KINGDOM OF BELGIUM

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

NATIONAL REPORT

October 2014

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, ELECTRABEL, SYNATOM, Bel V and the SCK•CEN.

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I.A. 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 indeed developed an important nuclear energy programme, which includes at present 7 operational PWR reactors on 2 sites having jointly a net electric capacity of approx. 5926.8 MWe. The political authorities have regularly assessed the future of this nuclear energy programme, for instance according to the progress made in the management of the radioactive waste produced by these nuclear power plants. Already in 1975, the Belgian Government has installed a high-level committee of experts, better known as the "Commissie van Beraad inzake Kernenergie" (deliberation committee on nuclear energy). One of the recommendations of this committee was to assess the continuation of the nuclear energy programme once every ten years.

Since then, these assessments have been organised on several occasions, for instance during the Parliamentary Energy Debate in the period 1982-1984 and by the 'Parlementaire Commissie van Informatie en Onderzoek inzake Nucleaire Veiligheid' (Parliamentary Information and Investigation Commission in the field of Nuclear Safety) between 1988 and 1990. Through its approval - in October 1990 - of the recommendation mentioned below, the Senate has clearly expressed the wish to pursue these assessments:

"Once every ten years the waste issue should be thoroughly assessed. This assessment will be contributory to the future of the nuclear programmes."

This tradition of assessing the nuclear energy programme was extended through the establishment of a "parlementaire onderzoekscommissie naar de opportuniteit van de opwerking van de bestraalde splijtstof en het gebruik van MOX-splijtstof" (Parliamentary Investigation Commission on the Opportunity of the Reprocessing of Spent Fuel and the Use of MOX fuel), which has deposited its conclusions in December 1993. Finally, the activities of the 'Commission for the Analysis of the Means of Producing Electricity and the Re-evaluation of Energy Vectors', better known as the Commission AMPERE have to be mentioned. This Commission was installed by the Government in April 1999; its final report - containing a new assessment of the future of the nuclear electricity production – was published in October 2002.

By means of the Law of 31 January 2003 amended in December 2013, 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 which will shut down in 2025, after 50 years of operation. According to article 4 of this law, the first nuclear power plant to be shut down will be Doel 1 in February 2015, the last nuclear power plant to be shut down will be Tihange 3 in 2025.

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) 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 developed 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. Since the fourth national report :

- ONDRAF/NIRAS prepared and submitted (31 January 2013) a license application for a disposal facility in Dessel;
- BELGOPROCESS, ONDRAF/NIRAS's subsidiary company, prepared and submitted a license application for a post-conditioning facility for the production of monoliths (concrete disposal waste containers). The operation license was granted by Royal Decree in March 2014;
- the financing of the societal aspects of disposal projects is regulated with the law of December 29, 2010 entitling ONDRAF/NIRAS to create a fund to cover all societal costs of a disposal project.

A global view of the foreseen surface disposal facility during the waste emplacement phase is given in the figure below.

Figure 1: Foreseen Belgian waste disposal facility for the category A waste

For the long-term management of the high-level and/or long-lived waste (category B&C waste) ONDRAF/NIRAS had submitted its final Waste Plan in September 2011 to the Federal Government (see fourth National Report, May 2012). This Waste Plan provides 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). No policy decision has been taken till now (September 2014).

I.A.1. **Structure and content of the report**

This national report, submitted to the fifth review meeting of the contracting parties to the Joint Convention, is established pursuant article 32 of the Convention. It is based on its previous editions. Particular emphasis has been put to clearly include relevant elements related to the questions which were raised during the previous review meeting by other contracting parties, and facts and events that occurred during the last two and a half years.

In addition, in order to underline relevant evolution since the last review meeting, a new section, section I.B., has been added, focusing on new developments since the last report. The table at the end of that section gives an overview of the current liabilities in Belgium.

This report takes into account the revised guidelines INFCIRC/604/Rev.3 (draft of May 2014). In particular, section K has been updated according to these new guidelines. An overview of the follow-up of the 4rd Review meeting, addressing the challenges and the measures to improve the safety reported for Belgium is reported in this section.

The following nuclear 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 subsidiary body of the FANC,
- ELECTRABEL, the licensee of the seven nuclear power plants who is responsible for the interim storage on site of the spent fuel,
- SYNATOM, the owner of the nuclear fuel from its fabrication to its transfer to ONDRAF/NIRAS when declared as radioactive waste, and the owner of the conditioned waste resulting from reprocessing, up to the transfer to ONDRAF/NIRAS
- 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.

I.B. Developments since the last meeting

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

I.B.1. Confirmation of the phase-out law and planned decommissioning of Doel 1 and 2 NPPs

According to article 4 of the law of 31 January 2003 on nuclear phase out, the lifetime of the Belgian NPPs is limited to 40 years. In the short term, the concerned NPPs are Doel 1 & 2 and Tihange 1 which have been commissioned in 1975

Article 9 of this law is an exception clause. In case of force majeure, the federal government may take exceptional measures to guarantee the supply of electricity. In case of force majeure the King, after deliberation of the Council of Ministers and on advice of the Commission of Electricity and Gas Regulation (CREG), can take the necessary measures, including a modification of the nuclear phase-out, to ensure the electricity supply.

On the 4th of July 2012, the government decided to confirm the shutdown of the Doel 1 & 2 NPPs in 2015 while allowing a lifetime extension of 10 year for the Tihange 1 unit, which should consequently be shut down in 2025. The government also decided to propose the deletion of article 9 of the phase out law, prohibiting thereby any future exception on the phase out law decided by the federal government. These amendments to the phase-out law have been voted by the Parliament and promulgated on 18 December 2013.

According to the current law, units 1 and 2 of the Doel Nuclear Power Plant, will be shut down in February and December 2015. The licensee Electrabel foresees an immediate dismantling, after, in a first phase, the removal of the fuel from the reactor, and, in a second phase, the removal of the fuel from the desactivation pool to a dry storage building on site. The actual dismantling is expected to begin in 2019. To reduce dose during dismantling activities, a chemical decontamination of the primary circuit is planned after the first phase, and before the start of dismantling activities.

To facilitate the dismantling, Electrabel intends to construct a Waste Management Facility (WMF) on the Doel site. This facility will be used to treat and condition waste from the dismantling activities and should preferably be operational by the start of the dismantling works. Electrabel has therefore started a pre-licensing discussion with the regulatory body, that should result in a license application for this facility in the first half of 2015.

Despite its imminent shut down, conclusions of the Stress Tests and other safety improvement projects remain applicable for the Doel 1&2 units, albeit in a reduced form. This scope reduction of future actions for Doel 1&2 was approved by the regulatory body.

I.B.2. Major non-conformities on conditioned NPP waste in Belgium

During a routine inspection of conditioned low-level waste packages, 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, 167 packages were opened, 126 of them showing the presence, to some degree, of the gel-like substance.

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

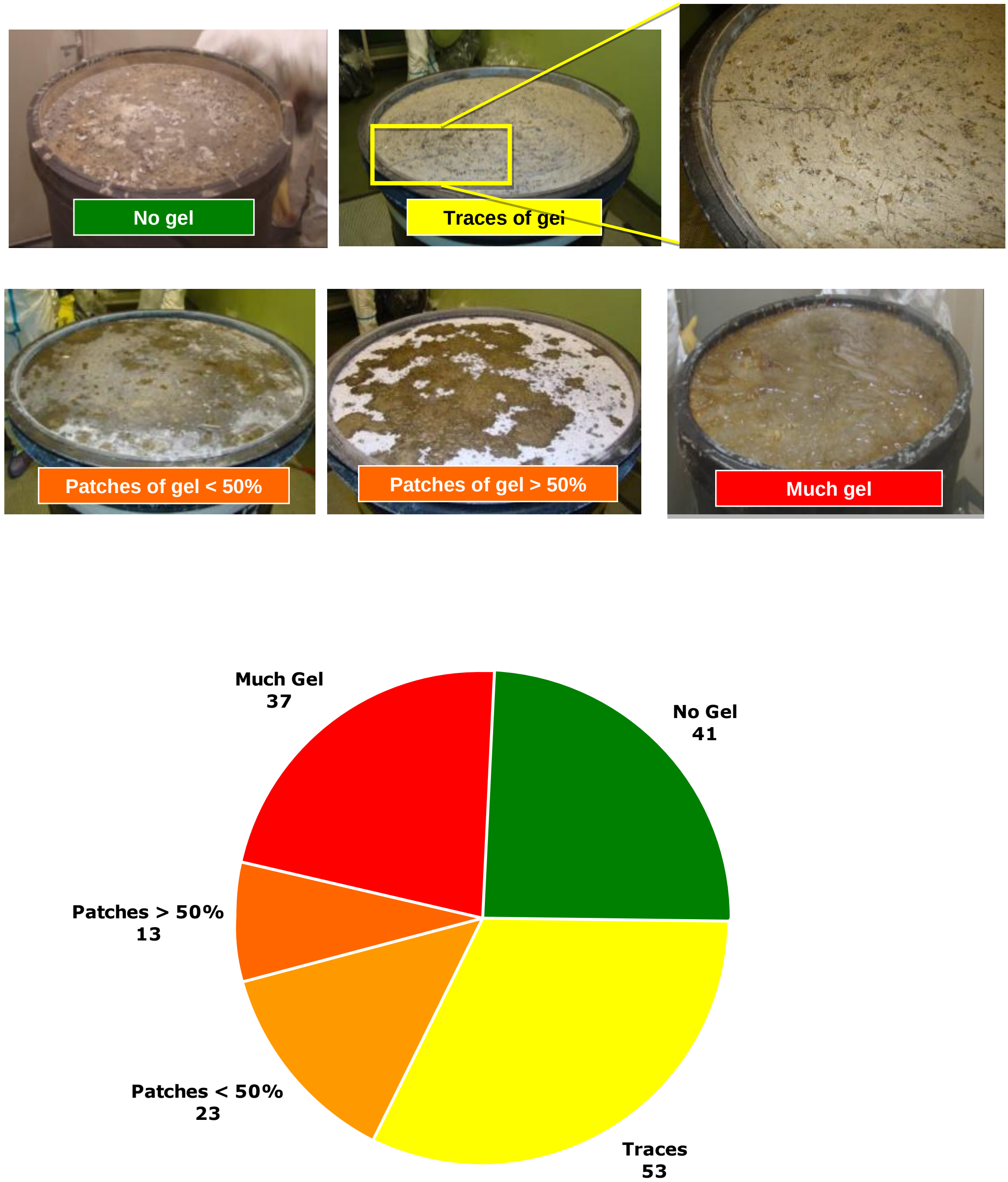

Figure 3: General overview of the results of the inspection programme showing the observations on 167 packages which were opened and inspected during this programme – More than 75 % are affected by the phenomenon most likely caused by an alkali-silica reaction (ASR)

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 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. At present, 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.

I.B.3. **Progress on decommissioning activities**

I.B.3.a) *Progress in the decommissioning of EUROCHEMIC reprocessing facility*

The dismantling of the former pilot fuel reprocessing plant EUROCHEMIC continued. The demolition of the EUROCHEMIC Reprocessing plant is being carried out in three phases. Since 2004 the plant 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,
- Removal of redundant ventilation circuits,
- The study for the dismantling (foreseen at the end of this decade) of two storage facilities for low and high enriched waste concentrate (LEWC and HEWC)
- Obsolete installations as part of its site remediation efforts on site 2, the former waste treatment facilities of the Belgian Nuclear Research Centre.

I.B.3.b) *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 2010-2013, the main decommissioning activities focussed on the dismantling of about 170 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.

The current planning for the remaining decommissioning activities is:

- 2014: finalize the dismantling of the glove boxes (about 10 glove boxes remain to be dismantled).
- 2014-2015: activities related to the infrastructure and the unconditional clearance of the buildings and the site.

The objective of the project is to reach the unconditional release of the buildings and of the site by the end of 2015.

I.B.3.c) *Progress in the decommissioning of FBFC international*

FBFC International, affiliate of the AREVA group, operates 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 dismantling 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, AREVA officially notified the Federal Agency for Nuclear Control that AREVA has decided to stop all its activities in the FBFC facility 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 dismantling 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 dismantling license was granted by Royal Decree in October 2013. The dismantling techniques, as well as the decommissioning license conditions are analogous to the earlier dismantling license project (see Previous Joint Convention report).

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 will be performed up to mid-2015, after which the dismantling of the MOX building will also start. The goal is to have all buildings dismantled by the end of 2015.

I.B.3.d) *Progress in the decommissioning of the THETIS research reactor*

The Ghent University 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 capacity of 250 kWth located on the site of the Nuclear Science Institute (INW site) 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 and the transfer of the fuel elements to Belgoprocess took place between May and September 2010.

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 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 actual dismantling works started in 2013 and are expected to be completed by the end of 2014. The dismantling project is managed by SCK•CEN, and the works are performed by Belgoprocess. Ghent University retains final responsibility. Its Health Physics Department remains fully functional and has been expanded to deal with the increased work in waste management and clearance resulting from the dismantling activities.

I.B.4. **Achievements of the first Periodic Safety Review of Belgoprocess**

Belgoprocess is the operator of the ONDRAF/NIRAS radioactive waste processing and storage facilities in Dessel (site 1) and Mol (site 2).

In compliance with the Royal Decree of 25 October 2004 amending its operating license, Belgoprocess has to perform a periodic safety review of all its installations on site 1 and site 2 at least every 10 years.

A periodic safety review of the nuclear installations on site 2 was performed in 2006. The results of this safety review were submitted to the regulatory body in July 2006. A safety review of the installations on site 1 has been also performed and the results have been submitted to the regulatory body in July 2008.

The safety reviews covered both general safety topics and the different individual nuclear installations on site 1 and site 2, with the exception of the installations in a formal stage of dismantling.

The general topics included training and qualification, radiological protection, fire safety, external hazards, emergency planning, operational experience feedback, etc... For each of the general topics the current situation was assessed and possible improvements were defined, taking into account the current and future use of the site.

For each nuclear installation a detailed assessment was performed. The different risks related to each nuclear installation (e.g. fire, explosion, loss of containment, flooding, ageing, chemical risks,…) were considered and an assessment of the existing safety measures was made. In this way, for each installation safety improvement measures could be defined in a systematic manner.

The safety review of site 2 has shown that the global situation of the nuclear installations on this site is mainly in conformity with the current safety standards. Progress in safety has been clearly made compared to the situation 10 years ago.

Additional actions to further improve the safety of the installations were proposed, an action plan was defined in agreement with the regulatory body and was being implemented. The action plan of the periodic safety review was formally closed by the regulatory body at the beginning of 2013. The next periodic safety review is being prepared for site 2 and should be submitted mid-2016.

The IAEA safety standard SSG-25 serves as reference for the periodic safety reviews, according to a specific FANC guidance.

The approach to the PSR is described in the Belgoprocess instruction document KB-1281:" Methodologie voor de opmaak van de Periodieke Veiligheidsherzieningen, PVH (PSR)". The structure is based on the analysis of 14 'safety factors' which cover all different topics of the PSR in line with the SSG-25 standard. These safety factors, their objectives, scope, tasks and also the specific methodology for review are listed in a formal 'methodology document'.

The methodology document was approved by FANC and Bel V mid-2014.

The periodic safety review of site 1 has shown that the global situation of the nuclear installations on site 1 is in conformity with the current safety standards. Progress in safety has been clearly made compared to the situation 10 years ago.

As for site 2, additional actions to further improve the safety of the installations on site 1 were proposed, an action plan was also defined in agreement with the regulatory body and was formally closed by the regulatory body mid-2014.

The next periodic safety review for site 1 is scheduled to be submitted mid-2018.

I.B.5. **The Royal Decree of 25 April 2014**

The Royal Decree of 25 April 2014 amends the "*Royal Decree of 30 March 1981 determining the missions and setting out the operating modes of the public agency for the management of radioactive waste and fissile materials*" and determines the guiding principles that are the basis for establishing the fees for contributing to the long-term fund.

This Royal decree sets out six guiding principles on the methods of calculation of the fees for waste transfer from the waste producer to ONDRAF/NIRAS and on the alimentation of the long-term fund (i.e. the fund created for financing waste storage and disposal by ONDRAF/NIRAS). These principles will be applied by adapting the contractual clauses and consequently by signing new contracts/amendments with the main waste producers (or the approval of notes for the management of liabilities)

The Royal Decree requires the contracts with the waste producers to be adapted as soon as possible and by the 31st of December, 2018 at the latest.

<u>Principle 1:</u>

This principle states that the fees are due to the taking charge of the waste (except as provided for in principles 3 and 4), that the agreements specify what is covered by the fees and that these fees are due for as long as the producer is liable for a part of the total cost of ONDRAF/NIRAS' services.

This principle strengthens the current contractual system.

<u>Principle 2: "Compartmentalisation of the long-term fund":</u>

Each of the segments - storage, surface disposal and geological disposal - is subdivided into "investments", "operation" and "closure"/dismantling" sub-segments.

The implementation of this principle means introducing a classification of costs in the cost estimates, adapting the reporting for the funds and amending certain contractual clauses.

Principle 3: Temporal uniformity of fees:

The fees are divided uniformly across all the waste produced and to be produced with a detailed statement drawn up for the waste already transferred.

The implementation of this principle requires:

- The actual quantities of conditioned waste transferred (as opposed to the contractual quantities) for each producer to be established
- An average rate to be established across the programme
- It to be deducted from the detailed statement for each producer
- Agreement on the accounting procedures for this statement
- The contracts to be adapted to cover the points above.

Principle 4: Advance payment

This principle states that in the event of a discrepancy between the expenditure (investments and operation) and revenue (taking charge of waste) schedules, ONDRAF/NIRAS can send a request for funding by advance payment.

The implementation of this principle means setting up a system to assess potential cash flow shortfalls and adapting the contractual clauses.

Principle 5: Optimization, information

The calculation of the charges is optimized, documented and justified.

The implementation of this principle could means adapting the contractual clauses.

Principle 6: Mediation

The introduction of a mediation step before resorting to imposing charges by Royal Decree in the event of disagreement between ONDRAF/NIRAS and one or several producers.

The implementation of this principle means adapting the contractual clauses.

I.C. Summary table of current liabilities in Belgium

Type of Liability	Current practices/ Facilities	Long-term management policy	Funding of Liabilities	Planned Facilities
Spent Fuel	SF: on-site wet or dry storage; BR2 R.R. : reprocessing	Interim storage on NPP sites; long term management policy still being developed (disposal of waste from reprocessing or direct disposal)	NPP contribute to the fund managed by SYNATOM; various funds for historical liabilities fed by state	ONDRAF/NIRAS proposal for policy decision for geological disposal in clay (waste plan)
Nuclear fuel cycle waste	Interim storage at Belgoprocess site HLW: storage at Belgoprocess	SL-LILW : Near surface disposal LL-LILW and HLW: see ONDRAF/NIRAS waste plan	Producer pays, contribution to ONDRAF/NIRAS long-term fund; Capacity reservations; Insolvency funds various funds for historical liabilities fed by state	Surface Disposal for SL-LILW at Dessel. (Gov. Decision taken in 2006, license application in 2013) Under investigation as long term management solution for LL-LILW and HLW: geological repository in Boom Clay or Ypresian Clay
Non-power reactors waste	Interim storage at Belgoprocess site Radium waste storage at Umicore/OLEN	SL-LILW: near surface disposal LL-LILW: see ONDRAF/NIRAS waste plan Radium waste : no decision yet	Producer pays, contribution to ONDRAF/NIRAS long-term fund; Capacity reservations; Insolvency funds Radium waste: Producer pays	Surface Disposal for SL-LILW at Dessel. (Gov. Decision taken in 2006, license application in January 2013) Radium waste: no decision yet ONDRAF/NIRAS geological disposal: pending decision in principle of government (waste plan) WMF: facility for treatment and conditioning waste from the dismantling activities at the Doel site.
Decommissioning Liabilities	Present projects : BR3 and THETHIS Research Reactors; Eurochemic reprocessing plant; SCK•CEN waste department; BN MOX and FBFC fuel fabrication plant; ex- "Best Medical Belgium" facility	Responsibility of operator; verification of arrangements and management of decommissioning wastes by ONDRAF/NIRAS SL-LILW: near surface disposal LL-LILW see ONDRAF/NIRAS waste plan	NPP contribute to the fund managed by SYNATOM; various funds for historical liabilities fed by state	
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

II. Section B: Policies and Practices

II.A. Spent Fuel

II.A.1. Spent fuel management policy

Seven commercial nuclear reactors of the PWR type are operated in Belgium, leading to a total installed capacity of 5926,8 MWe and to approximately 5 000 t_{HM} spent fuel to be unloaded during 40 years of operation. Until the mid-nineties the Belgian strategy for the management of the back end of the fuel cycle was the reprocessing of spent fuel from all commercial nuclear power reactors. This policy led to the reprocessing of 672 t_{HM} of the spent uranium-oxide fuel type by COGEMA (now AREVA) at La Hague: the last Belgian fuel elements sent to La Hague have been reprocessed in late 2001.
The uranium recovered after reprocessing has been re-enriched and recycled in the Belgian NPP, mainly in Doel 1. Most of the plutonium has been recycled in Belgium as MOX fuel, in Doel 3 and Tihange 2.

Due to the changing international context, a parliamentary resolution on 22 December 1993 urged the government to take action in order to temporarily prevent the implementation of new reprocessing contracts for a five-year period and to take profit of that time to make a thorough comparison of the back-end strategies, namely direct disposal and reprocessing of spent fuel. The Council of Ministers implemented this resolution by its decision of 24 December 1993. To give effect to this decision, an overview report was produced in 1998 by the Administration for Energy, in which the two management options were compared.

In 1998 the Council of Ministers specified in its session of 4 December 1998 that the data available at that time and presented in the above-mentioned report were not sufficient to make a global evaluation of the benefits of both options. Therefore they decided to suspend the conclusion of any new reprocessing contract until new data were available and reported to them, allowing them to make this global evaluation. They also urged SYNATOM to cancel a reprocessing contract concluded in 1991. The global evaluation has not been finalised up to now.

Besides spent fuel from commercial power reactors, there is also a small amount of spent fuel resulting from research reactors at SCK•CEN (Nuclear Research Centre in Mol) and from the University of Ghent. The back-end policies for the spent fuel from these research reactors differ. For the spent fuel from the high-flux-test-reactor BR2 at SCK•CEN, using highly enriched U (HEU) as fuel, reprocessing is the current back-end option. For the spent fuel from the 10 MWe PWR BR3 reactor at SCK•CEN, in decommissioning since 1987, dry interim storage in CASTOR casks is implemented. The spent fuel of the pool type Thetis reactor at the University of Gent, using UO2, has been unloaded in 2010 and transported to Belgoprocess where it has been conditioned as radioactive waste. Finally, for the spent fuel resulting from the other research reactors (the graphite moderated BR1 reactor using natural uranium and the zero power Venus reactor using UO2 and MOX both at SCK•CEN) no final back-end strategy has yet been defined. In the framework of the GUINEVERE-project (2007-2014) at VENUS, uranium metal fuel rodlets are used coming from CEA Cadarache. Since this fuel is on loan from CEA and will return finally to CEA no spent fuel issues for Belgium are related to the use of this fuel in VENUS. During the GUINEVERE-project, (part of) the UO2 and MOX VENUS fuel is temporarily stored at the BR2 facility for storage of fresh fuel, in order to allow for the storage of the CEA fuel at VENUS.

II.A.2. Spent fuel management practices

The reprocessing of 672 t_{HM} spent fuel was executed in accordance with four contracts concluded by SYNATOM (Belgium) and COGEMA, France (now AREVA) during the period 1976-1978. These foresee the gradual sending back of the resulting waste to Belgium. The sending back of the following quantities of different waste types initially foreseen was as follows :

- 387 canisters of vitrified high level waste (CSD-V);
- 528 canisters of compacted technological and structural (hulls and end pieces) waste (CSD-C);
- 1100 drums of bituminised waste.

As a consequence of a change of the treatment and conditioning process, the number of canisters of compacted technological and structural waste was reduced to 432.

The initially foreseen bituminised waste will be replaced by intermediate level vitrified waste (CSD-B) originating from the rinsing operations carried out following the UP2-400 plant final shutdown. The estimated quantity from this type of waste to be returned to Belgium is maximum 62 canisters.

See Section IV.A.2 for the current inventory of the waste returned to Belgium.

At the end of 1993, the Belgian parliament voted a five-year suspension on further reprocessing contracts. After this period and up to now, the government confirmed this decision. As the available storage capacities were becoming short in the existing spent fuel storage pools, interim storage facilities needed to be built. Technical and economic studies were started in order to find the most appropriate solution for every nuclear site. Flexible and reversible solutions for the temporary storage of the spent fuel had to be found.

Two different solutions have been selected for the nuclear sites in operation: dry storage in metallic dual-purpose casks on the Doel site and a centralised storage pond on the Tihange site. A detailed description of both installations is provided under section L (appendix 1). On the Doel site construction of the modular storage buildings started in May 1994 and the first cask was loaded in June 1995. The buildings in their present layout are able to house 165 storage casks. Additional modules can be added, if necessary. Metallic casks are periodically ordered by SYNATOM and loaded by the operators of the power plant in order to allow the transfer of spent fuel elements from the three deactivation pools of the site to the centralised dry casks storage facility. Such casks are designed both for storage and transport purposes.

On the Tihange site the centralised storage pond received its operating license in May 1997 and the first fuel elements have been transferred in July 1997. The total capacity of the pond is approximately 3700 spent fuel assemblies divided in eight sections. All sections are presently equipped with racks. The safe power supply and cooling capacity for the storage pond are provided by the corresponding systems of the neighbouring Tihange 3 reactor unit.

Spent fuel in storage pending a decision regarding its future is at this moment neither regarded nor declared radioactive waste by its owner SYNATOM. Consequently its management is not included in the scope of responsibility of ONDRAF/NIRAS (see also section E).

The same resolution from the Belgian parliament requested to consider spent fuel and waste arising from reprocessing in an equal manner in the RD&D programmes regarding the long-term management of these materials. This is applied by ONDRAF/NIRAS in its RD&D programmes.

SCK•CEN has concluded a contract with COGEMA (now called AREVA NC), covering the whole remaining life of the BR2 reactor, without any limit in time nor in quantity. The processing of the fuel includes the dilution of uranium to less than 1.2% in U-235 and the interim storage of waste prior to conversion into residues. The vitrified waste and the compacted technological and structural waste are returned to Belgium and stored in storage building 136 – storage building for the reprocessing waste from spent fuel reprocessing – on the Belgoprocess site for several decades before final disposal. Since 2012, the import of cemented waste form DSRL Dounreay (UK) to Belgoprocess Dessel is ongoing. There are 21 shipments foreseen until end 2014. This waste is the result of the reprocessing of fuel assemblies of reactor BR2 from SCK•CEN Mol which was transferred previously from Belgium to UK. It is stored in the surface storage building 136 at Belgoprocess, together with the compacted waste from Synatom.

All the spent fuel (some 2 tons of HM) from the former BR3 research reactor is dry-stored in 7 CASTOR BR3 type casks at the Belgoprocess site.

II.B. Radioactive waste

II.B.1. Radioactive waste management policy

The foundation of the 'Organisme national des déchets radioactifs et des matières fissiles / Nationale instelling voor radioactief afval en splijtstoffen' or ONDRAF/NIRAS (Belgian National Agency for Radioactive Waste and Fissile Materials) by law on 8 August 1980 is the result of a decision of the Belgian authorities to entrust the management of radioactive waste to one single institution under public control. This was done in order to ensure that the public interest would play a crucial part in all decisions on the subject. This law was modified by the law of 11 January 1991, which also slightly changed the name of the institution towards 'Belgian National Agency for Radioactive Waste and Enriched Fissile Materials'.

The tasks and modes of operation of ONDRAF/NIRAS were laid down by the Royal Decree of 30 March 1981 and supplemented by the Royal Decree of 16 October 1991.

The law of 3 June 2014 transposing the European Directive 2011/70/Euratom modifies the aforementioned laws and integrates the obligations from the European Directive 2011/70/EURATOM of 19 July 2011 *establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste* w.r.t. national policies, national framework and national program.

In general terms, ONDRAF/NIRAS is responsible for the management of all radioactive waste on the Belgian territory. The task laid down for it by law is to outline a policy for the coherent and safe management of radioactive waste covering the following aspects:

- Compiling an inventory of radioactive materials (and enriched fissile materials) and of all sites containing radioactive materials, and assessing the decommissioning and remediation costs of all sites containing radioactive materials (inventory of nuclear liabilities);
- Compiling an inventory of all radioactive waste streams;
- Collection and transport of the waste;
- Processing of the waste;
- Interim storage of all conditioned waste;
- Long-term management with disposal as the option in preparation (category A waste) or under investigation (category B&C waste);
- Tasks relating to the management of excess enriched fissile materials and to the decommissioning of nuclear facilities.

For all radioactive waste from nuclear activities and facilities (nuclear fuel cycle, and nuclear applications in medicine, industry and research), ONDRAF/NIRAS has a policy of centralised waste management, making use of processing facilities and interim storage facilities centralised on the sites of Belgoprocess in Dessel (site 1) and Mol (site 2). Some waste producers have their own processing facilities and they transfer conditioned waste to Belgoprocess site for interim storage and the ownership and related responsibilities to ONDRAF/NIRAS. .

More specific tasks assigned to ONDRAF/NIRAS are the following.

- In the Royal Decree of 16 October 1991 one of the missions entrusted to ONDRAF/NIRAS was the qualification of installations for treatment and conditioning of radioactive waste. Some issues of practical implementation of the qualification of treatment and conditioning installations, but also storage buildings and installations for the radiological characterisation of radioactive waste, are laid down in the Royal Decree of 18 November 2002.
- Another mission of ONDRAF/NIRAS laid down in the Royal Decree of 16 October 1991 was the establishment of acceptance criteria for conditioned and unconditioned radioactive waste based on General Rules to be approved by the competent authority. The set of General Rules was established by ONDRAF/NIRAS, approved by its Board and by the competent authority, and came into force by ministerial letter of and as from 10 February 1999.
- Some aspects concerning the decommissioning of nuclear installations were also entrusted to ONDRAF/NIRAS by the Royal Decree of 16 October 1991. These concerned the collection and evaluation of decommissioning data in order to establish programmes for the waste that will result from it, the approval of the decommissioning programme (except for the financing and funding of the nuclear reactor decommissioning and spent fuel back-end management for which the Law of 11 April 2003 about the nuclear provisions is applicable) and the execution of the decommissioning programme if the operator asks for it or in case of incapacity of the operator. With the law of 12 December 1997 this mission of ONDRAF/NIRAS was extended, by entrusting ONDRAF/NIRAS with the establishment of an inventory of all nuclear installations and sites containing radioactive materials, and with the assessment of their decommissioning and remediation costs.
- ONDRAF/NIRAS is also responsible for drawing up and proposing a programme for the long-term management of all the radioactive waste; with the law of February 13, 2006 this programme is submitted to a strategic environmental impact assessment for plans and programmes, as defined in the European directive 2001/42/EC.
- With the law of December 29, 2010, modifying a.o. the law of August 8, 1981, ONDRAF/NIRAS is given additional legal tasks w.r.t. activities and measures in the domain of the societal support for the integration of a disposal faculty at local level. The law of December 29, 2010 entitles ONDRAF/NIRAS to create a fund to cover all the costs related to the societal conditions for the integration of a disposal facility at the local level. The supply to this fund is by the waste producers on the basis of the waste volumes to be disposed of.

The Council of Ministers decided on 23 June 2006 of on the disposal of low and intermediate level short-lived radioactive waste should be carried out in a *surface disposal* facility to be developed in the *municipality of Dessel* in close collaboration with the local stakeholders (co-design). Through this decision ONDRAF/NIRAS was commissioned to:

- Continue the participatory process, first of all with the municipality of Dessel that will be the first partner for the negotiations on the associated conditions, but also with the neighbouring municipality of Mol that must be able to defend its interests. Extend the participatory process to the neighbouring municipalities that want it and that do have a justified interest in the integrated project (e.g. information, surveillance, safety, environment, …). In the framework of this process, the preliminary integrated surface disposal project for Dessel as developed in the partnership with Dessel in the pre-project phase (1999-2006) constitutes the basis for future negotiations and discussions;
- By the end of 2008, specify the costs of the corresponding accompanying conditions and their financing methods;
- Pursue the further development of the integrated disposal project, with the aim of obtaining the licenses needed, as well as a binding agreement (based on the "polluter pays"-principle) between the involved parties on the financing of the accompanying conditions;
- Make proposals related to a legal and regulatory framework to ensure the legal soundness of the integrated project, especially concerning the financing of the accompanying conditions.

The decision of the Council of Ministers of 23 June 2006 on the disposal of low and intermediate level short-lived radioactive waste commissioned the FANC to:

- Develop a licensing procedure adapted to the specific nature of a disposal project of radioactive waste;
- Inform ONDRAF/NIRAS of the elements that it deems necessary for the safety assessments (regulatory guidance);
- Present to the government the stipulations that it deems necessary for organizing the intervention of the regional instances competent for environmental impact studies;
- Conduct a formal follow-up of the activities of ONDRAF/NIRAS in view of a license application;
- Systematically analyse the points of attention for the safety of the chosen integrated disposal project.

For the high-level and long-lived waste, ONDRAF/NIRAS has been studying geological disposal in a clay layer as the reference option since more than 30 years. However, unlike the situation for the low and intermediate level short-lived radioactive waste, there is still no institutional policy in Belgium for the long-term management of high-level and/or long-lived waste (including spent fuel if declared as waste). In order to carry out its statutory task, ONDRAF/NIRAS must be able to develop and implement a solution for the long-term management of all radioactive waste that it takes in charge.

To the extent that:

- ONDRAF/NIRAS is legally required to have a general program of long-term management of radioactive waste that it takes in charge;
- ONDRAF/NIRAS was commissioned in 2004 by its supervising authority to prepare and engage in dialogue at all societal levels and to assess all possible strategies for the long-term management of high-level and/or long-lived waste to help determine the management solution to be implemented;
- The law of February 13, 2006 (known as SEA law) requires that the general programme of long-term management of ONDRAF/NIRAS be subject to a strategic environmental assessment (SEA) and to a public consultation; this law transposes in the Belgian legal system the European Directives 2001/42/EC on the assessment of the effects of certain plans and programs on the environment and 2003/35/EC providing for public participation in the development of certain plans and programs relating to the environment as well as certain principles of the Aarhus Convention.

ONDRAF/NIRAS has taken the initiative to bring together in one document, called **Waste Plan**, all the necessary 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).

The ONDRAF/NIRAS Waste Plan for the long-term management of conditioned high-level and/or long-lived radioactive waste was adopted by ONDRAF/NIRAS Board of Directors on 23 September 2011. In its Waste Plan, ONDRAF/NIRAS proposes that high-level and/or long-lived radioactive waste be disposed of in a unique repository located at depth in a poorly indurated clay formation, on the Belgian territory and that the development and implementation of such solution should:

- be carried out without undue delay and at a pace proportionate to its technical maturity and its societal support;

- be accompanied by a stepwise, adaptive, participative and transparent decision-making process;
- take into due consideration societal conditions linked to reversibility, retrievability, control and knowledge maintenance and transfer.

ONDRAF/NIRAS Waste Plan must be considered as a proposal to the Federal Government strategy to complete the system for the management of high-level and/or long-lived waste. This strategy involves a technical solution for the long-term management, a framework for future decisions as well as various conditions associated with the development and implementation of the recommended solution. Given the considered timescale, it is certain that the implementation of the Waste Plan will be gradual and take several decades in which many decisions will have to be taken.

In order to ensure the continuity of the ONDRAF/NIRAS disposal programme, the supervising Ministers have entrusted the agency by letter of October 3, 2011 with a series of tasks:

- continue RD&D in the field of disposal in poorly indurated clay (Boom Clay or Ypresian Clays) with a view to confirming and refining the scientific and technical bases of this solution, and ensure its financing by the waste producers at the appropriate level;
- further define the gradual, adaptable, participative, transparent and continuous decision-making process that will take place in parallel with the development and implementation of the management solution; this process will start a priori with the making of a decision in principle;
- develop a proposal for a normative system framing the implementation of the Waste Plan; this system should include the creation of an independent monitoring body entrusted with ensuring that the decision-making process advances in completely documented stages, that it is adaptable and transparent, and that it ensures continuity and integration of the social and technical aspects;
- develop the social dimension of the B&C programme and ensure the related financing;
- clarify, in consultation with all stakeholders, the demands arising from the consultations concerning operational reversibility and retrievability of the waste disposed of, monitoring of the good functioning, transfer of knowledge on the disposal, including the memory of its location, and on the waste it contains; and
- follow the evolutions regarding management options that were examined but not chosen in the Waste Plan.

II.B.2. **Radioactive waste practices**

II.B.2.a) ***Classification: definitions and criteria***

For the purpose of its safe management in the short and long term, radioactive waste, which possesses extremely diverse characteristics, is classified according to certain similarities. The internationally recommended classification systems — IAEA and the European Union (EU)—make no distinction between conditioned and non-conditioned radioactive waste. They classify waste according to its activity and half-life.

In Belgium, ONDRAF/NIRAS has adopted a hierarchical classification system for conditioned radioactive waste, oriented towards the long-term management of the waste, and a hierarchical classification for unconditioned waste, directed at the waste processing routes. This classification system is compatible with the IAEA and EU international classification systems and can, if necessary, be adapted to take account of changes that may occur in the waste management.

The three main **categories** (Table 1) of conditioned radioactive waste are defined by a radiological criterion (radionuclide activities in Bq and Bq/m^3) and by a thermal power criterion.

Category A waste is the one of which the radionuclides present specific activities low enough and half-lives short enough to be compatible with surface disposal. This waste category corresponds to low-level waste in the IAEA waste classification.

In the safety case for the license application (submitted 31 January 2013) for the surface disposal facility in Dessel, ONDRAF/NIRAS has proposed to the safety authority FANC specific disposal limits for the category A waste. These have to be approved by the FANC in the licence.

Category B waste is waste that does not meet the radiological criterion for belonging to category A, but does not generate enough heat to belong to category C. It corresponds to the medium-level waste of the IAEA waste classification.

Category C waste or high-level waste (IAEA classification) contains very high quantities of alpha and beta emitters that generates a significant heat. It must therefore cool down during a period of interim storage (currently foreseen period of 60 years) before disposal , and its residual thermal power at the time of the disposal may require either limiting the number of packages per meter of disposal gallery, or increasing the distance between the galleries.

The waste categories are further subdivided in waste classes and waste streams.

Table 1: Characteristics of the three categories (A, B and C) of radioactive waste used by ONDRAF/NIRAS

	Low-level activity	**Medium-level activity**	**High-level activity**
Short-lived waste	**A**	**A**	**C**
Long-lived waste	**B**	**B**	**C**

II.B.2.b) *Practices*

1. From the year 1997 onwards, the legislator requires ONDRAF/NIRAS to compile a register of the localisation and the state of all nuclear installations and all sites containing radioactive materials, to assess their decommissioning and remediation costs, to evaluate the existence and adequacy of the funds in order to finance the operations (current or future), and, finally, to repeat this exercise every five years. The official legal name of this task is "inventory of nuclear liabilities". The second inventory was established end 2007 and was, after a review by an international team, presented to the supervising Minister for Energy on March 26, 2008. The third inventory has been presented to the supervising Minister for Energy beginning 2013.

   Besides this inventory of nuclear liabilities, ONDRAF/NIRAS compiles also at regular time intervals (typically also about every five years) an inventory of all radioactive waste, covering both the already produced waste and estimates of expected future waste. This waste inventory contains not only the waste volumes, but also the physical, chemical and radiological characteristics.

2. ONDRAF/NIRAS is also responsible for the shipments of conditioned and unconditioned radioactive waste, mainly towards the centralised conditioning and intermediate storage facilities on the Belgoprocess site (Dessel). These shipments need to be licensed by the Federal Agency for Nuclear Control (FANC), as stipulated in the GRR-2001 (General Regulations for the protection of the workers, the population and the environment against the hazards of ionizing radiations, laid down in 2001 by Royal Decree of 20 July 2001). These shipments are subcontracted by ONDRAF/NIRAS to specialised transport companies.

3. The processing of radioactive waste is partly done by the nuclear operators themselves on the sites of the nuclear reactors at Doel and Tihange, and partly by Belgoprocess at the centralised processing facilities the site in Dessel. All waste processing and storage facilities have to be qualified by ONDRAF/NIRAS according to its legal tasks and the provisions of the Royal Decree of 18 November 2002.

4. The interim storage of the waste constitutes an intermediate level between short-term and long-term radioactive waste management. As already explained above, spent fuel from commercial reactors is stored by ELECTRABEL in thereto especially designed surface storage buildings in Doel and Tihange. Storage of radioactive waste is done in surface storage buildings at the Belgoprocess site. Currently there are seven storage buildings in operation, two buildings for low-level radioactive waste, one for intermediate-level waste, three for high-level waste and one for alpha- contaminated waste and radium-bearing waste (see also section H and appendix 3).

5. For the long-term management, a distinction is made between the category A (short-lived waste) programme and the categories B (long-lived waste) and C (high-level waste) programmes.

(1) Disposal of category A waste

Following the Federal Council of Ministers on 23 June 2006, ONDRAF/NIRAS' category A programme has entered the project phase consisting of the detailed design and the safety assessment studies. The integrated disposal project entails not only a surface disposal facility but also a waste post-conditioning facility (emplacement of waste drums or bulk waste from dismantling activities in concrete boxes to form disposal "monoliths") and the realisation of the accompanying conditions set out by local stakeholders. The review and assessment of the licence application by the regulatory body is ongoing (See article 15).

(2) Disposal of category B&C waste

In Belgium, the long term management of category B&C waste has not been confirmed at the institutional level, although studies related to the geological disposal in clay have been initiated more than 30 years ago. An extensive and systematic RD&D program on geological disposal in clay (Boom Clay and Ypresian Clay as potential host rocks) has been carried out. An interim report (SAFIR 2) had been produced, presented to the Government and other stakeholders in 2001, and afterwards peer reviewed by the NEA/OECD. It was decided to:

- Pursue the RD&D efforts to reduce uncertainties and increase safety margins;
- Develop specific regulatory guidance related to geological disposal;
- Develop societal legitimisation of the fundaments of the RD&D programme and of the ONDRAF/NIRAS reference long term management option.

In 2013, ONDRAF/NIRAS published its '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' (State-of-the-art report as of December 2012 NIROND TR 2013-12E). This reports aims to:

- Present the status of knowledge regarding the development of geological disposal of B&C waste in poorly indurated clay, as of December 2012. This high-level document refers to numerous references, for more details.
- Identify the RD&D needed to support geological disposal of B&C waste in poorly indurated clay. It prioritises the RD&D needs in function of the current level of understanding, of their potential impact on safety or feasibility and of the stage of the disposal programme when they should be catered for.
- Integrate societal concerns expressed in the frame of the Waste Plan, e.g., retrievability, controllability and follow-up of long-term management options discarded in the Waste Plan.
- Illustrate with a few examples the applicability of the safety assessment methodology.

The FANC and ONDRAF/NIRAS regularly interact, since 2003, to discuss the safety related aspects of the category B&C disposal programme and the themes and elements of regulatory requirements and guidance to be developed.

