be operationalized towards an operational surface disposal facility, by taking into account the 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 related 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. In addition the programme on disposability of waste is continued with the aim to provide solutions for specific waste streams with issues on (chemical) waste conformity criteria.

K.3.1.d Deep geological disposal of category B&C waste

The establishment and the implementation of a national policy on long-term management of high-level and long-lived wastes, including a stepwise, reversible, and participative decision-making process was identified previously as a challenge.

A first part of the national policy was established by the adoption of the Royal Decree of 28 October 2022, but its scope is limited to the principle of a deep underground disposal and the reversibility of the decision-making process. The preparation of the successive parts of the national policy remains a challenge as those should define all the necessary milestones of the decisional process up to the choice of the disposal site. In addition, the outcomes of the societal debate should also be taken into account (see "*Geological disposal*" under § A.2.3 – Other Developments).

In parallel to the policy development, the production of a generic safety case (i.e., host rock not decided, no specific site) is ongoing and is designed to challenge the methodology implemented by ONDRAF/NIRAS and the regulatory framework developed by FANC. As such, it will support the pre-licensing process for deep underground disposal.

In addition, 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 will be continued.

Finally, R&D programme will ensure the continuation by ONDRAF-NIRAS of the studies, notably on:

- Host rock assessment and systematic comparison with a view to applying the optimisation principle to the future choice of one or more host formations for geological disposal;
- The iterative revision process of the design of the geological disposal facility in poorly indurated clays (chosen as a reference option for R&D) with a focus on operational safety issues;
- The ethical issues related to geological disposal such as those related to the reversibility of the decisions and the retrievability of the waste with respect to intergenerational equity, long-term memory, etc. The consequences of delayed decisions are also ethically assessed, and multinational repositories are investigated in the light of intra- and intergenerational equity.

K.3.1.e Long-term management of radioactive radium-bearing waste

A dedicated national policy proposal for the disposal of radioactive radium-bearing waste project will be submitted in 2025 to the Federal Government for adoption, after a strategic environmental assessment procedure with a national consultation. After the establishment of national policy, phase 3 of the roadmap for the remediation of all the radium-contaminations and disposal of all the resulting radium-bearing wastes, will be elaborated, with the stepwise definition of the various remediation projects and disposal projects, up till the licensing of these projects. Execution of projects will start after the various licensing steps (phase 4, to be defined and elaborated in due time). In phase 3, an overall plan for the phased execution of all projects will be developed.

K.3.1.f New buildings at Belgoprocess

The decommissioning of the NPPs will produce large quantities of category A&B waste. The interim storage of large volumes of category B waste at Belgoprocess will require additional buildings. Consequently, an extra storage building 136F near the existing building 136 is planned.

The construction of two new storage facilities is also planned to replace the existing storage building 127:

- a new storage facility (building 168X) is planned to replace bunkers 1, 2 and 3 of the existing building 127 for the storage of bituminised waste, and
- a new storage facility (MESSINA) is planned to replace bunker 4 of the existing building 127 for the storage of mainly cemented waste.

In 2024, the basic design for these two projects will be carried out to further plan the detailed design and realisation phases of these projects.

In addition, two buildings have recently been licensed (165X and 167X, see § A.2.3 – Other Developments). These buildings must still receive the confirmation of the construction and operation licence according to the process described in § E.2.4 – System of licensing of spent fuel and radioactive waste management activities. The buildings are expected to become operational in 2028 and 2024/25, respectively.

K.3.1.g National programme, legal framework and ARTEMIS

The update of the first national programme (2015) is following a two steps approach with the first step (already done) being a new edition of the national programme in 2024, without new normative content, and containing a description of the existing situation as of 31 December 2022 (report currently submitted to the federal government for adoption by the Council of Ministers) The 2nd step consists of a thorough update of the national programme including the Belgian Government and ENGIE Electrabel agreement, the future Ra-bearing waste policy, the second part of the B&C policy and their consequences on radioactive waste and spent fuel management as well as the regulatory framework completed accordingly (i.e., licensing procedure for *all* disposal facilities; safety requirements for *all* disposal facilities; full set of technical guidance documents for disposal).

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

- the establishment of a Royal Decree on the general rules 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 of 18 November 2002 on the qualification by ONDRAF/NIRAS of the equipment 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.

Besides, the follow-up of the ARTEMIS recommendations and suggestions is considered of particular importance.

K.3.1.h Implementation of the four Laws of 26 April 2024

The four Laws promulgated on 26 April 2024 (see "*Preparation of Long-term operation of Doel 4 and Tihange 3 units*" under § A.2.3 – Other Developments) will be implemented in the forthcoming years which will result in major changes and challenges and in new responsibilities for all the actors involved. e.g. creation of new entities such as Hedera, the implementation of the waste transfer criteria, the knowledge transfer in relation to spent fuel.

In this context, the regulatory body will also need to accommodate the new role of the Belgian state, as co-owner of the two units in LTO (Doel 4 / Tihange 3).

K.3.1.i Capacity building

In order to implement the national programme and be in accordance with the legal framework, several actions should be taken by the different actors to obtain, maintain and further develop the necessary expertise and skills within each organisation.

For this, ONDRAF/NIRAS aims at developing a dynamic HR-policy to mobilise collaborators with respect to the challenges the organisation is and will be facing, such as the implementation of the different national policies with respect to the long-term management of the different waste categories, meaning running three different disposal programs in parallel. The achievement of such objectives demands an adapted organisational structure and culture and the strengthening of the organisation by increasing its in-house staff. This was also acknowledged by the ARTEMIS peer review, which recommended and suggested that:

- the Government should ensure adequate financial and human resources will be available for ONDRAF/NIRAS to fulfil its mission;
- ONDRAF/NIRAS should consider exploring means to increase in-house staff resource in the safety case area, including actively recruiting and developing younger team members.

Additionally, ONDRAF/NIRAS focuses on the improvement of the effectivity and efficiency of its information, data, and knowledge management on radioactive waste. The objective is to obtain a global and new digital information and data management platform for the complete integrated management system based on the principle of one single point of truth. This system should allow to preserve the data and knowledge on the waste even if producers cease their activities which is internationally seen as a challenge and a risk for guaranteeing a safe management of the radioactive waste and spent fuel. Therefore, waste and spent fuel knowledge management and knowledge transfer is addressed specifically in the Phoenix agreement between ENGIE Electrabel and the Belgian State as well.

K.3.1.j Implementation of the IRRS recommendations

The IRRS review team has issued several recommendations, among others in relation to the evolving nuclear context in Belgium (shut-down of 5 NPPs in the short-term). Two particular challenges relate to the financing of the FANC, which will have to be modified, and to the preservation of knowledge and competence in the future.

K.3.2 Areas of Good Performance & Good Practices

This subsection is added as a result of the agreement reached at the 5th Extraordinary Meeting on the reporting of Good Practices. Belgium leaves it to the Country Group Peers to identify Areas of Good Performance and Good Practices, based on the reported developments during the previous period (see § A.2 - Developments since the last meeting), and on the Country Group discussions.

K.4 Peer reviews

Peer reviews are regularly organized in Belgium. A list of recent or planned missions in NPPs is given in section I.C.5) of the Belgian national report for the 9th Review Meeting of the Convention on Nuclear Safety, available on the IAEA or the FANC web sites.

The area “Radioprotection” of OSART missions addresses issues in relation with on-site waste management and with radioactive discharges. An OSART mission was conducted at Tihange Nuclear Power Plant Unit 3 from 17 April to 4 May 2023.

As a member of the European Union, Belgium has to receive peer reviews missions in the frame of EURATOM Directives :

- According to the Directive 2009/71/EURATOM, a peer review of the national regulatory framework shall be conducted every 10 years. In November 2019, Belgium requested the IAEA to organize an IRRS mission. This mission was conducted from 19 to 30 June 2023; it took place about six months prior to an Integrated Review Service for Radioactive Waste and Spent Fuel, Decommissioning and Remediation (ARTEMIS). The report of the mission is available on the IAEA website (link) ; the main outcomes are summarized in § K.4.1 – IRRS mission of 2023.
- According to the Directive 2011/70/EURATOM, Belgium shall organize self-assessments of its national framework, competent regulatory authority, national program, and its implementation, and invite international peer review of its national framework, competent regulatory authority, and national programme with the aim of ensuring that high safety standards are achieved in the safe management of spent fuel and radioactive waste. An IAEA ARTEMIS peer review was conducted from 3 to 13 December 2023, about six months after the IRRS mission. . The report of the mission is available on the IAEA website (link) ; the main outcomes are summarized in § K.4.2 – ARTEMIS mission of 2023.

- Audits are organized by the European Commission in the frame of article 35 of the EURATOM treaty. These audits are related to the monitoring of the levels of radioactivity in air, water, and soil. The last audit in Belgium took place in November 2016 at the Tihange NPP.

Similarly, Belgian experts volunteer to participate as reviewers in different peer review missions in foreign countries (e.g. IRRS and ARTEMIS).

K.4.1 IRRS mission of 2023

A full scope IRRS-mission was conducted in Belgium from 19 to 30 June 2023 to review the Belgium governmental, legal, and regulatory framework for nuclear and radiation safety, against the IAEA safety standards and the Code of Conduct on the Safety and Security of Radioactive Sources as international benchmarks for safety.

The IRRS mission included a policy issue discussion on the challenges on competence management in a changing environment. The IRRS mission was conducted about six months prior to an Integrated Review Service for Radioactive Waste and Spent Fuel, Decommissioning and Remediation (ARTEMIS) mission scheduled from 3 to 13 December 2023.

One good practice has been identified that relates to the oversight approach to regulate the interfaces between safety and security based on their unique use of “confidentiality and the principle of a need-to-know.” A particularly noteworthy aspect is the conduct of dedicated annual inspections at all NPPs on this topic.

In addition, the areas of Good Performance include, amongst others:

- The development and effective use of advanced IT systems for managing the regulatory activities
- The development and implementation of the assessment of leadership for safety and safety culture within Bel V
- The position paper of an integrated approach for site release from regulatory control and its implementation for the release of the FBFC fuel fabrication site from regulatory control
- The regular comprehensive assessment of the licensee’s safety performance
- The implementation of “Fast Limited Inspections with Thematic Scope” (FLITS)
- The way the regulatory body takes into consideration research and development results when preparing regulations and guides for radioactive waste management, including deep geological disposal
- The interactive tool “Pathway Evaluation Process,” which facilitates structured interactions among interested parties on radioactive waste disposal matters
- The inclusion of the “General Emergency in Reflex Mode” as a fifth emergency class within the Emergency Classification System.

The IRRS team considered that the main challenge in Belgium is to identify and ensure the necessary competences and adequate financial resources of the regulatory body due to the evolving nuclear energy policy in the country.

