KINGDOM OF BELGIUM

Fourth 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 2011

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

Content

1 Section A: Introduction

1.1 General context

On 8 December 1997 Belgium signed the Joint Convention. The Belgian legislator has expressed its consent with the obligations resulting from the Convention by the Law of 2 August 2002. The ratification followed on 5 September 2002. The Convention became effective on 4 December 2002, i.e. 90 days following ratification.
Belgium belongs to the group of Contracting Parties having at least one operational nuclear power plant on their territory. Belgium has indeed developed an important nuclear energy programme, which includes at present 7 operational nuclear power plants having jointly a net electric capacity of approx. 6224 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 an important 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, 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. According to article 4 of this law, the first nuclear power plant to be shut down will be Doel 1 in 2015, the last nuclear power plant to be shut down will be Tihange 3 in 2025. This law will have considerable consequences for the future of the nuclear sector in Belgium, but, in the short term, it will not have any implications for the radioactive waste management sector.

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 assure the electric power supply of the country. Successively three expert groups have

already been formed to advise the government on the issue. The already mentioned report of the “AMPERE Commission” published in 2002; a second commission, called “Commission Energy 2030”, presented its final report in June 2007; and finally, the government set up a third expert group, called “GEMIX”, whose final report was handed over to the Minister of Climate and Energy on October 7, 2009.
Taking all these reports into account, an agreement has been concluded on 22 October 2009 between the Government acting on behalf of the Belgian State and the GDF-Suez group to extend their operational lifetime of three nuclear power units, namely Doel 1&2 and Tihange 1, by 10 years, through to 2025, in optimum safety conditions. However that agreement has not been enforced by law nor royal decree. Therefore, at the time of writing this report, all the provisions of the law of 31 January 2003 on the phase out of nuclear energy are still in force.

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 in Dessel. As a result of this decision, ONDRAF/NIRAS launched an integrated project, that entails a disposal facility, a waste post-conditioning facility and the realisation of the accompanying conditions requested by local stakeholders. The aims of the project phase are:

- to prepare and submit a license application for a disposal facility in Dessel, based on FANC’s regulatory guidance for surface disposal;
- to prepare and submit a license application for a post-conditioning facility for the production of monoliths (concrete disposal waste containers);
- to reach a binding agreement between all parties concerned w.r.t. the financing of the societal aspects of the integrated project.

A global view of the foreseen surface disposal facility is given in the figure below.

For the long-term management of the high-level and/or long-lived waste (category B&C waste) ONDRAF/NIRAS has submitted its final Waste Plan in September 2011 to the Federal Government. 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).

1.2 Structure and content of the report

This national report, submitted to the fourth review meeting of the contracting parties to the Joint Convention, is established pursuant article 32 of the Convention. It is based on its first, second and third edition. Particular emphasis has been put to clearly include relevant elements related to the questions which were raised during the third review meeting by other contracting parties, facts and events that occurred during the last two and a half years and that characterize the evolution in that period of time, as well as updates of the actions devoted to the improvement of safety, related to section K of the report.

In addition, in order to underline relevant evolution since the last review meeting, a new section, 1.3 has been added, focusing on new developments since the last report, and especially on measures taken to improve safety and to address the challenges identified during the last review meeting.
The table at the end of that section gives an overview of the current liabilities in Belgium.

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 operator of the seven nuclear power plants and 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,
- 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 is structured according to revision 1 of the guidelines INFCIRC/604 (19/7/2006).

The report will be made available on different Belgian Websites, such as www.fanc.fgov.be, www.nirond.be, www.belv.be.

1.3 Main achievements since the last meeting and follow-up of the 3rd Review meeting.

This section intends to highlight the main evolutions that have occurred since the last report and to give an overview of the follow-up of the 3rd Review meeting, addressing among others the challenges and the measures to improve the safety reported for Belgium.

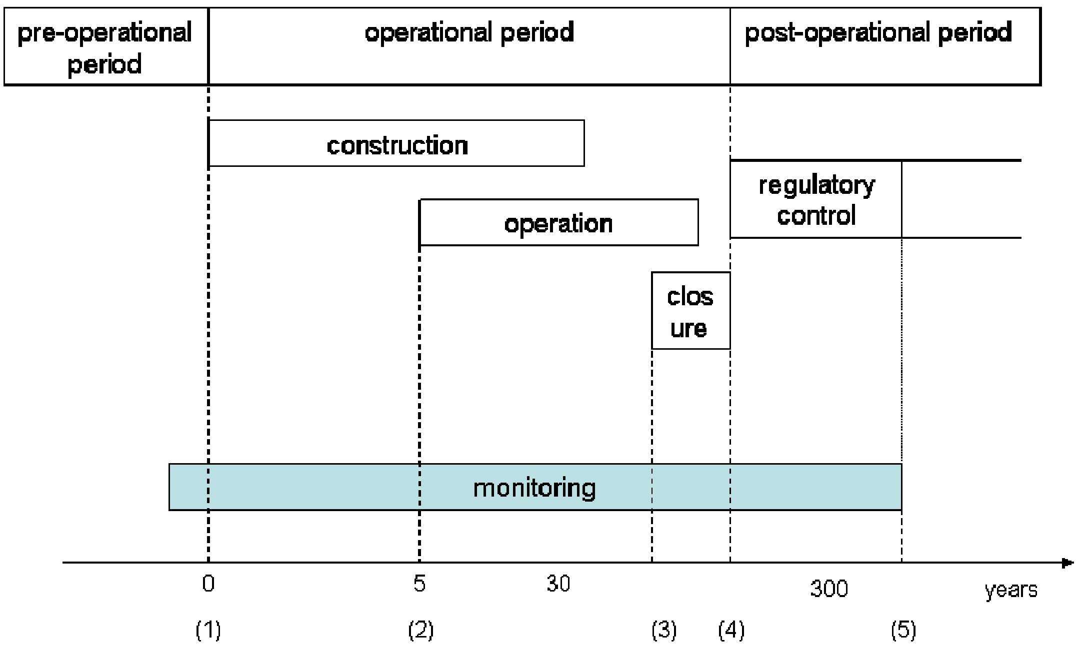
1.3.1 Challenges identified during the 2009 review meeting

Challenge no 1 : ***Development of a regulatory framework for the licensing of disposal facilities and for the licensing of long-term management of historical liabilities***

As a result of the Federal council of Ministers decision of June 23, 2006 mentioned above, the FANC has proposed to complete the existing licensing system for disposal facilities, taking into account that the characteristics of the waste disposal facilities can differ significantly from the other fuel cycle installations:

- The time frames involved (the very long period from the start of the construction up to the final closed configuration) and the phased approach;
- Simultaneous operation (waste emplacing) and construction (or additional waste emplacements) activities;
- The closure, which is a significant (foreseen) modification of the installation;
- The long regulatory control period.

The figure below shows the conceptual timeframe and the phases foreseen for a SL-LILW surface disposal facility:



The foreseen licensing system consists of the following steps:

(1) The initial creation and operation license is granted by the King before the start of the construction activities. This licensing system roughly follows the same general scheme as for other "class I" facilities (see Section 5.3.1.1 of this report).
(2) After construction and delivery of the first installations, the first confirmation (granted by Royal Decree) of the initial licence, allows the emplacement of radioactive waste.
(3) The second confirmation allows the start of the closure phase.
(4) Once closure activities are finished, the third confirmation allows proceeding to the control phase.
(5) After an appropriate control period, the repository is released from regulatory control.

For the granting of a confirmation decree, the Safety Analysis Report and the environmental impact report are updated for the next phase. On advice of the scientific council of the FANC, the conditions set in the license may be completed or modified.

In addition to the international consultations (namely in the frame of article 37 of the EURATOM treaty), a consultation of the general public is foreseen before granting the initial licence and before the confirmation decree allowing the closure of the repository.

The regulatory proposal setting up the licensing system for disposal facilities has now been sent to the Minister of Home Affairs. The approval of this proposal and the promulgation of the licensing system can be expected by the end of this year.

In conclusion, the complete regulatory framework being reshaped for disposal facilities can be illustrated as follows:

	Euratom Treaty (Article 37)	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 of the Law of 1994 related to the security of nuclear materials Proposal** of modification of the Law of 1994 related to the security of radioactive materials other than nuclear materials
Royal Decrees (general)	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 (Generic part)*	*RD** on the security of nuclear materials and nuclear installations*
Royal Decree (specific for disposal facilities)	*RD* on the licensing system for disposal facilities*	*RD* on the safety of disposal facilities (Specific part of RD on the safety of nuclear installations)*	
FANC Guidances (non binding)	General guidance: - Physical protection (Security) - Safety assessment - Qualification, validation & verification - Operational and long-term radiological protection - Biosphere		
	Surface waste disposal guidance : - Surface disposal - Earthquake - Accidents of external origin - Human intrusion - Underground water	Geological waste disposal guidance - Underground disposal	

Table 1 : Belgian Regulatory Framework for disposal facilities

* the RD proposal is currently in the approval stage.
Publication is expected in the second half of 2011.
** in development phase

For the achievements in developing a regulatory framework for the licensing of long-term management of historical liabilities: see the developments concerning the “planned measure to improve safety no 1” in section 1.3.2 hereafter.

Challenge no 2 : ***Preparation of a license application for the SL LILW surface disposal facility (Dessel)***

Since 2006 ONDRAF/NIRAS, in continued interaction with the local stakeholders, has finalised all studies and activities on site characterisation, design and safety assessment for the surface repository, and is currently preparing the safety case for the licence application to be submitted to the FANC. The actual submission is planned for 2012, following an international peer review of specific parts of the safety case (mainly design and long-term safety aspects), under the auspices of the NEA/OECD, which is planned in the period October 2011 – June 2012.

ONDRAF/NIRAS will be the operator of the licensed surface repository. To that extent an integrated management system (IMS) is being developed, following the IAEA safety requirements GS-R-3. The step-wise development and implementation of this integrated management system is planned in line with the licensing steps of the surface repository (construction phase and operational phase).

In agreement with the decision of the Council of Ministers, the preparation by ONDRAF/NIRAS of the safety case for the license application for disposal is being discussed regularly and systematically with the FANC (pre-licensing phase) to take account of the FANC’s regulatory guidance and expectations with respect to the contents of the safety case.

ONDRAF/NIRAS has delegated the preparation of the license application for the post-conditioning facility for the category A waste (production of concrete monoliths containing either conditioned category A waste in waste drums or bulk waste from dismantling) to Belgoprocess. The license application is planned for the end of 2011.

In March 2010 ONDRAF/NIRAS published the Master Plan for the integrated surface disposal project in Dessel, presenting and integrating all the elements of the project (technical, financial societal, economical, …) in an accessible manner for all stakeholders. An interim report to the Federal Government was issued in November 2008.

These aspects are treated more in detail in sections 2.3, 2.4.2 and 8.3.2

Challenge no 3 : ***Completion of the remediation plan and its implementation for the Umicore site in Olen***

A detailed description of the current situation is given in section 4.3.3 hereafter.

Challenge no 4: ***Development of a waste acceptance system and criteria for disposal taking into account the roles and responsibilities of the safety authorities, disposal facility operator, and the waste producers and conditioners avoiding any conflict of interest between all the parties***

ONDRAF/NIRAS as the national waste management agency is the only competent entity in Belgium for the long-term management 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. A central tool of this system is ONDRAF/NIRAS's set of waste acceptance criteria: all waste presented to ONDRAF/NIRAS for acceptance has to comply with these 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 (surface disposal for the category A waste, and 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 formulated a common position 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. Through the Safety report for the licence application ONDRAF/NIRAS will propose to FANC the radiological waste acceptance criteria for the surface disposal of category A waste.

1.3.2 Planned measures to improve safety

Planned measure to improve safety no 1 : ***Development of a regulation for remediation activities***

In the period 2007-2009, the FANC established a working group with the participation of ONDRAF/NIRAS with the goal of developing a comprehensive regulation for the management of radioactively contaminated sites. The main elements of this regulation were based on the regulations applied by the environmental authorities for chemical soil contamination. The working group drafted a proposal of law which has been submitted by the FANC to the responsible Minister.

This law proposal includes among other an explicit definition of liabilities and responsibilities, and a stepwise decision-making process with the following main steps:

- a screening assessment in order to validate the existence of the contamination and to evaluate its magnitude;
- a detailed risk-assessment which provides an evaluation of the potential exposure taking into account the possible evolution of the site, as well of its physical and chemical characteristics as of its use;
- if the risk exceeds some intervention levels, a description of the various remedial or management options for the site; a preferential option is selected on the basis of an integrated analysis of all relevant factors; the preferential option does not necessarily consist in a remediation of the site. It may be based on risk-management measures such as restrictions on the use of the site;
- a remediation or risk-management project, which describes in details the option to be implemented;
- remediation works or implementation of the risk-management measures;
- end-report and follow-up.

Next to the legal and administrative aspects, recommendations on intervention levels and on the minimal content of the risk-assessment studies have also been drafted by the working group.

Planned measure to improve safety no 2 : ***Implementation of the WENRA reference levels for waste and SF storage and for decommissioning in the Belgian regulation***

WENRA is a non-governmental association set up by the Heads of the Nuclear Regulatory Authorities of European countries with nuclear power plants. Currently, the regulatory authorities of 17 countries are members of WENRA. WENRA has two active working groups: the RHWG (Reactor Harmonization Working Group) and the WGWD (Working Group on Waste and Decommissioning).

The WGWD made an extensive study on the nuclear safety requirements related to waste and spent fuel storage and to the decommissioning of nuclear facilities. This resulted in the publication of two reports which present the safety reference levels for radioactive waste and spent fuel storage facilities and for the decommissioning of nuclear facilities. These safety reference levels are based on the relevant IAEA safety standards and are thought to be a good basis for harmonization of safety approaches on a European level.

For waste and spent fuel storage, 77 reference levels were issued in December 2006, for 4 safety areas: Safety management, Design, Operation and Safety verification. An update of these reference levels has been published in February 2011.
For decommissioning 81 reference levels were issued in March 2007, for 4 safety areas: Safety management, Decommissioning strategy and planning, Conduct of decommissioning and Safety verification.
More information can be found on: www.wenra.org.

Two regulatory projects are currently in progress at the FANC:
- A regulatory project to include the Reference Levels related to decommissioning into the Belgian legal framework This regulatory proposal complements a more general project called “safety requirements for nuclear installations” developed on the basis of WENRA RHWG (Reactor Harmonization Working Group”) reference levels.
- A regulatory project to include the reference levels related to waste storage facilities into the Belgian legal framework.

At the time of writing this report, the first regulatory project is sent to the licensees for comments, while the second one is still in the drafting phase. It is expected that these projects will be completed in due time with the WENRA schedule commitment.

In parallel, the Belgian operator of the nuclear power plants, ELECTRABEL has set up an action plan, to address the reference levels that have been rated “C’ (i.e. non-conformity) on the practical side. This action plan started beginning 2011 and is currently ongoing.

Planned measure to improve safety no 3 : ***FANC self assessment and planning of an IRRS mission***

According the European Directive 2009/71/EURATOM on the Nuclear Safety, the request of an international peer review every 10 years is mandatory in the European Union. A working group established by ENSREG, the European Nuclear Safety Regulators Group, is in charge of planning and arranging IRRS missions in the European member states for the next decade.

The FANC participates to the ENSREG activities, and to the ENSREG working group in charge of planning and arranging IRRS missions in European countries for the next ten years. As Belgium did not yet receive an IRRS mission, Belgium will have the priority to schedule an IRRS mission early in the coming years, taking into account the practical possibilities and it is now foreseen that this IRRS mission will take place around 2013.

However, the FANC started an internal self-assessment in June 2011, which is still ongoing. At a workshop at the FANC, an IAEA team provided information about the “Self Assesment Tool (SAT)” that is intended to be used for the exercise. This first self assessment is pursuing two objectives:

- to familiarize the FANC with the process, taking the opportunity to complete, a first self assessment “lifecycle” without dead line pressure before the self assessment that will take place in the frame of the IRRS mission;
- to get the opportunity to set up a first action plan before the IRRS mission.

Planned measure to improve safety no 4: ***Continue participation in International groups and collaborations***

Belgium is a member of the IAEA and the NEA. Its representatives have been continuing to take an active part in the activities regarding radioactive waste management, such as the Radioactive Waste Management Committee (RWMC) of the NEA and the Waste Safety Standards Committee (WASSC) of the IAEA.

The FANC is also a founding member of the West European Nuclear Regulators Association (WENRA). With Bel V, it participates actively in the Reactor Harmonization working group (RHWG) and in the Working Group on Waste and Decommissioning (WGWD) and in particular in the working group developing reference levels for waste disposal facilities.

The FANC continued its participation to the “European Pilot Group” (EPG), created under the co-chairmanship of the French and Belgian Regulators (ASN, FANC) to undertake a study on the regulatory review of the safety case for the geological disposal of radioactive waste. This group involves regulatory bodies and technical support organizations from eight European Countries and representatives from the IAEA, OECD/NEA and EC. Two working group have been set up, the first produced a report on “The regulatory review of the safety case for geological disposal of radioactive waste”, the second is carrying out a study on the “Waste acceptance in disposals” which should lead to a report in 2012.

At the European level, the FANC and ONDRAF/NIRAS have been participating since the beginning in the European Nuclear Regular Safety Regulators Group, ENSREG. This group was set up as an advisory body to the European Commission, in particular in view of the elaboration of the first European Directive on nuclear safety (2009/71). The FANC participated actively in the discussion and preparation work of this Directive (2009/71/Euratom) and participated actively in the preparation work of the directive 2011/70/Euratom on spent fuel and radioactive waste management. ONDRAF/NIRAS is involved in the working group set up by ENSREG for dealing with radioactive waste management, and more specifically the 2011/70/Euratom directive.

ONDRAF/NIRAS is also member of the Club of Agencies at the European level.

At the European level, the Belgian Nuclear Forum, national federation grouping Belgian companies, institutes and associations related to nuclear, is member of the European Atomic Forum FORATOM. Some members of the Belgian Nuclear Forum participated actively in some Foratom task forces (TF) like the Decommissioning Financing TF and the Waste Management TF. The industry, through this last TF on radioactive waste management, followed the discussions taken place in ENSREG and had actively contributed to the work performed within the ENEF (European Nuclear Energy Forum) sub-group on the implementation of adequate nuclear waste disposal.

ELECTRABEL has been participating actively in the ENISS initiative of Foratom. ENISS represents the nuclear utilities and operating companies from 17 European countries with nuclear power programme. The first task of ENISS is to establish a common industry position with regards to the safety reference levels that WENRA has proposed. Another task of ENISS is to strengthen the industry influence in the revision work of the IAEA Safety Standards. At the European level, ENISS is also cooperating with the European Commission on regulatory issues in the area of nuclear safety, waste management and decommissioning. A specific group is dealing with radioactive waste and spent fuel preoccupations (the Waste & Decommissioning Safety group).

1.3.3 Other developments

a) Adoption of the ONDRAF/NIRAS Waste Plan regarding the long term management of high-level and/or long-lived 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 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), will provide the Federal Government with 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 fuels if declared as waste). Such decision in principle is needed by ONDRAF/NIRAS in order to be able to complete its management system by having a final destination for this type of radioactive waste.
Pending a decision in principle to be made by a full-power government and in order to ensure the continuity of ONDRAF/NIRAS’ public service tasks, in particular the agency’s activities in the field of long-term management of category B and C waste, the supervising Ministers (the Minister for Climate and Energy and the Minister of Economy) have entrusted, by letter of October 3, 2011, ONDRAF/NIRAS with the responsibility of implementing the following six tasks:

1) 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;

2) 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;

3) 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;

4) develop the social dimension of the B&C programme and ensure the related financing;

5) 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

6) follow the evolutions regarding management options that were examined but not chosen in the Waste Plan.

This request prejudges neither the making of a decision in principle on the long-term management of the waste concerned in Belgium nor the contents of this decision.

b) The modifications of the law of August 8, 1980, establishing the creation of a fund for the financing of the cost of the societal integration of a disposal project at the local level

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 facility at the local level. This law entitles ONDRAF/NIRAS to create a fund to cover of 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 total amount of the fund for a specific disposal project, and on the basis of the waste volumes to be disposed of.

c) The Safety audit of Belgoprocess 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 that for some areas additional efforts are needed for improvement.
Belgoprocess developed an action plan based on the outcomes of the audit team in which all necessary improvements are addressed.

The FANC and Bel V will follow up the action plan and verify that the improvements are carried out.
The final results of the safety audit are presented in a comprehensive report that has been published on the FANC website.

d) Progress in the decommissioning of Belgonucleaire

BELGONUCLEAIRE has been operating a MOX-fuel manufacturing facility in Dessel from the mid-80's at industrial scale. In this period, over 35 tons of plutonium were processed into almost 100 reloads of MOX fuel for commercial West-European Light Water Reactors.
At the end of 2005, it was decided to stop the production because of the shortage of MOX fuel market remaining accessible to Belgonucleaire after the successive capacity increases of MOX-plants in France and the UK. Belgonucleaire definitively ended its production activities in the MOX-factory in mid-2006.
The decommissioning license was granted by Royal Decree on 26 February 2008. The current planning of the decommissioning activities is as follows:

- 2009 : Training of the operators and qualification of the tools/equipments and techniques;
- 2010 -2012 : Dismantling of the glove boxes. 12 glove boxes have been dismantled in 2010, 28 glove boxes are foreseen to be dismantled in 2011;
- 2013 : activities related to the infrastructure and to the unconditional clearance of the site.

The objective of the project is to reach the unconditional release of the buildings and of the site in 2014.

e) Progress in the decommissioning of EUROCHEMIC

The dismantling of the former 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 part started in June 2008 and was completed in September 2008. During the demolition of the eastern part decommissioning activities in the remaining and separated building were continued. The demolition of the central part was performed in 2010. Afterwards the demolition of the western and smallest part will follow. Demolition of this part should start in 2013.

f) <u>The removal, transport and conditioning of the Thetis research reactor spent fuel of the University of Ghent (Belgium) achieved in 2010</u>.