6. The tasks of ONDRAF/NIRAS relating to the management of enriched fissile materials are currently limited to studies relating to the possibilities of direct disposal of spent fuel and to the estimation of management costs. The sites and storage facilities containing the spent fuel are part of ONDRAF/NIRAS' inventory of radioactive materials and sites.

7. Different financing mechanisms have been developed, each based on the same basic principle of 'polluter pays'. ONDRAF/NIRAS is a non-profit company; its financing has to cover the actual costs made or foreseen.

    a. The research and development programmes on disposal are financed by specific agreements between the main waste producers and ONDRAF/NIRAS. For the disposal programme of high-level and long-lived waste the current contractual agreement covers the period 2009 - 2014 (Negotiations with the Producers for the period 2015-2020 are ongoing). The RD&D programme has benefited from its inception from EC contributions, especially regarding the construction of the HADES Underground Research Laboratory (URL) and the performance of in situ experiments. Currently, ONDRAF/NIRAS is actively participating in the EC technology Platform on Implementing Geological disposal.

    b. Short-term management of radioactive waste is financed by two kinds of five-year-long contracts for waste processing on the one hand, and for intermediate storage on the other hand. Since 1996, a system of capacity reservation is applied, in which each waste producer makes a reservation of the capacity of the facility, and subsequently pays a part of the fixed costs of the installation. Besides, the variable operation costs of the installation are paid according to the actual amount of waste that is transferred to the installation.

c. Long-term management (disposal) will only be established in the future, but in order to respect the principle of intergenerational equity, current generations should not only guarantee technical means to future generations for a safe management of radioactive waste, but also financial means. On request of ONDRAF/NIRAS, the waste producers have started to pay for future storage and disposal services from 1985 onwards. Since 1999 a long-term fund of ONDRAF/NIRAS is operational and gradually takes over the funds set aside by the waste producers since 1985. The fundamental ideas from the financing scheme of short-term waste management are retained in this fund-system, i.e. capacity reservation and the payment of variable costs with the transfer of waste to ONDRAF/NIRAS.

d. In 1992 an insolvency fund has been set up, in order to be able to mitigate the consequences of bankruptcy or insolvency of a waste producer. This fund is fed through a levy of 5% on the sums that waste producers deposit for the management of their waste (with the exclusion of the RD&D work, which is financed by the waste producers by separate agreements)

e. Following the publication of the European Directive 2003/122/Euratom of 22 December 2003 on the control of high-activity sealed radioactive sources and orphan sources and its transposition in the Belgian regulatory framework, the question of financing the treatment of recovered sealed orphan sources as waste became more prominent.

f. The relevant aspects of the decommissioning funds are dealt with under Article 22.

8. Orphan sources

When a radioactive source, sealed or not, is discovered, the FANC will try to identify the real polluter in order to be able to charge to him all related costs. ONDRAF/NIRAS will charge him with the associated costs for waste management by applying the "polluter pays" principle. In case a polluter cannot be identified the associated costs will be covered by the insolvency fund mentioned in point d. above.

In collaboration with the stakeholders and the environmental administrations of the three Belgian Regions (the Flemish, Walloon and Brussels-Capital Regions) the FANC established a list of facilities for which the monitoring of radioactivity could be made compulsory. In order to do so, a careful study of the flows of scrap and waste has been made so as to identify the nodal points in the scrap recycling network where a monitoring system would be the most appropriate choice. The goal is to keep a balance between the need to monitor as much scrap flow as possible without imposing heavy burdens on small facilities.

Discussions have been undertaken with orphan sensitive sectors in order to conclude an agreement defining the responsibilities of each of the parties involved. On 19 October 2007, the FANC, ONDRAF/NIRAS and most of the professional federations from the metal sector, the waste treatment and the recycling sectors signed this agreement regarding the tracking and management of radioactive materials and objects outside of the nuclear sector. Undertakings wanting to profit from the financial arrangement for orphan sources have to register their facilities at the FANC. The operators of these facilities are obliged to take measures in order to prevent the presence of orphan sources on their sites, in their installations or in the supply of goods and bulk materials. When such a source is detected, FANC investigates if its guidelines are complied with and tries to determine responsibilities. It is expected that with this instrument more orphan sources will be recovered and declared at ONDRAF/NIRAS.

The Royal Decree of 14 October 2011 makes the installation of radiation portal monitors, previously only implemented to a set of facilities on a regional basis, mandatory at the federal level.

This Royal Decree applies to orphan-source sensitive facilities that handle one or more orphan-source sensitive flows and that are subject to notification or licensing pursuant to the regional environmental legislation. The European list of waste was taken as a basis for the definition of these flows.

III. Section C: Scope of Application.

Belgium concluded several reprocessing contracts for its spent fuel (see Section B: policies). The waste arising from this reprocessing (vitrified high-level and intermediate-level waste, and compacted structural waste) that is repatriated to Belgium falls within the scope of the Convention. Currently, both options (direct disposal of the spent fuel or reprocessing) remain open and under study (see also section B: policies).

The protection of the population, the workers and the environment against the hazards of radiation emitted by naturally occurring radioactive materials (NORM) is also regulated by the GRR-2001. Work activities involving NORM must be notified to the FANC and licensed in case FANC judges that the radiation hazards are not negligible. Only waste generated by such licensed work activities or generated by site remediation activities is considered as radioactive waste. In this case, these materials are regulated by the waste management rules, as described in this report.

The armed forces have no nuclear fuel, either fresh or spent. The radioactive waste produced by the armed forces is managed according to laws and regulations similar to those applicable for civilian radioactive waste.

IV. Section D: Inventories and Lists

IV.A. Spent fuel and waste from reprocessed fuel from nuclear power plants: management facilities and inventories.

IV.A.1. Non-reprocessed spent fuel from NPPs

The spent fuel which is not reprocessed is currently stored on the sites of the two nuclear power plants in Belgium operated by ELECTRABEL SA, namely the Tihange nuclear power plant (pool storage) and the Doel nuclear power plant (dry storage).

The current inventories are given in appendix 1 (section XII.A.5.c)).

IV.A.2. Waste from reprocessed fuel.

In total, Belgium has reprocessed 672 t_{HM} of spent fuel. The reprocessing contracts stipulate that conditioned waste is repatriated to Belgium.

By the end of 2013, 390 "CSD-V" canisters amounting to an average mass of 493 kg per canister and a total volume of 70 m³ of vitrified high-level waste (fission products are immobilised in a borosilicate glass matrix) - had been returned to Belgium (12 shipments of 28 canisters each were organised, one shipment of 27 canisters and one shipment of 24 canisters). 432 "CSD-C" canisters of compacted waste (technological and structural waste) had been returned.

	# canisters already returned to Belgium	Total activity β/γ	Total activity α	Average activity β/γ	Average activity α
CSD-V	390*	5.90E+18	8.03E+16	1.52E+16	2.07E+14
CSD-C	432**	3.98+16	1.70E+14	9.23E+13	3.95E+11

*: 3 CSD-V belong to SCK•CEN

**: 1 CSD-C belongs to SCK•CEN

These canisters are temporarily stored in different zones, specially designed to that purpose, inside building 136 (see also section H) on the Belgoprocess site in Dessel until a solution for the final disposal is operational.

To conclude the actual contract, an estimated number of maximum 62 containers with intermediate-level vitrified waste (CSD-B) will be returned to Belgium.

IV.A.3. Spent fuel and waste from reprocessed fuel coming from research reactors: management facilities and inventories.

Beside the seven power reactors, Belgium also possesses research reactors: BR1, BR2, BR3 (now dismantled) and VENUS, all located on the SCK•CEN site in Mol.

- Since reactors BR1 (natural uranium) and VENUS (enriched UO_2 and MOX) are still working with their initial fuel load, this report does not consider these reactors. In the current GUINEVERE experiment at VENUS, uranium metal fuel rodlets are used as mentioned before (see section II.A.1).
- The BR2 reactor fuel (uranium enriched to more than 90%) is considered by this report. A part of its spent fuel is stored in the pool next to the reactor; another part of the spent fuel is transferred to the AREVA reprocessing plant of La Hague. Dounreay is no longer an option.
- As the BR3 reactor (PWR type) is currently being decommissioned, its fuel (175 assemblies stored in 'CASTOR' containers, having very different enrichments up to 11%), is stored in building 156 at Belgoprocess.

The THETIS reactor on the site of the University of Ghent was permanently shut down on 31 December 2003. The reactor was unloaded in 2010 and the spent fuel was transported to Belgoprocess where it was conditioned as radioactive waste. Seven 400 l-drums with the conditioned waste are stored in a storage facility on the site of Belgoprocess awaiting disposal.

IV.B. Radioactive waste: management facilities and inventories.

Storage and processing facilities in Belgium are spread over several sites:

- Belgoprocess Sites 1 and 2 in Dessel and Mol respectively
- Tihange and Doel nuclear power plants sites
- Umicore site in Olen
- the Institute for Radioelements (IRE in Fleurus), universities, hospitals, research centres, laboratories.

IV.B.1. The Belgoprocess sites 1 and 2

ONDRAF/NIRAS has subcontracted the industrial aspects of the waste management to its 100% subsidiary company, Belgoprocess. In that respect, Belgoprocess operates in Mol (site 2) and Dessel (site 1) radioactive waste processing and storage installations.

These installations 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).

These processing facilities are:

- **EUROBITUM**, started up in 1978, on site 1 of Belgoprocess for the processing and the conditioning into bitumen of low and intermediate level sludge and evaporator concentrates coming from the processing of liquid waste. No further bituminization in this facility is foreseen and alternative waste processing options are being evaluated for these types of liquid waste and sludges.
- **BRE**, started up in 1980 on site 2 of Belgoprocess to process high and intermediate level liquid waste.
- **MUMMIE** (site 2) was constructed in the late 60's for bituminization of sludges (low level waste). No further bituminization in this facility is foreseen. An alternative processing of the sludges, consists of incinerating them in the existing CILVA facility. This application is not yet in operation.
- **CILVA** (site 1) is the infrastructure for the processing of solid and liquid low-level waste. This installation was started up in 1994 and is composed of five units:
  - The reception and pre-storage unit for unprocessed radioactive waste (weighting, control of radiation levels and external contamination).
  - The pre-treatment unit (waste sorting, cutting, and pre-compaction).
  - The supercompaction unit with a 2000 ton press to compact the 200 litre carbon steel drums containing the unconditioned radioactive waste into 15 to 40 cm³ thick compaction disks (compaction capacity: 8 000 drums/year).
  - The incineration unit has a capacity of 7.5 ton solid waste per week. Organic and aqueous liquids containing a lot of organic compounds or complexing agents are incinerated together with the solid waste.
  - The conditioning unit to immobilise with cement the supercompacted disks inside the 400 litre drums (capacity: 2 000 drums/year)
- **Pyrolysis installation** (site 2) for the thermal decomposition of alpha contaminated organic effluents coming from the former Eurochemic reprocessing plant. The remaining solid waste is then cemented. This installation was started up in 1999 and processed organic effluents between 2000 and 2002. For the moment, no further use of this installation is foreseen.
- **PAMELA** (site 1) was put into service in 1985 and was used until 1991 for vitrifying the 860 m³ liquid high-level waste coming from the Eurochemic reprocessing plant. Afterwards, the PAMELA cementation unit conditioned into cement solid intermediate-level waste arising from its own operation and the waste arising from the dismantling of its vitrification unit as well as solid intermediate and high-level waste coming from the refurbishment of the BR2 reactor and the dismantling of the BR3 reactor. The facility has been modified for the treatment and conditioning of alpha-contaminated waste (e.g. glove box from Belgonucleaire) and medium-high level solid waste streams. After licensing and testing, the facility became operational early 2007 and is still in operation.
- **ALPHA-ROOM** (site 2) for the treatment of low Ra-contaminated waste. This installation started to treat waste in 2013.
- **HRA-Solarium** (Building 280x, site 2) for the processing of alpha and beta-gamma waste and radium-bearing waste. This solid and liquid historical waste results from former SCK•CEN research

programmes, from Electrabel, from the IRE and from the dismantling of the Union Minière plant (now UMICORE) in Olen. The installation is still in operation

- **Building 110X** (site 1) for the sorting and separation, in operation since 2005, of alpha-contaminated solid low-level waste coming mainly from the nuclear fuel fabrication (mainly Belgonucleaire, in Dessel), in view of its conditioning in the PAMELA facility from 2006 on. The installation has been put out of operation in 2008 after having dealt with the foreseen sorting operations.

The conditioned waste (listed in table 2 hereafter) is stored in different appropriate buildings on sites 1 and 2 (see also section H and appendix 3).

- **Building 150**, started up in 1986, for the storage of low-level waste (mainly category A). It is now filled with packages of different volumes (400, 500, 1000, 1200, 1500, 1600, and 2200 litre). It has 25 cm thick reinforced concrete walls. This building has a storage capacity of 2 000 m³ and is divided in three areas: the North hall, the South hall and the central hall. The stored waste arises from the Doel and Tihange nuclear power plants (filters, concentrates, resins …) and from the former SCK•CEN Waste department (waste arising from the Belgoprocess site 2).
- **Building 151**, put into service in 1988, to store the waste of the same types and origins as in building 150, but with a larger capacity (14 000 m³).
- **Building 127**, has a capacity of 5 000 m³ for the storage of bituminised and cemented intermediate-level waste (mainly category B, 220 and 400 litre packages) coming mainly (76 %) from the operational Eurochemic reprocessing pilot plant. It has 80 cm thick reinforced concrete walls.
- **Building 129** for the storage of high-level waste (category C). It contains 195 m³ of conditioned high-level waste (60 and 150 litre packages) arising from the vitrification, in the PAMELA installation, of the 860 m³ Eurochemic liquid waste, the waste coming from the partial dismantling of this vitrification installation and the cemented high and intermediate-level waste coming from the reactors BR2 and BR3.
- **Building 136**, modularly designed, for the storage of high and intermediate-level waste coming from the reprocessing by COGEMA of spent irradiated fuel. It can currently contain 590 canisters of vitrified waste (zone C) , and initially about 820 canisters with compacted hulls and end pieces mixed with technological waste and up to 2 000 containers (210 l) of bituminised waste (sludge) (zone D). The capacity of zone D in the building has been adapted to take into account the newly defined types of waste that have to be stored in this zone.
- **Buildings 155 et 156**, for the storage of conditioned alpha- and radium- contaminated waste (building 155) and the irradiated fuel from the BR3 reactor (building 156).
- **Building 270**, is not a storage facility, but a buffer containing packages which have to be transferred to building 155 immediately or after having been reconditioned. The packages in this building are mainly filled with radium-bearing waste conditioned in the MUMMIE installation or arising from the Umicore plant in Olen. A large number of different waste packages (under characterisation) coming from the passive of the former SCK•CEN Waste department is also temporarily stored in this building.

Table 2: volume and activity per storage building as of December 31, 2013

Buildings	**Waste categories**	**Number packages (#) / volume (m³)**	**Capacity (m³) / filling rate (%)**	**Activity (Bq)**	
				Alpha	**Beta-gamma**
127	A + mainly B	15855 / 3863	4651 / 83 %	$3{,}3\ 10^{14}$	$4{,}5\ 10^{16}$
129	C	2335 / 215	250 / 86 %	$1{,}7\ 10^{15}$	$3{,}7\ 10^{17}$
136–Zone C	C	390 / 70 (vitrified)	106 / 66 %	$8{,}1\ 10^{16}$	$5{,}9\ 10^{18}$
136-Zone D	B	462 / 104 (compacted)	600 / 17 %	$1{,}6\ 10^{14}$	$3{,}9\ 10^{16}$
150	A + B	3317 / 1914	1929 / 99 %	$1{,}9\ 10^{12}$	$2{,}2\ 10^{14}$
151	A + B	35114 / 14153	14710 / 98 %	$5{,}7\ 10^{13}$	$1{,}1\ 10^{15}$
155	B + Ra	3442 / 1404	4221 / 33 %	$1{,}6\ 10^{15}$	$1{,}1\ 10^{16}$
156	C	7 castors	8 castors / 88 %	$2{,}0\ 10^{15}$	$1{,}0\ 10^{17}$
270	A + B + Ra	461 / 198	Temporary buffer	$2{,}3\ 10^{12}$	$7{,}0\ 10^{13}$

IV.B.2. **The sites of the Doel and Tihange nuclear power plants**

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 (ion-exchange resin, filters and other diverse waste) with a dose rate higher than 2 mSv/h, and evaporator concentrates. Non-conditioned waste with a dose rate lower than this limit is sent to Belgoprocess where it is conditioned in the CILVA facility.

The waste storage on the nuclear power plant sites is only temporary until ONDRAF/NIRAS removes the waste and transfers it to Belgoprocess where the conditioned (in the NPP or in the CILVA installation) waste is stored in buildings 151 or 127. More details can be found in appendix 2 and 3.

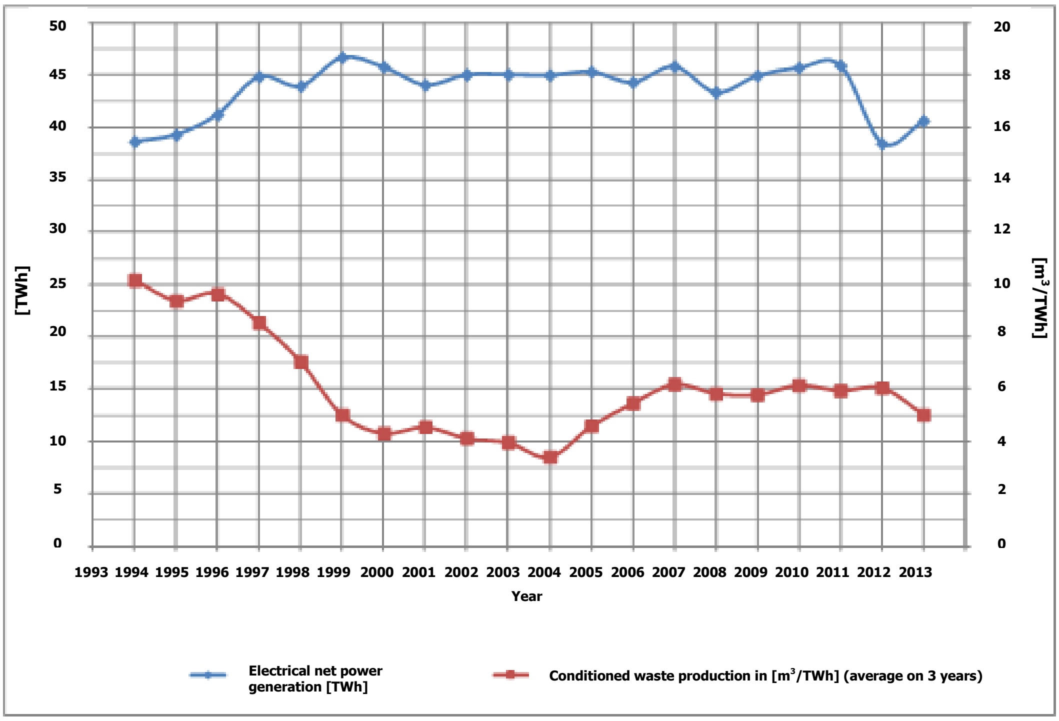

Figure 4: Waste production and net power generation of the Belgian nuclear power plants

IV.B.3. **The Umicore site in Olen**

IV.B.3.a) *Context and overview*

A production unit for radium was started in Olen in 1922 by Union Minière (now UMICORE). Radium was extracted from rich uranium ores from the former Belgian colony Congo, where "Union Minière du Haut Katanga" operated a mine in Shinkolobwe, Katanga. Because of the development of nuclear reactors, starting in the 1950's other radioactive substances, with shorter half-lives could be produced and used for medical purposes, which gradually reduced the use of radium. In Olen, a stock of pure radium remained behind in the "use packaging". The production process for radium and the various purification stages gave rise to a dispersed pollution inside and outside the premises of the UMICORE plant. In the middle of the 1950's, a central storage facility was built for all final products (Ra-needles), intermediate products and wastes. In the 1970's, the Ra production activity was stopped and all the production installations were dismantled. However, the storage facility and the local contamination within and outside the plant grounds remained.

Today, the "Olen radioactivity file" consists of 3 subfiles as schematically presented below.

- The UMTRAP facility is the authorized Class II storage facility built on the plant grounds for radioactive waste from the Ra-production activity. It is the result of a remediation activity of the former storage facility built in the 1950's, a.o. with an emplacement of a multi-layer cover on the former storage facility, realised by UMICORE in the eighties and licensed by the safety and radiation protection authorities. This licensed storage facility has a covered storage area for radium sources (Ra-needles emplaced in a tight container), contaminated materials and soils. It is composed of concrete bunkers with a copper confinement for radium-bearing waste and sources and of silos for low-radium waste. The contaminated soils fill the gaps between the silos and the bunkers. All this is covered with a multilayer consisting of clay, sand and gravel. It has a total estimated ^{226}Ra inventory of 3 10^{13} Bq and a total waste volume of about 55 000 m³, with the following specific waste streams:
    - 200 g of Ra-226 in the form of Ra-needles;
    - 2 000 ton of *tailings*, with a total of about 700 g of Ra-226 and with Ra-226 activities up to about 30 000 Bq/g;
    - 4 000 ton of Ra-bearing residues, with a total of about 110 g of Ra-226 and with Ra-activities up to about 7 500 Bq/g;
    - 60 000 ton of Ra-contaminated soil and scrap material with a mean Ra-activity of about 15 Bq/g.

  The principle applied for the multilayer covering is generally used in the USA (Uranium Milling and Tailing Remediation action) and was accepted by the involved national ministries as affording better protection for humans and the environment. The existing licenses from the production period were converted by the government into a license with special conditions for this storage facility of radioactive waste. These special conditions were formulated in the Royal Decree of June 20, 1995 and in one of these conditions UMICORE is required to perform a study of the long term management option for the storage facility. UMICORE still has to finalise this study, for which no timing has been imposed. It is agreed by all parties involved (UMICORE, FANC, NIRAS, regional authorities) that the long-term management of the UMTRAP facility has to be integrated in a global plan for the site.
- The second file (BRAEM) relates to the radioactive waste and radioactive contamination outside the plant grounds:
    - radioactive (and chemical) contamination of the Bankloop brook
    - the D1 landfill north of the canal.

  Studies commissioned by the federal government and performed in the early nineties have shown that the present-day risks are limited, mainly because the D1 landfill is fenced and there is no direct access for the public. However, the radiation protection authorities asked Umicore to proceed to a cleanup "not because there is any danger at present for public health, but rather in order to substantially improve the isolation of the contaminated materials from the environment, which will keep the dose impact for the local population very limited in the future as well." In May 2000, Umicore was entrusted with the task to propose a site remediation project. The current situation is described below.
- The third file (SIM) deals with the residual pollution within the plant grounds besides the UMTRAP facility. Due to the many years of activities there are remaining contaminations present within the plant enclosure as well. During the decommissioning and clean-up of the old radium factory, not all

pollution on the plant grounds could be removed. However, there are no radiation risks for the personnel or the environment.
This file has three major components, namely
- The old dump site in the NE corner of the plant, with a limited quantity of radioactive material;
- The local contamination of the subsoil;
- A former measurement lab.

IV.B.3.b) *Situation mid 2014*

UMICORE has executed the remediation of the Bankloop in the period 2007-2008. All the removed radioactively contaminated materials (about 30 000 m³) are stored in a surface storage facility (licensed by FANC for a period of 10 years) on the plant grounds, awaiting a final destination. This temporary solution has to be integrated in a global site remediation plan including the remediation of the D1 landfill and the remaining contaminations on and off site.

In the period 2009 – 2011 UMICORE has studied in a preliminary way the possible options for a global site remediation plan integrating the remediation of the D1 landfill and the remaining contamination on site, as well as the waste in the surface storage facilities UMTRAP and Bankloop storage. Additional measurements of the radiological contamination on the D1 landfill were performed and analysed, providing sufficiently precise and complete information to prepare a site remediation project.

UMICORE organised in March 2011 a workshop with the authorities (FANC, authorities of the Flemish region, ONDRAF/NIRAS) to make a global evaluation of the situation and to discuss remaining issues and a way forward.

Since the workshop, ONDRAF/NIRAS has taken the initiative to start preparing its second Waste Plan (focussing on Radium-bearing waste) by issuing two documents:

1. ONDRAF/NIRAS Vision on the long-term management of the radioactive contaminations and the radioactive waste present at the Olen-site.

   This document describes the general approach and basic waste management principles that ONDRAF/NIRAS will apply to make step-wise decisional progress and to eventually come to the definition and implementation of all the required site remediation and disposal projects. It also describes main responsibilities for the site remediation activities or projects and the management of the radioactive waste.

2. ONDRAF/NIRAS Reference Framework document on the long-term management of all radioactive waste in Belgium.

   ONDRAF/NIRAS has identified in the Reference Framework document also the regulatory elements that will have to be developed and issued w.r.t. (1) radiological site remediation and the caracterisation and identification of waste from site remediation as radioactive waste, and (2) the disposal of long-lived very low-level and low-level radioactive waste. Without these regulatory requirements and regulatory guidance the radiological site remediation projects and radioactive waste disposal projects for such type of waste cannot be developed.

   The Reference Framework document and the Vision document constitute for ONDRAF/NIRAS a basis for preparing in due time its radium-bearing Waste Plan. The timing of this plan will be proposed in the National Programme to be issued by August 2015 as imposed by the European Directive 2011/70/Euratom. The radium-bearing waste plan aims at the definition of a national policy for the long-term management of this waste category. This policy will define the framework within which all required projects (site remediation and disposal) can be prepared and implemented.

In a convention signed by UMICORE and the regional authorities a start of the remediation activities for the D1 landfill before end 2014 was agreed upon; in the meanwhile protective measures to avoid further contamination of the groundwater underneath and around the landfill were imposed by the regional authorities.

IV.B.4. **Others**

Some universities (Katholieke Universiteit Leuven, Université catholique de Louvain-la-Neuve, Vrije Universiteit Brussel and Université de Liège), hospitals and other important companies (pharmaceutical research) have their own buildings to temporarily store non-conditioned waste. When practicable, waste is stored until its radioactivity decays below the clearance level and is then released as 'conventional waste'. If not practicable, waste is transferred to Belgoprocess. The Catholic Universities of Leuven and Louvain-la-Neuve centralise in their buildings the radioactive waste coming from neighbouring companies and hospitals.

The Institut des Radioéléments (IRE in Fleurus) is involved in the collection, pre-conditioning and temporary storage of sealed sources. These pre-conditioned sources will be transferred to Belgoprocess as soon as it has defined a conditioning technique specific to sealed sources.

In its third inventory of nuclear liabilities published beginning of 2013, according the law of 12 December 1997, ONDRAF/NIRAS identified more than 159 000 sealed sources on 1 January 2011 on the Belgian territory, comprising:

- 12517 sealed sources for general industrial and medical purposes (namely 1311 high active sealed sources and 11206 low active sealed sources);
- about 157 000 ionizing smoke detectors;
- some 275 ionizing lightning rods.

The fourth inventory report of nuclear liabilities will be available beginning of 2018.

Specific actions were organized by ONDRAF/NIRAS and the FANC in order to collect radioactive sources at secondary schools and pharmacist. A collection organized by ONDRAF/NIRAS and the FANC for typical hospital waste is scheduled in 2014. Furthermore, the management of ionizing household smoke detectors is now organized via a collection at municipal waste facilities. A centralized dismantling of the radioactive sources, followed by further management as radioactive waste is organized by ONDRAF/NIRAS. The industrial ionizing smoke detectors are directly collected by ONDRAF/NIRAS as radioactive waste and also the radioactive sources are dismounted. Typical types of disused radioactive sources are still being collected throughout Belgium, i.e. Am241-sources and Ra226-needles.

IV.B.5. **Nuclear facilities being decommissioned.**

For the decommissioning status of EUROCHEMIC (former reprocessing plant), Belgonucleaire (MOX fuel fabrication plant), FBFC (UO2 fuel fabrication plant) and THETHIS (research reactor), we refer to section I.B.3.

Other facilities concerned are:

- the reactor BR3 of SCK•CEN and its building should be completely dismantled in 2020; decommissioning and dismantling serve as a pilot project;
- the dismantling of the former SCK•CEN Waste department (site 2 of Belgoprocess) started in 1998 and should end in 2050;
- Resorting to one of the provisions of the law of 31 January 2003 on nuclear energy phase-out, the Belgian Government decided in July 2012, and in December 2013 imposed by Law, that only Tihange-1's lifetime will be extended to 2025. The two oldest reactors at the Doel site (Doel 1 and Doel 2) are set to be closed in 2015. The remaining Belgian reactors Doel 3, Tihange 2 are set to be closed down in 2022 and 2023, Doel 4 and Tihange 3 in 2025.
  Based on the current planning of Electrabel for the units Doel 1 and 2, it is foreseen to have a final decommissioning plan for approval by ONDRAF/NIRAS by mid-2016, to get the dismantling licence in 2019 and to start the dismantling activities that same year.
- **Role of ONDRAF/NIRAS as nuclear operator: O/N site Fleurus (ONSF)**
  The company "Best Medical Belgium SA" (BMB) located in Fleurus, previously owned by "MDS Nordion SA" until April 2011, produced radioisotopes for medical applications and went bankrupt on May 2012. The facility includes two cyclotrons (CGR 110 and IBA Cyclone 30) and many hot cells and labs. On August 8^{th}, 2012, these installations have been entrusted to ONDRAF/NIRAS.
  An action plan was developed for taking over the operations in the framework of remediation, cleaning and decommissioning. Indeed, in accordance with article 179, § 2, 9° of the Belgian law of August 8th, 1980 and with article 2, § 2, 3 and § 3, 3, a) of the Belgian Royal Decree of March 30th, 1981, one of ONDRAF/NIRAS's legal assignments is to carry out the decommissioning program and the decommissioning operations of the contaminated facilities belonging to radioactive waste producers in case of failure.

On 28 September 2012, ONDRAF/NIRAS submitted to the Federal Agency for Nuclear Control (FANC) a license application for operating the facility. The license, granted on October 8, 2012, covers all the necessary activities for:

- maintaining the safety of the installations;
- the evacuation of waste still stored on site, including radioactive sources and materials;
- the clearance of materials and buildings.

The current license does not yet cover the dismantling of the facility, for which a specific license is needed (dismantling license, in accordance with Article 17.2 of GRR-2001).
ONDRAF/NIRAS has taken steps to integrate his new role as a nuclear operator in its management system and to make the necessary recruitment. The installations of Best Medical Belgium SA are now referred to as the "O/N - Site Fleurus" (ONSF).

V. Section E: Legislative and Regulatory System

V.A. Article 18: implementing measures

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.

Since the signing of the Convention in 1997 the legislative and regulatory framework has undergone important modifications, mainly as a consequence of the operational start-up of the Federal Agency for Nuclear Control (see art. 19), the adoption of the Law of 31 January 2003 (amended in 2013) concerning the phasing-out of nuclear power, the Law of 11 April 2003 on the financial liabilities for the decommissioning of the nuclear power plants and for the management of the fissile materials irradiated in these plants and the law of 3 June 2014 transposing the European Directive 2011/70/Euratom establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste.

V.B. Article 19: legislative and regulatory framework

Belgium participated in the first, second, third and fourth Review Meeting of the Joint Convention, which took place in November 2003, in May 2006, in May 2009 and in May 2012 at the IAEA headquarters.

Belgium is also a contracting party to the *Convention on Nuclear Safety* of 1994. The ruling legislative and regulatory framework concerning nuclear safety is described in extenso in the National Reports, which were elaborated as a result of the six Review Meetings. Below, attention is paid exclusively to those regulatory aspects relevant for the management of radioactive waste and spent fuel.

V.B.1. Identification of the competent authorities

The federal nature of the competent authorities

Belgium is a federal state, meaning that certain competences are exercised at a centralised (federal) policy level, while others are exercised at a decentralised (regional) policy level, constituted by the Flemish Region, the Walloon Region and the Brussels-Capital Region. Since the State Reform of 1980 (Special Law of 8 August 1980 on the Institutional Reforms, completed with the reforms of 1988 and 1993) the competences in the field of environmental protection are exercised by the Regions, such as the surveillance of all industrial activities which may be harmful to man and environment and the waste management policy. However, the regulation of the nuclear industrial activities can be considered as an exception to this regional competence: The protection of the population and of the environment against the hazards of ionising radiation has remained exclusively a federal matter. In the same line, the management of radioactive waste on the Belgian territory, of whatever origin, is organised at the federal level.

The Regions are also involved in some aspects of the energy policy and in the management of the energy infrastructure. However, the decisions concerning the nuclear fuel cycle, including all activities upstream as well as downstream of the nuclear power plants, explicitly remained a federal competence. Consequently, the management of irradiated and non-irradiated nuclear fuel is in Belgium an exclusively federal policy matter. The federal competence with regard to the management of radioactive waste generated by the nuclear fuel cycle follows from the repartition of the competences within the field of the environmental policy, and more precisely the radiation protection policy (Special law of 8 August 1980).

The involvement of the regional authorities in the regulation of nuclear activities remains limited to spatial planning and consultation (for instance in the framework of the licensing of construction and clearance) and exchange of information, with the aim to ensure a coordinated treatment of the nuclear and non-nuclear environmental aspects. To this end, the Regions are represented in some of the federally competent public bodies (the board of directors of ONDRAF/NIRAS).

In addition, each region is represented by 2 members with consultative voting share in the Scientific Council of the FANC.

Another way to ensure this coordination is by the conclusion of cooperation agreements, as is the case for the clearance of radioactive waste.

V.B.2. **Safety Framework**

Belgium is a member of the European Union and of the European Atomic Energy Community (EURATOM) since the foundation of these institutions. The Belgian rules and regulations in the field of radiological protection have been developed in implementation of and in agreement with the European Treaties and directives concerned. The development of the Euratom Treaty has triggered, in parallel with the construction of national nuclear facilities, the necessary development of national laws and regulations in different nuclear areas not covered by the Treaty or not subject to mandatory provisions under the Treaty.

The table below outlines the general safety framework:

	Euratom Treaty (Article 37) EU Directive 2009/71/Euratom (amended by Directive 2014/87/Euratom) EU Directive 2001/70/Euratom EU Directive 2013/59/Euratom (BSS)	Law of 15 April 1994 on the protection of the population and environment against the hazards of ionizing radiation and on the Federal Agency for Nuclear Control	Modification (2011) of the Law of 1994 related to the security of nuclear materials
Royal Decrees (general)	RD laying down the General Regulations regarding the protection of the public, the workers and the environment against the hazards of ionising radiation (GRR-2001)	RD on the safety of nuclear installations (SRNI-2011) *(FANC proposal for a) RD* on the safety on the decommissioning of nuclear installations* *(Specific part of RD on the safety of nuclear installations)*	RD on the security of nuclear materials and nuclear documents *(FANC proposal for a) RD* on the security of radioactive materials*
Royal Decrees (specific for storage and disposal facilities)	*(FANC proposal for a) RD* on the licensing system for disposal facilities*	*(FANC proposal for a) RD* on the safety of waste and spent fuel storage facilities* *(FANC proposal for a) RD* on the safety of disposal facilities* *(Specific parts of RD on the safety of nuclear installations)*	
FANC Guidance (non-binding)	FANC General guidance		
	FANC guides for Surface waste disposal	FANC guides for Geological waste disposal	

RD: in development/approval phase*

Since 1 September 2001 the supervision of nuclear activities is within the responsibility of the Federal Agency for Nuclear Control (FANC). According to the Law of April 1994 (as amended), the FANC may call upon the assistance of recognised bodies for health physics control, called "authorised inspection organisations" (AIO) in this report, or on legal entities especially created by it to assist it in the execution of its missions. The FANC makes use of this provision and, in the case of nuclear facilities, delegates different tasks to Bel V, its subsidiary, a.o. routine inspections

The Belgian legal framework for safety consists mainly of:

- The General Regulations regarding the protection of the public, the workers and the environment against the hazards of ionising radiation (GRR-2001) set the licensing system for the different facilities and activities involving ionising radiation. They specify the safety measures the licensee has to take into account to protect workers and the public, and they organise the health physics control. This regulation transposes the ruling European legislation into Belgian Law, such as the Basic Safety Standards directive 1996/29/Euratom, the directive 1985/337/EEC on the environmental impact assessment of projects, the directive 1992/3/Euratom on the transboundary movements of radioactive waste[1], the obligations resulting from the Euratom Treaty (e.g. article 37), etc. The GRR-2001 has been amended several times, in particular to regulate the evacuation of lightning rods containing radioactive substances, the transposition of the European Directive on high-active sealed sources and the management of orphan sources. The GRR-2001 contains general provisions with regard to radioactive waste management in the licensed facilities, including the characteristics of gaseous, liquid and solid radioactive substances which, for reasons of radiological protection, are not allowed to be discharged into the environment, and which have to be managed as radioactive waste. The General Regulations are modified regularly in order to take account of the evolution of the scientific, technical and social insights. In the near future, GRR-2001 will have to be amended to bring it in line with the new European Basic Safety Standards (2013/59/EURATOM).

- The "Royal Decree on the Safety Requirements for Nuclear Installations" (referenced SRNI-2011 in this report) has been signed by the King on the 30th of November 2011 and has been published in the official journal on the 21st of December, 2012. This Royal Decree incorporates all the WENRA RHWG reference levels into the Belgian regulations. This Royal Decree has a wider scope than the NPPs, as some generic reference levels were found applicable to other nuclear facilities (for example, the obligation to proceed to periodic safety reviews, to have a Safety Analysis Report, to have an integrated Management system, …) including waste management and disposal facilities. This Royal decree is currently being completed with specific safety requirements for to waste disposal facilities, for waste storage facilities and for decommissioning of nuclear installations (from the WENRA WGWD).
- 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 - Algemene Directie Civiele Veiligheid and General Directorate Crisis Centre - Algemene Directie Crisiscentrum). For a nuclear or radiological crisis, its organisation and the role of the various intervening instances is prescribed in the Royal Decree of 17 October 2003. For each nuclear site, the measures to be taken are elaborated further in a nuclear emergency plan, which is approved by the Minister of Home Affairs and which is regularly tested. The nuclear expertise within the framework of the emergency planning is ensured by the FANC and by some organisations (SCK•CEN, Bel V and IRE) having concluded agreements with the competent Minister. Belgium is a contracting party of the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the case of a Nuclear Accident or Radiological Emergency, both done in 1986 under the auspices of the IAEA. Further information is given in section VI.E of the present document devoted to article 25 of the Joint Convention. The national nuclear emergency plan is going to be revised in the near future.

V.B.3. **Radioactive Waste Management Agency (ONDRAF/NIRAS)**

In addition to the safety regulations mentioned above, the management of radioactive waste and excess 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 mission and functioning of ONDRAF/NIRAS were first laid down by the Royal Decree of 30th March 1981. The law of 8th August 1980 was modified by the law of 11th January 1991. The Royal decree of 30th March 1980 has been amended and supplemented by the Royal Decree of 16th October 1991 passed in execution of the law of 11th January 1991. The law of 1991 was amended and supplemented by the law of 12th December 1997. The 1991 law also amended the name of ONDRAF/NIRAS to "Belgian Agency for Radioactive Waste and Enriched Fissile Materials". In the table below, the legal framework is summarised.

[1] It must be noted that directive 1992/3/Euratom has been replaced by directive 2006/117/Euratom on the supervision and control of shipments of radioactive waste between Member States. This directive has been transposed in Belgian law by the Royal Decree of 24 March 2009 regulating import, transit and export of radioactive substances and suppressing chapter IV of GRR-2001.

	Main legal texts governing ONDRAF/NIRAS
Law	the Law of 8 August 1980 on the budgetary proposals for 1979-1980, art. 179 §2 and §3, as amended by the laws of 11 January 1991 and 12 December 1997
Royal Decrees	Royal Decree of 30 March 1981 on the missions and tasks of ONDRAF/NIRAS, as amended by the Royal Decrees of 16 October 1991, 4 April 2003, 1 May 2006, 18 May 2006, 2 June 2006, 13 June 2007
Other legal elements	Ministerial letter of 10 February 1999 concerning General Rules for the establishment of acceptance criteria by ONDRAF/NIRAS for conditioned and non-conditioned waste Royal Decree of 18 November 2002 regarding the qualification of installations for the storage, treatment and conditioning 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. Law of 29 December 2010 regarding the societal integration of a disposal facility at the local level and the creation of a mid-term Fund for covering the societal costs of integration. The law of 3 June 2014 integrating the obligations from the European Directive 2011/70/EURATOM of 19 July 2011 establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste.

The legal framework concerning ONDRAF/NIRAS imposes obligations on the producers (or owners) of radioactive waste and excess fissile materials. It establishes the relations between ONDRAF/NIRAS and the waste producers on the one side and between ONDRAF/NIRAS and the Safety Authority (the FANC) on the other side. The legal missions of ONDRAF/NIRAS are explained below, starting with a short description of the nature of the radioactive materials subject to its management. It is followed by an explanation of the different tasks of ONDRAF/NIRAS with regard to the management of radioactive waste and excess fissile materials: the predisposal and the disposal activities .

V.B.3.a) *Nature and origin of the waste and fissile materials to be managed by ONDRAF/NIRAS*

The legislator has charged ONDRAF/NIRAS with the management of all radioactive waste, of whatever origin, present on the Belgian territory. Consequently, ONDRAF/NIRAS is not only competent for the management of the waste generated in the nuclear fuel cycle (nuclear power plants, fuel fabrication plants), but also for the waste produced by the medical, industrial and scientific research sector. The residues originating from industrial activities using natural radioactive materials (indicated with the acronyms NORM and TENORM) belongs to the competences of ONDRAF/NIRAS, once the FANC has classified them as radioactive waste for reasons of harmfulness for public health.

According to the ONDRAF/NIRAS legal framework, waste can only be considered as radioactive waste if the contamination with radionuclides exceeds a determined level, namely if the concentration of radionuclides exceeds the values which the Safety Authority (FANC) considers acceptable for substances permitted to be used or released unsupervised. The bases for it are published in the GRR-2001 (see further section V.B.4 a) 2)).

The possibility to manage in Belgium waste from foreign countries, under the supervision of ONDRAF/NIRAS, was not excluded in principle by the legislator, but was made subject to the prior consent of the responsible minister (e.g. Spain, Germany).

The Belgian government has exceptionally, and due to the small quantities, accepted to treat and take in charge the radioactive waste coming from the Grand Duchy of Luxemburg.

For the processing of LLW in the Cilva facility a general framework was developed on the basis of a decision by the federal council of Ministers. Before waste can be imported for processing an authorisation by the supervising Minister is required.

Both ONDRAF/NIRAS and the FANC regulations oblige the waste producer (or owner) to establish inventories and prospects concerning the generation of radioactive waste, the quantities of waste in storage and to be disposed of. The gathered information must be available for ONDRAF/NIRAS. These declarations are essential in order to enable ONDRAF/NIRAS to fulfil its missions. As long as a substance has not been declared as radioactive waste by the owner/producer, ONDRAF/NIRAS is not yet responsible for its management. However, the possible accumulation of radioactive waste on a particular site, as a consequence of a non-declaration, can be prevented by the Safety Authorities. For this purpose, the inventory mission of ONDRAF/NIRAS (see section II.B.1) is also an important complementary instrument to inform the responsible minister about potential unwanted accumulations of radioactive substances.

