KINGDOM OF BELGIUM

Seventh 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

October 2020

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A. 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 includes at present 7 operational PWR reactors on 2 sites having jointly a net electric capacity of approx. 6000 MWe.

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 45% in 2019. By means of the Law of 31 January 2003 on nuclear energy phase out, amended in December 2013 and in June 2015, the Political Authorities have chosen to abandon the use of nuclear fission energy for industrial electricity production. Article 4 of the law of 31 January 2003 limits the operational period of the Belgian NPPs to 40 years. However, to ensure the electricity supply of Belgium, the government and the parliament modified article 4 of this law in 2012 and in 2015, to allow an extended operation of Tihange 1 and Doel 1 & 2 units by 10 years.

The legal shutdown dates of the Belgian reactors are given in the following table:

Doel 1	15nd February 2025
Doel 2	1st December 2025
Doel 3	1st October 2022
Doel 4	1st July 2025
Tihange 1	1st October 2025
Tihange 2	1st February 2023
Tihange 3	1st September 2025

Shutdown dates of the Belgian reactors

The construction of new NPPs in Belgium is forbidden by this law (Article 3).

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 (Belgonucleaire and FBFC International).

All these activities have been 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 for the long-term management of the resulting radioactive waste to be taken by the Federal Government.

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 1. These activities generate spent nuclear fuel and radioactive waste with highly diverse characteristics, which must be managed safely.

Principal activities	Main facilities or types of radioactive waste
Activities related to the nuclear fuel cycle	
Fuel fabrication	
FBFC International (1973–2015, Dessel), currently at the end of decommissioning stage	Fabrication facilities for UO_2 fuel and fuel assemblies from enriched UO_2 and fuel assembly facilities for MOX from rods of MOX fuel
Electricity production	
ENGIE Electrabel (Doel and Tihange) (SYNATOM owns the fuel)	7 PWR reactors (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): 15 February 1975 – 15 February 2025 Doel 2 (433 MWe): 1 December 1975 – 1 December 2025 Doel 3 (1006 MWe): 1 October 1982 – 1 October 2022 Doel 4 (1039 MWe): 1 July 1985 – 1 July 2025 Tihange 1 (962 MWe): 1 October 1975 – 1 October 2025 Tihange 2 (1008 MWe): 1 February 1983 – 1 February 2023 Tihange 3 (1046 MWe): 1 September 1985 – 1 September 2025 Radioactive waste treatment, conditioning and storage facilities, including storage facilities for spent fuel
Activities related to radioactive waste management	
Belgoprocess	Various facilities for the processing and storage of radioactive waste
Research	
Belgian Nuclear Research Centre (SCK CEN, Mol)	4 research reactors: BR1, BR2 (operational), BR3 (being dismantled) and VENUS (changed into VENUS-F for GUINEVERE), laboratories
Institute for Reference Materials and Measurements of the Joint Research Centre of the European Commission (JRC), Geel	2 linear accelerators, laboratories
Ghent University (Ghent)	1 cyclotron, 2 linear accelerators put out of service
Seven other Belgian universities	11 cyclotrons (including 4 attached to university hospitals), 2 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 (including 2 put out of service)
Radium and uranium production (from 1922 to 1977)	
Umicore (formerly Union Minière, Olen)	Three storage facilities (UMTRAP, Bankloop and the "2016"), subject to nuclear licences and containing radioactive substances and radioactive waste Radioactively contaminated industrial landfills and diffuse radioactive contamination, likely to require remediation generating radioactive waste
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 without generation of radioactive waste
Old domestic devices	Ionising smoke detectors, lightening conductors, etc.

Table 1 – Principal activities generating spent fuel and radioactive waste and main associated facilities or main types of associated waste.

The Federal council of Ministers, in its decision of 23 June 2006 regarding the disposal of "category A" waste (short-lived low and intermediate level radioactive waste or LILW-SL) on the Belgian territory, requested the Belgian National Agency for Radioactive Waste and enriched fissile materials (ONDRAF/NIRAS) to develop an integrated project for a surface disposal facility for category A waste (LILW-SL) in Dessel. In line with this policy decision, ONDRAF/NIRAS is developing an integrated disposal project, that entails a disposal facility, a waste post-conditioning facility and the realisation of the accompanying conditions requested by the local stakeholders. The waste post-conditioning facility is under construction. The license application procedure for the disposal facility is running.

For the long-term management of the high-level and/or long-lived waste (category B&C waste) ONDRAF/NIRAS has submitted a 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 is subject of a strategic environmental assessment procedure (2019 - 2020) with consultation of institutional actors and of the public (April 2020-June 2020). On the basis of the outcomes of the procedure ONDRAF/NIRAS has submitted its adapted policy proposal to the Federal Government in September 2020.

A.1.1. Structure and content of the report

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

This report takes into account the guidelines INFCIRC/604/Rev.3. An overview of the main developments since the 6th Review Meeting is reported in Section A.2. An overview of the follow-up of the 6th Review meeting, addressing the suggestions and challenges identified for Belgium is reported in section K.

The following actors have participated in 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,
- Bel V, the technical subsidiary of the FANC,
- ENGIE ELECTRABEL, the licensee of the seven nuclear power plants who is responsible for the interim storage on site of the spent fuel,
- SCK CEN, the Belgian Nuclear Research Centre, operating research reactors 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 about it from the peer review will be made available on different Belgian Websites, such as www.fanc.fgov.be, www.nirond.be, www.belv.be.

A.1.2. **Summary table of current liabilities in Belgium**

Type of Liability	Current practices/ Facilities	Long-term management policy	Funding of Liabilities	Planned Facilities
Spent Fuel	- On-site wet and/or dry storage of spent fuel (SF) from NPPs - Storage (at Belgoprocess) or reprocessing of SF from research reactors	Long term management policy still to be defined: disposal of waste from reprocessing or direct disposal	NPP operators contribute to the fund managed by SYNATOM; Various funds fed by state for spent fuel of research reactors	Geological disposal still to be confirmed by policy decision. (disposal and pre-disposal facilities to be decided)
Nuclear fuel cycle waste	Centralised storage at Belgoprocess site of all SL-LILW, LL-LILW and HLW transferred to ONDRAF/NIRAS	SL-LILW : Near surface disposal LL-LILW and HLW: policy still to be defined	Producer pays, contribution to the ONDRAF/NIRAS long-term fund; Various funds for historical liabilities fed by state	Surface Disposal for SL-LILW at Dessel, including the disposal facility and other facilities for waste packaging for disposal. (Gov. Decision taken in 2006, license application in 2013) Storage building for the ASR non-conform waste at Belgoprocess Geological disposal of LL-LILW and HLW still to be confirmed by policy decision. (disposal and pre-disposal facilities to be decided)
Non-power reactors waste	Centralised storage at Belgoprocess site of all SL-LILW, LL-LILW and HLW transferred to ONDRAF/NIRAS Radium waste storage at Umicore/Olen	SL-LILW: near surface disposal LL-LILW: policy still to be defined Radium waste : policy still to be defined	Producer pays, contribution to ONDRAF/NIRAS long-term fund; Insolvency fund; Radium waste: Producer pays	Idem
Decommissioning Liabilities	Present projects : BR3 Research Reactor; Eurochemic reprocessing plant; SCK CEN waste department; FBFC UO2 fuel fabrication plant; Radio-element production facility ex-"Best Medical Belgium"	Responsibility of operator; approval of decommissioning plan by ONDRAF/NIRAS SL-LILW: near surface disposal LL-LILW policy still to be defined	NPP operators contribute to the fund managed by SYNATOM; various funds for historical liabilities fed by state; Transfer of financial means to ONDRAF/NIRAS (waste funds managed by ONDRAF/NIRAS) when waste is	Idem

			transferred to ONDRAF/NIRAS	
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

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 2016-2019

(1) The National declaration regarding nuclear safety, nuclear security and radiation protection

As a response of the recommendation n°8 of the IRRS hosted in Belgium end 2013, the Government issued the National declaration regarding nuclear safety, nuclear security and radiation protection. This declaration has been published in the Belgian Official Journal on 12 October 2018. It addresses the following topics:

- the principle of continuous improvement;
- the principle of justification;
- the principle of defense in depth;
- the safe management of radioactive waste;
- the coordination between the different bodies having responsibilities in nuclear safety and security;
- the requirement of a high level of competency;
- the need to ensure a transparent communication;

(2) The new national nuclear and radiological emergency plan

On March 1st, 2018, the new Belgian Nuclear and Radiological Emergency Plan (NEP) was published as a Royal Decree in the Official Journal. The new NEP integrates the lessons from past exercises and events (IRE 2008, Fukushima), the results of dedicated working groups, international recommendations and requirements such as GSR-7, GSG-11, the European BSS, the HERCA-WENRA approach and the advice from national Scientific Committees and other stakeholders (local and regional authorities and Greenpeace Belgium).

Before being published, the draft NEP was submitted for comments to a large panel of Belgian interested parties including Scientific Committees and other stakeholders (local and regional authorities, emergency services, licensees and NGO's).

The new NEP redefines its scope to include all operational Belgian Class I facilities and all foreign facilities within 100 km from the border. It also considers emergencies created by terrorist or malevolent action as well as accidents during the transport of nuclear fuel or waste from fuel reprocessing. To improve the communication with neighbouring countries and international bodies, the new NEP adopts the classification systems of GSR-7 and translates the notification levels previously used in facility emergency (former N1 level), site area emergency (former N2) and general emergency (former N3). The former notification level NR is kept and translated as general emergency in reflex mode.

The management structure has been slightly adapted to reinforce the principle of integrated crisis management and graded approach. At the federal level, the decision is entrusted to a Management Cell (Ministers) based on a global analysis of the situation (radiological, socio-economic, available resources…) provided by a Federal Coordination Committee. This committee is also in charge of following up the decision's implementation. The role of local actors (mayors and governors) is reinforced in a way that they can take operational decisions to protect their population provided they consult with the Federal Coordination Committee. More emphasis is also given to the later phases of an emergency (i.e. transition to the declaration of the end of the emergency) and the post-accidental phase, describing the changes in the management structure and the required flexibility to adapt to the evolution of the situation.

The updated emergency plan introduces the HERCA-WENRA approach concept of planning zones and extension zones. In this regard, the pre-distribution in pharmacies of ITB agents (Iodine Thyroid Blocking - KI tablets) has been extended up to 100 km from each concerned facility (Belgian operational Class I facilities and foreign NPPs), i.e. the whole country. Each Belgian family or responsible of a public or private establishment is strongly advised to collect tablets for the people which could be present in their house or establishment, especially if there are children amongst them.

(3) The Law of 7 May 2017 on Health Physics organization

This law amends the law of 15 April 1994 (see article 8 of the Convention related to the legal and regulatory framework). In particular, this law:

- allows the Government to publish a National declaration regarding nuclear safety, nuclear security and radiation protection (see (1) above);
- states the prime responsibility of the licensee for its activities;
- requires each licensee to set up a health physics department (HPD);
- allows the FANC to issue binding technical (non-policy) regulations, in matters fixed by Royal Decree;
- provides a legal basis for Bel V as part of the regulatory body.

This new law also resolved three recommendations from the 2013 IRRS mission in Belgium.

(4) The Royal Decree of 6 December 2018 on Health Physics Control organization and regarding Bel V

This Royal Decree has been signed by the King on 6 December 2018. It was published in the Belgian Official Journal on December 21st, 2018. This Royal Decree amends the existing regulations on health physics organization (the Royal Decree of 20 July 2001 laying down the *General Regulations regarding the protection of the public, the workers and the environment against the hazards of ionising radiation* (hereafter "GRR-2001")) and legally set up the missions and responsibilities of Bel V, the technical subsidiary body of the FANC. This legislative adaptation was made to provide greater clarity for both nuclear licensees and transport operators as well as for authorized inspection organizations (AIOs). The Royal Decree also integrates the concepts of Radiation Protection Officer "RPO" and Radiation Protection Expert "RPE" as defined in the Directive 2013/59/EURATOM laying down the basic standards for protection against the dangers associated with exposure to ionizing radiation, and through this decree, the relevant provisions of this Directive are therefore transposed into Belgian law.

The principles on which the new regulation is based are:

- A clear separation between the regulatory body and the license holder. Regulatory supervision can only be performed by the FANC and its subsidiary body Bel V (in facilities of Class I and IIA).
- Prime responsibility of the operator or the company head for organizing a Health Physics Department, that has to be organized within the operator's organization.
- A flexible and effective system that allows licensees or transport operators to call upon the expertise of recognized experts and/or on an authorized organization to ensure an effective radiation protection and nuclear safety of their installations and/or activities. Each licensee or transport organization is therefore given the freedom by the legislator to arrange its Health Physics Department in the way that best suits its organization.
- A sustainable and transparent legal and regulatory framework for Bel V, which clearly positions it on the regulatory side by assigning it supervisory missions by direct delegation from the FANC.

(5) The Royal Decree of 29 May 2018 related to the safety of facilities for storage of spent fuel and radioactive waste.

This Royal Decree aims at introducing an additional chapter entitled "*Specific safety requirements for waste and spent fuel storage facilities*" in the Royal Decree *on the safety requirements for nuclear installations* (30/11/2011). This proposal would introduce the safety reference levels of the WENRA's Working Group on Waste and Decommissioning (WGWD) related to waste and spent fuel storage into the Belgian regulations. The scope of this royal decree is larger than the WENRA reference levels as it is not limited to storage of conditioned waste.

(6) The Royal Decree of 29 May 2018 aiming to avoid situations which can give rise to possible liabilities of radioactive waste or of installations to be dismantled

This Royal Decree is focused on transfer of licences and on waste management and dismantling. It addresses certain recommendations of the 2013 IRRS-mission and aims at increasing the accountability of the operator for its radioactive waste and dismantling liabilities (see the Belgian National Report for the Joint Convention 2017 for more details). In particular, it:

- addresses the transfer of licences for facilities and activities;
- requires a "Radioactive Waste file" and a "Decommissioning file" as part of the licence application file. ONDRAF/NIRAS gives its advice on these files to the FANC in the frame of the licensing process;
- requires the Licensee to maintain a full inventory of all radioactive substances present in its installations;
- allows the FANC to order evacuation of unused (for 5 years) radioactive substances;

- requires a surveillance of the degree of utilisation of on-site waste storage installations, with a notification to the FANC in case of exceedance of a predefined level.

(7) The Royal Decree of 9 October 2018 completing the transposition of the Nuclear Safety Directive 2014/87/EURATOM

This Royal Decree aims mainly at including the Nuclear Safety Objective of article 8.C of the Directive 2014/87/EURATOM which is similar to the Vienna Declaration in the Belgian regulations, by amending the Royal Decree of 30 November 2011 *on the safety requirements of nuclear installation* (hereafter "SRNI-2011"). References to the Nuclear Safety Objective are made in the Periodic Safety reviews and in Experience Feedback requirements.

Two proposals of Royal Decree related to waste disposal facilities were developed by the FANC:

- A proposal for a Royal Decree on the licensing system for disposal facilities. The Council of Ministers approved this Royal Decree end 2016. The proposal has then been submitted to the Council of State who raised some issues related to the fulfilment of the requirements of the European Directive 2014/52/EU on the assessment of the effects of certain public and private projects on the environment.
- A proposal for a Royal Decree on the Safety Requirements for Waste Disposal Facilities. In 2015, the WENRA published reference levels for waste disposal facilities. In 2016-2017, the FANC project has been benchmarked with the WENRA's RLs and the proposal slightly adapted, in order to fully comply with the WENRA requirements.

In the meantime, the provisions of the European Directive 2014/52/EU were incorporated in the Belgian regulations (see section E2.3 – Licensing system), in article 6.1bis of GRR-2001. The proposal related to the licensing system needs to be adapted to take the comments of the Council of State into account and to refer to the new art 6.1bis for the Environmental Impact Assessment

These royal decrees have not been needed for starting the licensing of the cAt surface disposal facility, which is currently in progress. The safety requirements for this facility have been defined in several FANC guides (See section H1.2).

Once a National Policy related to geological disposal will be decided by the Government, these proposals of royal decree will be submitted again to the government.

A.2.2. **Other Developments**

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

The current national policy for the management of spent fuel from commercial nuclear power plants is the safe interim storage of spent fuel followed by reprocessing or final disposal. This policy is consistent with the resolution adopted by the House of Representatives in December 1993, which asked electricity generators to ensure a safe temporary storage of spent fuel. Taking the expected operation time of the nuclear units into account, the interim storage capacity has to be extended making it possible to empty the pools of the nuclear units before the start of the decommissioning activities.

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), the 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 definitive shutdown. These new facilities (SF² Doel and SF² Tihange) are designed for an operating lifetime of 80 years.

The choice is made for a dry storage at both sites in the framework of this project. The internal return of experience with the building SCG in Doel and the international feedback from other operators of interim dry storage facilities for spent fuel elements were satisfying. In addition, the dry storage of spent fuel elements offers more flexibility and is a passive installation compared to the wet storage.

In 2018 the license application was introduced by ENGIE Electrabel to construct and operate a new spent fuel storage facility (SF^2) at the NPP site in Tihange. The licensing process (review, consultation of public and other advise instances) took place in 2019. The review of the application showed, amongst others, that the concept meets the most recent expectations related to the safety demonstration by the Belgian nuclear authority which were developed in response to the European directive 2014/87/EURATOM, in particular the avoidance of large and early releases. The license was granted by a Royal Decree in January 2020. The construction activities for Tihange were started early May 2020 with the objective to have the building operational by 2023.

For the storage building at Doel the licensing application (at federal level for nuclear aspects) was introduced in January 2020 and the permit application (for urbanistic and non-nuclear environmental aspects) will be introduced to the Flemish Region in Q3 2021. In Doel, it is foreseen to start the construction in 2021 with the objective to have the storage building operational by Q1 2025.

(2) Inspection program on nuclear waste management

Since 2018, nuclear waste management inspections on sites operated by the waste producers have been reinforced within the regulatory body. Before 2018, these inspections were carried out by nuclear safety inspectors during specific campaigns.

The specific campaign from 2017, comprising the class I facilities, has shown that special care should be taken towards interdependencies, more concertation between waste producers has to be established, FANC/Bel V and ONDRAF/NIRAS should avoid conflicting requirements during inspections carried out by both organizations autonomously and follow up of the inspections should be more frequent.

In 2018, a follow up campaign was conducted for the class I facilities. Inspection guidelines for radioactive waste management were updated in an integrated guide. Experts from ONDRAF/NIRAS were invited to join the inspection team. At the same time, experts from FANC were invited to participate in audits carried out by ONDRAF/NIRAS during the qualification of equipment used by waste producers for treatment, processing, characterization and storage of radioactive waste.

In 2019, the regulatory body organized and carried out dedicated inspections aiming at the waste management systems used by the waste producers. In order to do so, the regulatory body drew up a specific inspection guide.

In 2019, FANC/Bel V and ONDRAF/NIRAS wrote a common position document which clarifies the role, responsibilities and scopes of the inspections carried out by both organizations. This document is now a baseline during the preparation, the execution and the reporting phase of the inspections simultaneously carried out by both organizations. During these inspections, one organization provides the lead inspectors while their counterparts act as expert observers. This modus operandi allows both organizations to cross check inspection procedures and data provided by the waste producers whereas the latter is provided with a coherent flow of observations and messages from both authorities.

In 2020, the inspection program scheduled 21 inspections but had to be reassessed following the COVID-19 country lockdown. 15 of the 21 inspections will take place in 2020 or have already taken place and 6 inspections will take place in early 2021

(3) Management of the non-conform waste from NPPs (ASR affected waste)

During a routine inspection in 2012 of conditioned low-level waste packages in storage at Belgoprocess, a yellow gel-like material was found on the outer surface of the lid of a waste package. This waste package, a 400-liter drum with borated evaporator concentrate immobilized in concrete and produced in 1995 by the nuclear power plant of Doel 1 was taken out of interim storage and opened by way of removing the lid. The gel-like substance was found on the whole of the surface of the concrete matrix.

After similar observations on waste packages containing the same type of waste were made, ONDRAF/NIRAS broadened the scope of its inspections to waste packages from a wide range of production periods and not only loaded with concentrates, but also with ion exchange resins and filters discharged from the primary circuit of the nuclear power plant. These inspections also comprised packages from the Tihange nuclear power plant.

During these inspections, which took place between February 2013 and December 2018, 221 packages were opened, 176 of them showing the presence, to some degree, of the gel-like substance.

An alkali-silica reaction (ASR) has been identified as the root cause for this phenomenon.

