KINGDOM OF BELGIUM

Sixth 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

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This report is produced by the Federal Agency for Nuclear Control on behalf of Belgium. Contributions to the report were also made by ONDRAF/NIRAS, ENGIE ELECTRABEL, SYNATOM, Bel V and the SCK•CEN.

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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 and near Belgium

The Doel and Tihange power plants 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 ENGIE Electrabel in electricity generating capacity in Belgium amounts to 45,5% in 2016. By means of the Law of 31 January 2003 amended in December 2013 and in June 2015, the Political Authorities have finally chosen to abandon the use of nuclear fission energy for industrial electricity production; this was done by prohibiting the construction of new nuclear power plants and by limiting the operational period of the existing nuclear power plants to 40 years, with the exception of Tihange 1 and Doel 1&2 which will shut down after 50 years of operation.

In the past there were in Belgium also other nuclear activities and facilities in the field of the nuclear energy 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.

Other 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 in the future as radioactive waste is currently being assessed by FANC and ONDRAF/NIRAS, with a view to future policy decisions 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 reprocessing	
Eurochemic (1966–1974, Dessel, end of dismantling)	Pilot reprocessing plant (built as part of an OECD project)
Fuel fabrication	
FBFC International (1973–2015, Dessel, being dismantled)	Fabrication facilities for UO_2 fuel assemblies from enriched UO_2 and fuel assembly facilities for MOX from rods of MOX fuel
Belgonucleaire (1973–2006, Dessel, end of dismantling)	Fabrication facilities for rods of MOX fuel from UO_2 and PuO_2
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 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)	6 reactors: BR1, BR2 and VENUS-F (operational), BR02 (dismantled), BR3 (being dismantled) and VENUS (changed into VENUS-F for GUINEVERE), laboratories
Institute for Reference Materials and Measurements (JRC-IRMM, Geel) of the Joint Research Centre of the European Commission	1 linear accelerator, laboratories
Ghent University (Ghent)	Thétis reactor (dismantled), 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 "third"), 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 of 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 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 had submitted its Waste Plan in September 2011 to the Federal Government. This Waste Plan provided the Federal Government with all the elements to allow an informed decision in principle to be taken regarding the Belgian policy for the long-term management of high-level and/or long-lived radioactive waste (including spent fuel if declared as waste).). ONDRAF/NIRAS resubmitted its proposal in May 2015, conform the legal procedure for national policy decisions, as defined in the law of June 3, 2014, transposing the EC Directive 2011/70/Euratom. No policy decision has been taken till now (October 2017).

A.1.1. Structure and content of the report

This national report, submitted to the sixth 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 5th Review Meeting is reported in Section A.2. An overview of the follow-up of the 5th Review meeting, addressing the suggestions and challenges identified for Belgium is reported in section K.

The following actors have participated in drafting and review:

- 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 body 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 gather 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.2. Developments since the last meeting

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

(1) Modification to the law of 31 January 2003 on nuclear energy phase out and the decisions on lifetime extension of the Tihange 1 (2012) and Doel 1 & 2 (2015)

According to article 4 of the law of 31 January 2003 on nuclear energy phase out, the lifetime of the Belgian NPPs was initially limited to 40 years. However, the government decided on the 4th of July 2012 to allow a lifetime extension of 10 year for the Tihange 1 NPP.

In order to *ensure the energy supply in Belgium*, the government and the parliament reconsidered the definitive shut down of Doel 1 & 2 end 2014 and decided in 2015 to extend the lifetime of the Doel 1 & 2 units by 10 years, by amending art. 4 of the law of 31 January 2003 and fixing the date of shutdown of all Belgian reactors. As a result, the phase out law of 2003 has been modified for the second time, on June 28th, 2015. The legal shutdown dates of the Belgian reactors are now:

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

Table 1: Shutdown dates of the Belgian reactors

Note that the construction of new NPPs remains forbidden by this law (Article 3).

(2) Regulatory framework developments

- The Royal Decree *on the decommissioning of Nuclear installations* has been proposed by the FANC and signed by the King on August 10th , 2015. This Royal Decree introduces an new section "Decommissioning" in chapter 2 (generic safety requirements) of the Royal Decree of 30/11/2011 *on the safety requirements for nuclear installations*. This Royal Decree transposes the safety reference levels of the WENRA's Working Group on Waste and Decommissioning (WGWD) related to decommissioning.
- A proposal of Royal Decree has been developed by the FANC and submitted to the Minister of Home Affairs for approval and enactment. This proposal is entitled "*Royal Decree aiming to avoid situations which can give rise to possible liabilities of radioactive waste or of installations to be dismantled*". This proposal of Royal Decree would amend 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*" (GRR-2001). This Royal Decree:
  - Addresses the transfer of licenses for facilities and activities
  - Requires a "Radioactive Waste file" and a "Decommissioning file" as part of the license application file. ONDRAF/NIRAS has to give 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 filling level of on-site storage installations, with a notification to the FANC in case of unexpected exceedance of a predefined filling level.
- A proposal of Royal Decree related to the *safety of facilities for storage of spent fuel and radioactive waste* has been developed by the FANC and submitted to the Minister of Home Affairs for approval and enactment. This proposal of 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.

Two proposals of Royal Decree related to waste disposal facilities are currently in progress :

- A proposal for a Royal Decree *on the licensing system for disposal facilities* is under processing at government level. 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.* The proposal is being modified by FANC according to the Council of State's advice.
- A proposal for a Royal Decree on the *Safety Requirements for Waste Disposal Facilities* is in development at the FANC. 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 slightly adapted, in order to fully comply with the WENRA requirements. It is expected that this project will be submitted to the Minister of Home Affairs for approval and enactment by end 2017.

(3) National programme (waste directive 2011/70/Euratom)

The national programme for the Management of Spent Fuel and Radioactive Waste (hereafter the "national programme") is the national programme referred to in 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 was drafted by the National Programme Committee created by Article 6 of the Law of 3 June 2014. In accordance with the law, this committee is comprised of representatives from the Federal Public Service responsible for Energy, which chairs the committee, the Belgian Agency for Radioactive Waste and Enriched Fissile Materials (ONDRAF/NIRAS) and the limited company Synatom *(Société belge des combustibles nucléaires)*, which is responsible for the fuel cycle for Belgian nuclear power plants, with the exception of activities assigned to ONDRAF/NIRAS, and is the owner of this fuel.

The National Programme Committee has decided to limit the first edition of the national programme to a description of the existing situation in terms of national policies, the implementation of these policies and the national framework for this implementation, without new normative content.

The national programme broadly describes the status of 31 December 2014 in terms of the management of spent fuel and radioactive waste.

In practice, the national programme's structure is pragmatically based on the guidelines established by the NAPRO working group of the European Nuclear Energy Forum of the European Commission and, in particular, adopts an approach based on waste management routes, where the management routes are defined according to the final (planned or anticipated) destination of the waste. More specifically, the following main types of waste are considered:

- very short-lived radioactive waste that can be cleared after decay;
- radioactive waste that after treatment and conditioning ends up in the category of:
  - short-lived, low-level and intermediate-level conditioned waste, also called category A waste (It corresponds to low-level waste in the IAEA 2009 classification; ONDRAF/NIRAS considers short-lived, very low-level waste that cannot be cleared to be category A waste;
  - long-lived, low-level and intermediate-level conditioned waste, also called category B waste (It corresponds to intermediate-level waste in the IAEA 2009 classification.);
  - high-level conditioned waste, also called category C waste, which includes non-reprocessed spent fuel from commercial nuclear power plants and from certain research reactors that would be declared as waste and vitrified waste from the reprocessing of spent fuel from commercial nuclear power plants (It corresponds to high-level waste in the IAEA 2009 classification.);
- radium-bearing waste that has radioactive waste status;
- radium-bearing waste likely to take on radioactive waste status, also called "potential" radium-bearing radioactive waste;
- NORM (naturally occurring radioactive materials) waste, i.e. waste from industries using raw materials containing naturally occurring radioactive substances, without the radioactive

character being a desired property of these substances and which is likely to take on radioactive waste status, in which case it is called "potential" NORM radioactive waste.

The Belgian national programme has been made available to the public on the Federal Public Service of Economy web site : http://economie.fgov.be/nl/binaries/National-programme-courtesy-translation_tcm325-279459.pdf (in English). It was also published as a Ministerial Decree of October 3, 2016 in the Belgian Official Gazette (June, 15, 2017).

(4) 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 Doel1 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, ONDRAF/NIRAS broadened the scope of its inspections to waste packages from a wide range of production periods and loaded not only 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, 175 packages were opened, 144 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.

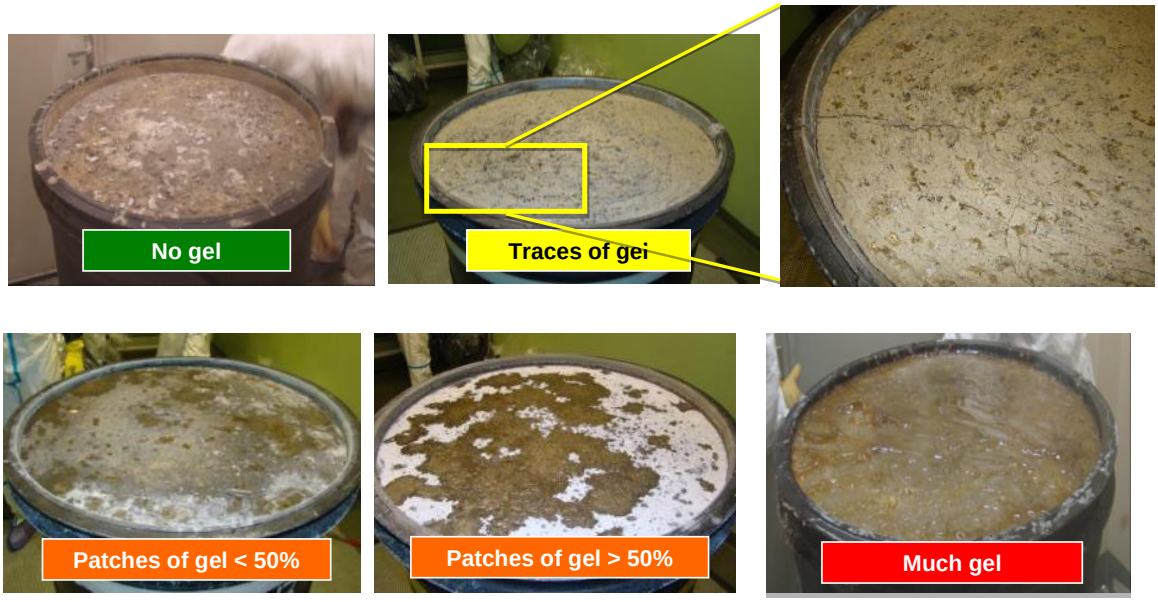

Figure 2: Opened drums with evaporator concentrates conditioned by the nuclear power plant of Doel –The top row shows a package with "no gel" (left) and "traces of gel" (right). The bottom row shows a package where "patches of gel" cover less than 50 % of the surface of the matrix (left), a package where "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 Electrabel, 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, Electrabel halted the conditioning of evaporator concentrates and ion exchange resins on its Doel site as ONDRAF/NIRAS revoked its qualifications. Electrabel launched the development of alternative conditioning processes for these waste types, again in close collaboration with ONDRAF/NIRAS.

ONDRAF/NIRAS, Belgoprocess and Electrabel inform the Federal Agency for Nuclear Control on a regular basis on the progress of this action plan.

For short-term management of the (potentially) ASR-affected waste drums from the Doel NPP, a dedicated storage facility will be constructed at the Belgoprocess site (storage building 167), with a foreseen lifetime of 75 years, in order to isolate the non-conform waste drums awaiting a solution for their long-term management by disposal. The licensing process for this storage facility is ongoing.

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

For this long-term management ONDRAF/NIRAS is currently studying all the possible 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.

(5) Progress on decommissioning programmes (Belgoprocess, FBFC, BN, others)

Progress in the decommissioning at Belgoprocess site

The dismantling of the former pilot fuel reprocessing plant EUROCHEMIC continues. The demolition of the main building of the EUROCHEMIC Reprocessing plant is being 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 will be 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 Evence-Coppée incinerator (combustion of LLW, building 236A) started end 2012 and was successfully accomplished mid-2015.

During the period 2014-2017, the following final decommissioning plans were established by Belgoprocess and approved ONDRAF/NIRAS. The following decommissioning licenses were granted by Royal Decree:

- Site 2 (Mol): Buildings 235A (storage building for alpha contaminated liquid waste), 234B/C/D/H/N (low level liquid waste treatment), 270L/M (storage facility for solid waste), 270K (storage facility for radium solid waste);
- Site 1 (Dessel): Buildings 103 (storage facility for solid alpha contaminated waste), 123 (solid waste processing/conditioning), 105/122 (storage facilities for low and high enriched waste concentrate (LEWC and HEWC) and 102N (storage ponds for fuel elements and wastes).

The decommissioning activities are ongoing in the above mentioned buildings, except for 105/122 (planning is 2020).

Progress in 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 2010-2015, the main decommissioning activities focussed on the dismantling of the glove boxes. In 2013 a radiological survey measurements programme was started for the building H, in order to reach its unconditional release. The main use of this building during the operational phase was related to non-destructive testing, storage and transport of finished leak tight MOX fuel rods. In 2016 this building H was demolished. In 2017 the dismantling activities for the remaining infrastructures and equipment are still ongoing in the buildings A (production MOX pellets and fuel rods) and L (technical building). In the next phase these buildings also will be demolished.

There were some delays related with the initial planning, due to the following:

- more glove boxes had to be dismantled on the site of BELGONUCLEAIRE: return of some glove boxes that were stored on the Belgoprocess site, due to technical problems for entering the biggest glove boxes into the alpha-cell of Pamela facility for remoted controlled dismantling;
- more complex operations for clearance of the buildings of the controlled area;
- conventional demolition of buildings of the controlled area (main buildings A, H and L). Initially these activities were not foreseen.

The objective of the decommissioning project is to reach the unconditional release of the site by 2018.

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 also 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 case of a stop of these activities 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 and the Scientific Council, and following consultation of the local authorities, a decommissioning license was granted by Royal Decree in October 2013.

In the meantime, FBFC continued the dismantling of the older buildings, for which a dismantling license was already granted in 2010. A limited number of MOX fuel assembly production campaigns were performed up to mid-2015. The dismantling of the MOX building started after the evacuation of the last remaining fissile materials in 2016.

There are delays in the initial planning due to the following:

- more profound depth contamination than expected in infrastructures;
- additional requirements for clearance measurements of the infrastructures;
- larger amount of very low level contaminated soils (sands) than expected on the site, so there was a need for the investment in a new monitoring system (conveyor with gamma-spectrometry). It will be used for sorting these soils in two fractions: wastes for conventional disposal facility (type landfill; option is still under investigation for conditional clearance) and unconditional clearance of the soil on site.

The objective of the project is to reach the unconditional release of the site by 2019.

Progress in the decommissioning of the THETIS research reactor

The Ghent University (UGent) operated the Thetis research reactor, which has been licensed as a Class I facility from 1967. This research reactor was a pool type reactor with a maximum power of 250 kWth located on the site of the Institute for Nuclear Science (INW site, presently site Proeftuin) in Ghent.

In December 2003, the reactor was shut down definitively and the necessary measures were taken to put the reactor in a stand-by mode and to ensure its safety while waiting for the core to be unloaded and ultimately the dismantling.

In July 2010, Ghent University applied for a license to dismantle the Thetis research reactor. The unloading of the reactor core by SCK•CEN and the transfer of the fuel elements by Transnubel to Belgoprocess took place between May and September 2010. These fuel elements were successfully treated and conditioned at the Pamela-facility (cutting and cementation in a 400 liter drum).

In November 2010, the facility was put in a "dormant state" until the start of the actual dismantling work. During this period, the building ventilation and the demineralisation circuit of the cooling water of the reactor pool were disconnected, among other things. Measures to be maintained during this dormant state (water sampling, checking the water level, monitoring the radiation levels and contamination, inspecting the ventilation circuit, etc.) were approved by Bel V.

Following the review of the license application by the FANC and the Scientific Council, and following consultation of the local authorities, the decommissioning license was granted by Royal Decree in May 2012. After the required removal of the operational waste, the dismantling works started in 2013 and was completed in 2015. The dismantling project was managed by SCK•CEN, and the dismantling activities on the field were performed by Belgoprocess (in collaboration with Mourik as contractor of the Ghent University). Ghent University retained the final responsibility. Its Health Physics Department remained fully functional and was expanded to deal with the increased workload in waste management and clearance resulting from the dismantling activities.