According to ONDRAF/NIRAS regulations, spent fuel is not regarded as radioactive waste. Consequently its management is not automatically subject to the competence of ONDRAF/NIRAS, as long as it is not declared as in excess by the owner/producer. The exceptions to this are ONDRAF/NIRAS' tasks related to the inventory of nuclear liabilities and to the R&D programmes on the long-term management of spent fuel. The latter task is based on the Parliamentary Resolution of December 1993 as endorsed by the Federal Government.

V.B.3.b) *The central mission of ONDRAF/NIRAS: the disposal of radioactive waste and excess fissile materials*

The creation of ONDRAF/NIRAS has to be seen in relation with the moral obligation for every country to establish within its borders a safe long term solution for the radioactive waste and excess fissile materials generated by the installations operating under its jurisdiction (cf. point xi of the preamble of the Convention and the European Council Directive of 19 July 2011). This approach will normally lead to the construction, on the national territory, of one or more repositories dedicated to the disposal of radioactive waste or fissile materials without the intention of retrieving the waste in the future. The national legislator decided that the final disposal of radioactive waste should be entrusted to a public institution, given the long term commitment that will be necessary for the development, the design and the construction of a repository, as well as for its operational phase and for the institutional control after its closure. The intervention of a public organisation was considered as a guarantee for the present and future generations that this kind of waste would be managed with the utmost care and in optimal conditions.

Seen from this perspective, the legislator has granted to ONDRAF/NIRAS a "monopoly" for the disposal of all radioactive waste on the Belgian territory. ONDRAF/NIRAS is entrusted with all the radioactive waste (or all the fissile material) that needs to be disposed of in the future, in exchange of full financial guarantees from the waste producers with the aim to cover the costs of its future management (cf. the Long Term Fund, see below). The waste producers have to bear the complete cost of the long-term management. By this formula, the waste producers obtain a guaranteed discharge of their waste, but also after the transfer of the waste to ONDRAF/NIRAS they remain accountable for the total cost of the long-term management. This is guaranteed by a contractual tariff system that is re-evaluated every ten years in order to determine the remaining cost of the long-term management and by a clause of hidden defects, for which the waste producers remain accountable for 50 years. With this system the population gets the guarantee that the management of the public interest will prevail over private interest.

ONDRAF/NIRAS is endowed with an extensive autonomy with regard to the technological choices and solutions it wants to use to implement its nuclear waste management. The legislation does not impose any obligations on ONDRAF/NIRAS, neither with regard to how the waste or fissile materials should be disposed of, nor with regard to the applied conditions (surface disposal, disposal in deep geological formations, reprocessed or non-reprocessed, …). In fact, these issues are or will be subject of policy decisions and, in a later phase, of the license application.

As a Party to the *"Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter"*, generally known as the London Dumping Convention of 1972, Belgium has abandoned the dumping of radioactive waste into the sea as a disposal route for some waste categories, first temporarily (since 1983) and afterwards permanently (since 1993). Consequently, ONDRAF/NIRAS has to resort to a solution on land.

ONDRAF/NIRAS focuses its efforts on the development of proper national disposal systems. Besides that international developments with respect to a disposal system on a broader regional scale are followed.

Regarding the dimensioning of the disposal and storage infrastructures and considering the estimate of the necessary financial means, ONDRAF/NIRAS departs from a reference programme based on the following elements:

- operating of nuclear power plants for 40 years and 50 years for Tihange 1, in agreement with the law on the phase-out of nuclear energy;
- complete or partial reprocessing of spent fuel discharged from the nuclear power plants, in agreement with the parliamentary resolution of December 1993 on the use of MOX and the reprocessing of spent fuel.

The research and development activities within the framework of the disposal are the responsibility of ONDRAF/NIRAS and are for the greater part subcontracted to the SCK•CEN, university teams and industrial study centres. An important instrument in this respect is the underground laboratory in Mol, run by ESV EURIDICE, an economic interest grouping of ONDRAF/NIRAS and the SCK•CEN.

V.B.3.c) *Missions of ONDRAF/NIRAS with regard to operations prior to the disposal*

(1) Acceptance criteria and qualification of installations

As explained above, an important mission of ONDRAF/NIRAS is the disposal of the radioactive waste. Its legal missions are, however, not limited to the final disposal, but extend to the complete chain of operations preceding the disposal, such as the waste inventory, the collection, the transport, the processing and the storage of radioactive waste. ONDRAF/NIRAS must have the guarantee that the radioactive waste has been processed according to techniques that are compatible with the future disposal. The legislator has therefore endowed ONDRAF/NIRAS with the competence of issuing *acceptance criteria*, which have to be met by the conditioned waste to be accepted. Given the fact that the characteristics of the real disposal system are not yet known, ONDRAF/NIRAS uses reference final destinations while elaborating these acceptance criteria. These criteria are elaborated based on *general rules* that have been approved by the Competent Authority. The general rules provide a regular follow-up of the conduct of the packages in the storage facilities over time in order to detect possible deficiencies and in order to regularly verify the conformity with the reference final destination of the waste.

Some waste producers either have their own installation for processing and temporary storage of their waste or they have their waste processed in national or foreign installations. The legislator has endowed ONDRAF/NIRAS with the competence of assessing the suitability of these installations, i.e. to verify whether these installations are capable of producing waste packages that comply with the acceptance criteria. This assessment is formally finalised with the qualification issued for a limited period. This qualification procedure is described in the Royal Decree of 18 November 2002. The processing and storage of radioactive waste in non-qualified installations should be regarded as forbidden by ONDRAF/NIRAS regulations, because it might generate waste packages which are by definition not in conformity with the waste acceptance criteria. Contracts concluded with foreign processors of radioactive waste have to be submitted for approval to ONDRAF/NIRAS in order to enable it to have an involvement analogous to that regarding the processing in domestic facilities.

Waste producers not disposing of equipment considered appropriate by ONDRAF/NIRAS may entrust the processing of their waste to ONDRAF/NIRAS. The processing of radioactive waste on behalf of producers which do not dispose of adequate (qualified) equipment is a legal task (mission) of ONDRAF/NIRAS. This waste is entrusted to ONDRAF/NIRAS in raw or unconditioned form, on the basis of the waste *acceptance criteria* for unconditioned waste. In order to fulfil its legal task, ONDRAF/NIRAS has its own installations for processing and storage of radioactive waste; these are operated by its industrial subsidiary Belgoprocess. ONDRAF/NIRAS may also resort to external processors (a.o. IRE). The collection of radioactive waste at the producers' place, as well as the transport of the waste, is part of the monopoly of ONDRAF/NIRAS. This task is subcontracted to specialised transport companies.

And, finally, ONDRAF/NIRAS is competent for the collection and assessment of all information necessary to carry out its missions, including the quantities and characteristics of the waste to be processed, stored or disposed of.

(2) Management of fissile materials

The management of irradiated or non-irradiated fissile materials is subject to a legislation similar to that of the management of radioactive waste, insofar these fissile materials are declared in excess by the owner/producer. As long as these fissile materials are not declared in excess, their management remains the exclusive responsibility of the owner/producer. This situation is completely comparable to that of radioactive materials that are not - or not yet - declared waste by the owner/producer. ONDRAF/NIRAS legislation makes an explicit distinction between its missions with regard to radioactive waste on the one hand, and to excess amounts of non-irradiated and irradiated fissile material on the other. The aim of the legislator was to endow ONDRAF/NIRAS with specific missions regarding the management of irradiated fissile material but not with the complete management responsibility; this remains the responsibility of the owner/producer.

a. Irradiated fissile material from *power reactors*

SYNATOM, a 100% subsidiary of ELECTRABEL is the owner of the fissile materials loaded and unloaded in the Belgian nuclear power plants. The Belgian State has recognised the exclusivity of this company with regard to the management of the nuclear fuel cycle including the management of the irradiated fissile materials (Protocol B.K.B./B.C.N. of 24 August 1981). The fact that, simultaneously with the establishment of ONDRAF/NIRAS, SYNATOM was transformed into a mixed society (50% State and 50% electricity producers), is a historic explanation of the repartition of the competences between SYNATOM and ONDRAF/NIRAS in the field of the management of irradiated fissile materials. When in 1994 the participation of the Belgian State was reduced to a 'golden share' to which specific rights were linked, the exclusivity rights of SYNATOM with regard to the management of fissile materials from nuclear power plants remained unchanged.

Up to now, the irradiated fissile materials subject to the management of SYNATOM have not been declared in excess, and consequently cannot be considered to be entrusted to ONDRAF/NIRAS with the accompanying transfer of financial means. The law of 11 April 2003 (as amended) has introduced (more) specific rules for the funds built up and managed by SYNATOM and dedicated to ensure the financing of the future management of the irradiated fissile materials, particularly in the context of the liberalisation of the European electricity market. For more information see also section VI.B.2.b). This law also determines the management of funds built up by SYNATOM for the decommissioning of the nuclear power plants (see paragraph (3) below).

Due to the initially foreseen gradual *phase-out of nuclear energy*, after 40 year of operation of the nuclear power plants, the amount of irradiated fissile material to be managed in the future, is estimated to roughly 4 700 t_{HM} produced by the existing nuclear power plants (after subtraction of the 672 t_{HM} which were already reprocessed). The management of these fissile materials, either through reprocessing and disposal of the waste produced, or through conditioning and disposal of the non-reprocessed fissile materials, has been the subject of a Parliamentary debate which has led in December 1993 to the acceptance of a resolution (see section I.A). No new reprocessing contract can be concluded by SYNATOM without the formal agreement of the government.

b. Irradiated fissile materials from *research reactors*

The fissile material resulting from the operation of research reactors (BR1, BR2, and Venus of SCK•CEN) continue to be managed by the scientific institutes operating these installations or by their supervisory entities, and this until they are declared in excess or as radioactive waste. Up to the present, only the irradiated fissile material of reactor BR3 and of the THETIS reactor has been declared as waste. The BR3 spent fuel has been transferred to a storage facility on the Belgoprocess site 1 (building 156) while the spent fuel of the THETIS reactor has been conditioned in the PAMELA facility of Belgoprocess. The irradiated fissile material of reactor BR2 has been transported for reprocessing purposes, partly to Dounreay (UK) and partly to the AREVA reprocessing facilities of La Hague. The suspension of reprocessing does not apply to the fissile material unloaded from the research reactors, so that in the future the BR2 fissile material will continue to be shipped to La Hague.

(3) Management of the decommissioning and dismantling of nuclear facilities

Each owner or operator of a nuclear installation is responsible for the future dismantling of his installations. ONDRAF/NIRAS verifies that the owner/operator undertakes timely the necessary steps in order to carry out the future dismantling of its installations; the owner/operator has to submit his decommissioning plan(s) to ONDRAF/NIRAS for approval. The radioactive waste resulting from the dismantling is subject to the management by ONDRAF/NIRAS according to the same principles as the waste from another origin. Furthermore, it is part of the missions of ONDRAF/NIRAS to follow up the evolution of the methodologies and technologies concerning dismantling.

From the regulatory point of view, the FANC requires early guarantees that appropriate measures are taken for proper management of waste. For this purpose, the operation license application must include an estimate of the waste quantities that will be produced during the dismantling of the installations. It also requests information on the management and processing of that waste before being transferred to ONDRAF/NIRAS.

Dismantling operations have to be covered by a specific dismantling license.

If the owner/operator chooses not to perform the dismantling operations himself, he can ask ONDRAF/NIRAS to perform these works for his account. To this end, ONDRAF/NIRAS legislation has been adapted in 1991. At present, ONDRAF/NIRAS is commissioned by the Belgian State with the dismantling of some important installations, such as the former reprocessing plant Eurochemic (known as "BP1 liability"), the former waste treatment installations of SCK•CEN ("BP2 liability. The dismantling operations on the Belgoprocess sites 1 (BP1) and 2 (BP2) have been entrusted by ONDRAF/NIRAS to its industrial subsidiary Belgoprocess. The financing of these activities was guaranteed till the end of the year 2000 by the Belgian State and the electricity sector. The Law of 24 March 2003 creates the legal framework for a structural financing mechanism of these dismantling activities on the BP1 and BP2 sites until their completion by a levy on the transported kWh. For each period of five years, ONDRAF/NIRAS has to present a financing plan to its supervising minister.

ONDRAF/NIRAS sees to it that the owners/operators build up the necessary funds for the financing of the future dismantling programme. In 1985, the nuclear electricity producers (now unified in ELECTRABEL) have concluded a convention with the Belgian State introducing a special arrangement for the creation of a fund dedicated to the dismantling of the 7 nuclear power plants. With the liberation of the electricity market these arrangements had to be and were strengthened. The Law of 11 April 2003 has introduced a new management system for the dismantling and spent fuel back-end management funds, controlled by a follow up committee composed of experts appointed by law. For the conclusions of the nuclear funds committee with respect to the sufficiency of financial funding level, a formal advice of ONDRAF/NIRAS is needed. SYNATOM has been entrusted with the mission of managing all the funds for the nuclear liabilities: the dismantling of the nuclear power plants and the management of the spent fuel (see section VI.B.2 b) for more details), including the cost for the related radioactive waste. The Law of 11 April 2003, already updated in 2007, was improved recently in 2014 by giving more control to the committee with regard to its organisation and procedure.

In 1997, the legal missions of ONDRAF/NIRAS were extended to the creation of a five-year inventory of all nuclear installations and sites where radioactive substances are present. The purpose of this inventory is the mapping of all potential nuclear liabilities with the aim to detect the creation of such liabilities in time and – if possible – to prevent them.

V.B.4. **Regulations regarding the management of radioactive waste and spent fuel**

V.B.4.a) ***The regulations applying to the facilities dedicated to the production, processing, storage or disposal of radioactive waste or spent fuel***

(1) The licensing system for the creation and operation of nuclear facilities.

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, the Scientific Council of the Federal Agency for Nuclear Control and the European Commission. The regulatory body performs a safety review 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 the King. The procedure to be followed is described in detail on the following page.

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 modified) and the Recommendation of the European Commission 2010/635/Euratom concerning the application of article 37 of the Euratom Treaty.

The license stipulates - among other things – that the safety of Class I facilities must be re-assessed with an interval of ten years (see section G, article 5).

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, these verification leads to a confirmation of the initial license, by Royal Decree, called "confirmation decree".

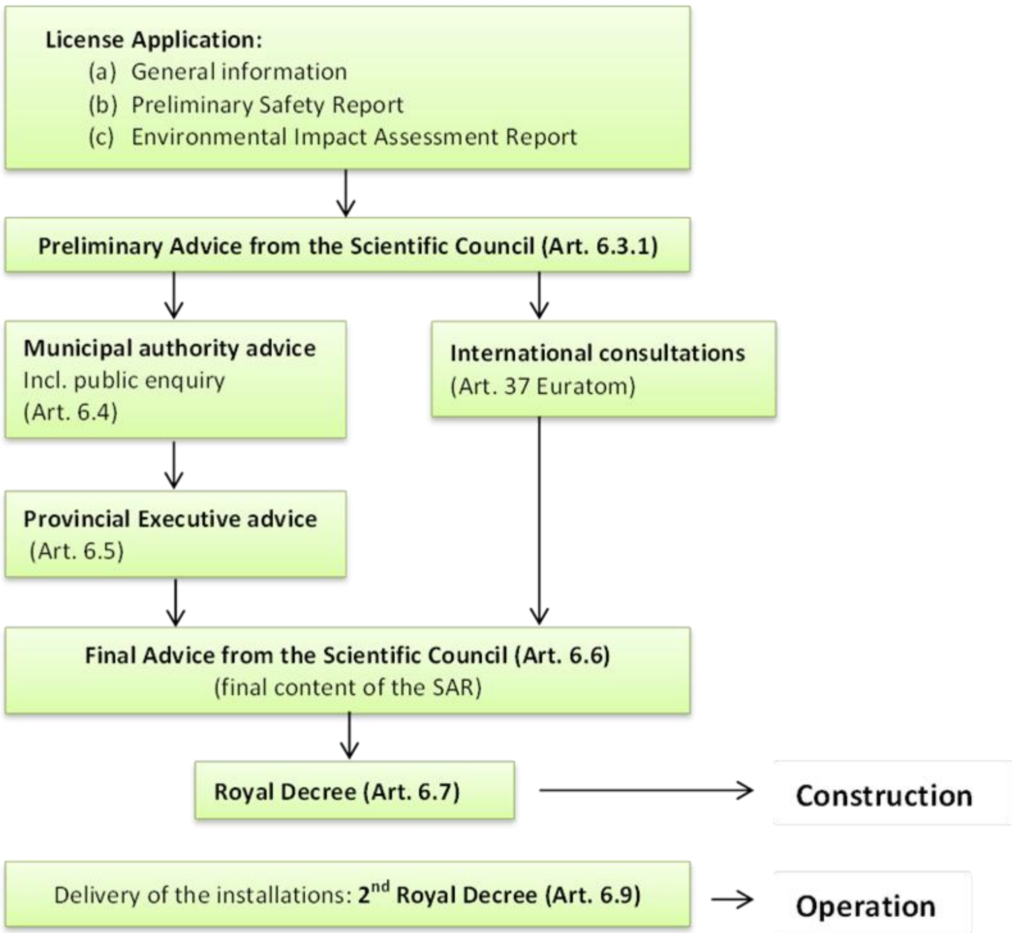

Figure 5: Licensing system for Class I facilities

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

A. Facilities dedicated to processing 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 facility is Belgoprocess and comprises the sites BP1 en BP2, respectively in Dessel and Mol.

B. Facilities dedicated to disposal of radioactive waste

Facilities for radioactive waste disposal are categorized as Class 1 facilities and are licensed in a similar way.

An amended licensing procedure for repositories has been submitted to the government for approval. This licensing procedure is similar to other Class I facilities, but takes more into account the specificities of repositories: modular "construction", phased approach, closure, long term regulatory surveillance and monitoring, no dismantling.

C. Facilities dedicated to production, storage, treatment of irradiated fissile material or to the conditioning or disposal of excess fissile material

All facilities producing, 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 nuclear power reactors of ELECTRABEL;
- The nuclear research reactors of SCK•CEN;
- The storage pools for fissile materials on the nuclear power plant sites;
- 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).

D. 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 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) to be produced, including the waste generated by the future decommissioning and dismantling of the installations. The license application also includes 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 creation 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.

(2) Operating conditions for nuclear facilities

The GRR-2001 comprises general provisions regarding radioactive waste.

- Radioactive waste that cannot be discharged as such has to be collected and treated and is subject to the management by ONDRAF/NIRAS.
- The evacuation of solid radioactive waste, originating from a licensed facility of Class I, II and III with the aim to its recycling, re-use, or management as non-radioactive waste (incineration, landfill disposal) is permitted if it complies with the clearance levels and conditions stipulated in the GRR-2001. These clearance levels are expressed in Bq/g. Deviations from these generic clearance levels may be granted by the FANC, provided the operator demonstrates that the radiological protection criteria are met, namely an individual dose of 10 µSv/year and either a collective dose of 1man.Sv per year or optimised protection. These specific clearance levels shall not exceed the exemption levels.

The cooperation agreement of 17 October 2002 between the federal State and the regions require that the FANC informs the regional authorities responsible for the non-radioactive waste management, of the clearances granted and of the cleared quantities. To this end the operators are required to send yearly this information to the FANC.

- The discharge of radioactive effluents into the environment is subject to very strict conditions and limitations and has to be kept as low as reasonably achievable. The concentration of radionuclides present in the gaseous effluents released into the atmosphere and in the liquid waste released into surface waters and sewerage, must comply with limit values published in the GRR-2001 (in Bq/l for liquid waste and in Bq/m³ for gaseous effluents), corresponding to at their discharge point :
  - one thousandth of the limit (calculated according to the method prescribed in the GRR-2001) of the annual intake through ingestion by an adult belonging to the public in liquid radioactive releases;
  - the derived limit (calculated according to the method prescribed in the GRR-2001) of the concentration in the air for persons belonging to the public, in gaseous radioactive waste.

  The licenses for Class I and II nuclear facilities can deviate from these generically determined values. In this case the discharge limits are determined by means of exposure scenarios, taking into account a dose constraint (a fraction of 1 mSv/year, which is the dose limit for members of the public).

(3) Relations between the waste producers and ONDRAF/NIRAS

According to ONDRAF/NIRAS legislation, every person possessing radioactive waste, operating installations producing radioactive waste or any person who has the intention of building such installations has to submit to ONDRAF/NIRAS all the information required for the execution of its missions. ONDRAF/NIRAS concludes agreements with the most important waste producers concerning the general radioactive waste management programme and the collection of the waste with a view to its transport, processing, storage and disposal.

These obligations are also stipulated in the GRR-2001 with regard to every operator of a licensed facility who is also a potential producer of radioactive waste. The commitment of the future operator to register with ONDRAF/NIRAS is an element of the license application file. Even though the regulations of FANC and ONDRAF/NIRAS are complementary, there are differences. While the GRR-2001 only applies to operators of a licensed nuclear facility, ONDRAF/NIRAS regulation also applies to the legal owners of (possibly future) radioactive waste (e.g. SYNATOM).

The relations between ONDRAF/NIRAS and the most important waste producers have been conceived by the legislator as being of a contractual nature. The agreements between ONDRAF/NIRAS and the producers are written down in long-term conventions guaranteeing a certain continuity and price stability (open-ended conventions, valid until decommissioning of producer's facilities and generation of last radioactive waste has been completed). Appendixes to these conventions are dealing with actual tariffs.

With regard to the processing of non-conditioned waste, the related attachments are concluded for a 5-year period.

With regard to the storage of conditioned waste and later disposal, the related attachments are concluded for a 10-year period. The waste producers or waste owners remain accountable for the costs of the waste management activities, also after transfer of ownership of the waste to ONDRAF/ NIRAS. This is guaranteed by this contractual tariff system that is re-evaluated every ten years in order to determine the remaining cost of the long-term management to be financed by the then existing waste producers, and also by a clause of hidden defects, for which the waste conditionners remain accountable during 50 years.

(4) Decommissioning and dismantling of a nuclear facility

According to ONDRAF/NIRAS legislation, the operators/owners have to submit their plans for the future dismantling of their installations to ONDRAF/NIRAS for approval. The dismantling of important licensed facilities (Class I and some of Class II) is subject to a license according to the GRR-2001 and requires in some cases an environmental impact assessment. The license application has to be accompanied by an advice of ONDRAF/NIRAS. For less important facilities, only a notification to the FANC is required.

Special attention needs to be paid to the management of the waste and of re-usable materials generated during dismantling. ONDRAF/NIRAS is charged with the gathering and assessment of all the information enabling it to manage the waste generated during dismantling. Initial information about the expected amounts, types and production planning of dismantling waste has to be provided in the initial license application file for Class I and Class II facilities.

The clearance of materials originating from the dismantling of Class I facilities and of certain Class II facilities is, considering the important volumes at issue, always subject to a license, regardless of the residual contamination level. The licensing procedure to be followed is described in the GRR-2001.

V.B.5. **Regulations for the transport, import, transit and export of radioactive waste and spent fuel**

The transport and transboundary movement of radioactive waste and spent fuel is performed according to the European and international regulations concerning the transport of dangerous goods by road, rail, ship, and airplane.

The provisions that apply to the transport of radioactive substances in general and of radioactive waste and spent fuel in particular, are laid down in chapter VII of the GRR-2001. This chapter requires that every shipment must be licensed in advance. This license is only granted if it can be demonstrated that the provisions of the relevant international conventions and agreements [2] are observed.

Following the promulgation of the European Directive 2006/117/Euratom of 20 November 2006 on the supervision and control of shipments of radioactive waste and spent fuel, chapter IV of the GRR-2001 dealing with the import, export, transit and distribution of radioactive substances was deleted and replaced by the Royal Decree of 24 March 2009 regulating import, transit and export of radioactive substances. In addition to the implementation of the European system of surveillance and control of shipments of radioactive waste and spent fuel, it states that persons who import radioactive substances must be registered and that import of sealed sources and fissile material is subject to licensing. Registered importers are required to keep the accounts of the material imported and to report to the FANC on a regular basis.

V.B.6. **Regulations applicable to the activities involving exposure to natural radiation sources**

In accordance with the current European directives in force, the GRR-2001 also covers activities involving natural radiation sources. Companies belonging to a list of industrial activities have to submit a declaration to the FANC. If the risk of exposure of workers or public may exceed the dose levels defined in the regulations, corrective measures or possibly licensing of the activity are enforced. Residues or waste generated by these activities may need, from the point of view of radiological protection, special attention. The FANC can decide that such activities are subject to specific provisions and in some cases that the generated waste is subject to the management principles of ONDRAF/NIRAS.

FANC has defined under which conditions these residues may be recycled or treated as non-radioactive waste: in March 2013, FANC published a new decree which added the facilities for processing, valorization and recycling of residues with an activity concentration above some generic clearance levels into the list of "work activities involving natural radiation sources". Residues processing facilities which accept residues with an activity concentration above these levels must submit to FANC a declaration, similar to the ones of the other NORM industries. Once the residues processing facility has submitted a declaration, specific acceptance criteria are imposed to the facility.

V.C. Article 20: Regulatory Body

As explained in the National Report elaborated within the framework of the Convention on Nuclear Safety, a safety supervision structure with 3 levels is in place: first by the licensee's Health Physics Department (HPD), then by Bel V which performs by delegation of the FANC a number of inspection and regulatory tasks, and finally by the Safety Authority (the FANC).
In "low-risk" facilities categorized as "Class II" and "Class III "by the GRR-2001, the licensee can entrust an external "health physics control organisation" recognised by the FANC according art. 74 of the GRR-2001.
Hereunder, the statute of the FANC, Bel V and ONDRAF/NIRAS are specified in more detail. The mutual relationships between these organisations and their relations with the most important nuclear actors (such as ELECTRABEL, SYNATOM, Belgoprocess,…) are represented on an organizational schema page 47.

[2]ADR: European agreement concerning the international carriage of dangerous goods by road.
RID: Regulation 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: The International Maritime Dangerous Goods Code of the International Maritime Organisation (IMO).
ADNR: Regulation concerning the Carriage of Dangerous Goods on the Rhine.

V.C.1. **The statute of the FANC**

Since 1 September 2001 the supervision of nuclear activities is within the responsibility of the Federal Agency for Nuclear Control (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 Agency is supervised by the Federal Minister of Home Affairs via a government Commissioner who attends the meetings of the Board of Directors. The Board 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 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 regulations enforced by Law/ Royal Decree. 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 - as prescribed in art. 8 of the Convention on Nuclear Safety.

More information is available on the website: www.fanc.fgov.be

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 five departments: the department "Regulations, International Affairs and Development", the department "Facilities and Waste", the Department "Security and transport", the department "Health and environment" and the department "Support".

The organisation chart of the FANC must take into account the law of 15 April 1994 and in particular article 43 which requires the regulation development missions and the supervision missions be carried out independently.

The present organisation of the FANC has been prepared beginning of 2007 and came into force on 1 September 2007. The FANC organisation chart can be drawn as follows:

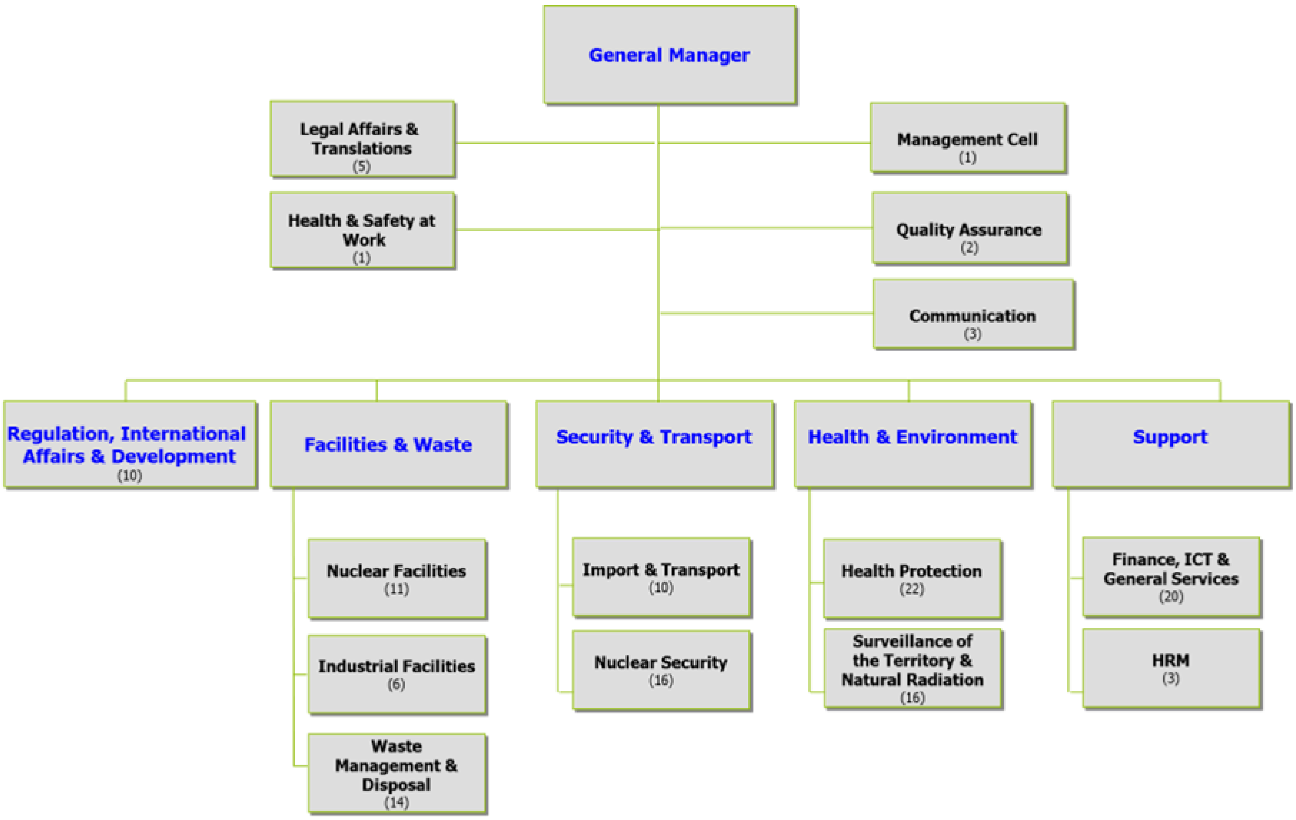

Figure 6: Organisational chart (with current staffing) of the FANC

The department `Regulation, International Affairs and Development' is in charge of:

- the development of regulations,
- international affairs,
- stimulating, following and carrying out the studies and the developments necessary in all fields to improve safety and the radiological protection of the population,
- managing, maintaining and developing a high level of knowledge,
- the coordination of FANC projects,
- activities requiring the collaboration between several departments (horizontal activities).

The missions of the department `Facilities & Waste' are specifically related to the nuclear industrial facilities, the management of the radioactive waste, the recognition of qualified experts in health physics control as well as the supervision of the bodies recognised for health physics control (Authorized Inspection Organisations).

The first mission includes the inventory, 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 the control, the inspections and the 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. Synergy between these two missions mainly aims at improving: 1) the safety in general, and 2) the protection of the workers, the public and the environment against the hazards of ionizing radiation.

The third mission includes the contribution to a regulatory framework for the disposal of radioactive waste of different categories, as well as the licensing for the facilities dedicated for surface disposal of short-lived low- and intermediate-level radioactive waste and future possible geological disposal of high-level and long-lived radioactive waste.

The department `Security & Transport' is responsible for the physical protection of nuclear material, and for the regulation of transport, import, transit and export of radioactive material. Here also, the licensing activity as well as the surveillance of a specific activity have been integrated in the same pillar, with the objective of optimizing the exchange of information and setting up a more effective control policy.

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

At present, the personnel of the FANC is composed of about 150 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.

According to article 9 of the law of 15 April 1994, the nuclear inspectors are nominated by the King. They search for non-compliances with the law and establish them by official entry. They can give a warning accompanied by a period (of maximum 6 months) in which the infractions must be resolved.

The operation of the Agency is entirely financed by the companies, organisations or persons it renders services to. In practice this is done through non-recurrent fees or annual taxes at the expense of the holders or applicants of licenses, recognitions or approvals the taxes are set by Law, the fees by Royal Decree. Taxes for particular pre-licensing activities such as for the disposal facilities and for the future MYRRHA research reactor are also regulated by law. The receipts and expenditures of the Agency have to be in equilibrium.

In accordance with the provisions or article 28 of the Law of 15 April 1994 (as amended), the Federal Agency for Nuclear Control created Bel V in September 2007, a subsidiary body with the statute of a so-called 'fondation' as defined in Belgian law. According to the law of 22 December 2008, Bel V is given a mandate to perform regulatory missions that can be legally delegated by the FANC, without consulting the public market.

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 of the Joint Convention is ensured.

In addition, for low risk facilities (Class II and Class III), the FANC may also call upon the assistance of recognised bodies for health physics control, called authorised inspection organisations (AIO).

V.C.2. **The statute of Bel V and its relations with the FANC**

Bel V is a 100% subsidiary body of the FANC.

Bel V performs its tasks and duties with experts that have to be recognised according to article 73 of the GRR-2001, ensuring that an expert has at least three years of experience in the nuclear field before he/she can be recognised as a Class I expert. Bel V's personnel training budget amounts to about 10 % of its overall budget in man-hours.

Bel V's technical personnel is composed of some 65 full-time 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 of installations, 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 (Barsebäck, Forsmark, Fukushima Daiichi…).

The inspections and analyses carried out by Bel V are invoiced to the operator on the basis of hours actually worked. This system is similar to that applied by, for example, the USNRC which, in addition to a set fee per installation, charges to the operators the time actually spent on their problems. 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 organisation, 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 a technical and regulatory documentation.

Besides the hierarchical structure in 3 departments, Bel V's technical staff, regardless of which department they hierarchically belong to, is attached to "Technical Responsibility Centres" (TRC), "horizontal" cells in charge of exercising nuclear and safety expertise and of maintaining the knowledge in the various technical specialities.

As from the end of the year 2006, Bel V's technical staff has carried out the technical activities within the operational processes as described above.

The management of all TRCs is performed within the process "Provide and manage expert services", managed by a director, in order to give it better support and have a harmonized approach.

The process "**Perform inspections during operation**" is in charge of inspections in all nuclear installations supervised by Bel V.

For the nuclear power plants, one Bel V engineer is assigned to one nuclear unit (hence 3 engineers for Doel, as the Doel 1 & 2 twin units are considered as a single unit, and 3 engineers for Tihange) and the managerial staff examines the problems common to a site as a whole, oversees the coherence of approaches between the sites and ensures experience feedback between all the Belgian units.

The activities performed in this process include also inspections in installations other than nuclear power plants, namely other Class I facilities as well as Class II and III facilities (universities, hospitals,…) having their own Health Physics Department.

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 projects/missions**".

At the national level, examples are the European "stress tests", the periodic safety reviews, the pre-licensing process of the MYRRHA Accelerator Driven System and, for NPPs, the power increase and the replacement of steam generators, the increase of the length of the cycles and the higher burn-ups.

At the international level, the co-operation with the Safety Authorities of several countries outside the European Union (bilateral aid or INSC contracts of the European Commission) is continued.

In the frame of the periodic safety reviews, Bel V follows the evolution of the safety standards in the world (USA, Member States of the European Union, IAEA…) and examines with the licensees which new standards should be followed, in order to define the new safety reference levels, in agreement with the FANC.

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: generic studies valid for all nuclear power plants, probabilistic safety assessment developed specifically for each unit but where the analysis methodologies must be identical, applications of these probabilistic studies in particular to the analysis of operational events, severe accident management, safety requirements for future reactors, safety analysis for the disposal of radioactive waste.

The process includes Bel V activities in the frame of its participation in the national emergency plan at the level of the evaluation cell (see article 16, section VI.E.2). It also participates in the emergency plan exercises related to the Belgian nuclear installations (nuclear power plants and other facilities), as well as in the exercises of foreign nuclear power plants located near the Belgian border, through bilateral or international collaborations.

Research and Development activities in which Bel V participates (international projects like research and development activities within programmes financed by the European Commission, bilateral and own developments in Bel V) are managed in the framework of the process "**Management of expertise and technical quality**".

Alongside its own experts, Bel V calls on services from outside specialists only very exceptionally (universities, research centres): on the one hand these should not have worked in the past on behalf of the operator on the subject, and, on the other hand, full definition of the scope, framework and precise objectives of the task or studies that would be subcontracted represents a non-negligible part of the overall effort and time that can be devoted to the job. Examples of Bel V's calling on outside expertise concerns the evaluation of neutron-ageing of the aluminium reactor vessel of the BR2 reactor or the recent reactor pressure vessel flaw issue of Doel 3 and Tihange 2 reactors.

The organisation chart of Bel V is given below:

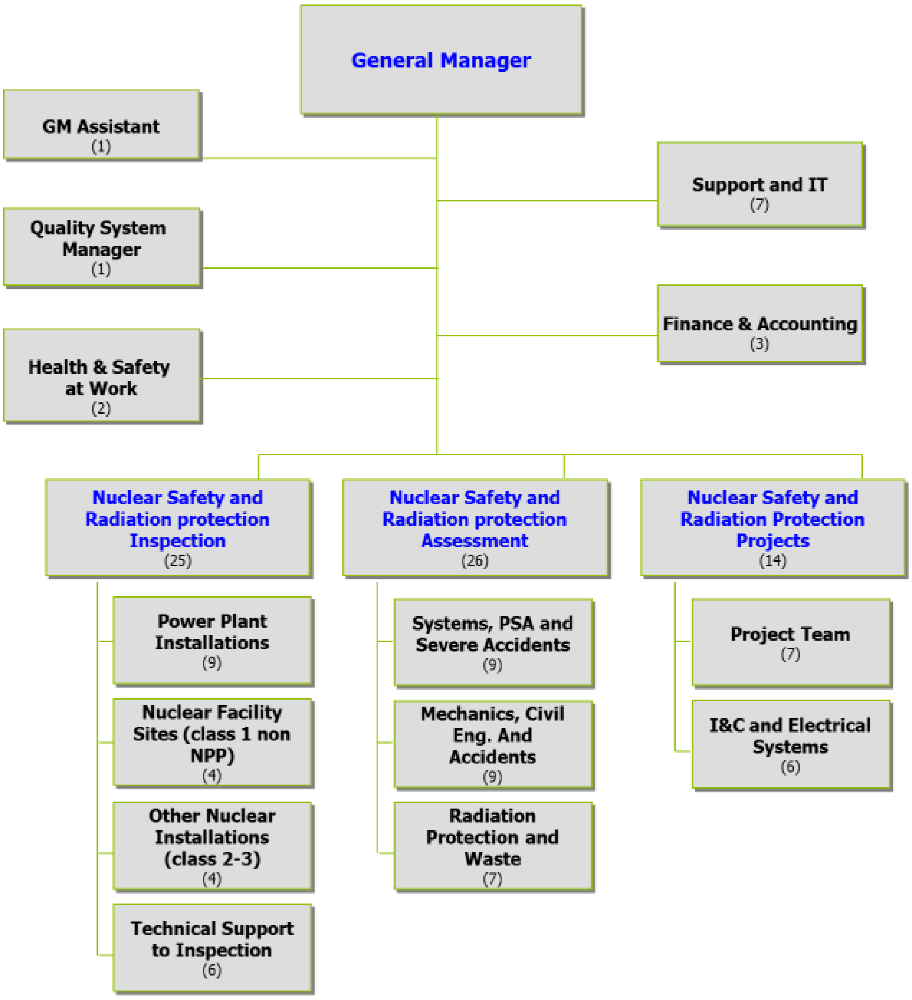

Figure 7: Organisational Chart (with staffing) of Bel V

V.C.3. **Relations between ONDRAF/NIRAS and the FANC**

The 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 Minister who is responsible for the energy policy which is represented at the board by a Commissioner. The federal Minister for Home Affairs also has a Commissioner in the Board of Directors of the ONDRAF/NIRAS. ONDRAF/NIRAS submits annually an activity report to Parliament.

With regard to the management of radioactive waste, the FANC and ONDRAF/NIRAS have been entrusted by the legislator with a legal objective, that is mostly identical, namely the protection of the public and the environment against the hazards of ionizing radiation, in particularly resulting from the presence of 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 conditioned waste 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 formal agreement which organises all 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 current 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 is the owner of large amounts of radioactive waste. 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. 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

Since 2012, ONDRAF/NIRAS became nuclear operator of the previous BMB installations located on the IRE Fleurus site. The relations with the FANC for this activities are the same as for all other nuclear operators.

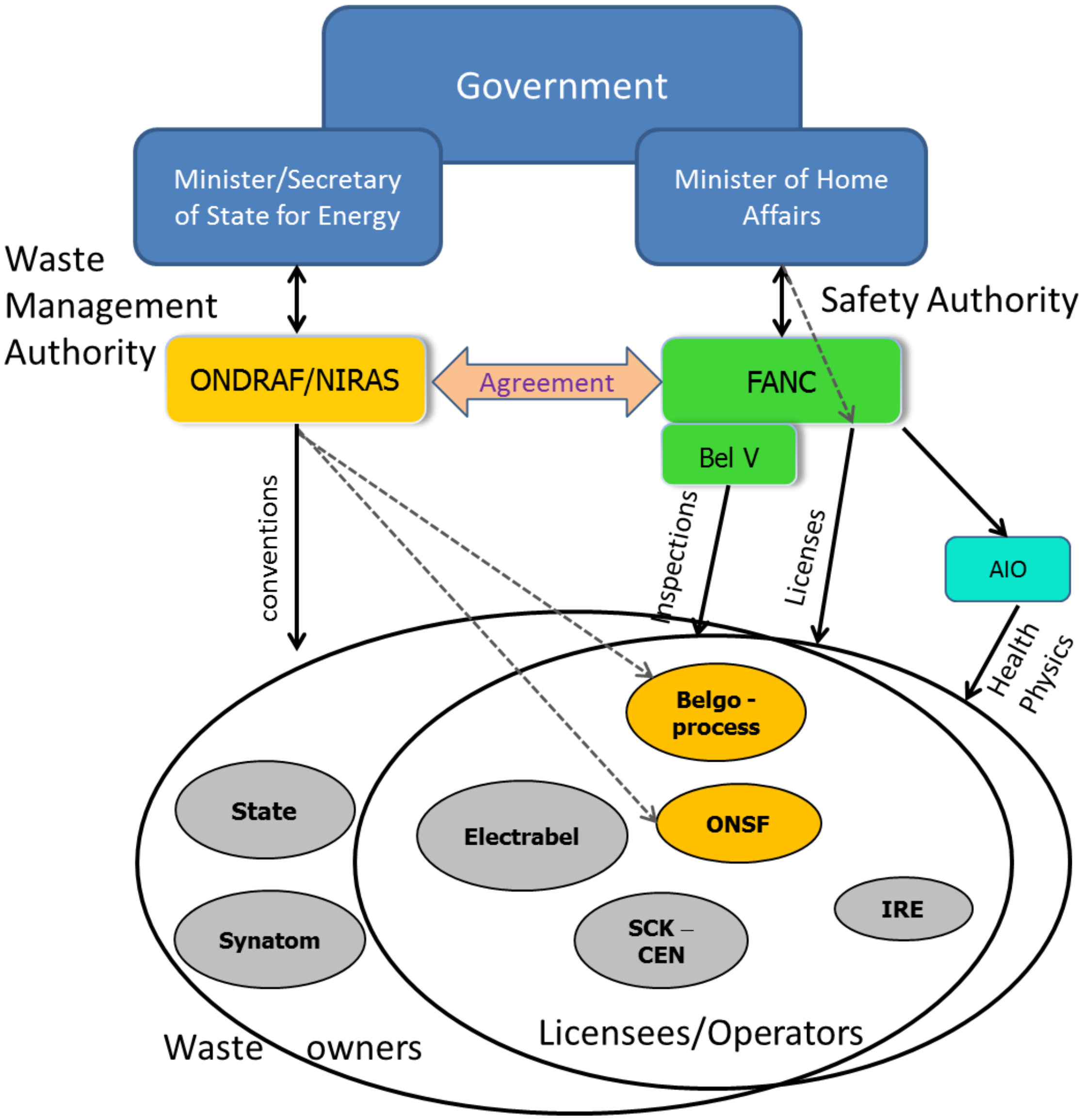

Figure 8: Organisational Structure of the Relationships between the Waste management Authorities and the Regulatory Body

ONSF refers to "ONDRAF/NIRAS Site Fleurus"

VI. **Section F: Other General Safety Provisions**

VI.A. Article 21: Responsibility of the licensee

The licensee has to comply with the regulations in force dealing with nuclear safety and radiation protection.

