KINGDOM OF BELGIUM

FIFTH MEETING OF THE CONTRACTING PARTIES TO THE CONVENTION ON NUCLEAR SAFETY

NATIONAL REPORT

SEPTEMBER 2010

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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 “Bel V”, “Electrabel”, “Tractebel Engineering” and “SCK•CEN”.

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I. INTRODUCTION

I.A. Content of the Present Report

This Belgian national report, submitted to the fifth review meeting of the parties to the Convention on Nuclear Safety, is based on its previous editions and has a similar structure. For each article of the Convention, relevant descriptions and explanations are provided on how the principles of the Convention are translated into the Belgian legislative framework and how they are applied to its nuclear installations. In addition, in order to underline relevant evolution since the last review meeting, the section, I.C is focused on new developments since 2008, including developments related to the follow-up of the fourth review meeting.

The report gives also information on the issues raised during the Belgian presentation at the last review meeting.

When drafting this report, due account was taken of the appropriate guidelines in INFCIRC/572/Rev.3 (28 September 2009).

On a voluntary basis and for the first time, information about the Belgian research reactors is included in the present National Report.

In order to keep the report to a reasonable size, rather than identifying for each Article the particularities and characteristics of the Belgian power plants, it was found preferable to give in Appendix 1 a detailed description of the power reactors, highlighting their original design and the major modifications brought to them during the periodic safety reviews which are mandatory under the Belgian regulations. Appendix 2 contains similar information about the BR1 and BR2 research reactors.

The principal nuclear Belgian actors have participated in its drafting:

- FANC, the Federal Agency for Nuclear Control, the safety authority.
- Bel V, the technical subsidiary of the FANC.
- Electrabel as the operator of the seven nuclear power plants.
- Tractebel Engineering, the engineering support organisation to the NPP's operator.
- SCK•CEN as the operator of the research reactors in Belgium

Together, the above-mentioned organisms encompass the legal and practical competencies necessary to collect and to structure the information required to elaborate the national report.
The report is available on different Belgian Web sites such as www.fanc.fgov.be, www.belv.be.

A list of the acronyms used in the present Report is given in Appendix 3.
Appendix 4 gives the web site addresses of Belgian organisations playing an important role in the nuclear field.
Appendix 5 lists the subjects which have been examined during the 10-year safety reviews of the Doel and Tihange units, and indicates topics to be examined during the next 10-year safety reviews.

I.B. History of Nuclear Energy Development in Belgium

Before the Second World War, Belgium was the world's largest radium producer, which gave rise not only to the related metallurgy, but also, in collaboration with the academic circles, to the development of metrology techniques. In the universities a number of teams worked on the latest discoveries in the field of particle physics and maintained close contact with their counterparts abroad.

By 1945, a Scientific Commission in Belgium examined the possibilities of civil applications of nuclear energy, and the "Institut Interuniversitaire de Physique Nucléaire" was created in 1947 in order to support the existing university laboratories and co-ordinate their activities. In parallel with nuclear physics research, this Institute also supported some related activities such as production of graphite and high-purity metallic uranium.

From 1950 onwards, Belgian engineers were trained in the UK and in the USA.

The Atomic Energy Commission was formed in 1950.

In 1952, a number of personalities of Belgium's scientific and industrial circles set up a private non-profit organisation -the "Centre d'Etude des Applications de l'Energie Nucléaire"-, which was to give birth to the "Centre d'Etude de l'Energie Nucléaire" (SCK•CEN) at Mol (i.e. the Nuclear Research Centre), and which became a public interest organisation in 1957.
Research reactors were built in Mol and became operational between 1956 and 1963. These are the BR1, a uranium/graphite reactor similar to the British experimental pile (BEPO), the materials test reactor BR2 (fuel assemblies with highly enriched uranium placed in a beryllium matrix shaped as an hyperbolic paraboloid, which ensures at the same time a high neutron flux and an easier access to the experiments from the top and the bottom of the reactor) and the 11.5 MWe BR3 which was the first Westinghouse-type pressurised water reactor built in Europe. This reactor, which went critical in 1963, served to develop the technology (e.g. reactivity control by boron dissolved in the water of the primary circuit, introduction of MOX and gadolinium fuel rods as early as 1963) and to train the first operators of the Belgian nuclear power reactors. This plant is currently being dismantled and the waste produced is immediately conditioned.

Beside these reactors, the Mol Centre has many laboratories for performing and analysing various experiments, for materials testing, fuel research, radiobiology studies, etc. It also has an underground laboratory (HADES) situated at 200 m depth in the Boom clay stratum to investigate the properties and characteristics of a deep geological repository for high level waste in clay.

This laboratory was extended in the framework of EURIDICE, a joint venture between ONDRAF/NIRAS and the SCK•CEN. EURIDICE - which stands for European Underground Research Infrastructure for Disposal of nuclear waste In Clay Environment - was in fact set up back in 1995 under the name EIG PRACLAY.
From 1950, the private industry has also invested in nuclear technology and participated in the construction of reactors. The "Ateliers de Constructions Electriques de Charleroi" acquired the Westinghouse licence; "Métallurgie et Mécanique Nucléaires" manufactures enriched uranium fuel assemblies, and was later on a part of the "Franco-Belge de Fabrication de Combustibles" (FBFC).
As regards the fuel cycle, the Mol Centre investigated several reprocessing techniques, as a result of which the Eurochemic Consortium, formed under the aegis of the OECD, built its pilot

reprocessing plant (adopting the PUREX process) in the Mol-Dessel region. This plant ceased its operations in 1975 and is now mostly dismantled. Dismantling operations should be completed by 2013.

A consortium of industries was formed in 1954 to develop the nuclear technology; later giving birth to Belgonucleaire which developed the plutonium fuel technology and contributed to the development of fast-breeder reactors, working with, among others, the partnerships between Euratom and various national organisations.

Belgonucleaire manufactured the first commercial MOX fuel (Mixed Oxides fuel) batch for the French PWR power station Chooz A in 1986. After having produced MOX fuel during 20 years, for both PWR and BWR reactors, Belgonucleaire definitively stopped its activities in mid-2006. The dismantling of the MOX fuel fabrication plant at Dessel has started in 2009. Belgonucleaire produced more than 660 tons of MOX fuel for commercial nuclear power reactors.

The Belgian power utilities and their architect/engineers closely followed-up the evolution in nuclear technology and, confident with their BR3 experience, they decided to take a 50 % stake in the construction of EdF's "Centrale des Ardennes" at Chooz, connected to the grid in 1967. Seven Belgian units, spread over the Doel and Tihange sites, were put into service between 1974 and 1985.

Table 1 gives for each Belgian unit the gross power, the year of first commercial operation, the total gross production for the years 2007 to 2009, and the total gross production since the start of operation. The variations over the years are linked to the fuel cycle length (between 12 and 18 months) or to large modifications (like the steam generators replacement).

In 1971, the "Institut des Radioéléments" (IRE) was built in Fleurus, manufacturing mainly radioisotopes for use in medicine.

The "Organisme National des Déchets Radioactifs et des Matières Fissiles Enrichies" – "Nationale Instelling voor Radioactief Afval en verrijkte Splijtstoffen" (ONDRAF/NIRAS) (i.e. the national organisation for radioactive waste and enriched fissile materials) was created in 1981, and waste treatment and storage activities were performed at the Mol-Dessel site through its subsidiary BELGOPROCESS .

This brief historic overview shows that, in addition to the nuclear power plants which are the subject of the present National Report, various aspects of the fuel cycle are present in Belgium. A full description of the nuclear sector in Belgium can be found in the book published by the Belgian Nuclear Society in 1995 "Un demi siècle de nucléaire en Belgique" (i.e. Half a century of nuclear activities in Belgium: ISBN 90-5201-405-1) as well as in "Histoire du nucléaire en Belgique, 1990-2005" (Nuclear history in Belgium 1990-2005, ISBN 978-90-5201-377-0).

Specific information on the safe management of spent fuel and on the safe management of radioactive waste may be found in the Belgian report presented to the fourth review meeting of the Joint Convention, Vienna May 2009, available on the FANC and ONDRAF/NIRAS web sites.

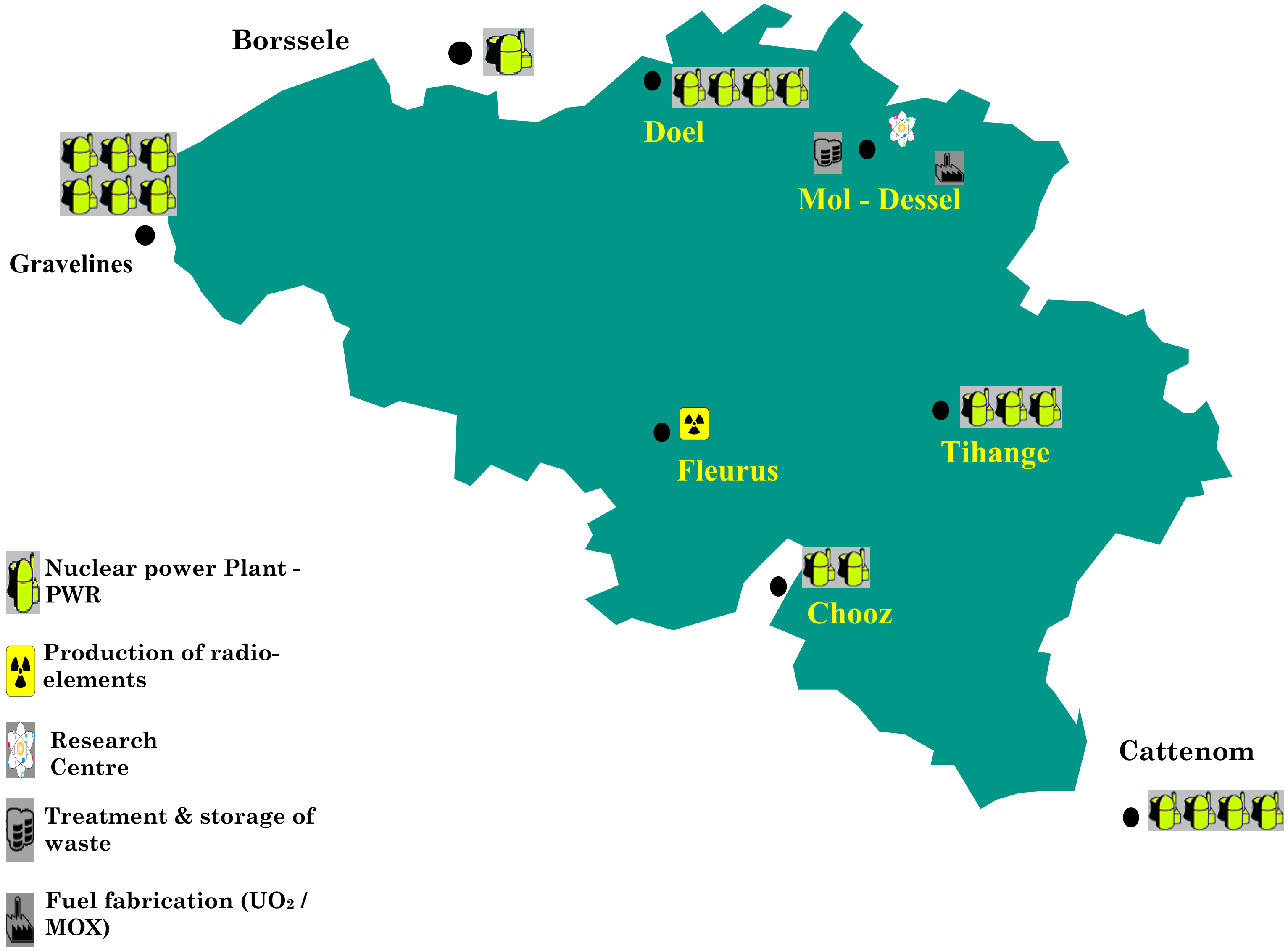
Borssele
Doel
Mol - Dessel
Gravelines
Fleurus
Tihange
Chooz
Cattenom
Nuclear power Plant - PWR
Production of radio-elements
Research Centre
Treatment & storage of waste
Fuel fabrication (UO2 / MOX)

Table 1 – Gross production of the Belgian nuclear plants

	Gross capacity end of 2009 (MWe)	**Commercial operation**	**Total gross production in 2007 (TWh)**	**Total gross production in 2008 (TWh)**	**Total gross production in 2009 (TWh)**	**Total gross production up to end 2009 (TWh)**
Doel 1	454	1975	3.2	2.8	3.0	108.7
Tihange 1	1 009	1975	7.4	7.6	8.7	241.5
Doel 2	454	1975	3.7	3.7	3.7	104.1
Doel 3	1 056	1982	8.1	7.3	8.4	208.7
Tihange 2	1 055	1983	9.1	7.4	8.0	202.4
Doel 4	1 094	1985	9.0	7.9	7.3	190.6
Tihange 3	1102	1985	7.7	8.8	8.1	200.2
Total	**6 224**	**-**	**48.2**	**45.6**	**47.2**	**1 256.2**
Nuclear electricity production share			**54.7 %**	**52.7 %**	**55.4 %**	

I.C. Developments since the last report (2008)

This part intends to highlight the main evolutions that have occurred since the last report, including those realized in the frame of the follow-up of the fourth review meeting, in particular:

a. Replacement of steam generators and power increase of unit Doel 1
b. Cycle extension up to 18 months for unit Doel 4
c. Follow-up – Barsebäck OEF
d. Follow-up – Forsmark OEF
e. Use of INES
f. Application of a new methodology for the periodic safety reviews
g. The OSART mission at Doel
h. The OSART Follow-up mission at Tihange.
i. The WENRA harmonization
j. Regulatory activities
k. Improvement of the efficiency of the FANC-Bel V collaboration
l. Towards an IRRS mission in Belgium

a. Replacement of Steam Generators and of power increase of Unit Doel 1

The application for the replacement of the Doel 1 steam generators was introduced to the safety authorities (FANC) in March 2007.

The replacement of the two steam generators of the Doel-1 Unit took place during the outage October 2009 –January 2010 within 76 days.

In order to remove the existing steam generators and install new steam generators, the same technique was used as for the steam generator replacement of its twin unit Doel 2: making two openings in the primary steel containment and in the dome of the secondary concrete containment. The openings in the primary containment had a diameter of 5.5 m, the steel being 25 mm thick. The square holes in the secondary containment had a side of 5.5 m, the concrete being 80 cm thick.
Before making the holes, the fuel was removed from the core and stored in the common nuclear building.
The reactor building was maintained in underpressure for as long as possible during the operation. The new steam generators were introduced into the reactor building on 4 December, 2009.