There were some limited delays, this due to the following facts:

- the amount of (non-contaminated) asbestos in the ventilation circuits) was higher than expected;
- some delays for the evacuation of the radioactive waste from the site;
- the bottom of the reactor pit was - against the expectations - activated slightly above the limits for clearance.

The reactor building, apart from the bottom of the reactor pit, has been released. Further there are no longer any radioactive substances in this building. The reactor pit will not be dismantled (as foreseen in the final decommissioning plan) and the surveillance is still guaranteed under the license of the remaining radioactive laboratories next to the reactor building. With additional decay of some years the reactor pit can be completely released.

The scenario for treatment & conditioning for the low level radioactive graphite waste (3,3 ton graphite blocks as reflector for the reactor core) at the site of Belgoprocess has been changed from cementation to combustion. This waste has not yet been treated or conditioned and the final approval process for this scenario is still ongoing.

Thetis is the first declassified reactor in Belgium (Royal Decree of 26 December 2015).

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 cleaning and dismantling the former BMB facility in Fleurus. ONDRAF/NIRAS became nuclear operator and license holder for this site, called 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.

From 2012 to now, some major goals were achieved. During the period 2014-2017, ONDRAF/NIRAS performed a first cleaning of the controlled areas. Rationalizing the management of radioactive waste accumulated on site during years and organizing the evacuation of old sealed sources were also important tasks. ONDRAF/NIRAS prepared 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. Namely, 68 200-liter drums of highly contaminated strontium-90 (Sr-90) solid waste have

been transferred for treatment at 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. It will be performed end of 2017 and during 2018
- The preparation of the cleaning operations is nearly completed:
  - specific workshop for cleaning and dismantling operations are now put in place in the existing facilities;
  - temporary storage for radioactive waste is also available for more than 800 200-liter drums;
  - specific cleaning procedures (work instructions, risk analysis…) are available;
  - cleaning of some labs already started.
- 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 is currently studied. Final elimination pathways of this concrete are analysed depending on its activation level;
  - the Final Dismantling Plan and the Safety Report are in preparation for application of a dismantling license to the FANC (Federal Agency for Nuclear Control).

As a conclusion, ONSF is ready to start large scale cleaning-up of the controlled areas prior to dismantling of the facility. Dismantling processes will require further studies before application for a dismantling license.

(6) Licensing process for 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, 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.

Between 2014 and 2017, many exchanges took place and most of the questions were answered. The exchanges gave rise to important changes that are discussed hereunder.

The license application lacked a demonstration that an optimization process was followed when developing the design. Further information revealed that such process was not undertaken in a systematic way by the applicant. Upon the FANC request, an optimization exercise took place concerning the most important design choices. In this exercise, different possibilities for design choices were compared, with the help of a list of safety attributes. The result of the exercise gave rise to some important changes in the design, emphasizing more the avoidance of contact between water and waste. For example, an anti-bathtub system will be integrated in the design and there is also the introduction of a space of a few centimeters between monolith piles, which will be filled with a coarse sand afterwards. The optimization process also gave rise to adding a new man-made barrier underneath the future facility consisting of a sand-bentonite mixture.

The design changes and the updated safety concept were further used to revise the defense in depth application in the facility.

Another issue was the lack of an operational risk analysis. This exercise was also undertaken by ONDRAF/NIRAS and led to newly defined incidents to be taken into account.

A fundamental change was made to radiological limits of the waste that will be accepted into the facility. Contrary to an approach based on backward calculations, starting from dose constraints and calculating admitted concentrations and quantities from there, a new approach was develop based on the actual foreseen inventory of the facility, and adding some margin and admitting some heterogeneity to that, in order to obtain workable limits. Those limits where then verified in the (revised) long term safety assessment.

The long term safety assessment was also profoundly modified by ONDRAF/NIRAS taking due account of the uncertainties. The scenarios are now more in line with the expected evolution of the facility. Moreover, a systematic assessment of all features, events and processes (FEPs) was undertaken to ensure that scenarios describing the altered evolution of the facility were complete, which gave rise to a new – but limited - set of such scenarios.

All those changes will enable ONDRAF/NIRAS to complete the license application.

(7) 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 raised question and to propose improvements or modifications at the legal and regulatory level. The Task Force is 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.

The Task Group identified all interfaces between the FANC and ONDRAF/NIRAS and domains with gaps or lack of clarity in terms of roles and responsibilities of the two agencies.

On the basis of a detailed analysis of these gaps the FANC and ONDRAF/NIRAS formulated 4 proposals for improvement, that were submitted to the Federal Council of Ministers:

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. intervenions and site remediations.

The final report of the Task Group was submitted to the Council of Ministers on July 20, 2017. The Council of Ministers approved the 4 proposals for improvement 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. This work is ongoing.

(8) 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.

In 1990, the Grand Duchy of Luxembourg's request led to an agreement for the treatment of Grand Duchy's radioactive waste in Belgium, confirmed by letter from ONDRAF/NIRAS' supervisory authority to the Luxembourg Minister for Health . This agreement was confirmed in 1992 and 1994. In 1994, ONDRAF/NIRAS was allowed by its supervisory authority to take charge of a quantity of radioactive waste from the Grand Duchy of Luxembourg every year as long as the volume of such waste once conditioned does not exceed 0,1 m^3.

In order to take account of the new context imposed by Directive 2011/70/Euratom, the Belgian and Luxembourg Governments have agreed to formalise the 1994 authorisation in a bilateral agreement establishing the technical and financial framework for the management and disposal of Luxembourg radioactive waste by Belgium. This agreement has been signed on July 4th,2016.

(9) 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 (4) above), ONDRAF/NIRAS has integrated the FANC recommendations in an improvement plan. ONDRAF/NIRAS is currently implementing this improvement plan. It covers various aspects of the waste acceptance system such as the management of revisions of waste acceptance criteria, the follow-up of non-conform waste, the system of sampling and control of all components of concrete-conditioned waste.

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 European ECURIE system,
- 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.

At the *OECD* level, the FANC 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) and the Committee on the Safety of Nuclear Installations (CSNI). ONDRAF/NIRAS participates in the RWMC, IGSC and FSC committees, and in the activities of the Clay Club and RK&M (Preservation of Records, Knowledge and Memory).

The FANC has a national coordinator 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 active members of the ENSREG (European Nuclear Safety Regulators group). Belgian representatives are members of the different working groups set up by ENSREG such as WG1 (nuclear safety) and WG2 (waste and spent fuel management issues).

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, FANC is an active member of HERCA (Heads of Radiation Protection Authorities) which brings together 49 radiation protection Authorities from 31 European countries.

Furthermore, the regulatory body (the FANC and Bel V) participates in the European Clearinghouse on nuclear power plants experience feedback, set up to share and analyse international experience feedback at European level.

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

ONDRAF/NIRAS participates in the Implementing Geological Disposal Technology Platform and in EDRAM.

(3) Cooperation at bilateral level

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 more recently 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 bilateral collaboration agreements with several other radioactive waste management agencies.

A.4. 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 or dry storage of SF from NPPs - Storage 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;	Extension of storage facilities on NPP sites 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 ONDRAF/NIRAS long-term fund; Insolvency funds 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; Belgonucleaire MOX fabrication plant and FBFC fuel fabrication plant; Radio-element	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	

	production facility ex-"Best Medical Belgium"		managed by ONDRAF/NIRAS) when waste is 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

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."

At 31 December 2016, there were national policies for (National Programme, Minsterial Decree of Octobre 3, 2016):

- 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 Mol–Dessel;
- 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.

More details are provided below.

B.1. Spent fuel management policy

B.1.1. Policy for the management of spent fuel from commercial nuclear power plants

At 31 December 2016, 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.1.2. Policies for the management of spent fuel from research reactors

At 31 December 2016, 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 Thétis research reactor are :

- *reprocessing* for the BR2 spent fuel;
- *safe dry storage* for the BR3 spent fuel, awaiting future decisions;
- *declaration as radioactive waste* to ONDRAF/NIRAS for the Thétis 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.

B.2. Spent fuel management practices

Until ONDRAF/NIRAS takes charge [1] 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, namely SYNATOM and SCK•CEN respectively (figure 3). 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

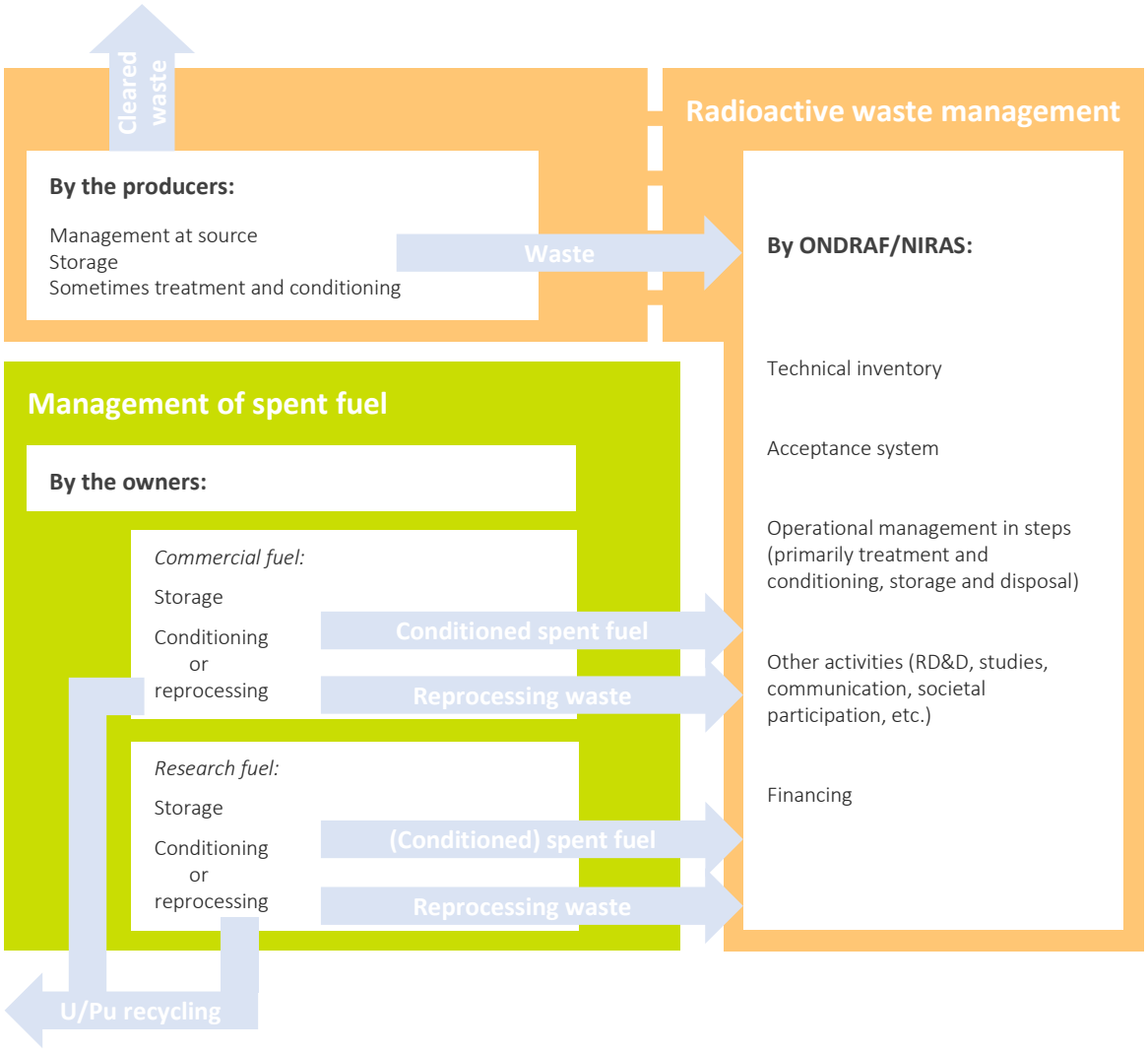

Figure 3: Organisation of the management of spent fuel and radioactive waste in Belgium

B.2.1. 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.

[1] 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).

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

SYNATOM can conduct its mission to manage spent fuel using its own resources or allow it to be carried out by third parties under its responsibility.

B.2.1.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 security 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.

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 AREVA NC). The fuel was reprocessed on the site of la Hague between 1980 and 2001.

(2) Management objectives

Pursuant to the national policy 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.2.1.b) *Inventory and facilities*

At 31 December 2016, 4080 tHM of spent fuel, including 66 tHM of MOX fuel, have been definitively unloaded from the Doel and Tihange reactors since they started operating:

- 27% of this fuel is stored in the reactor's cooling ponds;
- 57% 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.
  These storage facilities, which were approximately 60% and 75% full respectively mid of 2017, will be saturated by 2022. So as not to jeopardise nuclear electricity production because of the saturation of existing storage facilities, new storage facilities are currently under study for commissioning prior to this date.
- 16% 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 will be 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, the total quantity of spent fuel stored at the Doel and Tihange sites will reach a maximum of 4 880 tHM .

B.2.1.c) *RD&D*

SYNATOM conducted safety studies (workers and population) and feasibility studies for the industrial conditioning of spent fuel from 1994 to 2001. These studies are currently being updated and will still evolve in the future until realisation.

SYNATOM is represented within 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.2.1.d) *Transparency and participation*

SYNATOM sends the inventory of the quantities of spent fuel present in the facilities at the Doel and Tihange sites at 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.2.2. Management of spent fuel from research reactors

Until ONDRAF/NIRAS takes charge of spent fuel from research reactors in the form of reprocessing waste or as radioactive waste, the spent fuel is managed by its owners:

- SCK•CEN, a foundation of public utility supervised by the Minister responsible for Energy, manages the spent fuel from the BR2 and BR3 reactors and will have to manage the spent fuel from the BR1 and VENUS reactors;
- Ghent University declared the spent fuel from the Thétis reactor, which it operated from 1967 to the end of 2003, as radioactive waste to ONDRAF/NIRAS, which took charge of it. The reactor has been officially recognised as dismantled by Royal Decree of 26 December 2015.

B.2.2.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, on the basis of a proposal of the holders of the spent fuel and after consultation with ONDRAF/NIRAS and FANC.

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 in la Hague and defines the obligations regarding the return of the generated waste.

The bilateral agreement between Belgium and the France on the reprocessing of spent fuel from BR2 at AREVA NC La Hague was subject to debate in the Belgian Parliament, the report of which is available on the Chamber and Senate websites.

B.2.2.b) *Management objectives and inventory*

The situation at 31 December 2016 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.
    - In 1998, SCK•CEN signed a contract with COGEMA (which became AREVA NC) for the reprocessing at la Hague of the spent fuel that will be generated until BR2 stops operating. Within this framework, 1172 fuel assemblies have been reprocessed to date. 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 and for the repatriation of reprocessing waste before the end of 2030.

- 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, has been dry 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 safe 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 from 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 *Thétis 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. Waste categorisation and criteria

For the long-term management of radioactive waste, ONDRAF/NIRAS has adopted a classification consisting of three categories [2], 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.

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 [3]. Its thermal power is potentially significant at the time of its conditioning, but it will emit too little heat after the storage period 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 the repository'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.4. Radioactive waste management policy

At 31 December 2016, there were national policies for

- the management of very short-lived radioactive waste, namely *management by decay and subsequent clearance*;

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

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

- 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.5. Radioactive waste management practices

ONDRAF/NIRAS, which was given responsibility for the management of radioactive waste by the legislature, is a public body with legal personality. Its missions and functioning rules are set out by Article 179, § 2, of the Law of 8 August 1980 and the Royal Decree of 30 March 1981. ONDRAF/NIRAS is supervised by the ministers responsible for Energy and the Economy. It presents an annual activity report to the Parliament.

B.5.1. 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 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, 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.5.2. 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.5.2.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 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 SA [4], 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 ONDRAF/NIRAS takes charge of it. 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.

B.5.2.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 waste.

[4] ENGIE Electrabel has temporarily suspended some of its waste treatment and conditioning activities for technical and regulatory reasons (see section D2.2.

B.5.2.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, that have therefore the status of *radioactive* substances (see hereafter), but also radium contaminations concentrated in landfill sites and diffuse radium contamination on grounds.

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, contains approximately 55 000 m^3 of low-level or 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. 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 almost 9 000 m^3 of these soils and substances.