The national legislation expresses in several statements the prime responsibility of the operator for safety.

- Article 2 of the Royal Decree of 20 July 2001 (GRR-2001) defines the "Licensee" as follows: "Any natural or legal person who is responsible of a facility or a work activity that is subject to licensing or reporting according to chapter II."
- 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 and with the document established in implementation of Article 37 of the Euratom Treaty. 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 licensee must organise a Health Physics Department in charge of the internal supervision of nuclear safety and radiological protection, and must also organise the safety and health at the workplace as well as in the neighbourhood. A detailed description of the duties is given in Article 23 of the GRR-2001. As far as the clearance of solid waste is concerned, the Health Physics Department of the operator must approve the proposals for clearance and the measuring procedures and techniques to verify that the clearance levels are complied with.
- 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. Belgoprocess obtained this derogation on 30 January 2001
- The nuclear and radiological emergency plan for the Belgian territory, established by Royal Decree of 17 October 2003, has explicitly assigned the prime responsibility for the radiological protection of the workers to the operator of the nuclear installation.

However, this principle is not explicitly stated as such in the Belgian regulation. The IRRS mission that took place in Belgium end 2013 recommended to include this statement in the Belgian regulations (Recommendation n°8 of the Final IRRS Report) in the future.

VI.B. Article 22: Human and financial resources

VI.B.1. **Human resources**

VI.B.1.a) ***ONDRAF/NIRAS – Belgoprocess***

As of 31 December 2013, ONDRAF/NIRAS had 76 permanent full-time employees. The temporary workforce comprised 34 employees.

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 (as of end of 2013).

ONDRAF/NIRAS stimulates its workforce to match or to go beyond the required level by attending regular training in specific technical fields (radiological protection, waste conditioning techniques, disposal of radioactive waste,…) as well as in general fields (languages, quality management, information technology,…). About 2 percent of the working hours and of the "personnel" budget is dedicated to this training.

Belgoprocess organises the legal training required by the relevant Royal Decrees as a minimum.

ONDRAF/NIRAS and Belgoprocess are also largely involved in working groups set up by international organisations (IAEA, NEA, European Commission, …) in the field of radioactive waste management.

VI.B.1.b) *About NPP's - ELECTRABEL*

The Doel and Tihange nuclear power stations are operated by the "Société Anonyme ELECTRABEL" which itself is part of GDF SUEZ company. As an international energy provider, GDF SUEZ structures its activities around the three key sectors of electricity (generation, trading, marketing and sales), natural gas and energy services.

With a world power generation capacity of 113,7 GWe, and a generating capacity in Belgium of 11195 MWe (100%, at the end of 2013), ELECTRABEL sales about 57% of the electric energy consumed in Belgium. ELECTRABEL is the licensee of the 7 NPP, and the owner of 100% of the units 1 and 2 of Doel, of 89,8% of the units 3 and 4 of Doel, of the units 2 and 3 of Tihange, and of 50% of Tihange 1.

The installed net power of Belgium's nuclear generating units accounts for some 38% of all installed power in Belgium. Nuclear electricity accounts for more than 57% of the electricity produced in Belgium

About 1900 people, among which 100 at corporate level, are devoted to nuclear power station operation among the 3000 personnel working for electricity generation as a whole, of ELECTRABEL's total Belgian workforce of 5500 employees. GDF SUEZ, 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 forty years of nuclear technology, which started with the construction of the research reactors at the SCK•CEN Research Centre.

(1) Organisation

The present 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 a nuclear power plant.

This organisation has the following targets:

- accurate identification of the responsibility of the nuclear site;
- well-defined activities giving clarity in the responsibilities' distribution;
- small number of interfaces by developing of partnerships in place of customer/supplier relations;
- continuous goal to strengthen nuclear safety.

In this organisation, the different departments at plant's level are: "Operations", "Maintenance", "Engineering support" ", "CIM – Continuous improvement", and "Care". The site is also supported by a local (depending of the site) representation of the (nuclear) "Fuel" central department, and of the "PPM" central department, and of the "HR" central department, and of the "Purchasing" central department.

- 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 Operations department is in charge of the safe conduct of the generation process and of the installations.
- Engineering Support 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. Furthermore the Engineering Support department has the competency of Design Authority, validating the conformity of proposed changes with the overall safety design basis.
- The Continuous improvement department is in charge of Human Factors and Operational Experience activities
- The Care department is in charge of surveillance in radioprotection (Health Physics Control in the sense of the GRR-2001), measurements, protection of the workers (industrial safety), fire protection, environment and safety of the installations (including the setting up and the management of the emergency planning and preparedness). It is the local representative of the centralized Health Physics Department (as required by the GRR-2001) and has the appropriate delegation from this department to perform the formal approvals required by the regulations. It ensures the respect of the nuclear safety culture by independent technical checks and thus forms the link with the ELECTRABEL Corporate Nuclear Safety Department (ECNSD).

The "Fuel" department is in charge of all the fuel handling operations, as well as the follow-up of the cycles, while SYNATOM remains in charge of all aspects concerning procurement of new fuel and the back-end of the cycle. The "PPM" corporate department, Process Performance Management, is in charge of activities related to quality assurance, continuous improvement, internal and external operating experience, human performance management, and business oversight.

A central and independent department is committed with nuclear safety: ECNSD, the ELECTRABEL Corporate Nuclear Safety Department. This department depends on the head of Health Physics of ELECTRABEL (in the sense of the GRR-2001) who delegates the Health Physics' mission to:

- the department "Care" at corporate level (health&safety, nuclear safety);
- the "Care" departments at site level;
- the ECNSD department.

ECNSD is in charge of evaluating the effectiveness of the management of nuclear safety in the nuclear power plants. The six processes ECNSD is involved in are determining nuclear safety strategy, coordinating actions regarding nuclear safety according to the ELECTRABEL Global Plan, reporting on nuclear safety, gathering expertise on nuclear safety, independent monitoring of nuclear safety and providing operational support for 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.

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

- Process and Performance Management (PPM): The PPM department is in charge of the Quality Assurance, Human Factors, and Operational Experience activities.
- Asset Management & Strategy (AM&S): The Assets Management & Strategy department is in charge of the strategic assets management and of some support activities. It manages large-scale safety projects common to the NPP's and handles project coordination between them.
- Nuclear Fuel: The Nuclear Fuel department is in charge of all the fuel handling operations, 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. It also gives advice to the Nuclear Power Plant Sites in the fields of dismantling and radioactive waste management.
- Nuclear Liabilities: The Nuclear Liabilities 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 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.

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

(2) Training

The 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.

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.

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. 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, ELECTRABEL is member of FORATOM.

VI.B.2. **Financial resources**

VI.B.2.a) ***ONDRAF/NIRAS***

The mission and competences of ONDRAF/NIRAS are defined by the Royal Decree of 30 March 1981, as amended.

This Royal Decree defines the mission and competences of ONDRAF/NIRAS with respect to waste management financing:

- All the costs related to ONDRAF/NIRAS' activities will be charged to those who benefit from the services performed ("the polluter pays principle")
- These charges, estimated at cost price, will be divided between the beneficiaries of the services in accordance with the objective criteria set by the Board of Directors of ONDRAF/NIRAS.
- ONDRAF/NIRAS may, following agreement by the Minister of Economic Affairs, manage a fund to finance its long-term duties, particularly the waste disposal. The waste producers pay contributions to the fund, in accordance with the rules approved by the Board of Directors of ONDRAF/NIRAS and the Minister of Economic Affairs. The use of this fund is audited regularly by a special monitoring committee.
- A special fund has been created to cover any contingent costs associated with failed producers. This fund is supplied by an additional fee paid by all waste producers. The use of this fund is audited regularly by a special monitoring committee.
- To finance the decommissioning activities for facilities other than nuclear power plants, in agreement with the producers concerned, ONDRAF/NIRAS will establish and/or approve the arrangements for financing such operations.
- The financial arrangements for waste management for the "regular" waste producers will be set out in an agreement to be concluded between ONDRAF/NIRAS and the producer.
- The Board of Directors of ONDRAF/NIRAS decides on the contribution to waste management costs for "occasional" producers.
- ONDRAF/NIRAS' tasks as stated in the law of 12 December 1997, extending the Agency's mission to the drawing up of an inventory of nuclear liabilities include the following:
    1. Drawing up a register specifying the location and condition of all nuclear facilities and all sites containing radioactive substances on Belgian territory;
    2. Estimating the cost of decommissioning and cleaning up of these facilities and sites;
    3. Evaluating the availability of sufficient funds to carry out these future or ongoing operations;
    4. Updating the inventory every five years.

In line with the above, ONDRAF/NIRAS works at cost price, with complete financial transparency in respect of the producer. For that purpose, it has established a financing mechanism based on fees per volume unit of waste delivered, in order to ensure complete financing of all the operations to be performed. The acceptance of the waste and the transfer of ownership also imply the transfer of financial resources from the waste producer to ONDRAF/NIRAS for short- (treatment and conditioning) and long-term (storage and disposal) waste management. The waste management system must therefore be properly assessed in order to determine accurate fees which limit the risk of insufficient financing becoming a burden for the community in the future.

For storage and disposal operations the fees are paid into the "long-term fund", which is interest bearing. ONDRAF/NIRAS is responsible for managing the fund. The financial performance of the fund is reassessed every financial year.

In accordance with the Royal Decree of 4 April 2003, the Agency's available medium- and long-term funds must be invested in financial instruments issued by the Federal State. Consequently, the Board of Directors of ONDRAF/NIRAS decided to invest the assets of the "Long-term fund" into Belgian Government Bonds which will be passively managed.

The financing mechanism has been changed in 1996. Previously there were no guarantees with regard to fixed costs and tariffs were based on simple net present value calculations. ONDRAF/NIRAS implemented a new mechanism in 1996 which aims to reduce risk while satisfying the fundamental principles of financing.

The provisioning mechanism for the long-term fund is such that, in theory, it ensures that ONDRAF/NIRAS' fixed costs will be covered as well as its variable costs as they arise. It applies to producers who have signed waste collection agreements with ONDRAF/NIRAS and is based on the following three key elements:

- contractual quantities: each of the main radioactive waste producers informs ONDRAF/NIRAS of its total waste production programme, enabling ONDRAF/NIRAS to allocate its fixed costs across the producers;
- tariff payment: each producer pays a contribution to the long-term fund. This contribution corresponds to the total costs (fixed and variable costs, including margins for technological and project risks) of the medium- and long-term waste management by ONDRAF/NIRAS;
- contractual guarantee: each of the main producers agrees to pay the balance of the fixed costs attributable to its waste not yet covered by tariff payments into the long-term fund.

The conditions for the operation of the long-term fund are set out in the so-called 'collection agreements' concluded between ONDRAF/NIRAS and the waste producers. The working hypotheses of ONDRAF/NIRAS and the contracted quantities notified by the main producers can be reviewed on an ad hoc basis, in order to adapt the financial conditions to the development of the long-term management activities and the economic situation.

In order to take into account the time value of money and the opportunity cost of capital, the fees are increased above inflation each year, by a constant interest rate, fixed at 1% in real terms. This corresponds to the net discount rate applied by ONDRAF/NIRAS for net present value estimates of its future storage and disposal costs.

This decrease in the net rate, which was previously 2%, corresponds to the inclusion of a withholding tax of 25% on the funds' performance.

The share of the payments relating to fixed costs is offset against the guaranteed sum and hence the size of the producer's guarantee reduces with time. Should a producer review its originally planned volumes to higher values, the guaranteed sum would be increased accordingly (and other producers' guarantees correspondingly decreased). At the end of the contractually agreed period, or in the event of an early termination of the relationship with ONDRAF/NIRAS by the waste producer, the waste producer must pay its outstanding share of the fixed costs in full, i.e. that part of the guaranteed sum which remains unpaid.

Financial provisions for decommissioning are not covered in this article but under article 26.

VI.B.2.b) *About NPP's*

(1) <u>Belgian legal context</u>

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 new 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 ELECTRABEL/ EDF-LUMINUS to SYNATOM;
- the percentage of the funds that can be lent to ELECTRABEL and EDF-LUMINUS;
- the management of the funds.

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 funded 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 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 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.
  The scenario (and his boundary conditions) is updated every 3 years to take the present economic conditions into account.
  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 included in the preliminary decommissioning plan of ELECTRABEL NPP's and the related cost evaluation are updated every 3 years, the last one in 2013.
  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 determined by the most likely and expensive identified scenario i.e. a mix scenario with a part of deferred reprocessing of spent nuclear fuels and a part of direct disposal.

VI.C. Article 23: Quality Assurance

The qualification of the waste treatment and conditioning (including radiological characterization), as well as storage facilities are imposed at national level by the Royal Decree of 18 November 2002, which is an important element of the quality system of the Belgian waste management regime.

VI.C.1. **Provisions for the qualification of storage and processing installations for radioactive waste.**

The qualification of the equipment intended for storage, conditioning and characterizing of radioactive waste as laid down by the Royal Decree of the 18th November 2002, ascertains that all technical and administrative measures implemented by the Operator[3] 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.

The Royal Decree of 18th November 2002 "regulating the qualification of equipment intended for storage, processing and conditioning of radioactive waste [translated [4]]" defines the legal framework for the equipment [5] intended for storage, processing and conditioning of radioactive waste. This Royal Decree is applicable from its date of publication in the Belgian Bulletin of Acts, Orders and Decrees, i.e. from 13rd December 2002. Article 7, § 2 of this Royal Decree requires ONDRAF/NIRAS to specify the practical terms, both technical and administrative. These practical terms have been specified in Technical Notes drawn up by ONDRAF/NIRAS.

Each Belgian equipment, 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 equipment 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 Institution, focusing particularly 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]]

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 spirit of the Royal Decree of 18th November 2002 will be respected.

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3 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*").

4 " *réglant l'agrément d'équipements destinés à l'entreposage, au traitement et au conditionnement de déchets radioactifs* " [original French text taken from the Royal Decree]

5 The Royal Decree of 18th November 2002, Article 1, 1° defines "equipment" as "every installation that can assure storage, processing and conditioning of radioactive waste, including the apparatus allowing the identification of the characteristics of the produced radioactive waste packages"[translated](" *équipement: toute installation qui permet d'assurer l'entreposage, le traitement et le conditionnement des déchets radioactifs, y compris l'appareillage qui permet de déterminer les caractéristiques des colis de déchets radioactifs produits* ". [original French text taken from the Royal Decree]

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 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]

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 spirit of this Article 7, § 2, the qualifications will be granted to the Belgian owner for a maximum duration of five years.

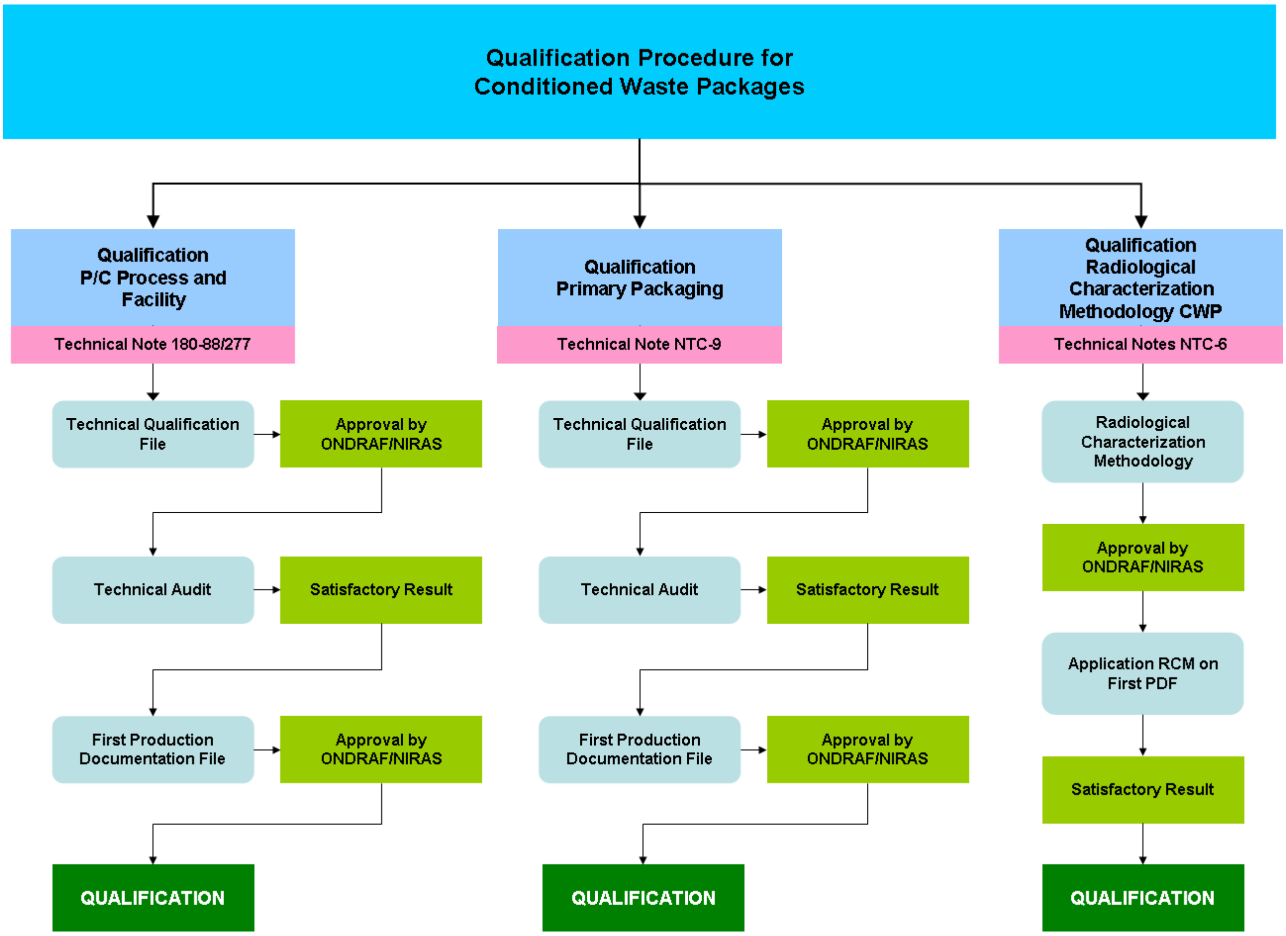

Figure 9: outline of the qualification procedure for conditioned waste

[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:

- the drawing up of the applicable Waste Acceptance Criteria by ONDRAF/NIRAS,
- the drawing up of the Technical Qualification Files (TOF'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,
- the approval by ONDRAF/NIRAS of the TOF's from Step 2,
- 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 – these Technical Audits must lead to a satisfactory result,
- the approval by ONDRAF/NIRAS of a First Production Documentation File pertaining to the Radioactive Waste Processing and Conditioning Process and the Primary Package,
- 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
- 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.

VI.C.1.a) *Acceptance procedure for conditioned radioactive waste packages*

Conditioned radioactive waste packages are accepted according to the sequence outlined below. A procedure APG – 4 DC 'General Procedure for the Acceptance of Conditioned Radioactive Waste' has been drafted in accordance with ISO 9001, 2000 edition.

1. Production of the packages during a 'campaign' according to a process qualified by ONDRAF/NIRAS who can also proceed to dedicated checks of the correct application of the procedures during the production itself.
2. Submission to ONDRAF/NIRAS of the production documentation of a 'campaign' including a request for acceptance, supported by radiological data for each individual package as determined following a physical inspection by the producer or by Bel V or by a recognized organisation for health physics control and using a radiological characterisation method approved by ONDRAF/NIRAS. The request for acceptance must be supported by a declaration of conformity with the acceptance criteria ruling at the time of production.
3. ONDRAF/NIRAS examines the production documentation and the acceptance request: this is the administrative check. ONDRAF/NIRAS then writes a letter to the producer with any comments resulting from this administrative check.
4. ONDRAF/NIRAS carries out a physical examination of the packages that form part of an 'effective request for physical transfer'. These packages may have been produced during several conditioning campaigns whose production documentation has previously undergone administrative inspection.
5. For each batch to be transported ONDRAF/NIRAS issues a 'clearance for removal report' setting out the results of the physical inspection and any administrative or technical reservations. This clearance report is signed before removal by the producer who returns it to ONDRAF/NIRAS.
6. ONDRAF/NIRAS finalises the inspection report related to the production documentation files, including comments made during the physical inspection; these will serve as a technical reference for the final acceptance report.
7. Planning of the transport of the primary packages of conditioned radioactive waste in one or more campaigns of which the production documentation has been successfully examined by ONDRAF/NIRAS.
8. Simultaneous issuance of a protocol of acceptance and of a protocol of transfer for the packages to be transferred; these two contractual documents are first signed by the producer and then by ONDRAF/NIRAS. The producer receives a copy of the reports signed by ONDRAF/NIRAS not later than the date of removal.
9. The packages of conditioned waste are physically removed from the producer's site and transported to a facility for storage designated by ONDRAF/NIRAS.

10. On arrival at the facility, the transferred conditioned radioactive waste packages are physically inspected for storage and a storage report is issued.
11. According to article 17 of the General Rules for the acceptance of conditioned radioactive waste, and as part of the conditioner's liability for hidden defects for a period of 50 years, the packages of conditioned waste will be regularly checked for conformity with the relevant acceptance criteria and for their compatibility with their disposal. The results of those periodical physical inspections are recorded in reports that are issued by ONDRAF/NIRAS and signed jointly by the producer and ONDRAF/NIRAS.

This procedure for the compacted waste (CSD-C) coming from the reprocessing of Belgian spent fuel in AREVA facilities at the La Hague facility (Plant UP3) has been described in the previous editions of this report. .

VI.C.1.b) *Quality Management certification of ONDRAF/NIRAS and Belgoprocess*

ONDRAF/NIRAS installed since 2000 and in a stepwise manner a Quality Management System. The "Quality Control" logic at the beginning evolved towards a "Quality Assurance" approach. Total Quality Management aims at improving the management of the operations. ONDRAF/NIRAS is currently making the necessary steps towards the adoption of an integrated management system (Quality, Safety, Environment, …) in line with the IAEA Safety Requirements and Safety Guides concerning integrated management systems. This is done in close collaboration with its daughter company Belgoprocess.

The "Acceptance system" of ONDRAF/NIRAS obtained the ISO 9001 certificate in June 2002. The Acceptance System constitutes the central point around which most activities of ONDRAF/NIRAS revolve. This is of course the main reason why it has been certified first.

The Quality management System has been extended to the 'upstream' and 'downstream' processes (i.e. entities of ONDRAF/NIRAS organisation). Only the paragraphs 7.5.4 "Customer Property" and 7.6 "Control of Measuring and Monitoring devices" were kept out of the certification scope. The whole ONDRAF/NIRAS organisation has been ISO 9001 certified in September 2006. This certificate was successfully prolonged in 2009.

The efforts to further extend the Management System will follow two directions:

- ONDRAF/NIRAS ISO 9001 Quality Management System will be harmonized with Belgoprocess ISO 9001, ISO 14001 (Environmental Management), OHSAS 18001 (Safety Management) systems.
- The three (Quality, Safety, Environment) systems can be considered as contributors to a common risk management philosophy that can include even more aspects (Finances, Corporate Social Responsibility,…). ONDRAF/NIRAS will use the ISO standards to gradually install a risk management philosophy into every level of the organisation.

ONDRAF/NIRAS' subsidiary Belgoprocess, responsible for the management of the radioactive waste on its site (including waste treatment and conditioning, waste storage, decommissioning and site restoration) has implemented a quality management system which complies with the ISO 9001 standard, and with the IAEA safety standard GS-R-3. Belgoprocess received the ISO 9001 certificate in 1995 for radioactive waste treatment and conditioning in the CILVA installation, and early 1996 for decommissioning and decontamination. These certificates were successfully prolonged in December 1998, 2001 and 2003 and are since early 2007 applicable for all Belgoprocess activities.

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.

VI.C.2. **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.

The values and behaviours are promoted in the Nuclear Safety Policy. The way to implement the principles defined in the Nuclear Safety Policy is described in the management system

The QA programme is described in chapter 17 of the Safety Analysis Report which deals with the design and construction phases (first part), followed by the operation period (second part). Since 2006, this second part is now common for all nuclear power plants of ELECTRABEL. All requirements are compiled within a common management system for nuclear safety, following the IAEA safety guide GS-R-3.

The Nuclear Safety Management System provides structure and direction to the organization in a way that permits and promotes the development of a strong safety culture together with the achievement of high levels of safety and excellent performance.

This management system, stated in the Nuclear Safety Policy of ELECTRABEL is supported by two documents: an "Internal code" (processes' definition) and a "References for nuclear safety" (corresponding quality requirements).

As there is no unit under construction at present in Belgium, emphasis is put on how the quality assurance programme is applied during operation; this point is illustrated below.

(1) Delegation and subcontracting

The objectives of the quality assurance programme remain fully applicable in case of delegation or subcontracting.

(2) Operational processes: equipment and activities concerned

The quality management system applies to any safety-related equipment, components and structure as well as to any activity that may affect their Quality. It applies also to the safety-related activities, 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.

These equipment, components, structures and activities are known as Quality Monitored items. Quality Monitored items are identified in the Safety Analysis Report of each unit.

Objective and origins

The principal goal of ELECTRABEL's quality management system is to ensure and to improve safety at ELECTRABEL's Doel and Tihange power stations through a common approach and via plant-specific approaches. The system accomplishes this by establishing policies and related objectives.

The Deming diagram, which specifies the following recursive four-step cycle, is the basis for this management system: plan, do, check, act.

The management system also integrates the provisions of the following regulatory requirements and guidance:

- Licenses to operate a nuclear power plant, inclusive the codes and standards they refer to
- Belgian Nuclear safety regulations
- Other international standards and codes adapted and implemented for ELECTRABEL's Generation Business Unit

Key documents

ELECTRABEL quality management system is described in a number of documents that move downwards from broad principles towards technical specifications and daily practices:

- ELECTRABEL's Nuclear Safety Policy
- Chapter 17.2 of the Safety Analysis Report (SAR)
- ELECTRABEL's Internal Nuclear Safety Code
- ELECTRABEL's Reference for Nuclear Safety
- ELECTRABEL's Global Plan for Nuclear Safety
- Execution documents

Focus and application

The management system supports the general objectives of safety management recognized at the international level and described in the IAEA report INSAG 13: "Management of Operational Safety in Nuclear Power Plants", 1999. The two objectives are as follows:

- Focus on the performance of the organisation to ensure and continuously improve safety, through planning, supervision and monitoring of safety processes in all situations (normal, incident and emergency)
- Stimulate and support a strong safety culture by developing and reinforcing good safety attitudes, values and behaviour in individuals, teams and organisations, in order to allow them to carry out their activities safely

The management system is applicable to every ELECTRABEL entity that exercises any activity related to safety, even if the entity is not within the management hierarchy of the Doel and Tihange sites. Moreover, the structure of separate quality management systems at each site has been replaced by a single unified system covering both sites.

The role, responsibilities and accountabilities of each level of the management regarding nuclear safety are clearly defined by following the INSAG-4 "Safety Culture" publication.

The management system is established, implemented, assessed and continually improved. It has been aligned with the goals of ELECTRABEL and contributes to their achievement. The main aim of the management system shall be to achieve and enhance safety by:

- Bringing together in a coherent manner all the requirements for managing the organization;
- Describing the planned and systematic actions necessary to provide adequate confidence that all these requirements are satisfied;
- Ensuring that health, environmental, security, quality and economic requirements are not considered separately from safety requirements, to help preclude their possible negative impact on safety.

Safety is paramount within the management system, overriding all other demands. This is stated primarily in the ELECTRABEL's Nuclear Safety Policy.

Electrabel's Internal Code and Reference for Nuclear Safety

The Internal Code defines all directives and general principles related to way to implement of the Nuclear Safety Policy within ELECTRABEL. ELECTRABEL Corporate Nuclear Safety Department (ECNSD) verifies it and the CEO approves it.

The goals of the Internal Code are to:

- Define Electrabel's strategy and policy in terms of nuclear safety.
- Define responsibilities regarding nuclear safety.
- Ensure the systematic and formal management of all aspects related to nuclear safety.

In addition, the Reference for Nuclear Safety (Référentiel Sûreté Nucléaire) describes the quality assurance requirements levels for the nuclear safety management system. It complements the Internal Code. ECNSD verifies it and the General Management approves it.

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.

Training regarding quality assurance objectives

A general training is given regarding the quality assurance objectives and the means for achieving these to all personnel who perform quality-related activities in the various services. This training is maintained and updated when necessary.

Periodic evaluation and improvements

The Plant Operating Review Committees (PORC), the Site Operating Review Committees (SORC) and the Independent Nuclear Safety Committee (INSC) perform a periodical assessment of the nuclear safety effectiveness, the way it is implemented, the possible improvements to be brought to the programme, ... The General Management approves the written action plan.

The Global Plan for nuclear safety is an output of the Nuclear Safety Management System. It lays down main objectives of ELECTRABEL in nuclear safety for the coming years (from 2011 to 2015). At a forth pillar, these are aimed in particular at continuously improving the performance and the safety culture.

These objectives are grouped in thirteen themes as following

- Management, organization, and administration
- Competence and Knowledge Management
- Operations
- Fire Protection
- Maintenance
- Engineering
- Facility Configuration Management
- Nuclear Fuel
- Operating experience feedback
- Radiation protection
- Emergency Plan
- Chemistry

- Site Security and Non-Proliferation

With this Global Plan, ELECTRABEL formally expresses clear objectives to consolidate its safety approach and improve its safety culture.

As regards the regulatory control activities, Bel V examined in the frame of the licensing process of each unit the quality assurance system to be implemented during the design, construction and operational phases (chapter 17 of the Safety Analysis Report, ELECTRABEL Internal Code, ...) and verified the practical implementation of the various regulations (10 CFR 50 Appendix B, ASME code,...) throughout these phases.

As regards pressure vessels for which the ASME code or the conventional Belgian regulations (Code of welfare at Work) are applicable, the intervention of an Authorised Inspection Organisation (AIO) is required as an independent inspection organisation, and Bel V has taken into account the results of those inspections.

During power plant operation, Bel V performs systematic inspections, including some dedicated to quality assurance procedures assessment during operation. The quality assurance aspects are also reviewed during examination of modifications to the installations, incident reports, etc.

VI.C.3. **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 after the 2011 self-assessment performed in view of the future IRRS mission, with the aim to comply with IAEA Safety Requirements, GS-R-3. The re-worked management system was successfully recertified to conform to ISO 9001:2008 in October 2012. The FANC intends to keep both the ISO certificate and meet compliance with GS-R-3.

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 "*Strategic plan*" which is established on a timeframe of 9 years. This strategic plan is translated in a 3 years operational plan and finally in an annual operational plan including budget.
- *FANC quality policies* developed in accordance with the FANC missions and the Strategic plan and validated by the senior management. They have committed themselves to follow the quality policy requirements and request every FANC employee to do the same. 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.
- the *regulatory procedures* described in the FANC management system are derived from the legislation and the FANC policies.

The FANC core processes and related support processes have been identified by the FANC management team and were integrated into the existing quality system in 2008. The 2012 review of the management system resulted in a new mapping of the management system and integrating governance documents, intention plans (strategy, operational objectives), and operational and support processes.

The interfaces between interacting FANC processes are identified and the process owner is responsible to verify the consistency of the process. For transversal operational processes, the responsibility for approving the procedures is with each senior manager in charge of the fields of activities concerned. In particular, for core business processes, a Managing Director is the owner of the process and has the responsibility to ensure that all parties concerned are involved in the development and approval of the procedure.

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 concept of continuous improvement is being applied to the FANC organization, to the management system, and to the individual workers at FANC. In preparation for this IRRS mission, the FANC performed two consecutive self-assessments using the IAEA self-assessment tools.

All staff members contribute to the identification of non-conformities. Responsibility on the solution of non-conformity is clear. The corrective and preventive actions are regularly monitored, and the status of the non-conformities is discussed with 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.

Each staff-member (including the management) is expected to actively participate in the improvement process of the management system by having a questioning attitude and making constructive proposals. All staff members are asked how they contribute to the goals of the organization. In the future, personal objectives will be aligned with the goals of the Strategic Plan.

As a result of the IRRS mission in Belgium, the team recommended, in addition to further develop the new management system, to :

- include a process that allows the FANC to oversee and review the activities of Bel V and of other organizations involved in the regulatory process;
- develop and implement a common safety culture together with Bel V.

Specific actions are currently addressing these recommendations and suggestions.

(2) Bel V

Bel V is a subsidiary of the Federal Agency for Nuclear Control (FANC). According to its statutes, Bel V – as a non-profit institution – aims to contribute to the protection of the population, the workers and the environment against the dangers of ionizing radiations. Bel V is fully operational since April 14th, 2008, by the transfer of the regulatory activities of the non-profit institution Association Vinçotte Nuclear (AVN).

Association Vinçotte Nuclear (AVN) already had a long experience in the Quality System area. Bel V also wished to dispose of a Quality Management System and has obtained its ISO 9001 :2008 certification in December 2009, for the regulatory activities as mentioned above.

Bel V performs activities that are, on the international regulation level, within the competence of the regulatory bodies for nuclear safety. Bel V subscribes to 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. These principles concern the safety criteria on the highest level that have been used as a basis for the Convention on Nuclear Safety (CNS).

The regulatory body needs to comply with a series of criteria (Article 8 of the CNS). Bel V endorses those criteria and puts them into practice during its inspections in the nuclear installations. Bel V has no other missions that might conflict with its primary mission of supervision of nuclear and radiological safety. Bel V is not associated to organizations that are (partially) involved in the promotion of nuclear energy.

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 this network.

VI.D. Article 24: Operational Radiation Protection

VI.D.1. Regulations

Chapter III "General Protection" of GRR-2001 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 dosimetric 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 has to be a qualified expert of Class I, recognized as such by the FANC. The conditions for recognition are specified in Article 73 of GRR-2001.

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

VI.D.2. **Design**

The safety analysis reports for the recently designed buildings or installations for storage of radioactive waste include the following topics:

- general safety philosophy
- fundamental design criteria and specifications for structures, systems, components, casks, etc…, being subject to quality requirements during design, construction and operation
- multiple barriers concept (confinement of radioactive materials, ventilation (depression cascade, rate of air renewal, etc..); ventilation during normal conditions and emergencies
- criticality safety
- shielding and radiological protection
- long term behaviour (internal and external influences) of storage
- thermal analyses for storage conditions (heat removal)
- fire protection
- industrial safety
- radiation protection programme (organisation, equipment, monitoring, procedures)
- normal operating conditions (atmospheric releases, radiological impact of workers and members of the public, etc..)
- abnormal operating conditions and design basis accidents (detection, consequences, corrective actions, interventions, etc..)
- procedures during start-up (components tests, functional and global tests), operation (equipment maintenance, periodic tests, etc…) and alarms (process, fire, radiation, security)
- specifications of operating conditions and limits (source limitation (activity, dose rate), fissile materials, radionuclides, surface contamination, radon concentration, etc....), with a programme for the surveillance and control of these limits and the corrective actions.

The license application includes an environmental impact assessment where, besides the radiological impact, non-radiological aspects have to be evaluated for the construction and the operation.

VI.D.3. **Operation**

VI.D.3.a) ***ALARA policy***

Different means are used for the ALARA-evaluation (related dose and cost evaluations): implementation of a good working plan; optimisation of working methodology during the receipt, transfer and storage operations; use of software tools (e.g. 3 D-models) for the visualisation of the up-to-date state of storage and for the evaluation of the individual and collective doses, before the operations are performed.

There is an initial dosimetric estimate by the work supervisor and the radiological protection agent in order to jointly agree on the protective means to be used, a new dosimetric estimate that takes into account the decided protective means, a dosimetric monitoring of the work, with check points or hold points of the estimated dosimetry, and a feedback of operating experience.

During the receipt, transfer and storage operations the workers are equipped with individual neutron (bubble type detectors and/or electronic dose meters) and gamma dose rate meters for a strict follow-up of the dose rate. Operational dosimetry is used for ALARA purposes only, with an on-line warning system 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 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…).

VI.D.4. **Follow-up in situ**

VI.D.4.a) ***Dose***

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. These dose rate limits guarantee that the doses received by the workers from the storage activities are minor. 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 (for a recent new storage building of Belgoprocess an occupation factor of 1 has been chosen for this impact evaluation).

Various measures have been taken over the years to reduce further the annual collective dose. For example at Belgoprocess: the value has been reduced by a factor of about 2.4 during the 1997-2001 period, resulting of a collective dose of about 112 man.mSv (an important part being due to dismantling projects). For the period 2002-2006, about the same values (105-150 man.mSv) have been recorded. For the last period 2007-2013, the range of the collective dose stays relatively constant (98 – 162 man.mSv).

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) Conform Article 23.2 of GRR-2001, the 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 a copy to the FANC. The registers of the licensee are stored for 30 years.

The modalities of the medical surveillance of the exposed workers are fixed by the medical officer, and depend on the radiological risks at the installations. The medical examination is at least once a year and each 6 months for the most exposed workers.

VI.D.4.b) *Contaminations*

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

Systematic measurements are performed periodically 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.

VI.D.4.c) *Discharges*

Discharges are defined as authorised and controlled releases into the environment, within limits set by the Safety Authority. 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.

The Euratom 96/29 Directive has been implemented in the Belgian legislation and as required by Article 81.2 of the GRR-2001 the authorised discharge limits (gaseous and liquid releases) have been revised in 2002. The discharge 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 2011-2013		
	Gaseous	Liquid	Total (maximum) (*)	Gaseous	Liquid	Total (maximum) (*)
SCK•CEN	0.1 mSv	-	0.1mSv	1 µSv	-	1 µSv
FBFC	10 µSv	-	10 µSv	11 nSv	-	11 nSv
Belgonucleaire	5 µSv	-	5 µSv	<1 nSv	-	<1 nSv
Belgoprocess	0.3 mSv	0.2 mSv	0.5mSv	9 µSv	42 nSv	9 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	19 µSv	<1 µSv	19 µSv
Tihange site (**) (3 NPPs)	0.19 mSv	0.08 mSv	0.21 mSv	47 µSv	2.4 µSv	49 µSv
Doel site (**) (4 NPPs)	0.18 mSv	0.23 mSv	0.37 mSv	19 µSv	0.93 µSv	19 µSv

(*) The total maximum is not the sum of the dose due to the gaseous and the dose due to the liquid releases because the most exposed individuals by each type of release do not belong to the same age category.

(**) The average value is given for the years 2004 - 2013

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 at the disposal of the Safety Authority and of ONDRAF/NIRAS.

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://www.fanc.fgov.be/fr/page/les-grandes-installations-nucleaires/1091.aspx (in French).

For the storage of spent fuel, and of non-conditioned and conditioned radioactive waste, the atmospheric releases at the stack are a very small fraction of the authorised limits, and the impact for the representative member of the public is a few nSv/year , based on a conservative approach for the dose calculations.

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 in order to comply with the discharge limits.

Each licensee is responsible for on-site radiological monitoring (monitoring and recording of the radioactive effluents discharges, radioactive contamination and monitoring of the dosimetry on the site). The results are evaluated by the HPD, Bel V and FANC.

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.

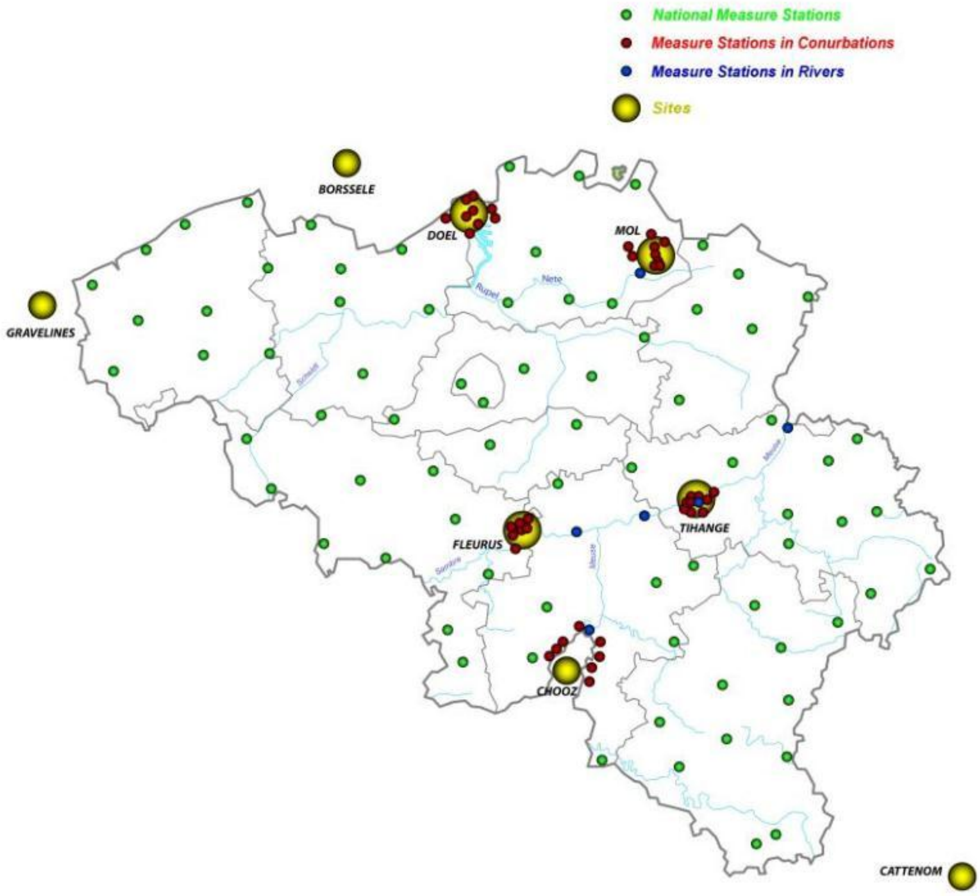

Figure 10: TELERAD network: location of the measuring stations

The data received through Belgium's Telerad automatic radiological monitoring network can also be used. Telerad is a network with principal aim to monitor the ambient dose rate level and make measurements in case of an accident occurring in a Belgian nuclear site or abroad. In total, measurements from 199 stations for the measurement of the ambient dose rate in air, 7 stations for the measurement of iodine and β/γ in aerosols and 6 stations for the measurement of radiation in river water are collected, treated and sent to the computer located at the FANC

The TELERAD network has been completely refurbished from 2010 on. New GM detectors replaced the old detectors in the existing dose rate measuring stations except around the installation (first ring) where the existing detectors have been replaced by NaI scintillators. A number of stations have been added to the network in order to allow a better coverage of the second ring around nuclear sites.