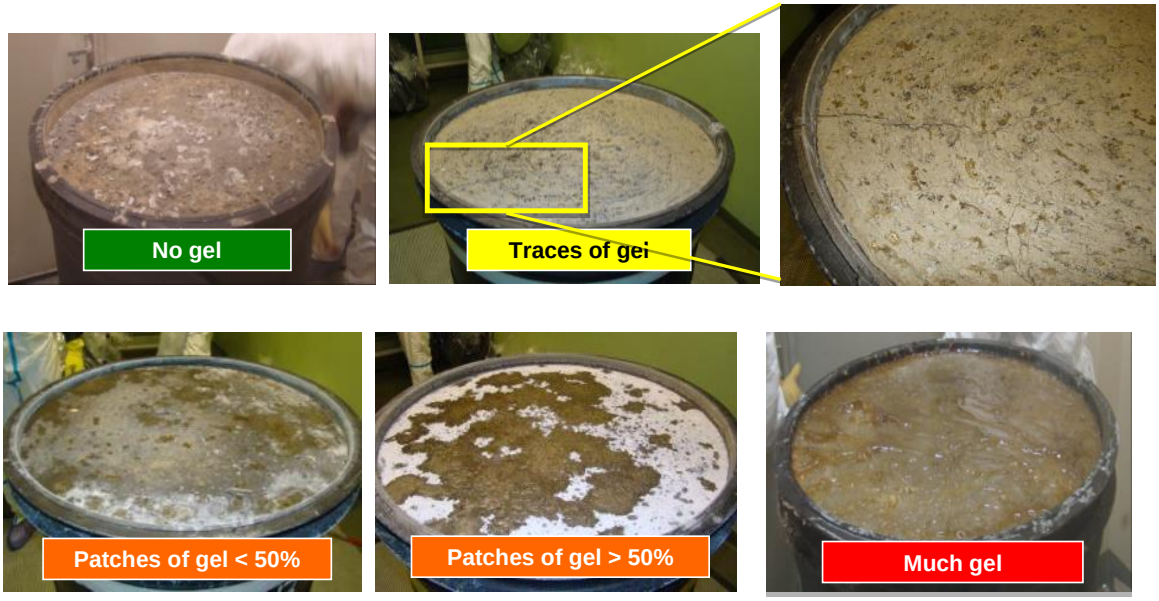

Figure 2: Opened drums with evaporator concentrates conditioned by the nuclear power plant of Doel –The top row shows a package with "no gel" (left) and "traces of gel" (right). The bottom row shows a package where "patches of gel" cover less than 50 % o% of the surface of the matrix (left), a package where "patches of gel" cover more than 50 % of this surface (middle) and a package with "much gel": the whole of the surface is covered by the substance (right)

As requested by its supervising Minister, ONDRAF/NIRAS developed a roadmap in order to deal with this situation, covering the following seven themes:

- a major inspection program,
- research and development,
- operational safety of interim storage,
- long term safety, i.e. impact on final disposal,
- impact on the Waste Acceptance System,
- impact on treatment and conditioning processes,
- financial aspects.

This roadmap outlines the action plan as developed by ONDRAF/NIRAS in close collaboration with Belgoprocess and ENGIE Electrabel, the operator of the Doel and Tihange NPP, identifying measures guaranteeing the safety of the interim storage facilities in which the affected drums are stored as well as actions focussing on understanding the phenomenon and avoiding this event in the future. This program uses a step-wise approach, incorporating the results of the on-going research and development program as these results become available.

From an operational point of view, ENGIE Electrabel halted the conditioning of evaporator concentrates and ion exchange resins on its Doel site as ONDRAF/NIRAS revoked its qualifications. ENGIE Electrabel launched the development of alternative conditioning processes for these types of waste, again in close collaboration with ONDRAF/NIRAS.

ONDRAF/NIRAS, Belgoprocess and ENGIE Electrabel inform the FANC on a regular basis on the progress of this action plan.

For short-term management of (potentially) ASR-affected waste drums from the Doel NPP, a dedicated storage facility will be constructed at the Belgoprocess site (storage building 167), designed for an operating lifetime of 75 years, in order to isolate the non-conform waste drums. The licensing process for this storage facility is ongoing. Construction is planned to start end 2020 – early 2021; the storage building should be operational in 2023.

These waste drums were initially planned to be disposed of in the surface disposal facility in Dessel.

For the long-term management of the non-conform drums, ONDRAF/NIRAS is currently studying the following options:

1. Surface disposal for those drums for which an alkali-silica reaction (ASR) can be excluded;
2. Surface disposal of ASR-affected drums with a modified design if further ASR can be excluded;

3. Surface disposal or geological disposal if the ASR-gel can be characterized and a negative impact of the ASR-gel on the main barriers can be excluded;
4. Reconditioning of the ASR-affected waste to a stable end-product for disposal.

In 2021 an integration of the information and research results obtained is foreseen. This should form the basis for a re-evaluation of potential options for the long-term management and for steering the future R&D efforts

(4) Progress on decommissioning programmes

Finalization of the decommissioning of the BELGONUCLEAIRE MOX fuel fabrication facility

BELGONUCLEAIRE has been operating a MOX-fuel manufacturing facility in Dessel from the mid-80's. All MOX production activities ended in 2006. The decommissioning license was granted by Royal Decree in February 2008.

During the period 2017-2019 the dismantling activities for the remaining infrastructures and equipment were finalized in the buildings A (production MOX pellets and fuel rods) and L (technical building). These buildings were cleared and demolished in 2019. After a radiological end characterisation of the site, demonstrating there was no residual contamination of the site, the site was unconditionally released from regulatory control, and the dismantling license was abrogated by Royal Decree in December 2019.

Progress in the decommissioning at Belgoprocess site

The dismantling of the former pilot fuel reprocessing plant EUROCHEMIC is ongoing. The demolition of the main building of the EUROCHEMIC Reprocessing plant was carried out in three phases. Since 2004 the main building has been divided in an eastern, a western and a central part. The demolition of the fully decontaminated eastern and central part started respectively in June 2008 and May 2010 and was completed within the same year. During the demolition of each part, decommissioning activities in the remaining and separated building were continued. The demolition of the last, the western part, was performed in the first 6 months of 2014. Using advanced decontamination techniques Belgoprocess realised to minimise the amount of radioactive waste to less than 5 % of the total quantity of produced materials.

In parallel decommissioning activities were started and are carried out in different installations on site. These include :

- The remaining head-end cells and several ponds in the reception building,
- Storage facilities for special nuclear materials and alpha-contaminated waste,
- Obsolete installations as part of its site remediation efforts on site 2, the former waste treatment facilities of the Belgian Nuclear Research Centre, SCK CEN.

The dismantling of the buildings 270L/M (storage facility for solid waste) and 103 (storage facility for solid alpha contaminated waste) was accomplished in the period 2015-2019.
In 2020, the decommissioning activities are still ongoing in the following buildings: 235A, 234B/C/D/H/N, 123 and 102.
Concerning the buildings 105 and 122, the construction of a new building is in preparation. This new building should allow for a remote controlled dismantling of former storage tanks of the Eurochemic plant. It should also provide a new safe access to the buildings 105/122 and hot cells, in order to facilitate the decommissioning.

In April 2020, Belgoprocess received the extension and amendment of the decommissioning license for site 2 in Mol. It concerns additional dismantling activities for the main building on site 2 (230Y, 231X and 236X) and the bacteria beds (233D and 233E). The technical preparations for the dismantling of these installations are ongoing in 2020. The dismantling of the main building will start in the course of 2020 and the dismantling of the bacterial beds will start at the earliest in 2022.

Progress in the decommissioning of FBFC international

FBFC International, affiliate of the AREVA group, operated a Low Enriched Uranium fuel manufacturing facility in Dessel from 1958, and since 1997 it also operated a large scale MOX fuel assembly facility starting from sealed MOX pins delivered by subcontractors.

A first decommissioning license was granted by Royal Decree in December 2010, based on the decision to centralize the nuclear activities from two old buildings into the newer uranium fuel manufacturing building (building n° 5) and to decommission the old buildings. This license also included the dismantling of the MOX building, in the event that these activities would be stopped in Belgium by AREVA.

In May 2012, FBFC international officially notified its decision to the FANC to stop all its activities in the FBFC facility at Dessel in the coming years. The production of uranium fuel was stopped at that time and immediately after ending the production activities, a number of technical risk-reducing measures were taken (removal of remaining fissile materials, disconnection of electricity cables, …). Due to this decision, FBFC submitted in December 2012 a decommissioning license application for the uranium fuel manufacturing building. Following review of this license application by the FANC(See section E2.3 of this report), and following consultation of the local authorities, a decommissioning license was granted by Royal Decree in October 2013.

During the period 2017-2020 most of the nuclear buildings were decontaminated, unconditionally cleared and demolished. The decontamination and demolishing of the remaining nuclear buildings and the unconditional release of the site is planned to be reached by 2021.

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, all activated metallic components have been dismantled. The last significantly activated metallic component, i.e.: the Neutron Shield Tank, has been dismantled in 2014.

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. Special attention is now given to manage walls and floors with contaminated cracks. 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 dismantling of the biological shield is now in progress.

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 the former BMB facility in Fleurus. ONDRAF/NIRAS became nuclear operator and license 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, etc.

During the period 2014-2020, ONSF performed a clean-up of the controlled areas. Rationalizing the management of radioactive waste, accumulated on the site during years and organizing the evacuation of old sealed sources were also important tasks. ONSF continued to prepare the installation of workshops dedicated to the treatment and decontamination of radioactive material.

In summary:

- Safety and security actions and procedures were resumed. A new safety culture was developed.
- Historical radioactive wastes were conditioned, characterized and transferred to Belgoprocess. 68 200-liter drums of highly contaminated strontium-90 (Sr-90) solid waste have been transferred for treatment to Belgoprocess. Several high activity cobalt-60 sealed sources and hundreds of small calibration sources have been evacuated to Belgoprocess.
- Cleaning of the strontium-90/yttrium-90 (Sr-90/Y-90) production labs started in 2016. Due to the high contamination level and dose rates, the cleaning of the Sr-90/Y-90 hot cells is the biggest challenge of the cleaning and dismantling project.
- In parallel to these operational activities, feasibility studies for the dismantling of the installations were initiated:

    - radiological characterization of the 2 cyclotrons and of the concrete vault has been performed; the level of activation of the concrete vaults was studied. Final elimination pathways of this concrete are analysed depending on its activation level;
    - the Final Decommissioning Plan and the Safety Report were prepared for application of a dismantling license to the FANC.
- The complete laboratory building (QA labs) has been cleaned and in 2020 release measurements have been performed. The building will be reused.
- Accelerator rooms, irradiation rooms and support rooms have been cleaned out with the exception of the accelerators.
- Further characterization of activated and contaminated areas has been performed. A complete physical and radiological inventory has been established. A general methodology for material removal (radioactive waste, melting, free release) has been set up and approved by the FANC. Complete isotopic vectors were determined
- Design and contracting has been finished for a new building to cut, characterize and prepare the removal of the activated concrete blocks from the irradiation/accelerator rooms.

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 license was granted in August 2019.

(5) Licensing of the surface disposal facility in Dessel

ONDRAF/NIRAS submitted to the FANC the license application for the surface waste disposal facility in Dessel in January 2013. In June 2013, FANC requested supplementary information from ONDRAF/NIRAS. During the course of 2013 and the beginning of 2014, FANC and its subsidiary Bel V conducted a detailed review. The regulatory review resulted in additional questions sent up to mid-2014 to ONDRAF/NIRAS. By the end of 2017 all questions were answered. In 2018 ONDRAF/NIRAS reworked the license application taking in to account the questions and their answers. The reworked application was formally sent to the FANC in January 2019 with a small addition in February 2019 and the reworked environmental impact assessment in July 2019. At this point the application was considered complete by the FANC and started the next step in the licensing process (see section E.2.3).

In October 2019 the Scientific Council for Ionizing Radiation (See section E2.3 of this report) gave its first advice allowing public enquiry and requested certain parts to be developed in greater detail, amongst others the QA/QC-process during construction, a description of the integrated management system, the necessary I&C and other information required before start of the construction.

In December 2019 the application was opened for public enquiry and for advice from the municipalities within a radius of 5 kilometres from Dessel and from the provincial authorities. The European Commission was asked for advice in accordance with article 37 of the Euratom-treaty.

The comments from the public, the various advises and the information requested from ONDRAF/NIRAS by the Scientific Council will be evaluated. The Scientific Council will then provide its final (second) advise. This advice, that will be followed by the license, is expected to be issued in 2022.

(6) Interfaces FANC- ONDRAF/NIRAS

The review team of the IRRS mission that was conducted in Belgium in December 2013 issued a recommendation (recommendation R7) on a clear separation of roles and responsibilities of the regulatory body FANC and the waste management agency ONDRAF/NIRAS:

"*The Government should review the current allocation of roles and responsibilities of ONDRAF/NIRAS and the regulatory body to ensure separation of roles and responsibilities of both organizations so that the regulatory body decisions are not unduly influenced by prior governmental or ONDRAF/NIRAS decisions*."

A Task Force was created by the Federal Council of Ministers in November 2016 to analyze the recommendation and to propose improvements or modifications at the legal and regulatory level. The Task Force was composed of representatives of the ministers for Economy and for Energy, supervising ministers of ONDRAF/NIRAS, representatives of the minister of Home Affairs, supervising minister of the FANC, and the general managers of the FANC and of ONDRAF/NIRAS.

In the final report of the Task Force, 4 proposals for improvement were formulated:

1. the acceptance system for radioactive waste;

2. the management of interdependencies of the successive waste management steps, and the transfer of waste to ONDRAF/NIRAS;

3. national policies for disposal and the implementation through the national programme;

4. interventions and site remediations.

The final report of the Task Group was approved by the Council of Ministers on July 20, 2017, and tasked the responsible Ministers to develop and to propose the required legal and regulatory modifications to implement these improvement proposals in the national framework. For point 1, modifications of the laws defining the tasks of the FANC and ONDRAF/NIRAS were submitted to the Federal Government and are awaiting approval. For point 3 ONDRAF/NIRAS is submitting a policy proposal for the geological disposal of high-level and/or long-lived waste to a Strategic Environmental Assessment Procedure. For point 4. the FANC and ONDRAF/NIRAS have established a common vision document with a general methodological approach for site remediations at the UMICORE Olen site and for the long term management of the resulting radium-bearing materials and waste. For point 2 actions still have to be a taken.

(7) Agreement between Belgium and Luxembourg

Since it does not have facilities for managing its own industrial and medical radioactive waste, the Grand Duchy of Luxembourg has solicited the services of Belgium for the treatment, storage and final disposal of the Luxembourgish radioactive waste.

In accordance with the requirements of the European Directive 2011/70/EURATOM, the law of 10 March 2019 gave 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.

(8) Waste acceptance system ONDRAF/NIRAS: analysis and verification by FANC

With the development of a surface disposal facility ONDRAF/NIRAS will realize the final step of radioactive management for the category A waste. This also requires that the waste acceptance system is extended by integrating the disposal acceptance criteria for the licensed operational disposal facility.

A common vision document on the impact of extending the Waste acceptance system to a surface disposal facility has been developed and agreed upon by both the FANC and ONDRAF/NIRAS. As a result, recommendations for improvement and extension of the Waste acceptance system to disposal were formulated.

Together with the lessons learnt from the identification and management of a large amount of non-conform waste from the Doel NPP (ASR-affected concrete-conditioned waste – see point (3) above), ONDRAF/NIRAS has integrated the FANC recommendations in an improvement plan.

The improvement plan consists of 7 themes regrouping 34 actions among which 19 were deemed high priority.

Several actions were taken in the fields of interfaces between NIRAS audits and FANC inspection (see point (2)), improvement of Waste Acceptance Criteria (WACs) imposed to the waste producers, financial and technical resources needed to optimize the acceptance system and disposal strategy.

The current status of the improvement plan (see figure 3 below) is that 12 of the high priority actions are completed, 5 are not fully completed and 1 is yet to start:

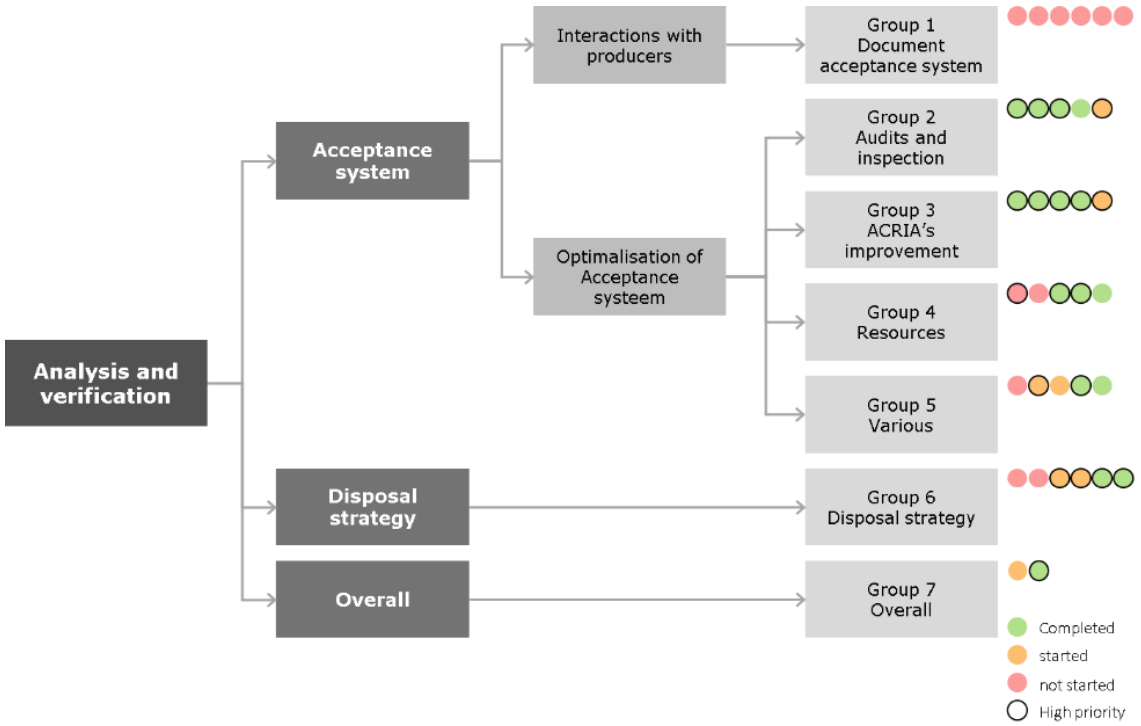

Figure 3: Improvement plan status

(9) The "European stress tests" action plans

For the NPPs and associated on-site spent fuel and waste treatment and storage facilities, the sites of Doel and Tihange have achieved several major improvements: reinforcement of structures, systems and components to face severe earthquakes, construction of protections against flooding, additional mobile means, such as mobile pumps and mobile diesels. Both sites are now adequately protected against natural hazards, such as flooding and earthquakes.

By the end of 2017, the strategy for the Complete Station Black-Out (CSBO) and for the Loss of Ultimate Heat Sink (LUHS) is well-defined on both sites and the related works were finalized.

The construction of filtered venting systems on all reactor buildings at Doel and Tihange was finalized in 2017 for most units, and in 2019 for the two remaining units (Doel 1 & 2).

The sites are now protected against external hazards and prepared against CSBO and LUHS events.

A complementary assessment, issued from the review of closed actions, concerning the revaluation of the capacity of the sewage system in Tihange in case of heavy rains is finalized and under review.

The last action, the construction and the final acceptance of a new emergency response facility (backup to current site operation centre) in Tihange has been delayed by a few months due to the COVID-19 pandemic. The final acceptance of the building is still planned in 2020. The action plans following the stress tests of waste management facilities have been approved by the FANC in July 2013. As for the NPPs, the stress test included topics such as safety functions, earthquake, flooding, extreme weather conditions, forest fire, explosive gas and shock wave, cyber-attack, loss of electrical power and loss of ultimate heat sink and severe accident management.

The table below summarizes the status (June 2020) of the action plan for Belgoprocess (centralised waste storage facility) and for the waste treatment installations at Doel site (WAB). All the actions plans are completed except for Belgoprocess, where the action on the distillation of liquid effluents will continue until the end of 2021, and where the action related to the construction of a new storage building for non-conditioned waste is still ongoing.

External Hazards: Earthquake

Seismic resistance	Belgoprocess	Evaluate resistance of several buildings against earthquakes	Done
	WAB Doel	Upgrade SSC's (structures, systems and components) from low or medium probability to resist the design basis seism to a high probability of resistance	Done
	Belgoprocess	The seismic resistance of important electrical equipment must be evaluated.	Done
		Adapt resources and procedures in order to take into account post-seismic actions (walk-down, …)	Done
Secondary effect of earthquake – Increase autonomy	Belgoprocess	Evaluate the seismic resistance of important electrical equipment	Done
		Conduct a review of the fire-risk after an earthquake, with identification of additional trouble spots and definition of any additional actions.	Done
		Limit the filling of the hot waste tanks in the 124X building to a level of 4.7 m.	Ongoing
External Hazards: Extreme weather conditions			
Heavy Rain	WAB Doel	Impact of extreme rainfall with a return period of at least 1000 years on the capacity of sewage and drainage system.	Done
	Belgoprocess	Perform a treatment/disposal of hazardous waste present on its "site 2" and eliminate the conditioned wastes from the 270M building.	Done
		Construction of a new storage building for non-conditioned waste on site 1. The concept note has been delivered to the FANC.	Ongoing
Loss of safety functions : Station Black-Out			
Operational procedures	WAB Doel	Prepare a control procedure to check the fail-safe position of WAB elements after a power failure	Done
	Belgoprocess	Drafting and testing of new global procedure "installations safe condition verification" in case of a station black-out or a loss of ultimate heat sink.	Done
Loss of safety functions : Loss of the primary and alternate UHS			
Backup heat sink	WAB Doel	Prepare a procedure for loss of primary ultimate heat sink, resulting in loss of air control, to verify the correct failsafe position of the insulation bodies.	Done
	Belgoprocess	Perform a new study on the production of heat by the vitrified wastes stored in	Done

		buildings is currently performed to justify that in case of loss of ventilation, the time available is sufficient to implement the necessary actions.	

Severe accident management

	WAB Doel	Installation of a level measurement to monitor any leakage in the WAB basement after external accidents.	Done
	Belgoprocess	Provide additional support protection means in the emergency headquarters (at least respiratory protection, iodine tablets, etc).	Done

Follow-up reports are published on the FANC web site : https://afcn.fgov.be/fr/dossiers-dinformation/centrales-nucleaires-en-belgique/stress-tests-nucleaires/rapports (in French)

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.

(1) Cooperation at international organisations level

Belgium is a contracting party 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:

At the IAEA level, the FANC with Bel V participate in the Nuclear Safety Standards Committee (NUSSC), the Waste Safety Standards Committee (WASSC), the Transport Safety Standards Committee (TRANSSC) the Radiation protection Safety Standards Committee (RASSC),– the Emergency Preparedness and Response Standards Committee (EPReSC), the Nuclear Security Guidance Committee (NSGC) and the INES advisory committee. ONDRAF/NIRAS participates in the IAEA WATEC meetings as well as in IAEA projects on disposal (GEOSAF), integrated management systems and safety culture.

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.