Moreover, the IRRS team concluded that the following issues are representative of those which if addressed by the government and the regulatory body, would further enhance the overall effectiveness of the regulatory system:

- The Government should:
    - ensure that its decisions relating to the nuclear energy policy and the financial resources are made in a timely manner so that FANC fulfils its legal mandate under any circumstances.

- amend regulations to require (a) authorized parties to inform the public on radiation risks; (b) authorized parties to keep the generation of radioactive waste to a minimum and (c) prompt notification of emergencies.
- ensure that national emergency response exercises involving nuclear security events are performed regularly.

- The regulatory body should:
  - clearly state its strategic organizational objectives
  - update its policy on safety culture and perform self-assessments accordingly
  - maintain necessary competence and skills of its staff
  - complete the regulations in relation to site evaluation for future nuclear facilities
  - revise the regulations relating to specific aspects of decommissioning; radiation sources facilities and activities; occupational, medical, and public exposures; transport of radioactive material; and emergency preparedness and response.

A follow up mission has been requested for March 2026.

K.4.2 ARTEMIS mission of 2023

The ARTEMIS review mission to Belgium was performed from 3 to 13 December 2023 by a team of seven experts from Austria, Finland, France, Slovenia, the United Kingdom, and the United States of America, as well as three IAEA staff members. It was coordinated by ONDRAF-NIRAS.

During the mission, the ARTEMIS Review Team held discussions with the representatives from the ONDRAF/NIRAS, the Federal Agency for Nuclear Control (FANC), the Belgian Nuclear Research Centre (SCK CEN), the Directorate-General for Energy, SYNATOM – the organization in charge of the management of the fuel cycle of Belgian nuclear plants, and the Commission for Nuclear Provisions (CNP).

The ARTEMIS Review Team provided the following recommendations and suggestions:

- The Government should formulate a well-defined policy decision regarding spent fuel management options, specifically addressing the choice between reprocessing and direct disposal. Policy or policies should encompass all nuclear power plants and research reactors.
- The Government should establish, without undue delay, a comprehensive geological disposal policy for the management of category B&C waste including all the necessary milestones and initiate as soon as possible the site selection process.
- The Government should establish a policy for management of radium-bearing waste in a timely manner to enable the effective remediation of the existing exposure situation.
- The Government should complete the process of establishing safety requirements and a licensing scheme specific to disposal facilities.
- The Government should ensure that waste streams that are non-conforming, have no clear end point or are waiting for a policy decision are included in the National Program with their proposed associated management options.
- ONDRAF/NIRAS should focus its main resources on solutions that are technically feasible and internationally acknowledged for the long-term management of category B&C waste of the Belgian inventory.
- The Government should act upon an ONDRAF/NIRAS' proposal to revise the legal framework to incorporate additional provisions to allow the definition and the review of the required information for the reference programs of the waste producers.
- ONDRAF/NIRAS should include in the national inventory a category for radium-bearing waste from past industrial activities to make the radioactive waste inventory complete.

- SCK CEN should consider extending its international cooperation through the EDF/DP2D Graphite Reactor Decommissioning Demonstrator, as this is a particularly timely opportunity.
- ONDRAF/NIRAS should develop the next safety case for geological disposal based on a reference host rock and also assess the range of alternative host rocks (in a stylized approach) to support a future site selection process.
- The Government should consider enhancing the harmonization and justification of financial parameters to be used by all relevant nuclear actors in the determination of nuclear provisions (time frames, discount rates, inflation rates).
- The Government should consider developing and maintaining a national skills strategy for radioactive waste management.
- The Government should ensure adequate financial and human resources will be available for ONDRAF/NIRAS to fulfil its mission.
- ONDRAF/NIRAS should consider exploring means to increase in-house staff resource in the safety case area, including actively recruiting and developing younger team members.

The Review Team also noted two good practices:

- The centralized management of the radioactive waste by Belgoprocess prior to disposal contributes to the minimization of waste and helps to optimize the interdependencies of the different waste management steps.
- The proposed approach for remediation of the radium-contaminated Umicore site in Olen is a very effective means for waste minimization.

SECTION L APPENDICES

L.1 APPENDIX 1 : Legal framework for safety and radiation protection

L.1.1 The Law of 15 April 1994

The Law of 15 April 1994 on "the protection of the population and the environment against the hazards of ionizing radiation and on the Federal Agency for Nuclear Control" constitutes the basic law that sets out the basic elements for protecting the workers, the public and the environment against the adverse effects of ionising radiation. The same law also creates the FANC as the Safety Authority.

- **Chapter I** defines a number of terms used and clearly establishes (Art. 2) the "Federal Agency for Nuclear Control", abbreviated as "FANC" as the public interest organisation having legal personality to become the Safety Authority.
- **Chapter II** gives more detail regarding the competent authority. The King is the competent authority for all activities involving sources of ionising radiation, including transport. The King may take all measures aimed at protecting the public and the environment in case an unforeseen event presents a danger. The King also nominates the persons in charge of supervising the compliance with this law and its implementing decrees dealing with the medical surveillance of the workers and the health conditions at work (Art. 7-11). These persons trace and record infractions to this law; they can issue warnings and set deadlines for corrective actions; they have access to the nuclear installations at any time; they can proceed to the seizure of equipment or sources;
- **Chapter III** enumerates the various missions of the FANC. Those missions comprise, among others:
    - Control and supervision activities;
    - to perform all acts contributing to this law and to create legal entities contributing to his law;
    - to perform safety and security assessment of nuclear facilities and conduct inspections in those facilities;
    - to examine the licence applications for nuclear facilities; to grant licences for specific facilities, except those with the highest risk (Class I facilities); the verification of compliance with licence conditions;
    - radiological surveillance of the territory;
    - to provide technical assistance to the Ministry of Home Affairs in case of nuclear emergencies;
    - to propose and prepare new regulations related to this law;
    - to gather a scientific and technical documentation in the field of nuclear safety; to stimulate and to coordinate R&D;
    - to issue neutral and objective information to the public.
    - The FANC may delegate, on a decision of its Board of Administrators, some of its surveillance missions to legal entities that it has created for this objective
    - The King determines the missions that can be delegated to the entity; the surveillance of the FANC to the legal entity and the financing mechanism of the entity.
    - The Board the entity is composed of at least 50% of the Board of the FANC
- **Chapter IIIter** has been introduced on December 6th, 2018, to transpose the dispositions of the European Directives 2011/92/UE and 2014/52/UE on environmental assessment of certain projects.
- **Chapter IV** deals with the organization of Health Physics.

- the licensee has the prime responsibility. Each licensee has to set up an internal Health Physics Department;
- the King determines the missions, the organization, and the working of the Health Physics Department. He also determines the needed resources and competencies;
- The King determines which tasks have to be performed by a recognized expert. Licensees (of low-risk facilities/activities) who have not such expert within their organisation may call upon recognized experts of recognized health physics organization (RHPO);
- the recognition of those organisations is based on criteria and process defined by the King.

- **Chapter V** deals with the funding of the FANC:
  - annual taxes on licence holders or future licence holders;
  - fees on the occasion of the application for a licence, recognition, or registration ;
  - administrative fines;
  - fees for special (control) activities;
  - gifts and legacies;
  - subsidies.
- **Chapter VI** describes the basic management mechanisms of the FANC:
  - FANC is directed by a Board, whose members are appointed by Royal Decree;
  - the Scientific Council for Ionizing Radiation, whose composition and duties are fixed by Royal Decree, is established as an advisory body to the FANC;
  - the FANC must be organised is such a way that the regulation development function and the control and supervision functions are carried out independently;
  - day-to-day management of the FANC is entrusted to the General Manager.
- **Chapter VII** describes some of the enforcement powers that the FANC can use such as administrative fines.
- **Chapter VIII** describes some final clauses and some transitional arrangements.

L.1.2 The Royal Decree of 20 July 2001

This Royal Decree provides the basic nuclear safety and radiological protection regulations. Amendments are regularly proposed by the Safety Authority in order to take account of scientific and technical developments, to transpose the European directives, etc.

An outline of the content of the GRR-2001 is given below.

- **Chapter I** – General Provisions
  - Scope and field of application
  - Definitions
- **Chapter II** – Categorised Facilities deals with the following :
  - Categorization of facilities
  - Licensing system of facilities
  - Modification of the licences
  - Licensing of dismantling
- **Chapter III** – General Protection.
  - Justification of practices, optimisation of protection
  - Doses limits
  - Arrangements for Health Physics
  - Medical surveillance of workers

- General protection equipment and arrangements
- Radioactive waste (solid, liquid, and gaseous), discharges and clearance

- **Chapter IV** – Subsidiary bodies of the FANC (Bel V) [updated December 6th, 2018]
  - List of regulatory missions that the FANC can delegate to Bel V: Inspections and safety assessments
  - Modalities for performing the delegated missions
  - Oversight of the FANC on Bel V
  - Financing mechanism for Bel V
- **Chapters V** and **VI** [withdrawn]
- **Chapter VII** – [withdrawn]
- **Chapter VIII** – Nuclear Propulsion
- **Chapter IX** – Bans and Authorisations
  - Specific prohibitions
  - Special licences for using ionising radiation
- **Chapter X** – Exceptional Measures
  - Measures against the loss or theft of radioactive substances.
  - Measures relating to accidents, concerted exceptional exposures and accidental exposures.
  - Decontamination
- **Chapter XI** - Surveillance of the Territory, the Population and Emergency Planning
  - Radioactivity monitoring of the territory,
  - (Radiological) monitoring of the population as a whole, and collection of the data,
  - Emergency response planning for nuclear risks and information of the population.
  - Interventions in cases of lasting exposure.
  - Interventions in case of discovery of orphan sources.
- **Chapter XII** - Recognition of Experts, Physicians and of Health Physics Organisations
  - Conditions for the recognition of experts in health physics control.
  - Conditions for the recognition of experts in radiological impact assessment.
  - Recognition of Organizations for Health Physics (RHPO).
  - Recognition of doctors in charge of the medical surveillance of workers.
- **Chapter XIII** – HASS Sources
  - Transposition of the Directive 2003/122/Euratom on the control of high-activity sealed radioactive sources and orphan sources

L.1.3 The Royal Decree of 30 November 2011

The Royal Decree of 30 November 2011 on the Safety Requirements for Nuclear Installations (SRNI-2011) is the result of the WENRA-harmonisation activities with respect to regulation. It also ensures the transposition of the European Directive 2009/71/Euratom on nuclear safety. The following chapters are available:

Chapter I- General Provisions sets the scope of the Decree and defines terms.