The issue of the long-term management of the radioactive substances contained in Umicore's licensed storage facilities, in other words the issue of their final destination, should be the subject of future policy decisions.

B.5.3. 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.5.3.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.5.3.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 practised 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.

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 side 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 coarse sand, 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.

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 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.

On 31 January 2013, 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 a nuclear construction and operation licence application for the repository to FANC. This application is currently treated by FANC (see also section A.2).

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) ;
- improvement of construction techniques;
- 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.

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.

Since then, discussions are ongoing and an official decision is still pending regarding this issue.

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 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: first in cooling ponds, then in the dedicated dry storage facility in Doel or the dedicated wet storage facility in Tihange. See also section B.2.1 b).

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 vast 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 National Radioelements Institute (IRE, Fleurus) provides in particular services to ONDRAF/NIRAS under the form of dismantling and conditioning of sealed sources. On 31 December 2015, there was a total of 453 30-litre boxes of dismantled ionising smoke detectors on the site.
- some universities, hospitals and large companies store their own very short-lived radioactive waste (and sometimes that of other nuclear operators) 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 2: 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	Decommissioning planned
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	Decommissioning planned
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	
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	End of operations foreseen in 2018

Table 3: 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, 2016

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	3948	$3,4\ 10^{14}$	$4,6\ 10^{16}$
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	C	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	17	104 (compacted)	$1,8\ 10^{14}$	$4,3\ 10^{16}$
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	1900	$1,9\ 10^{12}$	$2,2\ 10^{14}$
151	1988	Same types of waste and origins as in building 150	A + B	14700	95	13965	$5,4\ 10^{13}$	$1,1\ 10^{15}$
155	2006	Alpha- and radium-contaminated waste and conditioned Thétis spent fuel	B + Ra	4221	33	1404	$1,8\ 10^{15}$	$1,7\ 10^{16}$
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	$4,4\ 10^{11}$	$6,0\ 10^{10}$

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 2016, the conditioned waste inventory on the sites of Doel and Tihange totalled 481 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 ion-exchange resin, filters from the primary circuit and other diverse waste with a dose rate higher than 2 mSv/h, and evaporator concentrates.

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 is still qualified as the alkali-silica reaction is not an issue for them.

At Tihange, the qualification for the processing and conditioning of evaporator concentrates and filters from the primary circuit was withdrawn by NIRAS/ONDRAF due to the risk of alkali-silica-reactions. 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 these issues, new conditioning processes have to be developed and new qualification files have to 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 sites.

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. They are as follows:

- 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 radium-poor 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**	**$3{,}79 \cdot 10^{13}$**	**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 *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 are developing an assessment methodology to be applied to all sites with radium contamination from historical activities (Olen) and to NORM. The results of this assessment are expected in 2018.

D.2.4. Total inventory of existing and planned conditioned waste

The technical inventory of radioactive waste, which ONDRAF/NIRAS updates about every five years, 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 inexisting), 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 during 40 years, is as follows:

- *category A waste*: 70 500 m^3. This volume is comprised of both conditioned waste packages and monoliths of future bulk waste and should not consequently be compared to the volume of the stored conditioned waste packages;
- *category B waste*: 11 100 m^3 – 10 430 m^3 (depending on the future 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*: 600 m^3 – 4 500 m^3 (depending on the future management of commercial spent fuel).

These figures are being recalculated to take into account of the life extension of Doel 1 and 2 and Tihange 1 NPPs. (see section A.2 (1))

D.3. Nuclear facilities being decommissioned

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

- the pilot reprocessing plant EUROCHEMIC on the BP1 site and some buildings on the BP2 site;
- the Belgonucleaire MOX fuel fabrication plant;
- 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). ONDRAF/NIRAS' current license does not cover the dismantling of the facility, for which a specific license is needed (Article 17.2 of GRR-2001).

The current status of these main decommissioning programmes is given in section A.2 (5).

Ghent University's Thétis research reactor has been officially declared as dismantled by Royal Decree of 26 December 2015.

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:

- the Law of 15 April 1994 in relation with inspection and enforcement, and regarding the organisation of the Health Physics Control (amendment of 7 May 2017);
- the Law of 31 January 2003 (latest amendment 02/07/2016) concerning the phasing-out of nuclear power;
- the Law of 11 April 2003 (latest amendment 29/12/2016) on the financial liabilities for the decommissioning of the nuclear power plants and for the management of the fissile materials irradiated in these plants;
- the law of 3 June 2014 (amending the Law of 8 August 1980 on the budgetary proposals for 1979-1980, art. 179) that transposes the European Directive 2011/70/Euratom establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste.

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"), 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 will have to be brought in line with the new European radiation protection directive (Basic Safety Standards - Directive 2013/59/Euratom) by February 2018.

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

Royal Decree of 30 November 2011 (hereafter referenced as "SRNI-2011") on the safety requirements for nuclear facilities. 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 specific section on decommissioning of nuclear installations has been added in August (Royal Decree of August 10th , 2015) .

Royal Decree of 17 October 2003 establishing the nuclear and radiological emergency plan for the Belgian territory: Emergency planning 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 General Directorate Crisis Centre). For a nuclear or radiological crisis, its organisation and the role of the various intervening instances is prescribed in this Royal Decree. The national nuclear emergency plan is going to be revised in the near future (2018).

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

Every facility in which an activity is performed, that involves the use of radioactive substances or ionising radiation, is subject to a prior creation and operation license issued by the competent authority. The licensing procedure to be followed, is described in the GRR-2001 and varies with the Class of the facility, ranging from I tot IV. Facilities holding radioactive substances in quantities or concentrations, which do not exceed the exemption levels set in GRR-2001, are categorized as Class IV facilities. Class IV facilities are exempted from notification and authorisation.

The license application is submitted to the Federal Agency for Nuclear Control. Depending on the Class, it is submitted for advice to certain authorities, such as the local authorities (municipality and province level), the Scientific Council for ionising radiation of the Federal Agency for Nuclear Control and the European Commission. The regulatory body performs a safety verification of the license application. The creation and operation license is granted by the Federal Agency for Nuclear Control, with the exception of licenses for Class I facilities which are granted by Royal Decree. The procedure to be followed is described in detail hereafter.

The license application for Class I facilities has to be accompanied by an environmental impact assessment, drawn up in agreement with the European Directive 1985/337/EEG (as amended) and the Recommendation of the European Commission 2010/635/Euratom concerning the application of article 37 of the Euratom Treaty.

The facility can only be put into operation following the verification of the conformity with the license granted. This verification may be performed by a recognized organisation for health physics control for Class II-III facilities or by Bel V for Class I facilities. With regard to the Class I facilities, this verification leads to a confirmation of the initial license, by Royal Decree, called "confirmation decree".

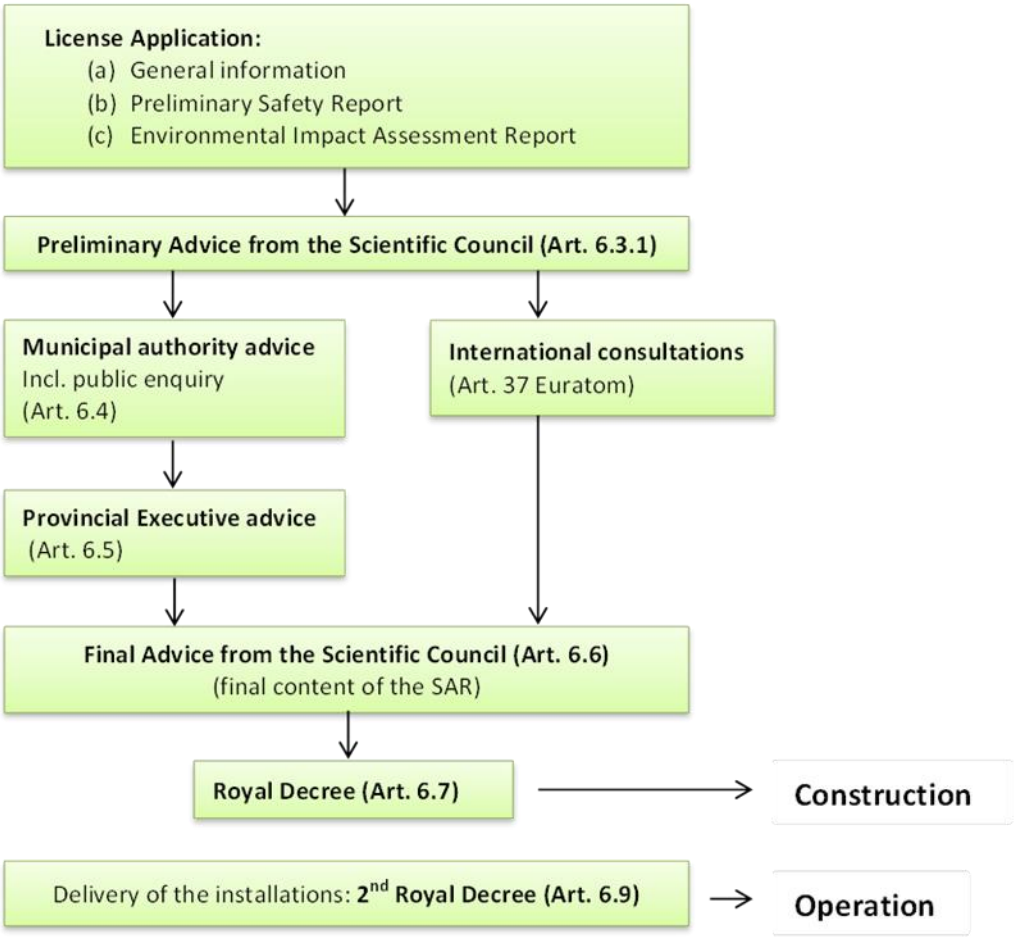

Figure 4: Licensing system for Class I facilities

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 en BP2, respectively in Dessel and Mol.

(2) Facilities for disposal of radioactive waste

Facilities for radioactive waste disposal are categorized as Class 1 facilities.

A specific licensing procedure for repositories has been submitted to the government for approval. 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.

(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 class (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.

For Class I and II facilities, the license application has to indicate information on the expected amount and characteristics of radioactive waste (gaseous, liquid and solid) that will be produced, including the waste generated by the future decommissioning and dismantling of the installations. 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.

The application of a construction and operation license for any facility considered as a potential waste producer, must include a written declaration in which the future operator commits himself to register with ONDRAF/NIRAS and to conclude an agreement with them concerning the management of the radioactive waste.

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 waste treatment and conditioning installations

The qualification of the facilities and equipment for storage, conditioning and characterizing of radioactive waste as laid down by the Royal Decree of the 18th November 2002, aims to ensure that all technical and administrative measures implemented by the Operator[5] 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. The focus is particularly put on the quality management system applicable to the technical equipment in order to guarantee the conformity of the waste with the acceptance criteria" [translated [6]]

[5] Article 1, 5° of the Royal Decree of 18th November 2002 defines an operator as "a business, a foundation, an institution or a natural person who operates equipment and for whom the Institution [ONDRAF/NIRAS] exercises its authority". ("*Exploitant: une société, un organisme, une institution ou une personne physique qui exploite une équipement et au benefice duquel l'Organisme exerce ses competences*").

[6] 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*

As such, a Belgian owner of radioactive waste shall impose 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 radioactive waste conditioning equipment offer the technical possibility of sampling the final product in active operation, in view of its qualification (…)" [translated [7]].

The general procedure for the qualification of conditioned waste packages consists of three components:

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 be granted to the Belgian owner also for a maximum duration of five years.

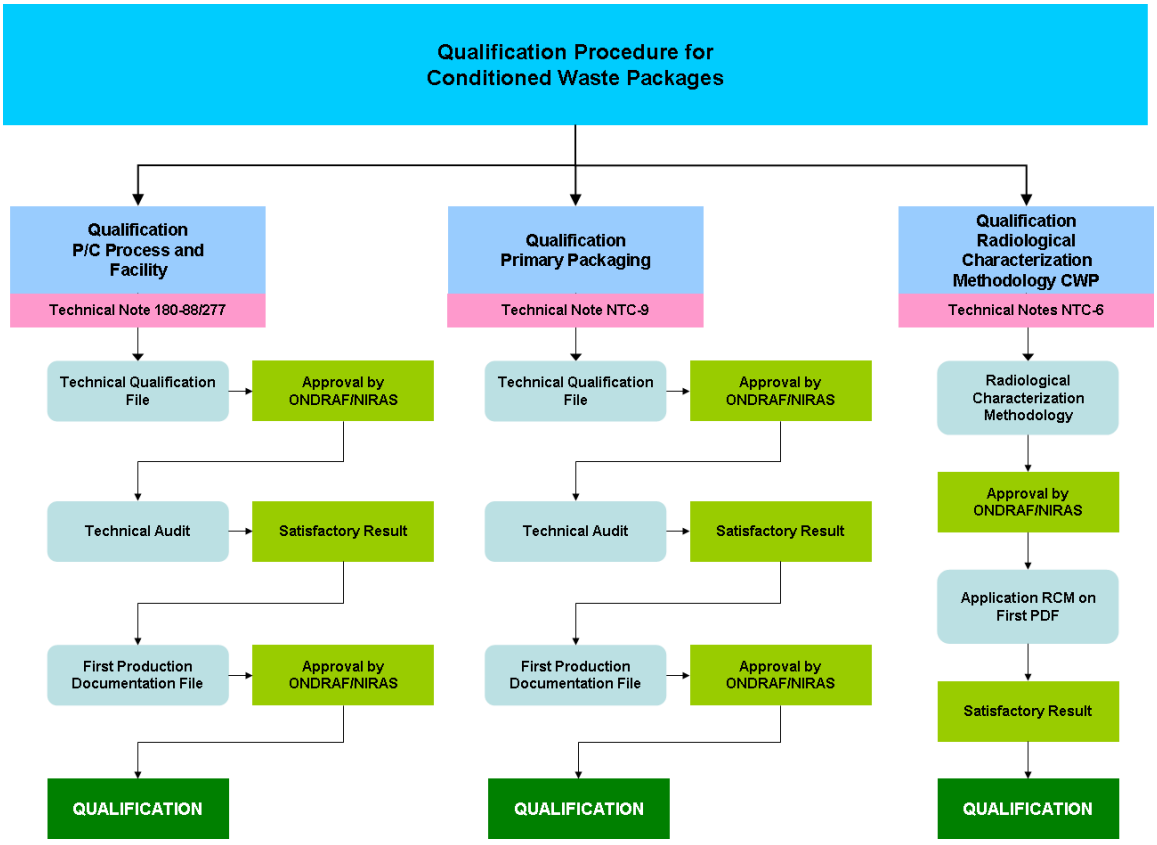

Figure 5: outline of the qualification procedure for conditioned waste

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]

[7] 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]

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 or its representative, of a Technical Audit pertaining to the Radioactive Waste Processing and Conditioning Process and the Primary Package –,
5. the approval by ONDRAF/NIRAS of a First Production Documentation File pertaining to the Radioactive Waste Processing and Conditioning Process and the Primary Package,
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.

The general procedure for the qualification of unconditioned waste packages consists of two components:

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

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

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.

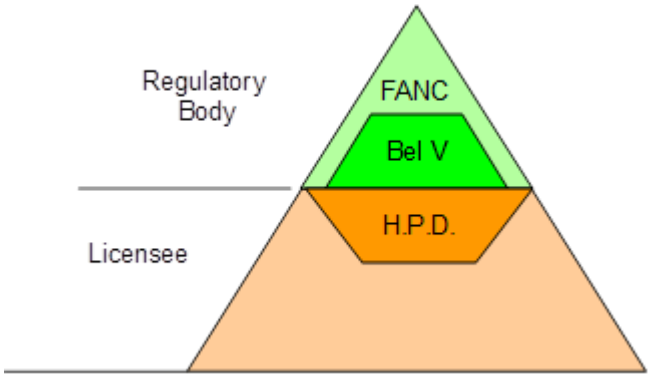

Figure 6 : 3-level control structure

The second level of supervision is provided by Bel V to which FANC has delegated certain inspection and regulatory tasks. The missions of Bel V are, among others, to verify the well-functioning of the HPD, to

commission 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 the FANC nuclear inspectors have 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 are 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.

The findings of the inspection visits and the observations made are recorded in the reports established by Bel V and transmitted to the FANC and to the operator; the latter implements then any necessary corrective action.

At this stage Bel V has only the power to make recommendations but 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.