ONDRAF-NIRAS representatives are also members of the International Nuclear Law Association (INLA)

At the OECD level, the FANC/Bel V also participates in the steering committee of the NEA and in the activities of the following NEA committees: the radioactive waste management committee (RWMC), the Committee on Radiation Protection and Public Health (CRPPH), the Committee on Nuclear Regulatory Activities (CNRA)), the Regulators Forum (RF), The Integration Group for the Safety Case (IGSC), Information, Data and Knowledge Management (IDKM) and the Committee on the Safety of Nuclear Installations (CSNI). ONDRAF/NIRAS participates in the RWMC, , in the Integration Group for the Safety Case (IGSC) and the Forum on Stakeholder Confidence (FSC) committees, and in the activities of the Clay Club and RK&M (Preservation of Records, Knowledge and Memory).

The FANC has a national officer for the International nuclear and radiological event scale (INES), allowing the exchange of information on significant nuclear safety and radiation protection events occurring in all types of industrial facilities.

(2) 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 WENRA activities and working groups (RHWG, WGWD).

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 members of the SITEX network (Sustainable network of Independent Technical EXpertise for radioactive waste Disposal).

Finally, Bel V is member of ETSON (the European Technical Safety Organisations Network) and of EUROSAFE and has a cooperation agreement with IRSN.

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).

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

ONDRAF/NIRAS has collaboration agreements with several other radioactive waste management agencies.

B. Article 32, 1 : Section B: Policies and Practices

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."

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 national programme broadly describes the status of 31 December 2014 in terms of the management of spent fuel and radioactive waste. There has been no revision nor update of the national programme. 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;
- 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.

B.1. Waste categorisation and criteria

For the long-term management of radioactive waste, ONDRAF/NIRAS has adopted a classification consisting of three categories[1], defined in accordance with the classification proposed in 1994 by the IAEA and that recommended by the European Commission in 1999 : 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 criteria and limits for the category A waste will be defined in the safety report and licensing conditions for the planned disposal facility in Dessel.

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

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[2]. 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 tens to several hundreds of thousands of years in some cases. After the period currently considered for its storage (around 60 years of cooling required, in the event of subsequent disposal in poorly indurated clay), its thermal power still causes a significant increase in the temperature of repositories's host rock. It corresponds to high-level waste in the IAEA 2009 classification. Category C waste includes vitrified waste from the reprocessing of spent fuel from commercial nuclear power plants (and from the BR2 research reactor) and non-reprocessed spent fuel declared as waste, except for certain fuels from research reactors, which belong to category B.

B.2. Spent fuel management policy

B.2.1. Policy for the management of spent fuel from commercial nuclear power plants

At 31 December 2019, the national policy for the management of spent fuel from commercial nuclear power plants is the *safe storage of spent fuel followed by its reprocessing or disposal*.

B.2.2. Policies for the management of spent fuel from research reactors

At 31 December 2019, 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, awaiting future decisions;
- *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 spent fuels from the research reactor VENUS are not yet defined.

B.2.3. Spent fuel management practices

Until ONDRAF/NIRAS takes charge[3] 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[4] (figure 4), SYNATOM and SCK CEN respectively. The spent fuel from the NPPs produced after the suspension of the reprocessing contracts (see section B.2.1.a) is stored at the NPP sites.

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

[3] 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).

[4] 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.

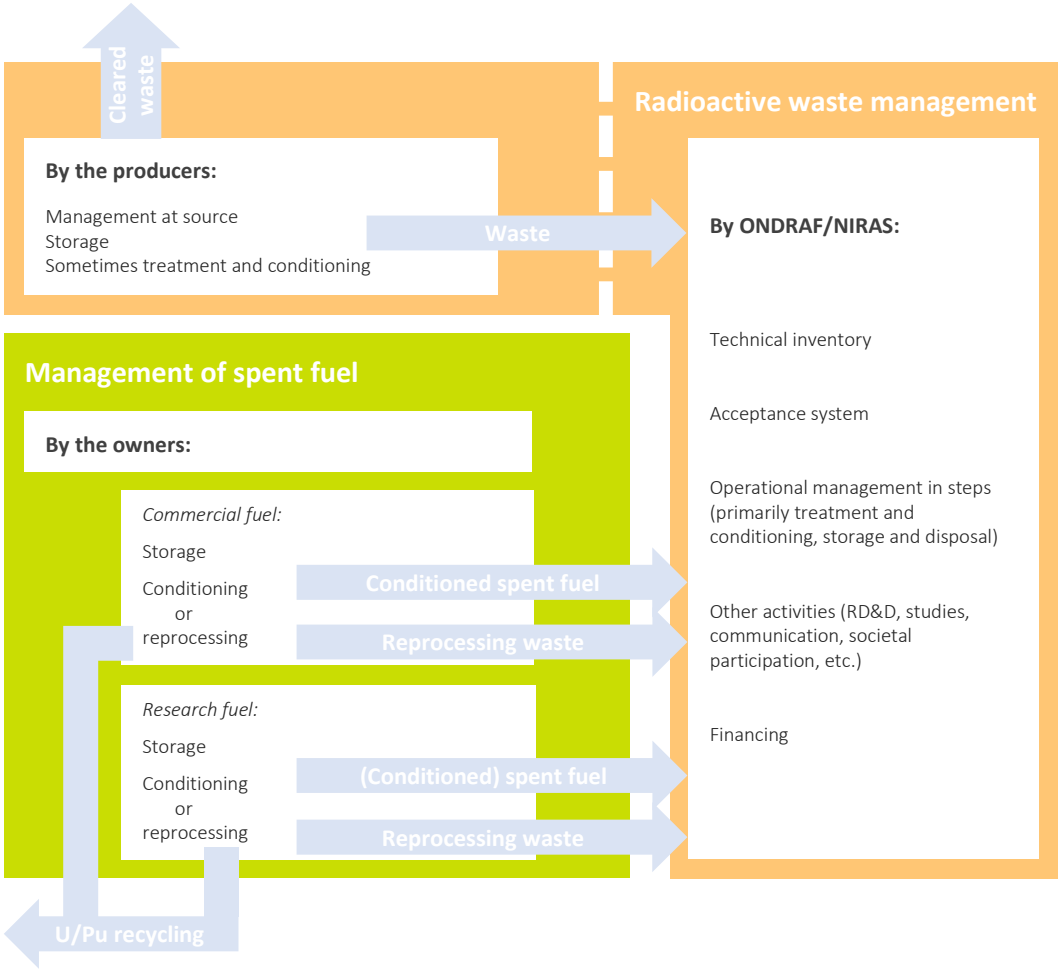

Figure 4: Organisation of the management of spent fuel and radioactive waste in Belgium

B.2.4. **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.

B.2.4.a) *Legal and regulatory framework*

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);
- transposes Directive 2011/70/Euratom into Belgian law (§ 2 and § 5 to 11) and, in particular, 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, on the basis of a proposal of the holders of the spent fuel and after consultation with ONDRAF/NIRAS and FANC.

Resolution 541/9–91/92 of the Chamber of Representatives of 22 December 1993

on the use of fuels containing plutonium and uranium in Belgian nuclear power plants and the appropriateness of reprocessing fuel rods [Chamber, 1993], which, in particular, orders that the government:

"1) in the future, no longer prioritises the reprocessing strategy compared with the conditioning and direct disposal strategy (once through cycle). The government can therefore no longer consider reprocessing as the obvious reference strategy. It must create the conditions to allow the conditioning and direct disposal strategy to be developed as an alternative;"

"4) submits, to the Chamber, within 5 years, the elements for a new global evaluation of the situation [...];"

…

"7) meanwhile, ensures that:

- the electricity producers and Synatom provide safe temporary storage for irradiated fuel;
- the electricity producers and Synatom conduct safety studies (workers and population) and feasibility studies for the industrial conditioning of irradiated fuel;
- all the costs, investments and various primary or additional charges which are related to nuclear electricity production and the nuclear fuel cycle are charged to the electricity producers. These costs cannot be imposed on third parties;"

Decision of the Council of Ministers of 24 December 1993, by which, in particular, the government fully accepts the mission entrusted to it by the Chamber of Representatives (see Resolution 541/9-91/92 above).

As a result, the competent administrations produced in 1998 an overview report comparing the two options for the back-end of the fuel cycle: direct disposal and reprocessing.

The Federal Public Service Economy made a comparative study of the management strategies for the Belgian spent fuel, which was published in January 2016.

Decision of the Council of Ministers of 4 December 1998, by which, in particular, the government asks SYNATOM

- to cancel, as soon as possible and at the latest by 23 December 1998, the reprocessing contract for 225 tonnes of fuel, agreed in 1991 with COGEMA;
- not to sign any new reprocessing contracts without its formal agreement.

The Council of Ministers considered the 1998 report to be insufficiently comprehensive and detailed to decide on the management option for the spent fuel from NPPs: reprocessing or direct disposal.

The global evaluation has not been finalised since.

(1) Past reprocessing contracts

In 1976 and 1978, four contracts for the reprocessing of 672 tHM (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.

(2) 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 general objectives:

- to bring past reprocessing contracts to completion,
- 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.2.4.b) *Inventory and facilities*

At 31 December 2019, 4360 tHM of spent fuel, including 66 tHM of MOX fuel, have been definitively unloaded from the Doel and Tihange reactors since they started operating:

- 23% of this fuel is stored in the reactor's cooling ponds;
- 62% is stored in the storage facilities built at Doel and Tihange (see appendix 2): wet storage in Tihange; dry storage in metal casks for storage and transport in Doel.
- 15% 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 in building 136 at Belgoprocess, awaiting an operational solution for its long-term management. The repatriation of the remaining reprocessing waste has been completed in 2017.

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

In 2025, when the last Belgian commercial nuclear reactor will be permanently shut down as stipulated in the Law of January 30. 2003, the total quantity of spent fuel stored at the Doel and Tihange sites will reach a maximum of 4 880 tHM .

B.2.4.c) *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 is having an encapsulation and drying process for leaking fuel rods developed.

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.2.4.d) *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 its obligation to keep confidential any information deemed sensitive by the relevant authorities.

B.2.5. Management of spent fuel from research reactors

B.2.5.a) *Legal and regulatory framework*

Article 179 of the Law of 8 August 1980 *on the budgetary proposals for 1979–1980*, which, in particular, transposes Directive 2011/70/Euratom into Belgian law (§ 2 and § 5 to 11) and, in particular, 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.

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.

B.2.5.b) *Management objectives and inventory*

The situation at 31 December 2019 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 tHM.
- The spent fuel from the *BR02 zero-power reactor* was reconditioned by CERCA, a subsidiary of AREVA, which fabricated new assemblies for the BR2 reactor.
- 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 the period 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, 1685 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 ONDRAF/NIRAS' 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 tHM, is stored in 7 dual purpose transport and storage casks (CASTOR) in ONDRAF/NIRAS' 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 fuel from the *VENUS zero-power reactor*, which is similar to the spent fuel from BR3, but with a very low burnup, was unloaded in 2008 for further use when the reactor was transformed into VENUS-F. This fuel 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 ONDRAF/NIRAS' building 155 at Belgoprocess.

B.3. Radioactive waste management policy

At 31 December 2019, 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 ONDRAF-NIRAS / 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 are establishing the national policy in terms of the long-term management of category A waste.

- On 16 January 1998, the Council of Ministers opted for *"a solution that was definitive or could become definitive, and was progressive, flexible and reversible"* for the long-term management

of category A waste, based on a report by ONDRAF/NIRAS comparing the various possible options for this management particularly from a safety, environmental and financial perspective.
- On 23 June 2006, on the basis of four preliminary disposal projects developed within the partnerships established on a voluntary basis between ONDRAF/NIRAS and the municipalities of Mol and Dessel, the Council of Ministers decided that category A waste would be disposed of on the territory of the municipality of Dessel. The preliminary technical projects, developed from proposals drafted by ONDRAF/NIRAS, were integrated into larger projects (preliminary integrated projects), comprising a significant societal aspect. In its decision, the Council of Ministers specifically requested that ONDRAF/NIRAS continue to develop the integrated surface disposal project in Dessel, maintain the existing participative process and even extend it.

B.4. 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 responsibles for Energy and the Economy. It presents an annual activity report to the Parliament.

B.4.1. Legal and regulatory framework

Article 179 of the Law of 8 August 1980 *on the budgetary proposals for 1979–1980*, which, in particular, creates ONDRAF/NIRAS (§ 2 — hereafter the "ONDRAF/NIRAS Law") and assigns it various missions (§ 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.

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.

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, 1 December 1978 and 1 December 1980*.

Resolution 541/9 – 91/92 of the Chamber of Representatives of 22 December 1993 *on the use of fuels containing plutonium and uranium in Belgian nuclear power plants and the appropriateness of reprocessing fuel rods*, which, in particular, "*orders the government: [...] 3) to prioritise research and development, including internationally, so as to be able eventually to carry out the direct disposal of irradiated fuel, without reducing the current research programme in the field of deep disposal of reprocessing waste*".

Decision of the Council of Ministers of 24 December 1993, by which, in particular, the government fully accepts the mission entrusted to it by Resolution 541/9 of the Chamber of Representatives.

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.

Letter of 10 February 1999 from the Minister for the Interior approving the general rules for the acceptance of conditioned and non-conditioned radioactive waste drafted by ONDRAF/NIRAS pursuant to the ONDRAF/NIRAS Royal Decree.

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

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.

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.

B.4.2. **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 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 through their annual or multi-annual budgets (see also article 19 - financing).

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 in general.

B.4.2.a) *Management of radioactive waste by producers in general*

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 for nuclear equipment and facilities that have been put out of service, using recycling and reuse options as well as clearance possibilities, in accordance with the applicable regulations.

This is a general practice for all decommissioning programmes. 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 seven 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.4.2.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 general regulations for radiation protection. The cleared waste does therefore not end up in ONDRAF/NIRAS' management system: it is then managed as conventional medical waste.

B.4.2.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 are the source of highly heterogeneous situations in radiological terms in the municipality of Olen: radium-bearing substances from dismantling and remediation operations in interim storage facilities licensed by FANC or the Ministry of Health, before FANC was created, but 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 until 15 December 2015 and licensed again on 4 December 2015 until 31 December 2025, contains approximately 30 000 m^3 very low-level and low-level, long-lived non-conditioned radioactive substances.
- The *storage facility licensed on 19 February 2016* by FANC until 31 December 2025 has a capacity of 11 000 m^3. An extension for an additional capacity of 6200 m^3 has been licensed by the FANC on March 20th, 2019. It is intended for long-lived, very low-level and low-level non-conditioned radioactively contaminated soils and substances from works on the Umicore site. It already contains more than 9 000 m^3 of these soils and substances.

FANC and ONDRAF/NIRAS have issued in 2020 a common vision document with a general methodology for the management of the various radium-bearing substances at the UMICORE Olen site. In the course of 2020 and 2021 UMICORE will make a feasibility study to implement this general methodology (see K.2.(4) for details).

The issue of the long-term management of the radioactive waste contained in Umicore's licensed storage facilities, in other words the issue of their final destination, will be the subject of future national policy decisions as required by the EURATOM/2011/70 directive.

B.4.3. 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 an integrated 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 most of the 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.4.3.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 inventory has a section referring to quantities, a radiological section and a physico-chemical section. It is based on the knowledge of waste stored in ONDRAF/NIRAS' buildings operated by 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.4.3.b) *Operational management in steps*

(1) 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, supercompaction 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.

(2) 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.

(3) Long-term management

The Belgian legal and regulatory framework defines the country's 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 repository by passive means. The European and international legal and regulatory framework also stipulates that radioactive waste must, unless otherwise specified, be disposed of in the Member State in which it was generated. As a consequence, ONDRAF/NIRAS' works on developing and implementing disposal solutions for category A, B and C waste aim to develop solutions to be implemented on Belgian territory. These works consider in a balanced way the four aspects of a sustainable solution, namely the technical and scientific, environmental and safety, financial and economic, as well as societal and ethical aspects.

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 and its site will be able to ensure protection of people and the environment without requiring human intervention. Surveillance and monitoring of the facility for a period of more than 100 years is foreseen as part of the strategy for long-term safety.

Figure 5: 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 fitted with a central inspection gallery at their base and there is an inspection space 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 operational phase. This roof is designed to be replaced, when the repository is fully closed, by a permanent, low permeability cover comprised of various natural and artificial protection layers forming a tumulus.
- 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 – 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 400L standard drums) in concrete caissons and filling them with mortar to form a monolith;
- A DT/NDT (destructive test / non-destructive test) facility to demonstrate waste conformity with the disposal criteria.

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

- a communication centre which, specifically, will become a hub for information about radioactive waste management and which will have multi-purpose premises that can be made 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.

In February 2019 , the detailed studies for the integrated surface disposal project in Dessel, conducted in close consultation with the local populations concerned through the STORA (formerly STOLA-Dessel) partnership in Dessel and the MONA partnership in Mol, resulted in ONDRAF/NIRAS submitting an updated nuclear construction and operation licence application for the repository to FANC (see also section K).

The ongoing 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) ;
- 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 partnerships methodology, underway since 1998:

- co-development of preliminary integrated disposal projects with ONDRAF/NIRAS;
- close consultation with ONDRAF/NIRAS for the development of the integrated project to be implemented.

Transparency is ensured through:

- ONDRAF/NIRAS' dedicated website, ONDRAF/NIRAS' electronic newsletter, websites of the STORA and MONA partnerships, cAt project leaflets, information evenings, 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 June 3, 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. On the basis of the outcomes of the procedure ONDRAF/NIRAS has submitted its adapted policy proposal to the Federal Government in September 2020.

C. Article 3: Section C: 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.

1. 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.

2. 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 will have to take charge of other NORM declared as radioactive waste: NORM from the dismantling of certain facilities where NORM were involved and, possibly, NORM from the remediation of NORM-contaminated sites. This NORM, declared as radioactive waste, falls within the scope of the convention. At present, this represents only a tiny fraction of the existing and still to be produced NORM waste in Belgium. ONDRAF/NIRAS and FANC are currently joining efforts to develop a methodology for deciding if and when NORM waste originating from remediation activities must be managed as radioactive waste as opposed to being managed as conventional hazardous waste.

3. 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.

D. Article 32, 2.: Section D: Inventories and Lists

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. Spent fuel: management facilities and existing inventory

D.1.1. 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 plants sites: in cooling ponds, and in the dedicated dry storage facility in Doel or the dedicated wet storage facility in Tihange..

The spent fuel storage facilities are described in appendix 2, which also provides an overview of their current spent fuel inventory.

D.1.2. 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 further use.

See also appendix 4 for more information.

D.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, 20x 30-litre drums containing dismantled ionization smoke detectors and 12x 30-litre 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 July 2020), transfer to Belgoprocess is ongoing:
  - 9x 30-litre drums containing dismantled Am-241 smoke detectors
  - 3x 220-litre drums containing dismantled Am-241 smoke detectors

- 30x 30-litre drums containing non-dismantled Ra-226 smoke detectors
- 22x 30-litre drums containing dismantled sealed sources
- 4x 220-litre drums containing dismantled sealed sources
- 1x 9TBq Cs-137 source
- 13x 30L-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 disposal facilities for radioactive waste on Belgian territory yet.

D.2.1. **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 (table 2) and dedicated storage buildings (table 3 and appendix 3). 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).

A detailed description of storage buildings at the Belgoprocess site is given in Appendix 3.

Table 1: 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 supercompaction 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 supercompaction 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 2: Main characteristics of the storage buildings for conditioned waste at Belgoprocess (all on site 1, except the buffer facility) in terms of capacity and the waste they contain as of December 31, 2019

Buildings	Commissioned	Type of conditioned waste	Waste categories	Capacity (m³)	Filling rate (%)	Volume (m³)	Activity (Bq)	
							Alpha	Beta-gamma
127	1976	Bituminised and cemented intermediate-level waste (mainly category B waste, 220 and 400 litre packages) mostly (76%) from the Eurochemic reprocessing plant	A + mainly B	4700	84	3903	$3,4\ 10^{14}$	$4,6\ 10^{16}$
129	1985	Conditioned high-level waste (60 and 150 litre packages) from the vitrification, in PAMELA, of the 860 m³ 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 commercial spent fuel by COGEMA/AREVA	B	600	26	154 (compacted)	$2.1\ 10^{14}$	$4,3\ 10^{16}$
150	1986	Low-level waste (400, 500, 1000, 1200, 1500, 1600, and 2200 litre packages) (mainly category A) from the Doel and Tihange nuclear power plants (filters, concentrates, resins …) and the former SCK CEN Waste department	A + B	1900	100	1922	$1,9\ 10^{12}$	$2,2\ 10^{14}$
151	1988	Same types of waste and origins as in building 150	A + B	14700	100	14658	$2.5\ 10^{13}$	$1,1\ 10^{15}$
155	2006	Alpha- and radium-contaminated waste and conditioned Thétis spent fuel	B + Ra	4221	81	3400	$2.0\ 10^{15}$	$1,8\ 10^{16}$
156	2002	Spent fuel from the BR3 reactor	C	8 castors	88	n.a.	$2,0\ 10^{15}$	$1,0\ 10^{17}$
270 (buffer facility)		Packages that have to 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 + Ra	Temporary buffer		198	$8.0\ 10^{10}$	$5.5\ 10^{10}$

D.2.2. **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 plants sites until ONDRAF/NIRAS takes charge of it on request of ENGIE Electrabel, and transfers the waste to dedicated buildings (151 or 127) on Belgoprocess' site 1 (see appendix 3). On 31 December 2019, the conditioned waste inventory on the sites of Doel and Tihange totalled 464 m^3.

The Tihange and Doel nuclear power plants have their own processing installations and conditioning processes qualified by ONDRAF/NIRAS. The types of waste conditioned on site are waste such as filters from the primary circuit and other diverse waste with a dose rate higher than 2 mSv/h.