Chapter II – Generic Safety Requirements is applicable to all Class I nuclear facilities

- **Section I** – Nuclear Safety Management
  - safety policy of the licensee
  - organisational structure
  - integrated Management System
  - training and formal habilitation of the personnel
- **Section II** – Design
  - design basis
  - classification of structures, systems, and components
- **Section III** – Operation
  - operational limits and conditions
  - ageing management programme
  - experience feedback management process
  - test, inspection, and maintenance programmes
- **Section IV** – Verification of Nuclear Safety
  - safety Analysis Report
  - periodic Safety Reviews
  - modifications
- **Section V** – Preparation for Emergencies
  - internal emergency plan.
  - protection against internal fires
- **Section VI**– Decommissioning [update of August 2015]
  - notification & information related to cessation of nuclear activities. It also lists the documents and information that has to be send to the FANC
  - safety measures and justification of deferred dismantling
  - SSCs and the OLCs during the dismantling of the installations
  - preliminary qualification of new dismantling techniques
  - radioactive waste from dismantling
  - management of documents and inventories
  - experience feedback management process
  - update of surveillance and maintenance programmes
  - update of the on-site emergency plan
  - dismantling safety report
  - Periodic Safety Reviews during the dismantling
  - radiological characterisation of the final state and final dismantling report.

Chapter III sets the specific **Safety Requirements for Nuclear Power Plants**

- **Section I** – Nuclear Safety Management
- **Section II** – Design
- **Section III** – Operation
- **Section IV** – Verification of Nuclear Safety
- **Section V** – Preparation for Emergencies

Chapter IV sets **specific Safety Requirements for waste and spent fuel facilities** [update of May 2018]

- **Section I** – Design and construction
  - Safety functions: sub-criticality, residual heat removal, confinement, radiation protection, retrievability
  - Design and construction
    - definition and justification of the expected lifetime
    - passive features if possible
    - sub-criticality and burn-up credit
    - requirements for handling equipment
    - design provisions for inspection of waste and spent fuel
    - retrievability of wats or spent fuel package
    - spare storage capacity and nominal filling grade
- **Section II** – Operation
  - Operating limits and conditions
  - Operation
    - inspection capability
    - inventories and characterisation
    - identification of spent fuel and waste package
  - Conformity criteria
    - establishment of conformity criteria
    - conformity criteria to consider handling, transport, storage and retrievability requirements
    - process for verification of conformity criteria
  - Surveillance programmes
    - establishment of surveillance programmes
  - Deviations (with respect of conformity criteria)
    - procedures for initial verification of conformity criteria
    - record of deviations
    - safe management of spent fuel or waste package with deviations
- **Section III** – Verification of Nuclear Safety
  - Content of the safety analysis report of a waste or spent fuel storage facility
  - Periodic safety reviews of a waste or spent fuel storage facility
  - Review of the conformity criteria

Chapter IV bis sets the specific **Safety Requirements for Research Reactors**
[update of 21 July 2023]

- **Section I** – Nuclear Safety Management
- **Section II** – Design
- **Section III** – Operation
- **Section IV** – Verification of Nuclear Safety
- **Section V** – Preparation for Emergencies

Chapter IV ter sets the specific Safety Requirements for surface disposal of radioactive waste
[update of 7 May 2024]

- **Section I** – Nuclear Safety Management
  - Policy for Safety
    - Fundamental principles
    - Safety principles
    - Safety Strategy
    - Safety Concept
  - Management System
- **Section II** – Design
  - Design basis
  - Classification of Systems, Structures and Components
- **Section III** – Operation
  - Operating limits and conditions
  - Requirements for construction and operation of facilities
  - Ageing Management
  - Maintenance, in-service inspections, and functional tests
  - Accident management procedures
- **Section IV** – Verification of Nuclear Safety
  - Safety report (operational and post-operational phases)
  - Periodic Safety Review
- **Section V** – Emergency Preparedness
- **Section VI** – Other requirements
  - Surveillance programme
  - Activity reporting
  - Closure / final configuration
  - Specific requirements for surface disposal facilities
    - Radioactive nuclide inventory
    - Duration of control phase
    - Covering of surface disposal facilities
    - Isolation performance

Chapter V contains **final provisions and transitional arrangements**

L.2 APPENDIX 2: Radioactive Waste Management and Spent Fuel Management at Nuclear Power Plants

L.2.1 Radioactive Waste Management

L.2.1.a Radioactive waste management principles

The radioactive waste generated at the Doel and Tihange Nuclear Power Plants are in gaseous, liquid, or solid form. Corresponding treatment/conditioning systems and systems for release to the environment are provided in order to process the waste in a safe, reliable, and controlled manner and to maintain the level of radiation exposure to the public and plant personnel as low as reasonably achievable, in compliance with the authorised limits for plant discharge to the environment and the applicable regulations. In particular, the solid waste treatment and conditioning systems ensure that the resulting waste-form meets the requirements for off-site transport, interim storage, and future disposal. A small number of large items of discarded equipment is stored on both sites in dedicated storage buildings awaiting later treatment/conditioning, possibly at the same time as the plants' decommissioning.

L.2.1.b Gaseous waste

The hydrogenated gaseous effluents produced by the Chemical and Volume Control System, the Pressuriser of the Reactor Coolant System and the Boron Recycle Hold-up Tanks are accumulated in deactivation tanks located at each unit. Hydrogenated effluents are transported by compressors to pressurised storage tanks. After filling, the storage tank is isolated for a period of several weeks, which allows the radioactivity of the fission gases to decay. After that decay period, samples are taken and analysed to check if the tank content meets conditions for release. If it does, the content is then released into the atmosphere via a filtration system or a ventilation exhaust system that is either specific to each building or shared by all of them.

L.2.1.c Liquid waste

Liquid waste is collected by category: hydrogenated or aerated effluents of Reactor Coolant quality, chemical effluents, laundry and changing-room effluents, floor drains and (in the case of Doel) polishing effluents. This waste is collected in various dedicated tanks located at the different units of each site. Where necessary, pretreatment is performed in the unit before the effluents are transferred, at each site, into the centralised Liquid Waste Treatment Systems. These systems consist of treatment equipment, such as filters, ion exchangers, gas-strippers, and evaporators. After treatment, measurements are performed to verify that the purified effluents comply with the radiological, physical, and chemical release limits. Continuous redundant radioactivity monitoring is performed during effluent release.

Secondary Solid wastes generated by the Liquid Waste Treatment Systems are conditioned (see below), while the boric acid recovered from the Reactor Coolant quality (hydrogenated) effluents is generally recycled.

L.2.1.d Operational solid waste

Two main categories of operational radioactive solid waste are distinguished:

- the waste that is treated/conditioned at the Doel and Tihange sites and the resulting conditioned waste being sent for interim storage at Belgoprocess;
- the waste with a dose rate of less than 2 mSv/h that is pre-treated at the Doel and Tihange sites and then sent for treatment/conditioning at Belgoprocess in the CILVA installation. (non-conditioned waste)

❖ **Waste conditioned at the NPPs**

The wet solid waste from the auxiliary systems and the liquid effluent treatment systems (spent ion exchange resins, spent filters, evaporator concentrates) as well as various solid wastes generally with

a surface dose rate higher than 2 mSv/h are envisaged to be conditioned in metallic 400 ℓ drums in the Solid Waste Conditioning Facility at each site.

The treatment and conditioning facilities of the NPPs are momentarily only qualified by ONDRAF/NIRAS for the conditioning of spent filters and divers solid waste. The treatment and conditioning of the solid waste is performed within the framework of a Quality Assurance Programme established by the utility company. Inspections and control of these operations are performed by ONDRAF/NIRAS. After checking and acceptance by ONDRAF/NIRAS of the conditioned waste at the conditioning site, the waste is transported to Belgoprocess for interim storage in Buildings 151 or 127.

❖ Waste not conditioned at the NPPs

Dry active solid waste (paper, clothes, plastics, wood, ventilation filters, etc.) is collected selectively at the NPPs.

The combustible fraction of this waste is subjected to a pretreatment in the centralised waste treatment facilities of the two NPPs. This pretreatment consists of sorting, shredding and compaction before wrapping in plastic bags and the subsequent packaging of these bags in transport containers.

The compressible fraction of this waste can be pre-compacted before being packed in metallic packaging suitable for further super-compaction at Belgoprocess. Some metallic components are treated abroad by a melting operation; the secondary waste concentrating the radioactivity returns to the NPP of production and is handled following the standards for the normal solid waste streams.

The different kinds of waste are packaged and transported to Belgoprocess site in adequate standardised packaging (200 ℓ drums, 1 m^3 stainless steel containers, etc.) in accordance with ONDRAF/NIRAS specifications. In particular, the dose rate in contact of the transport packages must be below 2 mSv/h.

❖ Non- routine large bulky solid used materials

The old Steam Generators of various units and the Reactor Vessel Heads which have been replaced are presently stored in dedicated facilities at the Doel and Tihange sites.

Those 2 common buildings received a specific licence to intermediately store those large bulky solid items until the decommissioning of the NPP correlated with the existence of a final disposal for category A radioactive waste. It means:

- GSG and GSR buildings at Doel: authorized to store 10 replaced Steam Generators + the reactor vessel head of Doel 4;
- SGV building at Tihange: authorized to store 9 replaced Steam Generators and replaced reactor vessel heads of Tihange 1 and Tihange 3.

The WENRA safety reference levels for radioactive waste and spent fuel storage are applied, “as appropriate”, for those 2 buildings and their contents.

It means that:

- all the data needed for the further steps in their processing are available,
- some realistic scenarios are described for their future treatment,
- a reference scenario is described in the preliminary decommissioning plan,
- the information about their future waste production (type, planning, quantities) is communicated and contracted with ONDRAF/NIRAS,
- and the cost related to those activities is included in the decommissioning funds.

L.2.2 Radioactive Waste Management Facilities at Doel NPP

L.2.2.a Gaseous waste treatment systems

The Gaseous waste treatment systems (called GW systems) are located in the Nuclear Auxiliary Building GNH of each unit and in the Waste Auxiliary Building WAB. They comprise the following equipment:

- For Doel 1-2, in the twin units' shared building GNH: 3 compressors, 5 storage/deactivation tanks;
- For Doel 3 and for Doel 4, in the GNH of each unit: 2 compressors, 10 storage tanks and 2 catalytic recombiners.
- For the WAB: 2 compressors, 2 storage/deactivation tanks.

L.2.2.b Liquid waste treatment systems

The liquid waste produced by the different units at the Doel site is treated in the WAB, the centralised waste treatment building.

After their collection, the Reactor coolant quality-type effluents are pretreated by means of filters, ion exchange columns and gas strippers in the GNH of the unit at which they are produced before being sent to the WAB. Some other effluents also require a filtration in the unit where they are produced before being sent to the WAB.