The THETIS research reactor on the site of the Nuclear Sciences Institute of the Ghent University has been in operation from 1967 until December 2003. This light-water moderated graphite-reflected low-enriched uranium pool-type reactor has been used for various purposes e.g. the production of radio-isotopes and activation analyses. During the first years its core power was 15 kW. In the early ’70, a core enlargement allowed for operation at typically 150 kW, while the maximum allowed was 250 kW. The fuel was 5% enriched uranium cladded with AISI304L stainless steel, and with graphite plugs at both ends of the tubes.

In order to decommission the reactor, the spent fuel and other radioactive materials present had to be removed from the reactor site.

ONDRAF/NIRAS has developed, together with Belgoprocess, a solution for final conditioning in 400 liter drums of the small amount of spent fuel (84.64 kg of UO_2) and further intermediate storage in its nuclear facilities at the Belgoprocess site in Dessel. This conditioned waste is foreseen to be emplaced in the future geological disposal facility after the intermediate storage period (not before 2050).

Once the feasibility for conditioning and storage was demonstrated, further actions were taken in order to remove the spent fuel from the reactor and to transport it to the processing installation (PAMELA facility) at the Belgoprocess site in Dessel.

Finally, after receiving all necessary licenses, the operations started at the reactor site beginning of 2010. The conditioning of the spent fuel at Belgoprocess resulted in a total of seven 400 L packages that where placed into the intermediate storage building.

g) Achievements of the first Periodic Safety Review of Belgoprocess

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

In compliance with the Royal Decree of 25/10/04, Belgoprocess has to perform a periodic safety review of all its installations on site 1 and site 2.
A periodic safety review of the nuclear installations on site 2 was thus performed in 2006. The results of this safety review were submitted to the Safety Authority 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 decommissioning.

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.
Some additional actions to further improve the safety of the installations were proposed, an action plan was defined in agreement with the regulatory body and is being implemented. The actions of the periodic safety review were planned to be achieved by the end of 2011. The next periodic safety review should begin by 2016.

The safety review on 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, some 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 is now being implemented. Some actions are common to both sites and require a particular attention.

The actions resulting from the periodic safety review are planned to be achieved by the end of 2013. The next safety review should begin by 2018.

A detailed overview of the first periodic safety review of the Belgoprocess facilities is given in annex, Appendix 5.

h) FANC guidance on clearance

On the 30th of April 2010 the FANC has issued guidance on the measurement procedure and measurement techniques for the verification of compliance with the clearance levels set in annex IB of the General regulations for radiological protection. The guidance also covers records management and the storage and the keeping of the inventory of cleared materials.

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 HLW: storage by Belgoprocess	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	SL-LILW : Near surface disposal LL-LILW : no decision yet	Producer pays, contribution to ONDRAF/NIRAS long-term fund; Capacity reservations; Insolvency funds	Surface Disposal for SL-LILW at Dessel. (Gov. Decision taken in 2006, license application in 2012) Under investigation as long term management solution: geological repository in Boom Clay or Ypresian Clay as alternative
Non-power reactors waste	Interim storage at Belgoprocess site	SL-LILW: near surface disposal LL-LILW: no decision yet	Producer pays, contribution to ONDRAF/NIRAS long-term fund; Capacity reservations; Insolvency funds	Surface Disposal for SL-LILW at Dessel. (Gov. Decision taken in 2006, license application in 2012)
Decommissioning Liabilities	Present projects : BR3 Research Reactor; Eurochemic reprocessing plant; SCK•CEN waste department; BN MOX fuel fabrication plant	Responsibility of operator; verification of arrangements and management of decommissioning wastes by ONDRAF/NIRAS SL-LILW: near surface disposal LL-LILW: no decision yet	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)
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

2 Section B: Policies and Practices

2.1 Spent fuel management policy

Seven commercial nuclear reactors of the PWR type are operated in Belgium, leading to a total installed capacity of 6224 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 UO_2, 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 UO_2 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 UO_2 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.

2.2 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;
- 528 canisters of compacted technological and structural (hulls and end pieces) waste;
- 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 62 canisters. See Section 4.1.1 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 economical 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. Another condition put forward by SYNATOM was that the technologies to be implemented needed to be safe, reliable and proven.

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. Six 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 a 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 is 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 . The shipments of the waste generated by the reprocessing of the spent fuel transported in 1993-1994 to the UKAEA (Dounreay) are foreseen from 2011 onwards. They will be 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 BR3-reactor is dry-stored in 7 CASTOR BR3 type casks at the Belgoprocess site.

2.3 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.

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:

1. 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);
2. Compiling an inventory of all radioactive waste streams;
3. Collection and transport of the waste;
4. Processing of the waste;
5. Interim storage of all conditioned waste;
6. Long-term management with disposal as the option in preparation (category A waste) or under investigation (category B&C waste);
7. Tasks relating to the management of 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.

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 safety authority. The set of General Rules was established by ONDRAF/NIRAS, approved by its Board and by the competent minister (Minister of Home Affairs), 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 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.

As decided by the Federal Council of Ministers on 16 January 1998, the policy of long-term management of low and intermediate level short-lived radioactive waste is *disposal*. With this decision ONDRAF/NIRAS was not only asked to develop and study possible disposal concepts, but also to develop structures to integrate such project at a local level. Between 1998 and 2006, ONDRAF/NIRAS worked in a participatory process with representatives of municipalities hosting nuclear facilities (partnerships, see section 8.3.2).

The Council of Ministers decided on 23 June 2006 that the disposal of this 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 analyze 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).

Waste Plan

Before the start of the legal SEA procedure, ONDRAF/NIRAS proactively involved the public in developing the Waste Plan and the SEA. Hence, in 2009 and 2010 a series of participative initiatives ("Dialogues", “Interdisciplinary conference” and a “Citizen’s Conference”) provided an opportunity for organizations, experts and concerned citizens to express their concerns and expectations regarding the long-term management of high-level and/or long-lived radioactive waste. The results of these societal initiatives, as well as the report of the audit committees, composed of independent academics, who observed the conduct of these initiatives, were publicly available and were considered for the drafting of the SEA and the Waste Plan. It is to be noted that the realisation of the Citizen’s Conference was fully entrusted by ONDRAF/NIRAS to the King Baudouin Foundation, a neutral, independent and pluralistic foundation with a proven experience in the use of participative method in technology assessment. In its final report, the Citizen’s Conference supported ONDRAF/NIRAS’ proposal to go for geological disposal in clays and provided a series of recommendations which ONDRAF/NIRAS took into account in the drafting of the Waste Plan.

The SEA considers possible all the options for the long-term management of high-level and/or long-lived waste, including the option that would be to prolong the current situation (status quo). The evaluation of these options was not limited to their environmental impacts, but integrated the four dimensions of a sustainable solution, namely the safety and environmental dimension, the scientific and technical dimension, the economic and financial dimension and the ethical and societal dimension. The evaluations remained however strategic and generic by nature as they were not linked with a specific implementation site.

In line with the procedure of the SEA law of February 13, 2006, the SEA and a Draft Waste Plan were submitted for advice and comments to a series of institutional bodies (the SEA Committee, the Governments of the Regions, the Federal Council of Sustainable Development, and the FANC, as well as to the public at large). Around 2700 comments were received in the framework of this public consultation and systematically analysed by ONDRAF/NIRAS in order to prepare the final version of the Waste Plan.

It is to be noted that in its opinion on the SEA and on the draft Waste Plan, the SEA Committee confirmed the position of ONDRAF/NIRAS, that a transboundary environmental impact assessment was not possible at this stage (considering the generic level, not specific to location, of the SEA analysis). Therefore, the legally requested transboundary consultation of Member States of the European Union or of another Party to the Espoo Convention of 25 February 1991 on the assessment of environmental impact in a transboundary context, is, at this stage, of no application.

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 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.

The Waste Plan as adopted by ONDRAF/NIRAS Board of Directors does not mean the start of its implementation. By "implementation", we understand here a series of concrete actions to achieve the long-term management solution, e.g. selection of a host formation, selection of potential areas of implementation, formalization of processes and structures of local communities' consultation and involvement, choice of one or more sites, local integration, licence applications, ... ONDRAF/NIRAS considers that the start of the implementation of the Waste Plan should be approved by Federal government through a decision-in-principle setting a clear policy for the long-term management of high-level and/or long-lived waste in Belgium and that the gradual implementation of this policy should be guided by a normative system still to be developed.

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 (see section 1.3.3 a)).

2.4 Radioactive waste practices

2.4.1 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/m³) 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, in compliance with the generic limits of 400 to 4 000 Bq/g of long-lived alpha activity according to the recommendations of the IAEA and the European Union, and in compliance with the specific limits for the critical radionuclides as determined by the safety assessments for a specific facility on a specific site. This waste category corresponds to low-level waste in the IAEA waste classification.

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), and its residual thermal power at the time of the disposal requires either limiting the number of packages per meter of disposal gallery, or increasing the distance between the galleries, or increasing the time during which such wastes are to cool down in aboveground purpose-built facilities.

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**

2.4.2 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.

   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).

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.

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 aim of the project phase is to prepare and submit a license application for a surface disposal facility and a production facility for monoliths in Dessel, as well as at reaching a binding agreement between all parties concerned w.r.t. the financing of cost related to the societal support and conditions for integrating the disposal project on the local level. With the law of 29 December 2010 all legal elements for financing of this cost are available.

ONDRAF/NIRAS plans to submit the license application to the FANC in 2012, following an international peer review of the long-term safety case (focussing on long-term safety strategy, long-term safety assessment methodology, as well as the proposed system design and the quality of the scientific and technical basis for the safety assessments) that will take place between October 2011 and June 2012 under the auspices of the NEA/OECD

Disposal of category B&C waste

In Belgium, although studies related to the geological disposal in clay have been initiated more than 30 years ago (see appendix 6), but, this long term management option has not been confirmed on the institutional level as the national policy for the long-term management of category B&C waste. An extensive ans systematic RD&D program on geological disposal in clay (Boom Clay as reference host rock, and Ypresian Clay as an alternative) has been carried out. The latest formal overview of the conducted RD&D was the SAFIR-2 report – Safety Assessment and Feasibility Interim Report 2 –, that ONDRAF/NIRAS presented to the Government and all other stakeholders in 2001. This overview covered the work carried out during the period 1990-2000. On request of the supervising Minister the SAFIR-2 report was submitted to an international Peer Review by NEA/OECD. The final report of the NEA/OECD Peer Review was published in April 2003. The SAFIR-2 report, the findings of the international Peer Review and the work conducted till now confirm that none of the information obtained from the RD&D has so far indicated any obstacle that might prohibit the disposal of the vitrified waste from the reprocessing of spent nuclear fuel or the disposal of spent fuel into the Boom Clay. This increases confidence in the studied solution and confirms that disposal in a poorly-indurated clay remains a viable option for the types of waste considered in the SAFIR-2 report. The international Peer Review and the decisions taken on its basis pointed to the need for:

- Pursuing the RD&D efforts to reduce uncertainties and increase safety margins;
- Specific regulatory guidance related to geological disposal;

- A societal legitimisation of the fundaments of the RD&D programme and of ONDRAF/NIRAS reference long term management option (i.e. the definition at the governmental level of a policy for the long term management of such waste).

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 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. For the different research and development, short term management and long term management activities, 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. The RD&D programme has benefited from its inception from EC contributions, especially regarding the construction of the HADES URL and the performance of in situ experiments. Currently, ONDRAF/NIRAS is actively participating in the EC framework programme 7 and 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.

A new agreement between the FANC and ONDRAF/NIRAS, transposed into regulations by two Royal Decrees of 13 June 2006, arose from the concern that the protection of the population and the environment is not favoured by imposing the associated costs on the finders of these sources, who already contributed to their detection and recovery. Before this new agreement, when a radioactive orphan source was discovered and no responsible person or operator could be identified, the costs for the management as radioactive waste had to be covered by the finder himself.

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 a fund managed by the ONDRAF/NIRAS, that was previously fed by a special contribution levied on the tariff for the normal radioactive waste treatment operations and that originally aimed at covering the risk of insolvency. The operators of the facilities must also follow the guidelines of the FANC to protect their facilities from the entrance of radioactive orphan sources and to prevent the presence of such sources in the supply of goods and bulk materials. Orphan sources that are detected in shipments coming from outside Belgium will not be compensated.

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 works, 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. In the event of the detection of such a source the operator has to follow the guidelines of the FANC and accept its investigation to verify if its guidelines are complied with and to determine possible responsibilities. It is expected that with this instrument more orphan sources will be recovered and declared at ONDRAF/NIRAS.

The mandatory installation of radiation portal monitors is, at present, only implemented to a set of facilities on a regional basis, but, in the near future, will be extended at the federal level with the adoption of a new royal decree proposed by the FANC.

According to the draft royal decree regarding the screening for radioactive substances in certain material and waste flows and the management of orphan-source sensitive facilities, an orphan-source sensitive facility is defined as that installation or that site that handles one or more orphan-source sensitive flows and where activities are performed causing harm to the environment and the public health and which, for that reason, are subject to notification and licensing pursuant to the regional environmental legislation.

The European List of Waste was taken as a basis for the definition of these flows.

The regulatory proposal was approved by the Council of Minister on 18 February 2011 and is currently being reviewed by the State Council.

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

3 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.

4 Section D: Inventories and lists

4.1 Spent and reprocessed fuel coming from nuclear power plant: management facilities and inventories.

4.1.1 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 mid 2011,, 387 “CSD-V”canisters containing about 150 litre of glass – amounting to an average mass of 493 kg per canister and a total volume of 59 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). 144 “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	387	5.90E+18	8.03E+16	1.52E+16	2.07E+14
CSD-C	144	1.44E+16	6.26E+13	1.00E+14	4.35E+11

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.

The number of CSD-C that must still be repatriated is estimated at 288 units. To conclude the actual contract, an estimated number of 62 containers with intermediate-level vitrified waste (CSD-B) will be returned to Belgium.

4.1.2 Non-reprocessed spent fuel

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).

As far as spent fuel storage is concerned, the dry storage building at Doel contained (on 30 April 2011) 74 containers, in which 2194 fuel assemblies are stored, i.e. about 45% of the current storage building capacity.
The wet storage building at Tihange contained (on 30 April 2011) 1979 fuel assemblies, i.e. about 55% of the total storage capacity.

4.2 Spent and reprocessed fuel coming from research reactors: management facilities and inventories.

Beside the seven power reactors, Belgium also possesses research reactors:

Reactors BR1, BR2, BR3 and VENUS, all located on the SCK•CEN site in Mol.

a) 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 GUINEVERE-project at VENUS, uranium metal fuel rodlets are used as mentioned before (see paragraph 2.1).
b) 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 plant in La Hague to be reprocessed. Dounreay is no longer an option.
c) 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. The conditioned waste is stored in a facility on the site of Belgoprocess awaiting disposal.

4.3 Radioactive waste: management facilities and inventories.

Processing and storage 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.

4.3.1 The Belgoprocess sites 1 and 2

ONDRAF/NIRAS has subcontracted the industrial aspects of the 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:

1. **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.

2. **BRE**, started up in 1980 on site 2 of Belgoprocess to process high and intermediate level liquid waste.

3. **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 will come into operation end of 2011.

4. **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 cm^3 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).

5. **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 after processing of the organic effluents between 2000 and 2002. For the moment, no further use of this installation is foreseen.

6. **PAMELA** (site 1) was put into service in 1985 and was used until 1991 for vitrifying the 860 m^3 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 conditioning of alpha-contaminated waste and medium-high level solid waste streams. After licensing and testing, the facility became operational early 2007 and is still in operation.

7. **ALPHA-KAMER** (site 2) for the treatment of low Ra-contaminated waste. This installation will be again be used after 2012

8. **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

9. **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 will be 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).

1. **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).

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).

3. **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.

4. **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.
5. **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.

6. **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).

7. **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.

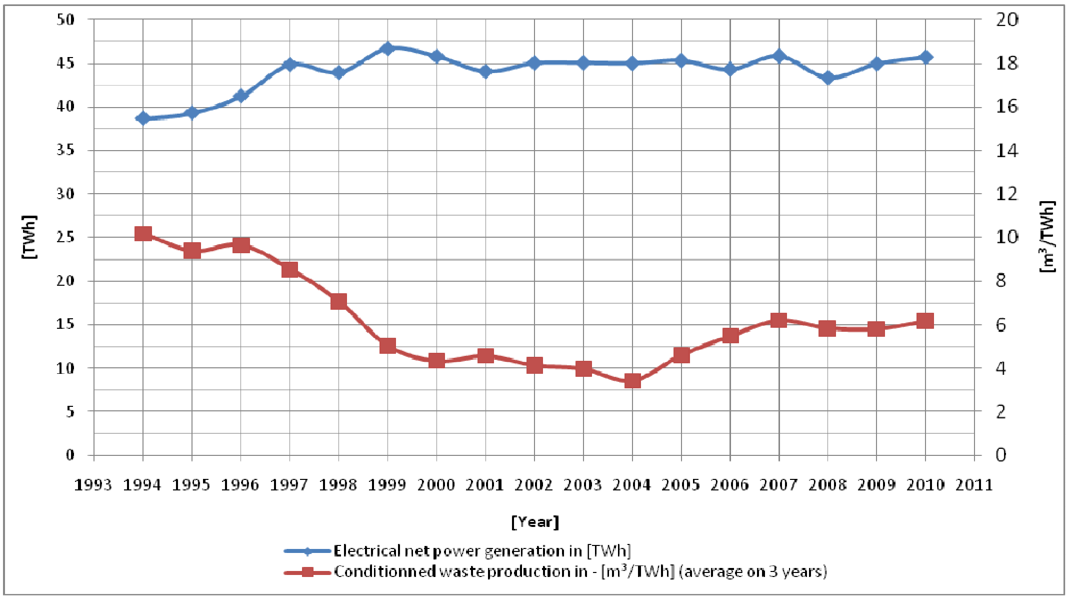
Table 2: volume and activity per storage building as of December 31, 2010

Buildings	Waste categories	Number packages (#) / volume (m³)	Capacity (#) / filling rate (%)	Activity [1](Bq)	
				Alpha	Beta-gamma
127	A + mainly B	15583 / 3748	18402 / 85 %	$3,3\ 10^{14}$	$4,5\ 10^{16}$
129	C	2335 / 215	2572 / 91 %	$1,7\ 10^{15}$	$3,7\ 10^{17}$
136–Zone C	C	390[2] / 59 (vitrified)	590 / 66 %	$8,0\ 10^{16}$	$5,9\ 10^{18}$
136-Zone D	B	48 / 9 (compacted)	2779 / 2 %	$5,9\ 10^{15}$	$2,0\ 10^{13}$
150	A + B	3317 / 1914	3424 / 97 %	$1,9\ 10^{12}$	$2,2\ 10^{14}$
151	A + B	33411 / 13282	37267 / 90 %	$5,9\ 10^{13}$	$1,1\ 10^{15}$
155	B + R	1584 / 634	9000 / 18 %	$8,0\ 10^{14}$	$7,7\ 10^{15}$
156	C	7 castors	8 / 88 %	$2,0\ 10^{15}$	$1,0\ 10^{17}$
270	A + B + R	735 / 289	4899 / 15 %	$8,1\ 10^{12}$	$8,8\ 10^{13}$

4.3.2 The sites of the Doel and Tihange nuclear power plants

The Tihange and Doel nuclear power plants have their own processing facilities qualified by ONDRAF/NIRAS. The waste processed on the production site is composed of the waste (ion-exchange resin, filters and other diverse waste) with a dose rate higher than 2 mSv/h and the evaporator concentrates. Non-conditioned waste with a dose rate lower than this limit is sent to Belgoprocess where it is conditioned in CILVA.

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 waste conditioned (in the NPP or in the CILVA installation) is stored in buildings 151 or 127. More details can be found in appendix 2 and 3.



Waste and net power generation of the Belgian nuclear power plants

[1] As of 30 September 2007 (while volumes in storage as of 31 December 2007)

4.3.3 The Umicore site in Olen

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 ^{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.

In order to advance with respect to the decision on the long-term management of the storage facility, ONDRAF/NIRAS has issued a document in which the possible options for the long-term management of the UMTRAP facility are described and assessed. This document has been presented to UMICORE and FANC for further discussion on a global plan for the Olen site.
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- 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 cleanup 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.

Situation mid 2011

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 has organised a workshop with the authorities (FANC, authorities of the Flemish region, ONDRAF/NIRAS) to make a global assessment of the situation and to discuss remaining issues and a way forward.

For the UMTRAP storage facility the options that ONDRAF/NIRAS has described and assessed in its position document (November 2009) are (1) continued storage with active management of the facility (monitoring, surveillance, maintenance when required) for an indefinite period of time, or (2) removal of all radioactive materials with radiological characteristics that require a disposal solution at depth, with surface disposal of the remaining material. As required by the Royal Decree of June 20, 1995, it is the responsibility of UMICORE to make a detailed assessment, in interaction with the authorities, in order to select the optimal option for the long-term management.

In a convention signed by UMICORE and the regional authorities a start of the remediation activities for the D1 landfill before 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.

ONDRAF/NIRAS will prepare a specific waste management plan for Ra-bearing waste in Belgium in the next years. This waste plan will cover all radioactive Ra-waste in the storage facilities in Olen, as well as Ra-bearing waste from the site remediation projects for the D1 landfill and all the other contaminations in Olen. It will also integrate other Ra-bearing waste on the Belgoprocess site in Dessel. The principal aim of this Ra-waste plan is to define a global policy for the long-term management of all this waste.