With regard to the steam generator replacement of the twin unit Doel 2, additional difficulties had to be tackled. The first difficulty was the presence of asbestos in the insulation of the old steam generators, requiring specific asbestos removal techniques subjected to heavy legal requirements. In addition, the asbestos removal was done in the reactor building (in the controlled area), creating additional challenges. The removal was carried out with success and with no contamination at all. Another difficulty was the weather conditions: November 2009 was the windiest month ever recorded in Belgium since the 19th Century, which impacted the planning.
The collective dose for this replacement of the steam generators amounts to 244 man-mSv, which is low in comparison with the international experience. This success was the result of experience acquired from previous replacements, a successful decontamination of the primary circuit, a well studied shielding with 110 tonnes of lead, and operational planning with a maximum attention to the ALARA principle, for example: keeping the steam generators that had to be replaced filled with water for as long as possible.

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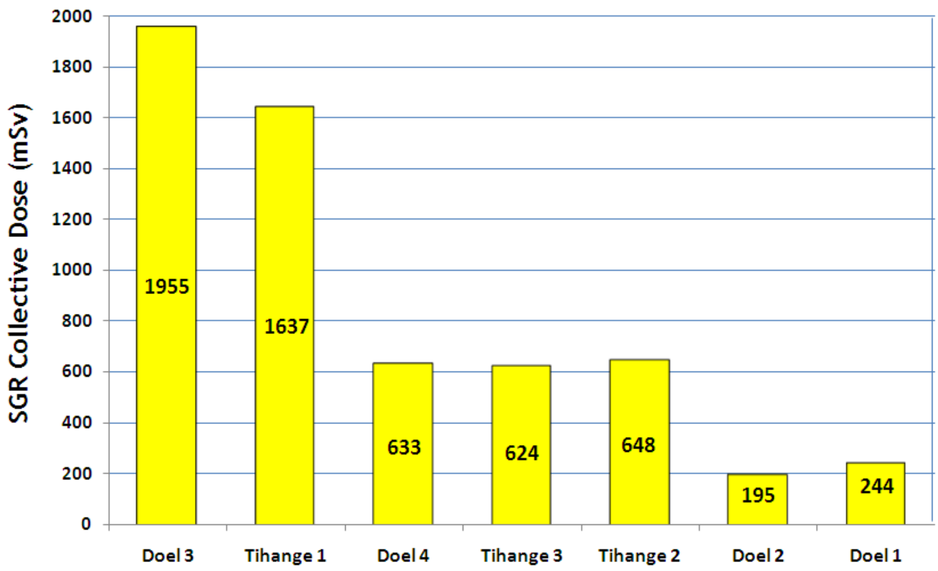

New designed steam generators were installed: Thanks to the use of a hexagonal lattice, the number of tubes was increased from 3300 for the old generators to 4800 tubes with lower tube diameter for the new generators. The thermal power of the reactor was increased by 10%.

b. Cycle extension up to 18 months for unit Doel 4

The operating license of Doel 4 limited the cycle length to 16 months at full power operation, followed by a stretch-out of maximum one month. Electrabel, the operator of the nuclear power plant of Doel - within the framework of a flexible revision planning – wanted to extend the full cycle length to maximum 18 months of full power operation, and submitted accordingly a license application. For this application, in addition to the reassessment of the safety studies that are impacted by the cycle length increase, an environmental impact reassessment had to be carried out.

The license allowing the Doel 4 cycle length extension from 16 to 18 months was issued by royal decree on 28 September 2009. The maximum power (2988 MWth), the maximum allowed burn-up level (55000 MWd/ton) and the maximum enrichment level of the nuclear fuel (4.35% U-235) of Doel 4 were not modified. The first 18 month cycle (cycle 24) of Doel 4 started after its revision at the end of 2009.

c. Follow-up – Barsebäck OEF (Sump Clogging during the Recirculation Phase)

The objective is to evaluate the potential of sump clogging during the recirculation phase of an accident, and if necessary to define adequate solutions to this issue. Electrabel performed experimental tests of self-cleaning strainers in collaboration with Vattenfall R&D in 2009. These tests did not succeed in demonstrating the robustness of self-cleaning strainers. The investigations related to this option are therefore suspended.

In order to evaluate the potential clogging of the sump during the recirculation phase, new specific tests have been planned. To simulate the most penalizing accidental conditions in these experiments, generic and specific studies are ongoing. The covered subjects of these studies concern especially the inventory of the debris source, break location, debris generation and transport, chemical effects, qualification of coatings, thermo-hydraulic hypothesis and downstream effects. Some feasibility studies of alternative insulation material or alternative strainers are also examined. The planning covers the period 2009-2012. Plant specific problems were analyzed. In particular, the strainer and train separation at Doel 1/2 and the containment spray pump chimneys at Tihange 1 (located in the reactor building) are subject to special attention.

d. Follow-up – Forsmark OEF

The first technical elements collected on the Swedish incident and a first evaluation of the situation showed that no complementary urgent measure should be taken to strengthen safety.

However the importance of a detailed and in-depth analysis was stressed, especially when taking into account further technical information provided by the operator and the Swedish authorities following the detailed analysis of the incident.

The operator was requested to implement an action plan with deadlines.

The action plan - based on a safety study considering a more penalizing spiking than the one at Forsmark - included technical analyses, design notes and practical tests performed on representative equipment which were intended to confirm the efficiency of the protections and, if necessary, to find out how to improve technically the electrical supply systems. This plan also encompassed the assessment of periodical tests carried out on the above-mentioned protections.

Detailed investigations were performed according to the lessons learned from this incident. Areas such as the resistance to voltage transients, response of voltage protection devices to transients, independence of diesel generators operation from external power supply were explored. Several actions were taken such as the improvement of coordination between protection devices on rectifiers and on inverters. The replacement of UPS devices at some nuclear units, scheduled for 2009-2011 are due to obsolescence and gave the opportunity to adapt the corresponding design specifications to introduce more stringent requirements on resistance to voltage transients and to complement qualification tests.

The design of the safety electrical systems will be further evaluated by the licensee on the basis of the final recommendations of the CSNI Task Group related to Defense in Depth of Electrical Systems and Grid Interaction. The final recommendations of the CSNI Task Group will be used as a reference for a future reassessment of the design of the safety electrical systems.

e. Use of INES

INES (International Nuclear and Radiological Event Scale) has been used in Belgium for about 20 years now. In the early years, the scale was only used for the NPPs, but was rapidly extended to all major nuclear facilities, including nuclear research institutes as well as fuel cycle facilities.

The use of INES is done via a convention between the Licensees, the FANC and Bel V. This convention stipulates in which circumstances and how INES is to be used. The licensee has to perform the INES-analysis according the latest INES manual, and this level has to be approved by Bel V and the FANC. Depending on the INES-level, a specific notice is issued. For events of level 1 or higher, the FANC publishes a short notice on its website. For events of level 2 or higher, besides the notice on the website of the FANC, the Licensee has to issue a press release about the event and the INES National Officer will notify the IAEA..

As of April – May 2010, the use of the INES-scale was extended to all activities involving the use sources of ionising radiation and transport of radioactive materials.

The FANC organised, in collaboration with Bel V, an extensive training course on the use of INES in December 2009. The target audiences of this training course were all people involved with nuclear safety in a broad sense.

In 2007, 2008 and 2009, the NPP Licensee reported respectively 9, 7 and 14 events, all classified at level 1. For the research reactors, respectively 0, 1 and 1 events have been reported for the same period.

f. Application of a new methodology for the Periodic Safety Reviews

The next periodic safety reviews (PSR) of the Belgian NPP's (3rd review for Doel 3, Doel 4, Tihange 2 and Tihange 3, and 4th review of Doel 1/2 and Tihange 1) will be based on the IAEA safety guide NS-G-2.10. A report describing the scope and the method for the PSR has already been transmitted by the Licensee (Electrabel) to the Safety Authorities. The periodic safety review will evaluate 14 safety factors, as defined in the IAEA safety guide.
For the three oldest units (Doel 1/2 and Tihange 1), FANC and Bel V issued a note on Long Term Operation (LTO), for a possible operation after 40 years. Accordingly, evaluations and results related to ageing and design upgrade are requested 3 years before the 4th PSR deadlines. The LTO is to be considered as part of the 4th PSR for these units and consists in an anticipated evaluation of some safety factors.

g. The OSART mission at Doel

During the first three weeks of March 2010, the OSART-team from the International Atomic Energy Agency (IAEA) carried out an in-depth audit at units 1 and 2 of the Doel nuclear power plant, operated by Electrabel, GDF-Suez Group.

Since July 2010, the report of this OSART mission is available on the FANC web site (in English): http://www.fanc.fgov.be/GED/00000000/2400/2458.pdf

The 15 international experts noted 14 'good practices', i.e. areas where Doel sets an example for other nuclear power plants. These include: the existence of individual training programmes for all emergency plan personnel, thorough training in the correct use of special protective clothing in the controlled areas and training and coaching for contractors, focusing on activities during overhauls.

The experts also formulated a number of recommendations (5) and suggestions (10) that will help the power plant to continue to develop in line with the world's best practices (i.e. the OSART reference framework).

The recommendations and suggestions cover several areas, including: formalising the existing cooperative arrangement with the local fire brigade, further development and active use of a theoretical model for planning and carrying out activities, and formalising the use of protective equipment in the control rooms. The power plant is also encouraged to more quickly share its experiences with other nuclear power plants, to continue developing its workplace accident prevention plan and to pay even more attention to small anomalies at the facilities.

The IAEA follow-up mission is expected to take place in 2012.

h. OSART Follow-up mission at Tihange

At the request of the Belgian Government, an OSART team visited the site of Tihange Nuclear Power Plant in May 2007, focusing on unit 1. The team issued 10 recommendations and 12 suggestions to further improve the operational safety at the plant.

During the whole year 2008, CNT developed an action plan in order to improve some areas identified by the OSART team.

Solutions and results were presented by CNT during the follow-up inspection in January 2009. The team was satisfied with the set of corrective actions taken to resolve the findings of the original mission. 73% of recommendations and suggestions were resolved and 27% were progressing satisfactorily. No recommendations/suggestions were found to have made insufficient progress.

The final report has been published. In agreement with the messages delivered by the team, the process of “continuous improvement” is ongoing.

i. WENRA Harmonisation

WENRA is a non-governmental organisation composed of the Heads and senior staff members of the Nuclear Regulatory Authorities of European countries with nuclear power plants.

Currently, 17 countries are members of the WENRA organisation. WENRA has two active working groups: the Reactor Harmonisation Working Group (RHWG) and the Working Group on Waste and Decommissioning (WGWD).
The RHWG made an extensive study on the national nuclear safety requirements for the operating NPPs comparing several hundred reference levels, grouped in 18 issues. A benchmarking has been conducted in 2006, when the countries assessed the implementation of the reference levels in their regulations and guides and in the field.

More information can be found on: www.wenra.org

In accordance with the commitment of the WENRA members, the Belgian regulator discussed the results of the self-assessment and the benchmarking with the Licensee for all the reference levels issued by WENRA. In collaboration with the Licensee, a Belgian action plan was set up, to be implemented by 2010, both on the legal and regulatory side, i.e. the nuclear laws and regulations, and in the field.

1.1 .Regulatory framework issues

All of the issues of the WENRA reference levels have been converted into a proposal of regulatory text. This work has been performed in different stages and with the involvement of several stakeholders
The drafting of the document started in 2007 and continued in 2008. This drafting was done in close collaboration with Bel V. End 2008, a first part of the text was ready and submitted for comments to the licensee. The second part of the text has been submitted mid 2009 to the licensee. The comments of the licensee were reviewed by the FANC and Bel V since mid 2009 and the text was amended where considered appropriate.

The regulatory text is structured similarly to the WERNRA Reference Levels into the 5 safety areas and the 18 safety issues. This structure tends to be ''universal'', in line for instance with safety standards and different other legislations. It also offers flexibility, allowing easy future complements and/or amendments.

End of 2009, the final draft was ready and has been presented to the Scientific Council of the FANC. The Scientific Council is an independent advisory committee to the FANC, composed of representative experts from universities and with industrial background. The Scientific Council advises the FANC on various aspects related to major nuclear facilities such as licence applications or licence renewals as well as for some aspects of nuclear safety regulations.

The text has been amended to reflect the comments from the Scientific Council early 2010. It has been finalised and submitted to official external advisory bodies (like Health Council, Minsitry of Labor, ..) in July 2010.

After this consultation of external advisory bodies, it is foreseen that the final text will be submitted to the Government for approval by the end of 2010 and will be published in the official journal early 2011.

2. Implementation issues

In the field, many of the reference levels were already met (approximately 85 %). For the gaps and deltas that have been identified, an action plan was drawn up by the Licensee. This action plan was approved by the regulator and a follow-up of this action plan is performed in close collaboration between the Licensee, Bel V and the FANC. In total 41 actions points have been identified. Half of them have been fully implemented by now and for the other half, implementation is scheduled according a strict time schedule. Some of the actions are to be fully implemented only by 2014: these actions are all related to the implementation of the probabilistic safety assessment (PSA) policy (See below). Among the different actions some of the most important ones are:

- A systematic approach to training with certification for contractors has been implemented as well as a performance based training and a basic nuclear safety training for all technical staff.
- Specific training programmes and the update of the procedures regarding severe accident management and ageing management have been successfully implemented.
- The emergency plan has been revised to reflect completely the WENRA requirements
- Categorisation of plant modifications as well as specific rules for temporary modifications have been implemented.
- An ambitious PSA policy has been developed by the Licensee to achieve plant specific PSA for level 1 and level 2, including safety significant operating modes and relevant initiating events and hazards. The PSA policy will also outline the role of the PSA in the decision-making process to support the safety management and its role to assess plant modifications. An extensive fire hazard analysis will be performed, as well as a specific fire PSA

The action plan has been published on the FANC web site end 2007 and can be found on:
http://www.fanc.fgov.be/GED/00000000/000/29.pdf

A formal structure for the follow-up of the implementation of the actions plan has been put in place in 2007. This "**Consultative Committee**" is composed of managers and senior experts of the regulatory body (FANC and Bel V) and of the licensee (GDF Suez - Electrabel) and its architect-engineer (Tractebel Engineering)..

The Terms of Reference of this committee specify amongst others the role of this committee:

"MANDATE and OBJECTIVES:
The consultative Committee brings together the regulator (AFCN/FANC), the authorized inspection organization (AVN)[1]*, the licensee (Electrabel) and its engineering support (Tractebel Engineering) in an effort*

- *To continue to achieve a common understanding of WENRA Reference Levels on Reactor Safety, integrating the possible amendments made by WENRA*
- *To update the self-assessment on the implementation status*
- *To adjust the existing implementation action plan in order to take into account the WENRA amendments*
- *To follow-up the implementation of the action plan (implementation side).*
- *On request of the FANC, to comment the FANC proposals for the legal side.*

The activities of the Committee are without prejudice to the roles and responsibilities of the respective organisations participating to it.
Its deliverables will take the form of recommendations.

[1] Now Bel V

Once the above mentioned objectives will be achieved, it will be decided whether it is useful to extend the mandate of the Committee. If not, the Committee will be automatically dismissed"

This Committee meets about every 2 to 3 months. At each meeting the status of the whole action plan is reviewed and the progress and status of some specific actions are discussed in detail.