In the WAB, the waste is received in dedicated buffer/storage tanks, maintaining the upstream segregation. The secondary waste produced in the WAB itself is collected according to the same categories.

Apart from filters and ion exchange columns, five evaporator units (evaporation capacity = 5 m^3/h) are available. Three of them process the reactor coolant quality-type effluents, allowing boric acid recovery. The other two are dedicated to the other types of liquid effluents and generate evaporator concentrates that have to be further immobilized with cement.

Various control tanks are provided, allowing for effluent control before release to the Scheldt through a unique release collector.

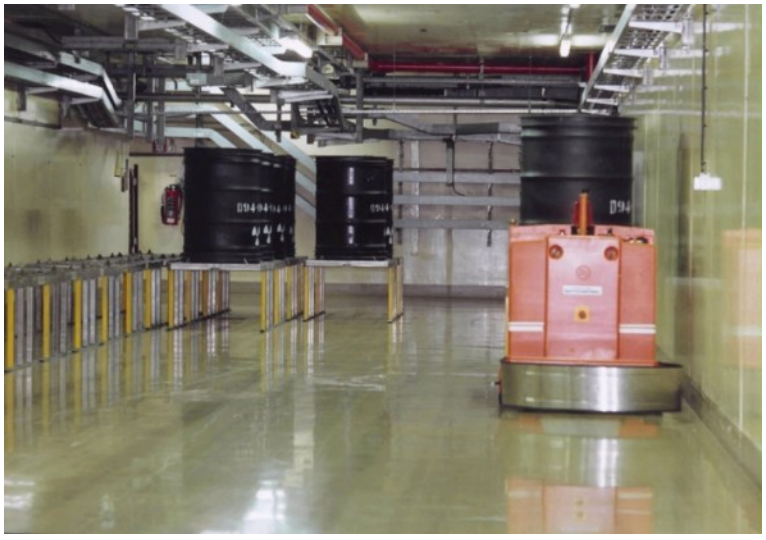


Figure 16 The WAB building (empty drums waiting for the next conditioning campaign).

L.2.2.c Solid Waste Systems

❖ **Waste conditioned at Doel**

The Solid Waste System (SW) consists of buffer tanks for Ion Exchange Resins and buffer tanks for evaporator concentrates. The conditioning process is based on the incorporation of waste with concrete. As a consequence of the observation of anomalies on alkali-silica reactions in conditioned waste (see § K.1.1.h – Programme for long-term management of non-conform waste), new treatment and conditioning routes are currently investigated:

- For the resins: treatment in a future pyrolysis installation at Belgoprocess. Pyrolysis has the advantages to produce an inert residue, with a significant volume reduction. The current reference for the conditioning is the homogenous cementation of the inert residue by Belgoprocess.
- For the evaporator concentrates: they will be centrifuged on the Doel site, in an installation which has been purchase for this purpose. Centrifugation allows extracting the chlorides and the boron from the concentrates. The further processing of the material is still under study.

Spent Filter Cartridges and/or various radioactive (possibly compacted and, for ALARA reasons, eventually handled by a remote-controlled robotic installation) solid wastes are immobilised with non-radioactive concrete.

One batch mixer with an associated concrete and aggregate silo is therefore used. An automatic guided vehicle is provided for the drum transportation. After filling, a coverlid is put on the drum by an automatic lid-fixing device.

Buffer storage is provided for the drums awaiting transportation to the Belgoprocess site for interim storage.

❖ **Waste not conditioned at Doel**

A shredder-compactor is installed in the WAB, enabling combustible waste to be shredded, slightly compacted, and packaged in plastic bags of a unit mass of 15-20 kg.

Compressible waste may be compacted by an in-drum 16-ton press or a small 100-ton press for small objects. Afterwards this waste is put in 200L drums. These are interim stored and transported for further treatment to BP.

❖ **Non-routine large solid used materials**

The 8 steam generators replaced at Doel 2, 3 and Doel 4 are stored as 'closed sources' (i.e. all fittings/openings are sealed) in a dedicated storage building called GSG. In a similar building called GCR, the 2 replaced steam generators of Doel 1 and the replaced reactor vessel closure head of Doel 4 are stored.

L.2.3 Radioactive Waste Management Facilities at Tihange NPP

L.2.3.a Gaseous waste treatment systems

The Gaseous waste treatment systems (called TEG systems) are located in one of the Nuclear Auxiliary Buildings of each unit. They comprise the following equipment:

- For Tihange 1: in the BAN-EST 2 compressors, 3 storage/decay tanks and in the building, extension called TEG: 2 storage/decay tanks
- For Tihange 2 and 3: in Building D of each unit 2 compressors, 8 and 7 storage tanks respectively and 2 catalytic recombiners.

In each unit a specific filtration system, comprising HEPA, charcoal, and HEPA filters in series, is provided on the decayed gas release line. This line is connected to a building ventilation exhaust duct, allowing the discharge of the gaseous effluents into the atmosphere via the Unit Stack.

L.2.3.b Liquid waste treatment systems

Liquid waste treatment systems are installed in the Nuclear Auxiliary Building of Tihange 1. The treatment parts of these systems are no longer in service, except for some filters, ions resins exchangers and resins and concentrates storage tanks. For all the radioactive effluents produced on-site, the liquid waste treatment is performed in the Auxiliary Nuclear Building N of unit 2. Collection tanks are provided in unit 3 together with some filters and resins storage tanks. The waste categories are the same in all three units, and segregation between the different waste categories is maintained from collection as far as treatment.

The non-aerated reactor coolant quality-type effluents are treated by filters, ion exchange columns and gas strippers before buffer storage and then evaporation, allowing for boric acid recovery. One evaporator package (evaporation capacity = 5 m^3/h) is dedicated to this task.

Other effluents are treated by filtration and/or evaporation and/or passage through ion exchange columns. A flocculation system is also installed. Two evaporator packages (evaporation capacity = 5 m^3/h) are available to process these effluents, producing evaporator concentrates that have to be further immobilized with cement.

Various control tanks are provided, allowing for effluent control before release to the River Meuse through 2 large 'transfer' tanks installed in each of the three units.

L.2.3.c Solid Waste Systems

❖ Wet solid waste systems at Tihange 1 (TES)

Tihange 1 is provided with:

- 1 buffer storage tank for evaporator concentrates and, 2 buffer storage tanks for spent ion exchange resins
- a facility allowing for the drumming of spent filters and of various solid waste, which is then transported to Unit 2 for conditioning
- Spent ion exchange resins can be transported, using a shielded cask, to Tihange 3 for storage.

❖ Wet solid waste systems at Tihange 2

The Solid Waste System (TDS) of Tihange 2 comprises, among other things:

- buffer storage tanks for evaporator concentrates, buffer storage drums for IER
- a facility allowing for the drumming of spent filters and of various solid wastes
- a conditioning facility for evaporator concentrates (currently no longer qualified by ONDRAF/NIRAS)
- an immobilisation facility for drummed spent filters and various solid wastes (currently not qualified by ONDRAF/NIRAS)
- a large buffer storage for conditioned waste drums awaiting transport to Belgoprocess
- spent ion exchange resins can be transported, using a shielded cask, to Tihange 3 for storage.

❖ Wet solid waste systems at Tihange 3

Tihange 3 is provided with:

- 1 buffer storage tank for evaporator concentrates and, 2 buffer storage tanks for spent ion exchange resins
- a facility allowing for the drumming of spent filters and of various solid waste, which is then transported to Unit 2 for conditioning
- Mobile interim storage containers for resins of 46.6 m^3 capacity
- Recently installed capacities of 40 m^3 for spent resins

❖ **Waste not conditioned at Tihange**

The pre-treatment and packaging of the 'dry' active waste are performed in Building Φ of Tihange 2. A shredder-compactor is installed, allowing for combustible waste-shredding, slight compaction, and packaging in small plastic bags of a unit mass of 15-20 kg. Non-combustible compressible waste is pre-treated in a unit comprising hydraulic shears, a metallic scrap press and, for the cut and/or compacted waste, a 200 ℓ drum-filling station. Filled transport container monitoring systems are provided upstream of a dedicated buffer storage.

❖ **Non-routine large solid used materials**

The 9 steam generators removed at Tihange 1, 2 and 3 are stored as 'sealed sources' (i.e. all the fittings/openings are sealed) in a dedicated storage building called SGV. The superseded reactor vessel heads of Tihange 1 and Tihange 3 is also stored in the same building.

L.2.4 Spent Fuel management at the Sites of Doel and Tihange

L.2.4.a Interim storage of spent fuel

At the Doel and Tihange NPP sites, the spent fuel assemblies removed from the reactors are fed for the purpose of radioactive cooling into the deactivation ponds located at each of the production units. Following the decision of the Belgian Parliament in December 1993 on the conclusion and implementation of any new reprocessing, a significant increase in interim storage capacity for spent fuel assemblies became necessary. A storage building was therefore constructed at each site. These buildings have been designed to receive and store the spent fuel elements from the units, either in underwater storage (Tihange) or in dry storage in shielded containers (Doel).

L.2.4.b Spent fuel storage systems

❖ **Deactivation pools**

The spent fuel assemblies removed from each unit's reactor core are temporarily stored in the deactivation ponds of the corresponding unit before being transported and stored in the interim storage building of the same site (Doel or Tihange). The deactivation pools are located in buildings 'GNH' (Doel 1/2), 'SPG' (Doel 3/4), 'BAN' (Tihange 1) and 'BAN-D' (Tihange 2/3).

The water treatment circuit of the deactivation pools at each unit (PL in Doel and CTP in Tihange) consists of two identical but independent loops. The circuit is designed to evacuate, in both normal and emergency situations, the residual power released by the spent fuel assemblies and ensure an acceptable environment for the personnel working in the vicinity of the pool. It also makes it possible to maintain an appropriate level of water in the pools so as to ensure adequate biological protection. Another function of this circuit is to allow the water from the pools to be decontaminated and treated.

When the water from the decay tank is being cooled and decontaminated, the spent fuel assemblies are placed in an upright position in the storage cells. The storage capacities of the deactivation pools make it possible to store at least one complete core plus the core already present in the reactor.

❖ **Interim storage at Doel (SCG building)**

The spent fuel elements from the 4 units at Doel are placed in sealed containers approved for their off-site shipment. The first dry storage container was loaded in 1995. The design of the containers is adapted to the designs of the fuel assemblies of the different units.

The SCG is composed of a preparation hall and a storage hall. The latter is divided in two parts and has a total capacity of 168 storage casks, while maximum 165 cask may be stored (3 positions remain free for interventions and accidental situations). The majority of the operations are performed in the preparation hall in order to limit the exposure of the workers. After it has been prepared, the container is transferred to its storage position in the storage hall by means of a remotely controlled overhead crane. The exterior of the filled containers is decontaminated before the containers are loaded onto a semitrailer for transfer to the SCG building. There they are unloaded onto their storage location by an overhead crane.