4.3.4 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 second inventory of nuclear liabilities published in 2009, according the law of 12 December 1997, ONDRAF/NIRAS identified some 156 000 sealed sources on 1 January 2006 on the Belgian territory, comprising:

- 11 837 sealed sources for general industrial and medical purposes (namely 1 353 high active sealed sources and 10 484 low active sealed sources);
- about 143 200 ionizing smoke detectors;
- some 1 000 ionizing lightning rods.

The third inventory report of nuclear liabilities will be available beginning of 2013.

Specific actions were organised by ONDRAF/NIRAS and the FANC in order to collect radioactive sources at secondary schools and pharmacist. A collection oganized by ONDRAF/NIRAS and the FANC for typical hospital waste is scheduled in 2012. Furthermore, the management of ionizing household smoke detectors is now organized via a collection at waste facilities and a centralised dismounting of the radioactive sources, followed by a further management as radioactive waste 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.

4.4 Nuclear facilities being decommissioned.

Five main facilities are concerned:

- the reactor BR3 of SCK•CEN and its building should be completely dismantled in 2020; decommissioning and dismantling serve as a pilot project;
- The demolition of the Eurochemic Reprocessing plant is being be 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 part started in June 2008 and was completed in September 2008. During the demolition of the eastern part decommissioning activities in the remaining and separated building were continued. The demolition of the central part was performed in 2010. Afterwards the demolition of the western and smallest part, follows. Demolition of this part should start in 2013;
- the dismantling of the former SCK•CEN Waste department (site 2 of Belgoprocess) started in 1998 and should end in 2050;
- BELGONUCLEAIRE (BN) has been operating a MOX-fuel manufacturing facility in Dessel from the mid-80's at industrial scale. In this period, over 35 tons of plutonium were processed into almost 100 reloads of MOX fuel for commercial West-European Light Water Reactors.
  At the end of 2005, it was decided to halt the production because of the shortage of MOX fuel market remaining accessible to BN after the successive capacity increases of MOX-plants in France and the UK. BN definitively ended its production activities in the MOX-factory in mid-2006.
  According to the Royal Decree of 20 July 2001 a decommissioning license must be granted before starting the actual decommissioning activities of nuclear facilities. A decommissioning license application was submitted to the FANC in April 2006. Such license application also deals with the disposal, the recycling or the reuse of the materials which can be removed, after possible decontamination, from these installations. The decommissioning safety case contained a risk evaluation of the potential decommissioning risks: criticality, fire and loss of containment, in addition to the common risks of industrial activities (load drops, injuries, etc).
  Following review of this license application by the FANC and the Scientific Council, and following consultation of the local authorities, a decommissioning license was granted by Royal Decree on 26 February 2008. This decommissioning license sets the conditions to ensure the safe decommissioning of the MOX-plant, with specific attention to:
  - the use of subcontractors with necessary training and experience;
  - the use of best available glove box cutting and dismantling techniques;
  - the clearance of decommissioning waste and final release of the site.

  As a significant part of the decommissioning project of this Dessel plant, about 170 medium-sized glove-boxes are to be dismantled. Different options for the decommissioning of the alpha-contaminated glove boxes were investigated by BN The selected strategy consists in using cold cutting techniques and manual operation in shielded disposable glove-tents, and packaging alpha bearing waste in 200-liter drums for off-site conditioning and intermediate storage.

The aim of the decommissioning project is to dismantle all the installations within the buildings of the MOX-plant. Immediately after ending the production activities, a number of technical risk-reducing measures were taken (removal of remaining fissile materials, disconnection of electricity cables in glove boxes,…). In the transition period between operation and the start of decommissioning the safety and security of the facility was ensured by remaining staff members.

After a first consultation round concluding that fixed price contracting was not possible, BN decided to take over the leadership and the management of the decommissioning project and to bear all associated risks; BN decided to perform the decommissioning works with three specialized main contractors, namely the Consortium Belgoprocess-SCK-CEN (B), Tecnubel NV (B) and Studsvik GmbH (D). The three main decommissioning services contracts were awarded in March 2009. These contracts cover a period of 5 years, corresponding respectively to one year (2009) for the education and qualification of contractors' staff and operators, three years for the decommissioning of the glove boxes (2010, 2011, 2012), and one year for the decommissioning of the main infrastructures and the release of the buildings and of the site.

The decommissioning project started in March 2009: 35 BN employees ensure the lead and management of the project and perform key safety related and technical functions. The total contractors' workforce amounts to 85 people, involved in various staff as well as execution functions.

The objective of the project is to reach the unconditional release of the buildings and of the site in 2014.

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- The University of Ghent has submitted to ONDRAF/NIRAS the final decommissioning plan of the THETIS reactor. This final decommissioning plan was approved by ONDRAF/NIRAS in 2009. Consequently, the dismantling licensing file was submitted to the FANC in 2010. It is foreseen to obtain the dismantling license by the end of 2011. The decommissioning will start immediately after getting the license and will take 3 years.

- Decommissioning License for old production buildings of FBFC International

FBFC International, affiliate of the AREVA group, operates a Low Enriched Uranium fuel manufacturing facility in Dessel from 1958. In this period, over 25.000 uranium assemblies were processed for commercial Pressurized Water Reactors in many countries all over the world. Since 1997 FBFC International operates also a large scale MOX fuel manufacturing facility starting from sealed MOX pins delivered by subcontractors. Up to now, more than 3.000 MOX assemblies were delivered to Light and Boiling Water Reactors worldwide.

At the end of 2008 it was decided to centralize the nuclear activities from two old buildings into the new production building and to decommission the old buildings.

According to the Royal Decree of July 20 2001 a decommissioning license must be granted before starting the actual decommissioning activities of nuclear facilities. A decommissioning license application was submitted to the FANC in December 2009 including the decommissioning of the MOX building, in the case of a stop of these activities in Belgium by AREVA. Such license application also deals with the disposal, the recycling or the reuse of the materials which can be removed, after possible decontamination, from these installations. The decommissioning safety case contained a risk evaluation of the potential decommissioning risks: criticality, fire and loss of containment, in addition to the common risks of industrial activities (load drops, injuries, etc).

Following review of this license application by the FANC and the Scientific Council, and following consultation of the local authorities, a decommissioning license was granted by Royal Decree on December 2010. This decommissioning license sets the conditions to ensure the safe decommissioning of the concerned buildings with specific attention to:

- the use of subcontractors with necessary training and experience;
- the use of best available dismantling techniques, including decontamination of contaminated metals;
- the clearance of decommissioning waste and final release of the buildings.

It was decided very recently to start the dismantling works in “building n° 3”. This is the oldest workshop of the facility in which liquid solutions of uranium such as UF6 and uranium solutions were treated. In such a situation not only superficial contamination, but also penetration in the floor is possible. Different options for the decommissioning were investigated by FBFC International. The selected strategies consist in shaving and scabbling of walls and floor, partially manually and partially by automated techniques. The waste will be put in 200 litre drums, measured by γ techniques (ISOC’s) and sent for offsite conditioning and intermediate storage to the Belgian National Disposal Centre for Nuclear Waste (Niras). Deliberation of surfaces will be performed by manual α/β measurements.

Metallic structures and machinery have been dismantled by FBFC International, cut in pieces and loaded in 200 litre drums. These drums will be sent to a melting facility in Europe. This facility is able to separate by melting the radioactive part from the non radioactive part. The cleared metal will be integrated in the classical metal scrap circuit. The contaminated slack will be sent as nuclear waste to ONDRAF/NIRAS.

The aim of the decommissioning project is to dismantle all the installations within the concerned buildings. Immediately after ending the production activities, a number of technical risk-reducing measures were taken (removal of remaining fissile materials, disconnection of electricity cables, …). In the transition period between operation and the start of decommissioning the safety and security of the facility is ensured by the personal of the rest of the site.

Because decommissioning is a specialized activity and not part of the core business of FBFC International, it was decided early on to subcontract the decommissioning work to specialized companies. The actual start of the decommissioning activities, after selection of the contractors, is expected to begin in September 2011.

Moreover, some smaller buildings of Belgoprocess and SCK•CEN were decontaminated and some of them decommissioned.

5 Section E: Legislative and Regulatory System

5.1 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, section 5.2.1.2), the adoption of the Law of 31 January 2003 concerning the phasing-out of nuclear power and 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.

5.2 Article 19: legislative and regulatory framework

Belgium participated in the first, second and third Review Meeting of the Joint Convention, which took place in November 2003 in May 2006 and in May 2009 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 was described in extenso in the National Reports, which were elaborated as a result of the five Review Conferences, organised respectively in April 1999, April 2002 , April 2005, April 2008 and April 2011. Below, attention is paid exclusively to those regulatory aspects relevant for the management of radioactive waste and spent fuel.

5.2.1 Identification of the competent authorities

5.2.1.1 **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 consultation (for instance in the framework of the licensing of 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, see sections 5.2.1.2 and 5.2.1.3.).

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.

5.2.1.2 **Safety Authority**

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.

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 class I facilities, delegates different tasks to Bel V, its subsidiary, a.o. routine inspections.

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[2], 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. A more detailed description of the provisions

[2] 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. See also section 9.1

concerned is given further in this report (see article 19, section 5.3). The General Regulations are modified regularly in order to take account of the evolution of the scientific, technical and social insights.

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 6.5 of the present document devoted to article 25 of the Convention.

5.2.1.3 **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, thus, 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.

	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 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 Authorities 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 (section 5.2.1.3.1). 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 disposal (section 5.2.1.3.2) and the predisposal activities (section 5.2.1.3.3).

5.2.1.3.1 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 for reasons of harmfulness for public health as radioactive waste.

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 Authorities* (FANC) *consider acceptable for substances permitted to be used or released unsupervised"*. These values are published in the GRR-2001 (see further section 5.3.1.2).

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

Radioactive waste, just as other categories of waste, are by definition substances for which no further use is foreseen. The assessment of the possibility to re-use certain materials or not, should normally be made by the owner/producer.

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 regulations do not apply to it. 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 5.2.1.5) 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. This aspect will be treated in section 5.2.1.4. 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.

5.2.1.3.2 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 systems. Besides that international developments with respect to a disposal system on a broader regional scale are followed,..

The final solutions considered will - at the proper time - be submitted for approval to the political and the safety authorities. The governmental decisions of 16 January 1998 and 23 June 2006 on the surface disposal of short-lived waste are an illustration of such a decisions. On the basis of these decisions ONDRAF/NIRAS is currently preparing the license application for a surface disposal facility in the municipality of Dessel.

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, 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.

5.2.1.3.3 Missions of ONDRAF/NIRAS with regard to operations prior to the disposal

As explained in section 5.2.1.3.2, 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 has to 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 Safety 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.

The involvement of ONDRAF/NIRAS in the different waste operations is clearly part of its waste disposal task. The qualification of waste processing equipments and the establishment of acceptance criteria for conditioned and non-conditioned waste aim at making the processing in conformity with unequivocal norms to obtain thus a quality guarantee of the waste management up to the disposal stage (see article 23 of the Convention).

ONDRAF/NIRAS is a service provider for the waste producers. An integrated waste management exceeds indeed the possibilities of the individual waste producers. Technological and financial implementation of the waste management with a view of reaching the strict equity between the waste producers implies the application of the “polluter pays” principle; achieving this is "pre-eminently" the role of a public body. All the costs linked to the activities of the Agency are at the expense of the waste producers, according to distribution keys based on objective criteria.

5.2.1.4 **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 the present, 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 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 6.2.2.2. This law also determines the management of funds built up by SYNATOM for the decommissioning of the nuclear power plants (see section 5.2.1.5).

Due to the gradual *phasing-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, underwritten by the government. No new reprocessing contract may 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 BP1 site (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 NC 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.

5.2.1.5 **Management of the decommissioning and dismantling of nuclear facilities**

Every owner or operator of a nuclear installation is responsible for the future dismantling of his installations, once they are definitely decommissioned. ONDRAF/NIRAS verifies that the owner/operator undertakes timely the necessary steps in order to carry out the dismantling programme; the owner/operator has to submit his decommissioning programme to ONDRAF/NIRAS for approval. The radioactive waste resulting from the dismantling is subject to the management of 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. Indeed, 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 of that waste before being transferred to ONDRAF/NIRAS.
At the time the installation is to cease its activities and is to be dismantled, the full procedure (described in 5.3.1.4) to obtain the required licenses is applicable.

If the owner/operator chooses to renounce the dismantling 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”), some decommissioned installations of SCK•CEN, such as the research reactor BR3 (technical SCK•CEN liability) and some of the IRE buildings (“IRE liability”). The dismantling operations on the BP1 and BP2 sites 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 buid 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 for 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 funds, controlled by a follow up committee, composed of experts appointed by law. For the conclusions of the follow-up committee with respect to the sufficiency of financial funding level, an assent 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 6.2.2.2.2 for more details).

In 1997, the legal missions of ONDRAF/NIRAS were extended to the creation of an 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. The second inventory was created in December 2007,and submitted to the responsible Minister. An update of this inventory will be made by 2013.

5.3 Regulations regarding the management of radioactive waste and spent fuel

5.3.1 The regulations applying to the facilities dedicated to the production, processing, storage or disposal of radioactive waste or spent fuel

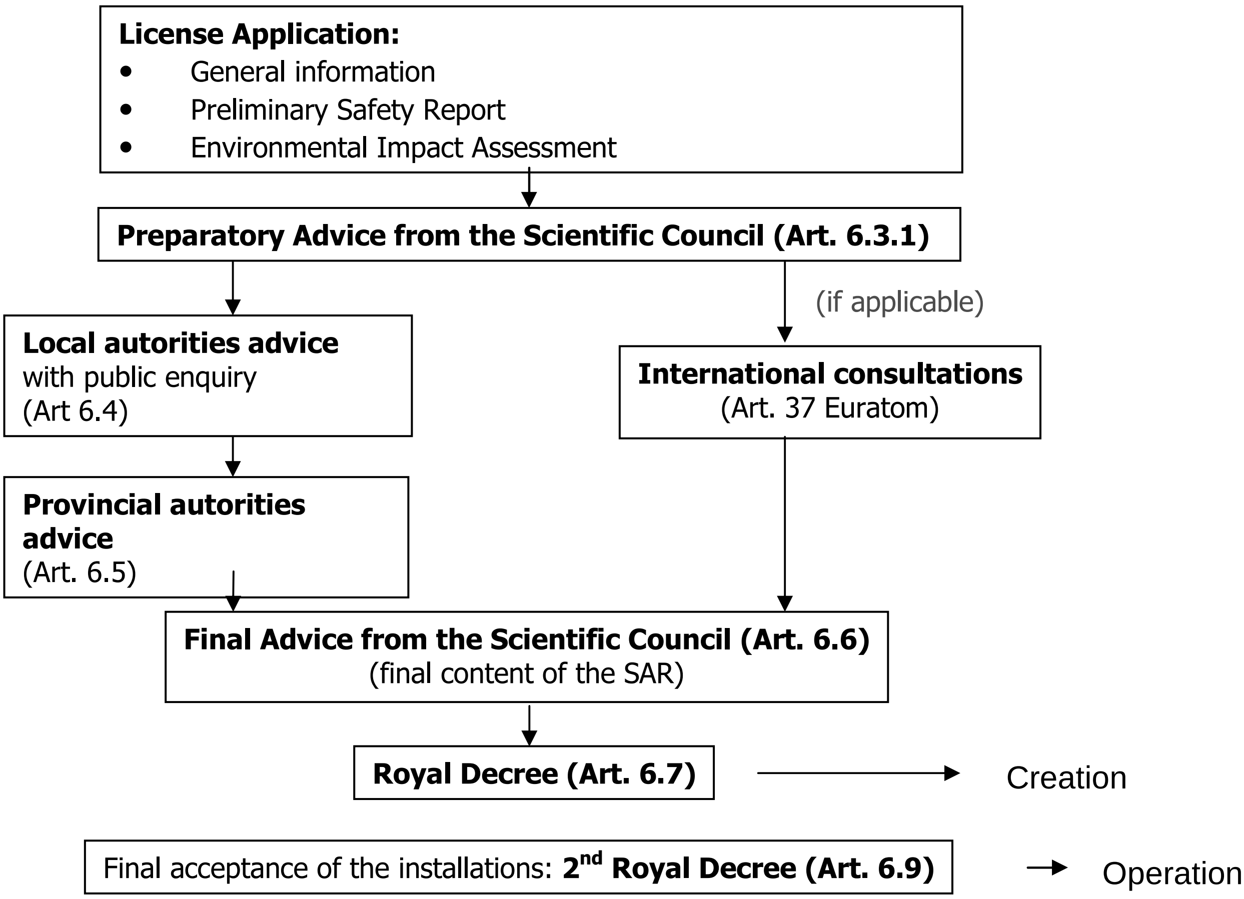
5.3.1.1 **The licensing system for the creation and operation of nuclear facilities.**

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 and investigated by 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. Bel V performs a safety review of the license application which is submitted to the FANC. 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”.



Licensing Procedure for Class I facilities.

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

A. Facilities dedicated to processing, storage of radioactive waste

Facilities for radioactive waste disposal and 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 is those on the two Belgoprocess sites BP1 en BP2, respectively in Dessel and Mol. ONDRAF/NIRAS is developing a surface disposal facility for the category A waste

B. Facilities dedicated to disposal of radioactive waste

A proposal of licensing procedure for repositories has been submitted to the government for approval (as described in section 1.3.1). This licensing procedure is similar to other Class I facilities, but take 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, treating or storing irradiated fissile material are 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 nuclear facilities that are legally subject to a license, and categorized into class I, II or III according to the GRR-2001, 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 kind 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 this Agency concerning the management of the radioactive waste.
ONDRAF/NIRAS receives systematically a copy of every license issued. By this way, ONDRAF/NIRAS is informed of the identity of the potential waste producers.

If the FANC grants a license exemption for the use of type approved 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.

5.3.1.2 **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 of 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 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). According to Article 81.2 of the GRR-2001, the authorised discharge limits (gaseous and liquid releases) for Class I facilities have been re-evaluated in 2002. The authorized discharge limits for 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 <u>authorized releases</u>			Calculation of the annual exposure to the most exposed individual resulting from the <u>average actual releases between 1991-2000</u>		
	Gaseous	Liquid	Total (maximum) (*)	Gaseous	Liquid	Total (maximum) (*)
SCK•CEN	0.1 mSv	-	0.1mSv	60 nSv	-	60 nSv
FBFC	10 µSv	-	10 µSv	5 nSv	-	5 nSv
Belgonucleaire	5 µSv	-	5 µSv	10 nSv	-	10 nSv
Belgoprocess	0.3 mSv	0.2 mSv	0.5mSv	60 nSv	625 nSv	685 nSv
IRMM	5 µSv	-	5 µSv	70 nSv	-	70 nSv
total MOL - Dessel site	*0.42 mSv*	*0.2 mSv*	*0.62 mSv*			
IRE site (**)	0.19 mSv	<10 µSv	0.2 mSv	80 µSv (**)	<10 µSv	80µSv (**)
Tihange site (3 NPPs)	0.19 mSv	0.08 mSv	0.21 mSv	47 µSv	2.5 µSv	49 µSv
Doel site (4 NPPs)	0.18 mSv	0.23 mSv	0.37 mSv	18 µSv	2.3 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 are not in the same age category.

(**) The actual average value is given for the years 2000-2005

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 disposition of the Safety Authority and of ONDRAF/NIRAS.

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.

5.3.1.3 **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 operator has to register with ONDRAF/NIRAS and has to conclude an agreement with ONDRAF/NIRAS with regard to management of all the 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 radioactive waste (e.g. SYNATOM). Finally, the GRR-2001 provides for sanctions in case of non compliance (see also section 5.4.1.).

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 has been completed). Attachments 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 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.

5.3.1.4 **Decommissioning and dismantling of a nuclear facility**

According to ONDRAF/NIRAS legislation, the operators/owners have to submit their programmes for the future decommissioning of their radioactively contaminated installations to ONDRAF/NIRAS for approval. The decommissioning of important licensed facilities (class I and some of class II) is subject to a license and requires in some cases an environmental impact assessment. The license application has to be accompanied by the 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 decommissioning. ONDRAF/NIRAS is charged with the gathering and assessment of all the information enabling it to manage the waste generated during decommissioning. The application for a creation and operation license for a class I or class II facility has to contain information about the expected amount of decommissioning waste.

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

5.3.2 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 [3] 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.

5.3.3 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 using natural radiation sources. Companies belonging to a list of industrial activities have to submit a notification to the FANC. If the risk of exposure of workers or public may exceed the dose limits, corrective measures or possibly licensing of the activity must be implemented. Because of enrichment of the radionuclides during processing of raw materials, residues or waste generated may need, from the point of view of radiological protection, special attention. The FANC can decide that such activities be subject to specific provisions and the generated waste subject to the management principles of ONDRAF/NIRAS.

FANC established a working group in order to more clearly define under which conditions these residues may be recycled or treated as non radioactive waste. A decisional flow-chart has been developed. Limits of activity concentration are defined for the various possible ways of treating NORM residues (recycling in building materials, land filling, incineration,…). A system of control and follow-up will also be established.

The proposals of FANC have been discussed with the stakeholders: professional associations of (non radioactive) waste treatment operators, environmental authorities,… These proposals will be finalized end 2011: they will subsequently be transposed into an appropriate legal framework.

[3]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.

5.4 Article 20: Regulatory Body

As explained in the National Report elaborated within the framework of the Convention on Nuclear Safety, a control 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 companies (such as ELECTRABEL, SYNATOM, Belgoprocess,…) are represented on an organizational schema (see chart on page 66).

5.4.1 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 (FANC) is an autonomous government agency with corporate personality. The Agency is directed by a 14-headed Board; 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 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.
According to article 9 of the law of 15 April 1994, the nuclear inspectors are nominated by the King and they are considered as judiciary police officers, auxiliaries of the King's Attorney. 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. The receipts and expenditures of the Agency have to be in equilibrium.