When an action nears completion, the licensee elaborates an explanatory note, describing what has been undertaken to bring the status of the plants or the status of the safety analyses in conformity with the Reference Level. The explanatory note is then reviewed by the regulatory body and, where applicable, the implementation of the Reference Level is checked by the regulatory body at both plant sites (Doel and Tihange).

When an action is considered to be dealt with in a satisfactory manner, FANC and Bel V declare the action closed and this is registered in the minutes of the meeting of the Consultative Committee.

j. Regulatory activities

The drafting of the regulatory text related to the WENRA waste and decommissioning reference levels has started end of 2009. Some efforts are made to structure it in the same way and to eliminate duplication with the RHWG reference levels, so that the whole set of the safety reference levels may be unified in the future in one single regulatory text.

The FANC has been participating since the beginning in the European Nuclear Regular Safety Regulators Group, ENSREG. This group was set up as an advisory organ by the European Commission, in particular in view of the elaboration of the first European Directive on nuclear safety.
The FANC participated actively to the discussion and preparation work of this Directive.

In June 2009, the European Directive 2009/71/Euratom on the safety of nuclear installations was published and made mandatory the basic safety principles of the CNS. However, the range of nuclear installations falling within the scope of the Directive is wider than the Convention, and the Directive contains additional requirements such as:

- the obligation to perform ten-yearly international peer reviews of the regulatory framework,
- provisions concerning the education of licensee and regulatory staff,
- provisions for the licensee to maintain adequate human and financial resources,
- provisions for continuous improvement,
- information to the public of the regulatory activities.

In the frame of the transposition of this Directive into Belgian regulations, a set of « generic » reference levels from the RHWG reference levels that could be applied to other facilities and activities has been determined. The RHWG reference levels cover the provisions of article 6 of the Directive for the NPPs, and some reference levels could adequately fulfil the directive requirements for other nuclear installations in the scope of the Directive.

Other existing regulatory texts and laws (see Section II.C - Article 7 of the Convention) are being screened and, if necessary, will be amended to fulfil all Directive obligations.

k. Improvement of the efficiency of the FANC/Bel V collaboration after the operationalisation of Bel V.

Following the transfer of part of the AVN staff to Bel V, the subsidiary of the FANC, which occurred in April 2008, several working groups (WG) have been set up to improve the efficiency of the FANC/Bel V collaboration and to develop synergies between the FANC and Bel V. These working groups were composed of FANC and Bel V managers and each group issued a final report when a consensus was reached on the issue discussed within the group:

WG1 : This working group had to define the common and complementary inspection and control system, avoiding any duplication and improving the efficiency of the regulatory inspections and control actions. Further details are given in section II.F.3.
WG2 : In the previous system, when the recognized Organization AVN was in charge of health physics control inspections, the AVN inspectors needed an official authorization of "health physics recognised expert". This working group investigated the need of maintaining such recognition system for Bel V inspectors, and the possibility to extend the requirement of such an authorization to the FANC inspectors. The group concluded that Bel V experts will continue to be recognised. The qualification of the FANC inspectors will be managed within the FANC management system.
WG3 was in charge of defining performance indicators for controls and inspections.
WG4 was devoted to medical applications (experts in medical radiation physics)
WG5 : This working group is in charge of defining the collaboration between FANC and Bel V in the field of Nuclear Security.
WG6 : This working group had to define the modalities of the safety assessments performed for the FANC by Bel V.
WG7 : This working group has defined the relations FANC-Bel V for the "transverse processes", i.e. the collaboration FANC/Bel V in the field of international affairs (Belgian international representations, sharing of feedback from international activities,...), synergies in R&D (avoiding duplications, complementary aspects, common positions,..., knowledge management (exchange of experts, common training activities,…)
WG8 was dealing with the organization of the Nuclear Emergency Planning, to improve the efficiency of the FANC/Bel V collaboration in this field. As a result, this group decided to locate a new crisis centre in the FANC building. The crisis centre of Bel V will no longer be used.

See also section II.D (Article 8 of the Convention) for further details about the regulatory body structure and organisation.

l. Towards an IRRS mission in Belgium

Since June 2009, issuing date of the European Directive 2009/71/EURATOM on the Nuclear Safety, the request of an international peer review every 10 years is mandatory in 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.

However, Belgium has not yet officially requested an IRRS mission to the IAEA:

- Although the situation concerning the status of the Authorised Inspection Organisations is clarified for the former AIO called AVN, which led to Bel V, and consequently for the nuclear installations falling under the scope of the Convention, the situation is not yet fixed for the control of lower risk nuclear installations. The regulatory proposals of the

FANC concerning the supervision regime of low risk nuclear installations have been submitted to the Minister of Home Affairs and are still awaiting a political decision. Considering that the situation is not yet fixed, it has been deemed appropriate to wait before requesting officially an IRRS mission.

- Belgium is a member state of the European Union. 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.

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II. GENERAL PROVISIONS

II.A. Article 4. Implementing Measures

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

After being adopted by the Belgian Parliament, the law endorsing the Convention on Nuclear Safety of Vienna of 20 September 1994 was signed by the King on 26 November 1996 and published in the "Moniteur belge" (i.e. Belgium's Official Journal) of 22 August 1997. As a result, the Convention is incorporated in the Belgian national legislation..

After the ratification, the national legislator decided that the existing legislative and regulatory framework was sufficient to implement the Convention, without adaptations or completions deemed necessary. This does not alter the fact that the efficiency and efficacy of the regulations are permanently evaluated by the public bodies involved and that they will be improved if necessary, in order to take into account the scientific, technological and social evolutions or in compliance with obligations resulting from other international or supranational conventions. Since the signing of the Convention, the nuclear laws and regulations have undergone important modifications, among other things, as a consequence of the operational start up of the Federal Agency for Nuclear Control (see art. 7 and 8), the adoption of the Law of 31 January 2003 concerning the phasing-out of nuclear power and the management of fissile materials irradiated in these nuclear power plants.

II.B. Article 6. Existing Nuclear Installations

Each Contracting Party shall take the appropriate steps to ensure that the safety of nuclear installations existing at the time the Convention enters into force for that Contracting Party is reviewed as soon as possible. When necessary in the context of the Convention, the Contracting Party shall ensure that all reasonably practicable improvements are made as a matter of urgency to upgrade the safety of the nuclear installation. If such upgrading cannot be achieved, plans should be implemented to shut down the nuclear installation as soon as practically possible. The timing of the shut-down may take into account the whole energy context and possible alternatives as well as the social, environmental and economic impact.

II.B.1. Nuclear Power Plants (NPPs)

Belgium's seven nuclear power units in operation are equipped with pressurised water reactors built either by Westinghouse or by Framatome, each time in partnership with Belgian manufacturers for the major equipment of the primary and secondary systems. These units were put into service between 1974 and 1985. More details on the 7 nuclear power plants can be found in Table 1 in Section I.B and in appendix 1 of this report.

The process applied for licensing of these installations was described in previous reports for the Convention. Since the process would no longer be the same today and since many organisations and committees that played a role in this process have been replaced by other organisations and committees, it was deemed no longer appropriate to describe this historic information in this report. However, if needed, the reader can find the information in the 2007 Belgian report for the Convention (in particular in paragraphs II.B, II.D en II.J.1), available on the FANC web site.

After the licensing of the plants, the safety of the installations was continuously reviewed through different processes.
The most important and systematic process is the series of periodic safety reviews (PSR) that have been performed for all seven nuclear power plants. The PSR are imposed through the operating license of the facilities. At present the third periodic safety review for Doel 1 and 2 and Tihange 1 is on-going; the fourth PSR is being prepared. For Doel 3 and 4 and Tihange 2 and 3, the second PSR is on-going; the third PSR is being prepared. More information on the PSR is given in section II.J.2 of this report.

In addition, many other projects with important modifications have taken place, amongst others steam generator replacements at all units, in some cases accompanied by power increase. Since the previous report for the Convention, a major project was the steam generator replacement at Doel 1. A table with a more complete overview of important projects (besides the PSR) is given below:

Summary of the main projects and modifications to the installations		
Year	**Unit**	**Description**
1993	Doel 3	Replacement of the 3 steam generators + power increase
1994	Tihange 2	Introduction of MOX fuel
1994	Doel 3	Introduction of MOX fuel
1994	Tihange 2	Power increase

1995	Tihange 1	Replacement of the 3 steam generators + power increase
1996	Doel 4	Replacement of the 3 steam generators
1998	Tihange 3	Replacement of the 3 steam generators
1999	Tihange 1	Replacement of the pressure vessel head
2001	Tihange 2	Replacement of the 3 steam generators + power increase
2004	Doel 2	Replacement of the 2 steam generators + power increase
2009	Doel 1	Replacement of the 2 steam generators + power increase

Some important projects for the safety evaluation of the installations took place in an international context. We refer in particular to the OSART missions undertaken for the Tihange site in 2007 and at the Doel site in 2010. All Belgian plants are also subject to a so-called WENRA Action Plan. This plan results from the WENRA RHWG self-assessments and benchmarking project, for which the results were published early 2006 (see WENRA website). This action plan covers design as well as operational issues.

Furthermore, operational experience feedback is an important factor in maintaining and improving safety of the installations. For more information (including recent events) we refer to section II.O.1.h of this report.

As mentioned in section II.C.7, a law relating to the phase-out of nuclear energy was voted by the Belgian parliament in January 2003. Recently the Belgian government decided[2] to postpone the shutdown of the three oldest reactors, so that for the Doel 1 and 2 and the Tihange 1 plants a prolonged operation is now open for discussion. This means that for these plants new safety evaluation projects on long term operation (LTO) are under preparation. The regulatory body (FANC and Bel V) has issued a strategic document on LTO (available on the FANC website, in Dutch and in French), requiring an “agreed design upgrade” as well as a thorough analysis of the ageing of safety related equipment. It is foreseen that these projects will further improve the safety of these installations.

The technical characteristics of each unit are described in detail in Appendix 1 to this Report. The original design is described together with the main modifications made since their construction.

A particular characteristic of the Belgian nuclear power plants, that merits to be described in some more detail, is their high level of protection against accidents of external origin. Indeed, for the four most recent units, it was requested at the licensing stage that accidents of external orgin had to be taken into account, such as an aircraft (civil and military) crash, a gas explosion, a major fire and the effects of toxic gases. These requirements resulted in a duplication of a significant number of safety systems, installed in bunkerised structures to withstand an aircraft crash, which is the most demanding loading case. Moreover, explosive or toxic gases detection systems isolate the ventilation systems in a redundant way in order to prevent the introduction of such gases in the control rooms and of explosive gases in the bunkerised part of the installations.

This high protection against accidents of external origin resulted in a greater redundancy, or diversity in some cases, of the protection and engineered safety systems. For example, the Doel 3 and 4 units, as well as Tihange 2 and 3, are three loop plants equipped with 3 independent and redundant safety trains (each train having its own safety Diesel group in a non-bunkerised building) and with 3 emergency trains to mitigate accidents of external origin (each train with a Diesel located in a bunkerised area and built by a manufacturer different from the one of the

[2] It must be noted that this decision has not been confirmed by law.

normal safety Diesels, ensuring diversity). The safety trains and the emergency trains are not designed to cope with the same accidents (of internal origin or of external origin respectively) but the emergency trains provide an equipment diversity which can be very useful even for some accidents of internal origin, according to the probabilistic safety studies results.

Afterwards, the protection against external accidents for the older units (Doel 1 and 2 and Tihange 1) was also considerably improved, amongst others by adding dedicated and bunkerised systems to these plants.

As a conclusion, the permanent in-service monitoring and inspection of the installations, combined with the periodic safety reviews during which the changes in regulations and practices and the systematic use of feedback of operating experience are also taken into account, ensures that the safety of the installations is maintained and even improved where possible. Ageing is systematically investigated in order to ensure the availability of all safety systems during the next decade.

II.B.2. Research Reactors

Several research reactors were operational in Belgium (5 at the Nuclear Research Centre SCK•CEN and 1 at the University of Gent). At this moment 3 of these reactors are still in operation. The BR1 and BR2 research reactors are included in this report. A detailed description of BR1 and BR2 is given in appendix 2. The other research reactors are:

- VENUS: a zero power critical facility, mainly used for experiments to validate nuclear calculation codes. In 2008-2009, a major overhaul of VENUS was performed to allow for experiments to study the coupling between an external neutron source and a fast spectrum reactor core. This core consists of uranium and lead. The neutrons are delivered by a deuterium accelerator, with a tritium target. The project is part of the feasibility study of an accelerator driven system.
- BR02: a zero power nuclear model of BR2. It was used to study various core configuration of the BR2 reactor. Since the years eighty, more powerful calculation methods were available and validated. BR02 was no longer needed. It was dismantled in the early nineties. The beryllium core was used for the second replacement of the BR2 beryllium core in 1996.
- BR3: a PWR with an electrical power of about 12 MW. In its early years BR3 was used as a spectral shift reactor, using a mixture of light and heavy water for burn up compensation. Later the reactor was used for testing MOX and gadolinium fuel types. BR3 was permanently shut down in 1989 and served since then as a pilot project for dismantling of nuclear power reactors. The dismantling is expected to be complete in 2011.
- THETIS: a small pool type research reactor at the University of Gent, with a thermal power of 250 kW. The reactor was mainly used for neutron activation experiments. THETIS was permanently shut down in 1999 in and will be dismantled in the near future.

II.B.2.a. BR1

The BR1 is a natural uranium graphite reactor, comparable to the reactor ORNL X-10 (USA) and BEPO (Harwell, UK). The reactor went critical for the first time in 1956. The core is composed of a pile of graphite blocks thus forming a cube with ribs of 7 meter. The reactor is air cooled. The fuel is metallic natural uranium with an aluminium cladding. Its design thermal power is 4 MW. However, since the start of BR2 this high power was no longer needed and since 1963 BR1 is operated at a maximum thermal power of 1 MW using only the auxiliary ventilation system. Due to its very well thermalised neutron spectrum, the reactor is mainly used for neutron studies, such as neutron activation analysis and instrument calibration. Neutronography is also possible.

No significant modifications have been made to the reactor. The original fuel is still loaded. The burn up is still low and the fuel can be used far beyond the lifetime of the reactor. In 1963, after the period of operation at high power, the fuel was unloaded and the graphite matrix was heated in order to release the Wigner energy. In the actual operation, using only the auxiliary ventilation, the graphite temperature is relative high compared to the fast neutron dose, such that the Wigner energy is still decreasing.