The outer casing of the containers consists of a massive steel wall. This casing guarantees the structural integrity of the elements throughout their transportation on-site, their interim storage and their transfer to offsite facilities. It also ensures a satisfactory level of biological protection. The dose rate limits in the interim storage building are 2 mSv/h at the surface of the container and 0.1 mSv/h at 2m from the container.

The leak-tightness of the container is ensured by a cover fitted with a double sealing system. The volume between the gaskets of each container is pressurised and connected to a helium system to make leak-detection possible. During storage the leak-tightness of the containers is monitored continuously. After some years of operation, a modification has been made to move the pressure monitoring devices from the top of the container to a more protected area in the building. This allows to reduce the dose for the operators when maintenance is needed.

The containers are cooled by natural convection. Their design foreseen minimum and maximum external ambient temperatures of -10°C and +45°C for storage, and of -40°C and +38°C for transport. Their present capacity varies from 24 to 37 fuel assemblies.

The interim storage building consists of a loading hall and two storage halls (with a total authorised storage capacity of 165 casks). Several types of containers are available so as to make due allowance for the differing lengths of the fuel elements and the different types of assembly originating at the 4 units on the site. Concerning the duration of the spent fuel storage, a continuous monitoring of the pressure between the gaskets of the primary lid of the dry casks stored is performed. The efficient drying of the SF elements and inertization by Helium injection in the cavity prior to cask sealing should prevent corrosion to occur. Moreover, the heat load dissipation is periodically monitored in order to avoid hot spots in the storage area. Any possible effort is paid to guarantee the extended life of the stored SF elements and to investigate information regarding the best practices abroad and experience gained in countries applying SF dry storage.

- **Interim storage at Tihange (DE building)**

The purpose of the spent fuel interim storage of the power station at Tihange (again known as the DE building) is to increase the storage capacity of the site at Tihange as a whole. The DE building is an extension of the existing spent fuel storage building (building D) of unit 3. It has been erected within the technical perimeter of unit 3.

The fuel from the 3 units is transported to the DE building in transfer containers. The pools and related equipment have been designed to accommodate spent fuel assemblies of different lengths and to allow different kinds of transport containers to be manipulated. The DE building is designed to store a total of 3720 assemblies distributed over 8 identical storage pools with a unit capacity of 465 assemblies (assemblies of a similar design to that of unit 3).

The container-unloading pool is also equipped with a storage module consisting of 30 cells in which the assemblies extracted from the container are temporarily placed - immersed in the tank - during unloading operations.

The pools' cooling and water treatment circuit (STP) is designed to evacuate the residual power released by the spent fuel assemblies while they are undergoing interim storage in the storage pools and to maintain in those ponds a temperature below 60°C under all circumstances. The racks in which the spent fuel assemblies are stored can accommodate without difficulty assemblies from all 3 units at the Tihange site.

Concerning the duration of the spent fuel storage, no indication of leakage on the SF stored in the centralized storage pool DE has been detected at this stage. The fact that only sound and tight SF elements may be transferred to the storage pool guarantees that the corrosion of the pellets by the water will not occur. Moreover, the low temperature of the fuel elements in the pool due to its permanent cooling by the water is a favourable parameter. Any possible effort is paid to guarantee the extended life of the stored SF elements and to investigate information regarding the best practices abroad and experience gained in countries were SF behaviour during wet storage.

❖ Spent Fuel Facility (SF²)

The SF² facilities are new interim spent fuel storage facilities on the nuclear sites (1 facility at Doel and 1 at Tihange). Together with the current interim spent fuel storage building on site (dry storage building SCG at Doel and wet storage building DE at Tihange), this additional storage facility will allow the storage of the spent fuel elements from the nuclear units (4 units in Doel and 3 units in Tihange) after their final shut-down and the emptying of the pools in these units. These new facilities (SF² Doel and SF² Tihange) are designed for a lifetime of 80 years.

For SF² Tihange, a total of 120 positions (physical limit: 15 rows of 8 positions for cask storage) for the storage of casks are foreseen where a maximum of 108 positions may actually be occupied by a cask (see Figure 17). 3 positions will remain free of cask allowing the evacuation of casks requiring an intervention or some maintenance. 9 positions will remain empty to assure mitigation actions in accidental conditions.

For SF² Doel a total of 108 positions (physical limit: 18 rows of 6 positions for cask storage) for the storage of casks are foreseen where a maximum of 97 positions may actually be occupied by a cask. 2 positions will remain free of cask allowing the evacuation of casks requiring an intervention or some maintenance. 9 positions will remain empty to assure mitigation actions in accidental conditions.

The casks have a capacity between 21 and 32 spent fuel assemblies per cask. The dual-purpose casks are massive metal casks, with a height of about 6 meters, a diameter of about 2.5m for a weight of about 120 tons. The SF² facilities at Tihange and Doel are very similar, except the number of storage positions. A SF² facility consists of (cf. Figure 17):

- A **main building SFB**, free from contamination but considered as a nuclear controlled area resulting from the dose rate coming from the loaded casks, with:
  - A storage hall for the storage of the casks.
  - A handling hall for the loading or unloading of the casks from the trailer, and for the inspection of the casks.
  - 2 rooms, monitoring halls, where the monitoring system of the leak-tightness of the casks is located.
- An **auxiliary building** (AUX);
- A **building for the storage of diverse equipment** (ASB) used for the handling of casks

A diesel generator is foreseen in a container for the electricity supply in case loss of offsite power.

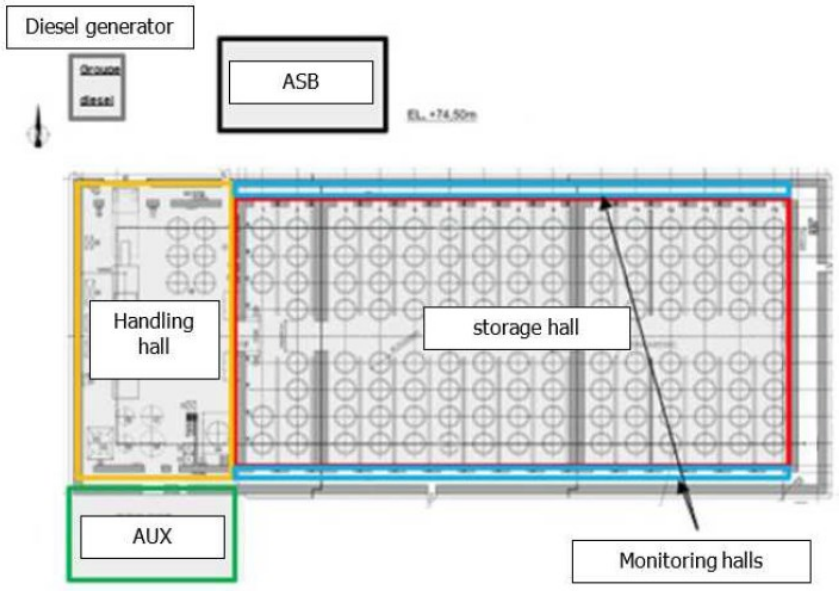


Figure 17 Global layout of the SF² facility (illustrated: facility at Tihange site).

❖ Description of the Main Spent Fuel Storage Building of Tihange (SFB)

The SFB of Tihange is foreseen for vertically stored casks, with enough free space between all of them for handling and thermal requirement (this one takes the global warming into account). 120 positions are foreseen in total, or 15 rows of 4 positions each in 2 zones separated by a free lane. The storage hall is separated from the monitoring halls by a concrete wall protecting them from the radiation and supporting the bridge crane. Openings are foreseen in this wall for the natural ventilation.

A motorized sliding shielding door and a concrete wall isolate the storage hall from the handling hall protecting the operators from the radiation of the stored casks.

The trailer charged with the cask, possibly loaded with the spent fuel elements, is received in the handling hall. In this hall, the cask is put vertically, discharged from the trailer, transferred, and put down in the preparation stand with the use of the bridge crane.

In the preparation stand, the cask can be visually inspected. If loaded with spent fuel elements, it is prepared for storage with the positioning of an antimissile cover, tubing for leakage monitoring, additional shielding material (if required), a supporting chair, leakage testing, …. Then, it is transported to the storage hall with the bridge crane.

The reception and storage of empty casks is also possible in the handling hall (6 free positions are foreseen in the handling hall for empty casks). In the storage hall, each cask is connected to a leakage monitoring system controlling the leak-tightness of the cask. The leakage monitoring system for each cask is located in the monitoring halls. The monitoring hall is 1,5m large allowing the ventilation, the circulation of the personnel, the passage of cables, ...

The bridge crane is a Single Failure Proof equipment following the NUREG-0554 guideline with a nominal capacity of 150 ton. It is designed for the realization of all handling activities of casks and other equipment within the SFB. The minimum lifetime for the mechanical and structural parts required from the supplier is the same as the lifetime of the SF² facility, 80 years. Thanks to the SFP conception of the bridge, the risk of cask drop during handling is minimized. In addition, the structural integrity of the bridge crane is guaranteed in case of earthquake. The bridge is able to maintain its load in case of loss of power supplies. In addition, the bridge also allows to deposit by manual emergency means the cask in a safe and stable position. A limitation of the handling height of the casks and a speed limitation are also foreseen in the design of the bridge crane to limit the risk of mechanical damage during cask handling (e.g., collision between a stored and handled cask, cask drop …).

The monitoring halls are foreseen at each side of the storage hall. They house the monitoring system for the leak-tightness of the casks and facilitate the ventilation of the building.

The monitoring halls are organized in 2 levels:

- The fresh air is entering from outside in the lower level, flowing through openings in the external wall and going into the storage hall through holes in the wall between the monitoring hall and the storage hall.
- The monitoring of the leak-tightness is situated at the upper level to limit the radiation dose of the workers.

The walls between the monitoring halls and the storage hall protect the personnel from irradiation.

By design, the cooling of the cask is passive (Figure 17), limiting the temperature of the fuel cladding to the design criteria. The fresh air flows through large lateral openings in the external walls of the building. It goes through the monitoring halls and comes in the storage hall via openings at the ground level in the walls between the monitoring halls and the storage hall. In contact with the casks, the air heats up and is evacuated by natural convection through openings in the roof of the SFB (see Figure 18).