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 delegates different tasks to Bel V, its subsidiary, a.o. routine inspections.
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.

5.4.2 The statute of Bel V and its relations with the FANC

Bel V's General Management reports to a Board of directors, appointed by the Board of the FANC.

The staff of Bel V is composed of experts from the former Authorized Inspection Organisation AVN and is carrying out all the regulatory activities since April 2008, including the surveillance activities, previously performed by AVN. Only recognized experts (according to article 73 of the GRR-2001) can perform surveillance activities.

Within the framework of the Belgian legislation, Bel V :

- Supervises the delivery and the operation of the installations, verifies the compliance with the licence requirements and recommends the licensee to take corrective measures if conditions of degraded safety are detected. Bel V has no enforcement power to impose actions on the licensee but has the possibility to indicate the problems to the FANC, if necessary.
- Advises the authorities on the development of nuclear emergency planning and intervenes in the management of nuclear and/or radiological crisis situations.
- Performs and evaluates safety reviews in the nuclear and radiation protection fields.

Bel V's technical personnel comprises some 55 university graduates (engineers and physicists), and recruitment is consistent with the foreseeable workload. The workload relating to inspection of installations is more or less constant; more variable is the time load regarding the progress of the applicants' projects and the number of studies to be reviewed, and also regarding the assessment of incidents or specific safety problems in the installations.

As supervision action of the FANC on Bel V, a "Management Agreement" is being concluded between the FANC and Bel V. It formalizes several aspects like:

- The description of regulatory tasks that Bel V performs on behalf of the FANC
- The approval by the FANC of the inspection programme of Bel V
- The control of the tariffs of Bel V
- The quality management policy of Bel V
- Some financial arrangement between FANC and Bel V
- Avoiding conflicts of interests
- Some human resource agreements
- Elements of the Bel V Management policy
- …

This management agreement is concluded for a period of 5 years and implicitly renewed at the end of each period. It can also change/evolve in function of experience feedback, future needs or missions.

Bel V being a non-profit organization, its financial resources are used to pay for its personnel (including training), to participate in national or international working groups, for research and development activities, for keeping technical and regulatory documentation.

More information on Bel V, the organisation and its duties is available on its web site: http://www.belv.be.

5.4.3 Relations between ONDRAF/NIRAS and the FANC

The Belgian Agency for Radioactive Waste and Enriched Fissile Materials (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, issued formally by the political Authorities. 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.

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, 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 by the FANC. ONDRAF/NIRAS is responsible for the decommissioning of installations on these sites, which ceased their activities. It is charged with the development of repositories for the waste. Even though ONDRAF/NIRAS is currently neither an operator of nuclear installations, nor a holder of nuclear licenses, the missions subcontracted by this Agency are performed by the operators (e.g. Belgoprocess) under its responsibility and supervision. None of the missions exercised by ONDRAF/NIRAS can be regarded as missions belonging to the Regulatory Body (in conformity with art. 20, paragraph 2, of the Convention).

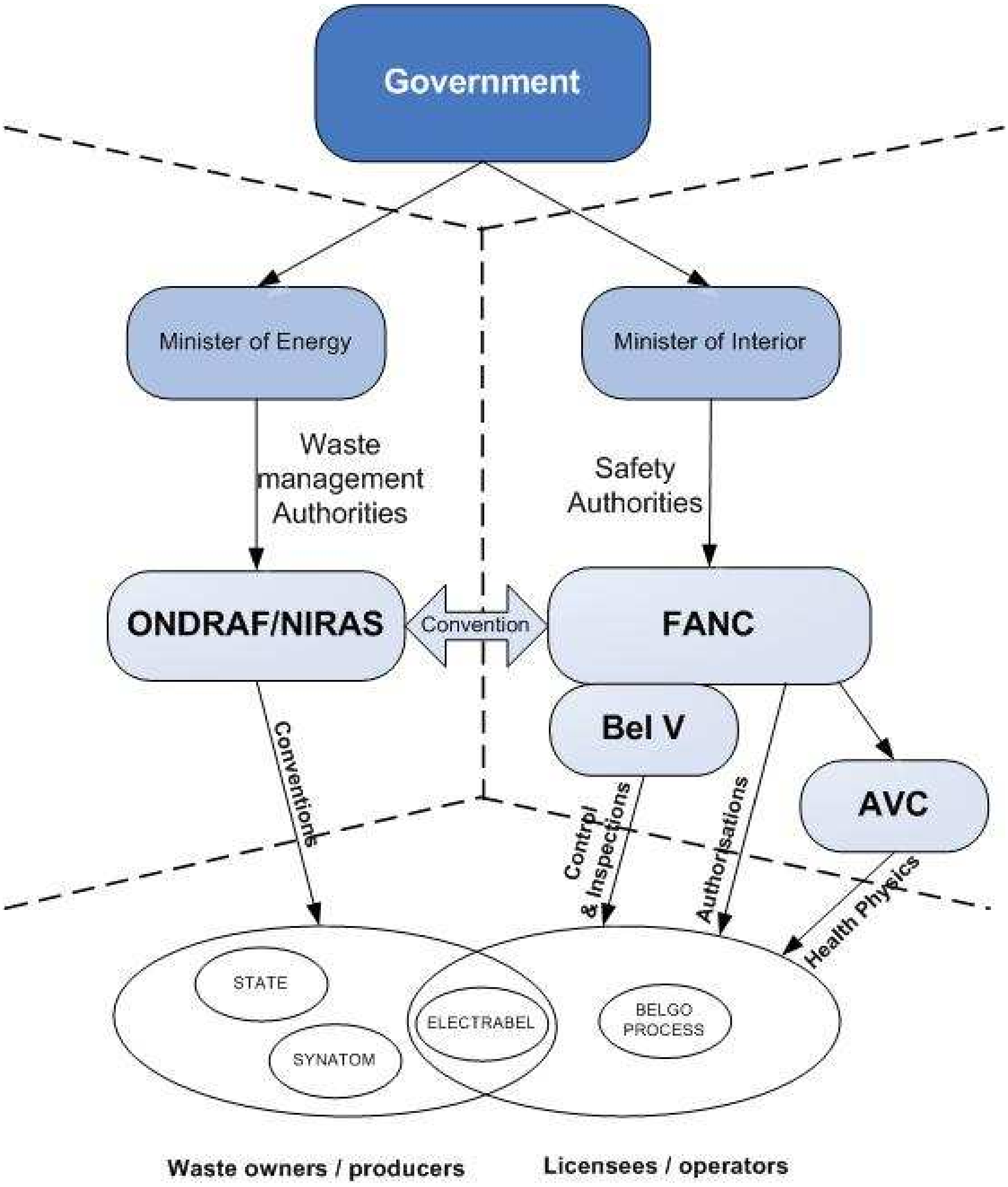
The distinction between the competences and responsibilities of the FANC and ONDRAF/NIRAS are formalized, because the supervision and political responsibility of these public institutions is exercised by different members of the federal government. This does not prevent both public institutions from 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. For more information: www.nirond.be

As the responsible agency for radioactive waste management, ONDRAF/NIRAS works for all matters related to the safety of waste management and the protection of the environment in close cooperation with the FANC. A formal agreement organising 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.

Belgoprocess is a company of which all the shares are held by ONDRAF/NIRAS. 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.

Belgoprocess is the industrial arm of ONDRAF/NIRAS. ONDRAF/NIRAS installations for processing and storage of radioactive waste are operated by Belgoprocess; these are located on two sites BP1 and BP2. Belgoprocess is holder of the operating licenses. The agreements between ONDRAF/NIRAS and Belgoprocess are laid down in long-term agreements. More information can be found on www.belgoprocess.be

Organisational Structure of the Relationships between the Waste management Authorities an the Safety Authorities



Belgoprocess is the daughter company of ONDRAF/NIRAS. AVC is an "AIO"

6 Section F: other general safety provisions

6.1 Article 21: Responsibility of the licensee

Radioactive materials can not be brought into or processed in a class I facility until it has been licensed by Royal Decree. For class II and III facilities, the licenses are issued by the FANC.

The Royal Decree of 20 July 2001 (GRR-2001) stipulates (art. 5.2) that the operators of the facilities are to comply with the conditions set in the licenses.

For class I facilities, one of the licensing conditions is the conformity with the ‘safety analysis report’ (SAR) handed in with the application. The SAR must be kept up to date. .

The license also requires that the installation is in conformity with the general data to be provided by virtue of article 37 of the Euratom Treaty (if applicable). This article 37 requires that each Member State is to provide the European Commission with general data relating to any plan for the disposal of radioactive waste in whatever form in order to make it possible to determine whether the implementation of this plan is likely to result in the radioactive contamination of the water, soil or airspace of another Member State.

Note that the Commission recommendation of 6 December 1999 stipulates that the ‘disposal of radioactive waste’ covers any planned disposal or accidental release of radioactive substances in gaseous, liquid or solid form, associated with the operation of nuclear reactors, fuel reprocessing, mining, fuel fabrication, fuel storage, waste processing and storage, dismantling, the emplacement above or under the ground of radioactive wastes, etc.

The licensee has to organise a Health Physics Department. In accordance with article 23 of the GRR-2001, this department is entrusted with the task of organising “health physics control” activities, which include amongst others:

1) delimitating and signalling the controlled areas

2) investigating and inspecting the existing protection means

3) recommending extra protection means and appropriate procedures in order to optimise protection

4) verifying the operation and the correct use of measuring devices

5) investigating the proposals for the transport of radioactive materials inside or outside the facility

6) supervising the conditioning, loading and unloading of radioactive materials inside the facility

7) the monitoring of dose rate and of radioactive contamination

8) keeping the inventory of liquid and gaseous discharges, as well as the recording the inventory and movements of solid waste

9) review and approval of proposals for clearance

and the verification of compliance with the other provisions of the GRR-2001 and with the license.

The Head of the Health Physics Department is an expert recognized by the Agency. Article 73 of the GRR-2001 regulates the recognition of the experts. There are two classes of experts. Class 1 experts must be engineer in physics, engineer in nuclear sciences or must have another education complemented by a specialisation in nuclear science; their application for recognition is also reviewed by the Scientific Council of the Agency. Class 2 experts must have an education that is appropriate for their task (engineer, physicist…). All must have successfully followed a dedicated course in radioprotection (120 hours).

In class I facilities, the head of the Health Physics Department must be a class 1 expert and is also head of the Safety and Health department.

In class II and class III facilities, the head of the Health Physics Department must be a class 1 or a class 2 expert. If there is no in-house expert, the health physics control activities are entrusted to the Agency, which can delegate these tasks to a recognized organisation for health physics control (AVC for instance).

The operator has also to subscribe an insurance policy covering his civil liability resulting from his nuclear activities. The Law of 22 July 1985, which integrates the Paris Convention and the follow-up Convention of Brussels and their additional protocols, and modified by the Law of 11 July 2000 set the maximum amount of the operator's civil liability for damages caused by a nuclear accident to about 300[4] million euros (per accident and per site).

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 GRR-2001 sets other obligations for the operator. He is required to inform the workers likely to be exposed to ionising radiation before they are affected to a work station (article 25) and he has to keep the individual and collective doses as low as reasonably achievable and below appropriate limits (article 20).

In the license applications, the operator must commit himself to register with ONDRAF/NIRAS and to conclude with this organisation an agreement on radioactive waste management.

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 recognized organisation for health physics control or Bel V has to confirm this approval if such a clearance for the same materials and according to the same procedures has not been approved previously.

6.2 Article 22: Human and financial resources

6.2.1 Human resources

6.2.1.1 **ONDRAF/NIRAS – Belgoprocess**

As of 31 December 2010, ONDRAF/NIRAS had 84 permanent full-time employees.

[4] This amount is being reviewed

The permanent workforce was made up of 65 employees with a university degree, 13 with a higher-education degree and 6 educated to secondary school standard.
The temporary workforce comprised 8 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 280 people (as of end of 2010).

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.

6.2.1.2 **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. ELECTRABEL is active across the entire energy value chain, in electricity and natural gas, upstream to downstream; it means: generation, trading, sales and energy services.
With a total generating capacity in Belgium of 11233 MW (2010), ELECTRABEL generates about 70% of the electric energy consumed in Belgium. ELECTRABEL is the owner of the units 1 and 2 of Doel, of about 90% of the units 3 and 4 of Doel, of the units 2 and 3 of Tihange, and of 50% of Tihange 1.The installed power of Belgium’s nuclear generating units accounts for some 40% of all installed power in Belgium. Nuclear electricity accounts for some 55% of the electricity consumed in Belgium.

About 1950 people 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 7200 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 Mol Research Centre.

6.2.1.2.1 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”, and “Care”. The site is also supported by a local (depending of the site) representation of the “Fuel” central department, and of the “PPM” central department, and of the “Purchasing” central department.

The profession of the “Operations” department is the operation of the installations. The one of “Maintenance” is the maintenance of equipments and installations. "Engineering support" is in charge of: the site projects' and modifications' portfolio management, the main multi-skills projects, and the role of design authority. “Care” is in charge of all controls (including delegation of Health Physics), measurements, protection of the workers (classical safety including fire protection) and safety of the installations (including the setting up and the management of the emergency plans). 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" 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 safey: 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 direction "Care" at corporate level (health&safety, nuclear safety);
- the "Care" departments at local level;
- the ECNSD department.

ECNSD assumes the following missions:

- nuclear safety strategy and coordination
- reporting
- expert advise
- independent controlling
- operational support

At the Business Entity Generation level of Electrabel, the following departments are present:

- 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 and Liabilities: The Nuclear Fuel and Liabilities 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.

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

6.2.1.2.2 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 power - 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", see next section).

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.

6.2.2 Financial resources

6.2.2.1 General information

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 states with respect to waste management financing:

- All the costs related to the activities of ONDRAF/NIRAS will be charged to those who benefit from the performed services ("polluter pays principle")
- Those charges, evaluated at cost price, will be distributed among the beneficiaries of the services in accordance with objective criteria set by the Board of ONDRAF/NIRAS.
- ONDRAF/NIRAS may, following agreement by the Minister of Economic Affairs, manage a fund in order to finance long term duties, in particular the disposal of the waste. This fund is fed by contributions from the waste producers, according to rules approved by the Board of Directors of ONDRAF/NIRAS and by the Minister of Economic Affairs. The use of this fund is submitted for regular auditing by a special surveillance committee..
- A special fund has been built to cover any contingent costs associated with failed producers. This fund is fed by an additional charge on all the waste producers. The use of this fund is submitted for regular auditing by a special surveillance committee.
- For the financing of the decommissioning activities of facilities other than the nuclear power plants, ONDRAF/NIRAS will establish and/or qualify, in agreement with the producers concerned, the arrangements aiming at guaranteeing the financing of those operations.
- The financial arrangements, for the waste management, for the "regular" waste producers will be fixed in an agreement to be concluded between ONDRAF/NIRAS and the producer.
- The contribution to waste management costs for "occasional" producers is decided upon by the Board of ONDRAF/NIRAS.
- The tasks of ONDRAF/NIRAS set by the law of 12 December 1997, extending the agency's mission to drawing up 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. Evaluation of 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 with respect to 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 property implies also the transfer of financial means from the waste producer to ONDRAF/NIRAS for the short (treatment and conditioning) and long term management of the waste (storage and disposal). Good assessment of the waste management system is therefore required 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 has the responsibility for managing the fund. Each accounting year the financial performance of the fund is reassessed.

According to the Royal Decree of 4 April 2003 the Agency's funds available in the medium and the long term must be invested in financial instruments issued by the Federal State. As a result, the board of ONDRAF/NIRAS has decided to invest the assets of the "Long-term fund" into Belgian governmental bonds which will be passively managed.

In 1996 the financial mechanism was changed. Before that date, there were no guarantees with regard to fixed costs, and tariffs were based on simple net present value calculations. A new mechanism was put in place in 1996 by ONDRAF/NIRAS which aims to reduce risk while satisfying the fundamental principles of financing.

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

- contractual quantities: each of the main producers of radioactive waste notifies ONDRAF/NIRAS of its total waste production programme, enabling ONDRAF/NIRAS to distribute its fixed costs among the producers;
- tariff payment: each producer pays the long-term fund a contribution corresponding to the total costs (fixed and variable costs, including margins for technological and project risks) of the medium- and long-term management of the waste taken over by ONDRAF/NIRAS;
- contractual guarantee: each of the main producers commits himself to paying the long-term fund the balance of the fixed costs attributable to his waste that has not yet been covered by tariff payments.

The conditions according to which the long-term fund must operate 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 evolution of the long-term management activities and of the economic context.

To take into account the time value of money and the opportunity cost of capital, the fees escalate each year, beyond inflation, by a constant interest rate, fixed at 2% in real terms, corresponding to the net discount rate applied by ONDRAF/NIRAS for net present value estimates of its future storage and disposal costs.

The parts of the payments which relate to fixed costs are 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 case the waste producer would terminate the relationship with ONDRAF/NIRAS before term, the waste producer will pay in full its outstanding share of the fixed costs, i.e. that part of the guaranteed sum which remains unpaid.

Financial provisions for decommissioning are not treated within this article but under article 26.

6.2.2.2 **About NPP's**

6.2.2.2.1 Belgian legal context

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

The 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, on behalf of ELECTRABEL and SPE (Public Electricity Society). 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/SPE to SYNATOM;
- the percentage of the funds that can be lent to ELECTRABEL and SPE
- the management of the funds.

ELECTRABEL and SPE remain liable for all costs regarding the future dismantling of the nuclear power plants, including cost overruns.

6.2.2.2.2 Dismantling funding system

The main characteristics of the applied methodology are the following:

- the amount of funds must be accrued over the life expectancy of the nuclear power plants (as defined by the law of 31 January 2003, i.e. 40 calendar years),
- the current technical scenario to evaluate the dismantling cost is a conservativeapproach 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.
- the initial funding is equal to the net present value of all future decommissioning expenses (based on a study performed by an independent engineering company and the engineering office Tractebel).

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 assent of ONDRAF/NIRAS is needed.

6.2.2.2.3 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 technical scenarios for reprocessing or direct disposal have been identified and their related cost duly evaluated following the same methodology. The amount of funds is determined by the most expensive identified scenario i.e. deferred reprocessing of spent nuclear fuels without recycling of the recovered fissile materials.

6.3 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.

6.3.1 Provisions for the qualification of storage and processing installations for radioactive waste.

The qualification of the equipment intended for storage, processing and conditioning 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[5] guarantee the conformity of the radioactive waste with the Waste Acceptance Criteria issued by ONDRAF/NIRAS. This qualification is one of the conditions for acceptance by ONDRAF/NIRAS of radioactive waste produced by an Operator.

The Royal Decree of 18th November 2002 “regulating the qualification of equipment intended for storage, processing and conditioning of radioactive waste [translated [6]]” defines the legal framework for the equipment [7] 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 national 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

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

6 “ *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]

7 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]

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 [8]]

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.

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 [9]].

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 primary packaging of the CWP;

3. the qualification of the radiological characterization methodology for CWP’s, including the qualification of the measuring equipment.

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.

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8 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]

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

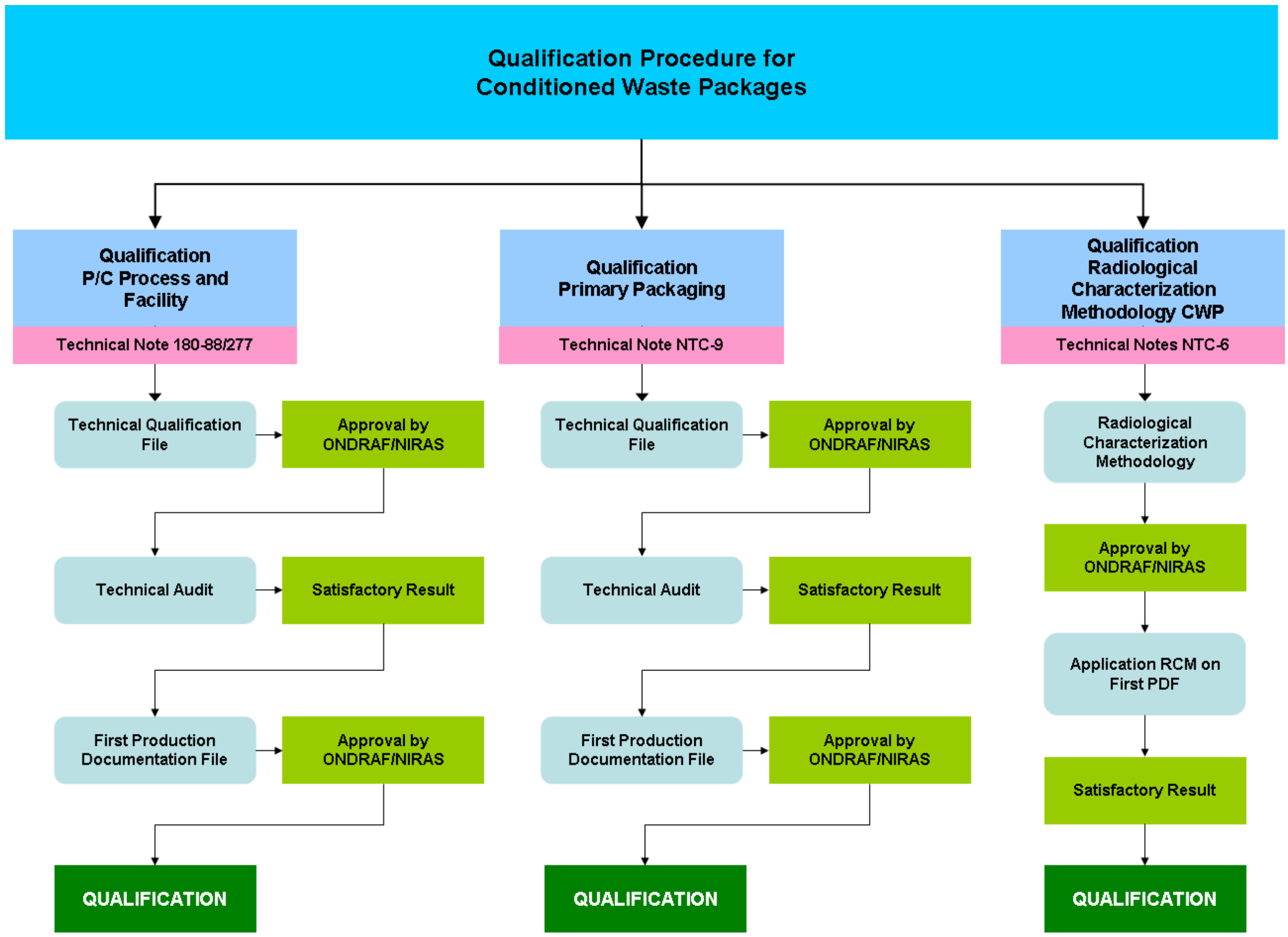

Figure 1: Outline of the Qualification Procedure for Conditioned Waste Packages

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

1. the drawing up of the applicable Waste Acceptance Criteria by ONDRAF/NIRAS,

2. the drawing up of the Technical Qualification Files (TQF's) for each of the three components of the Qualification Procedure (Radioactive Waste Processing and Conditioning Process, Primary Package and Radiological Characterization Methodology) by the Operator,

3. the approval by ONDRAF/NIRAS of the TQF's from Step 2,

4. the performance, by ONDRAF/NIRAS or its representative, of a Technical Audit pertaining to the Radioactive Waste Processing and Conditioning Process and the Primary Package – these Technical Audits must lead to a satisfactory result,

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

6. the drawing up of an Application for Qualification for each of the three components of the Qualification Procedure by the Operator or, in case of a foreign Operator, by the Belgian owner of radioactive waste

7. the deliverance of the Qualifications by ONDRAF/NIRAS when the requirements of Step 3, 4, 5 and 6 are met.