Another possibility to strengthen safety is foreseen in article 13 of the GRR-2001: the Safety Authority (The Scientific Council or the FANC services in charge of the supervision) can, on its own initiative and at any moment, propose additional conditions to be included in 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, after advice of the Scientific Council for Class I facilities. The granting of a license for Class I facilities is by Royal Decree.

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, responsible for protecting people and the environment against the risks of ionising radiation, 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. The federal Minister for Home Affairs also has a Commissioner in the Board of Directors of ONDRAF/NIRAS. 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 www.ondraf.be.

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). Belgoprocess is holder of the operating licenses for the processing and storage facilities on its site. ONDRAF/NIRAS is also involved in the processing and storage of radioactive waste. It 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.

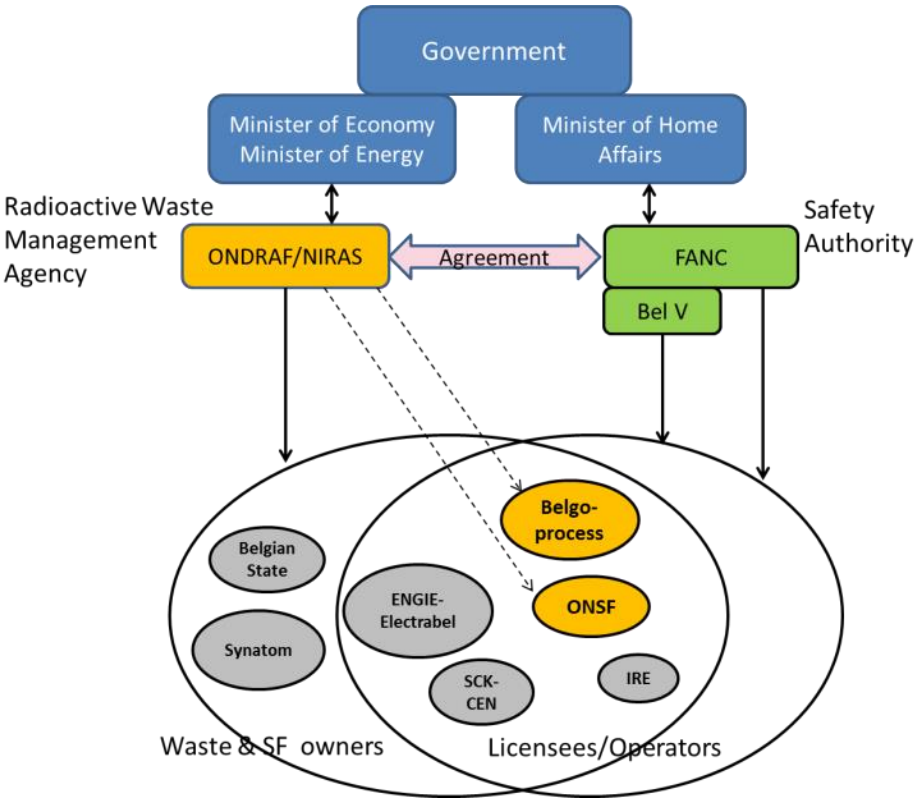

Figure 7: Organisational Structure of the Relationships between the radioactive waste management Agency, the operators and the owners of radioactive waste and the Regulatory Body

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 within the responsibility of the Federal Agency for Nuclear Control (FANC), which constitutes the Safety Authority. This mission has been given to the FANC by the Law of 15 April 1994. The FANC created Bel V in September 2007, a subsidiary with the statute of a so-called 'foundation' as defined in Belgian law to assist it in the execution of its missions. Bel V is given a mandate to perform regulatory missions that can be legally delegated by the FANC, without consulting the public market. The FANC delegates different tasks to Bel V, a.o. on site routine inspections in class I facilities (including the Research Reactors) and some high-risk Class II facilities.

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

E.4.1. The FANC

The Federal Agency for Nuclear Control 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 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 Agency is advised by a Scientific Council; 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 Agency 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 Agency 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 Agency 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 Agency 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".

The FANC organisation chart can be drawn as follows (as from 1 March 2016)

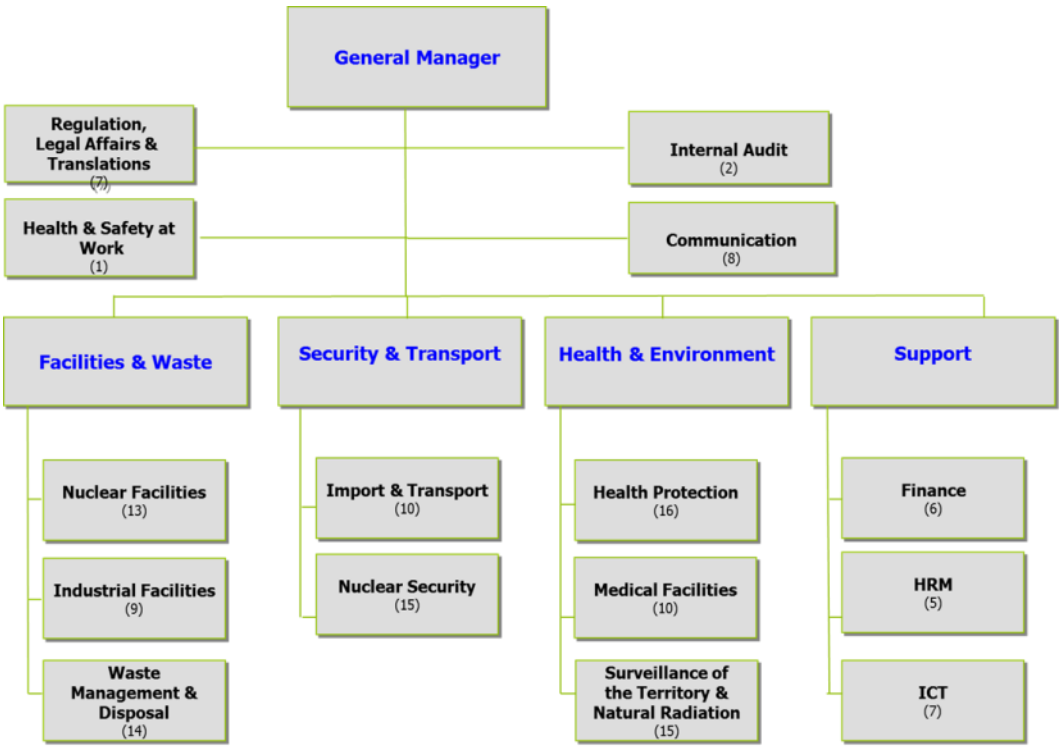

Figure 8 : Organisational chart of FANC

The missions of the department `Facilities & Waste' are specifically related to the nuclear and industrial facilities, the management of the radioactive waste, and the recognition of qualified experts in health physics control.

- The first mission includes the analysis and the evaluation of license applications. This mission consists in ensuring that ionizing radiation can be used safely and that a licence can be granted.
- The second mission involves inspections and investigations that ensure that the activities carried out comply with the license and the conditions attached to, 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.
- Finally, the department makes regulation proposals in its field of activities and develops the related guidance, including the development of a regulatory framework for the disposal of radioactive waste of different categories.

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, 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 humans and the environment . 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 radiological monitoring network Telerad), the national nuclear emergency plan and the remediation of contaminated sites.

The department `Support' is in charge of the activities at the organizational level, comprising:

- knowledge management;
- development and maintenance of the Management System;
- coordination of projects;
- coordination of international activities;
- human resources;
- finances and Information & Communication Technology.

At present, the personnel of the FANC is composed of about 160 persons. 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.

Bel V's technical personnel is composed of some 70 full-time equivalent university graduates (engineers and scientists), and recruitment is in step with the foreseeable workload. The workload consists of a more or less constant portion related to inspection in Class I and in certain Class II facilities, and a more variable load in time related to the progress of the licensee's projects and the number of safety assessments to be examined, and also to the assessment of incidents or specific safety problems in the installations in Belgium or abroad (e.g. Fukushima Daiich). An overview of Bel V main technical processes is given in section F3.4 (2).

Bel V inspectors that have to be recognized according to article 73 of the GRR-2001, ensuring, amongst others, that an expert has at least three years of experience in the nuclear field before he/she can be recognised as expert. Bel V's personnel training budget amounts to about 10 % of its overall budget in man-hours.

The inspections and analyses carried out by Bel V are invoiced to the operator on the basis of hours actually worked. In the next future, the hourly tariff of Bel V experts will be fixed by Royal Decree.

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.

A 'Management Agreement' has been signed between the FANC and Bel V. This management agreement is concluded for a period of 3 years and implicitly renewed at the end of each period. It can also change/evolve in function of experience feedback, future needs or missions.

The main elements of this management agreement are given hereafter:

a) Operational and strategic objectives

By delegation of the FANC, Bel V is in charge of the following regulatory activities:

- On site regulatory inspections and controls;
- Delivery of new installations;
- Safety assessments and environmental impact assessments;
- Emergency preparedness and response.

On request of the FANC, Bel V is in charge of the security of nuclear installations (review of security plans, associated on-site inspections and assessment of the modifications of the security plans).

b) Transverse processes

Collaboration between FANC and Bel V is established in the following areas:

- Advice on regulation proposals;
- Cooperation in international activities (e.g. WENRA, the Convention on Nuclear Safety and the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management);
- Research and Development;
- Knowledge management, improvement and development of knowledge.

By virtue of its activities and its relations to the FANC, Bel V is the Belgian "Technical Safety Organisation" (TSO), in accordance with the definition by ETSON (European TSO Network). Bel V is a member of ETSON.

The organization chart of Bel V is given below:

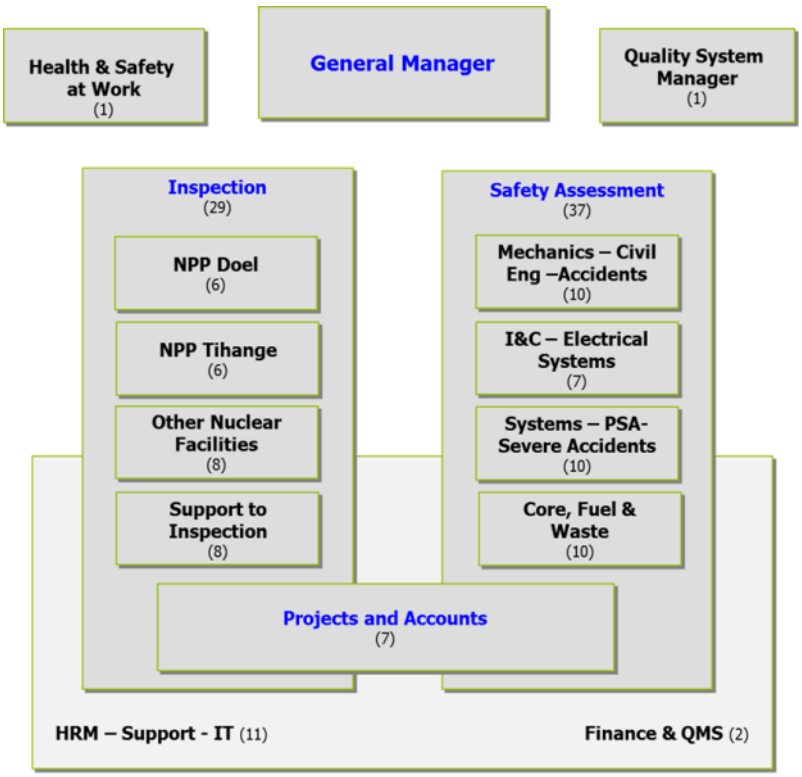

Figure 9: Organisational Chart (with staffing) of Bel V

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.

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 also 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 Ministry of Energy.

The Regulatory Body plays no part in nuclear energy promotion, although the FANC also has the mission to "stimulate and co-ordinate research and development". 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 administrative publicity*
- **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;
  - 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.

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 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.

In view of implementing certain IRRS recommendations, the Law of 15 April 1994 has been amended by the Law of 7 May 2017. Article 28 of this amended law 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 disadvantages 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 of GRR-2001 sets out training and qualification requirements for "Heath Physics Experts" who are in charge of supervising radiation 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 retention 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 31 December 2016, ONDRAF/NIRAS had 123 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 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 50% of the electricity consumed in Belgium.,

About 2200 people, among which 140 at corporate level, are devoted to nuclear power station operation among the 2800 personnel working for electricity generation as a whole, of ENGIE Electrabel's total Belgian workforce of 4500 employees. ENGIE, of which Electrabel is a part, also has an Engineering division (Tractebel Engineering - TE) 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 of over fifty years of nuclear technology, which started with the construction of the research reactors at the SCK•CEN Research Centre.

(1) Organisation

As responsible nuclear operator ENGIE Electrabel wants to optimize the added value of the nuclear fleet through operational excellence with nuclear and industrial safety as the overriding priority and with the greatest respect for the environment.

The present ENGIE Electrabel organisation for the two nuclear sites follows a matrix structure conform with the main professions and the collaborative relationship between the different actors in the operation and the management of nuclear power plants.

This organisation has the following targets:

- accurate identification of the responsibility of the nuclear site;
- well-defined activities giving clarity in the responsibilities' distribution;
- continuous goal to strengthen nuclear safety.

In this organisation, the different departments and sections at plant's level are: "Operations", "Maintenance", "Care", "Fuel" and "CIM – Continuous improvement. The site is also supported by a an Engineering department. Additionally on corporate level by "Nuclear Liabilities & Risk Management", "Nuclear Fleet Performance and Purchasing" and central "HR", legal, finances and competence & knowledge management departments.

- 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 "Fuel" section is in charge of all the fuel handling operations.
- The Continuous improvement department is in charge of Human Factors and Operational Experience activities

Nuclear Engineering: Engineering is in charge of the management of the modifications and projects on site and of the management of the generic issues and long-term concerns. They must ensure the availability of the equipment on the medium and long term. Furthermore the Engineering department has the competency of Design Authority, validating the conformity of proposed changes with the overall safety design basis.

- **Design authority & configuration management:** Provide governance for the qualification of goods & services. Facilitate the process to manage the reliability and "aging" of equipments.
- **Fleet projects:** management of projects that are common for all NPP's, such as : 10 year safety revision, general safety evaluations, LTO, studies and coordination.
- **Project governance & support**: provide governance & policies for project management, support engineering projects.
- **Nuclear Fuel:** The corporate Nuclear Fuel organisation is in charge the follow-up of the cycles as well as of the relations with SYNATOM, the company who is in charge of all aspects concerning procurement of new fuel and the back-end of the fuel cycle.

At the Business Entity Generation level of ELECTRABEL, a specific department **Nuclear Fleet Performance & Purchasing** is in charge of the following departments related to the nuclear activities :

- Process management :
  - The Quality Assurance (auditing) and the facilitation of the implementation and improvement of The Nuclear Generation Management System.
  - Document management.
- The strategic asset management and corporate support activities (e.g. management of large-scale safety projects common to the NPP's).
- Operational Fleet management: follow-up and improvements of technical performance of the installation, including Operational Experience activities and Human Factors.
- IT & IT Security (Nuclear)
- Purchasing & Warehousing: Management of all purchases and warehouses for Nuclear Production (with the exception of nuclear fuel.)

Nuclear Liabilities & Risk management:

The Nuclear Liabilities & Risk management department is in charge of all radioactive waste and decommissioning questions common for the two nuclear sites, providing advice and support to the plants, assuming the legal and contractual duties of ENGIE Electrabel related to waste and decommissioning, is in charge of managing radioactive wastes inventories, defining plant shutdown and dismantling strategy, periodically assessing the financial provisions to cover liabilities and preparing final shutdown and dismantling. This department is also in charge of managing strategic risks

An independent department is committed with the governance of the nuclear safety: ECNSD, the **ELECTRABEL Corporate Nuclear Safety Department**. This department depends on the head of Health Physics of ENGIE Electrabel who delegates the Health Physics' mission to:

- the department "Care" at corporate level (Health&Safety, Electrabel Corporate Nuclear Safety Department);
- the "Care" departments at site level;

ECNSD is in charge of evaluating the effectiveness of the management of nuclear safety in the nuclear power plants. The processes ECNSD is involved in determining nuclear safety strategy, coordinating actions regarding nuclear safety improvements, performing independent Nuclear Safety Oversight, reporting on nuclear safety, and providing operational Nuclear Safety support to the nuclear power plants. The ECNSD department reports directly to the Health and Safety and Nuclear Safety Officer, who is by law the head of the Health Physics Department. Through the Health and Safety and Nuclear Safety Officer, ECNSD reports directly to the CEO.