VI.D.5. **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).

Belgian representatives participate in the WENRA working group on Waste & Decommissioning. The main goal of this working group is the harmonisation of safety approaches for waste management and decommissioning. Several topics are dealt with, e.g. storage facilities and decommissioning policies.

In addition, the FANC is an active member of HERCA (Heads of Radiation Protection Authorities) which brings together 49 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.

VI.E. Article 25: Emergency preparedness

VI.E.1. Regulatory framework

The emergency preparedness is primarily the responsibility of the Minister in charge of Home Affairs. The law of 15 May 2007 defines the notion of Civil Safety and describes the roles and missions of the different entities involved. The Royal Decree of 16 February 2006 organises the planning and interventions during emergency situations. The Royal Decree of 17 October 2003 precises the national emergency plan for nuclear and radiological situations as a particular emergency plan and the tasks of each of the parties involved. The relevant infrastructure is being provided accordingly.

This emergency plan for addressing nuclear risks on the Belgian territory aims at co-ordinating the measures to protect the population and the environment in the event of a nuclear accident or any other radiological emergency situation in which radioactive substances could be released and dispersed outside the nuclear installation.

This document is to serve as a guide for the protective measures to be implemented in the event of a necessity. It establishes the tasks that the various departments and organisations would have to accomplish if the case arises, each within their legal and regulatory competence.

The provisions of the emergency plan apply in the cases where the risk exists that the population could be exposed to significant radiological doses in any of the following ways:

- external irradiation due to air contamination and/or deposited radioactive substances;
- internal irradiation by inhalation of contaminated air and/or ingestion of contaminated water or food.

This plan has been designed essentially for:

- nuclear accidents or any other radiological emergency situations arising at the Belgian nuclear power plants of Doel or Tihange or in the other main Belgian nuclear installations such as the Nuclear Research Centre (SCK•CEN) in Mol, the "Institut des Radioéléments" (IRE) in Fleurus, Belgoprocess and Belgonucléaire in Dessel;
- cases of detection of abnormal radioactivity on the Belgian territory ;
- nuclear accidents or any other radiological emergency situations arising in other countries, especially in those installations located close to the border (Chooz, Gravelines and Cattenom in France, Borssele in The Netherlands).

It therefore covers all installations managing spent fuel or radioactive waste.

This plan can also be activated in radiological emergency situations arising from accidents during transport of nuclear fuel, isotopes or radioactive waste, following re-entry of spacecraft containing radioactive material, following accidents or situations involving military equipment or in military facilities, or during accidents at Belgian nuclear installations other than those referred to above (THETIS reactor in Ghent, FBFC in Dessel, IRMM in Geel,...). It also applies to terrorist actions using radiological dispersion devices.

The off-site operations are directed by the "Governmental Centre for Co-ordination and Emergencies" (CGCCR), under the authority of the Minister of Home Affairs. The implementation of the actions decided at the federal level and the management of the intervention teams are conducted by the Governor of the Province concerned.

In addition to the duties defined in the Royal Decree of 17 October 2003, the Federal Agency for Nuclear Control (FANC) is a main actor within this emergency plan. Its role is defined in articles 15, 21 and 22 of the law of 15 April 1994, creating the FANC, and in articles 70, 71 and 72 of the GRR-2001. These articles stipulate that the FANC is responsible to survey, to control and to monitor the radioactivity on the territory and to deliver technical assistance to set up the emergency plan. It is also in charge of participating and/or organising operational cells (i.e. evaluation cell and measurements cell).

VI.E.2. **Implementation of emergency response organisation**

VI.E.2.a) *Classification of emergencies*

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 CGCCR 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 kinetic. 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 level, immediate protective actions for the off-site population – without any further assessment – are taken by the local authorities (Governor of the Province), waiting for the full activation of the emergency cells. The criteria leading the operator to launch this 'reflex' phase have been defined in advance, based on the potential source terms of rapid scenarios and in agreement with the competent authorities. 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 alert 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. For example, the criterion associated with the N_1 level is defined as follows: "Event which implies a potential or real degradation of the safety level of the installation and which could further degenerate with important radiological consequences for the surrounding area of the site. Radioactive releases are still small and there is thus no danger for the surrounding area of the site (no action required to protect the population, the food chain or drinking water). Actions to protect workers and visitors on site might be necessary." In addition, for each nuclear installation, a set of particular types of events is established for each of the notification levels.

Each of these 4 notification levels (N_1 to N_3 + N_R) activates the federal emergency response 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 response plan.

All emergencies (N_1 to N_3 + N_R) have to be notified to the Governmental Centre for Co-ordination and Emergencies (CGCCR). This centre is permanently manned, alerts the cells involved in the crisis management at the federal level (Emergency and Co-ordinating Committee, evaluation cell, measurement cell, information cell, economico-social cell) and houses these cells during the crisis situation as well. The staffing of the crisis management cells is supposed to be operational at the CGCCR at least within two hours after the initial notification. The implementation of protective actions at the provincial level is expected to be performed within approximately three hours.

The "Emergency Director" of the Authorities (EDA) 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 governor of the province hosting the nuclear site immediately and automatically transforms the notification level into an U_R alarm level.

VI.E.2.b) *General overview of the organisation in the event of nuclear or radiological emergencies*

The CGCCR is composed of the "Co-ordination and crisis Committee" chaired by the Emergency Director of the Authorities, the "Evaluation cell", the "Measurement cell" chaired by the FANC and the "Information cell" and the "Socio-economical cell" chaired by a person nominated by the EDA according to the situation, as indicated in the figure below.

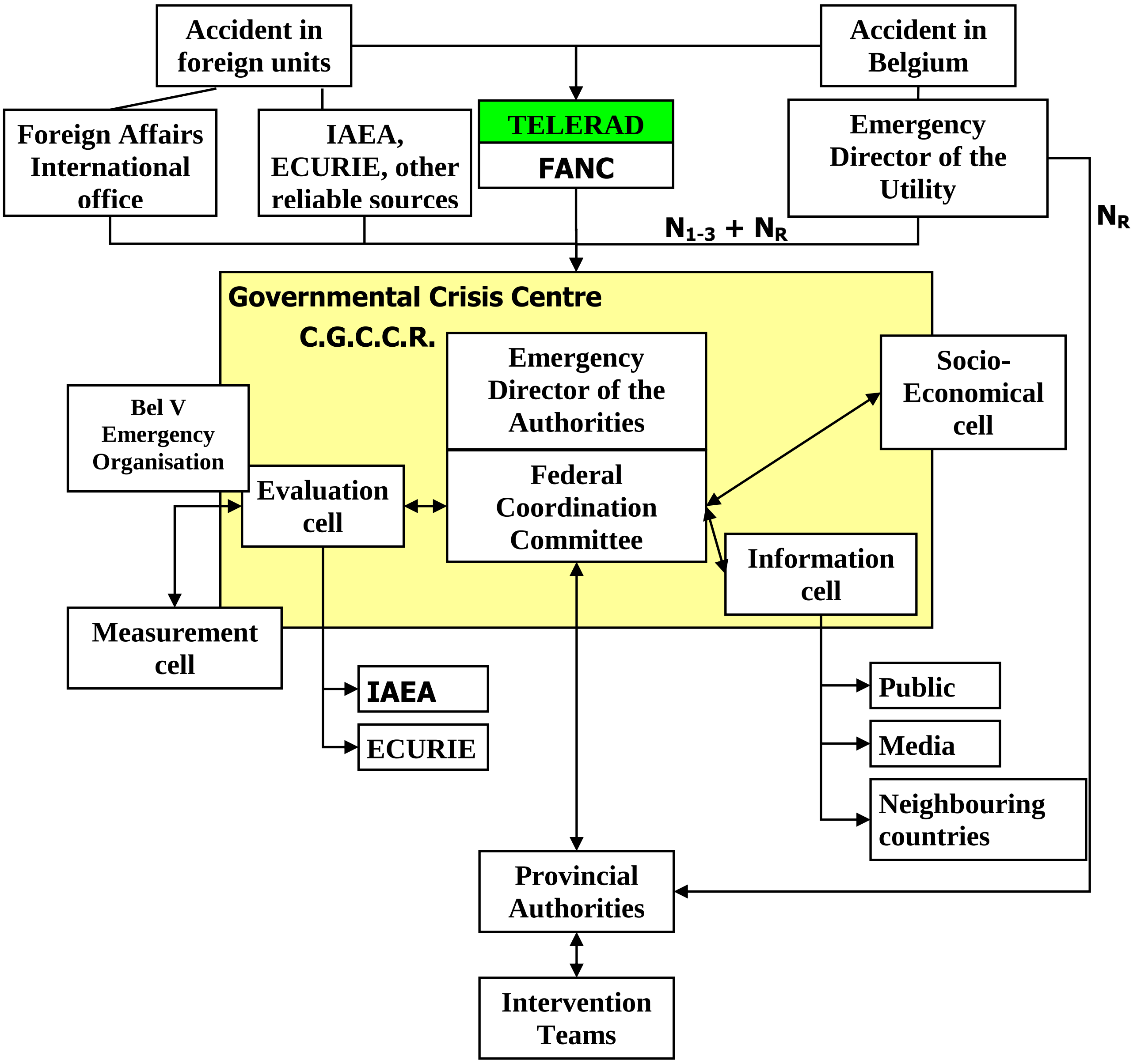

Figure 11: National Nuclear emergency organization

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

The data received through Belgium's Telerad automatic radiological monitoring network managed by the FANC can also trigger a nuclear or radiological emergency. The monitoring of the Belgian territory consists in a measurement network having a 20 km mesh. Besides, around the Belgian nuclear sites, the network is arranged in two rings: the first ring is on the site border and measures ambient radioactivity around the site, the second ring covers the near residential zone, between 3 and 8 km from the site, depending on the direction.

In addition, there are measurements along the Belgian border, particularly in the vicinity of foreign nuclear power plants (Chooz, Gravelines, Borssele).

The Federal Coordination Committee immediately meets when a notification level NR is declared or as soon as the Emergency Director decides a U2 (or higher) alarm level. Based on the information and recommendations provided by the evaluation cell the Committee decides whether protection actions for the population and/or the food chain or drinking water supply are necessary. Their decisions are sent to the Provincial Emergency Centre for implementation by the different intervention teams (fire brigade, police, emergency medical services …).

The evaluation cell is composed of representatives of the relevant organizations, in particular FANC (chair), 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, and of experts of the Mol Nuclear Research Centre, the "Institut national des Radioéléments" (IRE), and of Bel V, as well as of a representative of the operator of the installation. This cell has to evaluate the situation in radiological terms and advise the Emergency and Co-ordination Committee about protective actions for the population and the environment. The recommendations of protective actions are elaborated on the basis of intervention guidance levels, published as a Decision of the FANC (24 November 2003). The evaluation cell is also responsible to prepare the relevant information to be communicated to neighbouring countries and to the international organisations (EU Commission, IAEA) in accordance with the "Ecurie" Directive and "Early Notification of Accidents Convention".

The measurement cell coordinates all the activities aimed at collecting the radiological information, based on ambient radiological measurements depending on the various exposure modes. It rapidly transmits the collected and validated information to the evaluation cell.

The "Information cell" is the CGCCR's communication channel with the public, the media, the international organisations (European Commission, IAEA), and the neighbouring countries.

The "Economico-social cell" advises the Federal Co-ordination Committee on the feasibility and economico-social consequences of their decisions; it informs the Federal Coordination Committee about the follow-up and ensures the management of the post-accidental phase and an as prompt as possible return to normal life.

In function of the scope, the cells which compose the CGCCR (Emergency and Coordination Committee, Evaluation Cell, Measurement Cell, Economico-social Cell and Information Cell) participate in exercises of the emergency plans at the relevant installations.

The Royal Decree of 24 November 2003 sets the emergency planning zones relative to the direct actions to protect the population (evacuation, sheltering, and iodine prophylaxis). These evacuation and sheltering zones vary from 0 to 10 km radius depending on the nuclear plant concerned; the stable iodine tablets pre-distribution zones extend from 10 up to 20 km around the nuclear plants.

The National Emergency Plan is under continuous improvement as concerns the organisation and the infrastructures: stable iodine tablets distributed around the nuclear sites (last campaign 04/2002), the working procedures developed, investment made at local level, Telerad put into service, sirens installed around the nuclear installations, etc. The web site address of Telerad is : www.telerad.fgov.be .

VI.E.2.c) *Internal and external emergency plans for nuclear installations, training and exercises, international agreements*

Each licensee of a nuclear installation has to establish an on-site emergency response plan to be approved by the regulatory body. This on-site emergency plan details the responsibilities, the roles and functions of all actors and the dedicated infrastructure, such as the On Site Technical Centre or the Emergency Operations Facility. This on-site emergency plan is regularly tested, as required by the Royal Decree of 30 November 2011.

The General Directorate of the Civil Security of the Ministry of Home Affairs organises once a year for each nuclear power plants site and each second year for other sites an emergency response exercise. According to the intended objectives aimed at, the Ministry includes different topics in these annual exercises (fire rescue, health care, police services, field measurements teams ...). The operator is then put in charge of building an appropriate scenario.

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

Information exchange at international level is performed through the Governmental Co-ordination and Crisis Centre (CGCCR), which is the "national contact point" for both the "Nuclear Accident Early Notification Convention" (IAEA) and for the similar European Union system (ECURIE).

Agreements also exist at local and provincial level between homolog's on both sides of the States border. The protocol Agreement between the province of "Noord-Brabant" (The Netherlands) and the province of Antwerp (Belgium) provides for a direct line between the alarm stations of Roosendaal (The Netherlands) and Antwerp, informing it as soon as the alert level U_2 notification is decided. This direct line is also used when certain accidents occur in the chemical industry (installations subject to the European post-Seveso Directive). A direct information exchange can also take place between the alarm stations of Vlissingen (The Netherlands) and Ghent should an accident occur at the Borssele nuclear power plant. For the Chooz and Tihange nuclear power plants, there are agreements between the Prefecture of the Ardennes department (France) and the province of Namur (Belgium).

In the frame of the agreement between the Government of the French Republic and the Government of the Kingdom of Belgium about the Chooz nuclear power plant and the exchange of information in case of incidents or accidents, a mutual alarm is foreseen between the two countries in case of an accident occurring in the nuclear plants in Tihange, Chooz or Gravelines. This alarm takes place between the CGCCR on the Belgian side and the CODISC ("Centre opérationnel de la Direction de la sécurité civile" which has now become the "COGIC","Centre opérationnel de gestion interministérielle des crises") on the French side.

During the exercises of Chooz and of Gravelines that transborder collaboration is regularly tested at the local and national levels. In addition a direct exchange of technical and radiological information takes place between the organisations in charge of the expertise (IRSN on the French side, Bel V on the Belgian side) and in charge of the advice (Nuclear Safety Authority in France, Evaluation Cell of CGCCR in Belgium) and is quite successful. Based on these experiences, information exchanges have been developed as well as their implementation modalities between the French and Belgian parties involved with the view to be operational for further exercises and in case of incidents and accidents.

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.

These evaluations of the consequences to the environment are made either with the same computer codes as those of the operator, or with tools developed in Bel V, so as to allow a validation of the results provided by the licensee. These various computer codes have been compared in terms of assumptions and calculation methodologies.

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.

VI.E.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.).

VI.F. Article 26: Decommissioning

VI.F.1. **Legal framework related to decommissioning and liability management.**

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 comprising a database of all nuclear installations and sites concerned, and of assessing their decommissioning and remediation costs. ONDRAF/NIRAS is also responsible for verifying the existence of sufficient funds to cover the execution of the programmes. A report on the situation must be submitted to its supervising Minister which may constrain the responsible body to take the necessary actions to avoid further uncovered "nuclear liabilities".

The results of the first national inventory exercise were submitted to the State Secretary for Energy and Sustainable Development in January 2003. The second and third national inventory were submitted in March 2008 and February 2013 to the Minister for Energy

VI.F.2. **Implementation of the legal requirements**

VI.F.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.

An initial decommissioning plan is set up by the licensees for new facilities and facilities in operation for which the ending of activities is not planned in the short term. This plan needs to be reviewed every five years or more frequently in the case of major modifications to the nuclear facility. The final decommissioning plan is submitted to ONDRAF/NIRAS three years before the foreseen definitive shutdown of the licensed operations of the facility or part of the facility.

VI.F.2.b) ***Decommissioning programmes***

The operator or the owner of a nuclear facility can call upon ONDRAF/NIRAS for the execution of his 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) 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 to be financed 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 BR1 reactor is still in operation; During 2008 and 2009, the VENUS facility was modified in the framework of the GUINEVERE project in order to allow the experimental programme to start in 2010;
- the BR2 complex, a material testing reactor which was restarted in 1997 after two years of refurbishment;
- 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.

Beside the nuclear installations, the fund also covers the management of spent fuel from these reactors as well as the management of other "exotic" fissile materials and specific special waste which are still stored on site.

The decommissioning activities are executed mainly by the SCK•CEN staff following annual programmes and budgets which have to 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.

(2) 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 (site BP1), and the former waste processing sites of the Nuclear Research Centre SCK•CEN in Mol (site BP2). All these facilities are located on the two Belgoprocess nuclear sites in Mol and Dessel.

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 processing installations;
- waste storage and processing facilities containing special waste.

The decommissioning activities are executed by the Belgoprocess staff following annual programmes and budgets which have to be approved by ONDRAF/NIRAS..

(3) 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 and for this, the legal framework will be elaborated from 2012 on.

(4) Programmes without financial liabilities funding system during operation

For the moment, the clearly identified nuclear facilities in Belgium for which no financial funding were 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.

(5) Settlement of liabilities funding during plant operation

One of the main tasks of ONDRAF/NIRAS is to avoid lack of financial means for the execution of future decommissioning programmes (article 9 of the Programme Law of 12 December 1997). Therefore, ONDRAF/NIRAS has to control the existence and the sufficiency of funds to be set up by the operator or the owner of nuclear facilities and sites contaminated by radioisotopes. 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 re-evaluated periodically.

The annual funds level is calculated on the basis of 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 while the facility is still providing benefits.

VII. Section G: Safety of Spent fuel Management

VII.A. Article 4: General safety requirements

VII.A.1. Sites at Doel and Tihange

The installations are described in appendix 1.

Three storage modes are used:

- in fuel desactivation pools in the units;
  The fuel desactivation pools are located in the buildings "GNH" (Doel 1/2), "SPG" (Doel 3/4), "BAN" (Tihange 1) and "BAN-D" (Tihange 2/3).
- in dry storage containers in building SCG (Doel);
- in storage pools in building DE (Tihange).

The spent fuel considered as radioactive waste is further treated in section H.

VII.A.1.a) *Fuel desactivation pools in the units.*

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, even if the external power supply is down, 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.

Recent efforts after the Fukushima-Daiichi accident were undertaken to evaluate possible improvements related to hardware, organization and procedures, to better cope with possible extreme accident scenarios. Some improvements have been implemented, consequently the robustness of the fuel-cooling pools has been enhanced:

- 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 lose 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 showed 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

VII.A.1.b) *Tihange site*

(1) <u>Intermediate storage in buildings «BAN» (Tihange 1) and «BAN-D» (Tihange 2/3)</u>

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, 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 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.

(2) <u>Intermediary storage building DE</u>

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.
- 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.
- 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, each for its own field, 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. In Belgium this periodic safety review 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 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 the 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 facilities. Through an exchanger, this CRI system transfers the heat extracted from the STP system to the third 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 accidental 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 rate) 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 (what is conservative).

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 level possible.

The mechanical features of the fuel rods cladding, especially corrosion resistance, have been improved by using new alloys.

VII.A.1.c) *Doel site*

(1) Intermediary storage in the buildings "GNH" (Doel 1/2) and "SPG" (Doel 3/4)

The intermediate storage buildings as well as the installations and systems that are integrated in these buildings have been designed and constructed according to the safety principles, the general design criteria, 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 regulations.

The design of these buildings complies with the provisions of GRR-2001.

(2) Intermediate storage of containers in building SCG

At Doel, the intermediate storage safety functions are fulfilled mainly by the storage containers. The storage container models are approved by the FANC for transport, and comply therefore with the IAEA transport regulations.

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 the IAEA requirements for the analysis of the 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.

The storage configuration of the containers is slightly different from the transport configuration.

The design of the intermediary storage – i.e. the containers configured for the storage and the storage building – complies with the provisions of GRR-1963 which was replaced later by GRR-2001.

In general, the design requirements for the intermediate storage are the same as those in force for the generating units on the site:

- The containers must resist seismic loads and the consequences of other natural phenomena like violent wind and tornado.
- The containers have been designed to cope with external accidents such as an airplane crash, an explosion accompanied by a shock wave and projectiles.
- The access to the building is controlled.
- The shields 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 generating 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:
- Radiological surveillance activities include:
    - Surveillance of the installations;
    - Fuel handling;
    - Control of the tightness;
    - 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 building is included in the periodic safety review. In Belgium this periodic safety review is performed every ten years. Therefore the lifetime of the installation is periodically reassessed.

During the operation and in the frame of the ten-yearly periodic safety reviews, the operator evaluates whether the installation are in line with recent development in international regulations and standards, including recommendations of the International Commission on Radiological Protection and of the International Atomic Energy Agency.

The SCG building is now included in the safety report of the Doel 3 unit. On the other hand the safety function is fulfilled by the fuel containers themselves, not by the building.

VII.A.2. **SCK•CEN site: BR2**

Additional information can be found in appendix 4

VII.A.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.

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 121.5mm 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.

VII.A.2.b) *Criticality considerations*

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

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.

VII.A.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,
- auxiliary.

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, there are 2 or 3 pumps 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.

VII.B.Article 5: Existing Installations

VII.B.1. Sites of Doel and Tihange

The installations are described in appendix 1.

The measures to investigate and improve the safety of the spent fuel management installations are addressed below.

VII.B.1.a) *Ten-yearly safety reviews*

The License of each Belgian nuclear power plant makes it mandatory to conduct ten-yearly safety reviews.

As a result, the operator and Bel V compare together, on the one hand, the conditions of the installations and the implementation of the procedures that apply to them, and, on the other hand, the regulations, standards and practices in force namely in the United States and in the European Union.

A report is established highlighting the differences found, the necessity and possibility of remedial actions and, as the case may be, the improvements that can be made and the time schedule for their implementation. The report is submitted to the FANC and presented to its Scientific Council.

The objectives of a ten-yearly safety review have been defined as follows:

- show that the unit has at least the same level of safety as it had at the last Periodic Safety Review;
- inspect the condition of the unit, devoting more particular attention to ageing and wear and to the other factors which may affect its safe operation during the next ten years;
- justify the unit's current level of safety, taking into account the most recent safety regulations, standards and practices and, if necessary, propose appropriate improvements.

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 possibly 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, fuel cooling and the confinement of radioactive material

In 2007, the FANC has required that the future 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 next periodic safety reviews (PSR) of the Belgian NPP's (3rd review for Doel 3 (including SCG building, WAB installation and GSG/GSR buildings), Doel 4, Tihange 2 and Tihange 3 (including DE building), and 4th review of Doel 1/2 and Tihange 1) will be based on this IAEA safety guide. A report describing the scope and the method for the PSR has already been sent by the Licensee (Electrabel) to the regulatory body. The periodic safety review will evaluate 14 safety factors, as defined in the IAEA safety guide.

The Doel 3 NPP was the first unit assessed using the new methodology. The Doel 3 PSR was completed in August 2012. The assessments of the fourteen safety factors identified both Strengths and Opportunities for Improvement (OFIs). The OFIs are weighted according to a resources/safety relevance scale (in accordance with the new international standards) to select the most relevant actions to be taken. Approximately 50 OFI's were selected for further action.

VII.B.1.b) *Safety assessments*

During the operation of the installations, experience feedback leads 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, and Bel V is informed. The procedure is described in article 14 of the National Report established for the meeting of the Contracting Parties in the framework of the Convention on Nuclear Safety. In short, the proposal is 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 Decree (Royal Decree) is established. The implementation of the modification will be authorised by the unit's Health Physics Department (HPD) and by Bel V.
- minor modifications having a potential impact on safety. The modification file is established by the requesting department, possibly with outside help, such as Tractebel Engineering, is presented for approval to the Unit or Site Operation Committee 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 of the unit, without formal involvement of Bel V.

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 certain neutron-absorbing materials (boraflex plates) present in a few racks in the fuel ponds of different units, by steel sheets containing boron.
  Operating experience from other plants showed that a degradation of these boraflex plates could occur. Therefore measurements were performed to monitor the state of the boraflex racks. The results of this monitoring were included in conservative criticality calculations to demonstrate the compliance with subcriticality criteria in the ponds.
  In parallel the preventive replacement of these racks was performed.
  Today all the racks in the fuel ponds which contained boraflex at Doel and Tihange have been replaced by racks containing boronsteel.
- modifications to the handling and transfer systems of spent fuel shipping containers.

VII.B.1.c) *Surveillance programmes*

The technical specifications (chapter 16 of the Safety Analysis Report) describe, for each status of the unit, the operational limits and conditions, specifying also the actions to be taken if limits are exceeded. They also list the controls and tests to be performed and their frequency.

Specific programmes are established, in particular for:

- inspections and controls
- 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.

VII.B.2. **SCK•CEN site: BR2**

Additional information may be found in appendix 4

The steps to investigate and improve the safety of the spent fuel management installations are dealt with below.

VII.B.2.a) *Ten-yearly safety reviews*

The Royal Decree granting the license N.0024 of 30 June 1986 for the operation of SCK•CEN makes it mandatory to conduct ten-yearly safety reviews starting from the inspection acceptance (granted during the first operation at full power). 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 methodology to be used for the periodic review is described in a FANC guidance and is based on the IAEA safety guide No. NS-G-2.10 (now SSG-25) Periodic Safety Review of Nuclear Power Plants. The objectives of a ten-yearly review are similar to those of the NPPs.

The safety evaluation of the installation is performed according to the safety factors described in the IAEA guide and cover the technical but also the organisational aspects of the installation.

In total 14 safety factors are used in five categories; plant, safety analysis, performance and feedback experience, management, environment.

The periodic review consists of a preparation phase where the methodology to be used in the review is defined, the evaluation phase where the analysis is performed and the implementation phase where the improvements in safety are implemented. On each of these phases reports are delivered to FANC and Bel V.

VII.B.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.

VII.B.2.a) *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.

(1) 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, as a result of an incident, 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.

VII.C. Article 6: Siting of proposed facilities

The installations are described in appendix 1.

The current spent fuel management installations have been sited after evaluation and consideration of the relevant factors related to the sites.

Informing neighbouring countries when planning a nuclear installation is required by Article 37 of the Euratom Treaty, and as a consequence is mandatory in Belgium (cf. the GRR-2001). The reports drawn up to meet this requirement has to be submitted to the European Commission as part of the licensing procedure for the Belgian nuclear installations. Direct information of the neighbouring countries which might undergo notable consequences on their territory is an obligation deriving from the Directive 85/337/EEC on the assessment of the effects of certain public and private projects on the environment, as replaced by Directive 2014/52/EU of 16 April 2014.

VII.C.1. Sites of Doel and Tihange

VII.C.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. But the design of the installations made allowance for the existing situation: the "low population zone" of the USNRC rules is in fact within the site. Consequently 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.
  Due to the very high source terms imposed by the U.S. safety rules, the design of the Belgian units incorporates strict demands on the containment leak rate (double containment with a steel liner for the primary containment) and systems to prevent liquid or gaseous leaks through the containment penetrations.

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, that probability was found sufficiently low.

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.

VII.C.1.b) *Stress tests*

Appropriate measures to ensure that such facilities have not unacceptable effects on other Contracting Parties are listed in article 4 (see above).

Following the Fukushima Daiichi accident, the licensee was asked to conduct 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 and 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 bad weather conditions,

An action plan was launched as a result of the assessment, including:

- Reinforcements of Structures, Systems and Components to improve their resistance against beyond design earthquakes;
- A site peripheral protection for Tihange, in relation to a 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 sewerage systems for protecting the sites against rains with return periods much larger than considered in the design.

The current status of the action plan can be found on the FANC web site : http://www.fanc.be/GED/00000000/3500/3597.pdf

VII.C.2. SCK•CEN site: BR2

Additional information can be found in appendix 4.

VII.C.2.a) *Siting*

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.

(1) Initial siting and periodic reassessment of the sites characteristics

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."

Information received from Belgian sources indicates that earthquakes are not taken into account in building design. The last appreciable earthquake occurred in 1938 and was of Class 7, which is defined as producing an acceleration 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.

For the restart of BR2 in 1997, following the replacement of the beryllium matrix, a seismic qualification was asked by the authorities. 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".

VII.C.2.b) *Stress tests*

Following the Fukushima Daiichi accident, all "Class 1" nuclear installations (including the power reactors and the research reactors), were asked to conduct stress tests. The safety evaluation report for SCK•CEN has been established by the licensee and reviewed by the FANC and Bel V. No peer review was foreseen.

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:

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

- 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 (in place 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. A seismic qualification will be done (action plan) for the remaining 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 will be considered.

The current status of the action plan can be found on the FANC web site : http://www.fanc.be/GED/00000000/3500/3598.pdf

VII.D. Article 7: Design and construction of facilities

VII.D.1. **Doel and Tihange Installations**

The design of the facilities is described in Appendix 1

VII.D.1.a) *Appropriate measures to limit the radiological effects*

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

On each site, the spent fuel assemblies discharged from the reactors are stored in the cooling ponds of the units for radioactive decay.

The 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 coming from the units (building DE-Tihange) or in shielded containers ('dry storage' -building SCG-Doel).

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.

A small hole in the pipes going down to the bottom of the pools avoids creating a siphon effect 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 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 function of radiological protection of the staff handling the assemblies and operating the pools of building DE, is mentioned in section VII.A.1.

The design of building DE also 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 are set off, but there is no automatic action.

Ventilating building DE

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 in building DE trough 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 permit 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 release 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.

Release 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 desactivation 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.

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 before being transferred to building DE (2 years).

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

Building SCG is an separate building used only for intermediate storage. It consists of a dry storage in containers qualified for transport. The containers are filled with spent fuel assemblies and are prepared and tested in the fuel building of the units before being transferred. There is no operation leading 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.

Building 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 place 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 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
- drop of a container on another container.

Category 4 includes the following accidents:

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

In any case, the metal seals integrity is 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.

VII.D.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 (cf. art 9, section VII.F.1.g).

VII.D.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. See appendix 1.

VII.D.2. Installations of SCK•CEN: BR2

Additional information may be found in appendix 4

VII.D.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. Also the secondary water, after the heat exchanger, is checked. 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.

VII.E. Article 8: Assessment of safety of facilities

VII.E.1. Doel and Tihange installations

The installations are described in appendix 1.

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 assessment. These assessments cover its lifetime.

The application file, together with the numerous technical supporting documents are reviewed by the Regulatory Body and may give rise to an intense exchange of questions and answers.

After acceptance of the installations (commissioning test programme) and updating of the Safety Analysis Report to bring it in its final status, the Regulatory Body may propose the confirmation of the construction and operation license (1st license) to allow the start-up of the operation.

The conformity investigation and the commissioning tests are conducted under the acceptance inspection procedures of the installations by the Regulatory Body.

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,

VII.E.2. Installations of SCK•CEN: BR2

See articles 4 to 7

VII.F. Article 9: Operation of facilities

VII.F.1. Doel and Tihange installations

The installations are described in Appendix 1.

VII.F.1.a) *Initial license and commissioning*

The licensing process and the related safety assessment have been described in detail in Article 7 of the Belgian National Report established for the meeting of the Contracting Parties of the Convention on Nuclear Safety and in section V.B.4a) (article 19) of this report. The license is signed by the King after it has been investigated in detail by the Regulatory Body and its Scientific Council.

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, sanctioned by a Royal Decree granting an operation license.

VII.F.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.

VII.F.1.c) *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.

VII.F.1.d) *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 Engineering (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.

VII.F.1.e) *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 where 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.

VII.F.1.f) *Operational experience feedback*

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

The license conditions prescribes 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

VII.F.1.g) *Decommissioning plans*

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

In particular, initial decommissioning plans for generating units have been established, including the spent fuel storage installations; these decommissioning plans are reviewed regularly.

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.

VII.F.2. **SCK•CEN installations: BR2**

A description of the BR2 may be found in appendix 4

VII.F.2.a) *Initial license and commissioning*

see Section E, article 19

VII.F.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.

This applies to any status of the installation.

VII.F.2.c) *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.

VII.F.2.d) *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.

VII.F.2.e) *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.

A « significant event » is in fact an event/incident that, on its own or in correlation with other events/incidents, could put the operational safety of the installations at risk.

To prevent and minimize the number of events in direct or indirect link with human, precise actions are taken to improve qualitatively the operation and its control. These measures can only improve the management of the spent fuel:

- Revision of each operational procedure: each procedure in force is re-examined periodically. Any modification of the installations requires automatically an adaptation of these procedures.
- Motivation of the personnel to comply strictly with the operational procedures.
- Training of the reactor operators: initial training and permanent training programmes have been set up. During the shutdown for refurbishment, each reactor operator has followed a theoretical and practical retraining. Since the reactor was started up again in 1997, sessions have been organised for each driving agent (level reactor operator). These training sessions include both theoretical and practical aspects, but also general information (e.g. modifications of the installations). Before starting up each cycle, a specific practical training is organised in the reactor - as far as possible – for the learning of some procedures.
- Improvement of the man-machine interface: specific actions have been taken – remote control of the valves – and are still taken – new control panel in the reactor control room, new regulation of the primary temperature, emergency panel in the reactor control room - during the refurbishment.

These measures, together with maintaining a stable and uniform operating team for the years to come, constitute the best way to guarantee a safe operation.

VII.F.2.f) *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. See also article 26

VII.G. Article 10 :

All issues related to spent fuel disposal are dealt with in section H.

VIII. 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:

- Future disposal facilities for radioactive waste
- Future disposal facilities for spent fuel if considered as waste, at that time,
- Existing facilities for temporary storage of radioactive waste (also for spent fuel considered as waste) and conditioning of radioactive waste.

As mentioned in section B of this report, Belgium is currently considering two options for the back-end of the fuel cycle, reprocessing and direct disposal of spent fuel.

For the category A waste policy decisions have been taken in the past to develop a surface disposal facility in Dessel. ONDRAF/NIRAS submitted the license application to FANC in January 2013.

For the category B&C waste, ONDRAF/NIRAS proposes in its final Waste Plan a policy decision, to be taken by the federal Government, for geological disposal in a poorly indurated clay host rock.

The gaseous, liquid and solid radioactive waste treatment facilities of the NPP's are briefly described in appendix 2

VIII.A. Article 11: General safety requirements

VIII.A.1. Safety objectives applicable for a disposal facility

FANC has developed and proposed a specific licensing system, as well as specific safety requirements for disposal facilities. It also developed guidance for disposal. International guidance, in particular the relevant IAEA safety standards, and best practices are used as bases.

A disposal facility for radioactive waste has to ensure a dual safety objective:

1. *First, to concentrate and isolate the waste from Man and his environment for as long as this is necessary, or equivalently, to afford Man and his environment adequate* ***protection*** *from the risks which this waste can pose;*
2. *Second, to provide protection which can, over time, become independent of active measures to be taken by future generations, such as maintenance, controls and supervision. This is the concept of* ***passive isolation and containment*** *or passive safety.*

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 lower 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).

ONDRAF/NIRAS has developed and implemented a system of waste acceptance criteria to ensure that the treatment and conditioning of the waste is coherent with the interim storage facility and with the reference disposal solutions studied. These acceptance criteria - based on the General Rules - set out the minimum requirements (mechanical, physical, radiological, chemical or others) which primary packages of conditioned radioactive waste must meet before they can be accepted by ONDRAF/NIRAS.

Irrespective of the requirements of Article 14 (which sets procedures for dealing with non-conformities) and Article 15 (exemptions from the acceptance criteria) of the General Rules, each primary package of conditioned radioactive waste which ONDRAF/NIRAS accepts must comply with the relevant statutes and regulations, including the terms of the operating licenses of the nuclear installations concerned (mainly interim storage facilities), the General Rules and ONDRAF/NIRAS's supplementary acceptance criteria. The conformity of the accepted waste packages with the reference disposal solutions being developed is periodically re-assessed, by control and inspection campaigns of the stored waste packages, the first time three years after acceptance and then every ten years. Acceptance criteria for disposal facilities (i.e. post-conditioned waste ready to be disposed of) are currently being developed by ONDRAF/NIRAS.

VIII.A.2. Safety objectives applicable for existing 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 some critical U and Pu isotopes is kept at values low enough to avoid any criticality risk.
- The processing techniques are implemented to reduce as much as possible the quantity of radioactive waste resulting from those operations.
- The protection and safety methods applied to the construction and operation of the processing and storage installations and any other equipment (containers, etc.) meet the regulations enacted by the competent national authorities (see next articles) in accordance with international rules and recommendations.
- 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 too heavy 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.

VIII.B. Article 12: Existing facilities and past practices

The storage facilities at the Belgoprocess site are described in appendix 3.

VIII.B.1. **Regulatory framework**

As the Joint Convention came into force in Belgium on 5 December 2002, every processing and storage installation in operation on the Belgoprocess site is concerned by article 12 of the Joint Convention.

Prior to the construction and the operation of the installations, the operator must first comply with all legal rules to guarantee the safety of the installations. Indeed, in accordance with the regulation[9] in force at that time, the operator had to submit a construction and operating license application. A safety analysis report[10] describing a set of applicable measures had to be annexed to the license application.

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 standards and quantities (in terms of volume and activities) of discharged 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 where 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. Staff qualification and competences.

Before the licenses are granted, this safety analysis report is reviewed by the competent authorities and by the Scientific Council of the FANC which may consult national and international experts.

[9] Royal Decree of 28 February 1963 (GRR-1963) providing the General Regulations regarding protection of the population and workers against the dangers of ionizing radiation (or one of the modifications). As mentioned in section E, this regulation has been replaced by the Royal Decree of 20 July 2001 (GRR-2001).

[10] The building license can be granted on the basis of a Preliminary Safety Analysis Report (PSAR) whereas the operating license is granted on the basis of a Final Safety Analysis Report. Additionally, this report is updated during the operational phase of the installation.

For some waste processing installations and some storage buildings, the operating licenses are granted for a limited period. At the end of this period, a new operating license application must be submitted, in accordance with the regulation in force at that time. A new license is also necessary for any major modification or extension of the installation.

The revision of the regulations in 2001 has obliged the operator, from this date onwards, to add a more detailed environmental impact assessment (in comparison with the assessments mentioned in f and g) to the license application.

For any modification of an existing installation having an impact on the environment, a new environmental impact assessment must also be added to the new license application.

VIII.B.2. **Regulation enforcement**

Bel V performs the acceptance inspection of the installations, including verification if regulations, license conditions and the objectives of the test programme are complied with. According to the acceptance report, the operation is authorised or not.

The above-mentioned Royal Decrees set out the obligation of organising an internal Health Physics Department. This department is entrusted with the task of organising the surveillance of the measures necessary to comply with the regulations and license conditions on workplace safety and health. Bel V supervises the performance of the Health Physics Department. It can propose any modification to improve the safety of the installations.

Belgoprocess monitors the liquid and gaseous discharge in the environment and the water quality of the river Molse Nete where the discharged liquid waste is released:

a. flow rate and volume of discharged water
b. chemical and radiological control of discharged water before and after being discharged
c. chemical and radiological control of the river water and the river bed sediment, upstream and downstream from the discharge point
d. radioactive contamination of the river banks, on and around the industrial sites
e. radiological control of air and ground water samples from the vicinity
f. radiological control of the chimney emissions

These controls are regularly performed and are reported twice a year to FANC and published each year in the sustainability report (www.belgoprocess.be). All releases (liquid and gaseous) remain far below the authorized limits and the assessments of potential impacts due to the actual releases remain far below the imposed dose constraints, as indicated in the publicly available sustainability reports.

Moreover, the regulatory body also takes some control samples, as part of its national surveillance and monitoring programme.

VIII.B.3. **Storage buildings on the Belgoprocess site**

The storage buildings for conditioned waste on site 1 of Belgoprocess are briefly described below. It concerns the buildings 127, 129, 136, 150, 151, 155 and 156 (further abbreviated as B127, B129, etc.). This description focuses on the waste acceptance criteria that are directly relevant for storage..

The current storage conditions are presented in the acceptance criteria mentioned below, in the safety files and in the IPA (Internal Project Application of Belgoprocess).

Table 3 summarizes the conditions (with regard to the radioactivity) applicable for the storage of the packages in the different buildings while **Table 4** is directly taken from the applicable safety reports of the buildings.

In 2003, ONDRAF/NIRAS and Belgoprocess started a visual inspection programme for all the stored conditioned waste drums. In case of observations of non-conformities with the waste acceptance criteria (e.g. degradation of waste packages due to corrosion phenomena) specific measures are taken:

- regular inspections of the waste packages to closely follow further evolutions;
- specific measures to avoid any release of activity;
- removal of damaged waste packages for individual follow-up;
- investigation of the mechanisms and phenomena leading to non-conformities (mainly container corrosion and swelling of bitumen), in order to be able to define and implement corrective measures.

This programme was finalized end of 2010. In total, 40412 conditioned waste packages were inspected. A follow-up inspection programme has been defined and implemented

Table 3: Acceptance criteria/conditions with regard to radioactivity

B 127
1. The dose rate at the external surface of the package has to remain below the limit of 2 Sv/h. A package with localized surface dose rate exceeding the (maximum) limit value may, in close consultation with the Health Physics Department and possibly with Bel V, be accepted on the condition that the criterion regarding the dose rate at 1 meter is observed (< 0.2 Sv/h). 2. The volume-activity concentration in the primary package is limited to 148GBq/m3 for alpha emitters and to 37 TBq/m^3 for beta-gamma emitters. 3. the removable surface contamination of the primary package needs to be below 0.4 Bq/cm^2 for alpha emitters; 4 Bq/cm^2 for beta-gamma emitters. 4. ^{226}Ra and ^{232}Th in the primary package are only allowed in mass-activity concentrations which do not exceed the natural radioactivity of these isotopes.
B 129
Storage building already filled.
B 136
Building mainly foreseen for SYNATOM waste coming from COGEMA (now AREVA). See specific acceptance criteria for more details about the radiological conditions.
B 150
Storage building already filled
B 151
1. the dose rate at the external surface of the package has to remain below the limit of 5 mSv/h. A package with localised surface dose rate exceeding the limit value may be accepted on the condition that the criterion regarding the dose rate on a 1 meter distance is observed (< 0.5 mSv/h). 2. the mass-activity concentration of alpha emitters in the primary package is limited to 4 GBq per ton. 3. the removable alpha surface contamination has to be below 0.04 Bq/cm^2; that of beta/gamma surface contamination below 0.4 Bq/cm^2. 4. ^{226}Ra and ^{232}Th in the primary package are only allowed in mass-activity concentrations, which do not exceed the natural radioactivity of these isotopes.