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

1. the qualification of the methodology that guarantees the conformity of the unconditioned waste packages with the applicable waste acceptance criteria, and

2. 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.

6.3.2 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 is illustrated below for the compacted waste (CSD-C) coming from the reprocessing of Belgian spent fuel in AREVA facilities at the La Hague facility (Plant UP3). The procedure is detailed for vitrified residues repatriated over the period 2000-2007. The same procedure is currently applied for the acceptance of compacted residues..

An important first step in the waste acceptance procedure is the approval of the processes and installations involved. This is explained below.

The AREVA compaction process and the facility (Atelier ACC) were officially approved by ONDRAF/NIRAS in April 2010, following the favourable evaluation of the following conditional provisions:

1. Ability of the process to meet the acceptance criteria set by ONDRAF/NIRAS

ONDRAF/NIRAS has been able to verify - on the basis of the data and information put down in the technical file of the compaction process - that AREVA has the technical and administrative means to meet each of the acceptance criteria during the approval stage of the process and, subject to compaction of the conformity of the produced CSD-C, during the waste package production stage.

2. Favourable evaluation of the quality system introduced by AREVA in its compaction facility.

The technical and administrative provisions applied by AREVA in the compaction facility, are subject to periodical audits conducted by BUREAU VERITAS. The audit reports testify to the ability of the quality system to ensure that the CSD-C are produced in accordance with the applicable technical reference frame.

3. Compliance with the CSD-C acceptance criterion, relating to the qualification of the compaction process and facility

This criterion consists in checking the equivalence between, on the one hand, the conditions defined in Belgium by ONDRAF/NIRAS for the qualification (approval) of the conditioning processes and facilities and, on the other hand, the procedure adopted by the French authorities and applied to the AREVA processes and facilities.
This equivalence is ensured by:

- the drawing up, by AREVA, of a technical file for the process, following the instructions defined by ONDRAF/NIRAS,
- the commitment of ANDRA to co-operate with ONDRAF/NIRAS, especially regarding the follow-up of the modifications of the Atelier ACC process and facility, the transmission of the results of the audits conducted in the compaction facility by ANDRA, and the accessibility of information on the quality of the CSD-C.

This commitment of ANDRA has been formalised by an agreement containing the provisions defined above. So far, this agreement has been scrupulously observed.

The next steps in this specific waste acceptance procedure are as follows.
Upon SYNATOM's request for acceptance of two batches of 24 canisters and 4 spare canisters (each batch corresponds to the load of the transport flask TN24) ONDRAF/NIRAS performs an administrative verification of the documentation and provides assistance during the physical inspection of the canisters.
The inspection modes are described in an inspection manual. Before ONDRAF/NIRAS can accept the batch of compacted waste, each canister must meet the applicable acceptance criteria.
During the whole acceptance procedure, ONDRAF/NIRAS draws up the necessary reports. Each step must be satisfactorily concluded before the next verification or inspection can be performed. Non-conformities may lead to the non-acceptance of the canisters submitted.
Before performing the administrative verification of the documents, the inspection of these documents and the physical inspection of the canisters, the validity of the approval granted by ONDRAF/NIRAS is verified.

Administrative verification of the delivery documents
First, ONDRAF/NIRAS checks the coherence and comprehensiveness of the individual quality documents of the canisters, prepared by AREVA. BUREAU VERITAS issues a certificate of conformity for each canister and ONDRAF/NIRAS checks the compliance of the acceptance criteria.

Administrative verification of the production documents at AREVA
Some documents that complete the production documentation coming with the delivery documents can be verified at the site of AREVA. The production documents contain the documents that are common to the compacted waste. This verification is performed to check whether the documents are coherent and complete and the raw materials used are in accordance with the specifications.

Administrative verification of the documentation at BUREAU VERITAS
After a positive evaluation of the verification of the correct application of the quality system of AREVA, BUREAU VERITAS draws up certificates. ONDRAF/NIRAS checks the traceability of the documents and the satisfactory character of the evaluation, in order to ensure the validity of the certificates.

Physical inspection of the canisters at AREVA
In presence of SYNATOM, ONDRAF/NIRAS takes part in the physical inspections performed by AREVA in order to verify and to attest the integrity of the CSD-C canisters, the surface contamination and the dose rate.

Administrative verification of the AREVA documentation after taking the canisters from stock

After taking the canisters from stock, AREVA draws up the necessary documents with the parameters obtained from the physical inspection. ONDRAF/NIRAS checks the coherence and comprehensiveness of these documents.

Administrative verification of the BUREAU VERITAS documentation after taking the canisters from stock
BUREAU VERITAS issues a certificate after taking the canisters from stock. ONDRAF/NIRAS checks the traceability of the documents and the satisfactory character of the evaluation, in order to ensure the validity of the certificates.

Administrative verification of the complete documentation file
Before transporting the 48 CSD-C canisters, ONDRAF/NIRAS checks the coherence and comprehensiveness of the complete documentation file.

Physical inspection of the canisters at Belgoprocess
On receipt of the canisters, ONDRAF/NIRAS attends the physical inspections performed by Belgoprocess before storing the canisters in hall D of building 136.

Administrative verification of the Belgoprocess documentation
After verifying the documentation on receipt of the canisters at Belgoprocess, ONDRAF/NIRAS can proceed to the acceptance of the canisters.

Protocol of Reception, Acceptance and Transfer
The receipt of the 48 canisters is formalised by drawing up a Protocol of Reception.
ONDRAF/NIRAS also issues a Protocol of Acceptance and a Protocol of Transfer to indicate its acceptance of the 48 canisters. ONDRAF/NIRAS thus certifies that the transferred compacted waste is in accordance with the applicable acceptance criteria. The finally accepted documentation file contains all documents and reports resulting from the verifications and/or inspections described above.

6.3.3 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 industrial 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 in the beginning of the year 2007.

6.3.4 Quality Management system of ELECTRABEL / SYNATOM

The responsibility for applying the quality assurance 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 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 GS-R-3. This management system 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.
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6.3.4.1 Delegation and subcontracting

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

6.3.4.2 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.

6.3.4.3 Quality management system

6.3.4.3.1 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

6.3.4.3.2 Key documents

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

- Chapter 17.2 of the FSAR
- Electrabel's Internal Nuclear Safety Code
- Electrabel's Reference for Nuclear Safety
- Execution documents

6.3.4.3.3 Focus and application

The quality 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 quality 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 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

6.3.4.3.4 Electrabel's Internal Code and Reference for Nuclear Safety

The Internal Code defines all directives and general principles related to the implementation 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. Electrabel Corporate Nuclear Safety Department 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.

6.3.4.4 **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.

6.3.4.5 **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.

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 (RGPT) 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.

6.3.5 Quality Management system of the Regulatory Body

6.3.5.1 The Federal Agency for Nuclear Control

Since 2007, the FANC has defined and deployed a management system to structure its internal activities in line with its mission statement, its long term objectives and strategy.

In an integrated approach, both quality aspects together with risk management and mitigation have been integrated in a single approach to define and document the management system.

After an initial phase; most operational processes in licensing, accreditation, inspection, handling of incidents and providing information to public and authorities were documented. This initial operational system was then complemented with related management and support processes to provide a complete management system.

Starting point and constant reference of all aspects developed in this management system is the Agencies mission statement, in the protection of the population, the workers, and the environment against the hazards and dangers of nuclear and ionising radiation.

Next to this strategic focus, is the deployment and conduct of constant improvement approach, from the initial system onwards.

After the initial period, an internal audit team was installed. In order to validate the compliance of the activities with the described management system, permanently evaluating the systems' efficiency and effectiveness, and continuous improvement, this internal audit service is at the disposal of General Management and the Board of directors.

The importance and the adhesion of the FANC management was illustrated by an extensive training programme, in which all staff members received training in the ISO 9001 standard, its structure and its key aspects, as drivers for the quality improvement and assurance programme, as well as in the actual management system in its managerial, support and operating aspects.

This management system was validated for its compliance to the ISO 9001-2000 quality standard, by an external certification organisation in 2008.

Further enhancements and adaptation to comply with the evolved ISO 9001 standard, while further streamlining, homogenizing and optimizing the defined processes the present version of the management system is in place. In particular attention was given to the application of identical quality objectives for all subcontracted and outsourced activities.

It comprises specific management processes for the guidance, structuring and feedback monitoring of the activities, as well as operational activities in all aspects of the Agencies responsibilities, comprising development of the legislative framework, licensing, monitoring and controlling of the activities within its course of responsibility, as well as the proper guidance in case of incidents and or infractions.

The Management system is certified in compliance with the ISO 9001-2008 standard for management systems.

6.3.5.2 **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, the European TSO Network. Bel V is a member of this network

6.4 Article 24: Operational Radiation Protection

6.4.1 Regulations

Chapter III "General Protection" of the GRR-2001 introduces in the Belgian law the radiological protection and ALARA-policy concepts.
Article 20 of this Royal Decree 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[10].
Article 23 of this Royal Decree 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 operational 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 1, recognized as such by the FANC. The conditions for recognition are specified in Article 73 of GRR-2001.

6.4.2 Design

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

- general safety philosophy

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

- 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.

6.4.3 Operation

6.4.3.1 **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. Operational (electronic) dosimetry is used for ALARA purposes only, equipped 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 Safety and the Health Physics Department and the work supervisor, well ahead of the planned date of the work.

If really required and also where possible, the operations are performed remotely (use of manipulators or use of automatic sequences, etc…).

6.4.4 Follow-up in situ

6.4.4.1 Dose

During the design, radiation zones are defined with the 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 which can be accessed by the public are 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 during operation 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, with 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.

Shielding is systematically installed at various locations during operations. Specific shields are also installed when dictated by the size of the work (e.g. detecting hot spots). Signals indicating the hot spots and the ambient dose rates informs the workers about the ambient radiological conditions in which they will carry out the work; access to certain locations is only allowed with specific authorisation of the Health Physics Department; specific ALARA signals forbid to the worker to remain stationary; signals indicate to the worker where the very low dose rate areas ("green" area) are, and may be used as falling-back station. On a voluntary basis there is implementation of a dose constraint for the individual dose. In practice for all the nuclear installations, this is about the half of the dose limit (20 mSv per 12 consecutive months, in accordance with the GRR-2001); the mentioned doses are the total doses (sum of external dose and committed dose).

Conform Article 23.2 of GRR-2001, the assessments and stipulations 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 Ministry of Labour and the FANC. The registers of the licensee are stored for 30 years.

The intervals of the medical surveillance of the exposed workers are fixed by the medical officer, and depend on the risks at the installations. The medical control (routine) is at least once a year and each 6 months for the most exposed workers.

6.4.4.2 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 the 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 about 4 and 0.4 Bq/cm^2 for respectively beta-gamma and alpha contamination during dry storage of spent fuel.

6.4.4.3 **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.

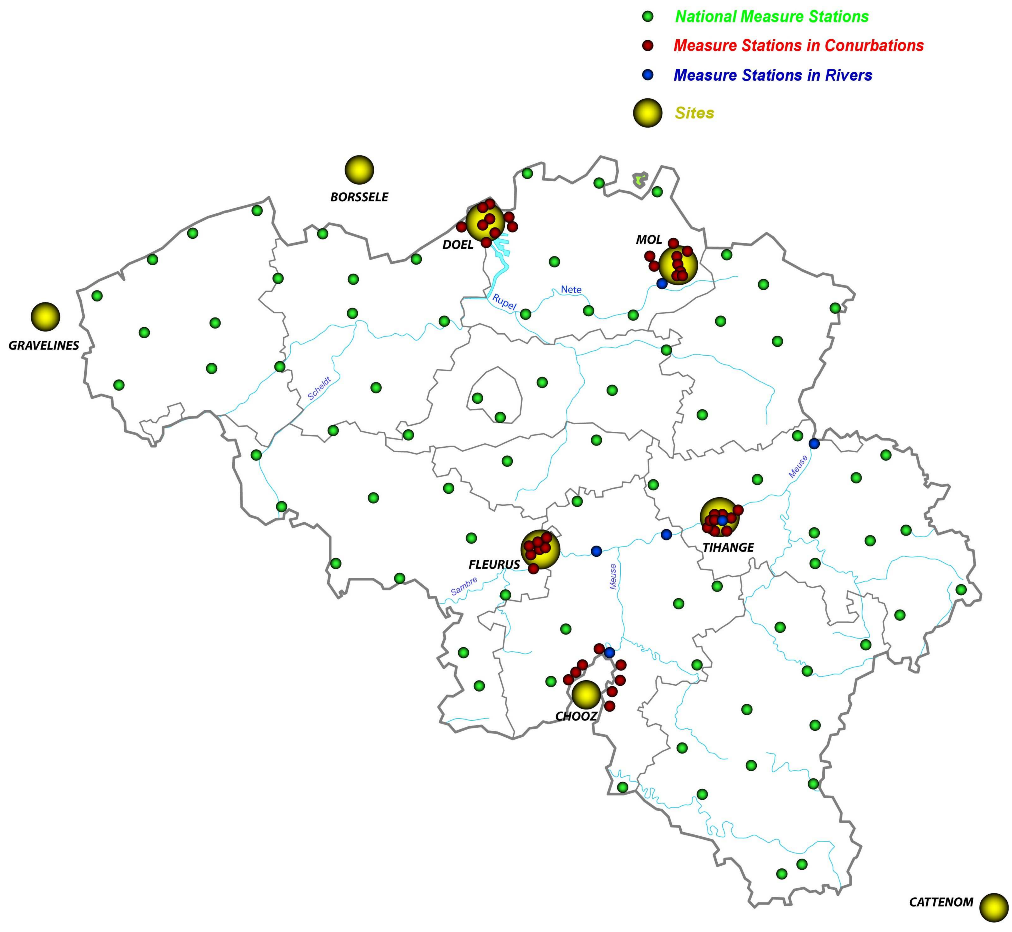
The Euratom 96/29 Directive has been implemented in the Belgian legislation and as required by Article 81.2 of the GRR-2001 the present authorised discharge limits (gaseous and liquid releases) have been revised. (see section 5.3.1.2).

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 critical exposed member of the public is a few nSv/year , based on a conservative approach for the dose calculations.

Storage facilities in Belgium involve wet pool storage and dry storage of intact fuel elements (at the NPPs, the SCK•CEN, Belgoprocess) and the storage of vitrified high level waste (at Belgoprocess). For the dry storage of spent fuel there is a continuous monitoring of the leak tightness of the casks.

At the NPPs and at Belgoprocess, the liquid effluents are released via a single pipe which is monitored in order to avoid exceedance of limits.

Environmental monitoring programmes (e.g. at SCK•CEN and Belgoprocess: emission, immission, dose rate, contamination, etc...) are established in agreement with the Bel V and the FANC in order to follow the impact on the environment. These results are periodically evaluated by the HPD and Bel V.



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. 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.

6.4.5 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.

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.

6.5 Article 25: Emergency preparedness

6.5.1 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).

6.5.2 Implementation of emergency response organisation

6.5.2.1 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.

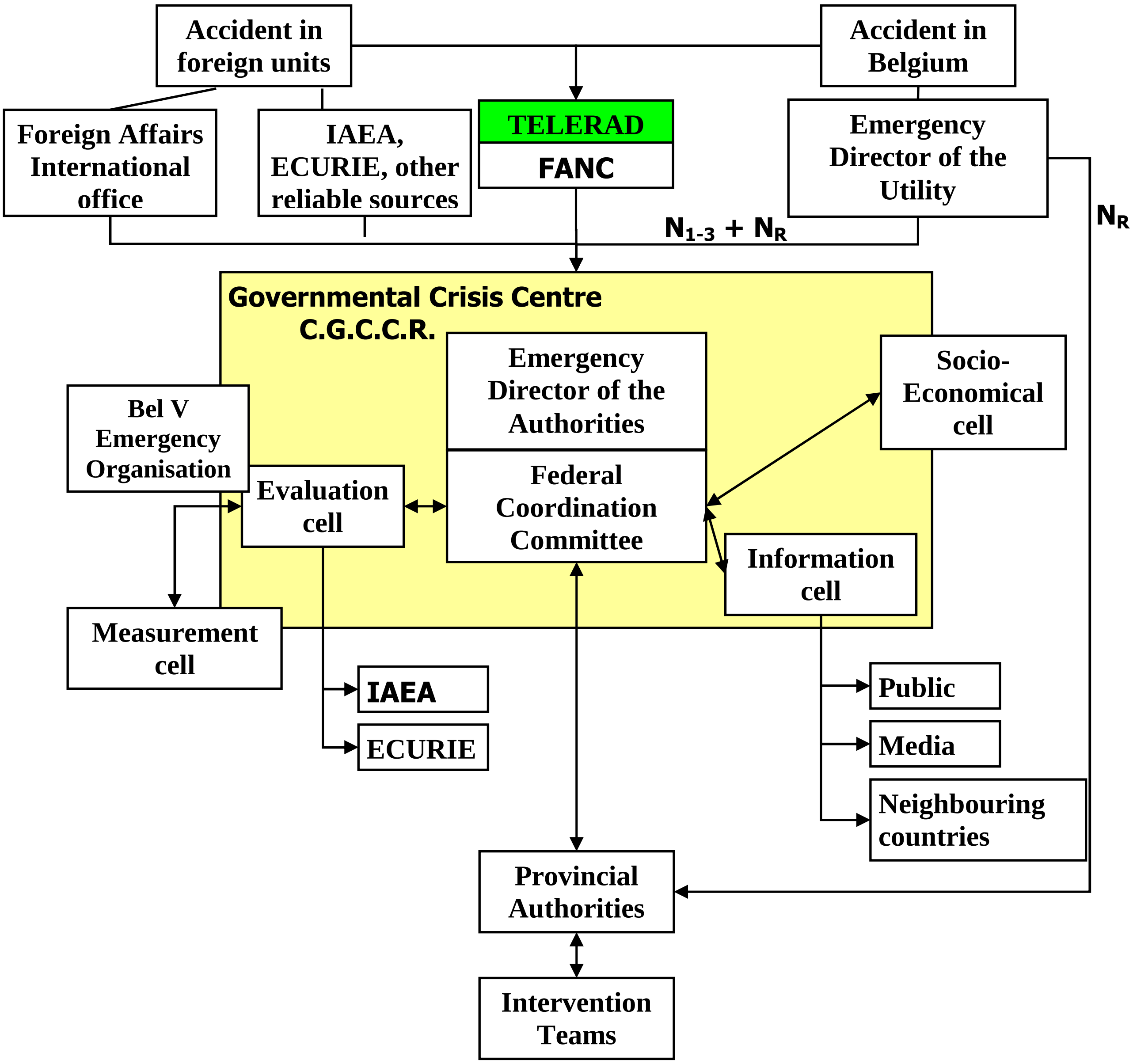
For each of these 4 notification levels (N_1 to N_3 + N_R) the notification criteria are defined in the Royal Decree of 17 October 2003. For example, the criterion associated with the N_1 level is defined as follows: "Event which implies a potential or real degradation of the safety level of the installation 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.

6.5.2.2 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.



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 N_R is declared or as soon as the Emergency Director decides a U_2 (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 .

6.5.2.3 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 17 October 2003.

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.

6.5.2.4 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.).

6.6 Article 26: Decommissioning

6.6.1 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,
- 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 national inventory was submitted in March 2008 to the Minister for Energy. The third report is in preparation and will be available early 2013.

6.6.2 Implementation of the legal requirements

6.6.2.1 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 final shutdown of the operations of the facility or part of the facility.