Chapter 13 of the Safety Analysis Report describes the structure of that organisation which has been approved by the Belgian Safety Authorities. At the time of writing the organisation is in a transformation phase.

(2) Training

The Safety Analysis Report (chapter 13) of a NPP deals particularly 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. This qualification is reviewed every two years or, if an operator has ceased during four months or more performing the function for which he was qualified. It is renewed conditionally to, amongst others, a favourable advice of the Assessment Committee on the basis of the individual's training and activity file.

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 work place.

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 the Institute of Nuclear Power Operations (INPO) whose mission is to promote the highest levels of safety and reliability – to promote excellence – in the operation of nuclear electric generating plants through plant evaluations, training, events analysis and information exchanges. At last, ENGIE Electrabel is member of FORATOM.

F.2.2. Financial resources

F.2.2.a) *NPPS*

(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 ELECTRABEL EDF-LUMINUS. The law addresses, among others, the following topics:

- the installation of a follow-up 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/ EDF-LUMINUS to SYNATOM;
- the percentage of the funds that can be lent to ENGIE Electrabel and EDF-LUMINUS;
- the management of the funds.

ENGIE Electrabel and EDF-LUMINUS remain liable for all costs regarding the future dismantling of the nuclear power plants, including 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 at the start of the nuclear power plant, and must be available when necessary,
- the amount of funds must be discounted over the life expectancy of the nuclear power plants (as defined by the law of 31 January 2003, modified on 18 December 2013, i.e. 50 calendar years for Tihange 1, Doel 1 and Doel 2 and 40 calendar years for the other units) until their use for the dismantling activities.

The current technical scenario to evaluate the dismantling cost is a conservative approach based on the immediate dismantling of all units of the same site (Doel or Tihange) 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 Engineering, 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 techniques, and based on a set of boundary conditions, the cost is evaluated by an addition of all the tasks.

Two types of return of experience (REX) are taken into account:

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

The technical scenario and his boundary conditions included in the preliminary decommissioning plan of 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 2016.

The new law stipulates a three-year review and a formal approval by the CPN of any changes in methodology, funding or investment policy. For the conclusions of the CPN with respect to the sufficiency of financial funding, the consultation and an advice of ONDRAF/NIRAS is needed.

(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 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 a conservative scenario namely a mix scenario with a part of deferred reprocessing of spent nuclear fuels and a part of direct disposal.

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 administered outside the SCK•CEN. 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

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. 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 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, referred to here using 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 SYNATOM, ENGIE Electrabel, FBFC International, Belgonucleaire, IRE and SCK•CEN 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.

Currently, the long-term fund mechanism is such that tariff increases are carried forward on waste still to be taken charge of by ONDRAF/NIRAS from the revision date of the tariffs. This means 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 will have to be made compliant with the provisions of the Royal Decree of 25 April 2014, which amends the ONDRAF/NIRAS Royal Decree, by 31 December 2018 at the latest. This new decree, which specifies the guiding principles for provisioning the long-term fund, stipulates indeed that, from then on, tariff increases will be 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.

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

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

Insolvency fund

The *insolvency fund*, implemented in 1992, is, in accordance with the provisions of the ONDRAF/NIRAS Law, mainly intended to finance services for the management of radioactive waste and the decommissioning of nuclear facilities that are not covered following the bankruptcy or insolvency of the financially liable entities, which are implicitly identified as not including the financially liable entities for class I nuclear facilities. The insolvency fund also covers the cost of managing sources declared by FANC as orphans 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.

(3) 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. In connection with this, it also evaluates the availability of these provisions. 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.

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

Table 4 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
Belgonucleaire (Dessel)	Belgonucleaire	Accounting provisions with additional measures
SCK•CEN (Mol)	Excluding liabilities: SCK•CEN	Accounting provisions with additional measures
	Liabilities: Federal State	External fund, without separate legal personality, with additional measures
IRMM (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 wasteto 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 4: 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 Royal Decree of 30 November 2011 (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 in Mol–Dessel. 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 as best as possible 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. 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 a Integrated Management System. In recent adaptations of the process model a process 'management systems' is 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:

- To develop 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.
- The review of the safety policy (in line with the revision of GS-R-3 in GSR part 2) and the development of an action plan with the main goal to improve and optimize the safety culture.

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 10) 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 which is treated and conditioned in Belgium, as well as 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.

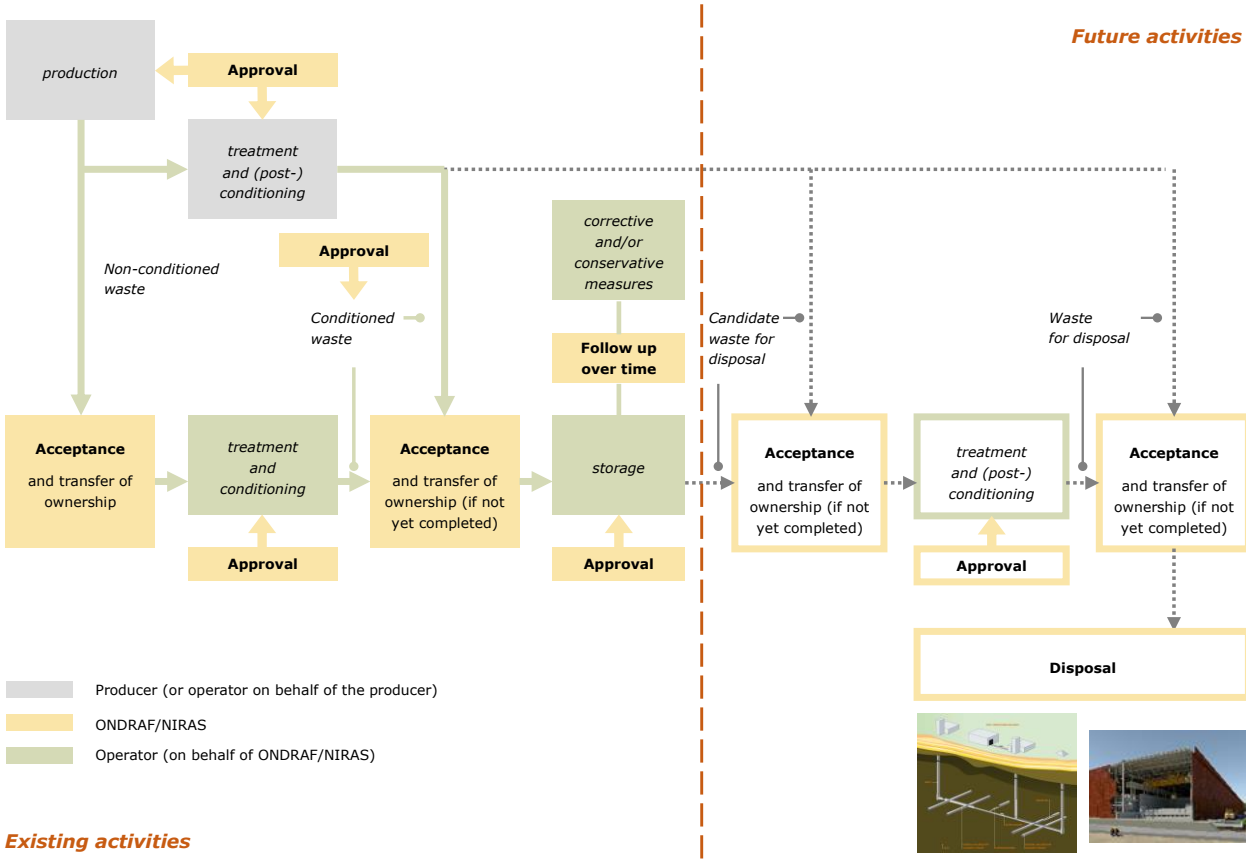

Figure 10: Simplified diagram of the ONDRAF/NIRAS acceptance system for radioactive waste. The system currently in force for the acceptance of non-conditioned and conditioned waste is being extended to waste for disposal

F.3.3. Quality Management system of ELECTRABEL / SYNATOM

The responsibility for applying the quality assurance (QA) programme is assumed by the operator, who subcontracts the related tasks to 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 his Architect-Engineer 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 the operator.

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
- Electrabel's Internal Code for Nuclear Safety
- Electrabel's Reference for Operational Nuclear Safety
- Electrabel's Nuclear Generation Management System Policy Manual
- Execution documents

(1) Electrabel's Internal Code for Nuclear safety and Reference for Operational Nuclear Safety

Two documents are developed and maintained by the Electrabel Corporate Nuclear Safety Department (ECNSD):

The Internal Code for Nuclear Safety is the cornerstone of the Electrabel internal governance regarding Nuclear Safety. It aims to:

- Support Electrabel in striving for operational excellence for all its Belgian nuclear activities, peculiarly fostering on the continuous improvement of its Nuclear Safety performance;
- Define rules that support the Electrabel management system to comply with the Belgian legal and regulatory requirements, as well as the ENGIE Group requirements regarding the management of Nuclear Safety;

- Define the internal stakeholders' roles and responsibilities with regard to Nuclear Safety at a corporate level.

The internal code for Nuclear safety is approved by the CEO of ENGIE Electrabel.

To meet its commitment to strive for excellence in all its nuclear processes and activities, Electrabel requires them to conform with requirements additional to the legal and regulatory ones. These additional requirements are identified in the document entitled "Reference for Operational Nuclear Safety". the Reference for Operational Nuclear Safety integrates the quality assurance requirements for the processes of the management system. It complements the Internal Code and is approved by the Head of H&S/Nuclear Safety/Security.

Each Electrabel entity must translate the directives and general principles of the Internal Code into local procedures and instructions taking into account the QA minimal requirements levels defined in the Safety Reference.

(2) Electrabel's Nuclear Generation Management System Policy Manual

The "Nuclear generation management system Policy Manual" gives a more detailed description of Electrabel's Nuclear Generation integrated management system to achieve its objectives and to ensure and to improve safety at Electrabel's 3 sites, the Doel and Tihange power stations and the Nuclear Corporate headquarters. This management system is process-based.

F.3.3.d) *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.e) *Evaluation*

(1) Nuclear safety oversight

Monitoring

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

Self-assessment

Management at all levels (Senior Management, Line Management and Process Owners) carry out self-assessments with the objectives to:

- Evaluate the performance of work;
- Prevent, identify and correct weaknesses that hinder the achievement of Electrabel's objectives;
- Improve the management system;
- Enhance the Nuclear Safety culture and the effectiveness of processes and activities.

Inspections and Audits:

A comprehensive system of planned and periodic inspections and audits is carried out to verify compliance with all aspects of the management system and to determine the effectiveness of the management system to provide adequate confidence that a structure, system, or component will perform satisfactorily in service.

Management System Review

A management system review is conducted at planned intervals at the ENGIE Electrabel 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.

(2) 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 this service, 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.

Nuclear Safety Committees

Within 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 Electrabel:

- The Plant Operating Review Committees (PORC),
- the Site Operating Review Committees (SORC) and
- The Independent Nuclear Safety Committee (INSC)

(3) 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

(1) The Federal Agency for Nuclear Control

Since 2008 the FANC has had a quality management system that conforms to ISO 9001:2008. A complete review of the management system started in 2012 in view of the IRRS mission that took place end 2013. This review resulted in a new mapping of the management system, integrating governance documents, intention plans (strategy, operational objectives), and operational and support processes. The FANC decided not to prolong its ISO 9001 certification. The management system that is being developed and implemented is based on the IAEA Standard GSR Part 2 and takes on-board relevant issues of the ISO9001:2014 standard, such as risk analysis and process description.

The FANC management system consists of:

- a governance document "*Vision, missions and organisation of the FANC - GD002-01*" which describes how missions and responsibilities entrusted to the FANC by the Law of 15 April 1994 are discharged through the different FANC departments and sections.
- the "*Strategic plan - IP002-01*", established on a timeframe of 9 years. This strategic plan is translated in a 3 year operational plan and finally in an annual operational plan including budget.
- *FANC quality policies,* developed in accordance with the FANC missions and the Strategic plan and validated by the senior management. Policies for licencing (GD010-04), inspection (GD010-02) and for management of incidents (GD010-05) contain decision criteria, foresee double check (or peer review) and validation by the senior management.
- *regulatory procedures* , that are based on relevant legislation and FANC policies.

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

The interfaces between processes are identified and the process owners are responsible to verify the consistency of the processes, ensuring that all concerned parties are involved in the development of them.

The principle of continuous improvement is being applied. Each staff-member (including the management) is expected to actively participate in the improvement of the management system.

All FANC members contribute to the identification of non-conformities. The corrective and preventive actions are regularly monitored, and the status of the non-conformities is discussed within the senior management during the Management Review. Currently, 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.

(2) 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 as regards safety are: to "**manage the accounts & projects"**, to **"provide and manage expert services",** to "**perform the inspections during operation"**, to "**manage expertise and technical quality"** (Research & Development, Safety Issue Committee, Operating Experience Feedback (Committee, etc.), to "**manage and to develop human resources"**.

The follow-up of all national and international projects linked to the operation of the installations is performed in the framework of the process "**manage the accounts & projects"**. 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**". The "Safety Issue Committee" belongs also to this process.

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

Bel V MS is aligned with the requirements of GSR-3. Furthermore Bel V has been certified ISO 9001:2008 in 2009. Bel V is preparing the transition to ISO 9001:2015 for 2018.

All the Bel V processes and their sub processes (e.g. horizontal activities) are identified in the Bel V Quality Manual. The Bel V Quality Manual translates the requirements of ISO 9001:2008 for Bel V. This Quality Manual sets out minimum requirements of the Bel V integral Quality Management System which applies to all nuclear safety monitoring and radiation protection activities of Bel V and to its advisory work.

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 Safety Authority 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[8].
- 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 the installations in the scope of the Joint Convention 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.

[8] Criteria and Modalities specified by Decree of the FANC, published in the Official Journal on 30th of July 2008.

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 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 are leading to the following radiological impact for the most exposed individual of the public:

Site or Facility	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 2014-2016		
	Gaseous	Liquid	Total (maximum)	Gaseous	Liquid	Total (maximum)
SCK•CEN	0.1 mSv	-	0.1mSv	0.7 µSv	-	0.7 µSv
FBFC	10 µSv	-	10 µSv	0.2 µSv	-	0.2 µSv
Belgonucleaire	5 µSv	-	5 µSv	<1 nSv	-	<1 nSv
Belgoprocess	0.3 mSv	0.2 mSv	0.5mSv	8 µSv	40 nSv	8 µSv
IRMM	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	14 µSv	<0.6 µSv	14 µSv
Tihange site (3 NPPs)	0.19 mSv	0.08 mSv	0.21 mSv	46 µSv	2.2 µSv	48 µSv
Doel site (4 NPPs)	0.18 mSv	0.23 mSv	0.37 mSv	19 µSv	0.6 µSv	20 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 solid radioactive waste stored on the site and of the cleared materials. This inventory is permanently available for the FANC.

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 in order 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 17 October 2003 defines a nuclear and radiological emergency plan for the Belgian territory.
  As already mentioned, this plan is presently under revision and the new version is expected by 2018.

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

F.5.2.a) *Classification of Emergency*

The Royal Decree of 17 October 2003 defines three levels for the notification of emergencies, which are in ascending order of seriousness N_1 to N_3, which the operator must use when warning the "Centre Gouvernemental de Coordination et de Crise - **CGCCR**" (i.e. the Governmental Centre for Co-ordination and Emergencies) which assembles under the authority of the Minister of Home Affairs. In addition, a fourth notification level ('reflex' level or N_R) has been considered to cope with events with fast kinetics. In case that 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 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 alarm level. In such case the governor of the province hosting the nuclear site is immediately notified in parallel to the warning message to the CGCCR.

For each of these 4 notification levels (N_1 to N_3 + N_R) the notification criteria are defined in the Royal Decree of 17 October 2003. 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 'reflex' notification level, the activation criteria are based on predefined scenarios.

Each of these 4 notification levels (N_1 to N_3 + N_R) activates the federal emergency plan. In addition to these four levels, a "N_0" level is defined for notifying the Authorities in case of an operational anomaly. This last level does not activate the emergency plan.

All emergencies (N_1 to N_3 + N_R) have to be notified to the CGCCR. This permanently manned centre alerts the cells involved in the crisis management at the federal level (Emergency and Co-ordinating Committee, evaluation cell, measurement cell, information cell, socio-economical cell) and houses these cells during the crisis situation as well.