II.B.2.b. BR2

The BR2 is a heterogeneous thermal high flux test reactor, designed in 1957 for SCK•CEN by NDA [Nuclear Development Corporation of America - White Plains (NY - USA)]. It has been built on the site of the SCK•CEN in Mol. Its first criticality dates from 1961 and routine operation of the reactor started in January 1963.
The reactor is cooled and moderated by pressurised light water in a compact core of highly enriched uranium positioned in and reflected by a beryllium matrix. The maximum thermal flux approaches 10^{15} neutrons / (cm².s) and the ultimate cooling capacity, initially foreseen for 50 MW, has been increased in 1971 up to 125 MW by replacement of the primary heat exchangers.
The reactor was originally designed for material and fuel testing. A test loop for irradiation under PWR conditions is available. This still is an important activity. However during the last years isotope production (Mo-99, Ir-192 and others) have become important. Besides this, two irradiation facilities for silicon doping are available.
The beryllium matrix swells under neutron irradiation due to the formation of gas (helium and tritium). This swelling causes cracking of the beryllium which is a brittle material. Furthermore, the build up of the helium-3 isotope results in neutron poisoning. Due to these effects the lifetime of the beryllium matrix is limited. Two replacements have already taken place. The first one took place in 1979 and the second one in 1996. For the second replacement the beryllium blocks of the BR02 were used.
During the lifetime of the reactor, continuous modernization projects have been executed. Various systems are completely renewed, such as nuclear instrumentation, non nuclear instrumentation and compressed air supply. On the occasion of the second beryllium matrix replacement, a full refurbishment programme was realized. In addition to the reactor vessel inspection, a vessel follow-up programme was defined, including the irradiation of material samples. In 2010 the cadmium control rods, which were end of life, were replaced by hafnium rods. Also in 2010, test irradiations were started for the conversion from highly enriched uranium fuel to lowly enriched fuel, using uranium molybdenum fuel plates.

II.C. Article 7. Legislative and Regulatory Framework

1. Each Contracting Party shall establish and maintain a legislative and regulatory framework to govern the safety of nuclear installations.

2. The legislative and regulatory framework shall provide for:

- **(i) the establishment of applicable national safety requirements and regulations;**
- **(ii) a system of licensing with regard to nuclear installations and the prohibition of the operation of a nuclear installation without a licence;**
- **(iii) a system of regulatory inspection and assessment of nuclear installations to ascertain compliance with applicable regulations and the terms of licences;**
- **(iv) the enforcement of applicable regulations and of the terms of licences, including suspension, modification or revocation.**

II.C.1. Introduction

The two basic Belgian legal texts regarding nuclear safety are the 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 (amended for the last time in 2008) and the Royal Decree of 20 July 2001 known as the "General Regulations regarding the protection of the public, the workers and the environment against the hazards of ionising radiation (GRR-2001, amended for the last time in 2009).

The scope of the GRR-2001 is very wide and covers practically all human activities and the situations with a risk resulting from the exposure to ionizing radiation, and this at the level of the protection of the workers as well as at the level of the protection of the public and the environment. In particular, the risks associated with the natural radioactivity (e.g. radon) are integrated in the regulations. This new rule ensures the transposition of all the European directives regarding radiological protection and in particular the 1996 and 1997 directives reinforcing considerably the standards protecting the population, the workers and the environment, and, in particular, the protection of the patients in the frame of medical exposures.

The Royal Decree of July 20th 2001 enforces many articles of the Law of April 15th 1994 and made **the Federal Agency for Nuclear Control (FANC),** created by that Law, operational. The organisation of this public agency will be explained under Article 8. This agency, which is endowed with wide competences, **constitutes the Safety Authority.**

The texts of the regulations now in force can be consulted on the website of the FANC (www.fanc.fgov.be).

The regulations deal with the licensing of nuclear facilities, the measures to protect the health of the workers and the public, nuclear civil liability, safeguards, transport of radioactive material, radioactive waste management, emergency plans, etc.

A brief overview of the legislation is given below in chronological order and for each main topic. Following this summary the legislation and regulations regarding the nuclear installations covered by this National Report is presented in more detail. The texts referred to are not frozen,

in the sense that they are likely to be replaced, completed or modified at any time by further regulations that amend the original texts, so as to limit the volume of texts to be referred to.
In this Article 7 most of the text is composed of excerpts of the Belgian laws and regulations, but these excerpts are not specifically identified.

Information concerning the management of spent fuel and radioactive waste can be found in the 2009 National Report for the "Joint Convention on the Safety of Spent Fuel Management and the Safety of Radioactive Waste Management".

II.C.2. Nuclear Safety (Protection of the Public and Workers against Ionising Radiation)

The GRR-2001 comprise the licensing procedures for various practices and work activities involving radioactive substances or ionising radiation. They specify the protective measures to be taken into account and the organisation of health physics control activities. The main provisions of this Royal Decree are described in § II.C.4.

The GRR-2001 transpose the ruling European Directives into Belgian Law[3], such as :

- the Directive 85/337/EEC on the assessment of the effects of certain public and private projects on the environment,
- the Directive 89/618/Euratom on informing the general public about health protection measures to be applied and steps to be taken in the event of a radiological emergency,
- the Directive 90/641/Euratom on the operational protection of outside workers exposed to the risk of ionizing radiation during their activities in controlled areas,
- the Directive 1996/29/Euratom laying down basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionizing radiation,
- the Directive 1997/43/Euratom on health protection of individuals against the dangers of ionizing radiation in relation to medical exposure, and repealing Directive 84/466/Euratom,
- the directive 2003/122/Euratom on the control of high-activity sealed radioactive sources and orphan sources,
- the directive 2006/117/Euratom on the supervision and control of shipments of radioactive waste and spent fuel,
- the obligations resulting from the Euratom Treaty (e.g. article 37).

Belgium is a member State of the European Union and of the European Atomic Energy Community (EURATOM), since their foundation in 1957. The Belgian rules and regulations within the field of radiological protection have been developed in implementation of and in accordance with the European Treaties and the relevant directives, as mentioned above.

[3] The directives 89/618/Euratom and 90/461/Euratom were already transposed in Belgian law by the Royal Decree of 2 October 1997 amending the GRR-1963.

II.C.3. Law of 15 April 1994

A description of the contents of the various chapters and the main articles relevant for nuclear safety and radiological protection is given below.

II.C.3.a. Chapter I - General Clauses

- Articles 1 and 1bis
  Define a number of terms used: ionising radiation, radioactive substance, recognized bodies (for health physics control), Health Physics Control Department, nuclear materials, physical protection measures, nuclear material, nuclear installations….

- Article 2
  Establishes the public interest organisation having legal personality, called "Federal Agency for Nuclear Control", abbreviated as "FANC".

- Article 2bis
  Nuclear materials and related documents are excluded from the law regarding administration transparency.

II.C.3.b. Chapter II – Competent Authority

- Article 3
  The King is the Competent Authority to take measures to protect workers, public health or the environment. These measures apply to import, export, production, manufacture, possession, transport, transit, sale, use for commercial, industrial, scientific, medical or other purposes, of equipment, installations or substances capable of emitting ionising radiation. These measures can also cover the accessories of equipments or installations and the safety-related software. The King can also regulate the release and disposal of radioactive waste.

- Article 4
  The transport of equipment and substances mentioned in article 3 can only be performed by carriers recognised by the Agency. The King regulates, after getting the advice of the Agency, the procedure for such recognition.

- Article 5
  The competent authority can, at any time, suspend and rescind the decisions of decentralised administrations which have a direct or indirect impact on the transport of radioactive substances or equipment containing such substances.

- Article 6
  The King may take all measures aimed at safeguarding the population and the environment when an unforeseen event puts the health of the population or the environment in jeopardy.
  The King may also take all measures in order to avert the hazards which could result from the accidental contamination of any place, material or product by radioactive substances.

- Article 7
The King nominates the persons in charge of supervising the compliance with this law and its implementing decrees dealing with the medical surveillance of the workers and the health conditions at work.

- Article 9
The staff members of the Agency appointed by the King to supervise this law and its implementing decrees are considered as judiciary police officers, auxiliaries of the King's Attorney. They trace and record infractions.
They can give a warning and set deadlines to correct the situation.

- Article 10
The persons mentioned in article 9 have at any time free access to the installations and means of transport. They can proceed to the seizure of equipments or substances and can officially take all necessary measures to avert the hazards.

- Article 11
The persons, companies, institutions or organisations concerned can appeal to the Minister who supervises the Agency against the measures imposed by the Agency. This appeal is not suspending. If no decision is taken within three months, the measures appealed against are no longer valid.

II.C.3.c. Chapter III– Missions of the Agency

- Article 14
The Agency is in charge of control and supervision. It also has to accompany the IAEA-inspectors when performing safeguard inspections and verifications on Belgian territory.

- Article 14bis[4]
The Agency can perform all acts and activities that contribute, directly or indirectly to the achievement of the missions referred to in this Law. The Agency may also, alone or jointly with others, create legal entities whose sole purpose is to contribute to the achievement of its missions and to participate in them. The Agency may also participate in legal entities whose sole purpose is to contribute to achieve its missions.

- Article 15
In a general way, the mission of the Agency includes the investigations useful to define all the operating conditions and to analyse the safety and security of the facilities involving sources of ionising radiation. It also includes related surveillance, control and inspection activities, radiological protection, training and information, contacts with the Authorities and national organisations concerned and interventions in case of an emergency. The Agency gives its technical support to the Minister of Foreign Affairs.
The Agency is also in charge of the control of the physical protection measures (for nuclear material).

- Article 16

[4] Modified by the Law of 22 December 2008

- The license preceding the construction and operation of a facility, installations for the industrial generation of electricity from nuclear fission excluded, is granted (or refused) by Royal Decree.
  The Agency examines the applications and seeks the advice of the Scientific Council (see article 37).
  The license sets, among others, the rules concerning the periodic safety reviews and the moment of delivery.
  The license may include conditions, which can be modified during the lifetime of the facility, including its dismantling.

- The operation of a facility cannot start before the license has been confirmed, following a verification of compliance with the license conditions. This confirmation is preceded by a favourable delivery report established by the Agency. The delivery takes place before the radioactive substances being subject of the license are brought into the facility.

- The Agency controls the compliance with the license conditions. The King can suspend or withdraw the authorisation upon advice by the Agency.

* Article 17
  The King regulates, via a decree approved by the Council of Ministers, the implementation of article 16. He categorises the facilities according to the hazard they present. He may not delegate the licensing of the facilities with the highest risk.

* Article 18
  The Agency examines the files for the transport of radioactive substances. It controls the compliance of the specific conditions included in the licenses.

* Article 18bis
  Every person who stores, uses or transports nuclear materials or possesses documents related to nuclear materials, is not allowed to give those materials or documents to persons other than those entitled by their function, without approval by the Agency.

* Article 21
  The Agency supervises the radioactivity on the whole territory in normal conditions and in emergency situations. In normal conditions, this includes the regular measurement of the radioactivity in the air, water, soil and the food chain, as well as the assessment and the follow-up of the doses received by the population.
  To this end, the Agency can appeal on competent private or public organisations.

* Article 22
  The Agency provides technical assistance to the Minister of Home Affairs for the elaboration of the emergency plans. It organises an intervention cell for emergencies.

* Article 23
  The Agency is in charge of gathering a scientific and technical documentation in the field of nuclear safety. The Agency can request any document, in any form, from the companies or organisations that it controls.

It stimulates and coordinates research and development. It establishes privileged relationships with the public organisations working in the nuclear field, with the scientific research circles and with the international organisations involved.

- Article 24
  The Agency makes proposals to the ministers supervising the Agency about the measures that the King imposes under the terms of this law.

- Article 25
  Within the limits of its competencies the Agency verifies the compliance of the operators' obligations related to training, information and protection of the workers.

- Article 26
  The Agency is in charge of issuing neutral and objective information in the nuclear field. It transfers technical information about nuclear safety and radiological protection.

  It collaborates, on the initiative of the Minister of Home Affairs, to the communication about the emergency plans that this minister elaborates.

  It draws up an annual report of activities that is presented to its supervising authorities and is intended for the Parliament.

- Article 27
  The Agency is allowed to submit any disagreement by convention to arbitration.

II.C.3.d. Chapter IV – Delegation of some Missions by the Agency

- Article 28[5]
  Under its own responsibility the Agency can, for exercising some of its missions, call upon the assistance of organisations specifically recognized for that purpose, or on legal entities specifically created for that purpose.

  The missions aimed at are the permanent supervision of the adequate execution of the Health Physics Control Department's tasks, the delivery of new installations, the approval of certain decisions made by the Health Physics Control Department.

  The Agency may also, for the transport of special fissile materials, delegate to an organisation that it specifically recognises for that purpose, the permanent supervision of the loading, the transport and the delivery of these materials.

- Article 29
  The specific recognitions mentioned in article 28 are issued on the basis of criteria set by the Agency, among others on:
  - the qualification of the organisation's staff
  - the means that the organisation must have to accomplish its missions
  - detailed rules related to the working methods of the organisation and to the execution of the entrusted missions

[5] Modified by the Law of 22 December 2008

The King regulates, via a decree approved by the Council of Ministers, after having taken the advice of the Agency, the procedure for granting and withdrawing the specific recognition of the organisations.

Any first recognition is valid for a maximum of five years. The period of validity can be extended for periods of maximum five years.

- Article 30[6]
  A Royal Decree has to detail the missions entrusted to a legal entity created by the Agency, as well as the way this entity will be paid for its services and the way the Agency will supervise its activities.
  The Agency selects the organisation on the basis of the specifications and the regular offers received.

II.C.3.e. Chapter V – Resources, Budget and Accounts

This chapter stipulates that the FANC is financed in the following manner:

- annual taxes on license holders or future license holders (e.g. the projects for disposal of radioactive waste); the amounts and the procedure for paying are fixed in this chapter;
- charges on the occasion of the application for a license, recognition or registration; the amounts are to be fixed by Royal Decree and are adapted annually to the price index;
- administrative fines; amounts and procedures are detailed in articles 53 to 64 of the law;
- fees for special (control) activities;
- gifts and legacies;
- subsidies.

It also deals with the accountancy of the Agency and its financial audit.

II.C.3.f. Chapter VI – Management of the Agency

The Agency is directed by a Board, appointed by Royal Decree, on the proposal of the Minister supervising the Agency and approved by the Council of Ministers. More details on procedures and functioning are given in articles 35, 36, 38 to 41.

- Article 37
  A Scientific Council is established, whose mission is to advise the Agency with respect to its supervision policy and more in particular to give an advice on the license applications for new installations or for the renewal of licenses. The composition and the duties of the Scientific Council are set by Royal Decree.

  The Board ensures the consultation between the Agency and the interested parties and in particular with the operators of nuclear installations.

[6] Modified by the Law of 22 December 2008

- Article 42
  The Agency has to obey the legislation relative to public contracts for works, supplies and services.

- Article 43
  The Agency is organised so that the regulatory missions and the supervision missions are carried out independently.

- Articles 44 to 46bis
  Deal with the statute of the Agency's staff.

- Article 47
  The Agency's employees take all necessary measures to secure the confidentiality of the data known to them.

- Article 48
  The Minister of Home Affairs supervises the Agency.

II.C.3.g. Chapter VII – Penalty Clauses

(Articles 49 to 64)

II.C.3.h. Chapter VIII – Final Clauses

(Articles 65 to 69)

This law repeals the previous law on radiological protection (29 March 1958).
This chapter includes transitional arrangements.

II.C.4. Royal Decree of 20 July 2001

This Royal Decree provides the basic nuclear safety and radiological protection regulations and is amended and updated regularly by the Safety Authorities in order to take account of scientific and technical developments, take into account the European directives, etc.