ONDRAF/NIRAS qualification for certain treatment and conditioning installations was withdrawn in 2015:

- At Doel, the ONDRAF/NIRAS qualification for the processing and conditioning for ion exchange resins and evaporator concentrate wastes was withdrawn following the detection of alkali-silica reactions in a number of waste barrels. The conditioning process for filters from the primary circuit and divers waste > 2mSv/h is still qualified as the alkali-silica reaction is not an issue for this conditioning process.
- At Tihange, the qualification for the processing and conditioning of evaporator concentrates and filters from the primary circuit and divers waste > 2mSv/h was not renewed by NIRAS/ONDRAF due to the risk of alkali-silica-reactions. The qualifications of those waste streams were regained after the modification of the conditioning processes. The newly developed resin conditioning process using thermo-compaction was finally rejected by NIRAS/ONDRAF due to risk of swelling of the thermo-compacted waste in the event of water infiltration.
  In order to solve the remaining issues, new conditioning processes are being developed and new qualification files will be submitted by ENGIE Electrabel for approval to ONDRAF/NIRAS. Pending the decision of ONDRAF/NIRAS, ENGIE Electrabel is not permitted to treat and condition the concerned types of waste on site. Consequently, unconditioned waste is currently stored at the NPP site.
  As of April 2020, Tihange lost its qualification for conditioning concentrate waste based on cementation. Fractures were discovered in the cemented matrix in 2018. Analysis and cause of these fractures is ongoing and future acceptance by ONDRAF/NIRAS will depend on the outcome. The findings will also serve as input for the new process being developed at Doel.

D.2.3. **The Umicore site in Olen : current situation**

The three licensed storage facilities managed by Umicore in Olen contain, together, almost 95 000 m^3 radioactive radium-bearing substances.

- The *UMTRAP storage facility*, built in the 1980s 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 (table 4). 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.

Description	Mass [tonnes]	Radium-226 activity [Bq]	Radium 226 [g]
Radium sources	n.a.	$7{,}26 \cdot 10^{12}$	195,4
Tailings	2 012	$2{,}56 \cdot 10^{13}$	691,8
Radium-rich substances	529	$2{,}17 \cdot 10^{12}$	58,7
Radium-poor substances	7 739	$1{,}16 \cdot 10^{12}$	31,4
Various residues	5 656	$8{,}07 \cdot 10^{11}$	21,8
Contaminated soils	58 500	$8{,}88 \cdot 10^{11}$	24,0
Total	**74 436**	$\mathbf{3{,}79 \cdot 10^{13}}$	**1 023,1**

Table 4: Inventory of the radioactive radium-bearing substances in the UMTRAP facility

- The *Bankloop storage facility* contains approximately 30 000 m^3 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 "2016" *storage facility* 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 m^3 of such soils and substances.

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 initiated in 2020. It was accepted by UMICORE and in the autumn 2020 it will be presented to the authorities of the Flemish Region for the chemical contamination.

D.2.4. **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 (see section A.1), is as follows (volumes of conditioned waste for disposal, not including the disposal container external volume):

- category A waste: 54900 m^3. This volume is comprised of both conditioned waste packages and monoliths of future bulk waste (internal volume) and should consequently not be compared to the volume of the stored conditioned waste packages;
- category B waste: 11000 m^3 (according 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: 2600 m^3 (according the currently foreseen management of commercial spent fuel).

D.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;
- the FBFC International UO_2 fuel fabrication plant;
- SCK CEN's BR3 research reactor and its building;
- 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 current status of these main decommissioning programmes is given in section A.2 (4).

E. 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 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 actors 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

Since the last review meeting of the Joint Convention the legislative and regulatory framework has undergone modifications (see section A.2.1 for further details).

In accordance with the constitution, for the implementation of the amendments, Royal Decrees have been issued or are in preparation.

E.2.1. Applicable national requirements for safety and radiation protection

Law of 15 April 1994 on the protection of the population and the environment against the dangers arising from ionising radiation and on the Federal Agency for Nuclear Control (hereafter the "FANC Law"), 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.

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 is currently being to be brought in line with the new European radiation protection directive (Basic Safety Standards - Directive 2013/59/Euratom).

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

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 on the safety requirements for waste and spent fuel storage facilities has been added on May 29th, 2018.

Royal Decree of 1st 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/

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).

ONDRAF/NIRAS was created by the law of 8th 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 Law of 8 August 1980 (article 179) on the budgetary proposals for 1979-1980, as amended in particular by the laws of 29 December 2010 and 3 June 2014, which, in particular,

- creates ONDRAF/NIRAS (§ 2 — hereafter the "ONDRAF/NIRAS Law");
- assigns it various missions (in particular, the inventory and management of radioactive waste, including non-reprocessed spent fuel declared as waste, and missions relating to decommissioning) (§ 2);
- recognises the need for societal integration of a disposal facility at the local level and allows ONDRAF/NIRAS to create a mid-term Fund for covering the societal costs of integration;
- stipulates that national policies for the management of radioactive waste and spent fuel are to be established and maintained by Royal Decree, debated in the Council of Ministers, on ONDRAF/NIRAS' proposal and after FANC's opinion.

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.

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

Royal Decree of 18 November 2002 governing the qualification by ONDRAF/NIRAS of facilities for the storage, treatment and conditioning of radioactive waste and also concerns the facilities and equipment (including methodologies) for radiological characterisation of radioactive waste.

Law of 11 April 2003 regarding liabilities for the dismantling of nuclear power plants and the management of the spent fuel from these nuclear power plants.

Decision of the Council of Ministers of 23 June 2006, in particular, 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.

E.2.3. System of licensing of spent fuel and radioactive waste management activities

The figure 6 below shows the licensing process for the Class I nuclear installations. This licensing process has been updated for the last time on May 29th 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.*

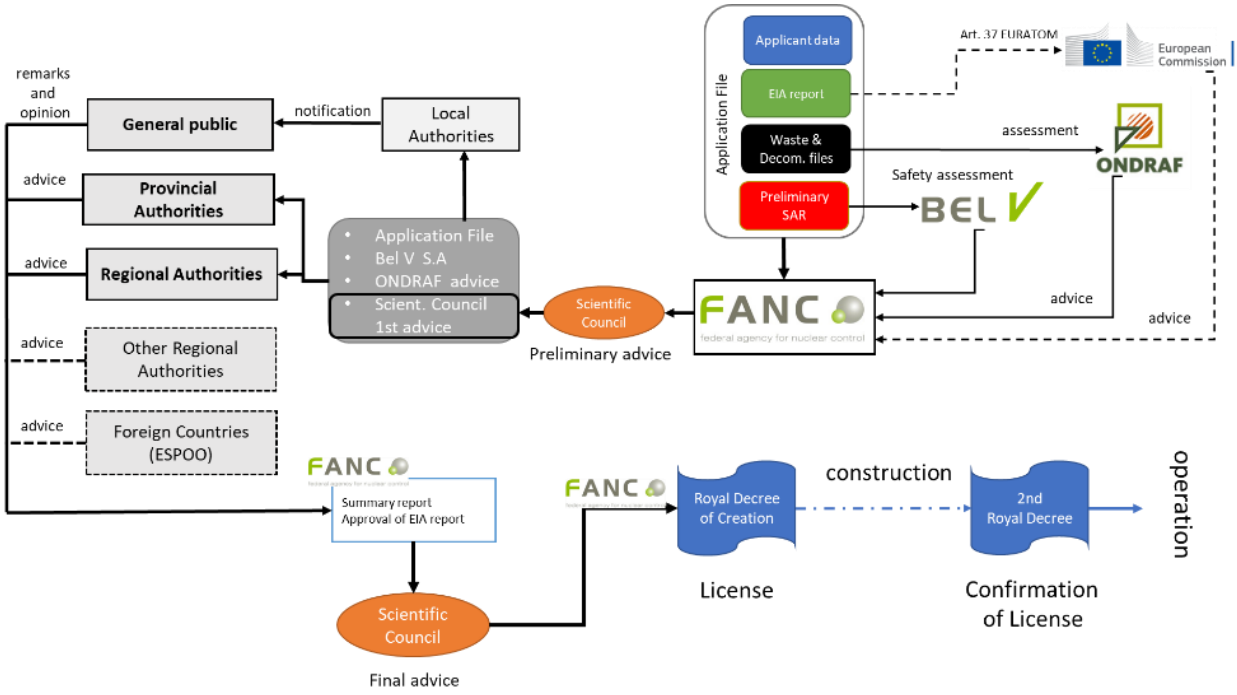

Figure 6: Licensing system for Class I facilities (2020)

Nuclear facilities are licensed according to article 6 of GRR-2001. The license application contains several parts:

- The first part consists mainly of administrative information, defining amongst 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 relation with the SRNI-2011 and GRR-2001 requirements;

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 license 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 (of the municipalities within a radius of 5 km of the projected facility)
- Provincial authorities (of the 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 advices and remarks and opinions of the public and the advices 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 license, 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 license allow the applicant to build the installations in conformity with the license.

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 installations. This acceptance has to verify that the constructed installation is fully compliant with:

- the regulations (GRR-2001 and SRNI-2011)
- the license 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 highest 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:

(1) 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 site and comprises the sites BP1 and BP2, respectively in Dessel and Mol.

(2) Facilities for disposal of radioactive waste

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

A proposal for a specific licensing procedure for repositories has been developed by the FANC. This licensing procedure is similar to other Class I facilities, but takes into account the specificities of repositories: modular "construction", phased approach, closure, long term regulatory surveillance and monitoring, no dismantling. When the National Policy on high level and long-lived radioactive waste will be adopted by the government, this proposal of Royal Decree will be resubmitted to the government (see section A.2.1).

(3) 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 irradiated fissile materials 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, ex-Eurochemic).

(4) 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 license, are considered as potential producers of radioactive waste.

The license application also 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 copy of every issued license. 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. The intention is to prevent that these devices contaminate non-radioactive waste streams.

E.2.4. **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 the 18th 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.

Each Belgian facility in which radioactive waste of Belgian origin is processed, conditioned or stored, falls within the scope of this Royal Decree of 18th 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 [5]]

[5] 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]

As such, 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 18th November 2002 will be respected.

Finally, Article 6 of Royal Decree of 18th November 2002 specifies that "the Minister supervising ONDRAF/NIRAS may require that certain equipment used for conditioning radioactive waste must offer the technical possibility of sampling the final product in active operation, in view of its qualification (…)" [translated [6]].

For conditioned waste packages, the qualification procedure consists of three items:

1. the qualification of the radioactive waste processing and conditioning process, including the Operator's temporary storage facility for Conditioned Waste Packages (CWP);
2. the qualification of the radiological characterization methodology for CWP's, including the qualification of the measuring equipment.
3. the qualification of the interim storage facility for CWP's

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 five years.

[6] Article 6 : " *Le Ministre chargé du contrôle de l'Organisme peut exiger que certains équipements de conditionnement de déchets radioactifs possèdent la possibilité technique d'échantillonnage du produit final en exploitation active, en vue de leur agrément (…)* " [original French text taken from the Royal Decree]

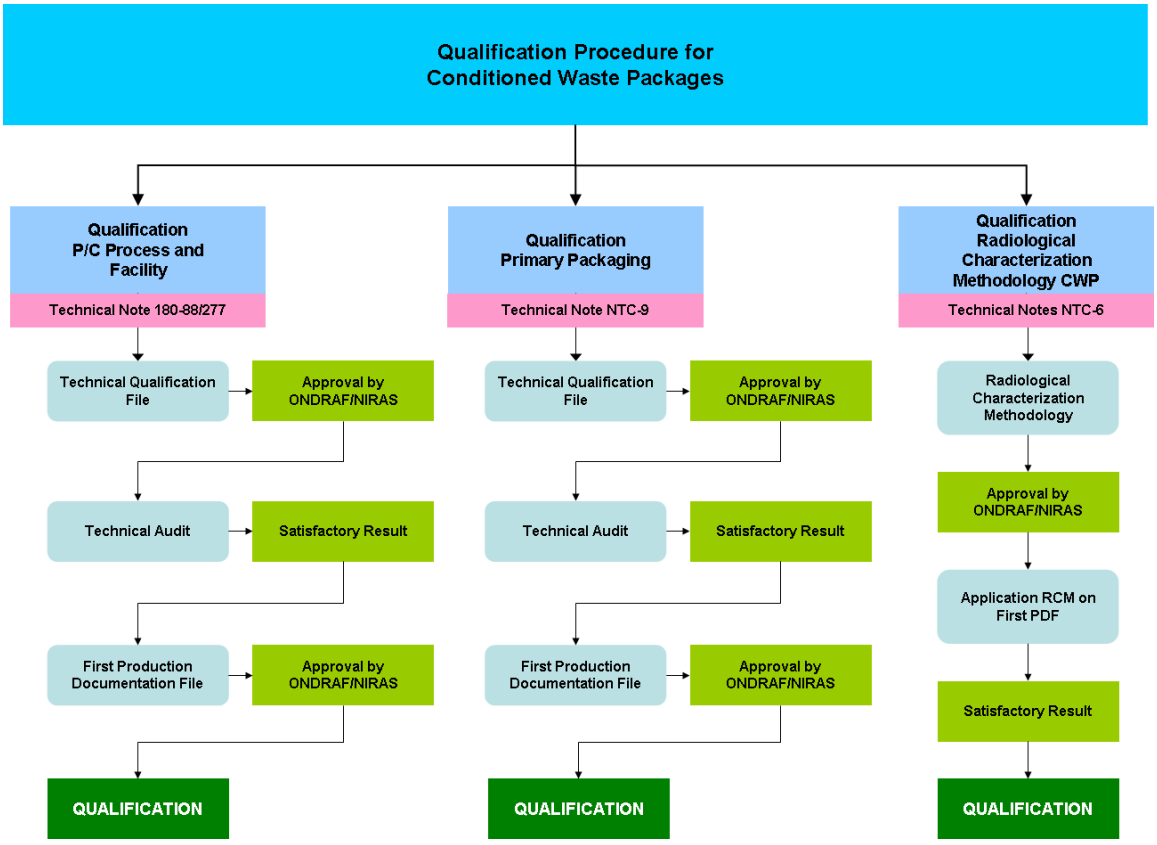

Figure 7: outline of the qualification procedure for conditioned waste

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 three components of the Qualification Procedure (Radioactive Waste Processing and Conditioning Process, Primary Package and Radiological Characterization Methodology) 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 three 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 Step 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 18th 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 storage facilities, aiming only at purpose build storage facilities in which conditioned waste packages are stored for long periods of time.

E.2.5. 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 license (FANC-law, art. 16; GRR-2001, art 5.1). The operator has to take the necessary measures to fulfil the conditions of the license (GRR-2001, art 5.2).

ONDRAF can withdraw a qualification in case of non-compliance or non-conformities.

E.2.6. System of appropriate institutional control, regulatory inspection and documentation and reporting

FANC inspects nuclear facilities, controls compliance with the licence provisions and, more generally, compliance with the provisions of the legal and regulatory framework for radiation protection, nuclear safety and nuclear security. If necessary, licences can be suspended or withdrawn by the authorities that have issued them.

During the operational period of a facility, a supervision scheme with 3 levels 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.

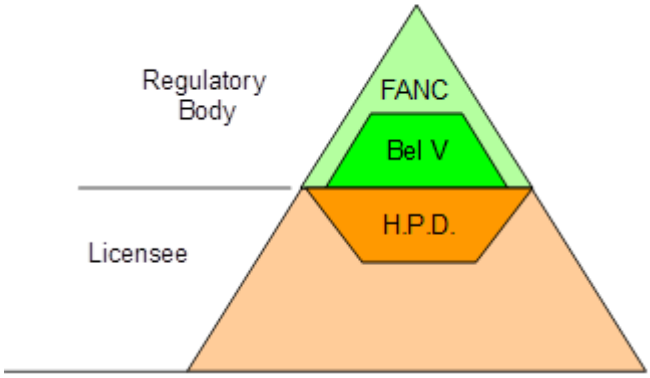

Figure 8: 3-level control structure

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.

E.2.7. 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 FANC-law;
- the GRR-2001;
- the Royal Decrees of December 20, 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, requests for corrective actions with a delay not exceeding 6 months (article 9 of the Law of 15 April 1994).

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 security 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 license with the aim of improving safety.

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

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 actors 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 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.

The organisational structure of ONDRAF/NIRAS can be found on https://www.ondraf.be/structure-interne and is given is the figure below:

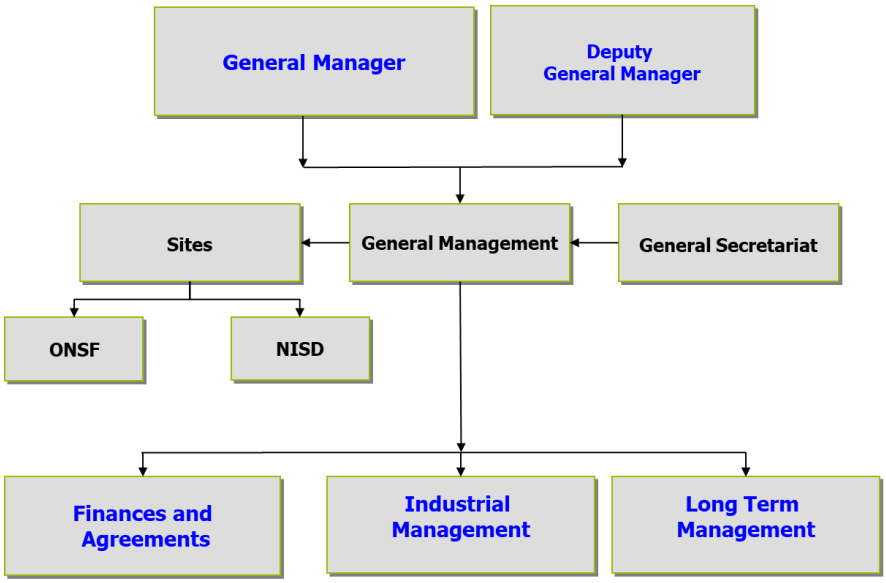

Figure 9: ONDRAF/NIRAS Organizational structure

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 particularly resulting from the presence of radioactive substances 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 licenses. 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 the aspects of radioactive waste management. 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.

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 licenses 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 http://www.ondraf.be

In 2012, ONDRAF/NIRAS became nuclear operator of the portion of the Best Medical Belgium installations that were not taken over by the South-African company NTP Radioisotopes SOC Ltd after the bankruptcy of BMB, located on the IRE Fleurus site, and now called "ONSF" (ONDRAF/NIRAS Site Fleurus). ONDRAF/NIRAS became responsible for all remediation and decommissioning activities on that portion of the installations of this former radioelement production site. The relations with the FANC for these activities are the same as for all other nuclear operators.

Figure 10 gives a schematic view of the relationships between ONDRAF/NIRAS and the FANC.

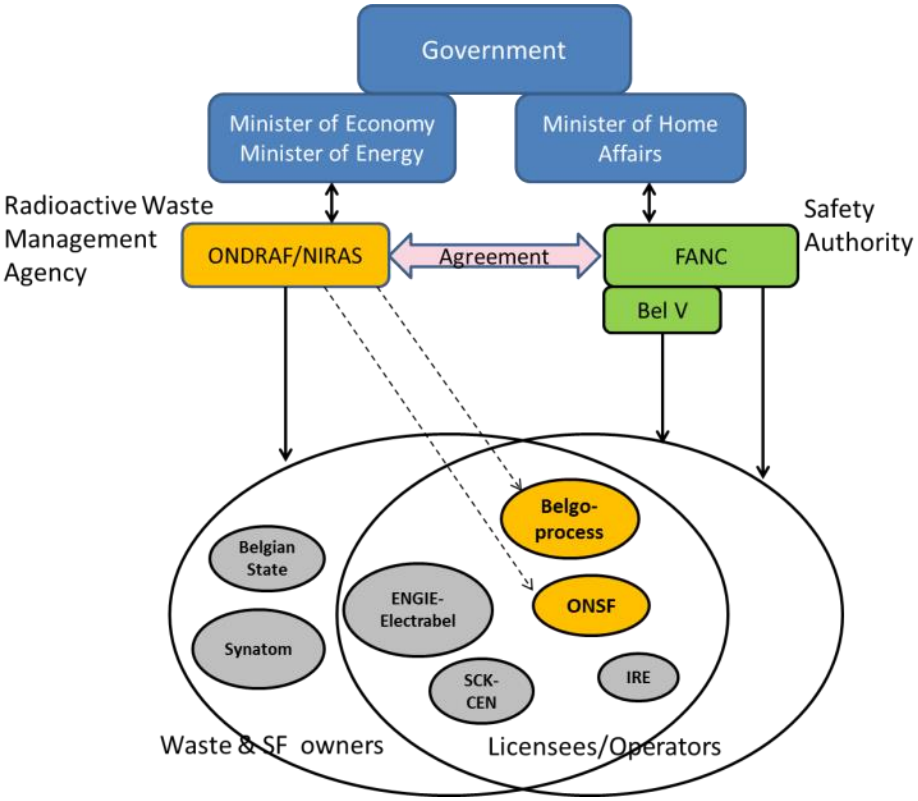

Figure 10: Organisational Structure of the Relationships between the radioactive waste management Agency, the operators and the owners of radioactive waste and the Safety Authority

E.4. Article 20: Regulatory Body

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 1 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, a.o. on site routine inspections – albeit without associated enforcement powers – and independent safety assessments. Only Class I facilities (including NPPs and Research Reactors) and some higher risk Class II installations – the so-called Class IIA – are inspected by Bel V.