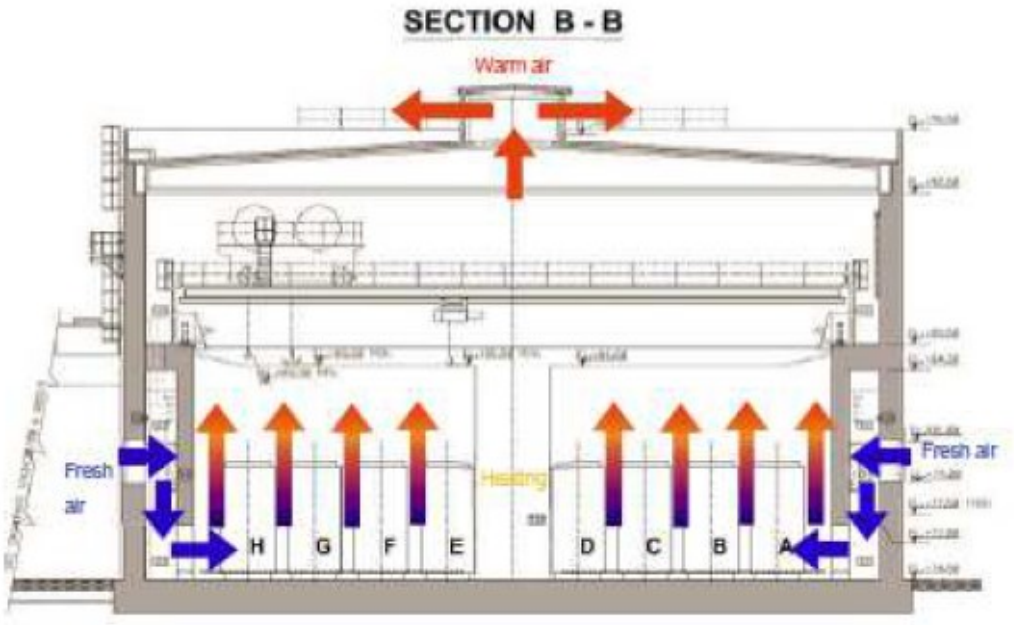


Figure 18 passive ventilation in the SFB building.

The cask is designed to satisfy following safety functions :

- The preservation of the subcriticality;
- The containment of radioactive products;
- The heat removal;
- The safety functions of the casks are guaranteed by design in normal situation and in accidental conditions like airplane crash, fire, earthquake, flooding, …
- The main spent fuel storage building (SFB) contributes to the nuclear safety functions (radiological protection of the population and heat removal) and is therefore seismically qualified. An earthquake of 0.25g (horizontal PGA) is taken into account for building design. The SFB building is designed in the seismic category SDC 5 and limit state D, following the rules and methods as described in norms ASCE/SEI 43-05 et ASCE 4-98, considering dynamic soil-structure interaction. The SFB building is also designed to resist to extreme natural phenomena (wind, snow, ice, or tornado's) and explosion.

Figure 19: example of dual casks for nuclear spent fuel

❖ Description of the Auxiliary building (AUX)

The auxiliary building (AUX) is organized in 2 levels. The first level is foreseen for the access room, the lockers and sanitary rooms, the batteries room, and the transformers room. The second level is foreseen for the electrical equipment, the control panel, and the extra low voltage rooms. The HVAC condensers dedicated to air cooling cabinets is placed on the roof of the auxiliary building.

No seismic qualification is required because having no safety function and not housing any SSC with a safety function. It is nevertheless built following the Eurocode 8 and its Belgian appendix where a seismic qualification is required for the protection of the personnel.

❖ Description of the Accessories Storage Building

The accessories storage building (ASB) is dedicated to the storage of diverse equipment used for the handling of the casks (like cask accessories, handling tools, …) and for some maintenance activities. No seismic qualification is required because not housing any SSC with a safety function. It is nevertheless built following the Eurocode 8 and its Belgian appendix where a seismic qualification is required for the protection of the personnel.

L.2.4.c Inventories

- The deactivation pools at Doel contain around 1367 definitively discharged Fuel assemblies, for a capacity of 2075 assemblies (at the date of 31/12/2023).
- The deactivation pools at Tihange contain around 1211 definitively discharged Fuel assemblies for a capacity of 1916 assemblies. (at the date of 31/12/2023).
- The dry storage building at Doel contained 123 containers, in which about 3648 fuel assemblies are stored (at the date of 31/12/2023), i.e. about 75 % of the current storage building capacity (165 positions).
- The wet storage building DE at Tihange contained 3311 fuel assemblies (at the date of 31/12/2023), i.e. about 89% of the total storage capacity (3720 positions).

L.3 APPENDIX 3: Description of the main waste management facilities at the ONDRAF/NIRAS and Belgoprocess sites

L.3.1 General site description

In the following picture the implanting of the disposal site for the surface disposal of the category A-waste and its relevant facilities and the Belgoprocess site in the municipalities of Mol and Dessel is shown. The repository (2) is located on NIRAS/ONDRAF grounds and will comprise two disposal facilities for a total of 34 disposal unites or concrete modules and their auxiliary infrastructure, such as the entrance cluster (indicated by the red boxes in the figure). The repository is adjacent to the Belgoprocess site (3, see next paragraph for details) including the caisson factory (4) and the installation for the Production of Monoliths (IPM, 5). Tabloo, the visitor and meeting centre and its adjacent park is situated at the north (1).

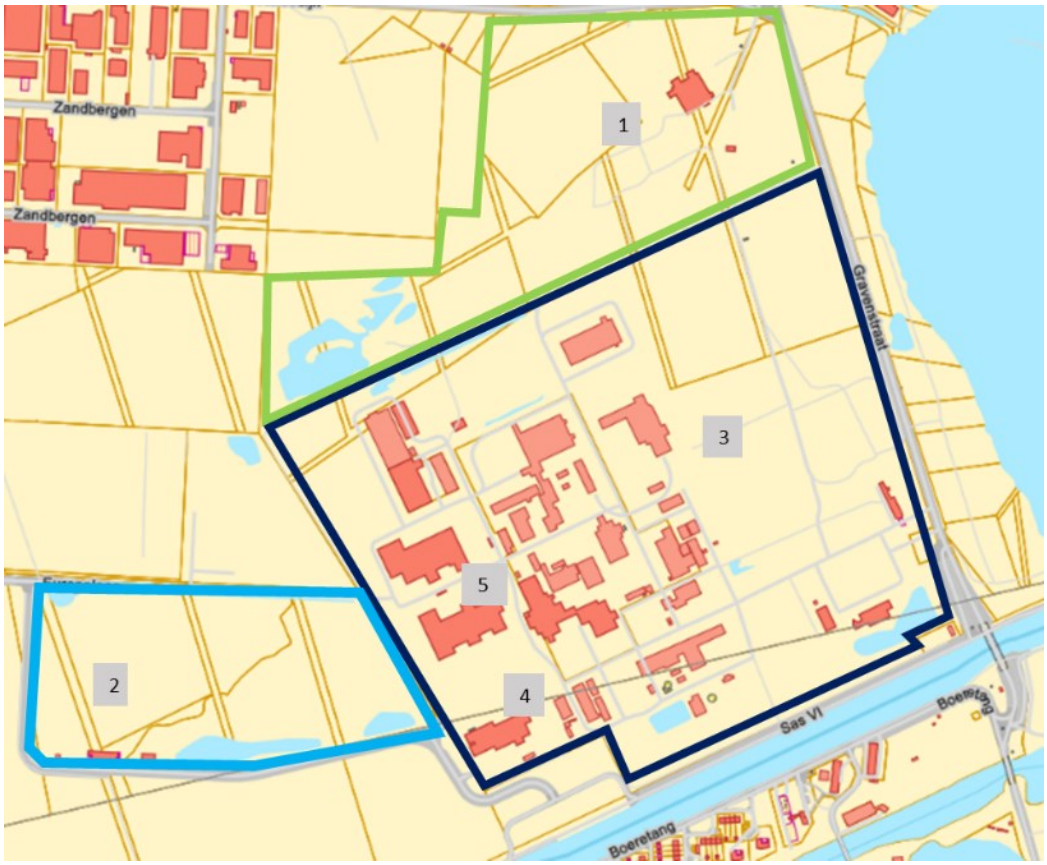


Figure 20 Map of the NIRAS and Belgoprocess site at Mol/Dessel with the main facilities indicated.

L.3.2 Belgoprocess site description

The different buildings of Belgoprocess of interest for waste storage are identified (in red) on Figure 21. The main characteristics of the buildings are given in Table 9 below.

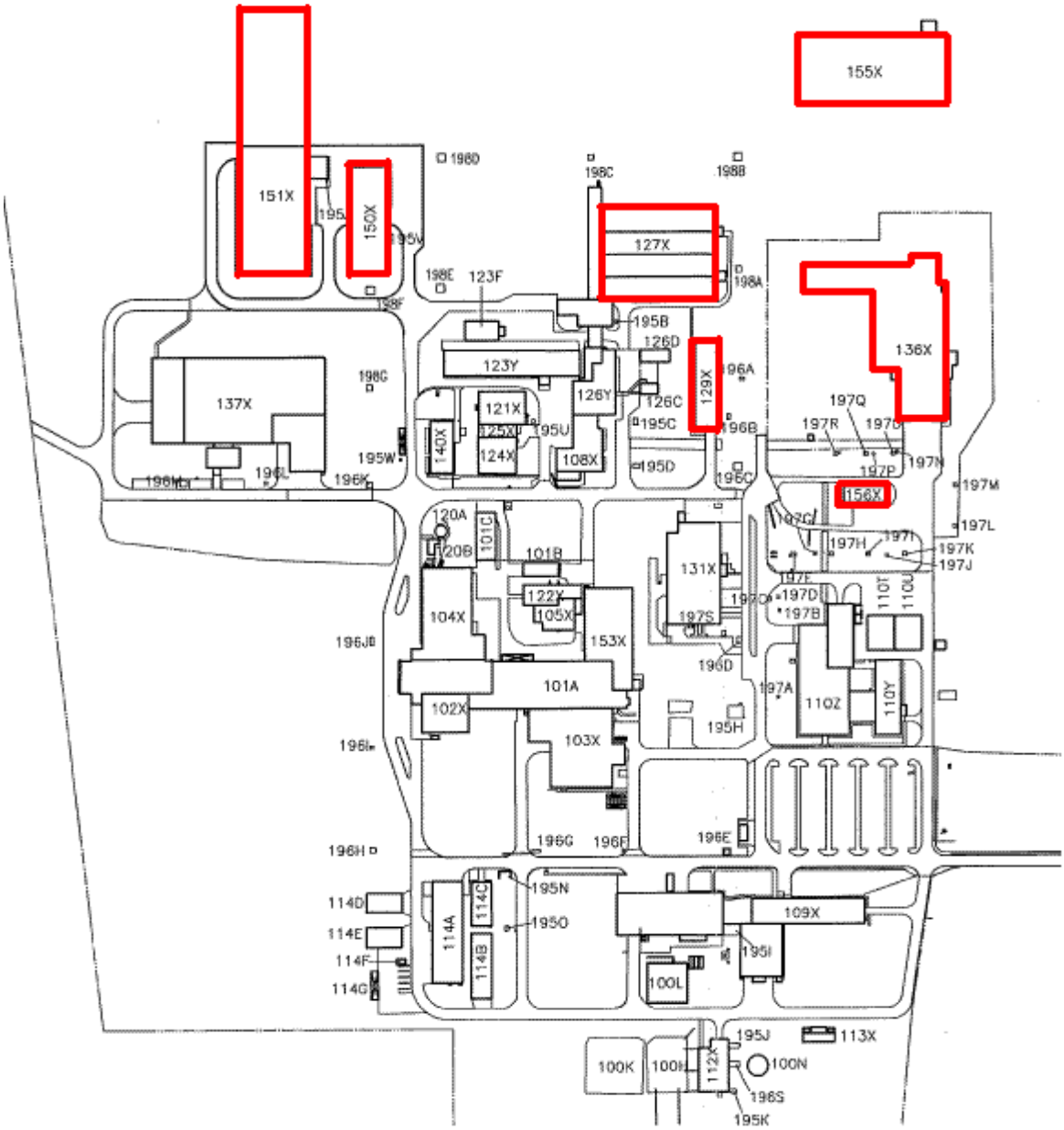


Figure 21 Map of Belgoprocess installations.