B155 LAGAL
1. the dose rate at the external surface of the package has to be below or equal to 5 mSv/h. If the surface dose rate exceeds 5 mSv/h, the radiation at 1 meter distance has to be below 0.5 mSv/h. 2. The ^{241}Pu quantity has to be below 112 g per package. The Pu-239 quantity has to be below 219 g per package. The ^{235}U quantity has to be below 326 g per primary package. The sum of the proportions of the quantities of these 3 radionuclides compared to the maximum quantities of each of these radionuclides has to be below 1. 3. The beta activity concentration, with the exception of that of ^{241}Pu, has to be below 40 GBq per primary package. 4. The removable alpha surface contamination needs to be below 0.04 Bq/cm^2; that of beta/gamma below 0.4 Bq/cm^2. 5. ^{226}Ra en ^{232}Th should not exceed their natural concentrations.
B 155 RAGAL
1. The dose rate at the external surface of the package must be below or equal to 5 mSv/h. If above 5 mSv/h, the radiation at 1 m must be below 0.5 mSv/h. 2. The removable alpha surface contamination must be below 0.04 Bq/cm^2 while the removable beta/gamma surface contamination must be below 0.4 Bq/cm^2. 3. The alpha activity concentration must be below 20 GBq/t. The maximum alpha Radium concentration must be below 740 GBq/package
B 156
4. Storage of BR3 fuel assemblies in CASTOR storage casks.

Table 4: Conditions stipulated in the Safety Files

<table>
<tr><td colspan="6">B 127</td></tr>
<tr><td colspan="6">Maximum dose rate on outer walls of the building. 25 µSv/h. Max. activity <3.7 E10 Bq/l, mainly beta; alpha activity negligible</td></tr>
<tr><td colspan="6">B 129</td></tr>
<tr><td colspan="6">Maximum dose rate on outer walls of building: 25 µSv/h. Per package maximum alpha activity up to 1.37E12 Bq and maximum beta activity up to 3.2E14 Bq, depending on the type of waste.</td></tr>
<tr><td colspan="6">B 136</td></tr>
<tr><td colspan="6">Maximum dose rate on outer walls of building: 20 µSv/h.</td></tr>
<tr><td rowspan="2"></td><td>Vitrified waste
(CSD-V)</td><td>Compacted waste
(CSD-C)</td><td>Vitrified waste
(CSD-B)</td><td>Dounreay</td><td>400 L drums</td></tr>
<tr><td>High active solutions</td><td>Hulls and ends</td><td>Process sludges</td><td>High active solutions
(cemented)</td><td>Compacted waste
(cemented)</td></tr>
<tr><td><u>Dose rate</u> (Sv/h)
D (contact)
D (1 meter)</td><td>
1.4 E4
4.2 E2</td><td>
1.5 E2
12</td><td>
2.8
0.2</td><td>
13
1.3</td><td>
1.0 E2
10</td></tr>
<tr><td><u>Activity per primary package</u> (TBq)
Beta/Gamma
Alpha</td><td>
2.8 E4
1.41 E2</td><td>
2.4 E2
0.6</td><td>
31
1</td><td>
4.0 E2
0.5</td><td>
4.0 E2
10</td></tr>
<tr><td><u>Removable surface contamination</u> (Bq/cm^2)
Beta/Gamma
Alpha</td><td>
< 4
0.4</td><td>
< 4
0.4</td><td>
< 4
< 0.4</td><td>
< 4
0.4</td><td>
< 4
0.4</td></tr>
<tr><td colspan="6">B 150</td></tr>
<tr><td colspan="6">Maximum dose rate in contact with package: 5 mSv/h, exceptionally, 10 mSv/h. Per package maximum alpha activity up to 2E9 Bq and maximum beta activity up to 3E12 Bq, depending on the type of waste.</td></tr>
<tr><td colspan="6">B 151</td></tr>
<tr><td colspan="6">Maximum dose rate in contact with package: 5 mSv/h, exceptionally, higher if value at 1 m is below 0,5 mSv/h. Maximum alpha activity 4GBq/t, except for 160 drums from historical production,< 75GBq/t. Maximum beta activity up to 3E12 Bq/ package, dependent on type of waste.</td></tr>
<tr><td colspan="6">B 155</td></tr>
<tr><td colspan="6">Maximum dose rate on outer walls of building: 10 µSv/h. Other conditions as in the acceptance files</td></tr>
<tr><td colspan="6">B 156</td></tr>
<tr><td colspan="6">The dose rate limits outside the building are:
• surface of the storage building 10 µSv/h
• 300 m distance from the storage building 0.1 mSv/y</td></tr>
</table>

VIII.B.4. **CILVA: Central Installation for Low-level Solid Waste (site 1 Belgoprocess)**

The **CILVA** installation (Central installation for low-level solid waste) is designed for the processing of low-level solid waste, mainly produced in Belgium. This low-level solid waste contains mainly beta-gamma waste, but also very low-level contaminated alpha waste.

With regard to the radiological characteristics of the waste that can be processed in these installations, the following limits apply:

- Maximum dose rate at the surface of the primary package and of the transport package: 2 mSv/h.
- Level of surface contamination of primary package must not exceed 4 Bq/cm² for beta-gamma emitters and low-toxic alpha emitters and 0.4 Bq/cm² for other alpha emitters.
- Regarding solid beta-gamma waste, the activity must not exceed 40 GBq/m^3 (averaged over volume of every primary package). No traces of alpha activity may be present up to 40 MBq/m^3.
- Regarding solid alpha-contaminated waste, the beta-gamma activity must not exceed 40 GBq/m^3. The alpha-activity may not exceed 10 GBq/m^3.

The waste contaminated with pathogenic substances is collected and packed for transportation separately.

In the installations, the following activities are performed:

- Waste reception;
- Pre-treatment of waste (sorting out, pre-compression, reduction);
- Compaction of waste drums;
- Incineration;
- Immobilisation;
- Inspection and transport of the conditioned waste to the storage facilities.

VIII.B.4.a) *General description of the building*

The building has a surface of 100 m x 65 m and is built on a foundation plate resting on compact, mainly sandy ground, at about 0.75 m depth.

The building is composed of a structure in reinforced concrete.

Its height is about 10 m with the exception of an area of 1000 m² which is 16 m high. The lower part contains areas on one or two levels, depending on the activity, while the higher parts have a variable number (two to five) of levels.

The roof is composed of lightweight concrete arches, covered with isolating materials and a sealing film. The floors are made of full plates of reinforced concrete.

In the areas requiring a biological shield for the roof, the roof is made of a full concrete plate.

The walls are made of reinforced concrete or of stonework, depending on the biological shield required and on the supporting capacity.

VIII.B.4.b) *Radiological protection*

The storage of unconditioned and conditioned waste as well as the processing of this waste in CILVA is performed in controlled and shielded areas. Access to these areas is strictly limited to the necessary operations, provided that the general and specific radiation protection procedures are observed. These areas are defined as "processing areas ".

The areas surrounding these areas are, depending on their protection level according to the criteria which apply to the Belgoprocess site, classified as follows:

Radiation area	Description	Maximum dose rate (µSv/h)
I	Adjacent processing premise	250
II	Intervention area	75
III	Working area not permanently occupied	25
IV	Working area permanently occupied	5

It must be noted that these maxima are "design dose rates", which were used for the calculation of the protection shields. During the operation, the ALARA principle is applied, implying that the doses for the personnel are only a fraction of the design values.

Processing areas (Area 0)

The processing areas are areas in which conditioned or non-conditioned waste is stored or in which the waste is not treated or processed manually.

The walls of these areas shield sufficiently to ensure that the maximum dose rates in the adjacent areas are not exceeded.

Area I

Between the adjacent processing areas, the necessary shielding is foreseen to ensure that in case of an intervention, the dose rate in the area in which the intervention takes place, will not exceed the limits with regard to area I. In normal operating conditions, there are no areas belonging to area I.

Area II

Area II includes the areas, which, in normal operating conditions, are not entered, but are used in the case of interventions in processing areas.

Area III

The areas in which the personnel is not permanently present, but during an important fraction of the working time, belong to this area. These are e.g. the areas where the waste is manually treated, processed and sorted out. Most of the technical areas and passageways belong to this area.

Area IV

Areas in which the personnel is normally permanently present, belong to this area (e.g. control rooms, offices, ...).

VIII.B.4.c) *Confinement*

In order to prevent dispersion of radioactive substances, the ventilation is designed such that a pressure gradient provides an air current from the areas with a small probability of contamination to those with a large probability of contamination.

Radioactive liquids are stored either in 30 l flasks, in storage containers, or in transport containers. All of these recipients are stored in areas equipped with retention tanks or leaktight reservoirs, which, in case of a leak, collect all of the liquids stored;

The transport packages are opened under an exhaust hood to extract the aerosols to deposit them onto filters.

The opening of the primary package and the manipulations of the waste are performed either in glove boxes or in accommodated areas.

The standard 400 l drums are filled through a lock in order to prevent any contamination of the outer surface of the drum. This lock is kept in underpressure by means of a specific ventilation system with a prefilter and an absolute filter.

VIII.B.4.d) *Decontamination*

The form and the surface finishing of floors, walls and materials in the controlled area are – as far as possible - designed to facilitate decontamination.

The apparatus in the controlled area are coated with a protective and easy-to-decontaminate layer (epoxy or equivalent).

The floors, and in some cases also the walls, are coated with an easy-to-decontaminate layer.

VIII.B.4.e) *Waste produced*

Conditioned solid waste

The conditioned solid waste produced in CILVA as a final product during the normal operation of the installation, is low-level waste comparable to the waste classification received at the entry of the installation. The secondary waste generated in CILVA consists mainly of packages, equipment, ventilation filters, and clothing for the personnel and secondary waste generated by the combustion installation.

Liquid waste

There is no direct discharge of liquid radioactive waste. All the liquid waste produced in the controlled area of the CILVA unit is collected in containers. Gas washing and cooling liquids from the CILVA combustion installation are sent to the water treatment installation of Belgoprocess site 2.

Gaseous waste

The gaseous waste produced in the CILVA installations is, after treatment, evacuated through the main chimney of Belgoprocess where a permanent monitoring is performed.

VIII.B.4.f) *Radiation monitoring devices*

In CILVA, a radiation monitoring equipment is installed. This gives the necessary information concerning the radioactivity levels in different parts of the building and in the gaseous effluents enabling the operating personnel to take the necessary measures in order to keep the activity level as low as reasonably achievable.

A distinction can be made between:

- dose rate monitoring in the areas;
- air contamination monitoring;
- monitoring of air evacuated through the chimney;
- surface contamination monitoring;
- monitoring of exposure of personnel.

VIII.B.4.g) *Workers' dose*

As indicated, the shielding between the areas was calculated on the basis of the radiation area to which these areas belong. In this regard, the activity of the waste treated, the dose rate at the surface of the package, as well as the radioactive contamination of the package are limited.

Moreover, appropriate measures are taken in order to keep the workers' dose, resulting from external radiation and the committed dose due to the intake of radioactive substances, as low as reasonably achievable and below the regulatory limits.

VIII.B.4.h) *Fire protection*

Around the building a fire strip of more than 15 m has been deforested.

The protection system is designed to detect the start of a fire and to extinguish a fire, or to limit it maximally.

VIII.B.4.i) *Accidents considered*

In the safety assessments, the following accidents were considered:

Accidents of internal origin:

- drop of a package;
- interruption of electric power supply;
- explosion;
- fire.

Accidents of external origin:

- earthquake;
- airplane crash;
- heavy wind;
- flood;
- explosion

VIII.C. Article 13: Siting of proposed facilities

VIII.C.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 addition to the license for the dismantling of these former installations, changing the use of both sites required licenses for new treatment and storage buildings as well (see article 12).

VIII.C.2. **Future disposal facilities**

VIII.C.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 the next phase of the disposal programme. 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.

Siting of a geological repository for high-level and/or long-lived waste cannot start before a decision regarding the long term management of such waste has been taken .

VIII.C.2.b) *Disposal programme of category A waste (Category A waste project)*

(1) An integrated project for surface disposal of category A waste (the "cAt" project)

The repository 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 nuclear facility dismantlement. 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, the establishment 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 at the same time. 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) The structure of the project

The cAt project is subdivided in seven subprojects:

the disposal facility, the communication centre, the Local Fund, participation, spatial planning and mobility, employment and retention of nuclear know-how and finally, safety, environment and health. Cohesion between these building blocks, both on an organisational level and on site, is essential; it guarantees the integrated character of the cAt project.

a. The disposal facility

In summary, the disposal process of the category A waste is as follows:

- The waste is placed in concrete caissons (boxes) and subsequently encapsulated with mortar to form a monolith.
- The monoliths stop radioactive radiation and immobilize radioactive substances, thus constituting a key safety element.
- The monoliths containing the waste are placed in modules: concrete bunkers with thick reinforced walls (figure hereafter).
- After backfilling, the modules are sealed with a concrete cover. A roof covering all modules will offer protection against weather conditions before, during and after backfilling.
- In time, the fixed roof will be replaced by a permanent, low permeability final cover.

Figure 12: Waste emplacement in the disposal facility

For realization of this surface disposal process, the Dessel repository comprises the following components:

- the quay for delivery of materials for the repository via the canal;
- the caisson plant for the manufacture of the caissons;
- the monolith production facility (MPF) where the waste is encapsulated into monoliths;
- the disposal modules;
- the peripheral provisions: the administration building, the storage zone, the maintenance building…

At present, the disposal process as foreseen provides for production and emplacement of 1,000 monoliths per year.

b. The communication center

Radioactive waste management is a delicate and social issue. Open and proactive communication about the subject is in the interest of the local communities. A communication center will therefore 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 center: the contact point for people living in the neighborhood 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 neighborhood, 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.

c. The Local Fund

Radioactive waste repositories have a very long life cycle. Their impact on the surrounding area will continue even after operation and closure of the disposal modules and after the monitoring phase.

The socio-economic added values connected with the repository must also be safeguarded in the future.

A Local Fund (LF) will be established for this purpose.

The LF will support and finance projects and activities that create sustainable opportunities for the local communities and improve the quality of life of the local population in the short, medium and long term.

The nature of projects and activities financed by the LF may vary: they may have a social, economic or cultural character or be aimed at the environment, health, welfare, etc. The LF thus provides additional opportunities for social, cultural, ecological and economic added values that surpass the added values created by the cAt project itself (employment, retention of nuclear know-how, spatial opportunities, etc.).

Management of the LF will be in the hands of a "foundation". .

d. Participation

A participation model was developed with respect to disposal of category A waste over the years. The inhabitants of the Dessel and Mol municipalities are closely involved in the realization of the aggregated cAt project via the local partnerships STORA and MONA.

Since participation is intended to remain an essential part of the cAt project in the future, ONDRAF/NIRAS is committed to maintain a partnership with the local communities throughout the duration of the project.

The functions of the partnership and its operational shape may evolve in time.

Apart from having a close watch on the cAt project itself, the population wishes to be actively involved in other nuclear activities in the area. This is already being implemented today and the partnerships will also keep a broad mission in the long term, through participation in all nuclear activities in the region in a format to be decided at a later stage.

e. Spatial planning & mobility

The cAt project will take up a considerable area in the northern nuclear zone of Dessel-Mol. The planning and licensing part involved in the construction of the repository is a prerequisite for the realization of the cAt project. In addition, the cAt project creates a number of distinct spatial opportunities for Dessel.

ONDRAF/NIRAS is committed to implement at maximum these spatial win-win opportunities in the scope of the cAt project.

As regards mobility, ONDRAF/NIRAS opts for rational access to the disposal site. Maximum use of the canal for delivery and transport of (raw) materials minimizes impact of the disposal project on road traffic.

(3) f. Employment and retention of nuclear know-how

Regional employment stimulus is one of the distinct opportunities resulting from the repository.

The disposal site will provide temporary jobs during the construction phase, and employment in the medium term as from the operational phase in 2016. The disposal project also holds indirect positive effects for employment. The caisson plant will be operated by a private partner. If legally permitted, this party can develop activities other than manufacturing and supplying caissons.

Thanks to years of experience, the area has built up unique nuclear expertise, recognized on a national as well as an international level. For the sake of employment, but also for the sake of safety, it is imperative to keep that expertise within the region. ONDRAF/NIRAS will establish a knowledge centre in the area to further develop know-how in the field of radioactive waste management. Preparing qualified personnel for the project requires specific training in radiological protection and radioactive waste management.

Such training programmes already exist but deserve extra attention within the framework of the project.

g. Safety, environment and health

The safety strategy for the repository describes how that safety is ensured and is the starting point for safety development and evaluation with respect to the entire repository (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 design's safety 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 safety of 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.

(4) 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 safeguard support for the disposal, now and in the future. The MTF is fuelled by taxes and retributions (law of 29 December 2010).

VIII.D. Article 14: Design and construction of facilities

According to the legislation in force, the Preliminary Safety Analysis Report describes how the following points have to be implemented:

- protection against potential criticality (limitation of U and Pu quantities in the 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,
- Probability Safety Analyses available at the time of the application.

The levels of details of the above-mentioned points, namely the accidental scenarios considered, depend on the type of installations.

The environmental impact is described in a report on the environmental impact assessment of the facility concerned. This study describes the direct and indirect environmental effects in the short, intermediate and long term of the installation. 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.

A preliminary decommissioning plan must be established at the design of the 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. It includes the points described above, but also:

- the description of the installations and their history,
- the description of the quality system,
- the description of the safe maintenance,
- the destination of all the waste,
- the available scientific and technical knowledge.

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.

VIII.E. Article 15: Assessment of safety of facilities

VIII.E.1. **Future disposal facilities**

Before a disposal facility can be constructed, a license for creation and operation has to be granted by the King. A safety assessment as well as an environmental impact assessment has to be conducted and submitted to the FANC as a basis for His decision to grant this license.

(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 indurared 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' (State-of-the-art report as of December 2012 NIROND TR 2013-12E). 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 on the basis of ONDRAF/NIRAS waste plan. The RD&D related to B&C waste is described in 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' (State-of-the-art report as of December 2012 NIROND TR 2013-12E).

(2) Category A programme

The review of the license application file for the surface disposal facility, currently being performed by the regulatory body is separated into two parts. A first part concerns the review of the safety of the facility during the operational period, up to the closure of the facility, whilst a second part concerns the review 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 of nuclear regulatory control.

ONDRAF/NIRAS submitted the license application of the surface waste disposal facility at Dessel in January 2013.

In the previous years, the FANC has developed several guides to help ONDRAF/NIRAS in their development of the safety assessment of the facility. More particularly, the following guides were developed:

- 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^{-6}/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 parallel and in view of the preparation of the review of the license application, the FANC developed in 2012 the internal review bases for the evaluation of the safety report. These review bases included the Belgian legal requirements and guides and the international IAEA standards and guides, such as 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).

Prior to the introduction of the license application, an NEA peer review was performed on key aspects of the safety case available at that time, amongst which the long term safety assessment methodology applied and its results. The International Review Team (IRT), who performed its work mostly during the first half of 2012, did conclude that ONDRAF/NIRAS' long-term safety strategy and safety assessment methodology are, in the main, credible and robust. The disposal program implements international recommendations and best practice, takes into account the conditions stipulated by the Federal Government and the local communities, and is technically mature. The IRT concluded that the long term safety assessment methodology was sound and closely followed the IAEA supported approach. The IRT also concluded that the proposed set of scenarios was sound, but complex. Eventually, the team suggested to perform some additional calculations in order to confirm the results of the current assessment.

Prior to the license application, the FANC developed a document providing a detailed table of content of the expected safety report of a disposal facility, together with explanatory text to provide ONDRAF/NIRAS with guidance on regulatory expectations.

The safety report submitted by ONDRAF/NIRAS is composed of several parts and can be found on the following web site : http://issuu.com/niras-cat/docs/niv1_overzicht_nirond-tr_2012-18_n_v1

VIII.E.2. **Existing facilities**

For the existing Belgoprocess installations, articles 12, 13 and 14 mention and describe the content of the Preliminary and Final Safety Analysis Reports and of the environmental impact assessment which are elements of the construction and operating license applications.

Bel V reviews the Preliminary Safety Analysis Report and the related technical notes and it expresses comments and remarks, which have to be taken into account in the final version of the Safety Analysis Report.

The FANC also follows up the drawing up of the safety analysis report; this report has to be updated and finalized before the actual start-up of the facility

VIII.F. Article 16: Operation of facilities

When the construction is finished, the installation must be inspected by Bel V or by an authorized inspection organization with regard to compliance with the regulations and the specific conditions set in the license and to verification of the cold tests. The operating license may be granted if the final acceptance report issued by this organisation is entirely positive.

Throughout the operation, the safety analysis report is updated so that it reflects the real state of the installation.

The operation, maintenance, surveillance, inspection and test conditions are described in the safety analysis report. The internal Health Physics Department is entrusted with the task of implementing the procedures necessary for complying with these conditions. These procedures are then be controlled by Bel V or by an authorized inspection organization. Following the experience feedback of any other observation, it proposes - if necessary - the appropriate modifications in order to improve safety.

In accordance with the regulations in force, the incidents must be notified to the authorized inspection organization and classified with reference to the INES international scale after approval by Bel V and the FANC, who decides on establishing an IRS report.

The know-how of the different parties involved in the construction or in the modification of the installations must remain available throughout the operational phase of the installations for any safety-related problem.

As mentioned in article 14, the preliminary decommissioning plan established during the design phase is updated throughout the lifetime of the installations. This updating takes into account:

- The evolution of the technologies related to decontamination and dismantling,
- The evolution of the regulatory aspects such as the release limits resulting in modifications of the estimated waste quantities,
- the destination of the waste,
- the history of the installation (maintenance, intervention, incidents, accidents, …),
- the modification of the "quality" policy,

In accordance with the Royal Decrees of 16 October 1991 and 12 December 1997, ONDRAF/NIRAS concludes an agreement with the installation’s operator to set which information related to the dismantling must be provided.

Following a proposal by the Scientific Council of the FANC in June 2003, all Class I facilities had to be subject to Periodic Safety Reviews, every 10 years. As this was not foreseen in the existing operating licenses of Belgoprocess, this was added to their licenses (Royal Decree of 24 October 2004) and implemented in 2 steps.

A detailed overview of the outcomes of the first Periodic Safety Review of the Belgoprocess facilities in given is Annex, Appendix 5.

VIII.G. Article 17: Institutional measures after closure

This is not yet applicable for disposal facilities, since no specific regulatory measures have been imposed so far, and since the long-term management programme is not yet in a detailed design phase for disposal facilities. These measures for disposal facilities will be developed in due time.

IX. Section I: Transboundary movements

IX.A. Article 27: Transboundary movements

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.

With regard to the transboundary shipments of radioactive waste and spent fuel, it was decided to thoroughly revise chapter IV of the GRR-2001 that deals with the import, export, transit and distribution of radioactive substances. This chapter was replaced by a new Royal Decree of 24 March 2009 regulating import, transit and export of radioactive substances. This new Royal Decree also transposes 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 licensing procedure the advice of ONDRAF/NIRAS in case of import and export of radioactive waste is foreseen.

Currently, there are few transboundary shipments of spent fuel and radioactive waste. Licenses have been granted for:

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

[11] ADR : European agreement concerning the international carriage of dangerous goods by road.
RID: Regulation 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: The International Maritime Dangerous Goods Code of the International Maritime Organisation (IMO).
ADNR: Regulation concerning the Carriage of Dangerous Goods on the Rhine.

X. Section J: Disused sealed sources

X.A. Article 28: 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 also performed in 2014 a removal campaign of radioactive waste and disused sources in the Belgian hospitals.

Fifty-seven Belgian hospitals with a radiotherapy department and/or a nuclear medicine department have registered to participate in the campaign of removing their waste and disused sources. 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 for hospitals;
- transport and waste treatment are less expensive when grouped
- batches of waste can be transported and processed together.

XI. Section K: General efforts to improve safety

XI.A. Measures taken to address suggestions and challenges identified for Belgium at the 4th review meeting of the Joint Convention (2012).

No Suggestion has been identified for Belgium at the 4th review meeting of the contracting parties to the Joint convention. The 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 – Challenges -2012 Review Meeting
1. Clarification of Statute of SF : reprocessing or direct Disposal 2. Approval and implementation of Waste Plan • for the long-term management of HLW, long-lived waste • for the long-term management of radium-bearing waste (preparation needed) 3. Licensing and construction of the surface disposal facility and the monolith production facility (Dessel) 4. Completion of various regulatory framework improvement programmes now in progress 5. Completion of the 'Stress tests' for non-NPPs (fuel cycle and waste management facilities)
Belgium - Planned Measures to Improve Safety - 2012 Review Meeting
1. The implementation of the safety improvement action plans set up by the licensees as agreed by FANC 2. Improvement of the regulatory framework related to RW/SF management and decommissioning : transposition of WENRA- WGWD RLs into the Belgian regulation 3. Bel V R& D programme in safety assessment of disposal facilities and decommissioning 4. Extension of waste acceptance system to disposal 5. Implementation of the Strategic Safety Plan by Belgoprocess according to the agreed planning of actions for the sites 1 and 2 6. Development and step-wise implementation of the Integrated Management System (part nuclear operator disposal and waste management system) 7. Integration in the ONDRAF/NIRAS programme of all tasks and actions imposed by the Federal Government which result from a governmental decision-in-principle regarding long term management of the category B&C waste

XI.A.1. Challenges to improve safety identified for Belgium at the 4th review meeting

XI.A.1.a) *Challenge nr 1: Clarification of statute of SF : reprocessing or direct disposal*

Until the mid-nineties, the Belgian policy for the management of the back-end of the fuel cycle was the reprocessing of the spent fuel. Since the Belgian parliament voted in 1993 a suspension on further reprocessing and the federal government confirmed this decision in December 1993, ONDRAF/NIRAS was requested to consider and study both the option of direct disposal of spent fuel as well as the option of disposal of the radioactive waste from reprocessing.

In 1998, on the basis of a report issued by the Administration for Energy in which the two back-end options were compared, the federal government council of ministers considered that there was insufficient information to take a policy decision on the statute and management of the spent fuel. Since 1998 no new evaluations were made.

In its 2011 Waste Plan on the long-term management of the high-level and long-lived waste ONDRAF/NIRAS concluded w.r.t. the statute of the spent fuel:

The issue of the status of irradiated fuel is (…) a complex one, with potentially very diverse implications on the management of both reprocessing waste and non-reprocessed irradiated fuel declared as waste, including in terms of costs and RD&D requirements, and broadly connected to each other. The difficulty that a lack of clarity regarding the status of irradiated fuel represents for ONDRAF/NIRAS was already highlighted in 2001 in the contextual document of the SAFIR 2 report [Reference: Towards the sustainable management of radioactive waste – Background to the SAFIR 2 report, report NIROND 2001-05 E, 2001] and in 2007 in the second nuclear liabilities inventory report [Reference: Inventaire des passifs répertoriés par l'ONDRAF durant la période 2003-2007. Rapport NIROND 2007-02 F, 2007]. It does not allow ONDRAF/NIRAS to optimise its RD&D programme for the disposal of category C waste.

The status of non-reprocessed commercial irradiated fuel must be clarified before the siting process begins.

The federal government has not yet taken a policy decision on the basis of ONDRAF's Waste Plan, and no decisions have been taken at this moment w.r.t. the statute of the spent fuel. Nevertheless, some impulse for clarifying the statute of spent fuel emerged during the past few years :

- In its advice about the ONDRAF/NIRAS' waste plan, the FANC recognized that taking a decision about the statute of the spent fuel is an important element in the decision making process for the future management of category B&C waste.
- As a result of the IRRS mission which took place in Belgium in December 2013, the IRRS team clearly recommended the development of a national policy and strategy which should include radioactive waste management and spent fuel management.
- The European Directive 2011/70/Euratom of 19 July 2011 *establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste* requires European member states to *establish and maintain national policies on spent fuel and radioactive waste management.* This directive has been transposed into the Belgian legal framework by the law of June 3rd, 2014 amending article 179 of the law of August 8th.
  This law puts in place the elements for developing a *National Programme* for the management of spent fuel and radioactive waste through a *National Programme Committee* composed of representatives of the Ministry of Energy, of ONDRAF/NIRAS and of SYNATOM.

XI.A.1.b) *Challenge nr 2: Approval and implementation of Waste Plan – for:*

- ***the long-term management of HLW, long-lived waste***
- ***the long-term management of radium-bearing waste (preparation needed)***

(1) long-term management of HLW, long-lived waste

The ONDRAF/NIRAS Waste Plan for the long-term management of high-level and/or long-lived radioactive waste was adopted by ONDRAF/NIRAS Board of Directors on 23 September 2011 and submitted to the Federal Governement. In this Waste Plan, ONDRAF/NIRAS proposes that high-level and/or long-lived radioactive waste be disposed of in a unique repository located at depth in a poorly indurated clay formation, on the Belgian territory and that the development and implementation of such solution should:

- be carried out without undue delay and at a pace proportionate to its technical maturity and its societal support;
- be accompanied by a stepwise, adaptive, participative and transparent decision-making process;
- take into due consideration societal conditions linked to reversibility, retrievability, control and knowledge maintenance and transfer.

The adopted Waste Plan, together with its accompanying Strategic Environmental Assessment (SEA), provided the Federal Government with all the necessary elements to allow an informed decision to be taken regarding the Belgian policy for the long-term management of high-level and/or long-lived radioactive waste (including spent fuels if declared as waste).
The FANC as well as other stakeholders have given their advice on the Waste Plan.

No policy decision has yet been taken at this moment (September 2014). Since the Directive 2011/70/EURATOM establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste has been recently translated in Belgian laws [3 June 2014], decisions related to the long-term management of HLW, long-lived waste has now to be part of the national policies."

As a consequence of the transposition of the European Directive 2011/70/Euratom in the Belgian law, the decision will have to be published as a Royal Decree.

(2) long-term management of radium-bearing waste

In its Waste Plan for the long-term management of the high-level and long-lived waste ONDRAF/NIRAS announced the preparation of a second waste plan, focussing on the long-term management of the Radium-bearing waste in Belgium. This Radium-bearing waste is mainly the result of historical Radium production activities at the UMICORE Olen site, from the 1920's till the 1960's.

The current situation at Olen in terms of radioactive materials and contaminations present on the site is succinctly described in section IV.B.3.

ONDRAF/NIRAS waste plan will cover all radioactive Ra-waste in the existing licensed storage facilities in Olen, and potentially also Ra-bearing waste from the site remediation projects for the D1 landfill and all the other contaminations in Olen, if the FANC decides that these radioactively contaminated materials have to be managed as radioactive waste. This waste plan will also integrate other historical Ra-bearing waste related to the past Radium production and present on the Belgoprocess site in Dessel. The principal aim of this Ra-waste plan is to propose to the Federal Government a policy for the long-term management of all this historical waste.

Before starting the preparation of this second waste plan ONDRAF/NIRAS had decided to issue first a strategic document that describes the overall approach for the long-term management of all radioactive waste categories in Belgium (HLW, ILW, LLW, VLLW, short-lived and long-lived), and that links all the specific waste plans for the various waste categories to the national programme (as required by the EU Directive 2011/70/Euratom) covering as such all waste categories. This is the "Reference Framework for the long-term management of all radioactive waste in Belgium", that will be issued by ONDRAF/NIRAS by the end of 2014.

ONDRAF/NIRAS started the process for this Reference Framework document in 2013. The draft version of the document was submitted to FANC for advice in September 2013. The FANC advice was issued in April 2014. On the basis of this advice and important new legal and regulatory elements (the federal law transposing the EU Directive 2011/70/Euratom and the EU Basic Safety Standards on Radiation protection, EU Directive 2013/59) ONDRAF will prepare and publish the final version of the Reference Framework by the end of 2014.

The timing of the preparation of the Radium-bearing Waste Plan will be presented in the first national programme, that Belgium will prepare by August 2015 as required by the EU Directive 2011/70/Euratom.

XI.A.1.c) *Challenge nr 3: Licensing and construction of the surface disposal facility and the monolith production facility (Dessel)*

(1) The monolith production facility

As part of the integrated surface disposal project in Dessel (surface disposal of category A waste in monoliths), Belgoprocess submitted to the FANC in December 2011 a license application for a new building 160X, called the Installation for Production of Monoliths (IPM).

The main purpose of this facility is the production of monoliths containing category A waste. These monoliths consist of a concrete container ("caissons"; to be produced in another, non-nuclear facility) filled with radioactive waste and a cementitious backfill material. Three types of concrete containers are developed: a type I container to be filled with conditioned waste in standard waste drums of 220 l or 400 l, a type II container to be filled with conditioned waste in non-standard waste drums (700 l, …), and a type III container to be filled with non-conditioned bulk waste from dismantling.

Figure 13: Monolith types

A yearly production of about 1000 monoliths is planned; according to the actual prognoses a total of 30000 monoliths will have be produced. The facility is designed for a minimal operational period of 50 years. The facility provides also in a temporary storage of up to 2080 waste drums (waiting for post-conditioning into monoliths), and a temporary storage of 1000 monoliths (waiting for selection to be transferred and finally disposed off in one of the modules of the surface disposal facility). The possibility to receive monoliths produced by external operators is also foreseen.

Safety assessments of this facility are similar to the existing facilities for processing and intermediate storage of radioactive waste. After supplying complementary information and studies (e.g. impact of airplane crash), Belgoprocess submitted a new license application, including the safety report, in August 2012. Following review of this license application by the FANC and the Scientific Council, and following consultation of the local authorities, a license for this facility was granted by Royal Decree in March 2014. One of the licensing conditions of IPM is that although the facility can be built, the production of monoliths itself can only start after granting the license for the surface disposal. The current planning is to have the facility operational in 2018.

(2) The surface disposal facility

In the years following the governmental decision of June 23rd 2006, NIRAS/ONDRAF carried out detailed design and safety assessment studies. Regular dialogue was installed between ONDRAF/NIRAS and FANC concerning the ongoing studies. In the meantime, the FANC developed guidance for ONDRAF/NIRAS on surface waste disposal in general and on specific issues, amongst others human intrusion, external events, biosphere, hydrogeology and dose and risk constraints applicable to the facility in operation and during post-closure. The pre-licensing dialogue and publication of the last guidance documents was ongoing till 2012.

In 2011, the Belgian Federal Public Service of Economy and Energy, following approval by the Minister, of Energy requested the NEA to organize a peer review of key aspects of the safety case being developed by ONDRAF/NIRAS, for the license application of the surface disposal facility. The NEA Secretariat assembled an International Review Team (IRT) comprising seven international specialists, including two from the NEA.

The IRT, who performed its work mostly during the first half of 2012, did conclude that ONDRAF/NIRAS' long-term safety strategy and safety assessment methodology are, in the main, credible and robust. The disposal program implements international recommendations and best practices, takes into account the conditions stipulated by the Federal Government and the local communities, and is technically mature.

On the 31st of January 2013, ONDRAF/NIRAS submitted to the FANC its license application for the surface disposal facility. When ONDRAF/NIRAS submitted the licence application the proposal for a Royal Decree on the licensing system for disposal facilities was not yet enacted; consequently, the licence application will follow the general licensing procedure for nuclear Class I facilities as defined in the General Rules on Radiation Protection (the GRR-2001). The FANC, together with its technical subsidiary Bel V, conducted the review of the safety analysis report and its supporting documentation in view of verifying its content and its completeness and doing so by using amongst others the evaluation bases (See section VIII.E, article 15).

In June 2013, a set of main questions was addressed to NIRAS/ONDRAF, followed by more detailed questions by the end of the year. The main questions concern aspects of the design and construction of the facility, the safety principles of optimization and defence in depth, the waste characteristics, the safety assessment and the proposed waste acceptance criteria and limits for the content of long lived radionuclides. During the first half of 2014, additional, more specific questions were sent to ONDRAF/NIRAS.

When all questions will be answered and the safety evaluation report completed, the report will be, in accordance with the licensing system stipulated in the GRR-2001, submitted to the 'Scientific Council' of the FANC, that will give a preliminary advise on the license application, based on the summary of the safety evaluation report and on the review and assessment report that will be provided by FANC and Bel V. If the preliminary advice is favourable, the license application file will be sent for advice and for public enquiry to the hosting community and its surrounding communities, and afterwards also to the council of the hosting province. At the same time, in the framework of article 37 of the Euratom treaty, a report will also be sent to the European Council for advice. When in possession of all these advises, the Scientific Council will meet a second time, in view of elaborating a final advise and if positive, elaborating preliminary licensing conditions. The advice of the Scientific Council is binding and in case favourable, a Royal Decree will grant the license and stipulate the final conditions attached to the license.

The licensing procedure stipulated in the GRR-2001 does not impose a timeframe within which the license should be granted or dismissed. The process takes in general several years and a license for the surface disposal facility is not expected to be granted before 2016.

XI.A.1.d) *Challenge nr 4: Completion of various regulatory framework improvement programmes now in progress*

The "Royal Decree on the Safety Requirements for Nuclear Installations" (referenced SRNI-2011 in this report) has been signed by the King on the 30th of November 2011 and has been published in the official journal of the 21st of December, 2012. This Royal Decree incorporates all the reference levels of the WENRA's Reactor Harmonization Working Group (RHWG) into the Belgian regulations. This Royal Decree has a wider scope than the NPPs, as some reference levels were found applicable to other nuclear facilities, including waste facilities such as waste storage facilities and waste treatment facilities (for example, the obligation to proceed to periodic safety reviews, to have a Safety Analysis Report, to have an integrated Management system, …).

Additional proposals for supplementing this Royal Decree have been prepared by the FANC and are at various stages of development/approval:

- The proposal for a Royal Decree on the safety of disposal facilities : This proposal is finished and is currently under processing at government level
- The proposal for a Royal Decree on the safety of decommissioning of nuclear facilities : This proposal is drafted, stakeholders have been consulted and this proposal has been sent for advice from official advisory bodies (the Superior Health Council, the Superior Council for Prevention and Protection at Work and the European Commission). This phase, in the regulation development process, is the last phase before the submission to the Government.
- The proposal for a Royal Decree on the safety of storage facilities is currently at the same stage as the preceding decree.

The proposed law for remediation/intervention of contaminated sites is still under processing at government level.

The proposal for a Royal Decree on the licensing system for disposal facilities is still under processing at government level.

In the coming years, the European Directive 2013/59/EURATOM (Basic Safety Standards) will have to be incorporated in the Belgian Regulatory framework.

XI.A.1.e) *Challenge nr 5: Completion of the 'Stress tests' for non-NPPs (fuel cycle and waste management facilities)*

As member of the European Union, Belgium participated in the "Stress Tests" programme initiated by the European Commission after the Fukushima - Daiichi accident.

Needs for safety improvements were first identified by the licensee as a result of the stress tests self-assessment, which led to a series of proposals presented in the licensee's final reports. The regulatory body reviewed the licensee's final reports and acknowledged the set of propositions formulated by the licensee. However, the regulatory body identified additional improvement opportunities that were detailed in the national report. The licensee's action plans were updated accordingly.

The licensee is responsible of the full implementation of the actions. Bel V is responsible for overseeing the progress of the action plan of the licensee, on behalf of the FANC. This responsibility involves close monitoring of the implementation's process of the action plan of the licensee and field checks to confirm actions implemented in the facility. Actions that should be closed are proposed by the licensee, with reference to any relevant document or evidence showing that the action was properly implemented. Once the checks performed, Bel V may ratify that these actions are indeed considered closed and the licensee action plan is then be updated.

Transparency is a key value of the regulatory body. As such, the different stress test reports and the post stress test national action plan are released in full to the public and media through the FANC website (http://www.fanc.fgov.be). In 2014 a progress report on the implementation of the stress test actions was published by the FANC.

(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 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),

Overall, the indicative deadlines proposed by the licensee for the implementation of the corresponding actions were in line with the safety importance of the issues. They also took account of the constraints related to the complexity of the actions, the dependence on internal or external resources for supply and implementation on the sites, and the potential interactions with other projects (especially the "LTO" project aimed at the earliest units).

A number of short-term actions were already implemented by the end of year 2013, and the majority of the remaining actions were to be implemented during 2014 even if some actions will take longer to be finalized.

The proposed actions for the spent fuel storage and waste management facilities were pursuing the following main objectives:

- Extreme natural events: enhanced protection against external hazards (earthquake, flooding, extreme weather conditions). The spent fuel pools of Doel and Tihange are well protected against these triggering events. However, in case of flooding, the accesses to the measurement of the pool level have been facilitated at Doel and Tihange.
- Loss of electrical power and loss of ultimate heat sink: several actions were planned to enhance the protection against complete station black out (CSBO) in Doel and Tihange. CSBO consists in loss of off-site power supply and first-level and second-level power supplies. In this framework, additional level measurements in the spent fuel pools, independent of the conventional power supplies, have been implemented in Doel and Tihange to provide a level lecture out of the pool building and in the control room.
- In addition, some procedures are under implementation for the spent fuel pool management in case of loss of the heat sink at Doel and Tihange. Finally, in the framework of the Long-Term Operation of Tihange 1, the installation of an electrical back-up for the cooling pumps for the spent fuel pools is planned.
- Severe accident management: an evaluation of the H2 risks due to hydrogen accumulation in the spent fuel buildings at Doel has indicated that the buildings are well protected.

Upon demand of the Belgian Federal Government, man-made events and terrorist attacks were also included as triggering events in the stress test program for the nuclear power plants. In this framework, additional water supplies for replenishing the spent fuel pools in case of damage due to an aircraft crash have been implemented in Doel 3 and 4 and are ongoing in Tihange 1.

(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.

For what concerns the "Institut des Radio-éléments" (IRE) in Fleurus and Belgoprocess in Dessel, both licensees have to implement, with external emergency services, a strategy to successfully fight large fires (forest fires, kerosene fires,...) and also to cope with events related to toxic and explosive gases and shock wave.

The consolidated action plan of IRE includes a set of 68 actions. Since the approval of the plan in July 2013, 15% of the actions have been closed or the results of the actions are in evaluation by the regulatory body.

In this framework, the IRE is currently studying measures that could reduce the releases in case of a total loss of containment (static and dynamic) and the arrangements for their implementation. Several actions are also related to the possible flooding of the basement (due to extreme weather or level rise of the groundwater) where liquid wastes are stored. Most of these actions are closed already. The seismic resistance of important electrical equipment has also been evaluated.

The consolidated action plan of Belgoprocess includes a set of 63 actions. Since the approval of the plan in July 2013, 16% of the actions have been closed or are in evaluation by the regulatory body.

The regulatory body will continue to carefully follow the progress of the stress test actions implemented by the licensees (NPPs and other nuclear facilities) in the future years. The general organization between the licensee and the regulatory body appears to be successful and will be continued until the finalization of the stress test action plans

The table below summarizes the action plan for the IRE, Belgoprocess facilities as well as for the waste treatment installations at Doel site (WAB)), mentioning the target completion period:

External Hazards: Earthquake

Seismic resistance	Belgoprocess	Evaluate resistance of several buildings against earthquakes	2014
	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 Or 2014
	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.	2014
Secondary effect of earthquake – Increase autonomy	IRE	Adapt resources and procedures in order to take into account post-seismic actions (walk-down, …)	2014
		Evaluate the seismic resistance of the lead windows.	2014
		Evaluate the seismic resistance of important electrical equipment	Under review
	Belgoprocess	Conducting a review of the fire-risk after an earthquake, with identification of additional trouble spots and definition of any additional actions.	2014
		Limit the filling the hot waste tanks in the	Modified

		124X building to a level of 4.7 m.	