The THETIS reactor (experimental pool reactor - 250 kWth), on the site of the University of Ghent, was permanently shut down on 31 December 2003 (operational standby). The final decommissioning plan was submitted for review by ONDRAF/NIRAS and it has been approved in March 2008. Several options for the spent fuel, i.e. reprocessing, dry storage or direct conditioning as radioactive waste were assessed. The direct conditioning of the spent fuel as radioactive waste in the facilities of Belgoprocess was the selected option.
In 2010, the research reactor has been unloaded and the fuel elements were all transferred to the site of Belgoprocess for processing and conditioning.
According to the Royal Decree of 20 July 2001 a dismantling licence still needs to be granted. It is assumed to start the decommissioning activities in 2012.

In 2009, ONDRAF/NIRAS has approved the final decommissioning plan for a part of the FBFC-International facility in Dessel. The decommissioning includes several buildings where no further nuclear activities are foreseen: some workshops, building for fabrication of MOX fuel elements and a laboratory.

6.6.2.2 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 1 (BP1), Belgoprocess 2 (BP2) and IRE.

6.6.2.2.1 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 a 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 the 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.

6.6.2.2.2 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..

6.6.2.2.3 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.

6.6.2.2.4 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.

6.6.2.2.5 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.

7 Section G: Safety of Spent fuel Management

7.1 Article 4: General safety provisions

7.1.1 Sites at Doel and Tihange

The installations are described in appendix 1.

The residual heat generated during the spent fuel management is removed, depending on the storage mode. Three storage modes are used:
- in fuel-cooling pools in the units;
- in containers in building SCG (Doel);
- in pools in building DE (Tihange).

7.1.1.1 **Fuel-cooling pools in the units.**

The fuel-cooling pools are located in the buildings “GNH” (Doel 1/2), “SPG” (Doel 3/4), “BAN” (Tihange 1) and “BAN-D” (Tihange 2/3).
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.

Recent efforts were undertaken to evaluate possible improvements related to hardware, organization and procedures, to better scope 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 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.
- At Doel and Tihange sites, some parts of the installation were reinforced to guarantee their correct functioning in case of a beyond design earthquake.

Calculation codes recognised by the safety authorities were used to verify that the K_{eff} (neutron multiplication rate) 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.

7.1.1.2 **Containers in building SCG (Doel)**

<u>Containers:</u>

The storage containers are designed in such a way that the residual decay heat is removed passively by convection and radiation. The thermal power removed by the container is determined to reduce as much as possible the maximum temperature of the fuel can in normal storage conditions (300 to 400°C depending on the container model), 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.

Building SCG:

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

7.1.1.3 **Pool building DE (Tihange).**

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 has been designed to minimise the number of fresh fuel assemblies loaded in the reactor core at each shutdown for reloading and to comply 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.

The coherence of the measurements described in the previous paragraphs has been verified at every step of the spent fuel management.

7.1.1.4 **Specificity of the Tihange site**

7.1.1.4.1 Intermediary storage in buildings «BAN» (Tihange 1) and «BAN-D» (Tihange 2/3)

The intermediary 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.

7.1.1.4.2 Intermediary storage building DE

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.

7.1.1.5 **Specificity of the Doel site**

7.1.1.5.1 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.

7.1.1.5.2 Intermediate storage 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 configuration of the containers is a bit different from the transport configuration and the regulation in force on the site is applied.
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
  - 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.

During the operation and in the frame of the ten-yearly reviews, the operator takes the appropriate measures to comply with the regulations in force, including recommendations by the International Commission on Radiological Protection and the International Atomic Energy Agency..

7.1.2 SCK•CEN site: BR2

Additional information may be found in appendix 4

7.1.2.1 **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 of this distance. As regards the wet-sipping rack, the minimum distance may be 121.5mm between axes, but the other fuel elements are more distant from each other, and 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.

7.1.2.2 **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.

7.1.2.3 **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.

7.2 Article 5: Existing Installations

7.2.1 Sites in 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.

7.2.1.1 **Ten-yearly safety reviews**

The License of each Belgian nuclear power plant makes it mandatory to conduct ten-yearly safety reviews starting from the inspection acceptance (granted during the first operation at full power).

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, codes and practices in force 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 transmitted to the FANC.

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

- show that the unit has at least the same level of safety as it had when the license was granted to operate at full power;
- 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 and practices and, if necessary, propose appropriate improvements.

The objectives of the Safety Review are multiple. In the review, the Operator should assess the state of the installation and the organisation in relation with international legislation, standards and good practices. Furthermore, strong points and weaknesses should be identified, as well as compensating measures in the case that some weak points possibly can not 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. 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

7.2.1.2 **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) will be established. The implementation of that 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 this, it is examined by Bel V, which may result in amendments being ordered to the modification file.. Commissioning the completed modification is subject to a positive acceptance report, issued after validation of the modification and requalification of the part of the installation that was 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):

- modifications of the overhead handling cranes;
- modifications to the access doors;
- replacement of certain neutron-absorbing materials (boraflex) by steel sheets containing boron;
- modifications to the handling and transfer systems of spent fuel shipping containers.

7.2.1.3 **Surveillance programmes**

The technical specifications (chapter 16 of the Safety Analysis Report) prescribe 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.

7.2.2 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.

7.2.2.1 **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 in the periodic review is described in a FANC guidance and is based on the IAEA safety guide No. NS-G-2.10 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 will consist 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.

7.2.2.2 **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.

Overview

<u>Committee on the Modification of Installations (CWI/CMI):</u>

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.
The modifications need to be:

- Either sufficiently small (GRR-2001 art. 12);
- Or having no negative effect on the safety in case they are more significant; (RD N°0024 art. 2.2, 2.3 and 2.4).

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 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) and by the Health Physics Department in addition to the approval by Bel V, according article 23 of the GRR-2001. The final approval has to be given by the Reactor Manager BR2.

Modifications having 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.

7.2.2.3 **Surveillance programmes**

A surveillance programme is established in order to guarantee the quality of all safety-related activities in the company, 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 so.

7.2.2.3.1 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).

OVERVIEW OF PERIODICAL INSPECTIONS		
Safety	CLASSICAL/NUCLEAR	
Frequency	≥ 3 months followed by an internal supervision programme	-< 3 months -Cyclic -Daily...
Legal	RGPT / AREI / R.D. N.0024........	
Voluntary	Risk reducing / Q.A. manuals / Standards / IAEA Safety Standards	

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

The company ensures that the products, machines, devices, installations, equipments, etc.. supplied, are not being used or processed before it is verified that they meet the safety requirements prescribed.

The entrance 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 observance of the safety requirements prescribed.

7.3 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.

7.3.1 Sites of Doel and Tihange

7.3.1.1 **Siting**

<u>Characteristics taken into account for the selection of the sites</u>

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 imposed originally. 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.

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 analyzed. 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.

International agreements

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 have been submitted to the European Commission as part of the licensing procedure for the Belgian power stations. Having consulted the “Article 37” group of experts, the Commission issued a favourable advice for the sites of Doel and Tihange. 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 amended by Directive 2003/35/EC.

7.3.1.2 Measures

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

7.3.2 SCK•CEN Site: BR2

Additional information can be found in appendix 4.

7.3.2.1 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.

7.3.2.1.1 Periodic review 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.

11.4.7.2 Earthquakes

Information received from Belgian sources indicates that earthquakes are not taken into account in building design. The last appreciable earthquake (see Section 11) 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”.

7.4 Article 7: Design and construction of facilities

7.4.1 Doel and Tihange Installations

The design of the facilities is described in Appendix 1

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

7.4.1.1 **Appropriate measures to reduce the radiological effects**

7.4.1.1.1 Fuel cooling 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 stopping of the transfer of spent fuel to the reprocessing plants. A storage building was constructed on each site. These buildings are designed to receive and store discharged spent fuel coming from the units under water (building DE-Tihange; see section 7.4.1.1.2. below) or in shielded containers ('dry storage' -building SCG-Doel; see section 7.4.1.1.3 below).
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 plane of the subassembly heads stored in the racks.
During the transfer operations between the pools and the transit operations in the transfer canal, the layer of water above the assembly heads is at least 3-meter thick.
To avoid emptying the pools and uncovering the spent fuel elements, 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 were undertaken and implemented to evaluate possible improvements related to hardware, organization and procedures, to better scope 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 GRR-2001 requirements are complied with.
The following measures have been taken during the design of the buildings to meet these requirements:

- 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 equipments that must be regularly inspected in order to reduce the exposure time.

The spent fuel storage ponds are designed in such a way that the fuel is only handled under water so that the shielding is sufficient to limit the dose rate at the level of the working desk.
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.

7.4.1.1.2 Building DE (Tihange)

7.4.1.1.2.1 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 biological protection of the staff handling the assemblies and operating the pools of building DE is the same as in the above-mentioned section 7.4.1.1.1.
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.

7.4.1.1.2.2 Radiation control in the areas

Inside building DE, the activity in the pool hall is permanently controlled by a gas chain and an ambient radiation monitoring.
The objective of both chains is to:

- monitor the radiation level around the storage pools and check indirectly if the layer of water separating the radioactive fuel from the handling areas is thick enough ;
- monitor the radioactive noble gas concentration in the air of the pool hall and, therefore, control 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.

7.4.1.1.2.3 Ventilating building DE

The VDE ventilation system is composed of 6 different circuits and is designed to fulfil in the first place the safety functions during the operation of the spent fuel storage installations. The tasks include:

- 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

The other classical functions fulfilled by the VDE system allow 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 the potential contamination limited to a room from spreading to other non-contaminated or low contaminated areas.

In normal operational conditions, the ventilation system of building DE allows the flow of air from potentially low contaminated zones to potentially more contaminated zones.
As a result, all the areas are ventilated.

"Normal operational conditions" relates to the situation when the radioactive contamination rate of building DE is not too high and when the normal operation of the building is not disturbed by an internal or external event.

7.4.1.1.2.4 *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-cooling 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.

7.4.1.1.2.5 Incidental releases of radioactive effluents

Incidental 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. Indeed, the nuclear 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 space pellet–can. 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 fraction 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 the fuel handling accident remain for the most exposed population groups far below the routine discharge limits.

7.4.1.1.3 Building SCG (Doel)

7.4.1.1.3.1 Protection against radiation

Building SCG is an isolated 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

conditioned 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 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.
Building SCG is part of the WAB controlled area; the requirements set out in the GRR-2001 are followed.
The following measures have been taken during the design of the buildings to meet these 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.

7.4.1.1.3.2 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
- wreckage 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.

7.4.1.2 **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 7.6.1.7);

7.4.1.3 **Technologies used**

The technologies used for the design and construction of the spent fuel management installations are based on the experience, the tests and the investigations. See appendix 1.

7.4.2 Installations of SCK•CEN: BR2

Additional information may be found in appendix 4

7.4.2.1 **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.

<u>Pools</u>
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.

7.5 Article 8: Assessment of safety of facilities

7.5.1 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.

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The application file, together with the numerous technical supporting documents are reviewed by the Regulatory Body and give rise to an intense exchange of questions and answers. The resulting information and data are used to update the Safety Analysis Report until it eventually becomes the “Final Safety Analysis Report” (FSAR).

The licence conditions foresee, amongst others, to:

- have the possibility to modify the installations if those have no adverse impact on safety,
- update the FSAR, which throughout the life of the installation has to exactly reflect its actual situation,
- perform ten-yearly safety reviews,
- follow up all the recommendations made in the “Safety Evaluation Report” established by Bel V and which gives a synthesis of the performed safety analysis. Bel V is responsible for assessing the satisfactory nature of the responses given by the operator to those recommendations.

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

7.5.2 Installations of SCK•CEN: BR2

See articles 4 to 7

7.6 Article 9: Operation of facilities

7.6.1 Doel and Tihange installations

The installations are described in Appendix 1.

7.6.1.1 **Initial license and commissioning**

The licensing process and the related safety analysis 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. 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 operating licenses that allows to proceed with the next step of the test programme. The FANC is informed and can intervene if it deems it necessary.
This process is complete when the final acceptance report is delivered by Bel V and sanctioned by a Royal Decree granting an operation license (See. also Section E, art. 19, section 5.3.1.1).

7.6.1.2 **Operational limits and conditions**

The Technical Specifications are referenced in the license (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, some 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.

7.6.1.3 **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.

7.6.1.4 **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 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.
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 minor 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.

7.6.1.5 **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 reports are established by Bel V for the incidents that this body deems interesting and transferred for commentary to the operator and to the FANC before it is distributed abroad.

7.6.1.6 **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.

7.6.1.7 **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, a set of 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;
- Giving access to the information relating 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.

7.6.2 SCK•CEN installations: BR2

A description of the BR2 may be found in appendix 4

7.6.2.1 **Initial license and commissioning**

see Section E, article 19

7.6.2.2 **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.

7.6.2.3 **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.

7.6.2.4 **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.

7.6.2.5 **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 new database set up was completed up to 1986 thanks to 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, 2X5 days 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.

7.6.2.6 **Decommissioning plans**

A fund - financed by the State – has been set up to cover obligations resulting from the decommissionning 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 the *green field*. However, if other installations or parts of the installations should be re-used for purposes other than the initial ones, the decommissioning would be limited to modifying the installations or installation parts so that they can be re-used. 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

7.7 Article 10 :

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

8 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 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 is preparing the licence application, planned to be submitted to FANC by mid 2012.

For the category B&C waste ONDRAF/NIRAS proposes with 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

8.1 Article 11: General safety requirements

8.1.1 Safety objectives applicable for a disposal facility

FANC is currently developing a specific licensing system, as well as specific safety requirements for disposal facilities. It is also developing regulatory guidance for disposal. In the meantime, 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 within its terms of reference.

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 own 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.

8.1.2 Existing installations (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 those radioactive waste processing and storage operations:

- The category C waste storage buildings are designed and laid out 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 the 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.

8.2 Article 12: Existing facilities and past practices

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

8.2.1 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[11] in force at that time, the operator had to submit a construction and operating license

[11] 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).

application. A safety analysis report[12] 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.

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 1994 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. According to the date of the license application, only building 155 and the HRA-Solarium processing installation were to comply with this obligation to add a detailed environmental impact assessment to the license application.

[12] 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. However, this report is updated during the operational phase of the installation.

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.

8.2.2 Regulation enforcement

Bel V performs the acceptance inspection of the installations, including verification if the rules and the cold tests are complied with. According to the acceptance report, the starting-up 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 on workplace safety and health and with the rules on neighbourhood safety and health. It can be assisted in its mission by Bel V. During the operation, Bel V must also verify the compliance with the rules, in accordance with the regulations in force. It can propose any modification to improve the safety of the installations.

Belgoprocess is implementing a wide programme to monitor 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.

8.2.3 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 foreseen until 2012 but was finalized end of 2010. In total, 40412 conditioned waste packages were inspected.

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</td></tr>
</table>

of waste.
B 155
Maximum dose rate on outer walls of building: 10 µSv/h. Other conditions as in the acceptance files
B 156
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

8.2.4 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.

8.2.4.1 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.

8.2.4.2 Radiological protection

The storage of unconditioned and conditioned waste as well as the processing of this waste in CILVA is performed in 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 regulations 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, ...).

8.2.4.3 **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 and depositing them then 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.

8.2.4.4 **Decontamination**

The form and the surface finishing of the material in the controlled area are – as far as possible - designed to facilitate decontamination.
The apparatus in the controlled area 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.

8.2.4.5 **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 received at the entry of the installation. This waste 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.

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.

8.2.4.6 **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.

8.2.4.7 **Workers' dose**

As indicated, the protection shield between the areas was calculated on the basis of the radiation area to which these areas belong and, accordingly, based upon the occupation and the presence of radioactive sources. 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.

8.2.4.8 **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.

8.2.4.9 **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

8.3 Article 13: Siting of proposed facilities

8.3.1 Existing facilities

Almost all processing installations and storage buildings in Belgium are currently located on the Belgoprocess sites, which were formerly the SCK•CEN WASTE Department (started up in 1956) and the EUROCHEMIC fuel reprocessing pilot plant (started up in 1966). All facilities were to comply with the regulations in force at that time. In addition to the license for the dismantling of these former installations, changing the use of both sites required new licenses as well (see article 12).

8.3.2 Future disposal facilities

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.

Since 2000, France and Belgium have developed a specific cooperation in the field of the safety approach to geological disposal. A working group was set up and the French and Belgian authorities that issued in 2004 a document entitled “Geological disposal of radioactive waste: Elements of a safety approach”. It was decided in 2005 not to lose the momentum created by the Franco-Belgian initiative and therefore the “European Pilot Group” (EPG) was created gathering together high level representatives of regulators from eight European countries and three international organisations. The EPG has undertaken a study on the regulatory review of the safety case for the geological disposal of radioactive waste. The first stage of the study led to a first version of a report “The regulatory review of the safety case for geological disposal of radioactive waste” available in March 2007, covering the early phases of development of a geological disposal facility. The second stage (2008-2010) led to an updated version of the report which covers all phases of development and therefore replaces the previous version. This interim report has been submitted for consultation to different organizations including national regulatory bodies and international organizations (IAEA, NEA …). The participants to the EPG proposed to undertake, a new programme of work to consider the characteristics of wastes that could be disposed in different types of repository. The objective is to present an overall perspective on the regulatory expectations for waste acceptance in a disposal facility. The work is still ongoing and a report on “Waste acceptance in disposals” should be issued by 2012.

Siting of a geological repository for high-level and/or long-lived waste cannot start before a decision-in-principle regarding the long term management of such waste has been taken (see Waste Plan in section 2.3).

Disposal programme of category A waste (Category A waste project)

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.
Radioactive waste management aims, 1) at immobilising radioactive substances, which prevents their entry into the environment, and 2) at separating those substances, to prevent any contact with human beings.
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, organising 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 count 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.

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.

The disposal facility
Summarised, the disposal procedure of the category A waste is as follows:

1. The waste is placed in concrete caissons and subsequently encapsulated with mortar to form a monolith.
   The monoliths block radioactive radiation and immobilise radioactive substances, thus constituting a key safety element.
2. The monoliths containing the waste are placed in modules: concrete bunkers with thick reinforced walls.
   After backfilling, the modules are closed off with a concrete cover. A permanent roof covering all modules will offer protection against weather conditions before, during and after backfilling.
3. In time, the fixed roof will be replaced by a permanent, low permeability final cover.
   For realisation 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…

   The repository currently provides for emplacement of 1,000 monoliths per year. That implies waste for 15 years of operation by 2016 – the expected start of the operation phase. Once this stock has been emplaced completely – probably by 2031 – the further strategy for emplacement of the waste from the dismantled nuclear facilities will be determined.

The communication centre
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 centre 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 centre will consist of three sections:

- a contact and reception centre: 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.

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 the local partnerships in Dessel and Mol. It will consist of one joint fund with two equal sub-funds.

Participation

An extraordinary 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.

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 has undertaken to effectuate maximum realisation of 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 minimises impact from the disposal project on road traffic.

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, recognised 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.

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 organisations ONDRAF/NIRAS is conducting a pilot project that will establish whether humane bio-monitoring would be an appropriate method.

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)..

8.4 Article 14: Design and construction of facilities

The Preliminary Safety Analysis Report describes how the following points have to be implemented:

- protection against potential criticality (very low acceptable 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 during 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 too heavy financial burden on future generations.

The decommissioning plan can be established 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.

8.5 Article 15: Assessment of safety of facilities

8.5.1 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 depth in appendix 6. 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.

2. Category A programme

The disposal programme for low- and intermediate level short-lived waste is since 2006 in the last phase before the licensing, i.e. the project phase with the detailed design and safety assessment of a surface disposal facility in Dessel aimed at submitting a license application for a surface disposal facility in Dessel. The general design of the facility has been defined and all safety assessments for the safety report have been conducted.

Since 2006 an intensive interaction in the pre-licensing phase has been organised with the FANC, addressing all main elements of the disposal system under development and of the safety report in preparation by ONDRAF/NIRAS. ONDRAF/NIRAS plans to submit the license application to FANC in 2012. Before that the parts on long-term safety of the license application (including main elements of design of the facility) will be subject to an international peer review by NEA/OECD, to be organised in the period November 2011 – June 2012.

In parallel to the actual disposal facility, a facility for the production of monoliths is being developed also within the integrated surface disposal project in Dessel. Waste will be delivered to the disposal facility in standardised disposal units, i.e. monoliths. Monoliths consist of a concrete container filled with waste and a cementitious backfill material. In the production facility of monoliths, concrete containers will be filled with waste and cementitious backfill material. Safety assessments of this facility are similar to the existing facilities for processing and intermediate storage of radioactive waste. Belgoprocess is preparing the safety report and license application for this category A waste encapsulation and processing facility and will submit the license application to FANC by the end of 2011.

8.5.2 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 are taken into account in the final version of the the Safety Analysis Report..
The FANC also follows up the drawing up of the safety analysis report; the final version will be submitted to the Scientific Council of the FANC for approval (see also approval procedures, section E, 5.3.1.1.).

8.6 Article 16: Operation of facilities

When the construction is finished, the installation must be inspected by Bel V or by a recognized organisation for health physics control 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 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 will then be controlled by Bel V or by a recognized organisation for health physics control. 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 recognized organisation for health physics control and classified with reference to the INES international scale after approval by Bel V and the FANC, which assess if it is useful to establish 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 of waste quantities,
- the destination of the waste,
- the “historical review” 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 1 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 periodic safety review of the nuclear installations on site 2 was performed in 2006. The results of this safety review were submitted to the Safety Authority in July 2006. A safety review of the installations on site 1 has been performed and the results have been submitted to the regulatory body in July 2008.

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

8.7 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.

9 Section I: Transboundary movements

9.1 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[13] 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 Directive 2006/117/Euratom of 20 November 2006 on the supervision and control of the shipments of radioactive waste between Member States. In the 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) 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.
- Export of tested spent fuel rods from the SCK•CEN (research centre) to Germany.
- 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.

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[13] 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.

10 Section J: Disused sealed sources

10.1 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 will cover all sources emitting, at the time of its production, a dose flow equal or greater than 1 mSv/h at 1 meter, and all 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.