It is through the association of the FANC on one side, and BeI 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 licenses, recognitions or approvals. It organises inspections to verify the compliance with the conditions stipulated in these licenses 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 Agency 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 Agency 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 a 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 can be drawn as follows (as from 1 March 2019)

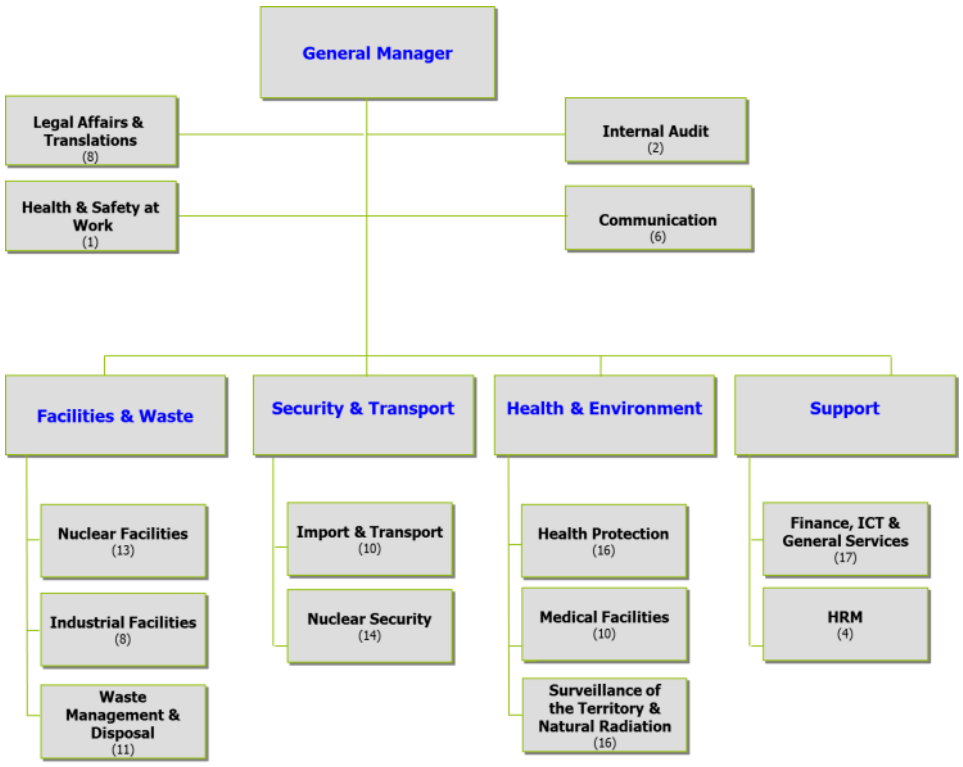

Figure 11: Organisational chart (with staffing) of the FANC

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 inventory, 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 regulation and guidance

The department `Security & Transport' is responsible for the physical protection of nuclear 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 control 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 and veterinary 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 is composed of about 155 persons. This figure is stable for around 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. 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 March 1st, 2019.

A 6-year integrated inspection strategy is developed jointly by the FANC and Bel V. An annual programme for inspections is derived from this strategy and is communicated yearly to the licensees. A revision of this strategy is possible each year, in order to take into account experience feedback from the previous years.

The annual inspection and safety assessment programme of Bel V is approved by the FANC.

Bel V's inspections reports are written following each inspection and are also sent to the FANC. Bel V discuss its findings with the FANC on a regular basis. In particular, 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 according to the Law of 15 April 1994 and to article 38 of GRR-2001.

Bel V is a non-profit organisation. It is funded 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 70 full-time equivalent university graduates (engineers and scientists), and recruitment is in line with the foreseeable workload.

Bel V inspectors that 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 being recognised as expert. Bel V's personnel training budget amounts to about 10 % of its overall budget in man-hours.

The organization chart of Bel V is given below:

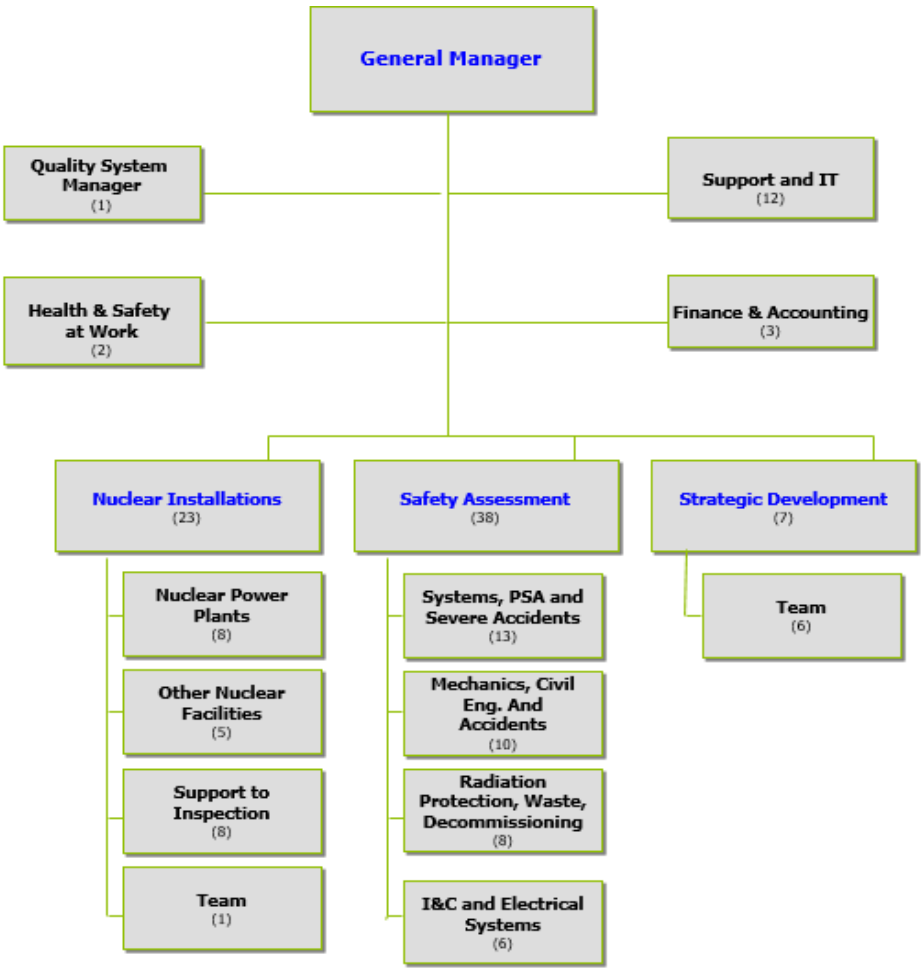

Figure 12: Organisational chart (with staffing) of Bel V

E.4.3. **Independence of the Regulatory Body**

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, being 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.

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

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 forf 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).

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.

Strictly speaking, 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* [Belgian Official Journal, 1999b].
- **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 itself 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.

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 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 journal ("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);
  - the general public is 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;
- 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;
- 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 licenses 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. Several reports, information files about the radiation risk of different facilities and activities or about particular subjects are available. Flash news are also regularly published on the web site.

Public enquiries related to license 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 http://telerad.fgov.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 : http://afcn.fgov.be/fr/chercher?keyword=rejets&=Appliquer (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.

F. 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 license 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 license requires conformity with the Safety Analysis Report. Moreover, the operator must commit himself in the license 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***

Art. 4 of the Royal Decree of 30 November 2011 (SRNI-2011) states that the organisational structure of the licensee has to be documented and that management of nuclear safety 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. 6 of the same Royal Decree sets out the requirements with respect to training and formal qualification of the personnel.

Art 73 and 23 of GRR-2001 sets out training and qualification requirements for "Heath Physics Experts" and organization and tasks of the health physics department which oversee radiation protection and nuclear safety within facilities.

Article 8 of Directive 2011/70/Euratom on the expertise and skills of the personnel of the parties concerned by the management of spent fuel and radioactive waste was transposed into Belgian law by Article 5 of the Law of 3 June 2014. This last article will be applicable once its implementing rules have been established by Royal Decree. The acquisition, maintenance and development of the necessary expertise and skills are nevertheless concerns that have already been taken into account, as illustrated by the following examples:

- the organisation, by the Belgian Nuclear Higher Education Network (BNEN), a consortium of six Belgian universities and SCK CEN, of a post-graduate qualification in nuclear engineering,
- the organisation, by SCK CEN, of a SCK CEN Academy, which organises courses in all SCK CEN's RD&D fields, especially radioactive waste management;
- the preservation of the nuclear knowledge in the Mol–Dessel region as a condition set by the local communities for constructing the surface repository for category A waste on the territory of the municipality of Dessel;
- the continuity of RD&D in terms of management, in particular the long-term management, of radioactive waste since the mid-1960s, i.e. before the first commercial nuclear reactors were commissioned, with a strong focus on the disposal programmes for the Belgian nuclear waste;
- the creation in 1995, by ONDRAF/NIRAS and SCK CEN, of the EIG PRACLAY, which became the EIG EURIDICE (European Underground Research Infrastructure for Disposal of Nuclear Waste in Clay Environment), primarily to manage the HADES underground research laboratory, recognised by the IAEA as a centre of excellence for disposal technologies and training of scientists.;

F.2.1.b) *ONDRAF/NIRAS – Belgoprocess*

As of May 31, 2020, ONDRAF/NIRAS had 144 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 300 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 – 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 nuclear plants is equivalent to about 40% of the electricity consumed in Belgium.

Among ENGIE Electrabel's total Belgian workforce of around 4300 employees, about 2200 people, among which 300 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.

(1) Organisation

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

a) Corporate level
b) Nuclear Power Plant level
c) Health Physics Department

a) The **corporate level** includes the following organisations:

- **The Technical Directorate:** The Technical Directorate is in charge of the following activities:
  - Manages the evaluations, design, studies, modifications and projects of the nuclear fleet. Ensures the management of the portfolio of nuclear and non-nuclear projects, consistent with the strategy and with respect for general planning.
  - Ensures the development and implementation of Design Authority & Configuration Management.
  - Ensures the activities related to the management of the reactor cores, as well as the development and implementation of governance in the field of nuclear fuel management at the site.
  - Ensures the development and implementation of the management system, the evaluation and its continuous improvement.
- **The Directorate Decommissioning:** The Directorate Decommissioning is in charge of
  - Preparation of the decommissioning of the units, including the application for final shutdown of nuclear activities, drawing up the declassification plan and the application file for the decommissioning permit.
  - Management of nuclear liabilities (for waste and decommissioning) and for contracts and communication with ONDRAF/NIRAS.
- **The Human Resources Department:** The activities of the Human Resources department are mostly focused on recruitment, career development and succession planning, and the competency development, training and knowledge management of the personnel of ENGIE Electrabel.

b) 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 section **Continuous improvement** is in charge of Human Factors and operational Experience activities.
- The section **"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 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.

c) 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 departement 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.

(2) 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 license is required. This license 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.

A 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, there are training and retraining programmes which are adapted according 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 work 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.

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**

F.2.2.a) ***NPP's***

(1) Belgian legal context

Since 1985, the Belgian utilities have set up a funding system for the dismantling and decontamination of the Doel and Tihange nuclear power stations (including the installations for waste and spent fuel management).

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. 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.

(2) 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 a.o. 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 2019.

The law of 11 April 2003 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 advices of ONDRAF/NIRAS and FANC for matters related to safety, security and safeguards. This advice is binding for SYNATOM.

(3) 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

(1) 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 periodically reassessed and total amounts have to 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.

(2) Financing 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 1 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 1 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, ONDRAF/NIRAS makes recommendations to the supervising Ministers on organising coverage for these management costs.

(1) 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.

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.

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.

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.

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.

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.

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, in particular,

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

(2) 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, namely, ENGIE Electrabel, FBFC International, IRE and SCK CEN , including SYNATOM as waste owner on the one hand and the Federal State as the financially liable entity for nuclear liabilities on the other hand, finance the treatment and conditioning of their waste in accordance with the provisions of the agreements between them and ONDRAF/NIRAS. Since 1996, these agreements have been based on a capacity reservation system that stipulates that each "main" producer guarantees the payment to ONDRAF/NIRAS of an agreed fraction of the fixed costs for the treatment and conditioning facilities and the payment of the variable operating costs for the management of its waste as it is accepted by ONDRAF/NIRAS. In practice, the "main" producers pay their share of the fixed costs according to a contractual schedule and pay the tariff amounts corresponding to the variable portion of the costs for the treatment and conditioning of their non-conditioned waste as ONDRAF/NIRAS takes charge of it. Pursuant to the provisions in the agreements, these tariffs can be revised every five years.
- 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 form 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.

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 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.

(3) 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.

(4) 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.

(5) 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 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 its management costs 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 last nuclear liability report covering the period 2013-2017 was published in March 2018.

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

Table 5 below gives a summary, drawn up from the fourth 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.

Sites (or groups of waste)	Financially liable entities (main)	Main financing mechanisms
Electrabel (Doel and Tihange)	Operational waste: Electrabel	Annual budget
	Spent fuel and dismantling: Synatom	"External" accounting provisions with additional measures
FBFC International (Dessel)	FBFC International	Accounting provisions with additional measures
SCK CEN (Mol)	New technical liabilities: SCK CEN	Accounting provisions with additional measures
	Technical liabilities: Federal State	External fund, without separate legal personality, 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
	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	Internal funds with additional measures
	Liabilities: Federal State	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

Table 5: Summary table of financial responsibilities for management costs

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 June 3, 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 is implementing 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 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.

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

- 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, 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 implementation of several activities and training sessions with the main goal to improve and optimize the safety culture.
- To implement a system of internal control at different levels: self-assessments of the processes, assessments in the context of audits, external audit and management reviews.
- Digital monitoring of incidents related to safety, environment, quality, health … and related measures.
- To develop a policy and management cycle to ensure the follow-op of different strategic activities.

Belgoprocess has implemented for its activities in a quality management system which complies with the ISO 9001 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 (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 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.

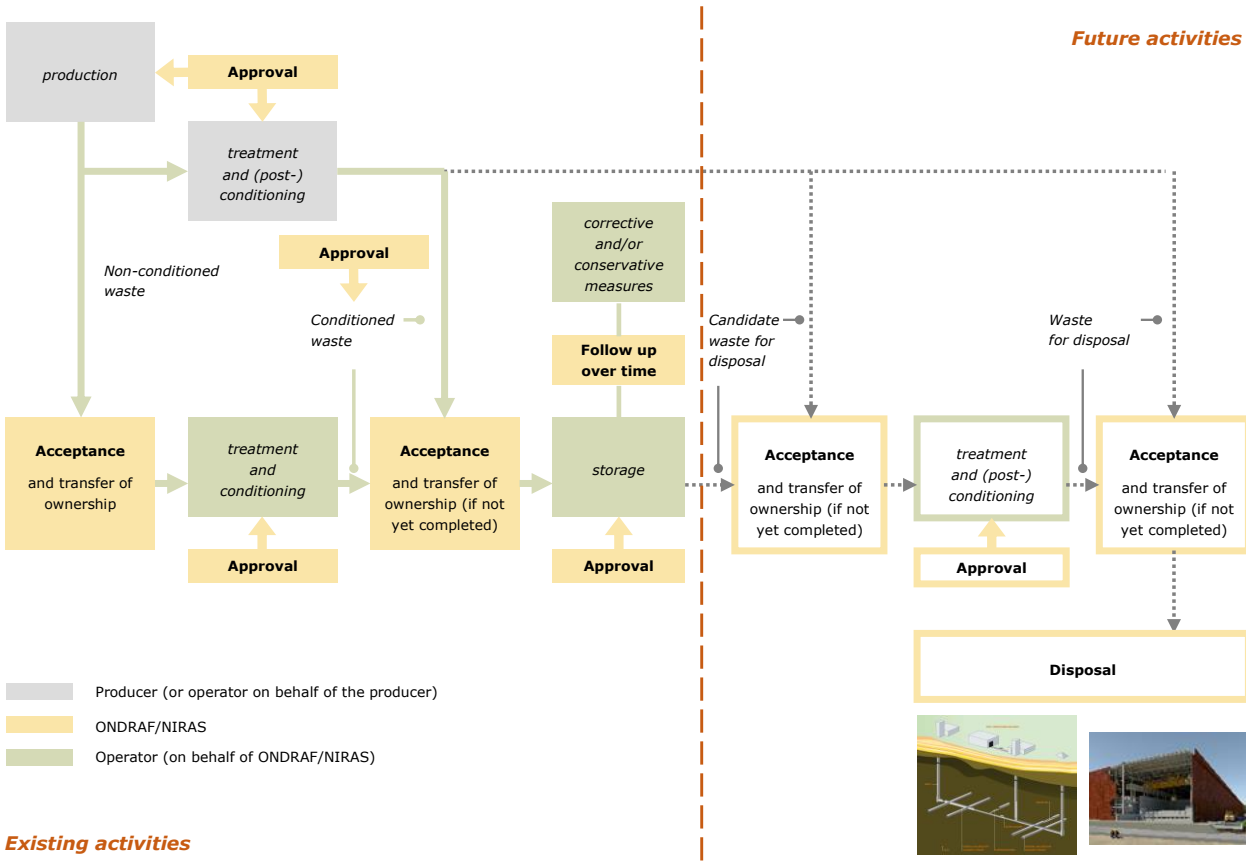

Figure 11: Simplified diagram of the ONDRAF/NIRAS acceptance system for radioactive waste. The system currently in force for the acceptance of non-conditioned and conditioned waste is being extended to waste for disposal

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 life time 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

(1) 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.

(2) 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.

(1) 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.

(2) 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.

(3) 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.

(4) 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.

(5) 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).

(6) 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*

Since 2008 the FANC has had a quality management system that conformed to ISO 9001:2008

The FANC core processes and related support processes have been identified by the FANC management team and were integrated into the existing quality system in 2008. A complete review of the management system started after the self-assessment in 2012 and the IRRS mission in 2013, with the aim to comply with IAEA Safety Requirements, GS-R-3 (now GSR part 2).

This resulted in a new mapping of the management system and integrating policies, intention plans (strategy, operational objectives), and operational and support processes.

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 years 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. These processes are managed by process managers who are accountable for the realisation of goals and 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 European "Stress Tests", the periodic safety reviews, the long term operation of NPPs, the pre-licensing process of new on-site interim spent fuel storage facilities for the Doel and Tihange sites, the safety assessment 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), "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" is in charge of inspections in all nuclear installations supervised by Bel V. The activities performed in this process include also inspections in installations other than nuclear power plants, namely other class I facilities, including Belgoprocess, as well in some high-risk Class II facilities. This process includes Bel V activities in the frame of its participation in the national emergency 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 GS-R-3 (now GSR part 2). Furthermore, Bel V has been certified ISO 9001:2008 in 2009 and ISO 9001:2015 in 2018.

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), etc.

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 individual dose limits. External (occupational) dosimetry has to be performed by a dosimetry service licensed by the FANC.
- 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 for 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 Royal Decree of 25 April 1997 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 a.o. 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 during 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 license. 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 written by each licensee and addressed 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 :

http://afcn.fgov.be/fr/chercher?keyword=rejets&=Appliquer (in French).

The releases of the Belgian Class I facilities leaded to the following radiological impact for the most exposed individual of the public:

	Calculation of the annual exposure to the most exposed individual resulting from the authorized releases			Calculation of the annual exposure to the most exposed individual resulting from the average actual releases between 2017-2019		
Site or Facility	Gaseous	Liquid	Total (maximum)	Gaseous	Liquid	Total (maximum)
SCK CEN	0.1 mSv	-	0.1mSv	2.3 µSv	-	2.3 µSv
FBFC	10 µSv	-	10 µSv	< 0.1 µSv	-	< 0.1 µSv
Belgonucleaire	5 µSv	-	5 µSv	<1 nSv	-	<1 nSv
Belgoprocess	0.3 mSv	0.2 mSv	0.5mSv	12 µSv	34 nSv	12 µSv

JRC (Geel)	5 μSv	-	5 μSv	< 0.1 μSv	-	< 0.1 μSv
total MOL - Dessel site	*0.42 mSv*	*0.2 mSv*	*0.62 mSv*			
IRE site	0.19 mSv	<10 μSv	0.2 mSv	16 μSv	0.41 μSv	16.4 μSv
Tihange site (3 NPPs)	0.19 mSv	0.08 mSv	0.21 mSv	46.4 μSv	2.4 μSv	48.8 μSv
Doel site (4 NPPs)	0.18 mSv	0.23 mSv	0.37 mSv	19.2 μSv	0.54 μSv	19.8 μSv

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 for 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). The results are evaluated by the HPD, Bel V and FANC.

Casks in which spent fuel elements are stored are equipped with a continuous monitoring of the leak tightness.

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.

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).

F.4.3. **International exchanges**

The regulatory body and the Belgian licensees participate actively since 1991 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 have been established with neighbouring countries.

F.5. Article 25: Emergency Preparedness

ARTICLE 25. EMERGENCY PREPAREDNESS

1) *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.*

2) *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 March 2018 (which replaced the Royal Decree of 17 October 2003) defines a nuclear and radiological emergency plan (NEP) for the Belgian territory.

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

F.5.2.a) *Classification of Emergency*

The Royal Decree of 1 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 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 1 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.

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 National Crisis Centre. 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) *National Master Plan for Organisation in the Event of Emergencies*

The National Crisis Centre (CGCCR in figure 13) 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.