External Hazards: Extreme weather conditions

Snow load	WAB Doel	Protection of a number of non-bunkered buildings against snow load	
Heavy Rain	IRE	Replacing a portion of the drainage network	2014
		Take into account a return period of 1000 years on the capacity of the drainage system and drain water.	2014
		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. In December 2013, over hundred waste drums still had to be evacuated from the building 270M.	Mi-2014
		Construction of a new storage building for non-conditioned waste on site 1.	2018

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.	2014

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 a new global procedure "installations safe condition verification" in case of a station black-out or a loss of ultimate heat sink.	2014

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 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.	2014

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.	Mid-2014

XI.A.2. **Progress on planned measures to improve safety identified for Belgium at the 4th review meeting**

XI.A.2.a) ***Planned measure nr 1: The implementation of the safety improvement action plans set up by the licensees as agreed by FANC***

On request of the Board of Directors of Belgoprocess, the FANC and Bel V organised an audit at Belgoprocess in Dessel in order to evaluate the management of safety. The audit took place from 18 to 22 October 2010 and was supported by external experts.

The scope of the audit focussed on the processes related to the management of safety at the two sites of Belgoprocess. The following areas were addressed during this audit:

- Management and organization of safety
- Management of radioactive discharges (liquid and gaseous)
- Management and control of the waste received
- Dynamic risk management system
- Fire prevention – and fighting
- Management of abnormal events and incidents
- Safety culture

The experts of the audit team worked according to an audit methodology derived from international audit practices. The references used were national regulations and the IAEA standards and guides.

Each area was investigated by two assessors, including one assessor external to FANC. It was verified that the necessary processes and procedures have been documented, implemented, and applied. This assessment was performed by means of interviews with the management and staff of Belgoprocess, by the study of available documentation and by observations of the activities on the field through visits of the installations

The audit revealed positive points, but for some areas additional efforts were needed for improvement.

The final results of the safety audit are presented in a comprehensive report that has been published on the FANC website.

Belgoprocess developed an action plan based on the outcomes of the audit team in which all necessary improvements are addressed.

From the defined action plan about 90 % of the deliverables were already carried out and were positively evaluated by the FANC and Bel V during their follow up programme. Major efforts will be done to finalise the total action plan by the end of 2014.

XI.A.2.b) ***Planned measure nr 2: Improvement of the regulatory framework related to RW/SF management and decommissioning : transposition of WENRA- WGWD RLs into the Belgian regulations***

See challenge nr 4 above.

XI.A.2.c) *Planned measure nr 3: Bel V R& D programme in safety assessment of disposal facilities and decommissioning*

(1) Bel V - R&D Programme on Decommissioning

The main aspects that were identified have been further developed, for instance, information from countries that have a relevant experience and that can be used in the Belgian context: Licensing process, transition phase, preparation and breaking down the whole project in decommissioning phases. Some issues are of particular interest as: Fuel storage, waste clearance level, radiological survey, safety and radiation protection, industrial safety, etc. As an output, a document has been produced synthetizing the information that could be needed by Bel V in its role of regulatory body for the decommissioning of nuclear plants.

The information gathered will help Bel V to be prepared to fulfil its role and responsibilities in the decommissioning process of the Doel 1 and Doel 2 NPPs.

In this regard Bel V has and is still taking part at IAEA projects such as DeSa (Demonstration of Safety for Decommissioning), FaSa (Use of Safety Assessment Results) and now DRiMa (Decommissioning Risk Management). For each project, Bel V is represented by two of its members.

(2) FANC & Bel V's R& D programme in safety assessment of disposal facilities

By Law of 14 April 1994 on the Protection of the Public and the Environment against Radiation, FANC is responsible for maintaining scientific and technical documentation in the area of nuclear safety and radiological protection. It is also responsible for fostering and coordinating R&D and establishing relationships with national and international research organisations.

FANC and Bel V, constituting together the Belgian Regulatory Body, have thus both an important effort in R&D. By means of periodic meetings, FANC and Bel V keep each other mutually informed about on-going and planned R&D activities and participations.

The R&D activities of Bel V are primarily related to the development and the maintenance of expertise in nuclear safety and to a lesser extent in radiation protection (the latter being covered extensively by FANC). Bel V's R&D activities are fully integrated in its Quality Management System. Within that framework, Bel V issues about every 5 years a R&D Strategy, a yearly R&D Program (defining Task Leaders and budgets) and a yearly R&D Report. The overall R&D effort foreseen by Bel V has been recently significantly increased to about 10% of the total available time for the technical staff.

Within the framework of radioactive waste disposal safety, the following three main types of R&D actions are undertaken by the regulatory body (FANC and Bel V). The choice of the action type is dictated by the importance and priority of the issue and by the availability of resources and competences within the regulatory body (FANC and Bel V).

Literature survey, participation to conferences, international working groups and international projects.

Such R&D actions are undertaken to cover fundamental issues addressed by the international community. For instance, the regulatory body has participated or participates in the following IAEA working groups: PRISM, PRISM II, GEOSAF II, DISPONET, HIDRA, MODARI). Bel V has also participated in the following European projects: 6th FP EC MICADO and 6th FP EC PAMINA. Recently, the regulatory body has participated to the 7th FP EC SITEX project (ended in 2013) bringing together organisations representing technical safety organisations (TSOs) and Nuclear Safety Authorities (NSAs) having an expertise function. This project has developed the terms of references of a sustainable network capable of harmonizing and coordinating the European approaches of the expertise function of TSOs and NRAs in the field of assessing the safety of geological repositories for radioactive waste (see deliverables D6.1 and D6.2 of the EC SITEX project). One of the objectives of this network is to develop a common Strategic Research Agenda (SRA). The SITEX project has paved the way to this SRA by identifying common R&D orientations and mapping the resources available in the future network for performing R&D (see deliverable D3.1, D3.2 and D3.3 of the EC SITEX project). In the future, the regulatory body will continue to contribute to the development of the SRA (FANC and Bel V participate in the submission of a SITEX II project in the framework of the topic NFRP-4 of the EC call H2020).

Sub-contract to other organisations (universities and research centres).

These R&D actions are undertaken to cover specific key issues for which the regulatory body (FANC and Bel V) does not have the necessary resources. For instance, in collaboration with among others IRSN, CEA, Ecole des Mines de Paris, Université de Montpelier and Université Libre de Bruxelles, Bel V supports and follows 3 PhDs aiming at improving the understanding of several key phenomena affecting the long term safety of radioactive waste disposal facilities (e.g. characterisation of the radionuclide migration at interfaces between cement and clay materials, the influence of porosity changes in clay and cement materials on the migration of radionuclides). Even if these PhDs are performed outside of Bel V, Bel V is regularly informed about the PhD progresses and takes part to the important decisions on the scientific orientation of these PhDs.

R&D within regulatory body (FANC and Bel V) or in collaboration with other organisations (Framework Programmes of EC,…).

Bel V conducts independent modelling investigations in order to assess the safety assessments provided by operators for radioactive waste repositories. The main objectives of these independent modelling activities are to improve the Bel V understanding of the modelling approach followed by the operator (e.g. the conceptual model, the main hypotheses, the calculation code), to identify potential difficulties/weaknesses, to verify the appropriateness of input parameters, to challenge safety margins by performing sensitivity and uncertainty analyses and to test model capabilities (e.g. by using multiple models or codes). The following topics are among other investigated within Bel V:

Topic 1: Radionuclide migration modelling

Bel V develops modelling capabilities in independently verifying assumptions made by operators in models devoted to the migration of radionuclides into radioactive waste disposal systems (near-surface and geological repositories). The advective and diffusive transport of radionuclides in the near- and far-fields of radioactive waste repositories is modelled by Bel V under saturated and unsaturated conditions, with one or two-dimensional models. These models are developed by Bel V with commercially available software packages (e.g. HYDRUS 2D STANDARD and FEFLOW), as well as in collaboration with other TSOs (e.g. with the MELODIE code developed by the IRSN specifically for the regulatory review of safety assessments for radioactive waste disposal facilities).

Topic 2: Geochemistry and reactive transport modelling

Bel V progressively develops modelling capabilities in verifying assumptions made by operators in models devoted to the geochemical evolution of confinement barriers of a waste disposal system. Bel V uses the PHREEQC and CHESS softwares that allow performing speciation calculations, involving chemical reactions between chemical species in minerals, aqueous and solid solutions, as well as in gaseous mixtures. Moreover, Bel V progressively develops capabilities in modelling reactive transport phenomena using chemical-coupled transport codes. In that framework, Bel V has become in 2013 a member of the "Pôle Geochimie Transport" managed by ARMINES (R&D center linked to the Ecole des Mines de Paris) and aiming at supporting the development of the reactive transport HYTEC code through creating scientific exchanges between HYTEC users.

Topic 3: Radiation protection

Bel V has developed modelling capabilities in verifying assumptions made by operators in models devoted to radiation protection. Bel V particularly uses the MCNPX software to evaluate the radiation protection aspects of specific situations.

XI.A.2.d) *Planned measure nr 4: Extension of waste acceptance system to disposal*

ONDRAF/NIRAS as the national waste management agency is the only competent entity in Belgium for the disposal of all radioactive waste. ONDRAF/NIRAS takes in charge radioactive waste, either in unconditioned form or after waste processing in conditioned form, through its waste acceptance system. Central tools of this system are the general rules for waste acceptance approved by the competent authority, the waste acceptance criteria issued by ONDRAF/NIRAS and based on the general rules, and the qualification of waste processing and storage facilities (including waste characterisation methods and equipment).

All waste presented to ONDRAF/NIRAS for acceptance has to comply with the acceptance criteria before a decision on actual acceptance of the waste can be taken. In the absence of operational disposal facilities for the long-term management of the waste the waste acceptance criteria are based on the concept of a reference disposal solution (generic surface disposal for the category A waste, and generic deep disposal in clay for the category B&C waste).

In order to extend the waste acceptance system to an operational surface repository, ONDRAF/NIRAS and the FANC have issued a common position document on the main principles, responsibilities and procedures for a complete waste management system (i.e. including the waste acceptance step for disposal). This common position integrates the role and responsibilities of ONDRAF/NIRAS as waste management agency and as (future) operator of the surface repository and the role and responsibility of the FANC as safety authority.

With the Safety Case for the licence application ONDRAF/NIRAS (31 January 2013) has proposed to the FANC the radiological waste acceptance criteria for the surface disposal of category A waste (activity disposal limits for the critical radionuclides).

The FANC is currently conducting a control and verification of ONDRAF/NIRAS operational waste acceptance system, in view of formulating its opinion on the operational system and, possibly, advice and recommendations for improving the existing system and for extending the system to an operational surface disposal facility. This control and verification process will run in several steps during the period 2014-2015

XI.A.2.e) *Planned measure nr 5: Implementation of the Strategic Safety Plan by Belgoprocess according to the agreed planning of actions for the sites 1 and 2*

See planned measure nr 1 above.

XI.A.2.f) *Planned measure nr6: Development and step-wise implementation of the Integrated Management System (part nuclear operator disposal and waste management system)*

The Royal Decree of 30 November 2011 on safety requirements for nuclear facilities (the SRNI-2011), imposes an Integrated Management System (IMS) for all Class I nuclear operators. Therefore ONDRAF/NIRAS needs to implement an IMS before starting the operational phase of the surface disposal facility for category A waste in Dessel. ONDRAF/NIRAS has made the strategic decision to implement one IMS for both the waste management activities as a waste management agency and the activities as nuclear operator (see the figure below).

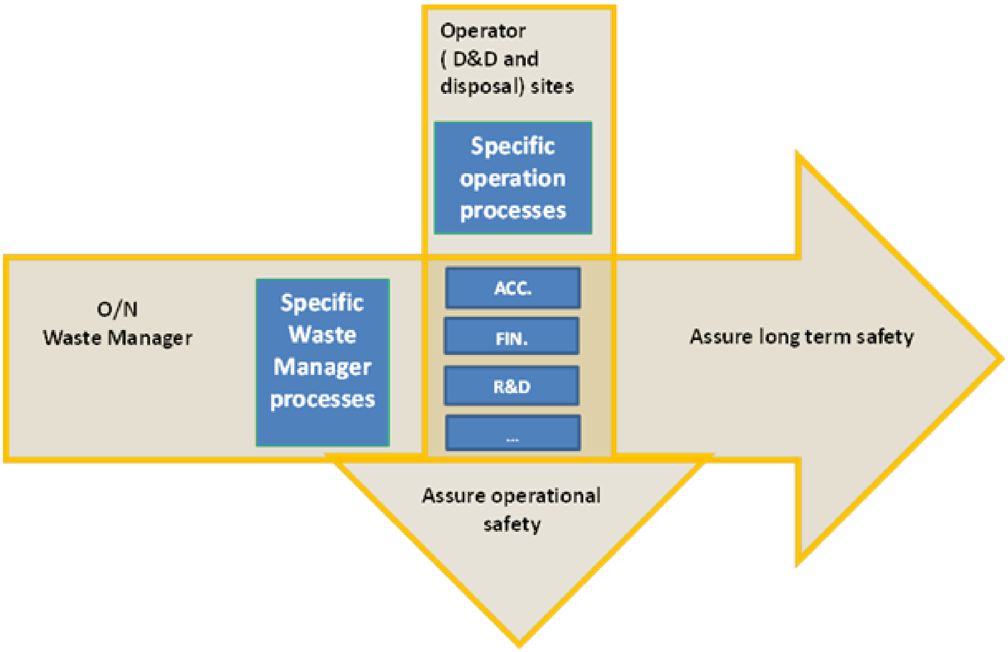

Figure 14: ONDRAF/NIRAS IMS

On this figure, D&D refers to the Dismantling & decommissioning activities of ONDRAF/NIRAS as nuclear operator at the Fleurus site. ACC refers to the waste acceptance system, FIN to al financial aspects of radioactive waste management under the responsibility of ONDRAF/NIRAS.

ONDRAF/NIRAS started the implementation with respect to the existing regulation but took also into account the IAEA recommendations.

The main depositions and requirements of the Royal Decree (and therefore also for ONDRAF/NIRAS) are:

- Safety is a priority;
- There must be a continuous improvement of the IMS and all the activities;
- IMS covers aspects related to organization, responsibilities, resources and quality assurance;
- IMS is implemented according to a graded approach.

Based on the Royal Decree and the IAEA recommendations ONDRAF/NIRAS has reviewed the policy statement. The goal is sustainable management of radioactive waste, taken into account the following four dimensions: safety and environment, finance and economy, science and technique and society and ethics.

To start ONDRAF/NIRAS identified the gaps between the existing standard ISO 9001:2008 and the requirements for the IMS.

The actions that already have been taken are:

- The identification of the processes;
- The description of the most urgent, important and critical processes (according the graded approach);
- A global (dynamic) planning of the implementation and the follow-up and review after the implementation, based on the graded approach;
- A description of the structure of the organization, the methodology for implementing an IMS and the description of the IMS itself in a manual;
- A gap-analysis concerning safety culture and operational safety including the making of an action plan;
- A gap-analysis concerning human resources, knowledge management, document management, communication and resources including the making of an action plan;
- Vision statement and action plan for implementing a structured risk management system.

Actions that need to be taken in the (near) future are:

- Implementing the conclusions of the different gap-analysis;
- Finalizing the description of the processes;
- Implementing a structured risk management system;
- Continuous evaluation of the effectiveness and the functionality;
- Setting values concerning safety culture.

All the individuals are involved in the implementation and on various moments there is a communication within the organization to make the individuals acquainted with the evolution of the implementation. Aim is to create a collective responsibility and engagement.

The objective is to have a fully implemented management system at the end of 2015.

XI.A.2.g) ***Planned measure nr 7: Integration in the ONDRAF/NIRAS programme of all tasks and actions imposed by the Federal Government which result from a governmental decision-in-principle regarding long term management of the category B&C waste***

See challenge nr 2 above.

XI.B. Peer review missions

XI.B.1. Status of peer review missions in Belgium

Peer reviews are regularly organized in Belgium. A list of recent or planned mission is given below:

- At the request of the Belgian Government, an OSART team visited the site of Tihange Nuclear Power Plant in May 2007, focusing on unit 1. The follow-up took place in February 2009.

- During the first three weeks of March 2010, an OSART-team from the International Atomic Energy Agency (IAEA) carried out an in-depth audit at units 1 and 2 of the Doel nuclear power plant. In March 2012, an IAEA team carried out a follow-up mission to the Doel NPP to examine how the operator has taken into account the recommendations and suggestions made in the 2010 OSART mission.
- In 2011, the Belgian Federal Public Service of Economy and Energy, following approval by the Minister of Energy, requested the NEA to organize a peer review of key aspects of the safety case being developed by ONDRAF/NIRAS, for the license application to construct and operate the surface disposal facility. The review took place during the first half of 2012.
- According to the European Directive 2009/71/Euratom, self-assessments and IRRS missions are mandatory every 10 years in European Member states. The Belgian Regulatory Body performed a self-assessment between June 2011 and September 2012, that led to an initial action plan comprising some 60 actions. The IRRS mission itself took place in December 2013. This mission was a "full scope" IRRS, covering all regulatory activities of the FANC and Bel V (see next paragraph).
- In the frame of the decision for life extension (LTO) of Tihange 1, The FANC requested the IAEA to perform a SALTO (Safety Aspects of Long Term Operation) for this reactor in January 2015.
- In November 2014, Belgium will host an IAEA IPPAS (International Physical Protection Advisory Service) mission. The associated preparatory meeting took place in March 2014.

Belgian experts also participate regularly in IRRS and in other peer review missions such as OSART missions.

XI.B.2. **IRRS mission in Belgium**

The Belgian Regulatory Body received an IRRS mission from December 1st until December 13th 2013. This mission was a full scope mission and covered all regulatory activities performed by the FANC and Bel V. Two reviewers were in charge of the module related to waste facilities and decommissioning activities.

The relations between the FANC and ONDRAF/NIRAS were also investigated. ONDRAF/NIRAS participated in two interviews with the reviewers and the Bel V's inspections practices were observed at the Belgoprocess facility.

The final report has been released on April 10th, 2014. It has been send to the supervising minister of the FANC and to the European Commission. The report has been published on the FANC web site and is available for the public at the following address:
http://www.fanc.fgov.be/CWS/GED/pop_View.aspx?LG=1&ID=3594

The reviewers team reported several findings in relation to waste facilities and decommissioning activities.

The FANC and Bel V are currently in the definition phase of the action plan to address these recommendations and suggestions.

The FANC and Bel V intend to receive the IRRS follow-up mission in 2016.

XI.C. Planned activities to improve safety

XI.C.1. **Planned activities of the Regulatory Body**

XI.C.1.a) ***Pursuing and finalizing current on-going activities***

As mentioned in the previous section, several activities are still on-going and will continue during the next three years period. They namely relate to :

- The implementation of the stress test action plan
- The completion of various regulatory framework improvement programmes, in particular for what concerns the WENRA reference levels and the regulation associated to the disposal facilities
- The completion of the safety assessment and licensing of the category A waste disposal facility
- Extension of waste acceptance system to disposal (planned measure nr 4)

XI.C.1.b) *IRRS action plan*

As a result of the full-scope IRRS which took place in Belgium in December 2013, the IRRS team issued 30 recommendations and 24 suggestions. Several of them (+/- 1/3) are addressed to the government, in order to improve the legal framework. The FANC and Bel V are currently preparing an action plan to address these recommendations and suggestions. The on-time completion of this action plan will represent a major challenge for the regulatory body.

XI.C.1.c) *Challenges related to the nuclear energy phase-out*

Decommissioning activities are increasing in Belgium. As mentioned above, two NPPs (Doel 1 and Doel 2) will shut down in 2015. The licensee foresees immediate dismantling.

The regulatory body will face several challenges, associated with the following points of attention :

- Regulatory framework and FANC related guidance
- Building knowledge and accumulating experience in dismantling activities
- Increase of staff for regulatory supervision of decommissioning, with associated training programmes
- Licencing (and safety assessment of) large dismantling projects and associated waste treatment and storage facilities (WMF)
- Clearance of material from dismantling
- Radiological characterisation and site release methodologies

XI.C.1.d) *Inspection campaign targeted on waste management*

The 2014 inspection program developed by the FANC includes an inspection campaign on the management of radioactive waste in Class I facilities (Nuclear Facilities), and in other lower-risk facilities.

It was decided to carry out this inspection campaign following a finding by the FANC and Bel V of difficulties with many operators in the management of radioactive waste and sometimes an accumulation of these on different nuclear sites.

ONDRAF/NIRAS, the Belgian waste management agency, participates in the inspection campaign as part of its legal mission program in this field.

The purpose of this inspection campaign is mainly to verify on site the performance of the waste management process set up by the operator. The regulatory body will verify the presence of a detailed inventory of radioactive waste, the waste storage conditions and also will be informed about the taking over and the processing of waste streams by ONDRAF/NIRAS. It is expected that this campaign will enable possible improvement of the management system of radioactive waste in Belgium, and in particular make coherent the missions to be performed by operators, by the FANC and by ONDRAF/NIRAS for the management of radioactive waste.

In 2014, FBFC International, the SCK•CEN and the Doel and Tihange nuclear power plants were inspected, while some lower risk facilities for medical radioisotopes production and cyclotrons already had received visits by an inspectors team.

XI.C.1.e) *FANC-BelV - R&D programme for geological disposal*

FANC and Bel V will together define and deploy a Strategic Research Agenda related to geological disposal. The aim is to structure the regulatory body R&D programme taking into account the milestones planned for the high-level and/or long-lived radioactive waste. The objective of the R&D programme will be to develop and maintain the expertise and the computing capacity necessary to realise independent reviews of Safety Cases.

XI.C.2. **Specific actions, on-going or planned by ONDRAF/NIRAS**

XI.C.2.a) *Non-conformities on conditioned NPP waste*

The major non-conformities on conditioned NPP waste, that were discovered during routine inspections in the course of 2013 and that are most likely due to alkali silica reactions in the concrete matrix, will be subject to a series of actions in order to:

- Continue to ensure operational safety of the storage facilities;
- Define the possible corrective measures to be taken for ensuring the safety of the long term management of these non-conform waste drums;
- Analyse the impact of these non-conformities on the waste acceptance system as a whole and propose recommendations for improvement;
- Analyse the impact on existing and future treatment and conditioning processes using concrete and/of cement,
- Assess all financial aspects.

ONDRAF/NIRAS will conduct these actions in close collaboration and/or interaction with all other parties involved : Belgoprocess, Electrabel and international experts. The Federal Agency for Nuclear Control and Bel V ensure follow-up.

XI.C.2.b) *Management of the short-lived waste*

For the long-term management of the short-lived waste (SL-LILW or category A waste) ONDRAF/NIRAS has submitted on January 31, 2013 the licence application file (including the safety assessment and the environmental impact assessment) for a near surface repository in Dessel. ONDRAF/NIRAS will provide the licensing authority FANC with the additional information that FANC deems necessary during the licensing procedure.

ONDRAF/NIRAS subsidiary company Belgoprocess has obtained the construction and operation licence for the post-conditioning facility for the production of the monoliths (emplacement of conditioned category A waste and, possibly, non-conditioned waste, e.g. decommissioning waste, in a concrete box for surface disposal). Belgoprocess will prepare the construction phase when the licensing procedure for the surface disposal facility has sufficiently advanced. Once this post-conditioning facility operational, the stored category A waste drums in the storage buildings 150 and 151 on the Belgoprocess site that are in conformity with the waste acceptance criteria for surface disposal, can be post-conditioned for surface disposal and, after acceptance for disposal, transfer to the repository can start.

XI.C.2.c) *EU Directive 2011/70/Euratom*

With the adopted Waste Plan, together with its accompanying Strategic Environmental Assessment (SEA), submitted by ONDRAF/NIRAS to the Federal Government in September 2011, the Government does have all the necessary elements to take a decision 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). Such policy decision is needed by ONDRAF/NIRAS to complete its management system by having a final destination for all the radioactive waste it has to take in charge. It is also needed to answer the requirements set up by the law of 3 June 2014 that translates in Belgian legislation the EU Directive 2011/70/Euratom.

With respect to the obligations imposed on EU member states by the EU Directive 2011/70/Euratom (and by its transposition in the Belgian legal framework), ONDRAF/NIRAS will contribute to the drafting of the national programme and the national report, to be issued by 23rd August 2015 at the latest.

ONDRAF/NIRAS will issue by the end of 2014 the "Reference Framework for the long-term management of all radioactive waste in Belgium", as a supporting document to the above mentioned national programme and national report. This document

- identifies the main waste categories to be managed or to be potentially managed by ONDRAF/NIRAS,
- describes the disposal options for specific waste categories already decided by national policy decisions and the waste categories for which national policy decisions still have to be taken,

- identifies the dedicated regulatory elements which need to be complemented in the national framework for the long-term management of the various waste categories.

Among the issues raised in the Waste Plan and in the Reference Framework, the one related to the long-term management of large amounts of (mostly (very) low-level) radium-bearing waste, mainly at the site of Umicore in Olen (waste arising from historical production of radium) will deserve particular attention the next years. Furthermore, potential large volumes of (very) low-level radium-bearing waste may also be produced during remediation and/or dismantling of (TE)NORM industries. For the definition of a strategy for long-term management of this radium-bearing waste in Belgium ONDRAF/NIRAS will develop one or several Waste Plan(s) with accompanying Strategic Environmental Assessment and public consultations. These initiatives should pave the way for policy decision regarding the long-term management of such waste. The timing and scope of this/these waste plan(s) will be presented in the national programme, issued by August 2015.

XI.C.2.d) *Improvement of the legal system for the financial coverage of nuclear liabilities and fourth inventory*

Based on the recommendations formulated in its second inventory report of nuclear liabilities (December 2007), ONDRAF/NIRAS was given the task by its supervising Minister to analyse the financial coverage of the nuclear liabilities, in order to be able to fully apply the polluter pays principle. A complete analysis of the coverage of costs for decommissioning of the NPPs and the management of the spent fuel has first been made, in terms of sufficiency and availability of financial means to cover the liabilities. A second analysis, focussing on all the other nuclear facilities, is also done. Both analyses will be taken into account by a work group directed by the Federal Ministry for Economy and with the active participation of ONDRAF/NIRAS, in view of the improvement by 2016 of the legal system covering these aspects.

ONDRAF/NIRAS will establish the fourth report on the inventory of nuclear liabilities by the end of 2017, and issue it to its supervising Minister(s).

XI.C.2.e) *ONDRAF/NIRAS' IMS development*

ONDRAF/NIRAS became a nuclear operator when taking over responsibilities of the ex-Best Medical Belgium site for all decommissioning activities. ONDRAF/NIRAS has taken the required steps at the organisational level to integrate all required functions and processes of a nuclear operator (e.g. health physics department). With the future planned licensing and construction of the surface disposal facility for category A waste, ONDRAF/NIRAS will also become license holder and operator of a disposal facility. For preparing this step, ONDRAF/NIRAS is developing an Integrated Management System (IMS) for all its activities as a radioactive waste management agency and as an operator of a disposal facility. This IMS will also take account of the interdependencies of all radioactive waste management steps (radioactive waste production, transport, processing, storage and disposal). The timing of the development and implementation of the IMS will be in line with the timing of the licensing process, and the processes of construction and commissioning of the disposal facility.

XI.C.2.f) *Decommissioning of "Best Medical Belgium SA" (ONSF)*

The company "Best Medical Belgium SA" (BMB) located at Fleurus (Belgium) produced radioisotopes for medical applications and industrial radiography. It was declared bankrupt in May 2012. The facility includes two cyclotrons and many hot cells and labs.

On August 8th, 2012, these installations have been entrusted to ONDRAF/NIRAS (see section IV.B.5 page 27).

On September 28th, 2012, ONDRAF/NIRAS submitted a license application for operating the facility to the Federal Agency for Nuclear Control (FANC). The license, granted on October 8, 2012 covers all the necessary activities for:

- the maintenance of the safety and security of the facilities;
- the disposal of waste still stored on site, including radioactive sources and materials;
- the clearance of materials and buildings.

This licence does not cover the dismantling of the facility: ONDRAF/NIRAS will prepare the decommissioning plan, for which a specific license will be required (dismantling license, in accordance with Article 17.2 of the Royal Decree of July 20th, 2001, which sets out general regulations for the protection of the public, workers and the environment against the hazards of ionizing radiation – GRR-2001).

Together with that, ONDRAF/NIRAS will take the necessary steps to ensure a proper financing of all costs related to the operation of the facilities and cleaning & decommissioning activities, including the radioactive waste management.

XII. Section L: Appendices

XII.A. APPENDIX 1: Description of the spent fuel storage facilities at the nuclear sites of Doel and Tihange

XII.A.1. Introduction

The aim of this appendix is to provide both a general overview and a list of the principal characteristics of the arrangements for the interim storage of spent fuel originating from the nuclear energy production units in Belgium at the sites of Doel and Tihange.

The technically-proven methods for the interim storage of spent fuel are: underwater storage in racks in the storage pools at the production units (Tihange and Doel), underwater storage in racks in the storage pools of the DE building (Tihange), and dry storage in shielded containers (Doel).

XII.A.2. Interim storage of spent fuel

At each site, the spent fuel assemblies removed from the reactors are fed for the purpose of radioactive cooling into the deactivation ponds located at each of the production units.

Following the decision of the Belgian Parliament in December 1993 on the conclusion and implementation of any new reprocessing, a significant increase in interim storage capacity for spent fuel assemblies became necessary. A storage building was therefore constructed at each site. These buildings have been designed to receive and store the spent fuel elements from the units, either in underwater storage (Tihange) or in dry storage in shielded containers (Doel).

XII.A.3. The sites

The nuclear power plants in Belgium are located on two sites, one in the south of the country (Tihange) and the other in the northern part of Belgium (Doel).

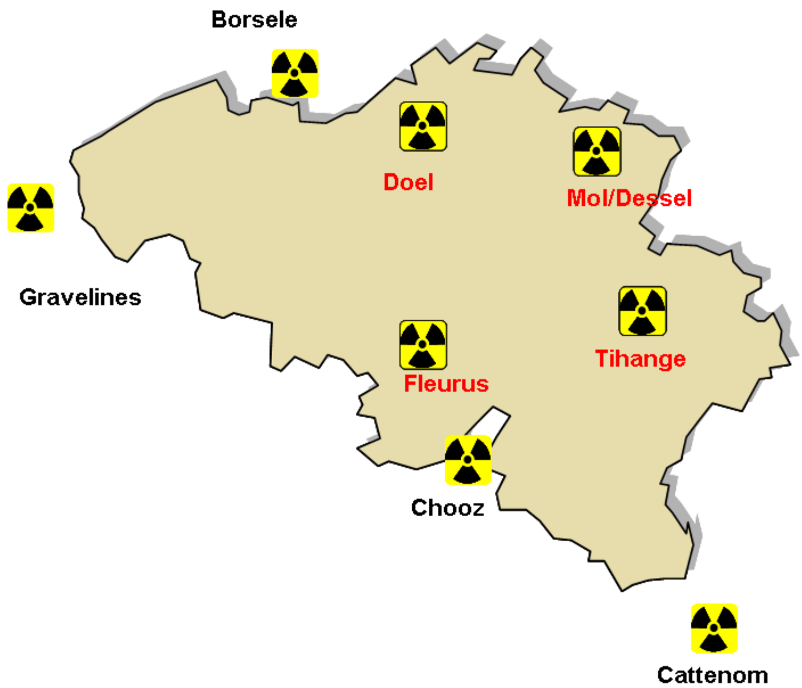

Figure 15: Belgian Nuclear sites

XII.A.3.a) ***The Doel Site***

The Doel Site, which is located on the banks of the Schelde 15 kilometres downstream from Antwerp, hosts the following installations:
The twin nuclear power unit Doel 1 and 2 (A);

- The nuclear power plant Doel 3 (B);
- The nuclear power plant Doel 4 (C);
- The centralised installations for radioactive effluent and waste treatment and conditioning (WAB) (D);
- The building SCG for dry storage of spent fuel (storage in containers) (E).

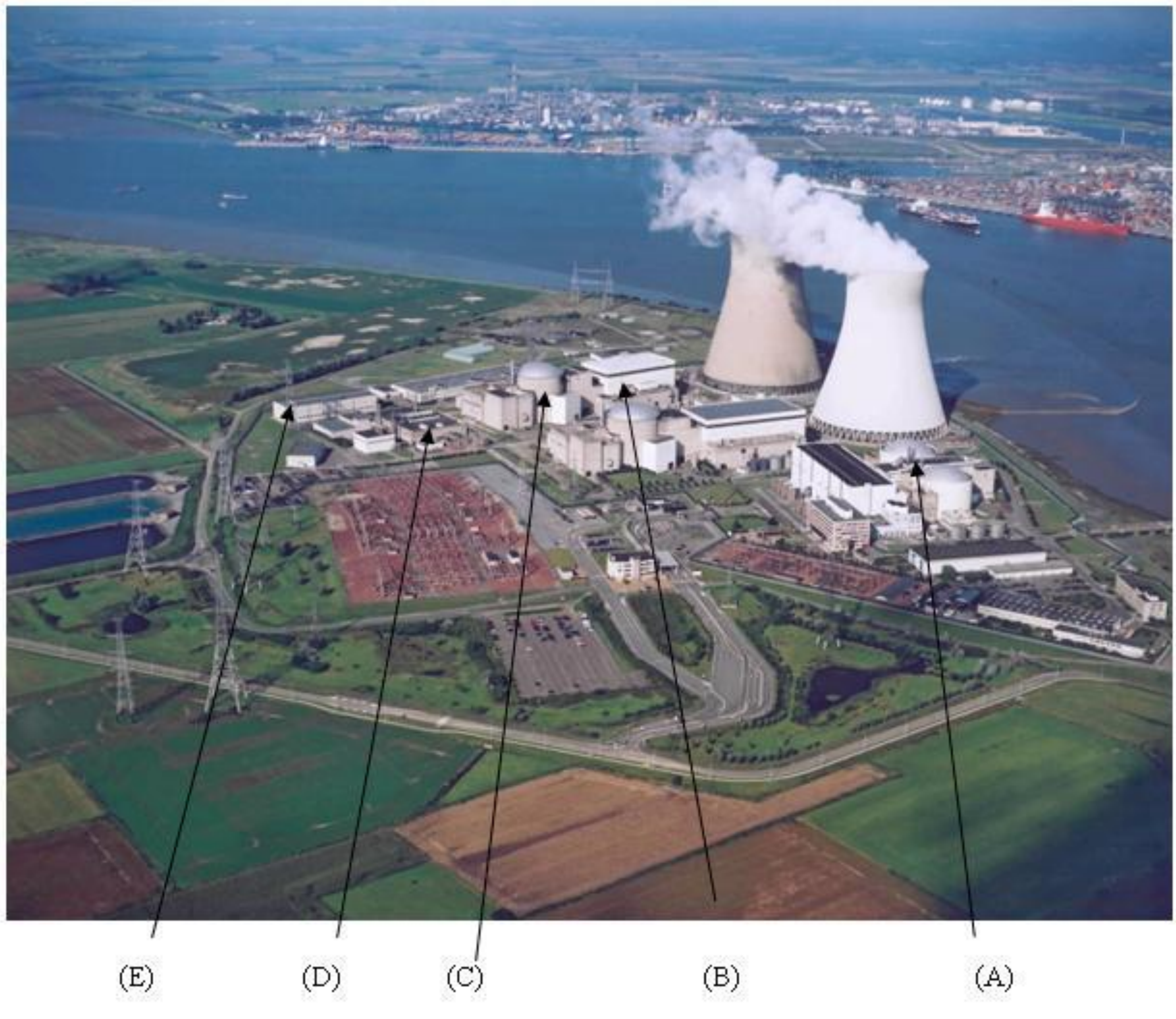

Figure 16: The Doel site

The total storage capacity at the Doel site will enable the spent fuel from all the units at the site to be stored for a period of 40 years.

XII.A.3.b) ***The Tihange Site***

The Tihange Site, located near Huy on the banks of the Meuse 30 kilometres upstream from Liège, comprises the following installations:

- The nuclear power plant Tihange 1 (A);
- The nuclear power plant Tihange 2 (B);
- The nuclear power plant Tihange 3 (C);
- The building for wet storage of spent fuel (storage in pools) “DE” (D).

Figure 17: The Tihange site

XII.A.4. Spent fuel storage systems

XII.A.4.a) *Deactivation ponds*

The spent fuel assemblies removed from each unit's reactor core are temporarily stored in the deactivation ponds of the corresponding unit before being transported and stored in the interim storage building of the same site (Doel or Tihange).

The deactivation ponds are located in buildings 'GNH' (Doel 1/2), 'SPG' (Doel 3/4), 'BAN' (Tihange 1) and 'BAN-D' (Tihange 2/3).

The water treatment circuit of the deactivation ponds at each unit (PL in Doel and CTP in Tihange) consists of two identical but independent loops. The circuit is designed to evacuate, in both normal and emergency situations, the residual power released by the spent fuel assemblies and ensure an acceptable environment for the personnel working in the vicinity of the pond. It also makes it possible to maintain an appropriate level of water in the ponds so as to ensure adequate biological protection. Another function of this circuit is to allow the water from the ponds to be decontaminated and treated.

When the water from the decay tank is being cooled and decontaminated, the spent fuel assemblies are placed in an upright position in the storage cells.

The storage capacities of the deactivation pools make it possible to store at least one complete core plus the core already present in the reactor.

XII.A.5. **Interim storage building at each site**

The purpose of the spent fuel interim storage building at each site is to increase the storage capacity of the site as a whole.

XII.A.5.a) *Interim storage unit at Doel (SCG building)*

Figure 18: Intermediate Storage Building for Spent Fuel at Doel

The spent fuel elements from the 4 units at Doel are placed in sealed containers similar to those approved for their off-site shipment. The first dry storage container were loaded in 1995. The design of the containers is adapted to the designs of the fuel assemblies of the different units.

The exterior of the filled containers is decontaminated before the containers are loaded onto a semitrailer for transfer to the SCG building. There they are unloaded onto their storage location by an overhead crane.

The outer casing of the containers consists of a massive steel wall. This casing guarantees the structural integrity of the elements throughout their transportation on-site, their interim storage and their transfer to offsite facilities. It also ensures a satisfactory level of biological protection. The dose rate limits in the interim storage building are 2 mSv/h at the surface of the container and 0.1 mSv/h at 2m from the container.

The leaktightness of the container is ensured by a cover fitted with a double sealing system. The volume between the gaskets of each container is pressurised and connected to a helium system to make leak-detection possible. During storage the leaktigthness of the containers is monitored continuously. After some years of operation, a modification has been made to move the pressure monitoring devices from the top of the container to a more protected area in the building. This allows to reduce the dose for the operators when maintenance is needed.

The containers are cooled by natural convection. Their design foreseen minimum and maximum external ambient temperatures of -10°C and +45°C for storage, and of -40°C and +38°C for transport. Their present capacity varies from 24 to 37 fuel assemblies.

The interim storage building consists of a loading hall and two storage halls (with a total capacity of 165 storage casks). Several types of containers are available so as to make due allowance for the differing lengths of the fuel elements and the different types of assembly originating at the 4 units on the site. Concerning the duration of the spent fuel storage, a continuous monitoring of the pressure between the gaskets of the primary lid of the dry casks stored is performed. The efficient drying of the SF elements and inertization by Helium injection in the cavity prior to cask sealing should prevent corrosion to occur. Moreover the heat load dissipation is periodically monitored in order to avoid hot spots in the storage area. Any possible effort is paid to guarantee the extended life of the stored SF elements and to investigate information regarding the best practices abroad and experience gained in countries were SF behavior during dry storage.

XII.A.5.b) *Interim storage cell at Tihange (DE building)*

Figure 19: Intermediate Storage Building for Spent Fuel of Tihange

The purpose of the spent fuel interim storage cell of the power station at Tihange (again known as the DE building) is to increase the storage capacity of the site at Tihange as a whole.

The fuel from the 3 units is transported to the DE building in transfer containers.

The ponds and related equipment have been designed to accommodate spent fuel assemblies of different lengths and to allow different kinds of transport containers to be manipulated.

The DE building is designed to store a total of 3720 assemblies distributed over 8 identical storage pools with a unit capacity of 465 assemblies and a design similar to that of unit 3.

The container-unloading pond is also equipped with a storage module consisting of 30 cells in which the assemblies extracted from the container are temporarily placed - immersed in the tank - during unloading operations.

The ponds’ cooling and water treatment circuit (STP) is designed to evacuate the residual power released by the spent fuel assemblies while they are undergoing interim storage in the storage pools and to maintain in those ponds a temperature below 60°C under all circumstances.

The racks in which the spent fuel assemblies are stored can accommodate without difficulty assemblies from all 3 units at the Tihange site.

The DE building is an extension of the existing spent fuel storage building (building D) of unit 3. It has been erected parallel to the cask storage building within the technical perimeter of unit 3.

Concerning the duration of the spent fuel storage, there are no detection until now of any indication of leakage on the SF stored in the centralized storage pond DE. The fact that only sound and tight SF elements (or fuel assemblies which only have a mechanical damage, with intact cladding – a sipping is performed to make difference between leaking or damaged fuel assemblies) may be transferred to the storage pond guarantees that the corrosion of the pellets by the water will not occur. Moreover the low temperature of the fuel elements in the pond due to its permanent cooling by the water is a favorable parameter. Any possible effort is paid to guarantee the extended life of the stored SF elements and to investigate information regarding the best practices abroad and experience gained in countries were SF behavior during wet storage.

XII.A.5.c) *Inventories*

The dry storage building at Doel contained (at the end of January 2014) 86 containers, in which about 2537 fuel assemblies are stored, i.e. about 52% of the current storage building capacity.

The wet storage building at Tihange contained (at the end of January 2014) 2423 fuel assemblies, i.e. about 65% of the total storage capacity.

XII.B. APPENDIX 2: Description of Belgian Nuclear Power Plant Radioactive Waste Management Facilities

XII.B.1. Radioactive waste management principles

The radioactive waste generated at the Doel and Tihange Nuclear Power Plants are in gaseous, liquid or solid form. Corresponding treatment/conditioning systems and systems for release to the environment are provided in order to process the waste in a safe, reliable and controlled manner and to maintain the level of radiation exposure to the public and plant personnel as low as reasonably achievable, in compliance with the authorised limits for plant discharge to the environment and the applicable regulations. In particular, the solid waste treatment and conditioning systems ensure that the resulting waste-form meets the requirements for off-site transport, interim storage and future disposal. A small number of large items of discarded equipment is stored on both sites in dedicated storage buildings awaiting later treatment/conditioning, possibly at the same time as the plants' decommissioning.

XII.B.2. Gaseous waste

The hydrogenated gaseous effluents produced by the Chemical and Volume Control System, the Pressuriser of the Reactor Coolant System and the Boron Recycle Hold-up Tanks are accumulated in deactivation tanks located at each unit. Hydrogenated effluents are transported by compressors to pressurised storage tanks. After filling, the storage tank is isolated for a period of several weeks, which allows the radioactivity of the fission gases to decay. After that decay period, samples are taken and analysed to check if the tank content meets conditions for release. If it does, the content is then released into the atmosphere via a filtration system or a ventilation exhaust system that is either specific to each building or shared by all of them.