The "Emergency Director" of the Authorities transforms the notification level into an alarm level (U_1 to U_3), putting into action the corresponding phase of the National Emergency Plan. In the case of N_R, the U_R alarm level is automatically triggered and 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 CGCCR's cells are in place and operational, the U_R alarm level will be converted to an appropriate alarm level 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 CGCCR is composed of the "Federal Co-ordination Committee" chaired by the Emergency Director of the Authorities, of the evaluation cell, of the measurement cell, of the information cell and the socio-economical cell, as indicated in the figure 11 below.

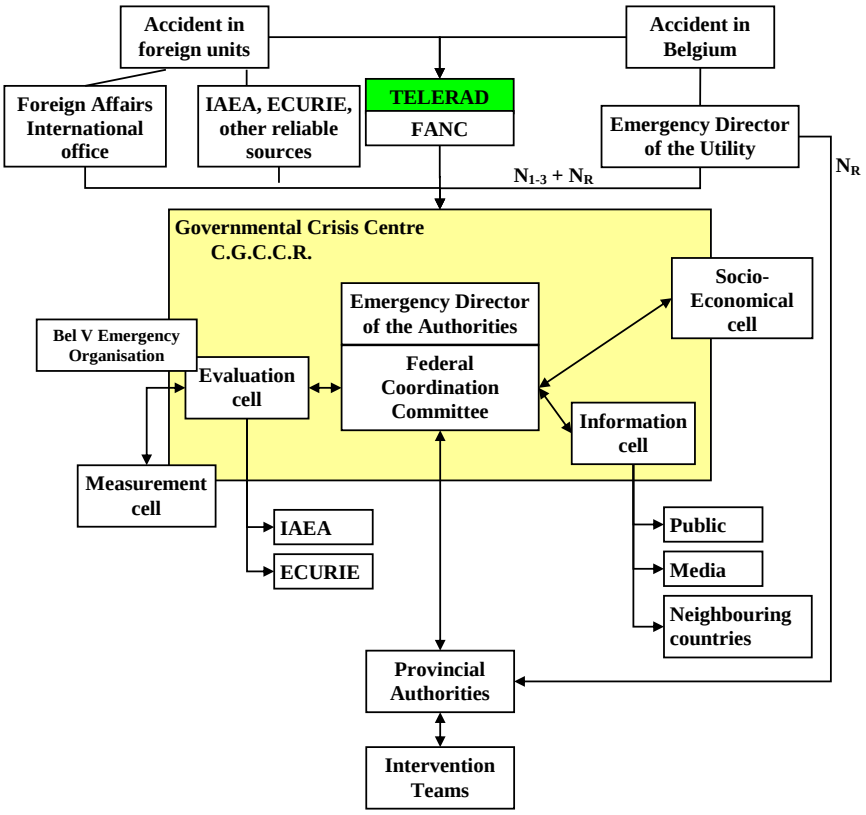

Figure 11 : EPP organisation for Belgium

The data received through Belgium's Telerad network for automatic radiological monitoring can also be accessed by the CGCCR. 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 222 stations for the measurement of the ambient dose rate in air, 7 stations for the measurement of iodine and β/γ in aerosols and 8 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.

The figure 12 below depicts the TELERAD network:

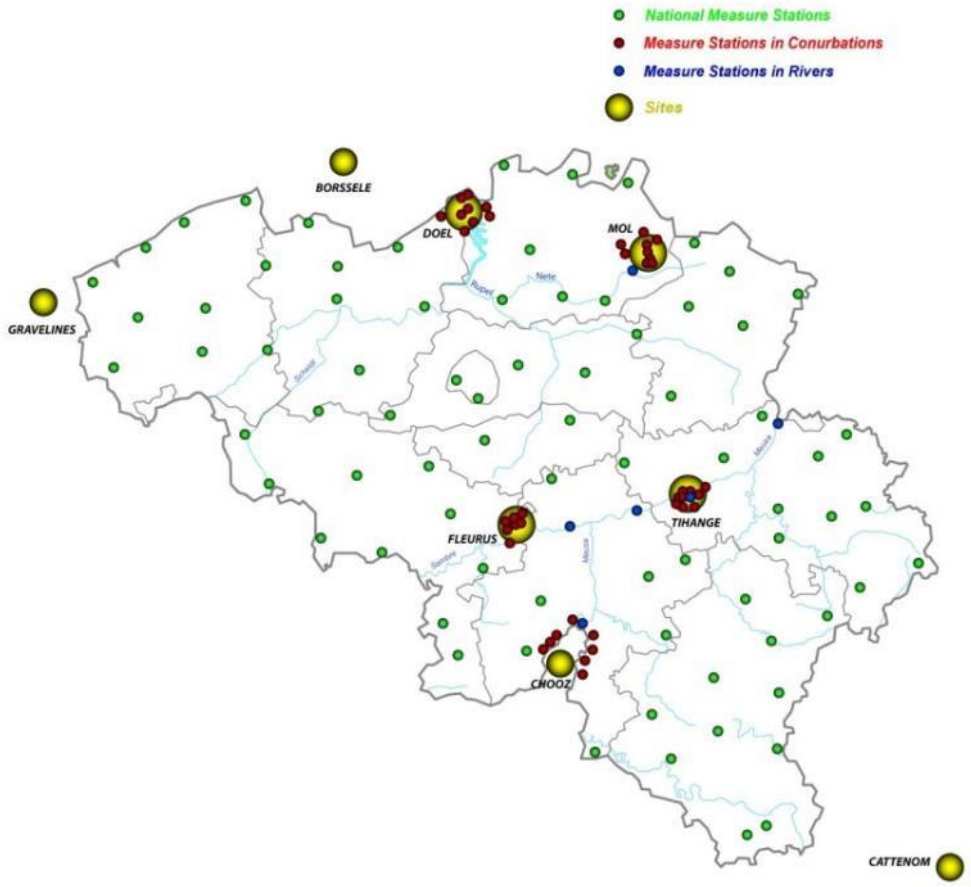

Figure 12 : TELERAD Network: location of the measuring stations

The **Federal Co-ordination 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 strategic 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. Their decisions lean notably on the advices of the Evaluation and Socio-economical cells. 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 Federal Public Service of Foreign Affairs (for accidents abroad), the Department of Defence, the Royal Institute of Meteorology, of experts of the SCK•CEN, of the IRE ("Institut des Radioéléments"), and of Bel V, 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 Federal Co-ordination Committee on protective actions for the protection of the population and the environment. This advice is elaborated on the basis of intervention reference levels, issued by the FANC (24 November 2003). 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 **Socio-economical** cell advises the Federal Co-ordination Committee on the feasibility and economic and social consequences of their decisions; it informs the Federal Co-ordination 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 CGCCR (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 17 October 2003 defines the emergency planning zones relative to the direct actions to protect the population (evacuation, sheltering, and iodine prophylaxis). These evacuation and sheltering zones have a 10 km radius around the nuclear plants; the stable iodine tablets pre-distribution zones extend to 20 km around the nuclear plants.

The intervention reference levels are set in the Decision of the FANC of 24 November 2003. They are 5 to 15 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 to 150 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 to 50 mSv thyroid equivalent dose for children less than 18 years and pregnant or breastfeeding women and 50 to 100 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 [9].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 [10], 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 tool 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 a continuously evolving issue on which is worked on a permanent basis. On the one hand 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 on the other hand.

[9] 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).

[10] 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).

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

The emergency plan of each Belgian unit is systematically described in its Safety Analysis Report (chapter 13, § II.I.3) and has been approved at the time of licensing. In complement, an "internal emergency plan" details the instructions for all the actors.

These emergency plans take into account the related post-TMI actions.

In case of accident the unit's "Centre Opérationnel de Tranche" (COT - Tihange) – "Bedrijfsfkamer" (Doel) (i.e. the On Site Technical Centre) is activated and manages all the technical problems to control the accident and mitigate its consequences. At site level, the "Centre Opérationnel de Site" (COS - Tihange) – "Noodplankamer" (NPK - Doel) (i.e. the Emergency Operations Facility) manages the environmental impact, liaises with the CGCCR, and communicates with the Corporate crisis Organization.

The nuclear power plant conducts internal exercises several times a year, and the General Directions of Civil Safety and of Crisis Centre 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 in these exercises the various disciplines (fire brigade, medical help, police force, civil protection, measurement teams ...).

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

During the exercise, the information corresponding to the scenario is gradually forwarded to the various participants; the Training Centre full-scope simulator may in certain cases also be used on-line during exercise to provide information needed.

Information exchange at the international level is performed through the CGCCR, which has contacts with the competent Authorities of the neighbouring countries, and which is the "national contact point" for Convention on Early Notification of a Nuclear Accident (IAEA) and for the similar European Union system (ECURIE).

Agreements also exist at local and provincial level including at trans-boundary level (with Netherlands and France). On April 28, 2004 an agreement was signed between Luxembourg and Belgium concerning the exchange of information in case of incidents or accidents with potential radiological consequences

As regards independent evaluation in the event of an emergency, Bel V which oversees the affected installation sends a representative to that site, a representative to the evaluation cell of the CGCCR, and activates its own emergency plan cell. This cell has dedicated telephone and facsimile lines to the affected installation and to the evaluation cell. Based on the technical information supplied directly by its representatives and all the information about the unit that it has at its head office, Bel V proceeds with a technical analysis of the situation, assesses the radiological consequences from the releases indicated in the scenario, and produces release forecasts from the estimated situation of the unit.

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 89/618/Euratom. During the accident itself, information is supplied to the media by the information cell of the CGCCR. 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 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 (form 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 reach. It also requests the licensee to establish a final dismantling report.

All requirements related to radioprotection (dose limits, discharges, clearance, …), imposed by GRR-2001, are 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 its 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 3rd inventory was published in January 2013; the 4th inventory is foreseen for January 2018

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 annual programmes and 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.

(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 annual programmes and budgets which have to be approved by ONDRAF/NIRAS.

(4) Liability fund IRE

The IRE liability fund was raised in 1997 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. For decommissioning of the facilities, a liability fund still has to be raised.

(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 operational 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 (5).

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 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 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 2 of the SRNI-2011 (i.e. safety requirements applicable for all class I facilities) is given in **Appendix 1**. This Royal Decree is currently being completed with a new chapter applicable to waste and spent fuel storage installations.

(1) 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 assessments 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.

(2) 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 (March 2017) of the action plan for NPPs can be found on the FANC web site (in English):
http://afcn.fgov.be/fr/system/files/national_progress_report_on_the_stress_tests_of_nuclear_power_plants_2017.pdf

The current status of the action plan for other Class I facilities can be found on the FANC web site : http://afcn.fgov.be/fr/system/files/rapport_national_de_suivi_des_tests_de_resistance_pour_les_autres_etablissements_de_classe_i_2017.pdf (in French)

(3) 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 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 had to be mentioned in this report concerns:

a. The purpose and the nature of the facility,
b. A plan of the installations,
c. A cadastral plan and a topographic survey of the region (500 m around the installations),
d. Demographic, topographic, geologic, seismologic, hydrologic and meteorological characteristics of the region (15 km around the installation) and information on the lay-out of the site,
e. An exhaustive description of the radioactive materials, with special attention to fissile material,
f. A report describing the most important accidents likely to occur in the installations and assessing the probability and the consequences for the population and the workers (accidental scenarios: explosion, fire, airplane crash, failure of the ventilating system, etc.),
g. A description of the systems for the storage, purification and discharge of gaseous and liquid waste; a description of the maximum daily and monthly discharged quantities of liquid and gaseous waste, the nature of the discharge, a plan of the areas showing the discharge points, the description of the local sewer system, the flow rate of the rivers in which liquid waste are discharged, the temperatures at the chimney outlet for the release of gaseous waste, the monitoring stations to measure the radioactivity levels in air; a description of the volumes and masses of solid waste to store.
h. Protective measures for the personnel working in direct contact with radioactive materials,
i. Assessment of the impact for workers, public and environment during normal operation as well as in accident conditions.
j. Staff qualification and competences.

FANC and Bel V review the Preliminary Safety Analysis Report and related technical documents, and express their comments and remarks, which have to be taken into account in the updated version of the Safety Analysis Report that has to be finalized before the actual start-up of the facility.

The license application also comprises an environmental impact assessment covering radiological and non-radiological impacts. This environmental impact assessment covers at least:

- data similar to the general data as they are set out in the Commission Recommendation of 11 October 2010 on the application of article 37 of the Euratom Treaty,
- data necessary to identify and assess the main environmental impact of the installation,
- a draft of the main alternative solutions investigated and an indication of the main reasons to justify the choice made.

The second phase consists of 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 delivery 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).

(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 operational 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 safety review of the application file is performed by Bel V and presented to the FANC, and an amendment to the License (Royal Decree) is established.
- minor modifications having a potential impact on safety. 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. Bel V issues 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 (reference 2010-054) for the practical application of this requirement in Class I facilities. Similar guidance for Class II-III facilities exists. The FANC guidance 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 use of INES is done via a convention between the licensees, the FANC and Bel V. This convention stipulates in which circumstances and how INES is to be used. 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).

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 not taken into account the presence of boric acid in the system (what is conservative). Burn-up credit is integrated in the criticality analyses, with the approval of the Safety Authorities, on a case-by-case basis.

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 motorpumps 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.

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 particular 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. Therefore the lifetime of the installation is periodically reassessed.

G.2.2. SCK•CEN site: BR2

Additional information on BR2 can be found in appendix 4

G.2.2.a) *Spent fuel storage*

The spent fuel and radioactive materials, stored under water in Side-pools, are cooled by the pool water circuit.

BR2 standard fuel elements are stored under water, mainly for shielding reasons. Storing 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 can only take place 100 days after their last irradiation, considering the ^{131}I content and the residual power.

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.

A single fuel element could approach a storage rack with other standard fuel elements. The distance between axes, however, is still larger than 120 mm (> 44.5 mm between surfaces), corresponding to a k_{eff} value of 0.9 for an infinite array in square lattice. As regards the wet-sipping rack, the minimum distance may be 121.5 mm between axes, but as the other fuel elements are more distant from each other, a critical assembly cannot be formed in this way.

As far as the racks for 200 mm type fuel elements are concerned, these fuel elements are neutronically nearly uncoupled. The distance between surfaces (75mm) is sufficient to avoid criticality, taking into account that the 200 mm type fuel element contains a cadmium screen. The tight tubes used for the transfer are stored with a protective cover.

A maximum admissible limit of 0.90 for k_{eff} has been fixed for every storage place/configurations.

The different types of standard fuel element (alloy A, cermet C, G or E) 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 of the type VIn A 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 m³) 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 m³/h (one in service and the other in standby). A third one of 90 m³/h is used when the reactor is stopped. The flow in the side-pools is ensured by 2 pumps of 85 m³/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 and of the beam-tube walls in the vicinity of the vessel.

Part of the flow of this line also cools down the beam-ports in the pool wall in order to evacuate the heat generated by the gamma heating.

When the pumps stop, the shutdown pump with a flow of 90 m³/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 m³/min and a pressure head of 4 kg/cm². 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 initial license of each Belgian nuclear power plant made it mandatory to conduct ten-yearly safety reviews.

The last Periodic Safety Reviews were performed:

- for the Tihange NPP in 2012 (units 1,2) and in 2015 (unit 3)
- for the Doel NPP in 2012 (units 1,2,3) and in 2015 (unit 4)

G.3.1.b) *Stress tests*

See sections G.1 and K.1.2.

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.a) *Stress tests*

See sections G.1 and K.1.2.

G.3.2.b) *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 sites 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 being 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 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.

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 km^2 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/sec^2."*

No special provisions have to be taken for earthquakes in the reactor building or control design.

The earthquake mentioned occurred on 11 June 1938, in the massif of Brabant. The epicentre was located in Zulzeke-Nukerke (geographical co-ordinates: Lat 50.783N; Lon 3.58E). The magnitude was 5.9 and the depth of the hypocenter 24 km. The intensity at the epicentre was VII (MSK) with a macro seismic region of 340 km^2. In the region of Mol, an intensity of IV was observed.

In the operating 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.