11 Section K: Planned activities to improve safety

From the **Regulatory body** side, the planned measures to improve safety are based on several pillars:

- The implementation of the safety improvement action plans set up by the licensees, namely in the frame of :
  - the periodic (10-yearly) safety reviews of Belgoprocess, of the BR2, of the NPP and their associated on-site waste and spent fuel storage installations,
  - The audit related to the management of safety of Belgoprocess.

- The improvement of the regulatory framework related to waste management and decommissioning activities:
  Several regulatory proposals drafted by the FANC are now in the stage of finalisation or are ready for engaging the legislative process of consultation, approval and promulgation. These regulatory proposals are:
  - The regulatory proposal related to the WENRA reference levels for Decommissioning, developed by the WGWD (Working Group on Waste and Decommissioning)
  - The regulatory proposal related to the WENRA-WGWD reference levels for waste storage.
  - The future law proposal for reinforcement of the regulatory framework regarding interventions and remediation of sites.
  - The regulatory proposals related to the licensing system and the safety requirements for disposal facilities.

- The “Stress tests” of fuel cycle facilities

Following the accident that occurred on 11 March 2011 at the Japanese Fukushima-Daiichi nuclear power plant, a wide-scale targeted safety reassessment programme was set up among the member states of the European Union operating such facilities. This “stress tests” program is designed to re-assess the safety margins of the European nuclear power plants when faced with extreme natural events, and to take relevant action wherever needed.
According to the recommendation of the Belgian Parliament’s Subcommittee for nuclear safety of the 18 May 2011 that was incorporated in a resolution of the Belgian Parliament on 16 June 2011, Belgium decided to include the other class I nuclear facilities in the Belgian stress tests programme. Consequently, the regulatory body published its final stress tests specifications applicable to Class I facilities on 4 July 2011, and formally communicated these requirements to the licensees.

The following radioactive and spent fuel management facilities will be subject to the “Stress tests”:
- Radioactive waste processing and storage facilities at the Belgoprocess site 1 and 2,
- The “Water en Afvalbehandelingsgebouw” (WAB), the waste treatment and storage facility at the Doel Site
- The Spent fuel storage installations: Building D3 at the Tihange site and the SCG facility at the Doel site

These “stress tests” are scheduled for the second half of 2012.

- Continuation of the participation to international groups

Belgium will continue to be active in international groups, such as the Waste Safety Standards Committee (WASSC) of the IAEA, the Radioactive Waste Management Committee (RWMC) of the NEA, and in European Union initiatives. In particular, Belgium will continue it participation to the WENRA working group devoted to waste disposal.

- The development of a regulatory framework regarding the security of waste storage and disposal facilities

Several regulatory projects (Proposals for Laws and Royal Decrees) are being developed at the FANC to set up a legislative and regulatory framework for the security (physical protection) of nuclear materials and others radioactive materials. In particular, the FANC is currently addressing the security of waste (treatment and storage) facilities, in view of the licence application for the future SL-LILW surface disposal facility.

- The safety review of the licence application file of the future surface waste disposal facility

- The transposition of the European Directive 2011/70/Euratom.

FANC and ONDRAF/NIRAS are members of the ENSREG group, which advised the European Commission for the development of 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.

As a result of this directive, the European Member states are obliged to establish and maintain a national legislative, regulatory and organisational framework (‘national framework’) for spent fuel and radioactive waste management. The FANC and ONDRAF/NIRAS will be actively involved in the preparation of an effective transposition of the provisions of this directive into the Belgian national framework, and in the activities required to implement the directive, such as the implementation of a national programme and the reporting on the implementation of the directive for the first time by August, 23, 2015.

In addition, the FANC and ONDRAF/NIRAS participate actively in the working group called “WG2” (Working Group 2) set up by ENSREG for dealing with waste management issues, and more specifically with the obligations for EU member states from the European Directive 2011/70/Euratom related to member state reporting and self-assessment and peer reviews .

- R&D Programme of Bel V

Regarding the present development of Belgian radioactive waste repositories Bel V has developed an R&D programme aiming at maintaining and further developing the knowledge and the skills related to the safety assessment in these fields.
Concerning the safety of waste disposal facilities, Bel V strengthens its technical skills (use of simulation tools, for instance) and contributes to the rulemaking by participating to dedicated symposia and international working groups, such as the PRISM network coordinated by the IAEA. Bel V has also participated and is presently participating in projects of the 6th and 7th Framework Program of the European Commission concerning development of technical expertise for the safety assessment of geological radioactive waste disposal.

Concerning the safety of decommissioning, the main task of the R&D programme was issuing a draft to be used by Bel V in order to have a broad view on decommissioning issues in general, and more specifically to support Bel V to understand the framework of a decommissioning project and to be able to fulfill its mission as subsidiary of the FANC (assessing and reviewing the documents, and follow up on the dismantling and decontamination on the field). The dismantling of the BR3 research reactor at SCK-CEN and the Eurochemic reprocessing plant at Belgoprocess have been major pilot projects that brought a valuable experience in these fields. Bel V is equally involved in international working groups dedicated to the decommissioning, such as the FaSa project coordinated by the IAEA and aiming at organizing and structuring the information and experience collected on decommissioning.

Specific actions, on-going or planned by **ONDRAF/NIRAS** are listed and explained below:

For the long-term management of the short-lived waste (SL-LILW or category A waste) ONDRAF/NIRAS is preparing, in the pre-licensing phase, interaction with the FANC/AFCN, the licence application file (including the safety report and the environmental impact assessment) for a near surface repository in Dessel. ONDRAF/NIRAS plans to apply mid 2012 for a construction and operation licence for the surface disposal facility, in view of an operational facility by 2016. Before the license application, the ONDRAF/NIRAS safety case will be submitted to an international Peer Review organised by the OECD/NEA, as requested by the Belgian Federal Government.

In collaboration with its subsidiary company Belgoprocess ONDRAF/NIRAS is preparing the licence application file 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 plans to apply for a construction and operation licence for this facility by the end of 2011. Once this post-conditioning facility operational (planned by 2016) the stored category A waste drums in the storage buildings 150 and 151 on the Belgoprocess site, can be post-conditioned for surface disposal and, after acceptance for disposal, transfer to the repository can start.

ONDRAF/NIRAS and Belgoprocess will continue their inspection programme of all the conditioned waste in the storage buildings on the Belgoprocess site 1 in view of a complete inspection of all stored waste by 2012. The analysis and investigations of the degradation mechanisms leading to non –conform waste packages (corrosion of waste packages and swelling of bituminous waste) will be continued in order to define and implement the required corrective measures. The post-conditioning of the category A waste packages in monoliths for surface disposal will be an important step towards the long-term management of non-conform category A waste packages.

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 in principle” 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 decision in principle 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.

Pending a decision in principle to be made by a full-power government and in order to ensure the continuity of ONDRAF/NIRAS’ public service tasks, in particular the agency’s activities in the field of long-term management of category B and C waste, the supervising Ministers (the Minister for Climate and Energy and the Minister of Economy) have entrusted, by letter of October 3, 2011, ONDRAF/NIRAS with the responsibility of implementing the following six tasks:

1) 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;

2) 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;

3) 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;

4) develop the social dimension of the B&C programme and ensure the related financing;

5) 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

6) follow the evolutions regarding management options that were examined but not chosen in the Waste Plan.

This request prejudges neither the making of a decision in principle on the long-term management of the waste concerned in Belgium nor the contents of this decision.

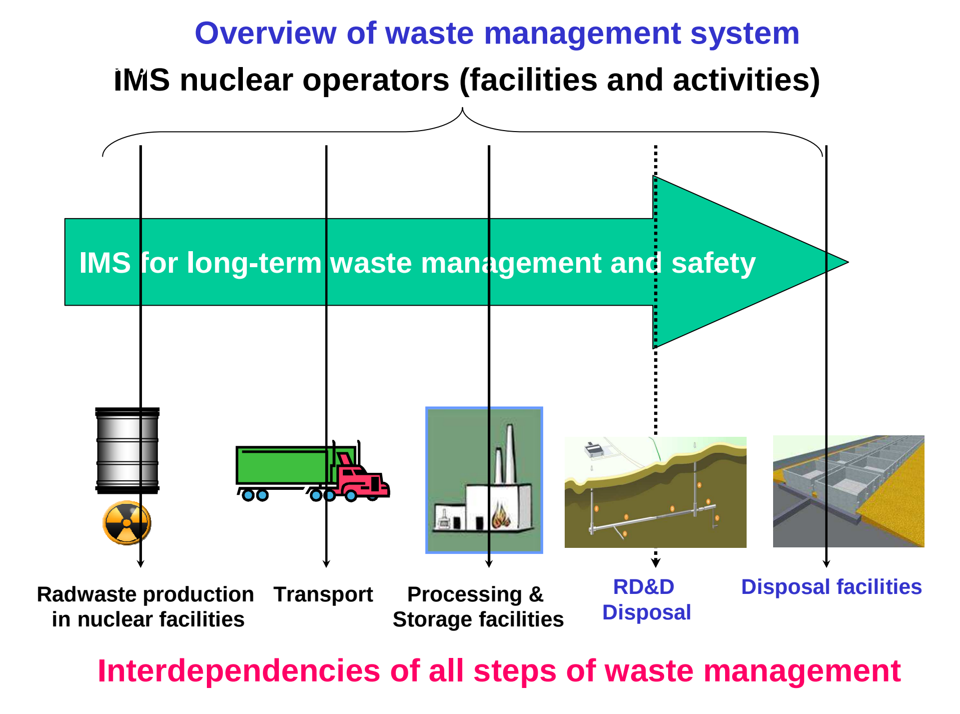
Among the issues raised in the Waste Plan, the one related to the long-term management of large amounts of (mostly low-level) radium-bearing waste, mainly at the site of Umicore in Olen and activities from historical production of radium, will deserve particular attention the next years. For the definition of a strategy for long-term management of this radium-bearing waste in Belgium ONDRAF/NIRAS will develop a second Waste Plan and a Strategic Environmental Assessment in the coming years.

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 already 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 ongoing, in view of the development by 2015 of a global system of financial coverage of all nuclear liabilities, based on the pillars of responsibility, security and control. This global system will be taken up in the legal system.

ONDRAF/NIRAS will establish the third report on the inventory of nuclear liabilities by the end of 2012, and issue it to its supervising Minister(s).

With the future planned licensing and construction of the surface disposal facility for category A waste, ONDRAF/NIRAS will become license holder and operator of a nuclear facility. For preparing this step, ONDRAF/NIRAS is developing a Integrated Management System (IMS) for all its activities as a radioactive waste management agency and as a 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) – see scheme below. 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. ONDRAF/NIRAS will also take the required steps at the organisationlaorganisational level to integrate all required functions and processes of a nuclear operator (e.g. health physics department).



Decommissioning of LEWC/HEWC-storage tanks of Eurochemic

The decommissiong of the experimental reprocessing plant Eurochemic, operated by an international consortium from 1966 until the end of 1974, is an important activity on the Belgoprocess BP1 site. Currently, ONDRAF/NIRAS and Belgoprocess are working together with the awarded contractors on detailed studies for the overall project for the decommissiong of the LEWC/HEWC-storage tanks and for the decontamination equipment. The construction of the infrastructures to be foreseen around the buildings 105X/122X will start in 2015. The decontamination activities are planned in 2018/2019.

12 Section L: Appendices

12.1 APPENDIX 1: Description of the spent fuel storage facilities at the nuclear sites of Doel and Tihange

12.1.1 Introduction

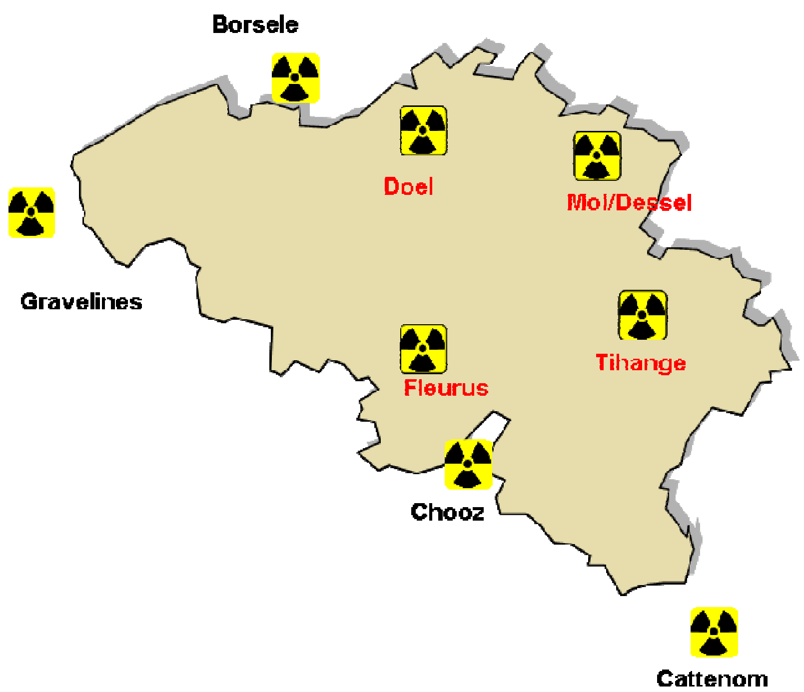
The aim of this appendix is to provide both a general overview and a list of the principal characteristics of the arrangements for the interim storage of spent fuel originating from the nuclear energy production units in Belgium at the the sites of Doel and Tihange.
The technically-proven methods for 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).

12.1.2 Belgian policy on the 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).

12.1.3 The sites

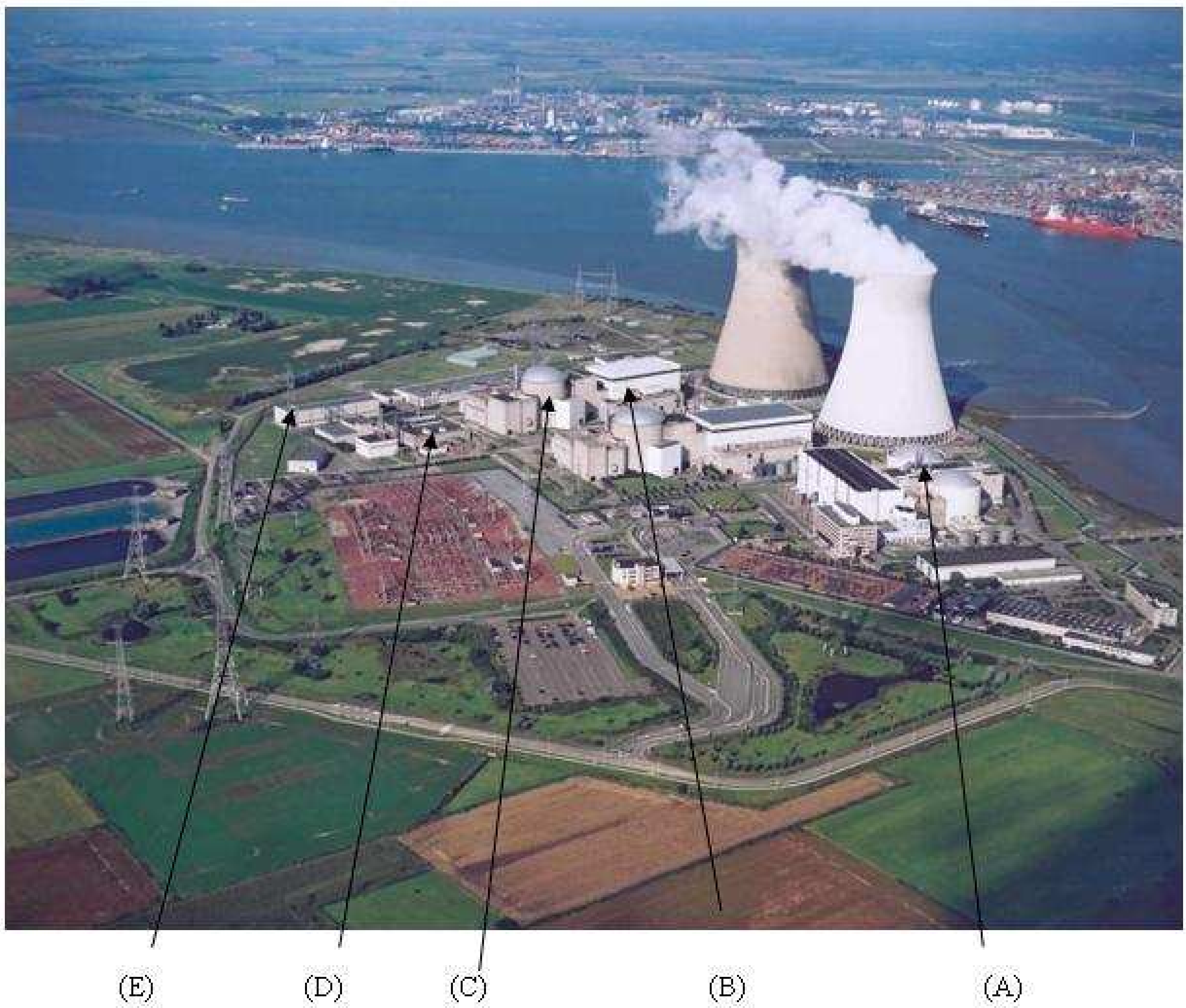
The nuclear power plants in Belgium are located on two sites, one in the south of the country (Tihange) and the other in the northern part of Belgium (Doel).



12.1.3.1 **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).



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.

12.1.3.2 **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).

12.1.4 Spent fuel storage systems

1.4.1 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 ponds make it possible to store at least one complete core plus the core already present in the reactor.

12.1.5 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.

12.1.5.1 Interim storage unit at Doel (SCG building)

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 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.
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.

12.1.5.2 Interim storage cell at Tihange (DE building)

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 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.

12.2 APPENDIX 2: Description of Belgian Nuclear Power Plant Radioactive Waste Management Facilities

12.2.1 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.

12.2.2 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.

12.2.3 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.

12.2.4 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.

12.2.4.1 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.

12.2.4.2 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.

12.2.4.3 Non- routine large 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.

12.2.5 Radioactive Waste Management Facilities at Doel NPP

12.2.5.1 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.

12.2.5.2 Liquid waste treatment systems

The liquid waste produced by the different units at the Doel site is treated in the WAB, the centralised waste treatment building.
After their collection, the Reactor coolant quality-type effluents are pretreated by means of filters, ion exchange columns and gas strippers in the GNH of the unit at which they are produced before being sent to the WAB. Some other effluents also require a filtration in the unit where they are produced before being sent to the WAB.
In the WAB, the waste is received in dedicated buffer/storage 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 m³/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.

12.2.5.3 Solid Waste Systems

12.2.5.3.1 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..

12.2.5.3.2 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.

12.2.5.3.3 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 3 dedicated storage buildings called GSG.

12.2.6 Radioactive Waste Management Facilities at Tihange NPP

12.2.6.1 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.

12.2.6.2 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 m³/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 m³/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.

12.2.6.3 Solid Waste Systems

12.2.6.3.1 Waste conditioned at Tihange

- 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.

- 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.

- 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, are conditioned by an outside company by means of a mobile unit using a polymer-binding agent. This task is 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. A process qualification file will be submitted to the approbation by ONDRAF/NIRAS.

12.2.6.3.2 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.

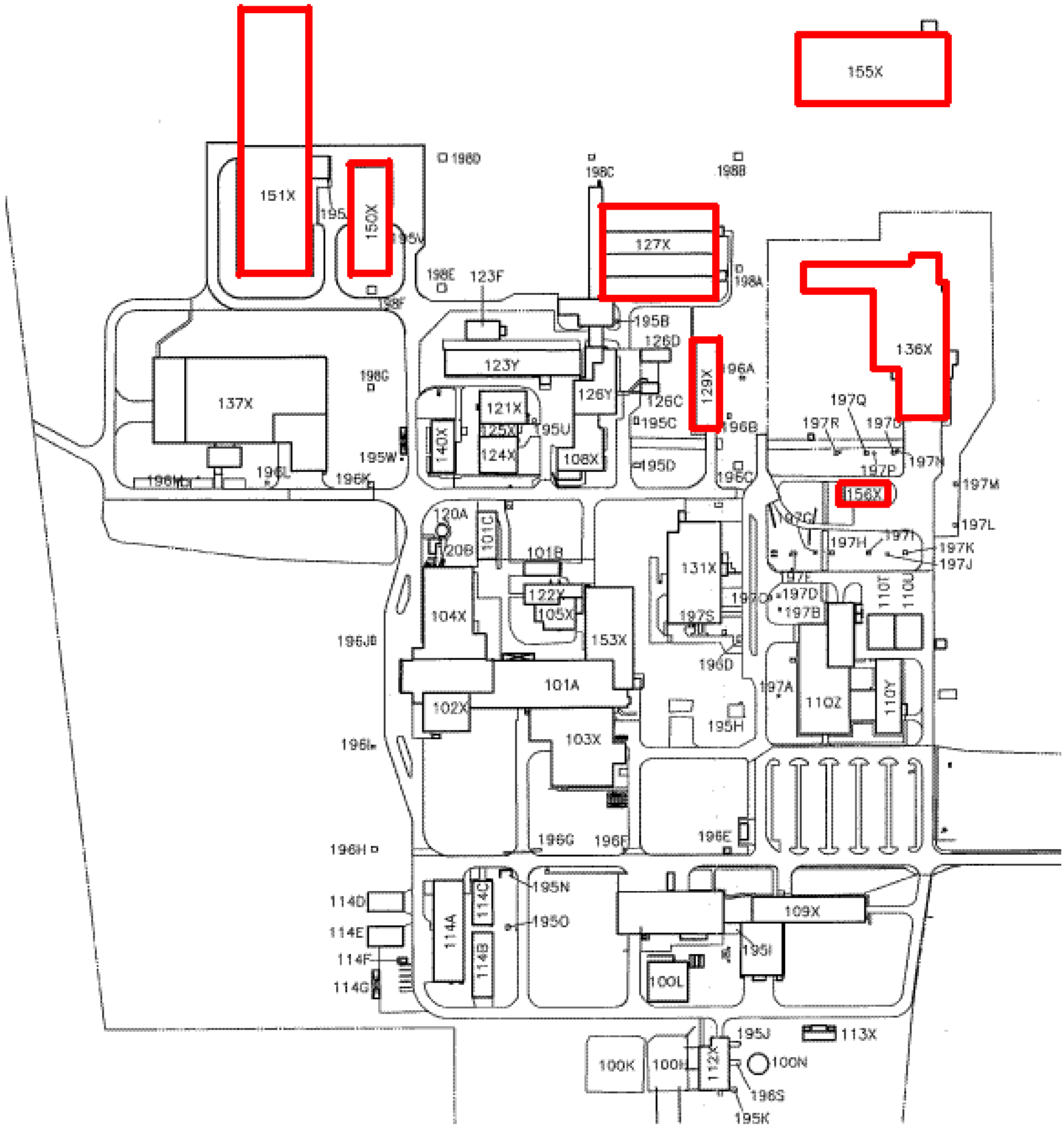
12.2.6.3.3 Non-routine large solid used materials

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. The superseded Reactor Vessel Head of Tihange 1 is also stored in the same building.