Table 9 Description of buildings at Belgoprocess.

Building	Picture	Acceptance criteria for waste packages/conditions with regard to radioactivity	Conditions stipulated in the Safety Files
127		1. The dose rate at the external surface of the package has to remain below the limit of 2 Sv/h. A package with localized surface dose rate exceeding the (maximum) limit value may, in close consultation with the Health Physics Department and possibly with Bel V, be accepted on the condition that the criterion regarding the dose rate at 1 meter is observed (< 0.2 Sv/h). 2. The volume-activity concentration in the primary package is limited to 148GBq/m3 for alpha emitters and to 37 TBq/m^3 for beta-gamma emitters. 3. the removable surface contamination of the primary package needs to be below 0.4 Bq/cm^2 for alpha emitters; 4 Bq/cm^2 for beta-gamma emitters. ^{226}Ra and ^{232}Th in the primary package are only allowed in mass-activity concentrations which do not exceed the natural radioactivity of these isotopes.	Maximum dose rate on outer walls of the building. 25 µSv/h. Max. activity <3.7 E10 Bq/l, mainly beta; alpha activity negligible
129		Storage building filled at 86%.	Maximum dose rate on outer walls of building: 25 µSv/h. Per package maximum alpha activity up to 1.37E12 Bq and maximum beta activity up to 3.2E14 Bq, depending on the type of waste.

Building	Picture	Acceptance criteria for waste packages/conditions with regard to radioactivity	Conditions stipulated in the Safety Files
136		Building mainly foreseen for SYNATOM waste coming from COGEMA (now ORANO NC). See specific acceptance criteria for more details about the radiological conditions.	Maximum dose rate on outer walls of building 136: 20 µSv/h. More information on individual dose rate from packages in 10 below.
150		Storage building already filled.	Maximum dose rate in contact with package: 5 mSv/h, exceptionally, 10 mSv/h. Per package maximum alpha activity up to 2E9 Bq and maximum beta activity up to 3E12 Bq, depending on the type of waste.
151		1. the dose rate at the external surface of the package has to remain below the limit of 5 mSv/h. A package with localised surface dose rate exceeding the limit value may be accepted on the condition that the criterion regarding the dose rate on a 1-metre distance is observed (< 0.5 mSv/h). 2. the mass-activity concentration of alpha emitters in the primary package is limited to 4 GBq per ton. 3. the removable alpha surface contamination has to be below 0.04 Bq/cm^2; that of beta/gamma surface contamination below 0.4 Bq/cm^2. ^{226}Ra and ^{232}Th in the primary package are only allowed in mass-activity concentrations, which do not exceed the natural radioactivity of these isotopes.	Maximum dose rate in contact with package: 5 mSv/h, exceptionally, higher if value at 1 m is below 0.5 mSv/h. Maximum alpha activity 4GBq/t, except for 160 drums from historical production, < 75GBq/t. Maximum beta activity up to 3E12 Bq/ package, dependent on type of waste.

Building	Picture	Acceptance criteria for waste packages/conditions with regard to radioactivity	Conditions stipulated in the Safety Files
155		B155 LAGAL : 1. the dose rate at the external surface of the package has to be below or equal to 5 mSv/h. If the surface dose rate exceeds 5 mSv/h, the radiation at 1 meter distance has to be below 0.5 mSv/h. 2. The ^{241}Pu quantity has to be below 112 g per package. The Pu-239 quantity has to be below 219 g per package. The ^{235}U quantity has to be below 326 g per primary package. The sum of the proportions of the quantities of these 3 radionuclides compared to the maximum quantities of each of these radionuclides has to be below 1. 3. The beta activity concentration, with the exception of that of ^{241}Pu, has to be below 40 GBq per primary package. 4. The removable alpha surface contamination needs to be below 0.04 Bq/cm^2; that of beta/gamma below 0.4 Bq/cm^2. ^{226}Ra and ^{232}Th should not exceed their natural concentrations.	Maximum dose rate on outer walls of building: 10 µSv/h. Other conditions as in the acceptance files
		B155- RAGAL : 1. The dose rate at the external surface of the package must be below or equal to 5 mSv/h. If above 5 mSv/h, the radiation at 1 m must be below 0.5 mSv/h. 2. The removable alpha surface contamination must be below 0.04 Bq/cm^2 while the removable beta/gamma surface contamination must be below 0.4 Bq/cm^2. The alpha activity concentration must be below 20 GBq/t. The maximum alpha Radium concentration must be below 740 GBq/package	

Building	Picture	Acceptance criteria for waste packages/conditions with regard to radioactivity	Conditions stipulated in the Safety Files
156		Storage of BR3 fuel assemblies in CASTOR® storage casks.	The dose rate limits outside the building are: • surface of the storage building: 10 µSv/h • 300 m distance from the storage building: 0.1 mSv/y

Table 10 Dose rates and activities for packages in Building 136.

	Vitrified waste (CSD-V) High active solutions	**Compacted waste (CSD-C)** Hulls and ends	**Vitrified waste (CSD-B)** Process sludges	**Dounreay** High active solutions (cemented)	**400 ℓ drums** Compacted waste (cemented)
Dose rate (Sv/h)					
D (contact)	$1.4\ 10^4$	$1.5\ 10^2$	2.8	13	$1.0\ 10^2$
D (1 meter)	$4.2\ 10^2$	12	0.2	1.3	10
Activity per primary package (TBq)					
Beta/Gamma	$2.8\ 10^4$	$2.4\ 10^2$	31	$4.0\ 10^2$	$4.0\ 10^2$
Alpha	$1.41\ 10^2$	0.6	1	0.5	10
Removable surface contamination (Bq/cm^2)					
Beta/Gamma	< 4	< 4	< 4	< 4	< 4
Alpha	0.4	0.4	< 0.4	0.4	0.4

L.4 APPENDIX 4 : Description of the installations of SCK CEN : BR2

The BR2 reactor, in service since 1963, is a test reactor with a high neutron flux for the irradiation of materials. Its main purpose is the irradiation of materials under high neutron flux (maximum thermal neutron flux of the order of 10^{15} n. cm^{-2} s^{-1}). These materials are irradiated in experimental rigs, the complexity of which depends on the nature of the irradiation and the intended objectives. The reactor loading is defined (fuel elements, control rods) in the light of the experimental specifications, and is adjusted for each cycle. It is cooled by pressurised water (nominal value: 1.235 MPa or 12.6 kg/cm^2 at the entrance of the reactor), which also serves as a moderator. The beryllium matrix comprises 79 cylindrical channels and contains fuel elements, control rods, experimental set-ups or reflector stops made of beryllium.

The beryllium matrix, already renewed twice (in 1980 and 1996), contains a large number of rods in the form of hexagonal prisms with cylindrical drillings (these form the reactor channels), which together form a cylindrical structure. It is placed into the central part of the reactor vessel. This vessel, made of aluminium alloy, contains an upper part and a lower part in the form of truncated cones, connected at both ends with a central cylinder. Stainless steel covers seal the vessel at each end. The upper cover has 79 round openings, which correspond to the 79 channels of the central part made of beryllium. Each opening is connected to one of these channels by a guide tube; the openings are sealed off with plugs during the operation of the reactor. In the lower cover there are only 18 round openings, which are normally sealed off with plugs and are also connected to the reactor channels. They allow experimental set-ups to be moved to a shielded room situated underneath the reactor.

Figure 22: BR2 fuel element

The fuel elements are composed of six (sometimes fewer) concentric pipes, which are composed of a combination of uranium and aluminium, and which are made according to the technique of powder metallurgy. The plates produced in this way are covered on both sides with an aluminium alloy cladding.

The uranium used is highly enriched (90 to 93 %): in the future, lower enrichments can be used, preferably with an increased density of the uranium in the nuclear fuel plates. Most of the elements contain burnable neutron absorbers (B_4C, Sm_2O_3) in the nuclear fuel plates.

This primary water is sent through heat exchangers; the heat is transferred to a closed secondary circuit equipped with cooling towers. These cooling towers allow the operation of the reactor up to 125 MW.

The reactor operation regime consists of successive cycles, each cycle consisting of a period of shut-down and a period of operation (21 days).

The reactor is placed in a pool (the reactor pool) with a water level more than 7 m above the upper cover. This offers sufficient shielding to the personnel during the operation of the reactor. During reactor shut-down, the water level can be lowered to allow access to the reactor cover. Two adjacent pools are used to store the irradiated equipment and fuel elements unloaded from the reactor and for gamma irradiations.

The reactor, the three pools and the reactor control room are situated in a cylindrical metallic building, which is regularly inspected.

In an adjacent building (the 'machine building') there are several auxiliary installations: a storage channel connected to the reactor pool through a transfer tube, dismantling cells connected to the storage channel, the pumps and heat exchangers of the primary circuit of the reactor, purification circuits, etc.

Other buildings house the ventilation fans (blowers), air filters, the electrical emergency groups, air compressors, the experiment hall, etc.

The solid and liquid waste is collected and sent to the waste treatment installations at Belgoprocess. The gaseous effluents are released, after filtration, through a 60-metre chimneystack.

It is possible to purify the atmosphere of the reactor building and the cells by means of active coal filters.

An elaborate system monitors the activity levels of the primary and secondary circuits, the activity of the pools and the storage channel in the machine building, the activity of the atmosphere of the reactor building, the activity of the air released through the chimneystack, etc.