XII.B.3. Liquid waste

Liquid waste is collected by category: hydrogenated or aerated effluents of Reactor Coolant quality, chemical effluents, laundry and changing-room effluents, floor drains and (in the case of Doel) polishing effluents. This waste is collected in various dedicated tanks located at the different units of each site. Where necessary, pretreatment is performed in the unit before the effluents are transferred, at each site, into the centralised Liquid Waste Treatment Systems. These systems consist of treatment equipment, such as filters, ion exchangers, gas-strippers and evaporators. After treatment, measurements are performed to verify that the purified effluents comply with the radiological, physical and chemical release limits. Continuous redundant radioactivity monitoring is performed during effluent release.

Secondary Solid wastes generated by the Liquid Waste Treatment Systems are conditioned (see below), while the boric acid recovered from the Reactor Coolant quality (hydrogenated) effluents is generally recycled.

XII.B.4. Operational solid waste

Two main categories of operational radioactive solid waste are distinguished:

the 'wet' solid waste that is treated/conditioned at the Doel and Tihange sites and the resulting conditioned waste being sent for interim storage at Belgoprocess;

the 'dry' active waste (DAW) that is pre-treated at the Doel and Tihange sites and then sent for treatment/conditioning at Belgoprocess in the CILVA installation.

XII.B.4.a) *Waste conditioned at the NPPs*

The wet solid waste from the auxiliary systems and the liquid effluent treatment systems (spent ion exchange resins, spent filters, evaporator concentrates) as well as various solid wastes generally with a surface dose rate higher than 2 mSv/h are conditioned in metallic 400 ℓ drums in the Solid Waste Conditioning Facility at each site. A qualification file has been submitted for approval by ONDRAF/NIRAS regarding the use of the 400 ℓ drums for the conditioning of waste at the Belgian NPPs.

The treatment and conditioning facilities of the NPPs are qualified by ONDRAF/NIRAS. The treatment and conditioning of the solid waste is performed within the framework of a Quality Assurance Programme established by the utility company. Inspections and control of these operations are performed by ONDRAF/NIRAS.

After checking and acceptance by ONDRAF/NIRAS of the conditioned waste at the conditioning site, the waste is transported to Belgoprocess for interim storage in Buildings 151 or 127.

XII.B.4.b) *Waste not conditioned at the NPPs*

Dry active solid waste (paper, clothes, plastics, wood, ventilation filters, etc.) is collected selectively at the NPPs.

The combustible fraction of this waste is subjected to a pretreatment in the centralised waste treatment facilities of the two NPPs. This pretreatment consists of sorting, shredding and compaction before wrapping in plastic bags and the subsequent packaging of these bags in transport containers.

The compressible fraction of this waste is generally precompacted before being packed in metallic packagings suitable for further supercompaction at Belgoprocess. Some metallic components are treated abroad by a melting operation; the secondary waste concentrating the radioactivity comes back and is handled following the standards for the normal solid waste streams.

The different kinds of waste are packaged and transported to Belgoprocess site in adequate standardised packagings (200 ℓ drums, 1 m³ stainless steel containers, etc.) in accordance with ONDRAF/NIRAS specifications. In particular, the dose rate of the transport packages must be below 2 mSv/h.

XII.B.4.c) *Non- routine large bulky solid used materials*

The old Steam Generators of various units and the Reactor Vessel Head of Tihange 1 which have now been replaced are presently stored in dedicated facilities at the Doel and Tihange sites.

Those 2 common buildings received a specific license to store intermediately those large bulky solid items for a few tenths of years until the decommissioning of the NPP correlated with the existence of a final disposal for category A radioactive waste. It means:

- GSG and GSR buildings and Doel: authorized to store 10 replaced Steam Generators;
- SGV building at Tihange: authorized to store 9 replaced Steam Generators and 1 replaced Reactor Vessel Head of Tihange 1

The WENRA safety reference levels for radioactive waste and spent fuel storage are applied, "as appropriate", for those 2 buildings and their contents.

It means f.i. that:

- all the data needed for the further steps in their processing are available,
- some realistic scenario are described for their future treatment,
- a reference scenario is described in the preliminary decommissioning plan,
- the information about their future waste production (type, planning, quantities) is communicated and contracted with ONDRAF/NIRAS,
- and the cost related to those activities is included in the decommissioning funds.

XII.B.5. **Radioactive Waste Management Facilities at Doel NPP**

XII.B.5.a) *Gaseous waste treatment systems*

The Gaseous waste treatment systems (called GW systems) are located in the Nuclear Auxiliary Building GNH of each unit. They comprise the following equipment:

For Doel 1-2, in the twin units' shared building GNH: 3 compressors, 5 storage/deactivation tanks;

For Doel 3 and for Doel 4, in the GNH of each unit: 2 compressors, 10 storage tanks and 2 catalytic recombiners.

XII.B.5.b) *Liquid waste treatment systems*

The liquid waste produced by the different units at the Doel site is treated in the WAB, the centralised waste treatment building.

Figure 20: The WAB building (empty drums waiting for the next conditioning campaign)

After their collection, the Reactor coolant quality-type effluents are pretreated by means of filters, ion exchange columns and gas strippers in the GNH of the unit at which they are produced before being sent to the WAB. Some other effluents also require a filtration in the unit where they are produced before being sent to the WAB.

In the WAB, the waste is received in dedicated buffer/storage pools, maintaining the upstream segregation. The secondary waste produced in the WAB itself is collected according to the same categories.

Apart from filters and ion exchange columns, five evaporator units (evaporation capacity = 5 m^3/h) are available. Three of them process the reactor coolant quality-type effluents, allowing boric acid recovery. The other two are dedicated to the other types of liquid effluents and generate evaporator concentrates that have to be further immobilized with cement.

Various control tanks are provided, allowing for effluent control before release to the Scheldt through a unique release collector.

XII.B.5.c) *Solid Waste Systems*

(1) Waste conditioned at Doel

The Solid Waste System (SW) comprises 2 buffer tanks for Ion Exchange Resins and 3 buffer tanks for evaporator concentrates (plus 3 spare tanks).

The conditioning process is based on the incorporation of waste with concrete using a batch radioactive mixer.

Evaporator concentrates or Ion Exchange Resins (IER) are mixed with cement (Portland type cement), various aggregates and, in the case of IER, chemical additives, in carefully controlled proportions according to recipes certified according to Waste Acceptance Criteria.

Spent Filter Cartridges and/or various radioactive (possibly compacted and, for ALARA reasons, eventually handled by a remote controlled robotic installation) solid wastes are immobilised with non-radioactive concrete or with concrete plus evaporator concentrates.

One batch mixer with an associated concrete and aggregate silo is therefore used. An automatic magnetic guided carriage is provided for the drum transportation. After filling, a coverlid is put on the drum by an automatic lid-fixing device.

Buffer storage is provided for the drums awaiting transportation to the Belgoprocess site for interim storage.

(2) Waste not conditioned at Doel

A shredder-compactor is installed in the WAB, enabling combustible waste to be shredded, slight compacted and packaged in small plastic bags of a unit mass of 15-20 kg.

Compressible waste may be compacted by an in-drum 16-ton press.

(3) Non-routine large solid used materials

The 10 steam generators removed at Doel 1,2, 3 and Doel 4 are stored as 'closed sources' (i.e. all fittings/openings are sealed) in a dedicated storage buildings called GSG and GSR.

XII.B.6. **Radioactive Waste Management Facilities at Tihange NPP**

XII.B.6.a) *Gaseous waste treatment systems*

The Gaseous waste treatment systems (called TEG systems) are located in one of the Nuclear Auxiliary Buildings of each unit. They comprise the following equipment:

For Tihange 1: in the BAN-EST 2 compressors, 3 storage/decay tanks and in the building extension called TEG: 2 storage/decay tanks

For Tihange 2 and 3: in Building D of each unit 2 compressors, 8 and 7 storage tanks respectively and 2 catalytic recombiners.

In each unit a specific filtration system, comprising HEPA, charcoal and HEPA filters in series, is provided on the decayed gas release line. This line is connected to a building ventilation exhaust duct, allowing the discharge of the gaseous effluents into the atmosphere via the Unit Stack.

XII.B.6.b) *Liquid waste treatment systems*

Liquid waste treatment systems are installed in the Nuclear Auxiliary Building of Tihange 1. The treatment parts of these systems are no longer in service, except for some filters, ions resins exchangers and resins and concentrates storage tanks. For all the radioactive effluents produced on-site, the liquid waste treatment is performed in the Auxiliary Nuclear Building N of unit 2. Collection tanks are provided in unit 3 together with some filters and resins storage tanks. The waste categories are the same in all three units, and segregation between the different waste categories is maintained from collection as far as treatment.

The non-aerated reactor coolant quality-type effluents are treated by filters, ion exchange columns and gas strippers before buffer storage and then evaporation, allowing for boric acid recovery. One evaporator package (evaporation capacity = 5 m^3/h) is dedicated to this task.

Other effluents are treated by filtration and/or evaporation and/or passage through ion exchange columns. A flocculation system is also installed. Two evaporator packages (evaporation capacity = 5 m^3/h) are available to process these effluents, producing evaporator concentrates that have to be further immobilized with cement.

Various control tanks are provided, allowing for effluent control before release to the River Meuse through 2 large 'transfer' tanks installed in each of the three units.

XII.B.6.c) *Solid Waste Systems*

(1) Wet solid waste systems at Tihange 1 (TES)

Tihange 1 is provided with:

- 1 buffer storage tank for Evaporator Concentrates and 2 buffer storage tanks for Spent Ion Exchange Resins
- a facility allowing for the casking of spent filters and of various solid waste, which is then transported to Unit 2 for conditioning
- a conditioning facility (no longer in use).
- Evaporator concentrates are no longer produced at Tihange 1. Spent ion exchange resins are transported, using a shielded cask, to Tihange 3 for conditioning.

(2) Wet solid waste systems at Tihange 2

The Solid Waste System (TDS) of Tihange 2 comprises, among other things:

- 2 buffer storage tanks for evaporator concentrates, 2 buffer storage drums for IER
- a facility allowing for the drumming of spent filters and of various solid wastes
- a conditioning facility for evaporator concentrates based on an in- drum mixer
- an immobilisation facility for drummed spent filters and various solid wastes
- a large buffer storage for conditioned waste drums awaiting transport to Belgoprocess.

(3) Wet solid waste systems at Tihange 3

Two Spent Ion Exchange Resins Storage tanks are installed, as well as a facility for the drumming of spent filters and various solid wastes.

Spent Ion Exchange Resins, produced by all the units on-site, were conditioned until 2007 by an outside company by means of a mobile unit using a polymer-binding agent and use of a styrene component (easily flammable giving extra safety concerns). This task was performed within the framework of a Process Qualification File approved by ONDRAF/NIRAS A new installation for conditioning the Spent Ion Exchange Resins in the premises of Tihange 3 is currently in construction and test phase. This new installation works with a thermo-compaction process: the Resins are first warmed, put in a loosed drum, supercompacted, and finally immobilized in concrete. This new process is efficient with an interesting volume reduction factor and is improving the waste quality f.i. conformity with the acceptance criteria "absence of free water" due to the warming and drying process. An intention letter for this new process was send to ONDRAF/NIRAS in 2007 and accepted. A process qualification file will be submitted in 2014 to the approbation by ONDRAF/NIRAS.

(4) Waste not conditioned at Tihange

The pre-treatment and packaging of the 'dry' active waste are performed in Building Φ of Tihange 2. A shredder-compactor is installed, allowing for combustible waste-shredding, slight compaction and packaging in small plastic bags of a unit mass of 15-20 kg.

Non-combustible compressible waste is pre-treated in a unit comprising hydraulic shears, a metallic scrap press and, for the cut and/or compacted waste, a 200 ℓ drum-filling station.

Filled transport container monitoring systems are provided upstream of a dedicated buffer storage.

(5) Non-routine large solid used materials

The 9 steam generators removed at Tihange 1, 2 and 3 are stored as 'sealed sources' (i.e. all the fittings/openings are sealed) in a dedicated storage building called SGV. The superseded reactor vessel head of Tihange 1 is also stored in the same building.

XII.C. APPENDIX 3: description of the storage buildings at the Belgoprocess site

A general view of the Belgoprocess site is shown on the picture below.

Figure 21: The Belgoprocess site 1

The different buildings of interest for waste storage are identified (in red) on the following picture:

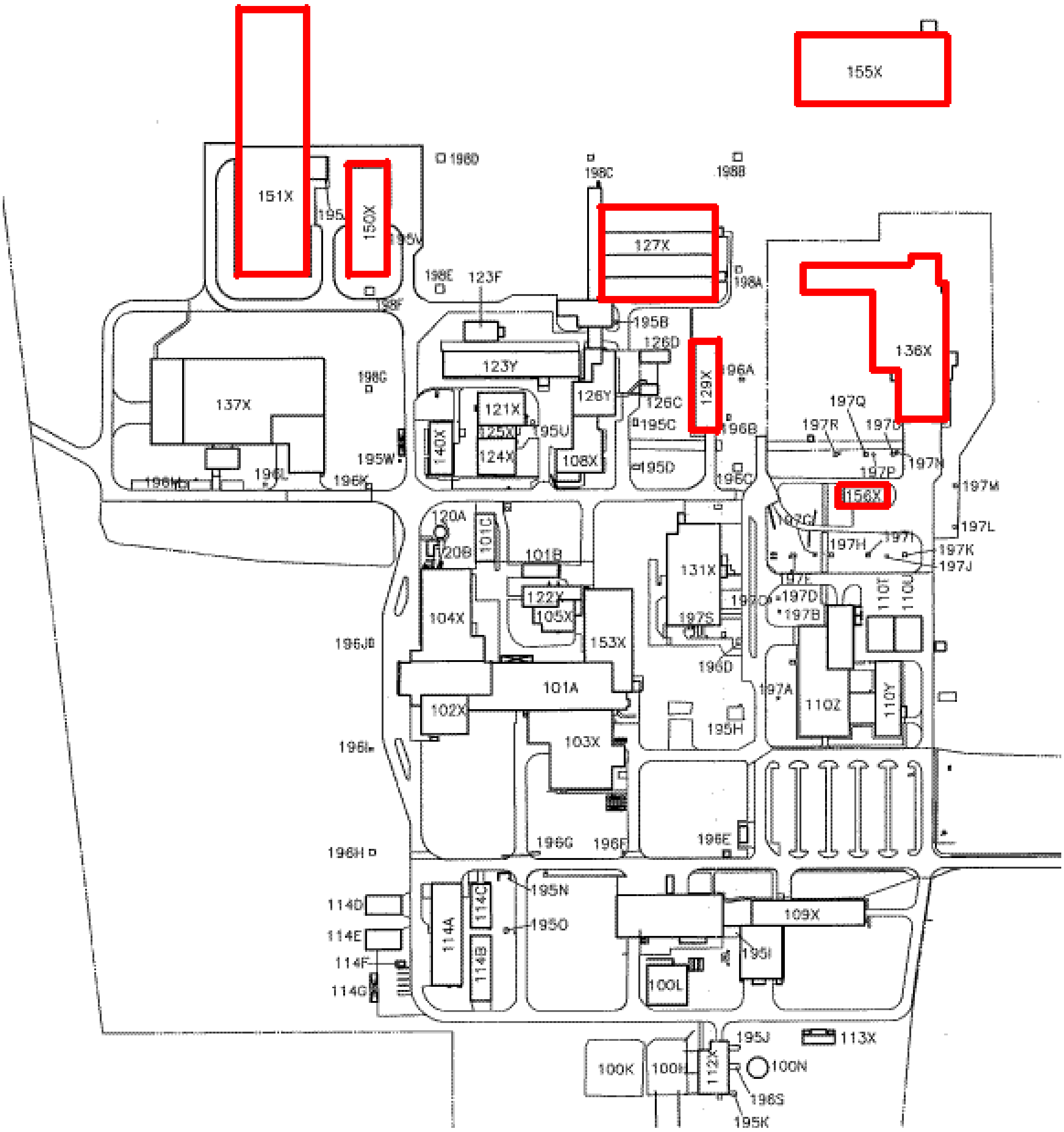

Figure 22: Map of Belgoprocess installations

XII.C.1. **Building 127**

Figure 23: Exterior view of Building 127

Building 127 consists primarily of four bunkers and has been in use since 1976. Each of the bunkers has the following dimensions:

length = 64 m,
width = 12 m,
height = 8.2 m.

Most of the walls of this concrete structure are 80 cm thick and the roof is 75 cm thick, which ensures a dose rate lower than 25 µSv/h outside the building.

Two bunkers were originally build. Over the course of time, two supplementary bunkers have been added. The design of the building allows for a modular extension to 8 bunkers. Bunkers '1' to '3' are suitable for 220ℓ drums, while bunker '4' accommodates 400ℓ drums.

Unshielded waste from building 126 (bituminised waste) is transported on a trolley from room 101 through corridor 103. A gantry with a 2-ton capacity raises the drums and places them in the bunker. Waste of a different origin enters lock 104 on a truck. The covers of the transport shielding are removed. A gantry places the drums on the trolley in room 102.

The drums are stacked 4-high, allowing a capacity of 5000 x 220ℓ drums for each of the bunkers '1' to '3'. Bunker '4' can accommodate up to 3370 x 400ℓ drums in 4 layers. Each layer consists of a square pattern with a radial shift in each direction. It can be necessary to remove 29 drums to reach a particular drum. In this case, the space above the 4 layers allows sufficient room for an interim storage of these 29 drums. Figure 3 hereafter gives an interior view of a bunker.

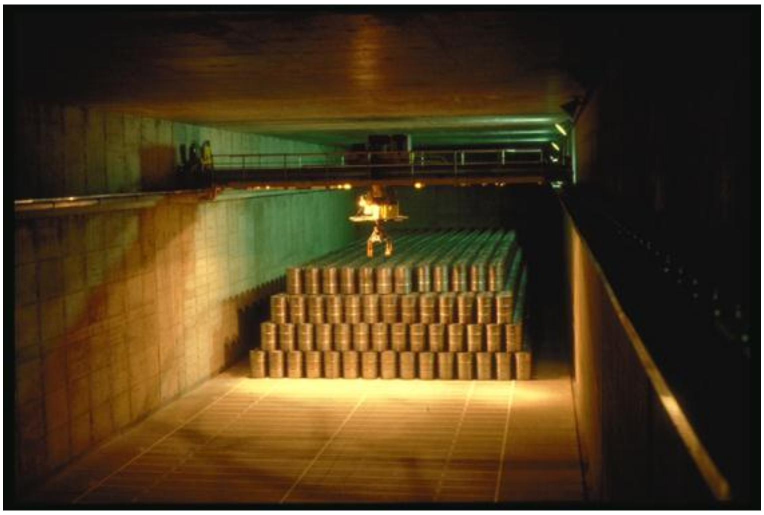

Figure 24: Interior view of a bunker in building 127

When a bunker is full the gantry is moved to the next bunker. For this purpose there are two gantries in corridor 103. The bunker is sealed with sand-filled boxes and concrete blocks. A small opening allows ventilation (1.5 air renewals per day, filtered discharge by chimney stack on building 126).

XII.C.2. **Building 129**

Figure 25: Exterior view of Building 129

Building 129 consists primarily of two shielded bunkers with a hall on the top. Since 1985 it has been used for the storage of high-level vitrified "Pamela" waste from the former pilot reprocessing plant Eurochemic. Each bunker has the following dimensions:

length = 18 m,

width = 12.2 m,

height = 20 m, including the hall.

It originally consisted of only one bunker (no. 110) which was constructed in such a way to enable further extension. Later on, a second bunker (no. 111) was put into service. Bunker 110 can accommodate 50ℓ Pamela containers, while bunker 111 is suitable for larger 150ℓ containers.

The concrete walls of this bunker structure are 120 cm thick, ensuring a dose rate lower than 25 µSv/h outside the building.

The shielded waste is transported on a small railway truck into a lock (101). A gantry with a 40-ton lifting capacity places a flask on top of the transport shielding and pulls the container into the flask. The gantry lifts up the flask and moves it into the hall (310) located above the storage zones of the bunkers (figure 7). The flask is placed on top of a stop on the middle floor and the stop is removed. After this operation the container sinks into a cylindrical basket and the stop returns to its position. This protection mechanism guarantees the safety of the personnel throughout the whole handling procedure.

Bunker 110 contains 252 baskets in which 6 containers are placed on the top of each other (i.e. a total of 1512 containers). Bunker 111 contains 20 baskets for 5 containers and 160 baskets for 6 containers placed on the top of each other (a total of 1060 containers). To reach a particular container, it can be necessary to manipulate 5 containers. In that case the removed containers must be placed in another basket.

Forced ventilation is provided in order to cool the containers. A ventilation of approximately 10 air renewals per hour through the bunkers per hour is provided for this purpose. The extracted air passes through a filter before being discharged through the 5-metre chimneystack on the top of building 129.

Figure 26: Hall above the storage bunkers

XII.C.3. **Building 136**

Figure 27: Exterior view of Building 136

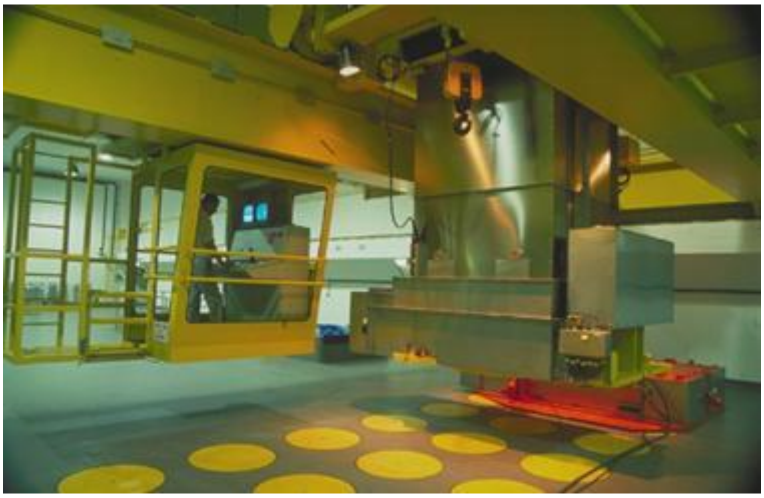

Figure 28: Interior view of building 136

The design of Building 136 (partially in use from 2000 onwards) is radically different from the other buildings of the site. Building 136 is not only intended for storage, but can also be used as a dispatch and reception station for the site.
The Synatom waste from the reprocessing of Belgian spent fuel by COGEMA (now AREVA- France) is housed in building 136. Synatom waste consists of:

- vitrified high-level waste,
- compacted hulls and ends and technological waste,
- bituminised medium-level waste,

The total storage capacity is distributed over two bunkers. The capacity is shown in table hereafter.

Table 5: Storage capacity of building 136

	Vitrified high-level waste	Compacted waste	Bituminized sludges
Primary packaging	180 ℓ CSD-V	180 ℓ CSD-C	210 ℓ
Capacity	590 pcs	820 pcs	2042 pcs

Since the design and construction of the building 136 AREVA is making the necessary steps to change the way of conditioning of the hulls and end pieces and of the technological waste. Only one type of standard canister with compacted hulls and end pieces together with technological waste is actually foreseen by AREVA. The storage capacity of building 136 for these new waste forms is being reassessed.

Receiving Hall (101)

The transport packages or containers arriving on the site or which are due to leave it are handled in the Receiving Hall; these transport packages and containers are fastened to a special semi-trailer pulled by a tractor.

The hall is equipped with a crane of 1300 kN to lift the transport packages or containers and place them on an unloading wagon on rails. The wagon can receive the various transport packages and containers vertically. The 1300 kN gantry of the receiving hall is equipped with grippers with which all the types of transport packages and containers encountered can be manipulated.

Lock (110)

The lock is located between the receiving hall and the unloading cell. It contains the equipment necessary for checking the transport packages before these are opened for unloading and before the transport packages are sent abroad. The lock also contains the equipment needed to perform any decontamination of a transport packaging that may be required. The lock is equipped with a gantry with a capacity of 200 kN.

Unloading cell (130)

The unloading cell is designed to handle transport containers for primary packages of vitrified waste, compacted waste and bituminised waste and technological alpha waste. The unloading cell is equipped to send these primary packages to the appropriate storage hall. The equipment is also suitable for the handling of a transport container of primary packages containing vitrified Pamela waste.

The bottom of the unloading cell has two different floors: one at 0 m (level of the receiving hall), and one at 4 m (level of the transfer corridor, along which the primary packages of hulls and end-parts, bituminised waste and medium-level technological alpha-waste are transferred).

The unloading cell contains two cell gantries that are operated from the control room. The gangway of the upper gantry is equipped with a lifting system with a capacity of 200 kN; this serves for the handling of the lids of the transport containers, as well as for the handling of the baskets for the primary packages of bituminised waste. The gangway of the lower gantry is equipped with two lifting systems: the first one has a capacity of 10 kN and is used for the handling of the primary packages containing vitrified waste; the second one has a capacity of 50 kN and is used for the handling of the other types of primary packages.

The lift, which is operated from the control room, brings the primary packages of vitrified waste from the upper level of the transport packaging to below the ceiling of the cell, from which the primary package is removed by the loading machine of the storage cell.

The transfer cart for the packages is intended to transfer the primary packages of hulls and end-pieces, bituminised waste and medium-level technological alpha waste from the unloading cell to the storage bunker.

Transfer hall for vitrified waste

The packages of vitrified waste are transferred from the unloading cell to the storage cell with the help of a loading machine located in the transfer hall. This loading machine comprises a shielded casing and is manipulated by a gantry to which it is connected. This operation is performed with the 650 kN gantry.

Bunkers 140/141

The storage cell has a capacity of 590 primary packages. This cell is subdivided into 2 modules, which are separated from each other by a wall that serves as a biological shield. Each module consists of three rows of 10 vertical pits. Each pit consists of a tube which is fixed into a metal frame in which are stacked, from bottom to top, a shock absorber, ten waste packages and an isolation stop.

The internal dimensions of the bunkers 140/141 are:

length = 15.1 m,

width = 11.2 m,

The wall thickness of the storage modules is determined in accordance with the radiological protection regulations, and makes due allowance for an aircraft crash. The thickness is 140 cm, with a further interior wall of 40 cm thickness. The partition between the two bunkers is 60 cm thick. This wall and the other exterior walls are sufficient to ensure a dose rate lower than 20 µSv/h outside the building.

Transfer corridor

The transfer corridor connects the unloading cell to the storage bunker for the primary packages of casings and end-parts, bituminised waste and medium-level technological alpha-waste. The storage bunker stands perpendicular to the axis of the transfer corridor. The primary packages are transported to the storage bunker on a transfer cart.

Storage bunker for non-vitrified waste (170)

Originally, storage of 820 packages containing hulls and end-parts was planned in this bunker. As a consequence of the changes in conditioning mode of the hulls and endpieces and the technological waste by AREVA this is being reassessed.

The packages containing bituminised waste, roughly 2000 in total, are stacked across four levels, with each package resting on four packages of the underlying layer. The packages containing bituminised waste are stacked at the entrance to the storage bunker.

The internal dimensions of this bunker are:

length = 60 m,

width = 15 m,

height = 12 m.

The wall thickness is 2 m, enabling to reduce the dose rate to 25 µSv/h outside the bunker.

Ventilation

The building is equipped with a complex ventilation system. The air renewal rates are: 2-6/hours for the unloading cells, 4-33/hours for the storage bunkers 140/141 of and $\geq$0.5/hours for the storage bunker 170.

The extracted air is filtered and discharged through two chimneystacks (30 m and 6 m in height).

XII.C.4. **Building 150**

Figure 29: Exterior view of Buiding 150

Building 150 has been in use since 1986 and is completely filled with low-level waste with a maximum surface dose rate of 5 mSv/h. The following types of packages are stored in the building:

Table 6: Packages stored in building 150

Packages	Material	Matrix
220 ℓ	Steel	Bitumen, concrete, cement
400 ℓ	Steel	Bitumen, concrete, cement
600 ℓ	Steel	Concrete, cement
1000 ℓ	Haematite concrete	Cement
1500 ℓ	Concrete	Cement+polystyrene
1600 ℓ	Concrete	Cement+polystyrene
1800 ℓ	Steel	Concrete

The external dimensions of the building are:

length = 60.5 m,

width = 19.7 m,

height = 7.9 m.

It is a fully prefabricated building made of reinforced concrete, with 25-cm thick walls. The construction and the stacking method ensure a dose rate lower than 25 μSv/h outside the building. The floor and interior walls have a smooth concrete finish. The walls are windowless.

The waste is brought in on trucks. The packages are unloaded and stacked with two forklift trucks, one of 3 tons and one of 10 tons capacity. These forklifts are also used for the stacking. The packages are stacked vertically with the apertures at the top, with each package resting on two packages of the underlying layer. The various packages are stacked according to table hereafter.

Table 7: Packages stored in building 150

Packages	Number of layers	Total height (m)
220 ℓ	5	4.40
400 ℓ	4	4.40
600 ℓ	3	3.75
1000 ℓ	2	2.50
1500 ℓ	3	3.90
1600 ℓ	3	3.90
1800 ℓ	2	2.73

Around the stacks, the free space is wide enough to allow checking and inspection. The stacking is designed and performed in such a way that the packages with the lowest dose rate are placed on the external sides, while the most radioactive ones are stacked in the central part.

No forced ventilation is provided.

XII.C.5. **Building 151**

Figure 30: Exterior view of building 151

Building 151 consists primarily of four halls, and has been put into service in 1988 for the storage of low-level bituminised waste and low-level cemented technological waste.

The following types of packages are stored:

Table 8: Packages stored in building 151

Packages	Material	Matrix
220 ℓ	Steel	Bitumen, concrete, cement
400 ℓ	Steel	Bitumen, concrete, cement
600 ℓ	Steel	Concrete, cement
665 ℓ	Asbestos cement	Cement
1000 ℓ	Haematite concrete	Cement
1200 ℓ	Asbestos cement	Cement
1500 ℓ	Concrete	Cement+polystyrene
1600 ℓ	Concrete	Cement+polystyrene
2200 ℓ	Steel	Concrete

Building 151 has been constructed in two phases. Phase 1 construction (length: 72.5m) consists of two parallel and adjacent halls (A and B). Hall A, with a width of 17.2 m, is preferred for packages of 220, 600, 665, 1000, 1200, 1500, 1600 and 2200 ℓ. Hall B, with a width of 21.2 m, is preferred for 400 ℓ drums. The two halls are separated by a continuous wall. Phase 2 construction is similar but has a length of 84.5m. Figure 18 shows an interior view of a hall.

Figure 31: Interior view of a hall in building 151

The last compartment of hall B and the last two compartments of hall A form a corridor that is reserved for unloading actions. The ends of this corridor are closed off with metal overhead doors of a sufficient height to enable trucks to pass beneath them. Each hall (108=A, 109=B, 111=C, 112=D) has a chicane to protect workers from receiving radiation from the stacks. These do not extend all the way upwards, in order to allow a roller bridge to pass through. Halls A and C are equipped with a manually-operated 10 t roller bridge. Packages can be delivered with a shielded forklift truck, so that all types of packages can be accommodated. Halls B and D are equipped with an automatic roller bridge and are reserved for 400ℓ drums. Halls A and B are now completely filled. Given the future supply will consist exclusively of 400ℓ drums, the 10 t roller bridge in hall C should be equipped with a 2 t device or, alternatively, the building will have to be expanded.

The 400ℓ drums are stacked in a triangular way, with a radial shift between the layers. The stacking of the other drums can be different. The capacity of the halls is 1900m^3 (A), 3900m^3 (B), 3000m^3 (C), and 5200m^3 (D).

No forced ventilation is provided. The wall thickness is 25 cm.

XII.C.6. **Building 155**

Figure 32: Exterior view of building 155

Building 155 is in operation since 2005. It is primarily intended for the storage of low-level long-lived waste (Pu-contaminated) and long-lived waste containing radium which are stored separately in two halls.

The various types of packages that will be stored in the building are shown in the table below (the last four OV packages are non-standard packages).

Table 9: Packages suitable for storage in building 155

200ℓ
400ℓ
400ℓ BL
600ℓ
OV900
OV900BL
OVSP
OV30

Given the similarity of the planning and of the foreseen final destination of the waste concerned (i.e. geological storage), it was decided to to design a building with two separate storage bunkers. The capacity of the bunker for low-level long-lived waste is ~2000 m^3 by 1200 m^2, the capacity of the bunker for long-lived waste containing radium is ~2450 m^3 by 1200 m^2.

Layout description

The most important parts of building 155 are:

an unloading hall (101) where the packages are unloaded from a truck onto a small railway truck (one per bunker) using a 100 kN gantry (an electrically-driven pallet is provided for the standard packages),

- a lock (102) between the unloading hall and the storage bunkers,
- two separated storage bunkers (105 for low-level long-lived waste, 106 for long-lived waste containing radium), each equipped with a 30 kN gantry and an interim storage facility on rollers (103, 104); each of the bunkers has the following dimensions:

  length = 67 m,

  width = 19 m,

  height = 12 m.
- a storage bunker (no. 115: 7.5 m long; 7.5 m wide and ~2.5 m high) for the standard waste packages (especially poison rods).

Stacking and manipulation of the packages

Preference is given for a stacking method in a triangular pattern in which the upper row of drums rests on the lower row of drums, which are stacked in a trapezium shape in two groups of five (like the dots on a dice), in order to maximise stability. The number of stacking levels is limited to:

- 4 for 400ℓ packages
- 4 for 200ℓ packages
- ~ 3 for 600ℓ drums
- 1 for all non-standard packages

The different types of packages will not be mixed. The stacking will allow for interventions that might have to be made in the bunkers in the event of an incident (e.g.: drop of a package) or for maintenance. No special corridors are provided for the inspection of individual packages. It should be possible to remove any package or drum from the stack at any time. To be able to access a particular drum or package, free space is provided in each storage bunker where the removed drums can be stacked (maximum of 40 for a stack 4 levels high). Between the packages there is a distance of ~5 cm. Taking this into account, the storage area in each bunker is 1200 m^2

The standard packages are handled with a gantry, while non-standard packages are handled with a forklift.

Radiation and contamination aspects

The most radioactive packages are, if possible, placed in the centre of the stack. The thickness of the bunker walls is 45 cm, which ensures a dose rate lower than 10 µSv/h outside the bunker.

The building has two separate ventilation circuits: one for low-level long-lived waste and the other for long-lived waste containing radium. These circuits force the extraction air (if necessary after filtering) into a common chimneystack. Under normal circumstances the extraction air is not filtered, but the filters are switched on when waste is being manipulated. The ventilation system in the bunker for long-lived waste containing radium can be expanded to ensure that sufficient amounts of radon are always discharged.

The air renewal rate is 0.5/hour.

XII.C.7. **Building 156**

Figure 33: Exterior view of Building 156

CASTOR BR3® casks are stored in Building 156

The storage building (L x W x H: 23.5 x 8.8 x 8.5 m) consists of a storage area with 8 cask positions and a receiving area. A radiation trap separates the storage area from the receiving area. Access to the storage area is via a metal sliding door equipped with a personnel entrance. Handling and maintenance of the casks is performed in the receiving area, which consists of the maintenance station, a storage room to house related equipment and a sliding entrance door for cask and material transports by truck. This entrance door allows personnel entrance. The handling of the casks in the storage building is performed by a 320 kN crane.

The dose rate limits outside the building are:

- surface of the storage building : 10 μSv/h
- 300 m distance from the storage building : 0.1 mSv/y

The decay heat is removed by natural convection.

The leak-tightness during storage is guaranteed by the primary lid as the first barrier and by the secondary lid as the second barrier. For both lids, the long-term sealing is guaranteed by metal-seals. A well-established monitoring system with a pressure sensor and signal transmitter ensures the permanent surveillance of the leak-tightness of the casks.

As only seven casks are loaded, the eighth CASTOR BR3® cask can be used as a 'spare' cask in case of a deficient cask (containing the spent fuel from this cask into the spare cask). This operation can be performed in the hot cell of the existing storage building for high level waste at the Belgoprocess site, situated some 50 metres from the storage building. After this intervention, the newly-loaded cask can be re-transferred to the storage building and the faulted cask checked for the cause of failure.

XII.D. APPENDIX 4 : Description of the installations of SCK•CEN : BR2

The BR2 reactor, in service since 1963, is a test reactor with a high neutron flux for the irradiation of materials. Its main purpose is the irradiation of materials under high neutron flux (maximum thermal neutron flux of the order of 10^{15} n. cm^{-2} s^{-1}). These materials are irradiated in experimental rigs, the complexity of which depends on the nature of the irradiation and the intended objectives. The reactor loading is defined (fuel elements, control rods) in the light of the experimental specifications, and is adjusted for each cycle. It is cooled by pressurised water (nominal value: 1.235 Map or 12.6 kg/cm^2 at the entrance of the reactor), which also serves as a moderator. The beryllium matrix comprises 79 cylindrical channels and contains fuel elements, control rods, experimental set-ups or reflector stops made of beryllium.

The reactor operation regime consists of successive cycles, each cycle consisting of a period of shutdown and a period of operation (21 days).

The fuel elements are composed of six (sometimes fewer) concentric pipes, which are composed of a combination of uranium and aluminium and which are made according the technique of powder metallurgy. The plates produced in this way are covered on both sides with an aluminium alloy cladding.

The uranium used is highly enriched (90 to 93 %): in the future, lower enrichments can be used, preferably with an increased density of the uranium in the nuclear fuel plates. Most of the elements contain burnable neutron absorbers (B_4C_2, Sm_2O_3) in the nuclear fuel plates.

There are two types of control rods, one type for compensation and safety and another for regulation; their absorbent part is made of cadmium, covered with aluminium.

The compensation and safety rods can be dropped into the reactor to cause a quick stop ('scram'); the regulation rods are permanently attached to their replacement mechanism and are therefore unable to cooperate in a scram action. Each rod moves inside a guide tube with cooling gaps.

The nuclear instrumentation consists of neutron monitors and radiation detectors, partly around and close to the reactor, partly at the reactor exit in the neighbourhood of the primary circuit.

These can trigger alarms and can also automatically reduce the power of the reactor. The speed of this power reduction depends on the seriousness of the recorded deviation. Similar actions can be commanded by instrument channels that monitor the cooling flow, the pressure and the temperature of the cooling water, the activity level of the radiation in water circuits or the radiation level in the buildings caused by malfunctions or faults of the electricity distribution network or the compressed air system, or during experiments.

The beryllium matrix, already renewed twice (in 1980 and 1996), contains a large number of rods in the form of hexagonal prisms with cylindrical drillings (these form the reactor channels), which together form a cylindrical structure. It is placed into the central part of the reactor vessel. This vessel, made of aluminium alloy, contains an upper part and a lower part in the form of truncated cones, connected at both ends with a central cylinder. Stainless steel covers seal the vessel at each end. The upper cover has 79 round openings, which correspond to the 79 channels of the central part made of beryllium. Each opening is connected to one of these channels by a guide tube; the openings are sealed off with plugs during the operation of the reactor. In the lower cover there are only 18 round openings, which are normally sealed off with plugs and are also connected to the reactor channels. They allow experimental set-ups to be moved to a shielded room situated underneath the reactor.

Fuel elements, control and safety rods, regulation rods, irradiation experiments or plugs made of beryllium can be loaded into the channels of the beryllium matrix; the reactor load configuration depends on the experimental requirements and the criteria that have to be fulfilled to guarantee safety during operation.

The reactor is cooled by the forced circulation of the water that enters the reactor vessel at the top and leaves the vessel at the bottom.

This primary water is sent through heat exchangers; the heat is transferred to a closed secondary circuit equipped with cooling towers. These cooling towers allow the operation of the reactor up to 125 MW.

The reactor is placed in a pool (the reactor pool) with a water level more than 7 m above the upper cover. This offers sufficient shielding to the personnel during the operation of the reactor. During reactor shutdown, the water level can be lowered to allow access to the reactor cover. Two adjacent pools are used to store the irradiated equipment and fuel elements unloaded from the reactor and for gamma irradiations.

The reactor, the three pools and the reactor control room are situated in a metallic cylindrical building, which is regularly inspected.

In an adjacent building (the 'machine building') there are several auxiliary installations: a storage channel connected to the reactor pool through a transfer tube, dismantling cells connected to the storage channel, the pumps and heat exchangers of the primary circuit of the reactor, purification circuits, etc.

Other buildings house the ventilation fans (blowers), air filters, the electrical emergency groups, air compressors, the experiment hall, etc.

The solid and liquid waste is collected and sent to the waste treatment installations at Belgoprocess. The gaseous effluents are released, after filtration, through a 60-metre chimneystack.

It is possible to purify the atmosphere of the reactor building and the cells by means of active coal filters.

An elaborate system monitors the activity levels of the primary and secondary circuits, the activity of the pools and the storage channel in the machine building, the activity of the atmosphere of the reactor building, the activity of the air released through the chimneystack, etc.

XII.E. APPENDIX 5: Overview of the Periodic Safety Reviews outcomes of the Belgoprocess installations

There were in total 42 actions defined for site 2.

Some of the more important actions that were defined as a result of the periodic safety review for the nuclear installations on site 2 are:

- Storage facilities for radioactive waste:
  - establishment and implementation of an evacuation programme for existing waste in the Stelcon-hall;
  - assessment of the further use of the Stelcon-hall, and in relation to this, re-assessment of the safety measures of this storage facility;
  - Study of the explosion risks of the remaining sodium bearing waste;
- Waste treatment installations:
  - assessment of the fire safety of the Mummie installation (building 234H);
  - HAZOP analysis of the Mummie installation (building 234H);
  - Inspection of underground liquid waste pipes;
- Safety provisions
  - assessment of fire compartmentalization of the steam room;
  - Selectivity of the electric supply network;
  - Renewal of alarm system.

By mid of 2011, the half of these actions are was already closed and most of the remaining actions were realized or close to be. Some improvements concerning the documentation of the actions have been agreed between the licensee and the Regulatory Body.

There were in total 36 actions defined for site 1.

Some of the more important actions that were defined as a result of the periodic safety review for the nuclear installations on site 1 are:

- General safety theme's areas:
  - Emergency preparedness: actions were defined regarding an update of the intervention plans and source terms, training follow-up training for emergency preparedness personnel;
  - Operational feedback experience: a thorough analysis of the available data has been planned;
  - External hazards: a general action has been defined to verify that the safety distance between buildings is sufficient;
  - Decommissioning: the specific arrangements concerning nuclear installations in future decommissioning (relevant remaining safety functions of a stand-by installation, keeping of records, …) are the aim of more thorough analysis;
- Storage and processing of radioactive waste
  - Optimization of the ventilation and humidity levels in storage buildings;
  - Development and implementation of a programme for the periodic follow-up of radioactive waste drums in storage buildings;
  - Follow-up of the radon-concentration in storage buildings;
  - Development and implementation of preventive maintenance and control programme of safety equipment (building 105X, 121X, and 122X);
- Safety provisions
  - Write Drafting of an inspection and maintenance programme for the underground release-stack corridors;
  - Evaluation of the air-sampling system in the main release stack;
  - Need for a back-up water supply for fire extinction;
  - Inventory of existing liquid waste pipes, their physical state and evaluation of the existing inspection and supervision programme;

- Inventory and evaluation of the existing alarms on site 1. Definition of a periodic tests programme.

One of the most important actions common for both sites is the update of safety assessment reports. The licensee is currently working on this action.

XII.F. 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