It replaces the Royal Decree of 28 February 1963. The main changes with respect to the previous Decree result on the one hand from the enforcement of the law of 15 April 1994 and on the other hand from the transposition of several European Directives, in particular the basic radiological protection standards (see II.C.2).

The GRR-2001 introduce the concept of clearance and strict rules concerning the reuse and the recycling of very low level solid waste that also have an important impact on the design, the operation and the dismantling of the nuclear installations concerned by the Convention. Above all, the GRR-2001 deeply modifies the licensing procedure for those facilities.

Since 2001, the new licensing procedure for facilities of class I has two phases, each ending with a Royal Decree, replacing the single licensing decree of the previous regime of the GRR-1963. The license application consists of three parts.

The first part consists mainly of administrative information, defining amongst others responsibilities, names and legal status of the applicant, …

The second part consists of a preliminary safety analysis report containing amongst others:

1. the safety principles that will be applied for the construction, the operation and the design basis accidents,
2. the already available probabilistic safety analysis,
3. the qualification of the mechanical and electrical equipment,
4. the principles that will be applied for quality assurance,
5. the expected quantities of waste and their management, including those related to the dismantling,

The third part of the application consists of an environmental impact assessment report, including as a minimum the general data referred to in the European recommendation 99/829/Euratom (application of Art. 37 of the Euratom Treaty); this report must comply with the European directive 85/337/EEC (as amended).

Belgium is a federal state composed of three Regions being legally competent for environmental protection on their territory (radiological impact excluded). Future cooperation agreements are being discussed in order to avoid work duplications and incompatibilities and to streamline the licensing procedures.

The application is examined by the FANC and then presented for advice to the Scientific Council of the FANC (previously known under the name Special Commission). A mandatory international consultation (application of Article 37 of the Euratom Treaty Directives on the trans-boundary impact) and/or a voluntary consultation of the European Commission may take place. Afterwards, the file is submitted to a public enquiry and to the local authorities concerned for advice, and then to the executive of the provinces concerned. The whole file returns to the Scientific Council for final advice. A positive advice of the Scientific Council is necessary for a positive decision, mostly including conditions. This construction and operation licence allows the applicant to build the installations in conformity with the Licence.

The second phase aims at confirmation of the construction and operation licence. The Federal Agency for Nuclear Control (FANC) or Bel V (previously an organisation recognized for health physics control) acting on behalf of the FANC proceeds to the approval of the delivery before the start up and the introduction of radioactive substances. A fully favourable delivery report leads to the confirmation decree allowing the operation of the facility.
The picture at the end of this Article 7 illustrates this licensing procedure.

<u>Appeal against the FANC decisions and authorisation decrees</u>.

The construction and operation licence of class I facilities is granted by royal decree on the proposal of the Minister of Home Affairs. Like any decree, anybody can introduce an action for cancellation of the decree, during 60 days after the publication of the decree.

The administration in charge of treating the appeal against the administrative decision is the "Council of State". If the situation is urgent or if it is needed, on request of the applicant, the council of state can suspend immediately the administrative decision.

A description of the contents of the various chapters and the main articles of the GRR-2001 related to nuclear safety and radiological protection is given below.

II.C.4.a. Chapter I - General Clauses

- Article 1: Field of application

The regulation applies to:
1. import, production, manufacture, possession, transit, transport, use for commercial, industrial, scientific, medical or other purposes, of equipment, installations or substances capable of emitting ionising radiation;
2. offering for sale, transfer against payment or for free, of substances, equipment or installations capable of emitting ionising radiation;
3. disposal and recycling of radioactive substances;
4. any other practice entailing a risk resulting from ionising radiation.

It does not apply to :
1. military equipment and installations;
2. transport of equipment or substances capable of emitting ionising radiation, ordered by the Minister of National Defence.

These two points are covered by specific regulations.
Natural background radiation is not within the scope of the regulation.

- Article 2 - Definitions

The physical terms, quantities and units, radiological, biological and medical terms, as well as a number of specific terms used in the Royal Decree are defined.

II.C.4.b. Chapter II – Categorised Facilities

- Article 3 – Classification of Facilities
  The facilities are categorised in four classes:
  - class I comprises the nuclear reactors, the facilities in which are used or stored quantities of fissile substances (excluding natural thorium and natural or depleted uranium) in quantities more than half of their minimal critical mass, the enriched or not enriched spent fuel reprocessing plants, the facilities for which the main activities are collection, treatment, conditioning or disposal of radioactive waste, and the facilities for disposal of radioactive waste.

  - class II comprises the facilities where radioactive substances are produced from irradiated fissile materials and where they are packaged for sale, the particle accelerators, the facilities where are used or stored any quantities of fissile substances other than class I (excluding natural thorium and natural or depleted uranium), the facilities using X-ray equipment operated at a peak voltage of more than 200 kV, the facilities where are used or detained quantities of radioactive nuclides of which the total activity is larger than the 50 000 (sealed sources) or 500 (non-sealed sources), (with other factors for some specific isotopes) time the exemption levels given in an annex IA of this Royal Decree. Class II also includes the nuclear medicine departments (injection in the human body of radionuclides for therapeutic or diagnostic use).

- class III comprises the facilities where are used or held quantities of radioactive nuclides of which the total activity ranges between the exemption levels and "class II values" the facilities using X-ray equipment operated at a peak voltage of 200 kV or less.

- class IV comprises the facilities using very low quantities of radioactive substances (i.e. below the exemption values) or using equipment emitting ionising radiation at a very low rate.
  The facilities in which are used or held natural or depleted uranium and natural thorium are categorised in class IV provided the corresponding quantities are equal to or less than respectively 5 MBq and 50 kBq (otherwise they fall in class III).
  A weighting formula is specified concerning mixtures of radionuclides, in order to determine the class of the facility where such mixtures are used or hold.

- Article 4 - deals with the work activities involving natural sources of radiation.
  It concerns, for example Radon, phosphate industries, zircon industries, rare earth industries, for which special provisions can be defined by the Agency.

- Article 5 - Licensing regime - General provisions
  5.1. Class I, II and III facilities require prior licensing by the Authority as specified by this regulation.
  5.2. The licensee must comply with the conditions stipulated in the license
  5.3. The licences can be issued for an unlimited or for a limited time period; they cannot be issued "on trial".
  5.4 Transfer of licence(s); 5.5 : change of licensee and 5.6 (dispenses)
  Those Articles further regulates possible transfers of the licence, changes of the licensee, and derogation from obligations to provide certain information.
  5.7 : Mobile installations and/or temporary activities.
  It is also specified that the facilities where ionising radiation is only occasionally used (e.g. for non-destructive testing of welds, …) do not fall within a class in the sense of this regulation but these activities must be performed by a duly licensed for such activities outside a licensed facility .

- Article 6 - Licensing regime for class I facilities.
  6.1. The licence is issued by Royal Decree co-signed by the Minister of Home Affairs.

  6.2. This section details the information and the documents to be provided in support of the licence application, and to whom the application must be sent. These include mainly (for the exhaustive list, refer to the regulation itself) three parts:

<u>Part 1</u> : administrative information:

- the identity of the applicant,
- the description of the planned facility, with the characteristics of the installed equipment, the quantities of radioactive substances, the protection and safety measures, designation of the responsibilities regarding nuclear safety and radiological protection in order to meet the basic safety standards,
- the qualification and competence of the personnel, as well as the presumed numbers of personnel occupied in the various sections of the facility,
- the commitment to conclude a civil liability insurance
- the commitment to conclude an agreement with ONDRAF/NIRAS (the National agency in charge of the management of radioactive waste and superfluous fissile material)

<u>**Part 2** : A Preliminary Safety Report including :</u>

- the geographical, and topographic data of the site and its surroundings,
- a short description of the installations,
- the safety principles, including the design base accidents (from internal or external origin),
- the choice of construction engineering rules,
- the probabilistic safety assessments already made (only for nuclear reactor and reprocessing plants),
- a short description of the electrical and fluid circuits and of the control-command system,
- the qualification procedures for the mechanical and electrical equipment,
- the quality assurance principles,
- an evaluation of the amounts of radioactive waste produced (including those from the future dismantling), the proposed measures for treatment and /or temporary storage before their transfer to ONDRAF/NIRAS.

<u>**Part 3** : An environmental impact assessment report :</u>

- Comprising at least the general data referred to in the European directive 1999/829/Euratom (application of Art. 37 of the Euratom Treaty), the evaluation of the radiological impact of the installation on the environment, the justification of the choices (regarding to the different alternatives).
- This study should be performed by recognized authors (by the FANC) and should include a non-technical abstract.

6.3. deals with the preliminary consultations :

- Preliminary advice of the Scientific Council
  The Council examines and states its advice on the licence application. It may seek opinions from outside, -national or international-, experts or foreign organisations.
- International consultations (if applicable)

6.4. and 6.5.

These sections deal with the public inquiry, the advice of the municipality and of the provincial authorities.

6.6. Final Advice of the Scientific Council

This section deals with the final advice of the Scientific Council.

A favourable advice of the Scientific Council may stipulate particular conditions or restrictions to construction and operation in order to ensure the safety of the facility and mitigate its environmental impact. The decision is transmitted to the applicant; who has the right to be heard by the Council.
The Scientific Council is composed of the Director of the Federal Agency and their operational department managers (but without voting rights), 16 personalities selected on account of their scientific or technical knowledge in nuclear safety, radiological protection and environmental protection. Each of the three Regions that compose Belgium may delegate 2 representatives who have a consultative capacity but have no voting right in the final judgment.

6.7. Final Decision.
The licence cannot be granted if the advice of the Scientific Council is negative. If the Scientific Council's advice is positive, a denial of the licence must be motivated.

6.8. relates to the notification of the decision to the civil, local, and federal authorities and to the public administrations and services.

6.9. Confirmation Decree:
Before the effective operation of a class I facility, a second Royal Decree must be issued. The Agency or the delegated recognized body for health physics control must approve the delivery of the facility, i.e. confirm that the facility fully complies with the conditions of the licence and with the regulatory provisions in force.
If the report of delivery is fully positive, a second Royal Decree confirms the first one.
This Decree must be issued before the introduction of radioactive materials inside the facility.

- Articles 7 and 8
These Articles deal with the licensing regime for class II and III facilities.

- Article 9
This article details the licensing procedure for work activities involving naturally occurring radioactive materials (NORM).

- Articles 11
This Article deals with facilities of mixed class or with installations involving Regional competence. ("non nuclear aspects").

- Article 12
This Article deals with modifications or extensions of the facility, proposed by the operator. The FANC decides whether a modification is significant (i.e. a new license is required) or not (i.e. a new licence is not required).

- Article 13
This Article deals with additional conditions and changes to operating conditions, on the initiative of the FANC or the Scientific Council.

- Article 15 - Delivery of class II and III installations and confirmation of the license.

- Article 16

  The competent Authority may suspend or withdraw the license (following consultation of the Scientific Council for the class I facilities), when the regulations and/or the particular operation conditions set in the licence are not complied with. Appeal against the decision of the Authority by the licensee is always possible.

- Article 17:Cessation of activities and decommissioning

  When the facility ceases its activities, the radioactive substances that it holds at that time must be given a destination that guarantees their recycling, reuse or disposal under satisfactory conditions. The same applies when the competent Authority refuses, suspends or withdraws the licence and its decision is definitive.
  The new regulation requires also a licence for the decommissioning of those installations. This license is granted following a similar procedure as for the construction and operation license. This licence mainly covers the methods, the safety of dismantling and of elimination of active or contaminated material as well as their destination.

- Article 18 : "Clearance" (disposal; recycling, re-use) of solid radioactive waste.

  Radioactive waste can be released from regulatory control, in short "Cleared", if its activity concentration is below the clearance levels set in annex IB of GRR-2001. These clearance levels are taken from EC-Radiation Protection nr 122). For radioactive waste which does not comply with these clearance levels but with the exemption levels set in annex IA of the GRR-2001, a special authorisation for clearance may be granted by the Agency.

- Article 19

  Refusal, suspension or withdrawal of the licence, or seizure of radioactive substances, will not entitle the facility to any compensation.

II.C.4.c. Chapter III - General Protection

- Article 20 - Limitation of doses

  The limitation of individual or collective doses is based on the fundamental radiological protection principles: justification of the practice, optimisation of protection (keeping the doses as low as reasonably achievable), and individual dose limits.
  These dose limits are specified in detail for occupationally exposed people, trainees and students, and for members of the public.
  The dose limits comply with the European basic safety standards (Directive 96/29/Euratom).
  Concerted exceptional exposure, accidental exposure and emergency exposure of the workers are also addressed in this Article.

- Article 23 - Health physics control

  The Licensee must organise a health physics control , entrusted to a Health Physics Department (HPD), in charge of nuclear safety and radiological protection.

This Health Physics Department is in charge, in a general way, of the verification of the compliance with the regulations, the conditions set in the Licence and the FANC decisions.
Specific tasks of this department are listed: the definition of controlled areas; the prior approval of modifications that do not require application for a new licence; prior approval of experiments, tests, treatments and handling that it had not already been approved in the past; commissioning of new installations; supervision of handling and transfer of radioactive or fissile material on-site and off-site; the determination of the intensities of radiation and contaminations; interface with the physician in charge of monitoring the follow-up of individual dose and contamination of people; the studies to prevent any incident, accident, loss or theft of radioactive or fissile substances; keeping an inventory of liquid and gaseous releases, solid waste stored and disposed of; approval of clearance procedures; testing the integrity of highly active sealed sources…
This department must be headed by a class I - Health Physics expert, recognised according Article 73.

- Articles 24 to 26
  These Articles respectively deal with the medical surveillance of occupationally exposed workers, with information and training of workers and of people possibly exposed and with the obligation of the workers to conform to the instructions and regulations.

- Articles 27 to 32
  These Articles deal with the general protection equipment and arrangements, including individual protection equipment, dosimetry and the use of warning signs.

- Articles 33 to 37
  These Articles deal with radioactive waste. Article 34 deals with the collection, treatment and discharge of liquid waste: discharge in the soil (always), and to surface waters, to the sewers as soon as the concentration in the effluent exceeds one thousandth (at the discharge point) of the limit on the annual ingestion level by adults of the general public. Deviations from these generic limits may be included in the licenses for class I or II facilities, based on performed surveys or studies of radiological impact.
  Article 35 deals with solid waste; short-lived radioactive waste should have sufficiently decreased (at least 10 half-lives) before disposal/clearance.
  Article 36 deals with gaseous waste.
  Article 37 deals with storage of liquid and solid radioactive waste that may not be disposed of. These wastes must be contained and kept in solid and tight recipients and stored in fireproof locations. Deposit of this waste on, or in the ground is forbidden, except authorised derogations for class I and II facilities.

- Article 37bis
  Entry in nuclear facilities must be authorised by the operator
  .

- Articles 37ter to 37quinquies
  These articles deal with the operational protection of outside workers when they work in a controlled area.