The main issues concerning siting 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.
- Remaining actions to be realized in the next three years consist of :
- Construction of a new seismic-qualified building for the diesel emergency power supply
- Construction a new firefighting water supply system

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

G.5. Article 7: Design and construction of facilities

ARTICLE 7. DESIGN AND CONSTRUCTION OF FACILITIES

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

(i) the design and construction of a spent fuel management facility provide for suitable measures to limit possible radiological impacts on individuals, society and the environment, including those from discharges or uncontrolled releases;

(ii) at the design stage, conceptual plans and, as necessary, technical provisions for the decommissioning of a spent fuel management facility are taken into account;

(iii) the technologies incorporated in the design and construction of a spent fuel management facility are supported by experience, testing or analysis.

G.5.1. Doel and Tihange facilities

G.5.1.a) *Appropriate measures to limit radiological effects*

(1) <u>Fuel deactivation pools in buildings "GNH" (Doel 1/2), "SPG" (Doel 3/4), "BAN" (Tihange 1) and "BAN-D" (Tihange 2/3)</u>

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 of 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 length of the pipes 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.

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, 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.

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*

The water of the secondary circuit 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 γ-activity.

Samples of the secondary water are regularly taken to be analysed by means of spectrometry.

For the pools, two measuring chains are installed to monitor the activity of the water in the storage canal. The water of the pools in the reactor building is monitored by these chains (γ-activity measurement).

Samples of the water in the pools are regularly taken to be analysed by means of spectrometry.

G.6. Article 8: Assessment of safety of facilities

ARTICLE 8. ASSESSMENT OF SAFETY OF FACILITIES

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

(i) before construction of a spent fuel management facility, a systematic safety assessment and an environmental assessment appropriate to the hazard presented by the facility and covering its operating lifetime shall be carried out;

(ii) before the operation of a spent fuel management facility, updated and detailed versions of the safety assessment and of the environmental assessment shall be prepared when deemed necessary to complement the assessments referred to in paragraph (i).

G.6.1. Doel and Tihange facilities

The construction and the commissioning of any installation, and in particular a spent fuel management installation, are subject to a licensing process that includes a systematic safety assessment and an environmental impact assessment as described in section G.1.

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 every ten years or on specific request by the Safety Authority,

G.6.2. Installations of SCK•CEN: BR2

See section G.1 and articles 4 to 7

G.7. Article 9: Operation of facilities

ARTICLE 9. OPERATION OF FACILITIES

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

(i) the licence to operate a spent fuel management facility is based upon appropriate assessments as specified in Article 8 and is conditional on the completion of a commissioning programme demonstrating that the facility, as constructed, is consistent with design and safety requirements;

(ii) operational limits and conditions derived from tests, operational experience and the assessments, as specified in Article 8, are defined and revised as necessary;

(iii) operation, maintenance, monitoring, inspection and testing of a spent fuel management facility are conducted in accordance with established procedures;

(iv) engineering and technical support in all safety-related fields are available throughout the operating lifetime of a spent fuel management facility;

(v) incidents significant to safety are reported in a timely manner by the holder of the licence to the regulatory body;

(vi) programmes to collect and analyse relevant operating experience are established and that the results are acted upon, where appropriate;

(vii) decommissioning plans for a spent fuel management facility are prepared and updated, as necessary, using information obtained during the operating lifetime of that facility, and are reviewed by the regulatory body.

G.7.1. Doel and Tihange facilities

G.7.1.a) *Initial 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.7.1.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.7.1.c) *Surveillance programmes*

The Technical Specifications also list the controls and tests to be performed and their frequency. Specific programmes are established, in particular for inspections and controls, and tests.

Each safety-related equipment has a qualification file that contains all the qualification test requirements and results. In this file are also recorded the results of ageing tests (based on IEEE 323 and the 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.7.1.d) *Operation in accordance with the approved procedures*

A general description of the procedures in force in the power plant is given in section 13.5 of the Safety Analysis Report.

The completeness (form and contents) of the procedures has been investigated on the basis of the USNRC Regulatory Guide 1.33 which lists the subjects for which procedures must be established. This investigation was conducted as part of the licensing process and the acceptance of the installations by Bel V. During the commissioning tests, the relevant procedures that were used by the operators were verified for adequacy.

G.7.1.e) *Engineering and technology support*

The organisation and know-how of the operator, dealt with in chapter 13 of the Safety Analysis Report, must be maintained throughout the operational life of the power plant, and even after its definitive 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 minor modifications projects, which allowed keeping up the competence and knowledge of the installations. TE is also consulted by the licensee when the latter wants to proceed to a modification of its installation. TE is also in charge of the follow-up of the provisioning of fuel reloads and of core management. Through its R&D projects, training actions and technological surveys, TE maintains a high competence in conformity to the state of the art. In order to reach these goals, TE is involved in many international research projects and is a member of various networks (or competence centres).

The design bases of the plants, i.e. the knowledge of the design of the plants and the reasons of the choices made in this design are an important part of the knowledge.

The operator - with the support of the Architect-Engineer - has developed a complete set of procedures to be able to cope with incidents ('I' procedures) or accidents ('A' procedures). These procedures are simulated, validated and used for the operators' training.

G.7.1.f) *Notification of significant incidents*

Section 16.6 of the Safety Analysis Report lists the events that must be notified to Bel V and/or to the FANC, indicating for each notification the delay within which it must be notified.

The same section also specifies the cases for which incident reports must be supplied to the Regulatory Body, and within which delay.

For each incident, a classification with reference to the INES international scale is proposed by the operator, discussed with Bel V, and decided by the FANC.

The IRS (Incident Reporting System – IAEA) reports are established by Bel V and transferred to the operator for comments, and to the FANC before it is distributed abroad.

G.7.1.g) *Operational experience feedback*

Operational experience feedback has always been considered essential to plant safety, both by the operators and the regulatory body.

Art. 11 of the Royal Decree SNRI-2011 requires vigilance and operational feedback (internal and external). Also the 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.7.1.h) *Decommissioning plans*

The operator entrusted Tractebel-ENGIE with the follow-up of the decommissioning issue for the spent fuel management installations.

In particular, initial decommissioning plans for nuclear power generating units have been established, including the spent fuel storage installations. These decommissioning plans are periodically reviewed.

In concrete terms, provisions have been taken to facilitate the dismantling:

- considering dismantling aspects when modifying the storage installations, in order to facilitate these operations and to reduce as much as possible the activity level during the dismantling;
- gathering the information related to the storage buildings in order to improve the organisation of the future dismantling operations;
- implementing an efficient waste management policy throughout the normal operation.

G.7.2. SCK•CEN installations: BR2

G.7.2.a) *Initial license and commissioning*

See Section E, article 19 and section G.1

G.7.2.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.7.2.c) *Surveillance programmes*

A surveillance programme is established in order to guarantee the quality of all safety-related activities in case of a 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.7.2.d) *Operation in accordance with the approved procedures*

A general description of the operation procedures is given in the Safety Analysis Report approved by the Regulatory Body.

G.7.2.e) *Engineering and technology support*

The organisation and know-how of the operator must be maintained throughout the useful life of the power plant, and even after its definitive shutdown as long as this new status is not covered by a new license.

G.7.2.f) *Notification of significant incidents*

Each operating cycle of the BR2 is preceded by a note called "start-up" justifying the operational safety on the basis of the observations made during the previous period. 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.7.2.g) *Decommissioning plans*

A fund - financed by the State – has been set up to cover obligations resulting from the decommissioning of the installations involved in the nuclear activities of the SCK•CEN before 31 December 1988. This fund is called "Technical Liability Fund" (Fond du Passif technique). The objective is to come back to *green field*, however, other end-states may be considered such as re-use of installations. Decommissioning of BR2 is covered by this fund. An initial decommissioning plan was worked out for BR2 and approved by ONDRAF/NIRAS and the Technical Passive Fund administrators.

G.8. Article 10 :

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 yet 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 in section G.1 applies.**

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 describes how safety is ensured and is the starting point for safety development and evaluation with respect to the entire repository system (waste, monoliths, modules, 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.

A nuclear site needs to be monitored in order to guarantee the safety of the people living in the vicinity at all times. ONDRAF/NIRAS is developing a programme to monitor the repository and its surroundings in accordance with legislation. This repository monitoring programme can also be integrated into general information about the wider nuclear site.

No matter how thorough and well thought-out the repository's safety management may be, accidents can never be ruled out. For this reason, ONDRAF/NIRAS is preparing an emergency plan; 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. Together with leading knowledge organizations ONDRAF/NIRAS is conducting a pilot project that will establish whether humane 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. It also developed guidance for disposal. These guides concerned:

- the requirements for surface waste disposal facilities
- the requirements for geological disposal facilities
- the aspect of human intrusions for surface waste disposal facilities
- the radiation protection criteria for long term safety for surface waste disposal facilities
- 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 the biosphere in a long term safety assessment

International guidance, in particular the relevant IAEA safety standards, and best practices are used as bases for these guides.

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 + 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 period after repository closure 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).

Information concerning the current status of the Stress Tests action plans for the facilities concerned can be found in section K (challenge n°10 from the previous review).

H.2.1.b) *Stress tests*

See sections G.1 and K.1.2

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 definition of a national policy for the long-term management of these radioactive materials and waste is being prepared by ONDRAF/NIRAS, in interaction with the FANC.

For the radioactively contaminated landfill D1 at the Olen site, a remediation project is being prepared in collaboration with the regional environmental protection authorities and the non-radioactive waste management authority.

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 one 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 planned 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 fuelled by taxes and retributions (law of 29 December 2010).

(3) The communication centre

A communication center will be established at the disposal site, serving as the core of all information and communication on 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 (DIN), which will allow local communities to get information from a distance, i.e. via tv and website, 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. Operation and feasibility of the DIN are currently being tested as a pilot project;
- a theme park about radioactive waste management: a tourist and educational activity centre 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 committed to deliver a first Safety and Feasibility Case called "SFC 1 V1", for the radioactive waste of category B and category C. This SFC 1 V1 consists of one self-supporting report describing the proposed disposal system aiming at presenting the arguments to sustain the safety and the feasibility to construct and operate a geological disposal in poorly indurated clays, i.e. to verify that, based on current knowledge, there is no major obstacle for such a project . Due to the current lack of policy decision by the Federal Government, this report will be mainly methodologic and based on the assumption that poorly indurated clays can be chosen as host rock.

(2) Category A programme

The license application submitted for the surface disposal facility, currently being under review by the regulator, is separated into two parts. A first part concerns the safety of the facility during the operational period, up to the closure of the facility, whilst a second part concerns the review of 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 facilities:
  This guide stipulates amongst others the radiological criteria 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"* 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 repository in its environment safety is part of the license condition.

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 underway 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.

The provisions related to the transport of radioactive material are set in chapter VII of the GRR-2001. This chapter stipulates that a prior license is required for every shipment. This license is only granted if it can be demonstrated that the requirements of the relevant international Conventions and agreements[11] are complied with.

[11] ADR : European agreement concerning the international carriage of dangerous goods by road.
RID: Regulations concerning the International Carriage of Dangerous Goods by Rail, appendix C to the Convention concerning International Carriage by Rail (COTIF).
ICAO: Technical Instructions for the Safe Transport of Dangerous Goods by air, of the International Civil Aviation Organisation.
IMDG: International Maritime Dangerous Goods Code of the International Maritime Organisation (IMO).
ADN: European agreement concerning the international carriage of dangerous goods by inland waterways.

The current Belgian legislation for the transport of radioactive material is under revision. The main goal of the revision of the Belgian legislation for the transport of radioactive material is to evolve from a license-based system combining reporting and notification with inspections toward a new system mainly based on registration with limited reporting and notifications and only a limited number of licenses being required after registration. This new system will focus on inspections and compliance audits in order to ensure compliance with the national and international regulations for the safe transport of radioactive material. It should reduce the administrative burden for the FANC and its stakeholders involved in the transport of radioactive material on the Belgian territory. We expect that the new legal framework will be published in the Belgian Official Journal in the autumn 2017 and coming into forces by end of 2017.

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 and granted licenses granted for:

- Transit of spent fuel from the Dutch nuclear power plant of Borssele to AREVA NC La Hague in France;
- Transit of compacted and vitrified radioactive waste from AREVA NC La Hague to the Netherlands;
- Import of radioactive waste from AREVA NC 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).
- 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.

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 deliverer/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 the regulation 1493/93. The producer has to take these used sources in "decay storage" or has to transfer them to ONDRAF/NIRAS.

Aware of the risks associated with the use of sealed radioactive sources and, in particular, of "orphan sources", the European Union has promulgated a directive (2003/122/Euratom) on the control of these sources. This initiative finds its justification in the significant number of accidents that happened worldwide during these recent years.

The purpose of this directive is to prevent the public and the workers from being exposed to ionising radiation resulting from an inadequate control of sealed sources. Its provisions cover sources emitting, at the time of its production, a dose rate equal or greater than 1 mSv/h at 1 meter, and orphan sources. This directive completes the Directive 96/29/EURATOM laying down basic safety standards for the health protection of the general public and workers against the hazards of ionising radiation, already integrated in the Belgian Law.

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 will have to be set up for the disposal and storage of the source when it becomes disused, or arrangement to return the source to the supplier or to a recognised storage installation will have to be made.

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 regularly updated copy of these sheets.

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 competent authorities must establish appropriate provisions in order to recover orphan sources and to deal with radiological emergencies resulting from any misuse of these sources. The Member States are encouraged to develop controls aimed at detecting orphan sources in places where orphan sources may be encountered such as metal scrap recycling installations. Campaigns for recovering the orphan sources shall be organised.

A fund financed by guarantees shall be established to cover the costs for recovering the orphan sources when the liabilities cannot be identified or when the liable person is insolvent.

This Directive has been transposed in the Belgian regulations by the Royal Decree of 26 May 2006, amending accordingly the GRR-2001.

With respect to disused sources, ONDRAF/NIRAS organised specific removal campaigns of radioactive waste and disused sources in the Belgian schools and pharmacies.

A grouped removal has several advantages:

- a safe management of radioactive waste is provided in the medium and in the long term;
- a reduction of administrative burden;
- transport and waste treatment are less expensive when grouped
- batches of waste can be transported and processed together.

K. Section K: General efforts to improve safety

K.1. Measures taken to address suggestions and challenges identified for Belgium at the 5th review of the Joint Convention (2015).

One suggestion has been identified for Belgium at the 5th review meeting. The Suggestion, Challenges and Measures to improve safety identified by the review group and gathered in the Rapporteur's report are listed in the table below:

Belgium – Suggestion -2015 Review Meeting
1. The need to build interim storage facilities as the remaining capacities were diminishing in existing spent fuel storage pools
Belgium – Challenges -2015 Review Meeting
1. Dealing with major non-conformities of conditioned NPP waste discovered during inspections gel-like material in conditioned low-level waste packages 2. Clarification of status and policy for SF: reprocessing or direct disposal 3. Approval and implementation Waste Policy for the long-term management of HLW, long-lived waste 4. Development of plan for radium-bearing waste 5. Decommissioning Financing ▪ liability fund for IRE decommissioning 6. Regulatory framework and FANC guidance on decommissioning (clearance, site release, staff, licensing) 7. Consequences of Nuclear Energy Phase-out on the waste management chain 8. IRRS action plan ▪ on-time completion by the regulatory authority involving full scope - Dec. 2013, 30 recommendations and 24 suggestions (follow-up mission in 2016) 9. Licensing and construction of the surface disposal facility 10. Implementation of safety improvement measures from the stress tests

K.1.1. Suggestion identified for Belgium at the 5th review meeting

In recent years ENGIE-Electrabel has been developing options for additional interim spent fuel storage at both its sites in Doel and Tihange. The additional capacity is needed because the currently available capacity for interim storage of spent fuel is foreseen to be exhausted before the shutdown of the NPP units involved.

Currently the FANC is being informed of the initiative through a pre-licensing project which allows the FANC to express its expectations for the safety demonstration and to identify any issues which should be resolved prior to the license application.

The concept that has been chosen by ENGIE Electrabel is dry storage in dual purpose casks. At the site of Doel a similar installation already exists whereas spent fuel on the site of Tihange is currently stored in pools. A license application for the new spent fuel storage facilities is expected in 2017, which, if successful, could lead to the start of construction in 2019-2020 and start of operations in 2022.

K.1.2. Challenges to improve safety identified for Belgium at the 5th review meeting

K.1.2.a) *Challenge nr 1: Dealing with major non-conformities of conditioned NPP waste discovered during inspections gel-like material in conditioned low-level waste packages*

See section A.2 (4) which presents developments on this issue.