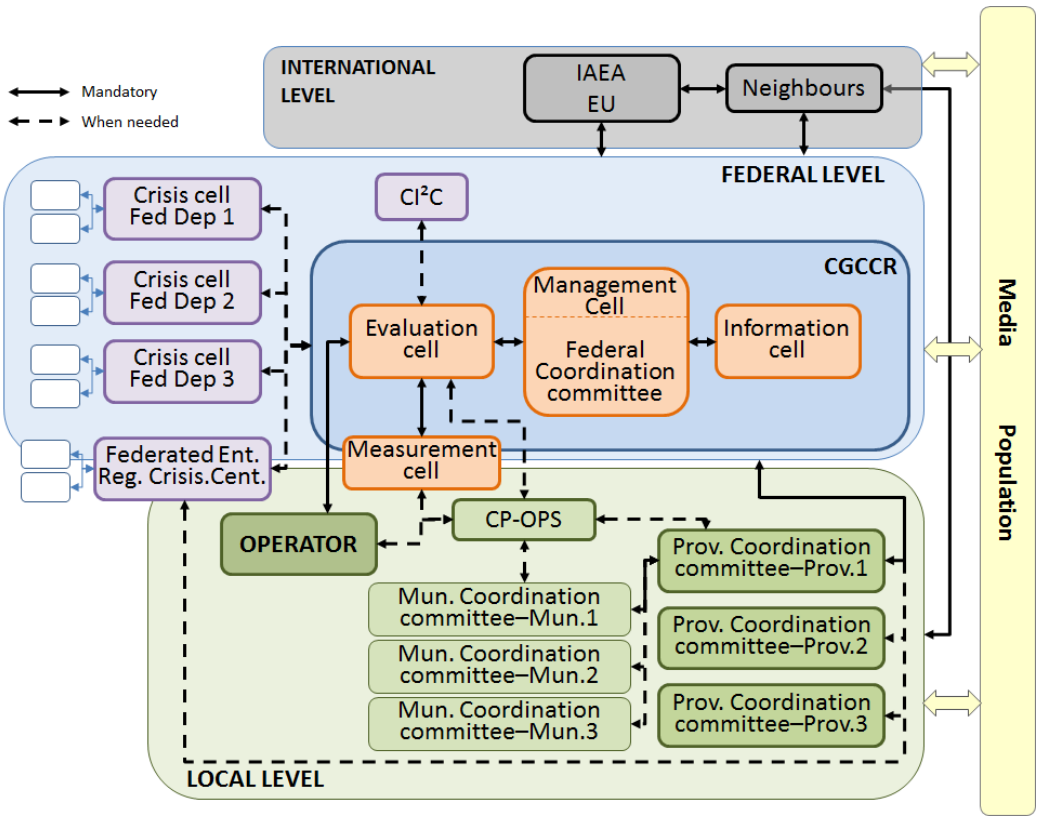

Figure 13: EP&R organisation for Belgium

In case of an accident abroad, the National Crisis Centre, 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) 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 National Crisis Centre and supplies all the information that becomes known to him as the accident evolves.

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.

Erreur ! Source du renvoi introuvable.14 depicts the TELERAD network:

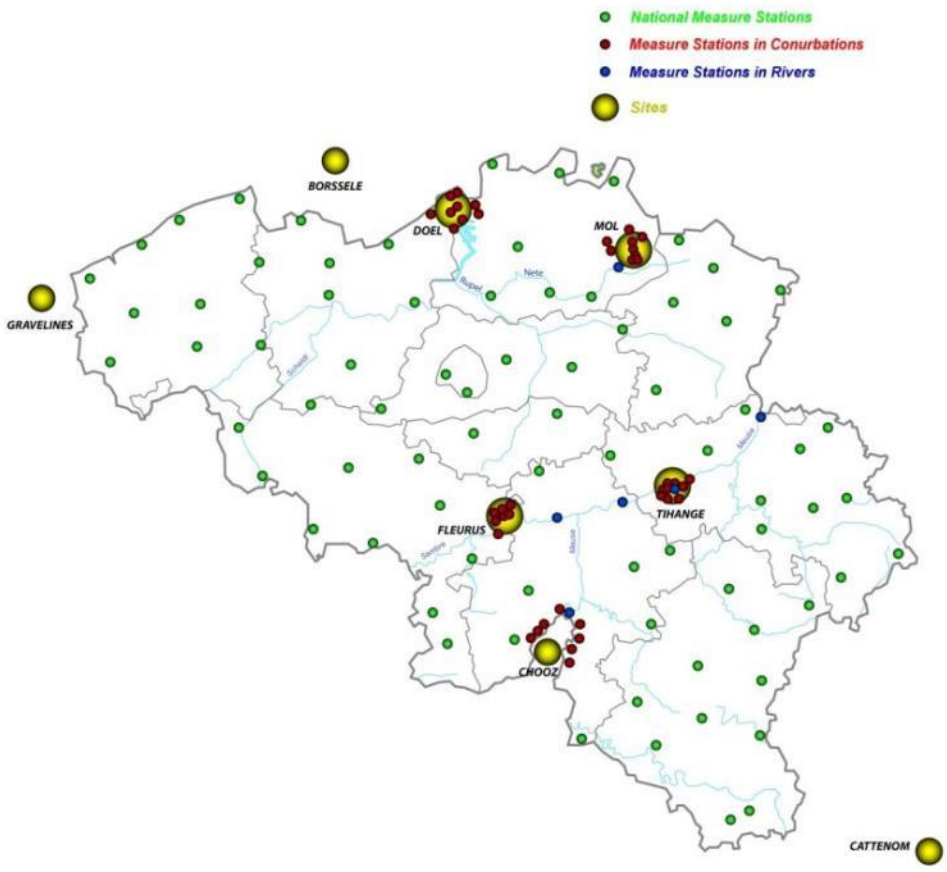

Figure 14: TELERAD Network - location of the measuring stations

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 advices 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 Public Service of Public Health, 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.

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 National Crisis Centre (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 1 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 [7]. 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 the latest version of the diffusion model [8], 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.c) *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 Civil Protection and of Crisis Centre Directorates of the Home Affairs Federal Public Service (FPS) 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 FPS involves 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 that site and to the evaluation cell of the National Crisis Centre to contribute, based on the collected technical information

[7] 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).

[8] 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).

and data, to the technical and radiological assessments used to support the issue of advices and recommendations of protective actions.

F.5.2.d) *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 National Crisis Centre. At local level the provincial emergency plan includes the ways to inform the population (sirens, police equipped with megaphones, radio and television) and following-up the instructions given to the population (iodine tablets, sheltering, evacuation, etc.).

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 Augustus 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.

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

- 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 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 a dismantling Safety Report;
- Art 17/11 deals with Periodic Safety Reviews during the dismantling phase of the 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.

Article 17 of the GRR-2001 imposes a specific license for dismantling of Class I and for some Class II facilities, as well as a notification for Class III facilities. The licensing process is similar to the construction and operation licensing process. As part of this process, ONDRAF/NIRAS has to give its opinion on matters under his responsibility.

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 decommissioning 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;
- the execution of decommissioning programmes as requested by the owner or in case of failure.

These legal assignments have been extended by law in December 1997 to all nuclear installations and sites containing radioactive substances. ONDRAF/NIRAS is in charge of elaborating and reviewing every five years a national inventory of nuclear liabilities comprising a database of all nuclear installations and sites concerned, and of assessing their decommissioning and remediation costs. The 4th inventory was published in January 2018; the 5th inventory is foreseen for the first quarter of 2023.

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 decommissioning 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. When the facility is definitively shut down, this plan becomes a final decommissioning plan. 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.

(1) Programmes without financial liabilities funding system during operation

For the moment, the clearly identified nuclear facilities in Belgium for which no financial funding was raised, are owned or were owned in the past directly or indirectly (via the public sector) by the Belgian State. For these facilities, decommissioning and site remediation or, in one specific case, waste and spent fuel management, are financed by a levy mechanism on the transported kWh, as determined in the law of 24 March 2003. This Law guarantees the financing of the BP1 and BP2 liabilities till the completion of the corresponding dismantling and waste conditioning activities. Following this law, every 5 year a 5 year programme has to be elaborated in order to determine the necessary funding to perform this programme

(2) 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. 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.

(3) 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 waste processing installations of the BP2 site cover waste storage and processing facilities.

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.

(4) 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

(5) Settlement of liabilities funding during plant operation

One of the main tasks of ONDRAF/NIRAS is to control 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 shutdown 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 section A.2 (4).

G. 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 spent fuel facilities and waste management 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 :
- 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 ionizing radiation, now superseded by the Directive 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, for what concerns spent fuel storage facilities and 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). An overview of the content of Chapter II of the SRNI-2011 (i.e. safety requirements applicable for all class I facilities) and of chapter IV (specific safety requirements for radioactive waste and spent fuel storage facilities) is given in **Appendix 1**.

(1) Safety assessment of new facilities

Prior to the construction and the operation of new installations, a construction and operating license application has to be submitted. A preliminary safety analysis report describing a set of applicable measures has to be annexed to the license application (See Article 19).

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:

   i) a topographic survey of the region located within a radius of 500 m around the facility as well as the indications relating to the population density within this perimeter

   ii) geology, seismology, hydrology, meteorology, climatology and other relevant natural features

   iii) 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 defense 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).

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

g) Safety demonstration:

   i) deterministic analyses demonstrating compliance with safety criteria and radiological limits, including a description of the margins,

   ii) preliminary probabilistic safety analyses for the establishments referred to in articles 3.1.a) .1;

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

i) Operational aspects, including:

   i) a description of the objectives of the accident management procedures,

   ii) 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 license 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 - http://www.etson.eu/reports-and-publications) 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 facilites (on-site dry spent fuel storage at Doel and Tihange), the specific safety requirements taken into account in the design are listed under article 8 – Assessment of Facilities – section G.5.3. The license 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 license conditions
- verifying the compliance with the regulation in force (a.o. 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).

(2) 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.

In 2007, the FANC required that the future periodic safety reviews of all nuclear units are carried out by using the IAEA Safety guide NS-G-2.10 (now SSG-25). Both the scope and the methodology are based on the approach adopted by the IAEA 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.

(3) 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.

The current status of the actions plans related to the stress tests is presented in section A.2.2 (9) (developments since the last meeting) of this report.

(4) Decommissioning plans

A preliminary decommissioning 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 decommissioning plan must be updated during the operation of the installation. This updating takes into account:

- 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

(5) 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 unit. These modifications are subject to a license 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 license (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, without formal involvement of Bel V.

(6) 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.

(7) 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 in 2010 a guidance document for the practical application of this requirement in Class I facilities. This guidance has been replaced by the FANC technical regulation of 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 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.

(8) 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 appendix 2.

Three spent fuel storage modes are used:

- 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);
- 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).

New interim spent fuel storage facilities (the SF² facilities) are intended to be built at both the Doel and Tihange sites. The licensing processes for these facilities are currently in progress.

G.2.1.a) *Fuel deactivation pools in the units.*

The intermediate storage buildings 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 K_{eff} (neutron multiplication factor) does not exceed the criteria in normal and accidental conditions. The calculations have conservatively not taken into account the presence of boric acid in the system. Burnup credit is only used for one plant for historical reason and the licensee has decided to remove it. A modification of the Safety Report will be triggered as the analysis have demonstrated that the burnup credit is no longer required.

Efforts after the Fukushima-Daiichi accident were undertaken to evaluate and implement improvements related to hardware, organization and procedures, to better cope with possible extreme accident scenarios. Examples of implemented improvements to increase the robustness of the fuel-cooling are:

- At Doel and Tihange sites, complementary means and procedures have been developed to refill the spent fuel pools in case of a total station black out of long duration in which these pools might start to loose cooling water inventory. Mobile motorpump units and mobile hose pipes have been installed; specific procedures and non-conventional configurations have been developed (f.i. through the fire extinguishing circuit) to refill the spent fuel pools; specific studies have been done to re-evaluate time to empty the pool by evaporation
- At Doel and Tihange sites, some parts of the installation have been reinforced to guarantee their correct functioning in case of a beyond design earthquake. It has been shown that sufficient margins (simplified seismic margin assessment) are available for the existing systems; some specific parts of the pool coolant circuit (pump fixing) and of the 2nd level safety systems (diesel tank) of the oldest unit have been reinforced

G.2.1.b) *Tihange site: Intermediate storage building DE*

This building is located within the perimeter of the Tihange 3 unit and is therefore an integral part of the Tihange 3 installations.

The different services of the Tihange nuclear power plant cover, all the activities related to this building. More specifically:

- Radiological surveillance activities and surveillance of the installations;
- Fuel handling;
- Fuel transport from buildings BAN to building DE.

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 DE building is linked to the Tihange 3 unit but it could be rendered autonomous if needed in the event of decommissioning of the Tihange 3 unit.

The design requirements for the safety of building DE are the same as for building BAN-D of unit 3. They are mentioned in the Safety Analysis Report of this unit:

- building DE is designed to resist earthquakes and other natural phenomena like violent wind, tornado and flood;
- the building is also designed to cope with external accidents such as an airplane crash, an explosion accompanied by a shock wave and projectiles and to avoid the seepage of explosive gas inside the installations;
- the entrance is controlled;
- specific physical protection measures are taken for the units where MOX fuel is present in the spent fuel pools. Note also that after the Belgian European Stress Tests (BEST) program, terrorisms actions have been considered in Belgium at regulatory body's requirement; this lead to an upgrade of the physical protection systems of all units;
- the mechanical and electrical systems and the instrumentation are qualified for their specific use;
- the shields and other measures (pipe arrangement, pool water purification) make it possible to meet the requirements of the regulations on radiological protection;
- the design also includes considering the recommendations set out in the American and international regulations for this kind of installations.

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.

The first system, named 'STP', is composed of a heat exchanger that transfers the heat released in the pool water to the second system.

This second system, called 'intermediary cooling system' (SRI), is part of the intermediate cooling system (CRI) of the Tihange 3 nuclear facility. Through an exchanger, this CRI system transfers the heat extracted from the STP system to the tertiary circuit.

This last, named 'raw water system' (CEB), cools down the heat in the CRI system with water pumped from the river Meuse. After having flowed through the exchangers between the CRI and CEB systems, this water is released in the river Meuse.

The CEB system constitutes the normal cold source in building DE.

If the raw water supply is unavailable (in accident conditions), the groundwater of the Tihange nuclear power plant site is used as an alternative cold source.

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 calculation have not taken into account the presence of boric acid in the system.

The fuel management minimises the number of fresh fuel assemblies loaded in the reactor core at each refuelling and complies with the limitations regarding the discharged fuel radiation rate. This management policy keeps intrinsically the production of radioactive waste at the lowest possible level.

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, and additional radiological shielding is ensured by the building. The container models are approved by the FANC for transport, and comply with the IAEA transport regulations. Furthermore, Bel-V has approved the container models 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 following safety functions are fulfilled by the containers themselves :

- subcriticality of the fuel inside the container;
- radiation shielding;
- confinement of radioactive substances;
- removal of residual heat;

while the building participate in radiation shielding.

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 in the long term the fuel integrity. 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 K_{eff} 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 containers must resist seismic loads and the consequences of other natural phenomena like violent wind and tornado, including wind induced missiles;
- the containers have been designed to cope with external accidents such as an airplane crash Fire & Burial ;
- the access to the building is controlled;
- the shielding of the containers and of the storage building make it possible to meet the requirements set out in the regulations on radiological protection;
- this building is located within the perimeter of the Doel nuclear power plant. It is independent from the power units. The management of this building is connected with the management of the waste processing installations (WAB);
- the different services of the Doel nuclear power plant cover, each for its own field, all the activities related to this building. More specifically:
    - fire Protection & intervention is covered by the Fire Safety Operators;
    - security is covered by Site Security;
    - radiation protection is covered by the radiation protection team;

- radiological surveillance activities include:
  - surveillance of the installations;
  - cask handling;
  - control of the leak tightness of the containers;
  - accountancy of the assemblies and controls in the framework of the Non-Proliferation Treaty.

The general safety provisions consider the biological, chemical and other risks resulting from the management of the spent fuel.

The spent fuel containers storage building (SCG) has been designed to remove through natural circulation the heat produced by all the containers stored in the building.

The dose rates due to neutron and gamma-radiation have been calculated inside and outside the storage building when it is completely filled with the number of containers planned during the design phase. In order to make a conservative calculation of the dose rate, it was supposed that each container emits radiation at the maximum allowable level at 2 meters in height and that all the containers were stored at the same time.

In these extremely penalising conditions, it was demonstrated that the dose rate at the site limit remains far below the dose limit

The SCG is included in the periodic safety review that is performed every ten years.

G.2.1.d) *SF² facilities*

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 shutdown 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 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 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).

The cask is closed by a primary lid equipped with 2 seals in series assuring confinement. An inert gas (helium) is injected between both seals of which the overpressure is continuously monitored allowing the control of the leaktightness of the cask.

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 can be occupied by a cask. 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. The total capacity of the SF² facility includes a certain margin to cover technical contingencies and ensure operational flexibility.

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 can 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 total capacity of the SF² facility includes a certain margin to cover technical contingencies and ensure operational flexibility.

The maximum authorized dose rate limits for a cask to be respected in normal situation are 2 mSv/h at contact and 0,1 mSv/h at 2 m. Before transport to the SF² facility, the loaded casks are decontaminated, excluding any external contamination. A dose constraint specific for the SF² facility of 0,1 mSv/y at the site limit is applied.

G.2.2. **SCK CEN site: BR2**

Additional information on BR2 can be found in appendix 4

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. In case the fuel elements have the most reactive state, they cannot reach the criticality level, even if they fall out of the basket. The fuel elements are locked in their baskets 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. Actually, 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, if they concern 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 gamma heating.

When the pumps stop, the shutdown 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 Installations

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 31 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 is being prepared in the framework of final plant shutdown before dismantling and decommissioning.

G.3.1.b) *Stress tests*

See sections G.1 (2) and A.2.2 (9).

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.

Based on operational feedback, a number of modifications have been made, such as (not exhaustive list):

- modifications of the overhead handling cranes;
- modifications to the access doors;
- replacement of neutron-absorbing materials (boraflex plates) present in a few racks in the fuel ponds of different units, by steel sheets containing boron.
- modifications to the handling and transfer systems of spent fuel dual purpose containers.

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*

License N.0024 of 30 June 1986 (Royal Decree) for the operation of the nuclear facilities of SCK CEN made it mandatory to conduct ten-yearly safety reviews. The periodicity of the reviews was set at 5 years in the past but is now 10 years to be in line with the nuclear power plants in Belgium. The objectives of the ten-yearly review are similar to those of the NPPs.

G.3.2.b) *Stress tests*

See sections G.1 (2) and A.2.2 (9).

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 license 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 license conditions, implying that no additional or modified license 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. The final approval has to be given by the Reactor Manager BR2.

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***

(1) Characteristics taken into account 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 these 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.

(2) Periodic reassessment of the site's characteristics

Reassessments are systematically performed during the periodic safety reviews of each unit.

During the 1st periodic safety review of Doel 1 and 2, as external accidents had not been considered in the initial design, additional emergency systems were installed in a reinforced building (the Bunker).

For the Tihange site, the safe shutdown earthquake originally considered (in the early seventies) for Tihange 1 was of 0.1 g acceleration. This value was increased to 0.17 g following the Tihange 2 safety analysis (end of the seventies). As a consequence, the latter value was adopted for the site as a whole; it did not need to be modified when the Liège earthquake of 1983 was analysed. The seismic reassessment of Tihange 1 was performed during its 1st periodic safety review in 1985.

This resulted in a considerable number of reinforcements being made in certain buildings, and in the seismic qualification of the equipment being re-examined (using the methodology developed by the US Seismic Qualification Utility Group).

Also, a review of the protection of Tihange 1 against external accidents was performed: the probability was assessed that an aircraft crash would result in unacceptable radiological consequences, taking into account the specificities of the buildings (including the spent fuel storage building), and was found sufficiently low and acceptable.

During the periodic safety review of each of the units, studies are performed and, where necessary, measures are implemented to ensure that the residual risk following external accidents remains acceptable taking into account the environment of the site with respect to the risks resulting from transport (including by aircraft) and from industrial activities.

The protection against potential floods is reassessed in the framework of periodic safety reviews as well as the possible rise in temperature due to climate changes.

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 pipings, 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.

The action plan will be completed in September 2020.

G.4.2. **SCK CEN site: BR2**

G.4.2.a) *Siting: Initial siting and periodic reassessment of the sites 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 taken into account, although the risk of earthquakes was considered, as the original safety report[i] 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 km². In the region of Mol, an intensity of IV was observed.

In the operating license, 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 0.1g 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 "Réévalutation 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 April 16, 2013.

[i] Belgian Engineering Test Reactor BR2 - Safety and Design - Final Report - Report CEN - Blg 59 - R.1996 - May 1, 1961.

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 PGA 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

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***

(1) 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 meter-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 occur 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.

Recent efforts after the Fukushima-Daiichi accident were undertaken and implemented to evaluate possible improvements related to hardware, organization and procedures, to better cope with possible extreme accident scenarios:

- complementary means and procedures were developed to refill the spent fuel pools in case of a total station black out of long duration in which these pools might start to lose cooling water inventory.
- some parts of the installation were reinforced to guarantee their correct functioning in case of a beyond design earthquake.
- The siphon breaker system was reassessed and subsequently adapted.

The ALARA principle, which consists in keeping the exposure of the workers as low as reasonably achievable, is applied.

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.

(2) Building DE (Tihange)

Protection against radiation

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 in compliance with the international regulations for the transport of radioactive material.

The design of building DE meets the requirements of the European Directive 96/29/EURATOM of 13 May 1996 laying down the basic safety standards for health protection of the workers and the general public against the dangers arising from ionising radiation, that has been transposed into the Belgian regulations by the GRR-2001.

Radiation control in the areas

Inside building DE, the activity in the pool hall is permanently controlled as follows:

- monitoring the radiation level around the storage pools and checking indirectly if the layer of water separating the radioactive fuel from the handling areas is thick enough;
- monitoring the radioactive noble gas concentration in the air of the pool hall and, therefore, controlling indirectly the integrity of the fuel rods; moreover, it is possible to take manually a gas sample in order to measure the aerosols and, if necessary, the radioactive iodine.

These functions (except the sampling) are performed continuously. If the limits established are exceeded, the alarms will activate. The alarms are monitored from the main control room of Tihange unit 3.

In complement, an inspection program for the fuel present in DE is being implemented. The purpose is to monitor by visual inspections that the fuel does not present signs of degradation and that no adverse mechanisms tend to reduce the safety margins of the stored assemblies. It is to be noted that the current operation practices forbid to send leaking fuel assemblies from the ponds of the units to the DE. Those leakers have to be previously repaired on the unit prior to be evacuated to the DE. Nevertheless, the DE has been designed to consider the rupture of fuel elements; therefore, in case of handling accident leading to fuel leaking rods, the safety is ensured by the current design and safety studies of the DE.