II.C.4.d. Chapter IV - Import, Transit and Distribution of Radioactive Substances

This chapter has been withdrawn and replaced by a specific Royal Decree of 24 March 2009 regulating import, transit and export of radioactive material. It also transposes Directive 2006/117/Euratom on the supervision and control of shipments of radioactive waste and spent fuel.

II.C.4.e. Chapter V - Radioisotopes used in non-sealed Form in Human and Animal Medicine

II.C.4.f. Chapter VI - Medical Applications of Ionising Radiation

II.C.4.g. Chapter VII - Transport of Radioactive Substances

Transport of radioactive material is subject to a licence granted by the FANC.

II.C.4.h. Chapter VIII - Nuclear Propulsion

II.C.4.i. Chapter IX - Bans and Authorisations

II.C.4.j. Chapter X - Exceptional Measures

Article 66 concerns the measures against the loss or theft of radioactive substances.
Article 67 concerns the measures relating to accidents, concerted exceptional exposures and accidental exposures.
Article 68 deals with decontamination, and Article 69 with the contaminated mortal remains.

II.C.4.k. Chapter XI – Surveillance of the Territory, the Population and Emergency Planning

Article 70 concerns radioactivity monitoring of the territory, and of the doses received by the population, which is taken care of by the FANC.
This Article details the required monitoring and inspection activities.
Article 71 deals with the (radiological) monitoring of the population as a whole, the collection of all the data, including those from occupationally exposed workers.
Article 72 deals with the emergency plan for nuclear risks and the information of the population.
Article 72bis deals with interventions in cases of lasting exposure.
Article 72ter deals with interventions in case of discovery of orphan sources.

A specific Royal Decree of 17 October 2003 has laid down the general Emergency planning organisation in case of nuclear/radiological accident.

II.C.4.l. Chapter XII – Recognition of Experts, Physicians and of Organisations

Article 73 sets all the conditions for the recognition of experts in health physics control. Article 74 deals with the organisations for health physics control. Article 75 deals with the recognition of doctors in charge of the medical surveillance of occupationally exposed workers.

II.C.4.m. Chapter XIII – Special provisions related to high-activity sealed sources

This chapter has been added in 2006 as part of the transposition of Directive 2003/122/Euratom on the control of high-activity sealed radioactive sources and orphan sources.

II.C.5. Emergency Plan

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 lays down the nuclear and radiological emergency response plan and the tasks of each of the parties involved.

It is mandatory for nuclear installation operators to set up an internal emergency plan approved by the Regulatory Body and to test regularly this plan to address possible accidents. The intervention of the Authorities outside the affected installations takes place under the authority of the Minister of Home Affairs, who supervises the Civil Safety.

This nuclear and radiological emergency plan for the Belgian territory aims at co-ordinating the actions towards protection of the population and the environment in the event of a nuclear accident or any other radiological emergency situation that could lead to an overexposure of the population or to a significant contamination of the environment.

This document will serve as a guide for the protective actions to be implemented, should a radiological emergency occur. It establishes the tasks that the various departments and organisations would have to accomplish if the case arises, each within their legal and regulatory competences.

The provisions of the emergency plan apply in the cases where the risk exists that the population could be exposed to significant radiological exposures 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.

The Nuclear and Radiological Emergency Plan for the Belgian Territory is mainly designed for emergency situations in the major Belgian nuclear installations : the nuclear power plants of Tihange and Doel, the Nuclear Research Centre in Mol, the Institute for Radioelements in Fleurus, the fuel fabrication factory Belgonucléaire (now stopped since mid-2006) and the waste treatment site (Belgoprocess) in Dessel. This plan is also activated for other emergency situations, which can occur either on the Belgian territory (accident during the transport of radioactive materials or radiological emergency resulting from a terrorist attack or events occurring in other Belgian nuclear installations for instance) or nearby (EdF nuclear power plant of Chooz for instance).

In case of an emergency, the off-site operations are directed by the "Governmental Crisis and Coordination Centre" (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 under the leadership of the Governor of the Province concerned.

The plan describes the overall organisation. It has to be completed by concrete internal plans based on the intervention, at various intervention levels, of:

- the provincial authorities;
- the municipal authorities;
- all the intervening institutions.

Belgium is contracting party to both the Convention on Early Notification of a nuclear accident and the Convention on Assistance in the case of a nuclear accident or radiological emergency.

II.C.6. Law of 31 January 2003 on the Phase-out of Nuclear Energy

On 31 January 2003, a law on the phase-out of nuclear energy was adopted by the Belgian parliament. It stipulates amongst others:

- Article 3
  No new nuclear power plants for industrial generation of electricity from nuclear fission may be constructed nor commissioned.

- Article 4
  § 1. Nuclear power plants for industrial generation of electricity from nuclear fission are deactivated forty years after the date of their industrial commissioning and can no longer generate electricity from that moment on.

  § 2. Every individual license for the industrial operation and generation of electricity from nuclear fission, granted by the King with no limitation in time

  a) in accordance with the Law of 29 March 1958 concerning the protection of the population against the dangers of ionising radiations and under article 5 of the GRR-1963, which remain into force according to article 52 of the Law of 15 April 1994 ;

  b) under article 16 of the Law of 15 April 1994 and under articles 5 and 6 of the GRR-2001;

  comes to an end forty years after the date of the industrial commissioning of the generating facility.

- Article 9:

If the electricity supply is threatened, the appropriate measures can be taken by royal decree, in accordance with articles 3 to 7 of this law, except in circumstances outside one's control.

According to article 4 of this law, the first nuclear power plant to be deactivated will be Doel 1 in 2015, the last nuclear power plant to be deactivated will be Tihange 3 in 2025.

Article 9 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 supply security of the country. Successively three expert groups have already been formed to advise the government on the issue. The final report of the "AMPERE Commission" was published in October 2002. A second commission, called "Commission Energy 2030", presented its final report in June 2007. 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, the Government decided on the 13th of October 2009 to allow Electrabel not to close the three oldest nuclear power reactors after 40 years but to keep them in operation for 50 years. However, this decision has not yet been confirmed by an amendment to the law. Therefore, at the time of writing (August 2010) this report, all the provisions of the law of 31 January 2003 on the phase out of nuclear energy are still in force.

II.C.7. Conclusions regarding the Provisions of Article 7

By becoming fully operational in September 2001, the FANC has taken over the tasks performed previously by the DTVKI/SSTIN (Ministry of Labour and Employment) and by the DBIS/SPRI (Ministry of Public Health and Environment) aiming at the enforcement of the Law of 15 April 1994 and its implementing decrees, in view of the radiological protection of the population and the environment.

- There has been in Belgium a legal and regulatory framework for safety of nuclear installations for almost 50 years.

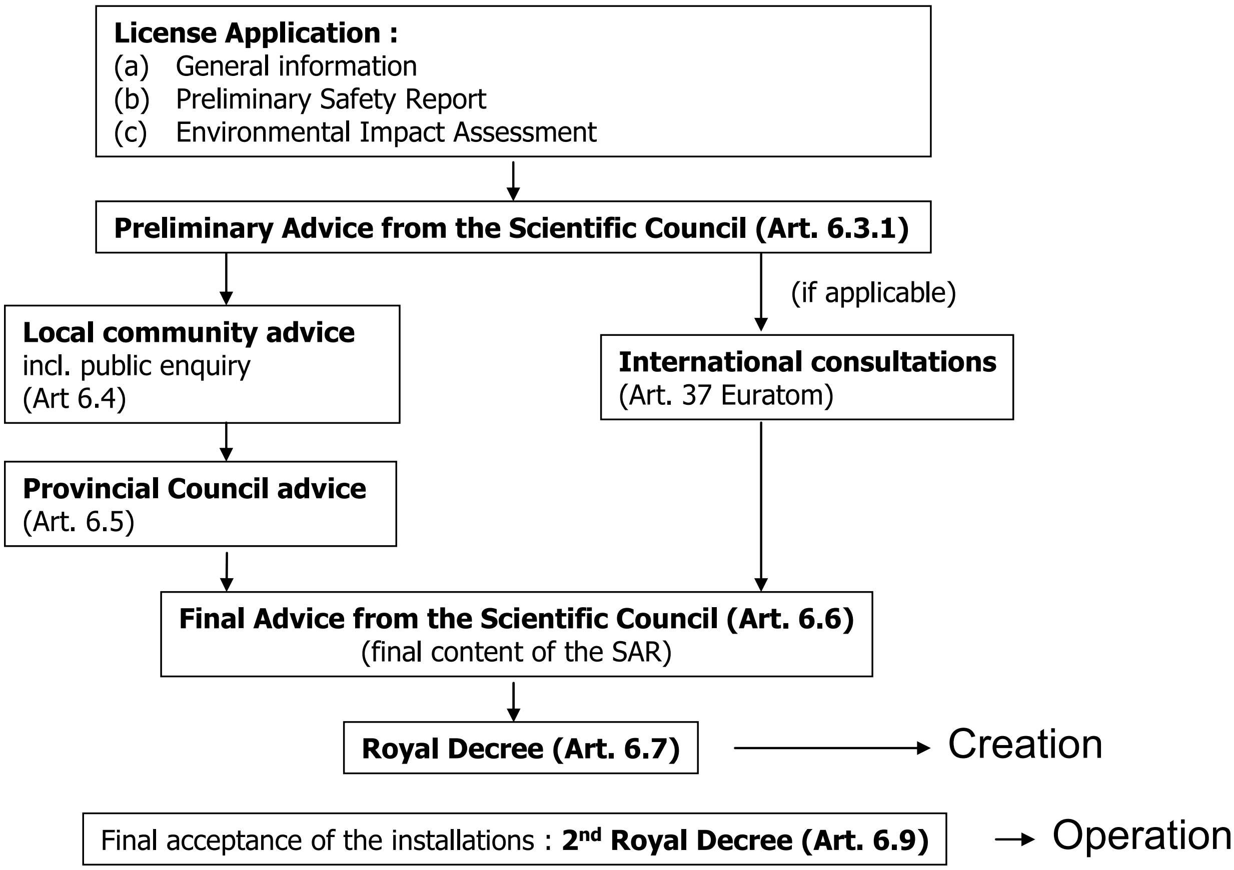
  The laws and royal decrees are regularly updated, and completed or, if necessary, amended (for instance to take into account the Euratom Directives, the international treaties signed by Belgium, etc.).

- The legislative and regulatory framework comprises:
  i. a set of laws and regulations (cf. description in II.C.3/4 above),
  ii. a licensing system for nuclear facilities and activities, and the prohibition to operate an installation without a licence (cf. GRR-2001 and, among other, its Articles 5, 6, 15, 16, 79 as well as all the Articles detailing the technical stipulations),
  iii. a regulatory inspection and evaluation system of the nuclear facilities and activities, to verify compliance with the regulatory provisions and conditions set in the licence (cf. GRR-2001, among other its Articles 6, 12, 13, 15, 16, 23, 78),
  iv. measures intended to enforce compliance with the relevant regulatory provisions and the conditions set in the licence, including the suspension,

amendment or withdrawal of licences (cf. GRR-2001, among other its Articles 5, 12, 13, 16).

- A schematic view of the licensing process for class I nuclear facilities, as prescribed by the GRR-2001, is given in the following figure.

Licensing process for Class I Facilities



II.D. Article 8. Regulatory Body

1. **Each Contracting Party shall establish or designate a regulatory body entrusted with the implementation of the legislative and regulatory framework referred to in Article 7, and provided with adequate authority, competence and financial and human resources to fulfil its assigned responsibilities.**
2. **Each Contracting Party shall take the appropriate steps to ensure an effective separation between the functions of the regulatory body and those of any other body or organisation concerned with the promotion or utilisation of nuclear energy.**

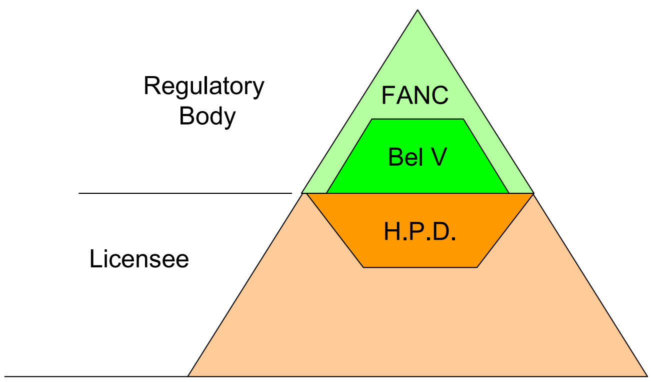
Since 1 September 2001 the supervision of nuclear activities is within the responsibility of the Federal Agency for Nuclear Control (FANC). According to the Law of April 1994 (as amended), the FANC may call upon the assistance of recognised bodies for health physics control, called authorised inspection 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 the nuclear installations covered by this National Report (nuclear power plants), delegates different tasks to Bel V, its subsidiary, a.o. routine inspections. Other class I facilities (including the Research Reactors) are controlled in a similar way by Bel V.

It is through the association of the FANC on one side, and Bel V on the other that the function of regulator as stipulated in article 8, is ensured.

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.

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. Background elements regarding AVN and the statute of "Authorized Inspection Organisation" can be found in the previous edition of this national report, available on the FANC web site.

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. This structure is illustrated below:



The descriptions in this article focuses on the tasks relating to the installations covered by the National Report, and thus is not an exhaustive overview of all the regulatory functions assumed by the various organisations.

II.D.1. Mandate and Function of the Regulatory Body

The GRR-2001 stipulates that the King is the competent Authority who grants the licenses for class I nuclear facilities (which include nuclear power plants and research reactors), it also specifies a number of tasks to be performed by the Federal Agency for Nuclear Control, which may delegate tasks to Bel V to perform supervision activities of all class I facilities.

The regulatory body is constituted by the FANC (being the safety authority) and Bel V.

In this way, the regulatory work, and in particular the supervision and inspection of the operating organisation, is performed at two levels:

a. at the level of general regulation and supervision:

The Safety Authorities are in charge of updating the general regulations, of transposing the European directives, international treaties, etc. and of maintaining the internal coherence of the general regulations (amending of application Royal Decrees,...).

As regards the general supervision of the operating organisation, the Safety Authorities and Bel V are informed of the organisation's operational issues and projects through the meetings of a "Contact Committee" composed of representatives from the Safety Authorities and Bel V, the operator. This Committee meets twice a year on average.

The Safety Authorities also systematically hold a control meeting at the end of each core refuelling period, to evaluate the activities and results of that shutdown period. Unexpected visits are also performed. In case of significant operation problems (e.g. generalised corrosion of steam generator tubes, deformation of fuel assemblies, possible contamination of transport containers, …), or in case of safety issues raised for example by international OEF, specific meetings are held between the Safety Authorities, Bel V and the operator in order to assess the technical problems and to consider and decide remedial action; these actions are in this way approved by the Safety Authorities.

The Safety Authorities can also act as an arbitrator in cases where the operator deems that the technical demands of Bel V are unreasonably high: after having heard the various technical standpoints the Safety Authorities can resolve about what is finally required.

b. at the level of the detailed technical analysis and the permanent supervision of the operator as required by the regulations.