K.1.2.b) *Challenge nr 2: Clarification of status and policy for SF: reprocessing or direct disposal*

The law of June 3, 2014 transposing the EC Directive 2011/70/Euratom, stipulates that the status of the spent fuel, in terms of the conditions for its future use, will be part of a national policy decision, to be taken on the basis of a proposal by the owners of the spent fuel (i.c. Synatom for the spent fuel from the nuclear power plants), and after taking the advice of ONDRAF/NIRAS and FANC.

At the moment, no such proposal is being prepared by the owner(s) of the spent fuel or being requested by the Federal Government.

K.1.2.c) *Challenge nr 3: Approval and implementation Waste Policy for the long-term management of HLW, long-lived waste*

The definition of a waste policy for the long-term management of the HLW and long-lived waste in Belgium is ongoing at Government level.

K.1.2.d) *Challenge nr 4: Development of plan for radium-bearing waste*

A methodology for a preliminary assessment of radium-contaminated sites, in order to assess the sites where interventions could lead to the generation of radioactive waste is currently being developed. The results of the application of this methodology will form an important element for the development of a plan for the long-term management of radium-bearing waste in Belgium. The results are expected to be available in 2018.

The supervising Ministers of the FANC - through a regulation (law) proposal developed by the FANC- and of ONDRAF/NIRAS - through its technical inventory-, are also informed of the need to define a specific decisional process for the long-term management of the radium-bearing materials and waste in the storage facility UMTRAP, at the Umicore site, Olen. The need for such a specific decisional process is argued by the specific technical (incl. safety) and economical challenges for these materials and waste:

- A historical situation (existing exposure situation), with mixed historical liabilities;
- Large quantities of unconditioned intermediate level radium-bearing waste;
- Important anticipated costs for waste retrieval from the storage facility and for waste disposal.

K.1.2.e) *Challenge nr 5: Decommissioning Financing: liability fund for IRE decommissioning*

No progress has been made on this issue, not considered as a priority.

K.1.2.f) *Challenge nr 6: Regulatory framework and FANC 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. The purpose of this project is to develop and define a clearly and structured approach for the regulatory body, covering all aspects of decommissioning and dismantling waste issues.

The project also deals with the training of sufficient staff of the regulatory body on decommissioning activities and for the preparation of specific decommissioning processes.

This project deals with five issues:

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

Several documents have been delivered by the project until now, including:

- Position paper for the clearance of buildings, with nuclide specific clearance levels
- Position paper for the release of sites
- Definitions and phases linked with the decommissioning of an installation
- Table of correspondence between the final decommissioning plan asked by NIRAS/ONDRAF and the safety report for decommissioning asked by FANC

There are other upcoming documents, like a position paper for the clearance of materials, guidance about the waste during decommissioning, information about the end of regulatory control. These documents are planned for 2017/2018.

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

K.1.2.g) *Challenge nr 7: Consequences of Nuclear Energy Phase-out on the waste management chain*

With the Royal Decree of April 25, 2014 the financing system for the long term management of radioactive waste was modified to take into account the phase-out of the nuclear power programme and the potential disappearance of waste generators contributing to the covering of all long-term management costs (storage and disposal). With the diminishing amounts of radioactive waste that will be generated in the future, the Royal Decree of April 25, 2014 stipulates that any increased costs of long-term waste management can be covered by tariff increases that apply both to waste already produced and future waste arising. Before, tariff increases did only apply to future waste arising.

The future decommissioning of the NPPs will require an operational waste management chain with an operational end-point, i.e. disposal for the large quantities of waste that will be generated. Most of the decommissioning waste belongs to the category A waste. Therefore, a high priority is given to the licensing and construction preparation of the surface disposal facility and connected facilities (concrete caisson fabrication plant and the facility for the encapsulation of the category A waste in concrete caissons, i.e. the monolith fabrication facility).The planned timing of construction and operation of these facilities is compatible with the anticipated calendar of decommissioning of the NPPs.

K.1.2.h) *Challenge nr 8: IRRS action plan*

Soon after the IRRS mission of end 2013, the FANC drew up an action plan to address the recommendations and suggestions. The action plan developed for the period 2014-2016 did not only address the recommendations and suggestions from the IRRS, but included also the action plan from the self-assessment performed in preparation of the IRRS mission, the FANC's strategic plan, taking into account the upcoming challenges such as the phase-out of nuclear energy, the implementation of the European BSS and specific demands from the operational departments of the FANC. The resulting action plan comprised 3 main "programmes" :

- Management System: mainly deals with the internal organisation and has as objective to develop and implement a management system such as described in IAEA GSR Part 2.
- Future of the Regulatory Body: deals with specific strategic options to be chosen within a short to medium time frame.
- Specific Actions : this programme covers all subjects that have been identified by the IRRS-mission and the strategic plan methodology as individual actions or projects that are not necessarily to be performed within the two other programmes.

Beginning 2017, a new three-year operational plan was developed and initiated by the FANC. Although this plan is of a different structure than the previous one, the IRRS actions that were not closed have been included in this new plan. One example is the continuation of the development of the Management System and its implementation. This new plan clearly identifies the deliverables expected for each action, and is also subject to regular (quarterly) follow-ups.

The IRRS follow-up mission will take place from 26 November 2017.

K.1.2.i) *Challenge nr 9: Licensing and construction of the surface disposal facility*

See also section A.2 (6).

The licencing process of a surface facility for Low and intermediate level waste – short lived has started on 31st January 2013.

From June 2013 to July 2014, FANC and Bel V requested additional information on the safety case.

The additional information is being discussed between the regulatory body and ONDRAF/NIRAS. Those discussions should lead to a update of the safety case towards the end of 2017. The licence application file with the FANC and Bel V's safety review will presented to the Scientific Council. The preliminary advice from the Scientific Council is expected early 2018.

K.1.2.j) *Challenge nr 10: Implementation of safety improvement measures from the stress tests*

The action plans resulting from the Stress Tests is currently nearly completed.

(1) For Belgian nuclear power plants (project BEST)

The scope of the Belgian stress tests for NPP's covers all seven reactor units including the associated spent fuel deactivation pools, and the dedicated spent fuel storage and waste management facilities at both sites, namely:

- "SCG" building at Doel (dry cask spent fuel storage facility),
- "DE" building at Tihange (wet spent fuel storage facility),

The current status (March 2017) of the Action Plan can be found on the FANC web site : http://afcn.fgov.be/fr/system/files/national_progress_report_on_the_stress_tests_of_nuclear_power_plants_2017.pdf

(2) For other nuclear facilities (project BEST-A)

The action plans following the stress tests of those facilities have been approved by the FANC in July 2013. As for 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 (March 2017) of the action plan for the IRE, Belgoprocess facilities as well as for the waste treatment installations at Doel site (WAB)):

External Hazards: Earthquake

Seismic resistance	Belgoprocess	Evaluate resistance of several buildings against earthquakes	Under Review
	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
	IRE and Belgoprocess	The seismic resistance of important electrical equipment must be evaluated.	Done
	IRE	Ensure the availability of two tanks of 3000 liters (unconventional means) in case of an earthquake.	Done
		Check anchoring of several structures.	Done
Secondary effect of earthquake – Increase autonomy	IRE	Adapt resources and procedures in order to take into account post-seismic actions (walk-down, …)	2017
		Evaluate the seismic resistance of the lead windows.	Done

		Evaluate the seismic resistance of important electrical equipment	Done
	Belgoprocess	Conducting 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 the hot waste tanks in the 124X building to a level of 4.7 m.	Modified and ongoing
External Hazards: Extreme weather conditions			
Heavy Rain	IRE	Replacing a portion of the drainage network	Done
		Take into account a return period of 1000 years on the capacity of the drainage system and drain water.	Done
		Measures to ensure water removal in case of water ingress into the cellars	Done
	WAB Doel	Impact of extreme rainfall on the capacity of sewage and drainage system, with a return period of at least 1000 years.	Under review
	Belgoprocess	Perform a treatment/disposal of hazardous waste present on its "site 2" and eliminate the conditioned wastes from the 270M building. The last waste drums have been evacuated from the building 270M. The treatment/disposal of hazardous waste present on its "site 2" is still ongoing. The related actions should be terminated in 2017.	End-2017
		Construction of a new storage building for non-conditioned waste on site 1. The concept note has been delivered to the Authorities.	Ongoing
Loss of safety functions: Loss of Offsite Power			
	IRE	Prepare a testing programme for activated coal traps in order to monitor their performance in case of accidental release.	Under review
Loss of safety functions : Station Black-Out			
	WAB Doel	Prepare a control procedure to check the fail-safe position of WAB elements after a power failure	Done
Operational procedures	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			
	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
Backup heat sink	Belgoprocess	A new study on the production of heat by	Done

		the vitrified wastes stored in 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
	IRE	Study measures that could reduce the releases in case of a total loss of containment (static and dynamic) and the arrangements for their implementation.	Done

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

K.2.1.a) *Specific actions, on-going or planned by the Regulatory Body*

(1) Continuation of improving the regulatory framework

The regulatory body continues its activities related to the legal and regulatory framework development. In particular, this includes finalization of current regulation development projects concerning:

- Licensing system of disposal facilities
- Safety requirements for disposal facilities
- Transposition of the European Basic Safety Standards
- Remediation activities

(2) In relation with licensing activities, several new licenses for waste facilities are expected to be issued during the next period (2018-2021) :

- The license for the surface disposal facility
- The license for a building (167G) for the storage and management of ASR-affected waste drums at Belgoprocess
- The license for spent fuel storage extension at NPP sites

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

(3) Other planned actions include :

- The implementation of the Taks Force recommendations (See A.2. (7)) (as suggested by the IRRS mission of 2013).
- Closure of the remaining actions of the IRRS action plan for the Regulatory Body
- Continuation of R&D activities and active participation in international working groups

K.2.1.b) *Specific actions, on-going or planned by ONDRAF/NIRAS*

(1) Status Spent Fuel

With the Parliamentary resolution of 22 December 1993, ONDRAF/NIRAS was requested to develop a geological disposal facility for both high-level and intermediate level waste from reprocessing of spent fuel and for spent fuel declared as radioactive waste. ONDRAF/NIRAS will prepare a safety and feasibility case (target 2020) for the geological disposal of the radioactive waste streams from these two options (reprocessing waste and spent fuel). Previous assessments were made in the past (e.g. SAFIR 2, 2001).

(2) Extension of waste acceptance system to disposal

ONDRAF/NIRAS will continue to work on the extension of its waste acceptance system to disposal by:

- Revising the general rules for the waste acceptance criteria (the existing general rules date from 1999), and submitting the general rules to FANC for binding advice; ONDRAF/NIRAS will submit the revised General Rules to its supervising Ministers for publication as a Royal Decree;
- Implementing the identified points and actions for improvement (also based on an analysis and verification of the existing operational waste acceptance system by FANC and on the identification of an important number of non-conform waste drums from the Doel NPP in storage – ASR affected waste drums)
- Integrating in the waste acceptance criteria the requirements from the disposal licence and safety case to be complied with.

(3) Storage capacity at the Belgoprocess site

ONDRAF/NIRAS and Belgoprocess will closely follow-up the remaining storage capacity for conditioned radioactive waste on the Belgoprocess site, by taking account of the following key factors:

- the expected waste arising on the Belgoprocess site, as based on the most accurate forecasts by the waste generators, mainly for the waste from the NPPs;
- the evolution of the projects for creating additional storage capacity on the Belgoprocess site, e.g. with the planned storage facility for the ASR-affected waste;
- the planned construction of the facility for the conditioning of the category A waste for disposal in the facility for the production of monoliths, where buffer capacity is foreseen, both on the in- and outside;
- the foreseen timing of the construction and the operation of the surface disposal facility for category A waste.

All actions needed to ensure a safe continued storage of all the conditioned radioactive waste will be taken when and where required.

(4) Long-term management of radioactive radium-bearing waste

ONDRAF/NIRAS in interaction with the other parties involved (such as the waste producers, FANC, Regional Competent Authorities) for waste management and environmental protection) will develop a proposal of national policy for the long-term management of radium-bearing waste in Belgium.

(5) Decommissioning ex-BMB site, now ONDRAF site Fleurus

ONDRAF/NIRAS will continue its activities of site clean-up and decommissioning at its Fleurus site (ex-BMB) – see section A.2.

When the decommissioning license will be issued by FANC (expected mid 2018) the decommissioning activities can be executed by NIRAS over the next years till completion. The scheduled end point of this programme is 2025, with a mix of decommissioning until green field and decommissioning to non-nuclear status of other buildings, remaining on the site.

(6) Non-conform waste from NPPs

For the short-term management :

Construction and operation of a dedicated storage facility for the safe storage and follow-up of the ASR-affected waste drums;

For the long-term management :

Execution of the RD&D plan for the study and preparation of the most appropriate option for the long-term management of the affected waste streams and drums:

1. Surface disposal for those drums for which an alkali-silica reaction (ASR) can be excluded;
2. Surface disposal of ASR-affected waste 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 drums to a stable end-product for disposal.

(7) Preparation and implementation of surface disposal

In parallel with the licensing procedure for the surface disposal facility, ONDRAF/NIRAS, together with Belgoprocess, is preparing for the construction and operation of the facility and the radioactive waste management steps before the actual disposal:

- extension of the waste acceptance system (see point (2) above);
- organization of project team for construction and organization of operational team, with the interfaces with Belgoprocess;
- technical specifications for construction and for operational equipment;
- construction and operation of the concrete caisson production facility (non-nuclear), the monolith production facility (nuclear facility) and the surface disposal facility;
- methodology and procedures for the disposal emplacement operations (including taking the waste out of storage);
- implementation of the societal conditions: communication center TABLOO, local fund, …
- installation and operation of the monitoring system.

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. Belgium received an IRRS missions end 2013 and its follow-up mission will take place end November 2017. The next IRRS mission will have to take place before end 2023.
- Peer reviews have also to be organized in the frame of the European Directive 2011/70/EURATOM. Belgium is currently considering to invite an IAEA-ARTEMIS mission that could be combined with the next IRRS mission.
- 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.

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. These persons are considered as judiciary police officers, auxiliaries of the King's Attorney and, as such, they have specific enforcement powers. They trace and record infractions to this law; they can issue warnings and set deadlines for corrective actions; they have at any time access to the nuclear installations; 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 license applications for nuclear facilities; to grant licenses for specific facilities, except those with the highest risk (class I facilities); the verification of compliance with license 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; the stimulating and coordination of R&D;
- to issue neutral and objective information to the public.

Chapter IV deals with the delegation of some of the missions of the FANC.

- the FANC can delegate some of its missions to organisations that it has recognized or to legal entities that it has created to that end;
- the delegation relates to certain missions of the health physics department that each licensee has to set up as well as the supervision of loading, transport and delivery of fissile material;
- the recognition of those organisations is based on criteria defined by the FANC;
- the missions delegated to the legal entities that the FANC created, are specified by the King who also determines the way of financing the entity as well as how the FANC can control the mission entrusted to this entity.

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, 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 – [withdrawn]

Chapters V and VI deal with medical applications of ionising radiation

Chapter VII – Transport

Transport licenses and licensing procedures

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 Inspection Organisations

- conditions for the recognition of experts in health physics control.
- Authorized Inspections Organizations (AIOs).
- 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 VI- Decommissioning [update of August 2015]

- notification & information related to cessation of nuclear activities. It also lists the documents and information that has to be send to the FANC
- safety measures and justification of deferred dismantling
- SSCs and the OLCs during the dismantling of the installations
- preliminary qualification of new dismantling techniques
- radioactive waste from dismantling
- management of documents and inventories
- experience feedback management process
- update of surveillance and maintenance programmes
- update of the on-site emergency plan
- dismantling safety report
- Periodic Safety Reviews during the dismantling
- radiological characterisation of the final state and final dismantling report.

Chapter 3 sets the specific Safety Requirements for Nuclear Power Plants

Section I – Nuclear Safety Management

- organisational entity for independent assessments.
- specific requirements for operators of the control room

Section II – Design

- design basis of existing reactors
- design extension

Section III – Operation

- operational limits and conditions to cover all operational states.
- ageing management programme.
- minimal requirements for the leak tests of the reactor primary circuit and integrity of the containment.
- accident management procedures (including severe accidents

Section IV – Verification of Nuclear Safety

- content of the safety analysis report.
- probabilistic safety assessment (PSA).
- periodic safety reviews at a minimum frequency of 10 years.

Section V – Preparation for Emergencies

- on-site coordination centre and fall-back control room
- specific requirement for protection against internal fires

Chapter 5 contains some 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