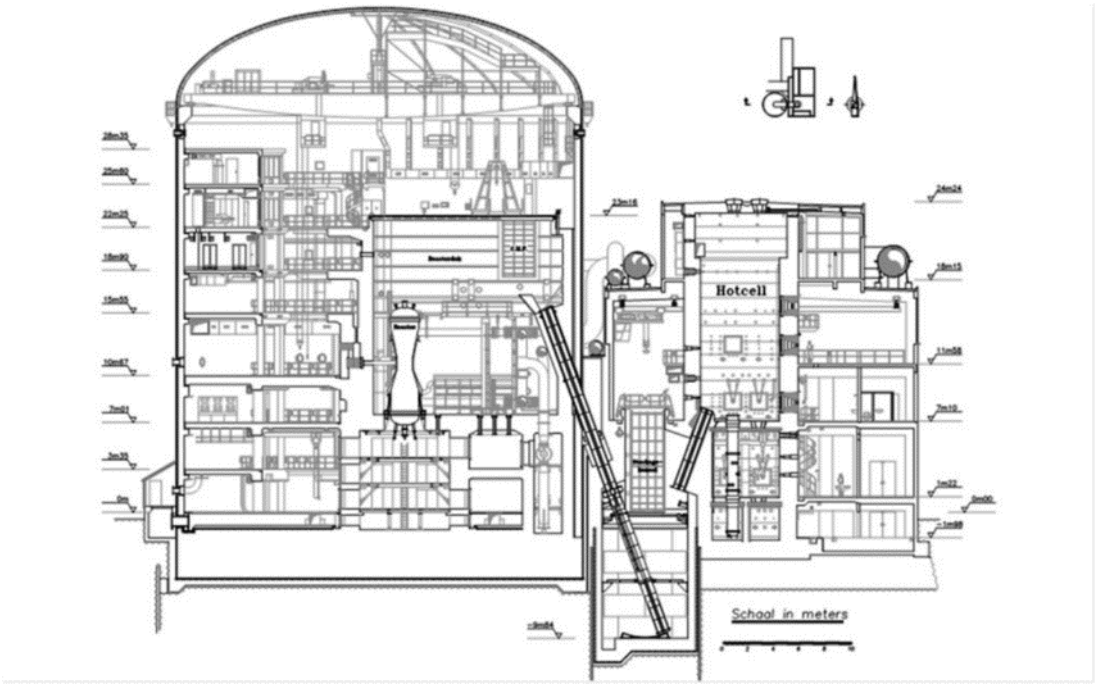
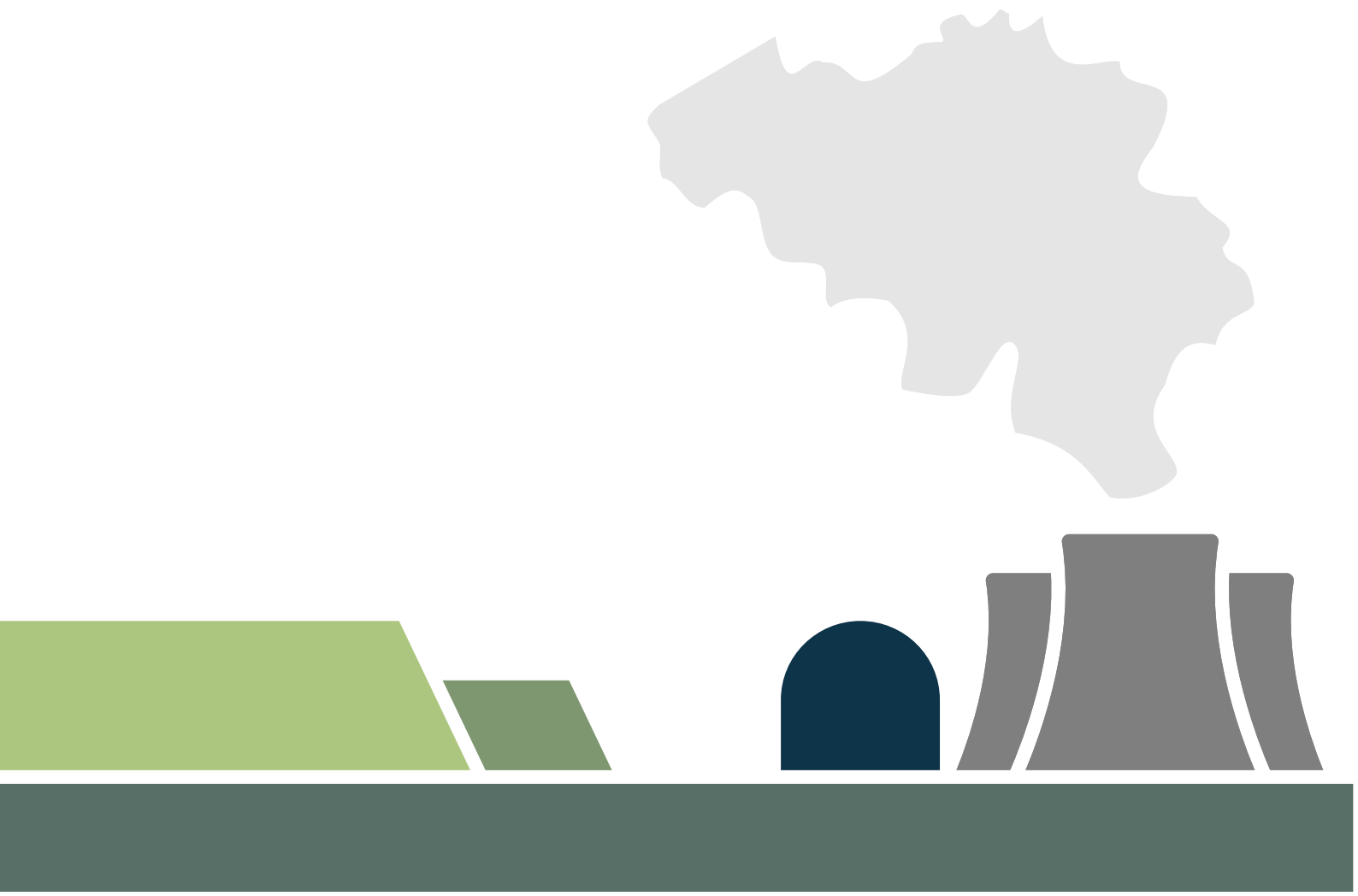


Figure 23: Cross section of the BR2 Reactor.

L.5 List of acronyms

Acronym	Definition
AIA	Authorised Inspection Agency.
ALARA	As Low As Reasonably Achievable
ANS	American Nuclear Standards.
ARTEMIS	Integrated Review Service for Radioactive Waste and Spent Fuel Management, Decommissioning and Remediation (IAEA).
Bel V	Subsidiary of the Federal Agency for Nuclear Control, to which it provides technical expertise.
BP1/2	Belgoprocess site 1/2.
BSS	Basic Safety Standards.
cAt	Category A surface disposal facility.
CGCCR	Comité Gouvernemental de Coordination et de Crise (the Governmental Centre for Coordination and Emergencies).
CPN	Commission for Nuclear Provisions.
CSD	Chemical full System Decontamination.
CSD-C	Conteneur Standard Déchets Compactés (Standard Container for Compacted Waste).
CSD-V	Conteneur Standard Déchets Vitrifiés (Standard Container for Vitrified Waste).
EIA	Environmental Impact Assessment
ENSREG	European Nuclear Safety Regulator Group
ENGIE Electrabel	Operator of the Belgian NPPs.
EU	European Union.
FANC	Federal Agency for Nuclear Control.
FBFC	Franco-Belge de Fabrication de Combustible (Franco-Belgian Company for Fuel Manufacturing).
FSAR	Final Safety Assessment Report
GRR-2001	General Regulations for the protection of workers, the population, and the environment against the hazards of ionizing Radiation, laid down by Royal Decree of 20 July 2001.
HAZOP	HAZard and OPerability study.
HERCA	Heads of Radiation Protection Authorities
HLW	High Level Waste.
HPD	Health Physics Department.
IAEA	International Atomic Energy Agency.
INES	International Nuclear Event Scale (IAEA).
IRE	National Institute of Radioelements (Institut national des Radio-éléments).
IRRS	Integrated Regulatory Review Service (IAEA).
IRS	Incident Reporting System (NEA/OECD-IAEA).
KCD	Kerncentrale Doel (Doel Nuclear Power Station).
LILW-SL	Short-lived low- and intermediate-level radioactive waste.
LILW-LL	Long-lived low- and intermediate-level radioactive waste.
MOX	Mixed-oxide U02-Pu02.
NCCN	Nationaal CrisisCentrum – Centre de Crise National (National Crisis Center)
NDA	Non-Destructive Analysis.
NEA (OECD)	Nuclear Energy Agency (OECD).
NEP	Nuclear Emergency Plan.
NORM	Naturally Occurring Radioactive Material.
NPP	Nuclear Power Plant.
NUSS	Nuclear Safety Standards programme (IAEA).
NUSSC	Nuclear Safety Standards Committee (IAEA).
ONDRAF/ NIRAS	Belgian radioactive waste management agency.
ONSF	ONDRAF/NIRAS site Fleurus (former Best Medical Fleurus facility, taken over by ONDRAF/NIRAS after its bankruptcy).
OSART	Operational Safety Review Team (IAEA).
PDF	Plan Final de Démantèlement (Final Dismantling Plan).
PSR	Periodic Safety Review.
RD&D	Research, Development and Demonstration.
RHWG	Reactor Harmonization Working Group (WENRA).
RGPT	Règlement Général pour la Protection du Travail (Occupational Health and Safety Regulations).
SAFIR-2	Safety Assessment and Feasibility Interim Report 2.
SCK CEN	Studiecentrum voor Kernenergie/Centre d'Etudes de l'Energie Nucléaire/, Nuclear Research Centre, situated at Mol, Belgium.

Acronym	Definition
SEA	Strategic Environmental Assessment
SF²	Spent Fuel Storage Facility
SRD	Safety Report for Dismantling
SRL	Safety Reference Level
SRNI-2011	Safety Requirements for Nuclear Installations, laid down by Royal Decree of 30 November 2011
SYNATOM	(Company) Owner of the fuel of the NPPs.
TE	Tractebel Engineering.
TENORM	Technologically Enhanced Naturally Occurring Radioactive Material.
USNRC	United States Nuclear Regulatory Commission.
WAC	Waste Acceptance Criteria
WASSC	Waste Safety Standards Committee (AIEA).
WENRA	Western European Nuclear Regulators' Association.
WMU	Waste Management Unit



FANC AFCN

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