When a licence for a (modification of) nuclear power plant is applied for, Bel V is requested to conduct a review of the Safety Report presented by the applicant, and to present its conclusions to the FANC. Using this safety review, the FANC can also propose additional conditions for operation that the scientific council may endorse. In this case, these operating conditions will be included in the Royal decree of authorisation (License). FANC and Bel V present the content of the safety review and the legal aspects, including proposals for additional conditions for operation, to the Scientific Council. If judged useful, the licensee concerned can be requested to provide specific information to the Scientific Council and respond to the latter's questions.

Before the installations are put into operation, the initial license must be confirmed by a second royal decree (see article 6), provided that the installations are subject to a fully favourable delivery, i.e. an in-depth verification of its conformity with the existing regulations and with the Safety Analysis Report, according to Article 6.9 of the GRR-2001. The delivery inspections and conformity checks are performed by Bel V, on behalf of the FANC.

Throughout the operation of the installation, the operator's Health Physics Department monitors nuclear safety and radiological protection, the department's performance being permanently supervised by Bel V (GRR-2001 - Article 23).
This permanent supervision in practice consists of systematic and periodic inspections devoted to defined subjects (operation, periodic tests, chemical control, radiological protection …) and specific items follow-up inspections, examination of modifications and incident analysis. An inspection report is written after each visit.
The inspection reports of the nuclear power plants are systematically transmitted to the FANC.

After each core refuelling, Bel V verifies that the new configuration is acceptable, and follows-up the start-up tests, assesses their results, and authorises (through its delivery report) operation at nominal power.

All modifications are notified to Bel V. However, Bel V and the Safety Authority will follow-up only the safety-related modifications.
Major modifications (power increase, use of MOX fuel, steam generator replacement …) require, under the appreciation of FANC, a procedure similar to that of the initial licensing, and sanctioned by a new Royal Decree of Authorisation.
Less important modifications are implemented by the Licensee under the supervision of its Health Physics Department (HPD). Bel V is in charge of approving the final delivery of the modification proposed by the HPD
Bel V may perform a step by step delivery, i.e. assessments and inspections that authorise proceeding with the next step in the modification implementation process.

II.D.2. Powers and Attributions of the Regulatory Body

After the Royal Decree of Authorisation of NPPs has been signed and after AVN (now Bel V) has approved the successive steps to nominal power, the Safety Authority and Bel V permanently supervise whether the operator complies with the regulations in force and with the conditions set in the licence.

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

At this stage Bel V has only the power to make recommendations but should the operator violate the conditions set in the licence and fail to correct that situation, or should the operation evolve towards an unsafe situation, this would be referred to the Safety Authorities, endowed with the power to suspend or withdraw the licence (GRR-2001, Article 16).

Another possibility to strengthen safety is foreseen in article 13 of the GRR-2001: the Safety Authority (The Scientific Council or the FANC services in charge of the supervision) can, on its own initiative and at any moment, propose additional conditions to be included in the License with the aim of improving safety. The process for amending the license is similar to the reference licensing scheme, with the exception that no consultation of the public, municipalities and provinces is foreseen.

II.D.3. Structure of the Regulatory Body, Financial and Human Resources

II.D.3.a. Safety Authorities

The Federal Agency for Nuclear Control is an autonomous public institution with legal personality. The Agency is directed by a 14-headed Board of Directors; its members are appointed by the Federal Government on the basis of their particular scientific or professional qualities. In order to guarantee the independence of these directors, their mandate is incompatible with certain other responsibilities within the nuclear sector and within the public sector. The Agency is supervised by the Federal Minister of Home Affairs via a government Commissioner who attends the meetings of the Board of Directors.

In order to perform its tasks, the Agency is assisted by a Scientific Council [established by article 37 of the Nuclear law of 15 April 1994]; the composition and the competences of this Council are determined by Royal Decree. The Council consists of experts within the field of nuclear energy, safety and radiological protection.

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

The operation of the Agency is entirely financed by the companies, organisations or persons to whom it renders services. In practice this is done through non-recurrent fees and annual taxes at the expense of the applicants or holders of licences, recognitions or approvals. The amount of the taxes is fixed by law, the amount of the fees is fixed by Royal Decree. The receipts and expenditures of the Agency have to be in equilibrium.

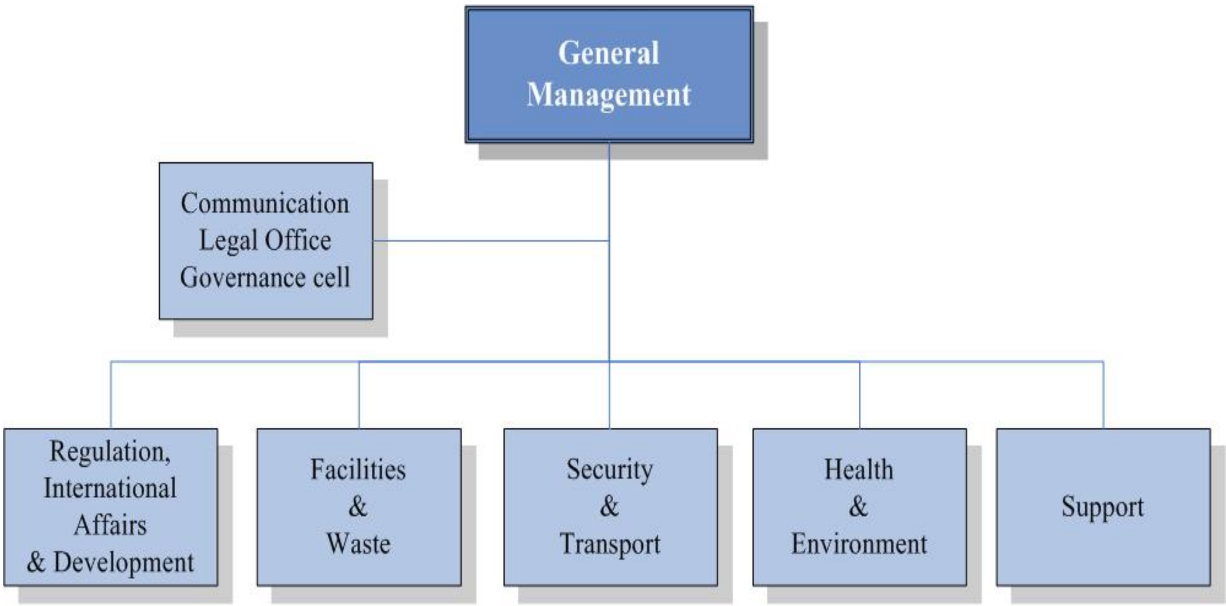
The above-mentioned statute confers to the Agency the indispensable independence to enable it to impartially exercise its responsibilities as a regulator of the nuclear activities - as prescribed in art. 8 of the Convention on Nuclear Safety.

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

Below the Board assisted by an audit Committee and a strategy Committee and below the General Management, the FANC is organized in five departments: the Department "Regulations, International Affairs and Development", the Department "Facilities and Waste", the Department "Security and transport", the Department "Health and environment and the Department "Support".

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

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



The department `Regulation, International Affairs and Development' is in charge of the development and the follow-up of the regulations. The department is also in charge of:

- stimulating, following and carrying out the studies and the developments necessary in all fields to improve the safety and the protection of the population,
- managing, maintaining and developing a high level of knowledge,
- coordination of FANC projects,
- international affairs.

On top of these tasks, the department is in charge of activities requiring the collaboration between several departments (horizontal activities).

The missions of the department `Facilities & Waste' are specifically related to the nuclear industrial facilities, the management of the radioactive waste, the recognition of qualified experts in health physics control as well as the supervision of the Authorized Inspection Organisations. The first mission includes the inventory, the analysis and the evaluation of the license applications. This mission consists in ensuring that ionizing radiation can be used safely and that a licence can be granted.
The second mission involves the control, the inspections and the investigations that ensure that the activities carried out comply with the license requirements and, in a more general way, with the regulations in force.

In addition, the department must also track down any illegal activity carried out without authorization. Synergy between these two missions mainly aims at improving: 1) the safety in general, and 2) the protection of the workers, the public and the environment against the dangers of ionizing radiation.
The third mission includes the contribution to a regulatory framework for the disposal of waste of different categories, as well as the future licensing for the sites dedicated for surface disposal of short-lived low- and intermediate-level radioactive waste and geological disposal of high-level and long-lived radioactive waste.

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

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

The department `Support' is in charge of all support activities: financial services, information technology, human resource management ...

At present, the personnel of the FANC is composed of about 140 persons. More than 60 % of them are university graduates in different fields of science (physics, chemistry, biology…) and engineering, law, economics, social sciences communication.

II.D.3.b. Foundation Bel V: overall Organisation

Bel V is a non-profit 'fondation', created by the FANC. Since the 14th of April 2008 it carries out, on behalf of the FANC, the regulatory supervision of the main Belgian nuclear installations. This supervision was carried out before that date by AVN. The majority of the experts working in AVN volunteered to be transferred to Bel V.
Bel V must perform its tasks and duties with experts that have to be recognised following Article 73 of the GRR-2001, assuring that an expert must have at least three years experience in the nuclear field before he/she can be recognised as a class I expert. Bel V's personnel training budget amounts to about 10 % of its overall budget in man-hours.

As a subsidiary of the FANC, Bel V can no longer be considered as an "Authorized Inspection Organization" like the former AVN, but as a legal entity created by the FANC, as referred to in article 28 of the Law of 15 April 1994 (as amended). It means that article 74 of the GRR-2001 is no longer applicable to Bel V.

Though, in order to keep the possibility of similar requirements as in article 74 for Bel V, the Law of 22 December 2008 amended the article 30 of the Law of 15 April 1994, by stipulating that the King determines the missions delegated to Bel V by the FANC, the financing of Bel V and the supervision conducted by the FANC on Bel V. This Royal Decree has been prepared and is now awaiting the approval of the Minister involved.

This decree will set out, among other things, that 2/3 of the members of Bel V's Board are appointed by the Board of the FANC. In addition, the General Manager of the FANC is also member of Bel V's Board.

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

Bel V's technical personnel is composed of some 55 university graduates (engineers and scientists), and recruitment is in step with the foreseeable workload. The workload consists of a more or less constant portion related to inspection of installations, and a more variable load in time related to the progress of the Licensee's projects and the number of safety evaluations to be examined, and also to the assessment of incidents or specific safety problems in the installations in Belgium or abroad (Barsebäck, Forsmark…).

The inspections and analyses carried out by Bel V are invoiced to the operator on the basis of hours actually worked. This system is similar to that applied by, for example, the USNRC which, in addition to a set fee per installation, charges to the operators the time actually spent on their problems. In the next future, the hourly tariff of Bel V experts will be fixed by Royal Decree.

Due to Bel V being a non-profit organisation, its financial resources are used for paying its personnel and related costs, for participating in national or international working groups, for personnel training, for its research and development activities, for maintaining a technical and regulatory documentation.

II.D.3.c. Bel V: Technical Activities

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

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

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

- The process "**Perform inspections during operation**" is in charge of inspections in all nuclear installations supervised by Bel V.
  For the nuclear power plants, one Bel V engineer is assigned to one nuclear unit (hence 3 engineers for Doel, as the Doel 1 and 2 twin units are considered as a single unit, and 3 engineers for Tihange) and the managerial staff examines the problems common to a site as a whole, oversees the coherence of approaches between the sites and ensures experience feedback between all the Belgian units.

Moreover additional thematic inspections are conducted in all the units.

The activities performed in this process include also inspections in installations other than nuclear power plants, namely all other class I facilities as well as class II and III facilities (universities, hospitals,…) having their own health physics department.

- The follow-up of all national and international projects linked to the operation of the installations is performed in the framework of the process "**Manage the projects/missions**".

  At the national level, examples are the periodic safety reviews, the power increase and the replacement of steam generators, the increase of the length of the cycles and the higher burn-ups.

  At the international level, the co-operation with the Safety Authorities of several countries outside the European Union (bilateral aid or INSC contracts of the European Commission) is continued and specific collaborations with Western Europe safety organisations are carried out.

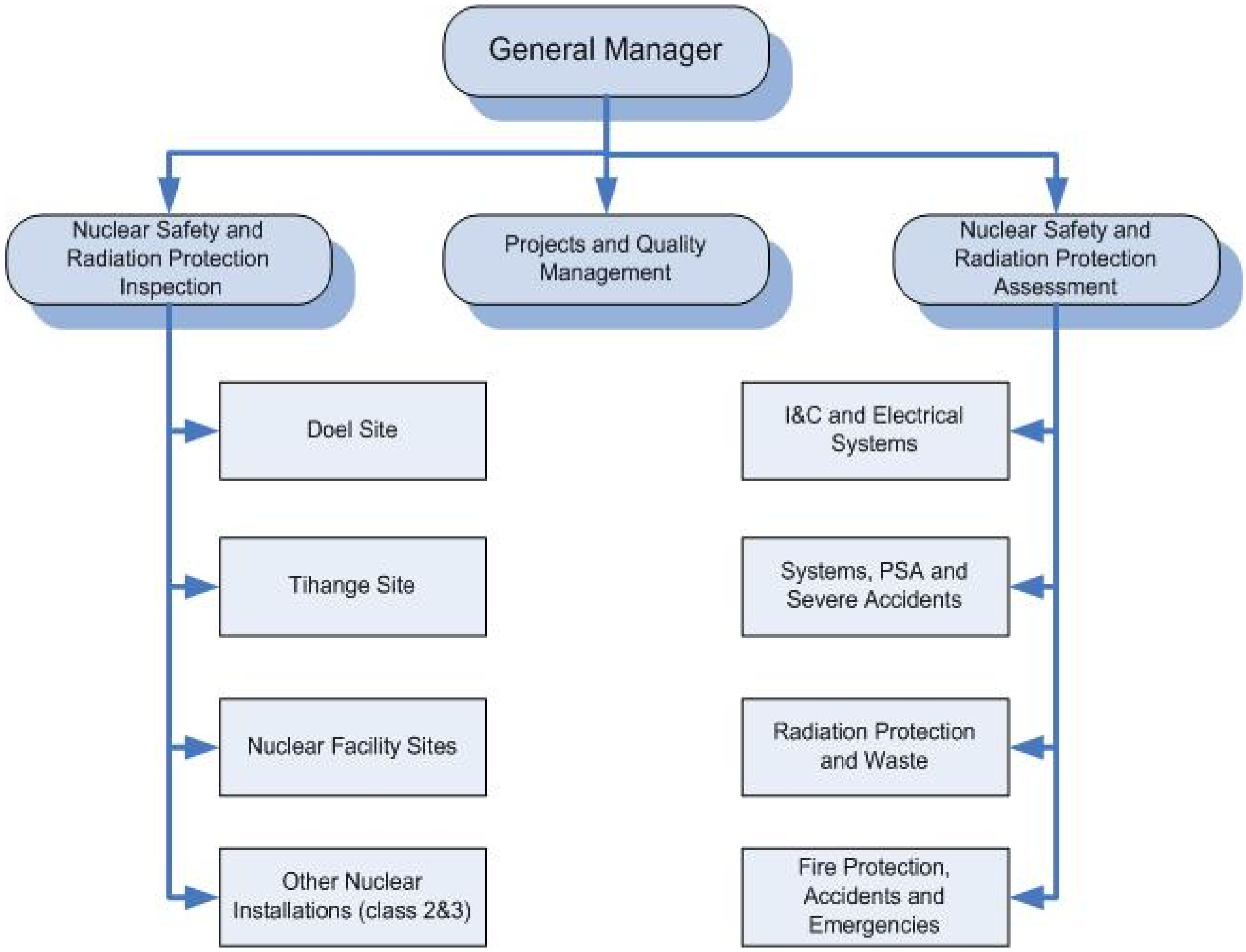
  In the frame of the periodic safety reviews, Bel V follows the evolution of the safety rules in the world (USA, Member States of the European Union, IAEA…) and examines with the licensees which new rules should be followed, in order to define the new safety reference rules, in agreement with the FANC.