Ventilating building DE (VDE)

The VDE 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.

In addition, the VDE system allows to:

- Keep the ambient temperature and the humidity in building DE at a level allowing good operation of the material and permanent accessibility to the personnel;
- Limit the radioactive gas or aerosols concentration in the air of building DE in order to allow access to the personnel ;

- Prevent local high contamination from spreading to other non-contaminated or lower contaminated areas by ensuring air flow from potentially low contaminated zones to potentially more contaminated zones.

Generation of waste and effluents

Radioactive releases in the air in normal operational conditions

In normal operational conditions, ^{3}H - that occurs at trace levels in the humidity of the air extracted from the pool hall - is the only isotope that can be released in the air through the ventilation system of building DE. This air is filtered continuously by packed bed filters before it is released in the air through the chimney of the Tihange unit 3. The gaseous effluents of building DE are monitored by the existing control chains in unit 3.

Releases of radioactive liquid effluents in normal operational conditions

Fuel handling operations generate no liquid effluents.

The feedback of operational experience of fuel cooling pools shows that these installations generate very few effluents. The liquid effluents generated by the operation of building DE are first transferred to unit 3 to be controlled a first time and to be temporarily stored. Afterwards, they are transferred to unit 2 to be treated by evaporation.

The pool water of building DE is mainly contaminated by activation products (^{54}Mn, ^{58}Co and ^{60}Co) that can be set free from the external surface of the fuel rods during the handling of the assemblies under water. This contamination is (a factor of 10) lower than the water contamination of the fuel deactivation pools of the three units in Tihange. Indeed, the assemblies must be stored at least 2 years before being transferred to building DE. This results in a substantial reduction of the activity of the residual deposits arising from the activation products (almost complete radiological decay for ^{54}Mn and ^{58}Co) on the fuel rods. Moreover, the permanent purification of the water in the pools of building DE keeps the contamination at a very low level.

Generation of solid radioactive waste

The solid waste that is produced during the operation of the building DE spent fuel storage ponds are:

- Spent filters and spent ion exchange resins arising from the pools water treatment systems
- Low contaminated dry active waste produced by the DE installations and systems maintenance and by the replacement of the pre-filters and HEPA filters from the building DE exhaust ventilation system.

The operation of the intermediate storage building does not create other categories of radioactive waste than these that have already been treated in the context of the operation of the energy generating units.

Unplanned releases of radioactive effluents

Unplanned releases of radioactive effluents in the environment results mainly from accidental situations that can occur during the operation.

The accidents considered during the design of nuclear installations can be divided in two categories:

1° The accidents of external origin (AEO), can be classified in two subgroups:

- the AEO resulting from natural phenomena: earthquake, violent wind and tornado, including the projectiles and flood.
- the AEO resulting from human activities: airplane crash, explosions and toxic gas.

2° The accidents of internal origin (AIO) are considered as particular operational situations. These situations are grouped per category according to their probability of occurrence:

- Loss of electric power
- Loss of the pool cooling
- Loss of pool water
- Fire in building DE
- Criticality accident
- Accidental drop of a container
- Drop of a spent fuel assembly; in the American regulations, this accident is considered as a design accident. The operational experience shows that the probability is very low for such an

accident to occur. This conclusion also prevails for the accident of a spent fuel assembly falling in building DE due to the many controls and the mechanical and physical safety measures imposed on the handling operations/equipment.

However, the safety assessment considers the drop of a fuel assembly being handled, leading to the rupture of every fuel rod.

This accident leads to a release of the gaseous and volatile fission products contained in the fuel rods. A part of these fission products is absorbed by the pool water. The activity that is not absorbed by the water passes through the air of building DE and arrives in the Tihange unit 3 chimney through the ventilating system.

The accident of a falling spent fuel assembly constitutes the reference accident, which is the most serious foreseeable accident for building DE.

Considering the different kinds of fuel that can be stored in building DE, the radiological consequences of the fuel handling accident have been assessed for MOX and UO_2 fuels having the highest burn-up and the shortest pool residence time (2 years) before being transferred to building DE.

Given the above-mentioned residence time, ^{85}Kr and ^{129}I are the only volatile isotopes remaining in the pellet-can space that can be released during the accident.

The radiological consequences of a fuel handling accident remain far below the routine discharge limits for the representative individual of the potentially most exposed population group.

(3) Building SCG (Doel)

Protection against radiation

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 SCG is composed of a preparation hall and a storage hall. The latter is divided in two parts and has a total capacity of 165 storage casks. 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 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 2 meter.

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 taken into account since there are no discharges.

The ALARA principle is implemented.

The following measures have been taken during the design of the buildings to meet radiation protection requirements:

- use of a remotely controlled overhead crane in the storage hall;
- use of concrete shielding;
- control of the contamination on the external faces of the containers before transfer;
- accessibility of the container to reduce the residence time during the inspections.

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.

The design of building SCG also meets the requirements of the EU 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, fully transposed in the GRR-2001.

Radioactive discharges in the air

Normal operation

Every container is equipped with two metal seals. The overpressure between the seals is monitored.

Incident/Accident

The accidents of internal or external origin are categorized according to their probability of occurrence.

For an accident of category 1 or 2, it is checked whether the monitoring system of the container is working correctly. There is no discharge.

Category 3 includes the following accidents:

- loss of electric power during a long period
- impact of a projectile on the container
- fall of the container during the (un)loading on (from) the trailer
- a container tipping over against another container.

Category 4 includes the following accidents:

- airplane crash on building SCG
- fire resulting from a transport
- fire resulting from an airplane crash
- collapse of the building on the container.

In any case, the metal seals integrity remains intact and the discharge is minor. Radiological consequences of accidents have been assessed. The criteria set in the national and international regulations dealing with the protection of the population are largely met.

(4) SF² (spent fuel facility for interim storage on-site)

The SF² facilities are new interim spent fuel storage facilities to be 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 shutdown 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 for the storage of casks are foreseen where a maximum of 108 positions can be occupied by a cask while the SF² of Doel will have a total of 108 positions where a maximum of 97 positions can be occupied by a cask

The SF² facility consists of (figure 15):

- 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 leaktightness of the casks is located.
- An auxiliary building (**AUX**);
- A building for the storage of diverse equipments (**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.

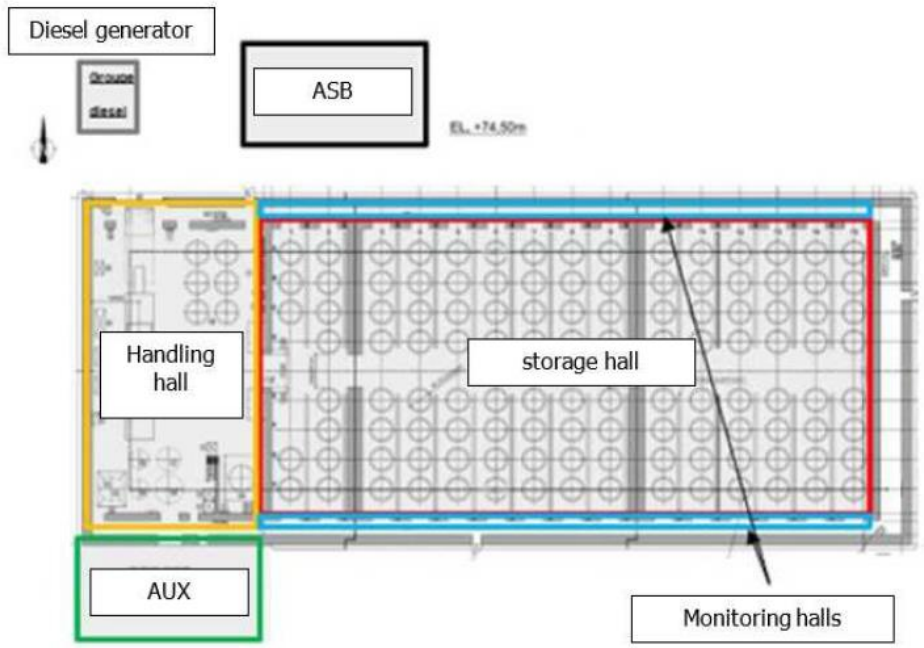

Figure 15: Global layout of the SF² facility

(5) Description of the Main Spent Fuel Storage Building (SFB)

The SFB is foreseen for a maximum of 117 casks, stored vertically, 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, 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 leaktightness 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 (eg. 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 leaktightness 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 leaktightness 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 the irradiation.

By design, the cooling of the cask is passive (Figure 17), limiting the external 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 foreseen 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 **Erreur ! Source du renvoi introuvable.**6).

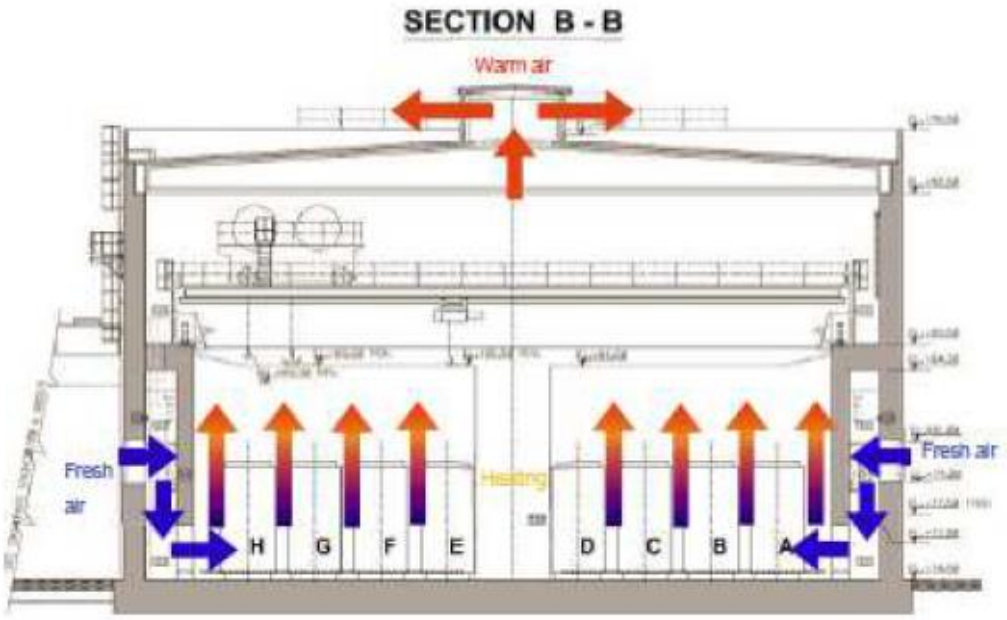

Figure 16: passive ventilation in the SFB building

The cask is designed to satisfy following safety functions :

- The preservation of the subcriticality;
- The containment of radioactive products;
- The heat removal;

Figure 17: example of dual casks for nuclear spent fuel

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, taking into account dynamic soil-structure interaction. The SFB building is also designed to resist to extreme natural phenomena (wind, snow, ice or tornado's) and explosion.

(6) 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 will be 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.

(7) 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.

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.5.1.c) *Technologies used*

The technologies used for the design and construction of the spent fuel management installations are based on experience, tests and analyses.

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 waste water 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

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.5.3. **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.

The licence conditions impose, amongst others, to:

- update the SAR, which throughout the life of the installation has to exactly reflect its actual situation,
- perform safety reviews at least every ten years or on specific request by the Safety Authority.

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 [2], 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 chapter on decommissioning (Royal Decree of 10 August 2015). This

chapter transposes the WENRA Decommissioning SRLs into Belgian law, with the exception of SRL DE-20, requiring the submission of an initial decommissioning plan to the safety authority (FANC) in support to the nuclear licence application for a new nuclear facility. 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 minimum content of such initial decommissioning plan is listed in SRL DE-21;
- The Royal Decree of 17 October 2003, 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 had recently (29 May 2020) been transposed in Belgian law. For the safety demonstration in the licensing application the FANC guidelines with regard to new class I installations were taken into account: The FANC (and Bel-V) developed non-binding guidance on the safety demonstration and on specific external hazards and on nuclear security. The contents of these guidance are expected by the FANC to be applied;
- The FANC/Bel V guidance on the nuclear safety demonstration of new Class I nuclear installations provides expectations by the safety authority (FANC) 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.5.4. **Installations of SCK CEN: BR2**

See section G.1 and articles 4 to 7

G.6. 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.6.1. Doel and Tihange facilities

G.6.1.a) *Initial license 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.6.1.b) *Operational limits and conditions*

The Technical Specifications are referenced in chapter 16 of 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.6.1.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 Arrhénius 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.6.1.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.6.1.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 shutdown as long as this new status is not covered by a new license.

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 an excellent 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.6.1.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.6.1.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 license conditions require that experience feedback from the Belgian and foreign units must be considered. Incident analysis includes an evaluation of the root cause, the lessons learnt and the 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.6.1.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.

G.6.2. **SCK CEN installations: BR2**

G.6.2.a) *Initial license and commissioning*

See Section E, article 19 and section G.1

G.6.2.b) *Operating limits and conditions*

As described before, the Technical Specifications are approved in the license. 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.6.2.c) *Surveillance programmes*

A surveillance programme is established in order to guarantee the quality of all safety-related activities in case of a shutdown, 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 license 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... etc.

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.6.2.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.6.2.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 shutdown as long as this new status is not covered by a new license.

G.6.2.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. In particular, these notes report 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 set up was completed up to 1986 by means of the data filed in the "start-up" notes.

G.6.2.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.7. Article 10 :

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.

No spent fuel has been designated for disposal in Belgium.

H. 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 section G.1 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 Appendix 2, sections L2.1 to L2.3.

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:

(i) 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 centers 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. 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 special 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 section E, Article 19) 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 2008 (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 (3) and A.2.2 (9).

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 license for the dismantling of these former installations, changing the use of existing facilities (such as processing facilities) on the Belgoprocess sites required new licenses 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 article 12). The licensing process also requires public involvement and the consultation of neighbouring countries (application of article 37 of the Euratom Treaty).

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 a policy decision for geological disposal. 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 of category A waste*

(1) 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 generated in the future, for instance after dismantling of the nuclear facilities. The radioactive waste involved is processed and conditioned and has to contain only limited amounts of long-lived radionuclides, making it appropriate 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 municipalities Dessel and Mol offer 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.

(2) Funding

Two ONDRAF/NIRAS funds will generate the necessary means for the cAt project: the Long Term Fund (LTF) and the Medium Term Fund (MTF).
The LTF finances all parts of the project directly servicing the waste producers, such as the repository, the quay, the caisson plant… LTF financing is based on compensations paid by the waste producers for ONDRAF/NIRAS' services in proportion with the waste taken in by ONDRAF/NIRAS.

The MTF finances all project components not directly servicing the waste producers, but with benefit to the local communities. These components, e.g. the Local Fund, health monitoring, etc. help to societal safeguard support for the disposal, now and in the future. The MTF is fueled by taxes and retributions (law of 29 December 2010).

(3) The communication centre

A communication center is being 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 communication center will consist of three sections:

- a contact and reception centre: the contact point for people living in the neighbourhood on everything pertaining to the cAt project and the nuclear facilities in the region;
- a digital and interactive network, which will allow local communities to get information from a distance about the cAt project and nuclear activities in the region. The network can also be used for initiatives from the neighbourhood, such as community television.
- a theme park about radioactive waste management: a tourist and educational activity center for all age groups

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 license 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 license 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 Section G.1

H.5.2. Disposal facilities

Before a disposal facility can be constructed, a license 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 license application file.

(1) 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 to be taken by the Federal Government. In the meantime, 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. 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.

(2) Category A programme

The license application submitted for the surface disposal facility, currently being under review by the regulator, 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 installations and has to rely on the development of a.o. scenarios, including those of human intrusion in the period after release from nuclear regulatory control. Together with the safety assessment, ONDRAF introduced an environmental impact assessment, from which the nuclear aspects were also assessed by the regulator.

The safety assessment and environmental assessment in the application of ONDRAF aimed to demonstrate that the radiological impact, both during operations as in the long term, will be below the criteria as set by the regulator through specific guidelines.

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 others 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 risk constraint of 10-5/y for altered evolutions scenarios are set.

- 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

In order to guide the assessment of the application, which was undertaken up to mid-2014, a Review Basis was developed by FANC. This includes the Belgian legal requirements and guides and the international IAEA standards and guides, such as IAEA Safety Fundamentals, GSR Part 5 (Predisposal management of radioactive waste), SSR-5 requirements (Disposal of radioactive waste), GSR part 3 (radiation protection), GSR part 4 (safety assessment), SSG-23 (The Safety case and safety assessment for the disposal of radioactive waste) and SSG-29 (Near Surface Disposal Facilities for Radioactive Waste).

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."

(1) 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.

(2) Operational requirements

Operational requirements as described in section G.1 apply to these facilities.

(3) Decommissioning plan

See section G.1

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."

No disposal facility is currently in construction nor in operation in Belgium. However, the following institutional measures after closure are currently foreseen:

H.7.1. Legal and regulatory framework (in development)

Art. 35 of the *project of Royal Decree on the "Safety Requirements for Disposal Facilities"* (see section A.2.1) 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. 46.1 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. 46.2 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:

The elaboration of a monitoring and control 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);
- checks of the base of the modules via the inspection space, detection of water in the inspection space, characterisation of the drainage water, etc.;
- monitoring of control structures;
- groundwater level measurements for supporting hydrogeological models.

A periodic review of the safety of the disposal facility in its environment will be taken up as license condition.

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 controls for 250 years after the complete closure of the repository

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.

A periodic review of the safety of the repository and its environment will be part of the license conditions.

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.

Transparency and participation:

In its Waste Plan, ONDRAF/NIRAS plans to conduct a societal consultation on the requirements for waste retrievability, controllability of the disposal system and knowledge transfer, this within the scope of the decision-making process to be established, and as stipulated in the law of June 3, 2014 on the proposal of national policies.

I. 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.

Since the 1st of January, 2018, 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. 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 Federal Agency for Nuclear Control 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 radiation protection officer;
- 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. Belgian has consented the transit or the import or the export and granted licenses granted for:

- Transit of spent fuel from the Dutch nuclear power plant of Borssele to ORANO La Hague in France;
- Transit of compacted and vitrified radioactive waste from ORANO La Hague to the Netherlands;
- Import of radioactive waste from ORANO La Hague to Belgoprocess Dessel. This waste is the result of the reprocessing of spent fuel of the nuclear power plants of Doel 1-2 and Tihange 1 which was transferred previously from Belgium to France;
- Import of waste, resulting from either the decontamination of Belgian materials (e.g. pumps, packaging) or from the melting of radioactively contaminated Belgian metallic materials;
- Import of disused sealed sources from Luxemburg within the framework of the existing convention between Luxemburg and Belgium.
- Import of cemented waste form DSRL Dounreay (UK) to Belgoprocess Dessel. This waste is the result of the reprocessing of fuel assemblies of the reactor BR2 from SCK CEN Mol which was transferred previously from Belgium to the UK.
- Export of radioactive waste from activities performed by Westinghouse Electric Belgium in their facilities (Nivelles) on equipment from foreign NPP's to the country of origin (namely France, UK, Spain,).
- Import of radioactive waste after treatment from Cyclife, Sweden to Belgium (Belgoprocess, Belgonucleiare, SCK CEN, ENGIE Electrabel Doel).
- Export of radioactive waste from Westinghouse Electric Belgium (Nivelles) to Sweden for incineration.
- Import of radioactive waste from Germany to Belgium (Belgoprocess Dessel) for incineration.
- Export of radioactive waste (technological and residues) resulting from the incineration of German waste by Belgoprocess Dessel to Germany.
- Export of radioactive waste after treatment from Belgoprocess, Belgium to Romania.
- Transit of radioactive waste for final disposal from Slovenia to the United States of America via Belgium.
- Import of melted radioactive waste from Germany to Belgium.
- Import of waste generated by revision of GMPP engine from Somanu, France to ENGIE Electrabel Tihange, Belgium.
- Export of radioactive waste for treatment from Westinghouse Electric Belgium to Cyclife, Sweden.
- Import of irradiated fuel for post-irradiation examinations with destructive tests from Sweden to SCK CEN, Belgium.
- Transit of radioactive waste for final disposal from Italy to the United States of America via Belgium.
- Export of irradiated fuel for treatment/retreatment from SCK CEN, Belgium to ORANO, France.
- Export of tritiated liquids for treatment from SCK CEN, Belgium to Tradebe Inutec, United Kingdom.
- Import of irradiated fuel for re-irradiation and post-irradiation examinations from Sweden to SCK CEN, Belgium.
- Transit of radioactive waste for treatment from Germany to the United States of America via Belgium.
- Import of melted radioactive waste from Siempelkamp, Germany to Belgoprocess, Belgium.
- Import of radioactive waste for treatment from Romania to Belgoprocess, Belgium.
- Import of radioactive waste for treatment from Germany to Belgoprocess, Belgium

J. 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 licenses are applicable to these sources as those regarding new sources: operation licenses, transport licenses for the carriers and import licenses 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 it is 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 license for the holder of a sealed source. The license 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 arrangement have to be made to return the source to the supplier or to a recognised storage facility.

The license 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 check regularly 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 any useful control 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.

The holder is obliged to regularly inspect the location and the state of the sources in his possession and to immediately warn the competent authority of any disappearances or accidents that have led to radiation exposure. The competent authority can perform inspections to verify the correct application of the directive. The holder is also obligated to transfer forthwith every disused source to a recognised treatment facility or to the supplier, in accordance with the arrangements made.

Retrieval of Orphan Sources

FANC, ONDRAF/NIRAS and the certified inspection body have worked out 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 (the waste processing facility). 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. The decline since 2017 can be explained by on the one hand a historical backlog of orphan sources that were retrieved between 2014 and 2016. On the other hand, the decline is a likely indication that the presence of uncontrolled radioactive sources in conventional waste streams is becoming a less frequent occurrence thanks to the measures taken.