12.3 APPENDIX 3: description of the storage buildings at the Belgoprocess site

A general view of the Belgoprocess site is shown on the picture below.

The different buildings of interest for waste storage are identified (in red) on the following picture:



12.3.1 Building 127

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.

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).

12.3.2 Building 129

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.

Hall above the storage bunkers

12.3.3 Building 136

Exterior view of Building 136

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 3 hereafter.

Table 3: 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 140/141 bunkers 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 ≥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).

12.3.4 Building 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 4 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 5.

Table 5 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.

12.3.5 Building 151

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 6: 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 18: 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.

12.3.6 Building 155

Exterior view of building 151

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 below (the last four OV packages are non-standard packages).

Table 7: 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 manipulated 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.

12.3.7 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.

12.4 APPENDIX 4 : Description of the installations of SCK•CEN : BR2

The BR2 reactor, in service since 1963, is a test reactor with a high neutron flux for the irradiation of materials. Its main purpose is the irradiation of materials under high neutron flux (maximum thermal neutron flux of the order of 10^{15} n. cm^{-2} s^{-1}). These materials are irradiated in experimental rigs, the complexity of which depends on the nature of the irradiation and the intended objectives. The reactor loading is defined (fuel elements, control rods) in the light of the experimental specifications, and is adjusted for each cycle. It is cooled by pressurised water (nominal value: 1.235 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.

12.5 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 weare 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’sareas:
  - 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 equipments (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.

By mid of 2011, more than the half of the actions on site 1 is was already closed and most of the remaining actions weare in an advanced state.

12.6 Appendix 6 : RD&D related to Geological disposal in a poorly indurated clay (Boom Clay or Ypresian Clay).

The solution recommended by ONDRAF/NIRAS for the long-term management of both existing high-level and/or long-lived waste (and this includes spent fuels when they have been declared waste) and those whose production is planned, principally in the framework of the current electronuclear programme, is geological disposal in a poorly indurated clay (Boom Clay or Ypresian Clay). This solution has attained an advanced degree of technical maturity, enough for it to be the object of a decision in principle. It is however necessary to make it the object of complementary RD&D activities, which will progressively change in nature, evolving towards the confirmation and the refinement of knowledge, preparation of the industrial phase of implementation and the preparation of files for licence application.

Actually, at the stage of methodological RD&D, the program of ONDRAF/NIRAS as regards geological disposal focuses on the Boom Clay at Mol-Dessel, without however prejudging the site on which a repository will eventually be implemented; the Ypresian Clay is researched as an alternative host formation. The RD&D programme is indispensable because of the fact that the disposal system to be designed needs to have unique characteristics, in particular because it must provide a maximum adequacy between wastes to be disposed of, engineered barriers and host formation. In order to do this, ONDRAF/NIRAS has adopted an approach that is prudent, systematic and in stages, aiming to ensure the absence of insurmountable obstacles, whether this is in regard to safety (operational and long-term, classical and nuclear) or feasibility.

Since the promising nature of the scientific and technical results obtained from the 1970's by Belgium as regards geological disposal in a poorly indurated clay, and in particular the Boom Clay, have never been challenged either in terms of safety or feasibility, and have been progressively confirmed on different occasions, notably during peer reviews, ONDRAF/NIRAS is today able to propose a solution for the long-term management of B&C waste.

The current RD&D programme aims to strengthen and refine the scientific and technical foundations of the proposed solution. The peer reviews and the recognition of achievements by the academic and industrial worlds play an essential role in this context. The evolution of the Belgian program as regards geological disposal is characterised by a succession of decisions, first of all by SCK-CEN, and then the ONDRAF/NIRAS, the effect of which has been to focus the research on the Boom Clay in Mol-Dessel, the Ypresian Clay being researched in an exploratory fashion as alternative host formation. The RD&D programme as regards the geological disposal of high-level and/or long-lived waste (and this includes spent fuels when they have been declared waste) is progressive and has gradually passed from basic RD&D to (semi-) industrial demonstration activities and activities to confirm achievements.

Description of the disposal system in a poorly indurated clay

ONDRAF/NIRAS has formalised a safety strategy on the basis of functions that must ensure the various components of the disposal system (host formation + engineered barriers + waste) during the different periods of the life of the system. This strategy thus proceeds from a systematic approach and enables the retention of every possible option as regards the design of the repository and the priorities of RD&D. This safety strategy also provides for a step-by-step process before a geological disposal can be implemented and the possibility of adding external demands and/or conditions to its further step-by-step development (always in the framework of a systems approach).

The director elements on which ONDRAF/NIRAS bases itself to design a repository for B&C waste in a poorly indurated clay capable of guaranteeing operational safety and long-term safety can be summarised as follows.

- Long-term safety:
  - -- The containment of high-level waste (heat-generating) must be ensured by the engineered barriers during the period in which the properties of the host formation can be temporarily disrupted, in particular because of the temperature increase that it causes (thermal phase). This period goes from a few hundred years for vitrified waste to a few thousand years for non-reprocessed spent fuel (average prior cooling in surface storage lasting 60 years).
  - -- Isolation of the repository in relation to external disruptions, like climactic or seismic changes, must be ensured by the clay layer and its geological environment.
  - -- Delay of the migration of radionuclides and chemical contaminants which will end up being released from the waste and from the engineered barriers is principally ensured by trapping them in the clay.
  - -- The design of the repository, including the choice of techniques and materials, is done in such a way to limit, as much as possible, the disruptions induced in the clay, which constitutes the most important obstacle to long-term safety.
- Operational safety:
  - -- The engineered barriers should ensure radiological shielding of waste during every operational phase (around 100 years) and this, from the moment when the conditioned waste containers are post-conditioned, on the surface, in order to form supercontainers or monoliths.

The geological repository foreseen for the B&C waste consists of a network of horizontal galleries constructed at mid-thickness of the layer of clay, at a sufficient depth. The shafts give access to a principal gallery, linking with the repository galleries of smallest diameter. These are distributed to numerous sections dedicated to the waste groups with comparable characteristics (for example, the heat they release, their chemical composition or again the nature of their conditioning matrix).

The system of engineered barriers foreseen for waste in the high-level category is based on the use of supercontainers intended to ensure complete containment of radionuclides and chemical contaminants during the thermal phase. These supercontainers are units formed by a watertight overpack of carbon steel (and the container(s) of vitrified waste or the spent fuel that it contains) and the thick protection layer of cement material that surrounds it. The use of carbon steel in a cement environment is widely known, well characterised and robust in the expected environmental conditions of geological disposal. The long-lived waste (non-heat-generating) is, for handling purposes, placed in the cement tanks and immobilised in the cement in such a way as to form monoliths. Both the supercontainers as well as the monoliths provide radiological shielding for the workers during the operational phase and the closing phase of the repository.

Once the wastes are deposited, the empty spaces in the repository galleries are packed with materials chosen for their ability to contribute to the overall safety of the system. All of the access galleries and all the shafts are packed and sealed once the underground activities are completed, possibly after a period of on-site controls. The system is then in a passive state.
After closure, the geological repository will be controlled from the surface and future generations will be able to prolong the controls as long as they wish. The controls will continue to be obligatory in the event of disposal of spent fuel, in order to avoid the risks of nuclear proliferation.

Principal scientific and technical achievements of the RD&D programme relative to the repository in the Boom Clay

The current system of B&C waste disposal in the Boom Clay is, according to the current state of knowledge and evaluations, able to ensure operational and long-term safety, and it is technically feasible.

Boom Clay as a barrier

Boom Clay offers various characteristics that make it a quality natural barrier to the migration of radionuclides and chemical contaminants toward the surface environment.

-- It is of very low permeability. That is to say, there is thus no movement of water within it, and therefore no transport of radionuclides and chemical contaminants by this vector. Consequently, the transport of radionuclides and contaminants is essentially diffusive, that is to say, it is of the migrating species as a result of their concentration gradient and is not among those that do not migrate with moving water in the pore water. Among others, this property was able to be demonstrated owing to the more than 20 years of experience in the underground laboratory.

-- It offers a great capacity for trapping radionuclides and chemical contaminants. Their migration through the clay is therefore significantly slowed (absorption capacity, favourable geochemical properties, …).

-- It has a great capacity for buffering chemical changes (for ex., introduction of oxygen during the excavation and operational phase and the diffusion of an alkaline plume from the cement used), whereby only a very small amount of clay is affected.

-- It is plastic. The fractures and fissures which could be generated there thus have the tendency to close (auto-sealing capacity).

-- As a result, the Boom Clay does not offer preferential paths for the migration of radionuclides and chemical contaminants progressively released from the repository.

-- The Boom Clay is also relatively homogeneous. Across its entire thickness of approximately 100m, the Boom Clay consists of various layers with a little more or a little less clay. But the transport qualities of radionuclides and chemical contaminants is very homogeneous across almost the entire thickness. Furthermore, the Boom Clay appears within simple geological structures ensuring an important lateral continuity: these two properties facilitate its characterisation.

-- It offers hydrogeological, geochemical and mechanical stability over periods of geological time; that is to say, over millions of years.

-- The components of the Boom Clay have remained unchanged since shortly after the establishment of the formation, 35 million years ago. During this entire period, the natural changes (seismic, fluctuations in sea level, glacial periods, etc.) have not affected the favourable properties of the clay.

-- The migration of natural chemical species through the Boom Clay has remained diffusive at least over the course of the last million years.

Evaluation of feasibility

The principal achievements concerning feasibility are the following:

-- demonstration of the possibility of achieving the industrial method of shafts and galleries within the Boom Clay at more than 200 metres depth, as well as the possibility of constructing a crossing between two galleries, all the while limiting the geomechanical disturbances of the clay; these demonstrations constitute the first:

-- demonstration of the artificial nature of fractures observed in the Boom Clay during the course of the excavations: these fractures, which are induced by the crossing, seal over time;

-- demonstration of the possibility of achieving a quality sealing in a shaft;

-- demonstration of the possibility of filling the empty spaces between the coating of the repository galleries and the supercontainers or monoliths with a grout mixture

-- possibilities for handling the supercontainers and monoliths in shafts and galleries according to known industrial methods;

-- capacity for a cost estimation of the repository and the margins for technological hazards and the projection of associated uncertainties.

Evaluation of long-term safety
The principal achievements concerning the evaluation of long-term safety under normal conditions have been obtained for a repository intended to be constructed in the environment of the layer of the Boom Clay 100 metres think in the region of Mol-Dessel. They can be summarised as follows:

-- It is the Boom Clay that contributes the greatest long-term safety.

-- The role of the waste matrixes and the engineered barriers for long-term safety is marginal, except in what concerns the UO2 matrix of nuclear fuels.

-- The maximum dosage produced by the repository is inferior to the regulatory limit by at least a factor of 10:

- the principal contributors to the dosage are the products of fission not trapped by the Boom Clay (129I, 36Cl, 14C, …),

- the actinides (U, Pu, Am, Cm and Np) only contribute very little to the dosage,

-- most of the radionuclides decrease to negligible activities during their stay within the engineered barriers and their transport route through the Boom Clay.

-- The most mobile products of fission leave the Boom Clay after a duration in the order of tens of thousands of years; the actinides leave the Boom Clay after several hundred thousand years. In both cases, the quantities are minimal.

-- The exploitation of the aquifers (water bearing layer) on both sides of the Boom Clay are not endangered by the presence of the repository.

Ypresian Clay as a host formation
There is only little in-depth knowledge of the Ypresian Clay in Belgium. Several studies and exploratory drillings have taken place at the initiative of the ONDRAF/NIRAS. The interpretation of the results is ongoing. The Ypresian Clay offer several potential advantages as a host formation compared to the Boom Clay:

-- they are present in certain places at more significant depths the Boom Clay;

-- they offer several zones richer in argillaceous minerals than the Boom Clay, these minerals being those at the origin of trapping the radionuclides and with the capacity to seal the formation;

-- they are surrounded by saline aquifers;

-- they sit on top of other argillaceous formations which constitute a natural multi-barrier whole.

Certain characteristics of the Ypresian Clay nevertheless constitute potential difficulties, which do not seem insurmountable but if need be would have to be analysed in greater detail. So, given that it is very swollen clay, the construction of underground installations within them at depths of the order of 300 to 400 metres, raises questions. Moreover, the presence of salt water imposes different geochemical conditions than those in the Boom Clay, which could have an impact on the corrosion of metal engineered barriers and the migration of radionuclides and chemical contaminants.
Finally, the Ypresian Clay displays its own characteristics which merit particular attention, such as the presence of structural discontinuities (faults) and an inferior capacity to dissipate heat compared to that of the Boom Clay. The circulation of water in the geological environment of this clay equally merits particular attention.

Principle future activities of RD&D in view of the development and progressive implementation of a geological repository
Concretely, the RD&D will have to allow the establishment of case statements which will have to support the decisions punctuating the decision-making process. And so it will aim at the confirmation, refinement and integration of the achievements (the way to reduce the remaining uncertainties and to augment the margins of certainty, the development of certain areas of knowledge (in particular as concerns the Ypresian Clay), the direct or indirect demonstration of all the aspects of the construction that have not already been demonstrated, the exploitation and the closing of a repository, as well as the demonstration of cost control.) The protection of aquifer (water bearing layers) resources is part of the major preoccupations of ONDRAF/NIRAS and the studies already underway on this subject will be continued and developed as necessary.
The principal axes of the RD&D and its objectives can be summarised as follows. They will be developed in the RD&D programme currently in preparation by the ONDRAF/NIRAS.

Boom Clay
For the host formation:
-- Establishment of acceptable disturbances (thermal, hydraulic, mechanical, chemical, …) in the Boom Clay. (This includes taking into consideration the indirect disturbances induced by the presence of certain compounds in the materials used for the construction of engineered barriers.)

-- Evaluation of disturbances generated in the Boom Clay by the production of hydrogen after closure of the repository (and analysis of the impact on the design of the repository.)

-- Confirmation, through the on-site PRACLAY demonstration experience, of the capacity of the Boom Clay and the coating of the galleries to support the thermal load imposed by the heat-generating waste, this load being one of the most important transients that the repository and the host formation will have to undergo. PRACLAY would have to strengthen the results obtained by the small-scale, on-site tests and help support confidence in the models, their fundamental hypotheses and their predictions. This test on the decametric scale and over a period of ten years has been conceived in order to be independent of the design of engineered barriers as well as the type of heat-generating waste. The results relative to the initial heating phase, during which the thermal gradient will be most important, should be available in 2013-2014.

-- Detailed understanding of the phenomena of the capture of radionuclides and chemical contaminants by the Boom Clay.

-- Confirmation research completed

-- Compatibility with other usage, exploration and exploitation of the subsoil (including drinking water extraction)

-- Long-term geological stability as concerns the depth, thickness, homogeneity and horizontal continuity of the host formation, impact of earthquakes and climate changes

-- Self-sealing and low permeability on a large scale

-- Limited impact of radiation and cement interaction on the positive qualities of the clay

-- Radionuclide migration

For the waste:
-- Verification of the new types of waste whose production can be anticipated (for example, presence of spent fuels at higher combustion rates than currently) does not raise new questions in relation to those already taken into account in the research.

-- Refinement of the understanding of the durability of the glass matrixes and of the UO2 in the cement environment.

-- Improvement of the definition of the characteristics of spent fuel taking into account their intrinsic evolution during the storage period required for their cooling, and taking this evolution into account in the research concerning their conditioning and their post-conditioning.

-- Confirmation of the compatibility of the bituminised matrixes with the Boom Clay. The swelling of the Eurochemic bituminised waste and the overpressures that ensue are indeed important.

-- Reduction of the uncertainties of the source term (few retarded components, gaseous components, …)

For the installations:

-- Demonstrating every production stage and the handling of the supercontainers and monoliths and verification of the reinforcement needs (including in the event of a drop).

-- Defining the requirements relative to the sealing of the galleries and shafts and refinement of the sealing strategy to be implemented (taking into account a possible period of reversibility).

-- Establishing the operational requirements concerning the presence of gas during the disposal and analysis of the impacts on the design of the installation and the engineered barriers.

-- Defining a strategy and analysis of the practical possibilities for controlling the repository in the operational phase, during its progressive closure and, eventually, post-closure.

-- Developing measures concerning security and safeguards.

-- Analysis, from a scientific and technical, safety and financial perspective, in the framework of a broad community dialogue, of the conditions for implementing a geological repository in terms of the ability to control the repository, to recuperate the stored waste and the transfer of knowledge (including the memory of the repository's location), in order to define their objectives, scope and respective limitations and to be able to integrate them in to the project of the repository, if need be initiating complementary RD&D activities.

For the evaluation of safety and impact on the environment:
-- Evaluation of operational safety.

-- Refining the methods for managing uncertainties in the evaluations of the radiological safety of a system of geological disposal and the evaluations of its impact on the environment.

-- Evaluation of the radiological safety of the disposal system according to a wide range of scenarios (and their variants). This evaluation must in particular make it possible to ensure that the quality of the water resources is not jeopardised by the presence of the repository.

-- Evaluation of the impact of chemical contaminants released by the disposal system in order to ensure, in particular, that this impact does not jeopardise the quality of the water resources and, more generally, does not affect the environment of the disposal system in an unacceptable way, including the surface environment and human beings.

-- Evaluation of the impact of increasing the temperature on the physico-chemical conditions and underground processes (disposal, …), biological diversity, flora, fauna and soil elevation.

-- Integrating the whole of arguments relative to the different components of the disposal system on which the safety of the system rests and making a judgment as to the level of confidence that one can have in this safety.

-- Reliability of simulations and models.

Ypresian Clay

Since the Ypresian Clay displays qualities comparable to Boom Clay, it is supposed that the same safety strategy can be applied, a similar design can be used and that a great deal of the knowledge about the Boom Clay is also applicable to the Ypresian Clay. It should be mentioned that the safety strategy is an iterative process and thus allows, on the basis of the knowledge gained, the implementation of step-by-step adjustments and controls if necessary.
On the basis of the previous, the strategy was developed to take the systematic definition of the primary requirements and more detailed RD&D aspects for the Boom Clay and adopt them as such for the Ypresian Clay. A systematic evaluation will then take place for the Ypresian Clay, namely:

- the extent to which the knowledge developed for the Boom Clay is applicable as such to Ypresian Clay (for ex., the expected climate changes)

- the extent to which the knowledge of the Boom Clay is transferable to the Ypresian Clay on the basis of a number of fundamental parameters such as, for instance, mineralogy, pore water chemistry, and so on (for ex., self-sealing that, for instance, is controlled by the presence of swelling clay)

- the extent to which detailed research must be launched in order to determine or develop specific parameters and models for the Ypresian Clay (for ex., specific geomechanical parameters to evaluate the feasibility of excavations)

The results of this exercise, research and calculations to explore the direction to take will make possible an initial approximation in order to ascertain whether the safety strategy should be adjusted or if it is possible to move on to a first assessment of the Ypresian Clay as a host formation. On the basis of this, in the next phase further development and guidance of an RD&D programme for the Ypresian Clay will be developed.

On the basis of a first evaluation/screening, the focus will probably be on the feasibility of excavations, the origin and influence of structural discontinuities, the determination of thermal conductivity, the determination of the hydro-geological framework, and improving the knowledge of the composition of pore water and the possible impact of a vertical heterogeneity.

On the basis of the strategy of systematic evaluation of the Ypresian Clay, it is the opinion of ONDRAF/NIRAS that an underground laboratory in the Ypresian Clay is not necessary. In function of the results of future research and evaluations, it may be determined up to which phase in the decision-making process the Ypresian Clay as an alternative host formation is taken. If necessary, there is still the possibility of developing a characterisation facility (= research facility on the site of the eventual repository) in the Ypresian Clay in case it is finally decided in favour of a repository in the Ypresian Clay.

12.7 List of acronyms

ANS: American Nuclear Standards.

ANDRA: Agence Nationale pour la gestion des déchets radioactifs, France (French Agency for the Management of Radioactive Waste).

AVN: Association Vinçotte Nuclear.

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.

GRR-1963: General Regulations for the protection of the workers, the population and the environment against the hazards of ionizing Radiation, laid down by Royal Decree of 28 February 1963.

HAZOP

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).

ONDRAF/NIRAS: Organisme National pour les Déchets Radioactifs et les Matières Fissiles Enrichies/ Nationale Instelling voor Radioactieve Afval en verrijkte Splijtstoffen (Belgian Agency for the management of Radioactive Waste and Enriched Fissile Materials).

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

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