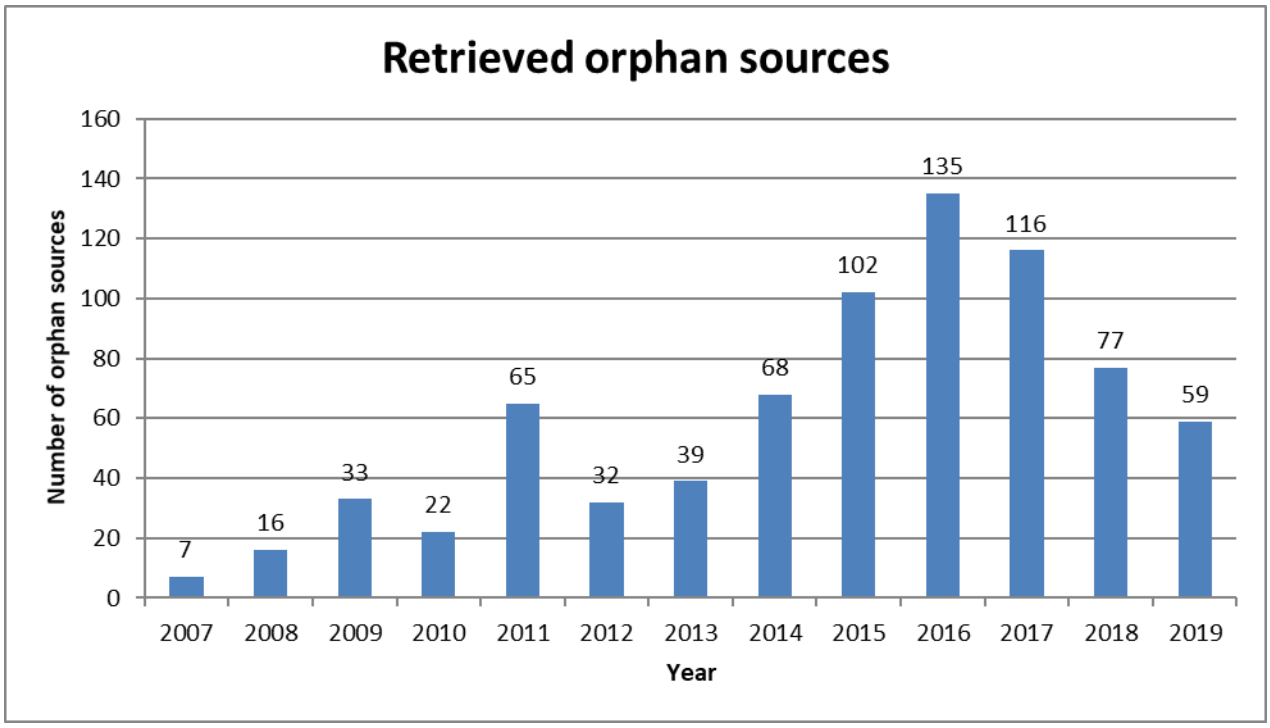

Figure 18: Retrieved orphan sources

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.

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.

K. Section K: General efforts to improve safety

K.1. Measures taken to address suggestions and challenges identified for Belgium at the 6th review of the Joint Convention (2018).

In 2018, two suggestions were identified for Belgium:

- Belgium is encouraged to establish a timeline for a policy decision on HLW disposal and radium-bearing wastes management and SF management
- Belgium is encouraged to fully complete implementing financial guarantees for all operators

As well as 8 challenges:

- Dealing with major non-conformities of conditioned NPP waste discovered during inspections such as gel-like material in conditioned low-level waste packages.
- Clarification of the status and policy for SF: reprocessing or direct disposal.
- Approval and implementation of the Waste Policy for the long-term management of HLW, long-lived waste
- Development of a plan for radium-bearing waste
- Regulatory guidance on decommissioning (clearance, site release, staff,licensing).
- Consequences of Nuclear Energy Phase-out on the waste management chain
- Licensing and construction of the surface disposal facility,
- Prepare final shutdown and decommissioning of NPPs (2022- 2025)

K.1.1. Suggestions identified for Belgium at the 6th review meeting

K.1.1.a) *Belgium is encouraged to establish a timeline for a policy decision on HLW disposal and radium-bearing wastes management and SF management*

The definition and establishment of a national policy for the long-term management of the HLW and/or long-lived waste (including spent fuel) in Belgium is ongoing at the Government level. In June 2018 ONDRAF/NIRAS made a national policy proposal for geological disposal on the Belgian territory, which was subjected to a Strategic Environmental Assessment (SEA) procedure, with a public consultation in the period April – June 2020. The FANC, in consultation with Bel V, delivered an advice on this proposal and the accompanying SEA with regard to nuclear safety and security aspects. After the SEA procedure ONDRAF/NIRAS submitted the final national policy proposal in September 2020 to the supervising Federal Ministers allowing the Federal Government to take a decision.

K.1.1.b) *Belgium is encouraged to fully complete implementing financial guarantees for all operators*

The recommendations formulated by ONDRAF/NIRAS in the frame of the 5 yearly assessment of nuclear liabilities (nuclear liability report March 2018) have not yet led to modifications of the legal and regulatory framework.

K.1.2. Challenges to improve safety identified for Belgium at the 6th review meeting

K.1.2.a) *Dealing with major non-conformities of conditioned NPP waste discovered during inspections such as gel-like material in conditioned low-level waste packages.*

The activities with respect to the management of the non-conform conditioned NPP waste are described in section A.2.3 (4).

K.1.2.b) *Clarification of the status and policy for SF: reprocessing or direct disposal.*

For the spent fuel that is stored at the Doel and Tihange NPP sites since the Parliamentary Resolution and the decision of the Federal Government in 1993 to stop the reprocessing of Belgian spent fuel, the options of reprocessing or direct disposal are still open.

According to the stipulations of the law of June 3, 2014 transposing the EC Directive 2011/70/Euratom, the National Policies include the accepted hypotheses for the subsequent use of the different types of spent fuel proposed by the holders of the spent fuel and after consultation with ONDRAF/NIRAS and FANC. Awaiting the clarification of the status of spent fuel as an element of the National Policies Synatom defines in its reference programme for ONDRAF/NIRAS the fraction of spent fuel for which it still considers future reprocessing.

K.1.2.c) *Approval and implementation of a Waste Policy for the long-term management of HLW, long-lived waste*

See section K.1.1 (a)

K.1.2.d) *Development of a plan for radium-bearing waste*

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 (see section B.5. c)). There are three licensed storage facilities and landfills with radium-contaminated materials.

Several actions have been taken to decide on the long-term management of the radium-bearing waste:

- FANC and ONDRAF/NIRAS formulated a common vision on the categories of radium-bearing materials and waste, depending on the activity levels, and the related long-term management options (clearance, management as non-radioactive waste in a landfill, management as radioactive waste in a sub-surface disposal facility, management as radioactive waste in a deep geological disposal facility);
- ONDRAF/NIRAS submitted to the Federal Government a national policy proposal for geological disposal, including in the waste inventory for geological disposal also radium-bearing waste that will have to be disposed of in a geological disposal facility (see also section K 1.1 a));
- ongoing discussions between FANC and UMICORE, together with ONDRAF/NIRAS and the regional authority for non-radioactive waste to evaluate possible scenarios for the remediation activities and for the activities of the resulting non-radioactive and radioactive waste. UMICORE and the regional authority have accepted the FANC-ONDRAF/NIRAS common vision as working basis to develop the remediation project.

K.1.2.e) *Regulatory guidance on decommissioning (clearance, site release, staff, licensing).*

In view of the future decommissioning of the Belgian nuclear power plants as required by the nuclear energy phase-out law, the regulatory body started in 2014 an internal competence building project. Since end-2019, this project is considered as complete.

The purpose of this project was to develop and define a clearly and structured approach for the regulatory body, covering all aspects of decommissioning and dismantling waste issues.

This project dealt with five issues:

1. Building knowledge and experience on decommissioning activities and on waste from decommissioning;
2. Licenses and safety assessments during the post-operational and decommissioning phases of an installation or facility;
3. Regulatory surveillance and inspections during the post-operational and decommissioning phases of an installation or facility;
4. Special attention to waste and to waste management from decommissioning;
5. The final state : release of buildings and/or of site and end of regulatory control.

This project has resulted in the drafting of several notes for Class I licensees. These notes are all referenced in an introductory concept note entitled "Shutdown & decommissioning of nuclear installations" and specifically address the following topics:

- definitions and phases linked with the decommissioning of an installation;
- notification of the cessation of activity and licensed activities in the post-decommissioning phase;
- information that is common to several documents that the licensee must submit to the FANC, on the one hand (dismantling safety report, periodic progress report and final dismantling report), and to NIRAS/ONDRAF on the other hand;
- position paper for the clearance of buildings, with nuclide specific clearance levels;
- position paper for the release of sites;
- position paper for the end of regulatory control.

The FANC also established standard conditions that should be part of any dismantling licence.

Most of these publications have been made public on the FANC web site: https://afcn.fgov.be/fr/professionnels/etablissements-nucleaires-classe-i/cessation-des-activites-et-demantelement

K.1.2.f) *Consequences of the Nuclear Energy Phase-out on the waste management chain*

ENGIE Electrabel and ONDRAF/NIRAS are developing and making operational all the waste management steps from dismantling of the NPPS till the surface disposal of the resulting low-level waste (see also sections K.1.2.g) and K.1.2.h) below).

K.1.2.g) *Licensing and construction of the surface disposal facility*

ONDRAF/NIRAS submitted to the FANC the license application for the surface waste disposal facility in Dessel in January 2013. In June 2013, FANC requested supplementary information from ONDRAF/NIRAS. During the course of 2013 and the beginning of 2014, a detailed review by FANC and its subsidiary Bel V took place. This review used internally developed review basis in line with Belgian legal requirements and guides and the international IAEA standards and guides, such as IAEA Safety Fundamentals and GRS Part 5 (predisposal management of radioactive waste), SSR-5 requirements (Disposal of radioactive waste), GSR part 3 (radiation protection), GSR part 4 (safety assessment), SSG-23 (The Safety case and safety assessment for the disposal of radioactive waste) and SSG-29 (Near Surface Disposal Facilities for Radioactive Waste). The regulatory review resulted in additional questions sent up to mid-2014 to ONDRAF/NIRAS.

On the basis of all the approved answers to the questions of FANC and Bel V, ONDRAF/NIRAS submitted to the FANC an updated safety case in February 2019. After analysis by the FANC, the Scientific Council for Ionizing Radiation issued a positive preliminary advice in the course of 2019. This advice also contains a list of items that need to be clarified and/or detailed before requesting the final advice of the Scientific Council. A public inquiry about the license application was held in the period November – December 2019.

Currently, ONDRAF/NIRAS is reworking the license application considering the items identified by the FANC, Bel V and the Scientific Council.

K.1.2.h) *Prepare final shutdown and decommissioning of NPPs (2022- 2025)*

In 2018, the FANC started discussions with ENGIE Electrabel about the future decommissioning of its plants. The main purposes of those meetings are to clarify strategic decisions on (1) the "post-operational phase", (2) the preparation of the dismantling licence or (3) to discuss the basic design of possible new facilities that will be needed on site to carry out the dismantling.

For point (1), article 17/1 of the SRNI-2011 requires a notification of permanent shutdown. Regarding this notification, most of the discussion focussed on:

- the description of plant modifications during the Post Operational Phase (adaptations to the Safety Analysis Report (SAR) and the Technical Specifications);
- the measures to maintain a good staffing level;
- the possible impact of decommissioning on the units that remain in operation.

In 2020, discussions also focused on the process of a possible Chemical System Decontamination (CSD) of the primary coolant loop and the management of the new resins generated by this process. The planning of the emptying of the pools for the inventory, the characterization and the development of disposal solutions for non-fissile materials present in the deactivation pools was also discussed between ENGIE Electrabel and the FANC.

For point (2), article 17 of the GRR-2001 fixes the different elements that should be part of the dismantling licence application. Priority chapters of the preliminary dismantling safety report have been identified. First exchanges already took place for Doel 3. For the most part, these exchanges concerned the status of the SSCs of the primary circuit during the Post Operational Phase.

Furthermore, bilateral contacts with foreign authorities have been established in the last years (Switzerland, Germany, France). These contacts will continue during the next years.

Since 2020, a tripartite Working Group with FANC (and BelV), ENGIE Electrabel and NIRAS/ONDRAF was also launched, with the main objective to define all interactions and competences for the authorization of the post-operational and decommissioning phase and the approval of the decommissioning plans for the first Belgian NPP's to be dismantled (Doel 3 and Tihange 2), including the management of materials and radioactive waste streams during each phase. Specific challenges for the post-operational phase and decommissioning phase are being identified and discussed to define all management steps on site in relation to subsequent management steps off site (waste acceptance, storage and disposal).

K.2. Future challenges and planned measures to improve safety

(1) In relation with licensing activities, several new licenses for waste management facilities are expected to be issued during the next period (2021-2024) :

- the license for the surface disposal facility in Dessel;
- the license for a building (167G) at the Belgoprocess site in Dessel for the management of ASR-affected non-conform waste the NPPS;
- the license for a building (165X) for the reception and storage of low-level unconditioned waste and non-destructive characterisation measurements at Belgprocess.

The construction and/or commissioning of these facilities should also start during the next period.

(2) Remediation and decommissioning activities at the ex-BMB site in Fleurus

The main objective of ONDRAF/NIRAS site Fleurus (ONSF) over the next three years is to finalise the remediation and dismantling of the former production facilities of the Sr/Y generators (2020 – mid 2022). These activities constitute the main challenge given the levels of contamination of equipment and infrastructure (shielded cells and related production equipment). During this same period, ONDRAF/NIRAS will dismantle the CGR 70 MeV cyclotron and its peripheral equipment (2020 – 2021) and the IBA 30 MeV cyclotron (2022). In parallel with these activities, ONDRAF/NIRAS will build a containment building around the activated concrete infrastructures (bunkers housing the cyclotrons) in order to dismantle these infrastructures when the time comes (from 2023 on).

Remediation of the other buildings will continue in 2020 (building formerly used for quality control activities) and 2021 (building for the production of radioisotopes for medical use).

The overall objective is to finish all decommissioning activities by 2028.

(3) National policy for the long-term management of high-level and/or long-lived radioactive waste and spent fuel

On the basis of the national policy proposal of ONDRAF/NIRAS (see section K.1.1 a) and the advice of the FANC the Federal Government will be able to establish the basis of the national policy for the long-term management of the high-level and/or long-lived waste (including spent fuel) in Belgium, as required by the EC Directive 2011/70/Euratom.

The next challenge, if the proposed policy is adopted, will be the definition, with all involved actors and stakeholders, at the national, regional and local level, and also in a transboundary framework, of a stepwise decisional process for the implementation of the disposal solution for the long-term management. This stepwise process should be flexible and adaptive, to be able to take into account

future evolutions of scientific knowledge and technology, as well as societal values. It should also ensure the effective participation of the stakeholders at the various levels.

In terms of the RD&D programme ONDRAF/NIRAS will prepare a safety and feasibility case (target 2022) for the geological disposal of the high-level and/or long-lived waste (including both reprocessing waste and spent fuel). Previous assessments were issued in the past (e.g. SAFIR 2, 2001) as well as state-of-the-art reports regarding the RD&D (Research, Development & Demonstration) related to the development of a geological disposal (e.g. RD&D plan, 2013.). FANC and Bel V conduct independent R&D related to radioactive waste management to establish the tools necessary for the independent review of the (preliminary) safety cases for disposal facilities set up by ONDRAF/NIRAS and to develop and retain expertise in the field. In this framework, FANC and Bel V have developed a programme called SRN, that is Strategic Research Needs — Strategic Issues Underlying the Development of Expertise and Skills of FANC/Bel V in Geological Disposal.

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 the different milestones of the decision-making process for the implementation of the disposal solution for the long-term management that will be defined if the proposed policy is adopted. These milestones typically coincide with decisions that need to be taken by the government (policy decisions).

(4) R&D programme on Partitioning and Transmutation contributing to the safe management of radioactive waste and spent fuel in Belgium

Belgium considers a priority to maintain its knowledge and expertise in the nuclear field, and in particular in the responsible management of radioactive waste and spent fuel, and thus to guarantee, in a gradual manner, a high level of safety in their management and to avoid leaving undue burdens on future generations. In an international context, Belgium will continue its search for innovative solutions for spent fuel management.

Partitioning and Conditioning (P&C) and Partitioning and Transmutation (P&T) of spent nuclear fuel could potentially optimize geological disposal and enhance its long term safety of the HLW management by reducing the radiotoxicity timespan and/or thermal output of the HLW to be disposed of, within the framework of advanced and sustainable energy production cycles. The reduction in the radiotoxicity of the waste would reduce the radiological risk associated with human intrusion in a repository. A reduction in thermal output significantly impacts the footprint of a geological repository, thereby significantly reducing its costs.

In 2005, various European actors from R&D institutions and industries working for more than 30 years in the field of closing the fuel cycle and P&T came with a global strategy aiming at the industrial deployment of P&T by 2035-2040: "The implementation of P&T of a large part of the high-level nuclear waste in Europe needs the demonstration of its feasibility at an engineering level." The respective R&D activities could be arranged in four "building blocks":

a) Advanced partitioning of PWR/BWR fuel. This is known technology, much of it already at semi-industrial scale.
b) Fabrication of minor actinide loaded fuels at semi-industrial scale.
c) Development and realization of Transmutation system(s) at pre-industrial transmutation scale,
d) Reprocessing (eventually by alternative routes than aqueous reprocessing) of the Minor Actinides fuels intended for multi-recycling transmutation.

Considering also that the potential application of advanced fuel cycles and P&T in the future cannot eliminate the need for a long-term solution for the safe management of the waste, Belgium has developed a research program on Partitioning & Transmutation (P&T) within a European framework among others via establishing the MYRRHA project. The MYRRHA project aims to become a prototype for the conceptual European industrial transmuter (EFIT).

(5) Preparation of site remediation projects for radium-contaminated places at the UMICORE site in Olen

FANC and ONDRAF/NIRAS have defined an assessment methodology to be applied to the UMICORE site with radium contamination from historical activities (Olen). This methodology constitutes the basis for discussions with UMICORE in view of preparing the site remediation projects and the long-term management of the resulting non-radioactive and radioactive waste. ONDRAF/NIRAS will be responsible for developing and presenting national policy proposal(s) for the long-term management of the resulting radium-bearing radioactive waste categories for which no policy has been established yet. This action will define the steps (objectives, milestones and timeframes) for all the remediation and radioactive waste management activities, but in a first phase excluding activities related to the UMTRAP installation

K.3. Peer reviews

Peer reviews are regularly organized in Belgium. A list of recent or planned missions in NPPs is given in section I.C.3) of the Belgian national report for the Convention on Nuclear Safety, available on the IAEA web site : http://www-ns.iaea.org/downloads/ni/safety_convention/7th-review-meeting/belgium-nr-7th-rm.pdf. The area "Radioprotection" of OSART missions addresses issues in relation with on-site waste management and with radioactive discharges.

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 is mandatory every 10 years. In November 2019, Belgium requested the IAEA to organize an IRRS mission. This mission has been fixed for the 1st quarter of 2023.
- According to the Directive 2011/70/EURATOM, Belgium will organize a self-assessments of its national framework, competent regulatory authority, national programme 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 (such as IAEA ARTEMIS peer review).
- 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).

L. 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 1 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 a.o.:

- 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 license holders or future license holders;
- fees on the occasion of the application for a license, 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 licenses 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 1- General Provisions sets the scope of the Decree and defines terms.

Chapter 2 – 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 V I– 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 3 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 4 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 5 contains final provisions and transitional arrangements

L.2. APPENDIX 2: Radioactive Waste and Spent Fuel Management at Nuclear Power Plants

L.3. APPENDIX 3: Description of the storage buildings at the Belgoprocess site

L.4. APPENDIX 4 : Description of the installations of SCK CEN : BR2

Not included in this version

L.5. List of acronyms

ANS: American Nuclear Standards.

SCK CEN: Studiecentrum voor Kernenergie/Centre d'Etudes de l'Energie Nucléaire/, Nuclear Research Centre, situated at Mol, Belgium.

Bel V Subsidiary of the Federal Agency for Nuclear Control, to which its provides technical expertise

BP1/2: Belgoprocess site 1/2.

BSS: Basic Safety Standards.

CGCCR: Comité Gouvernemental de Coordination et de Crise (the Governmental Centre for Coordination and Emergencies).

CSD-C: Conteneur Standard Déchets Compactés (Standard Container for Compacted Waste).

CSD-V: Conteneur Standard Déchets Vitrifiés (Standard Container for Vitrified Waste).

EU: European Union.

FANC: Federal Agency for Nuclear Control.

FBFC: Franco-Belge de Fabrication de Combustible (Franco-Belgian Company for Fuel Manufacturing).

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

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).

IRS: Incident Reporting System (NEA/OECD-IAEA).

KCD: Kerncentrale Doel (Doel Nuclear Power Station).

MOX: Mixed-oxide $U0_2$-$Pu0_2$.

NDA: Non Destructive Analysis.

NEA (OECD): Nuclear Energy Agency (OECD).

NORM: Naturally Occurring Radioactive Material.

NUSS: Nuclear Safety Standards programme (IAEA).

NUSSC: Nuclear Safety Standards Committee (IAEA).

RGPT: Règlement Général pour la Protection du Travail (Occupational Health and Safety Regulations).

SAFIR-2: Safety Assessment and Feasibility Interim Report 2.

SEA Strategic Environmental Assessment

SRNI-2011 Safety Requirements for Nuclear Installations, laid down by Royal Decree of 30 November 2011

USNRC: United States Nuclear Regulatory Commission.

TE: Tractebel Engineering.

TENORM: Technologically-Enhanced Naturally Occurring Radioactive Material.

WASSC: Waste Safety Standards Committee (AIEA).

WENRA: Western European Nuclear Regulators' Association.

FANC

federal agency for nuclear control