- Safety review is performed by the process "**Provide and manage expert services**". It covers support to inspection activities, the analysis of important modifications, and analysis having a more general character: generic studies valid for all nuclear power plants, probabilistic safety assessment developed specifically for each unit but where the analysis methodologies must be identical, applications of these probabilistic studies in particular to the analysis of operational events, severe accident management, safety requirements for future reactors, safety analysis for the disposal of high level or low level radioactive waste.
  The process includes Bel V activities in the frame of its participation in the national emergency plan at the level of the evaluation cell (see article 16, paragraph II.L.2). It also participates in the emergency plan exercises related to the Belgian nuclear installations (nuclear power plants and other facilities), as well as in the exercises of foreign nuclear power plants located near the Belgian border, through bilateral or international collaborations.

- Research and Development activities in which Bel V participates (international projects like research and development activities within programmes financed by the European Commission, bilateral and own developments in Bel V) are managed in the process "**Management of expertise and technical quality**". This process includes also the analysis of operating experience feedback from Belgian and foreign nuclear power plants (DIANE and ARIANE data bases) and from other installations (ANCES data base).

A brief organisation chart of Bel V is given below.

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



II.D.4. Position of the Regulatory Body in the Governmental Structure

- The Safety Authority (FANC) is a public interest body, with a large independency and that reports to its Competent Minister, the Minister of Home Affairs. See also para.III.D.3.a

  The FANC has the duty to communicate with the public. Therefore, they answer for instance any questions and requests for information received from the Government, Members of Parliament or from others.
  The FANC annually presents its report of activities to the Parliament.

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

II.D.5. Relations between the Regulatory Body and the Organisations in Charge of Nuclear Energy Promotion and Use

In Belgium the nuclear power plants are operated by a private operator. He promotes the use of nuclear energy, as does the Nuclear Forum - Forum Nucléaire, member of Foratom.

The organisations dealing with questions related to the use of nuclear energy, such as the "Centre d'Etudes Nucléaires" SCK•CEN in Mol, or the Belgian Agency for Radioactive Waste and Enriched Fissile Materials (ONDRAF/NIRAS) report to the Ministry of Economic Affairs (also State Secretary for Energy).

As mentioned before, the Safety Authorities report to the Minister of Home Affairs.

The Safety Authorities and the Regulatory Body play no part in nuclear energy promotion, but the FANC also has a mission to "stimulate and co-ordinate the research and development works. It establishes privileged relationships with the public organisations working in the nuclear field, with the scientific research circles and with the international organisations involved." (Art. 23 of the law of April 1994).

II.D.6. Relations between FANC and Bel V.

As highlighted in section I.C, several working groups have been created in order to strengthen and optimize the relations between the FANC and Bel V.

As a result of the activities of Working Group 1, an integrated control and inspection strategy has been developed jointly by the FANC and Bel V. A 3-year programme is defined and communicated to the licensees. An annual planning for inspections and controls is derived from this programme. A revision of the programme is foreseen each year, in order to take into account experience feedback from the previous years.

As supervision action of the FANC on Bel V, a "Management Agreement" has been 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.

II.D.7. International relations

The FANC is actively involved in relevant international activities. At the IAEA it is member of the Belgian delegation to the Board of Governors, member of the RASSC, WASSC, TRANSSC, NUSSC (this last representation is delegated to Bel V) and the INES advisory committee.. It participates in the steering committee of the NEA as well as to the RWMC, CRPPH, CNRA (accompanied by Bel V as technical support). At the European Union level it is member of the Belgian delegation in different working groups of the Council (atomic question group, working group on nuclear safety…) or of the Commission, some of its experts are member of groups of experts (article 31, 35, 37), or to the scientific and technical committee …

The FANC, accompanied by Bel V, is also member of WENRA which gathers the EU Safety Authorities (+ Switzerland) and works on different common projects including the development of a harmonised approach of safety, based on in-depth analysis of the regulatory provisions and the practices within WENRA countries.

The FANC is also member of the European Nuclear Safety Regulators Group (ENSREG), which is an advisory expert group to the European Commission, composed of senior officials from national regulatory or nuclear safety authorities from all 27 member states in the EU.

On the bilateral side, it should be mentioned that the FANC has signed cooperation agreements with the French Safety Authority (ASN), the US-NRC; the Safety Authority of Russia and Luxembourg.

In addition to the activities related to the nuclear installations, Bel V participates in numerous international committees. For instance, Bel V is the national co-ordinator for the Incident Reporting System (IRS) of the OECD/IAEA, the Incident Reporting System for Research Reactors (IRSRR) of the IAEA and the technical officer for the FINAS system of the OECD regarding the fuel cycle.

Bel V personnel are members of CNRA, CSNI and the Sciences Committee of OECD/NEA, as well as of all the main groups of CSNI and CNRA, the Western European Nuclear Regulators Association (WENRA) and of NUSSC (IAEA).

Thanks to the Working Group 7 (See Section I.C), international representations and participations have been optimized between FANC and Bel V, regular information exchange meetings between FANC and Bel V take place, documentation/feedback is systematically shared and common positions are defined.

II.D.8. Conclusion

The legal framework and system described in chapter 7 and in this chapter offers solid basis for effective and efficient implementation of regulatory responsibilities and duties.

The Belgian regulatory body has the legal powers and human and financial resources necessary to fulfil its assigned responsibilities including the powers and resources to:

- require the licensee to comply with national nuclear safety requirements and the terms of the relevant licence;
- verify this compliance through regulatory assessments and inspections; and
- carry out regulatory enforcement actions, including suspending the operation of nuclear installation if needed.

Independence of the regulator is strengthened by the legal structure of the FANC and by a clear and well defined relationship with the Government. As extensively discussed during previous review meetings of the CNS, while recognising that a regulatory body cannot be absolutely independent, it was stated and commented that both aspects of independence, de jure and de facto, are essential. It can be found in literature[7] that those concepts rely on different important parameters like:

- clear safety objectives
- appropriate financing mechanisms
- defined accountability procedure and reporting
- transparency, adaptability to industry and society changes
- available competence
- quality assurance
- management of human resources in the regulatory body
- access to expertise

Since September 2001, when the FANC became fully operational, and in further developments of the Regulatory Body, particular attention has been devoted to implement the national structure in accordance with those values and concepts.

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[7] INSAG-17 Independence in regulatory body decision making

II.E. Article 9. Responsibility of the Licence Holder

Each Contracting Party shall ensure that prime responsibility for the safety of a nuclear installation rests with the holder of the relevant licence and shall take the appropriate steps to ensure that each such licence holder meets its responsibility.

Article 2 of the Royal Decree of 20 July 2001 (GRR-2001) defines the "Licensee" as follows:
"Any natural or legal person who is responsible of a facility or a work activity that is subject to licensing or reporting according to chapter II.".
Article 5.2 of the GRR-2001 also indicates that the licensee is responsible for complying with the conditions set in the licence. For the nuclear power plants the Royal Decree of Authorisation requires conformity with the Safety Analysis Report and with the document established in implementation of Article 37 of the Euratom Treaty.
Modifications are nevertheless acceptable if they improve the safety of the nuclear installations or have no impact on their safety. The Safety Analysis Report, established to the standard USA format, describes not only the overall installations, but also refers to specific documentation during operation such as operation procedures during normal operation, incident or accident situations, and to the Internal Code and Reference Guide, which are conformable to the IAEA requirements in GS-R-3. The Technical Specifications are also part of the Safety Analysis Report.

The licensee must organise a Health Physics Department in charge of nuclear safety and radiological protection, and must also organise the safety and health at the workplace as well as in the neighbourhood. A detailed description of the duties is given in Article 23 of the GRR-2001 (Article 7- section II.C.4.c of this National Report). The operator must also conclude a civil liability insurance (Article 6.2.5 of the GRR-2001); the law of 22 July 1985, which makes the conventions of Paris and Brussels and their additional protocols applicable, and the law of 11 July 2000 set the maximum amount of the operator's liability for the damage at some Euro 300 million per site and per nuclear accident. Other obligations of the operator include information and training of the workers (including workers not belonging to its own personnel) who might be exposed to radiation, and implementing the policy to limit individual and collective doses (respectively Articles 25 and 20 of the GRR-2001).

The Belgian law also requires that the Regulatory Body permanently controls the proper implementation of the duties of the operator's Health Physics Department. Article 23.8 of the GRR-2001 specifies a number of specific tasks in that respect.

As referred to in Article 8 of the present National Report, a Bel V inspector is assigned to each nuclear power unit. The inspection visits that he makes at the unit (where he has total freedom of movement, regardless whether or not he is accompanied by unit personnel) take up about half of his working time; the rest of the time, the inspector is at Bel V offices where he follows-up the inspections, writes the inspection reports, collects and analyses relevant information, discusses with the technical experts and exchanges information and gets feedback from the other nuclear power units. In this way the Bel V inspector can verify daily how the operator assumes his obligations and responsibilities.

II.F. Article 10. Priority to Safety

Each Contracting Party shall take the appropriate steps to ensure that all organisations engaged in activities directly related to nuclear installations shall establish policies that give due priority to nuclear safety.

II.F.1. NPPs Licensee Safety Policy and Safety Culture

II.F.1.a. Nuclear Safety policy Declaration

In order to state precisely the nuclear safety policy during operation, the General Directorate of Production at Electrabel has established and backs up the following "Policy Declaration on Nuclear Safety", which is now included in the Safety Analysis Reports of the nuclear units:

"*We attach the greatest importance to the protection of all members of personnel involved in operation of our power plants, of the public and the environment. We therefore actively support a strong nuclear safety policy in all phases of the operating process of our power plants.*

Together with our partners and contractors we work towards the practical application of this safety policy, based on the following principles:

Safety = the first priority

- *We make safety take precedence over production, in all circumstances.*
- *We ensure that safety is everywhere present in all operational processes.*
- *We anticipate the laws and regulations concerning nuclear safety, apply them and follow them scrupulously.*
- *We develop and promote a high level of safety culture.*

Safety = a process of continuous improvement

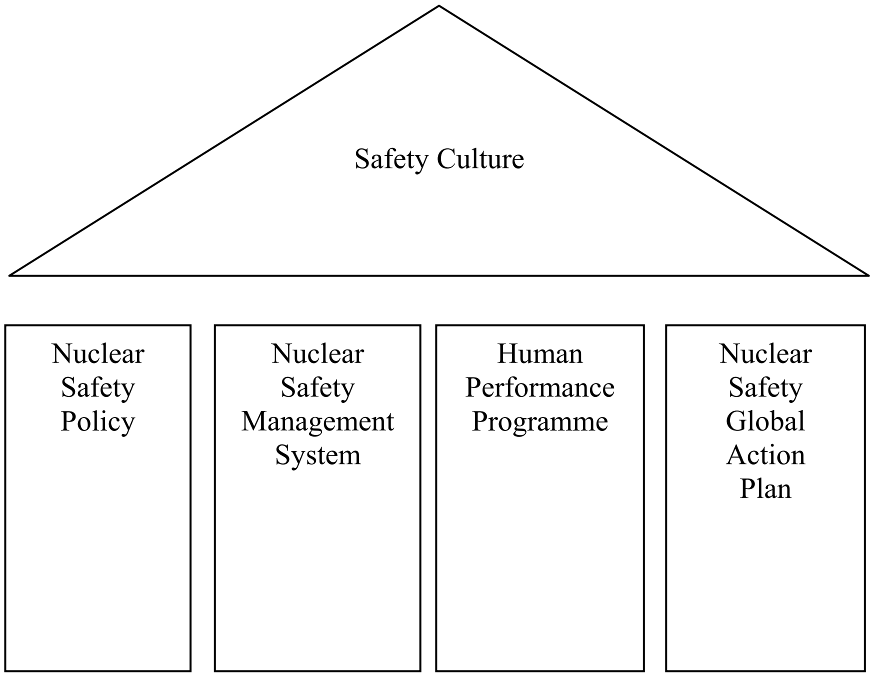
- *We set objectives and corresponding action plans so as to continually improve nuclear safety.*
- *We constantly assess the level of safety of our activities, and compare them with the best practices and international standards.*
- *We involve all our members of personnel in this process of continuous improvement, and ensure that they participate actively in it.*

Strict controls

- *We maintain a constructive dialogue with the authorities and safety institutions, and also with the other parties involved.*
- *We constantly measure the effectiveness with which our safety policy is applied.*
- *We regularly have external audits and international comparisons carried out*."

II.F.1.b. Safety Culture

The GDF-Suez Electrabel approach for implementing "Safety Culture" is schematically given in the figure below:



It is based on the following four pillars:

- **Pillar 1 : Values and Behaviours promoted by the Nuclear Safety Policy Declaration**
  The first principle stated in this Nuclear Safety Policy is "Safety = the first priority" (see I.A.1.a).
  This Nuclear Policy is posted in many places on the site and at least at the entrance of each building. The document is also integrally copied in the management expectations booklets. During the initial training in nuclear safety, all employees receive the Nuclear Safety Policy document and a specific module is devoted to explain this policy.
  The way to implement the principles defined in the Nuclear Safety Policy is described in the management system. The role, responsibilities and accountabilities of each level of the management regarding nuclear safety are clearly defined by following the INSAG-4 "Safety Culture" from IAEA.

- **Pillar 2 : Organizational and individual behaviours implemented through Nuclear Safety Management System**
  Below the Nuclear Safety Policy, on a second level, the Nuclear Safety Management System provides structure and direction to the organization in a way that permits and promotes the development of a strong safety culture together with the achievement of high levels of safety and excellent performance.
  The organizational and individual behaviours described in the Nuclear Safety Management System are provided as guidance to staff. Process owners are in charge to integrate these behaviours into the processes they are responsible for.
  The management system promotes a working environment in which staff can raise safety issues without fear of harassment, intimidation, retaliation or discrimination.
  The change management covers both the management of organizational changes and the willingness of teams and individuals to adapt to organizational changes that improve safety business performance.

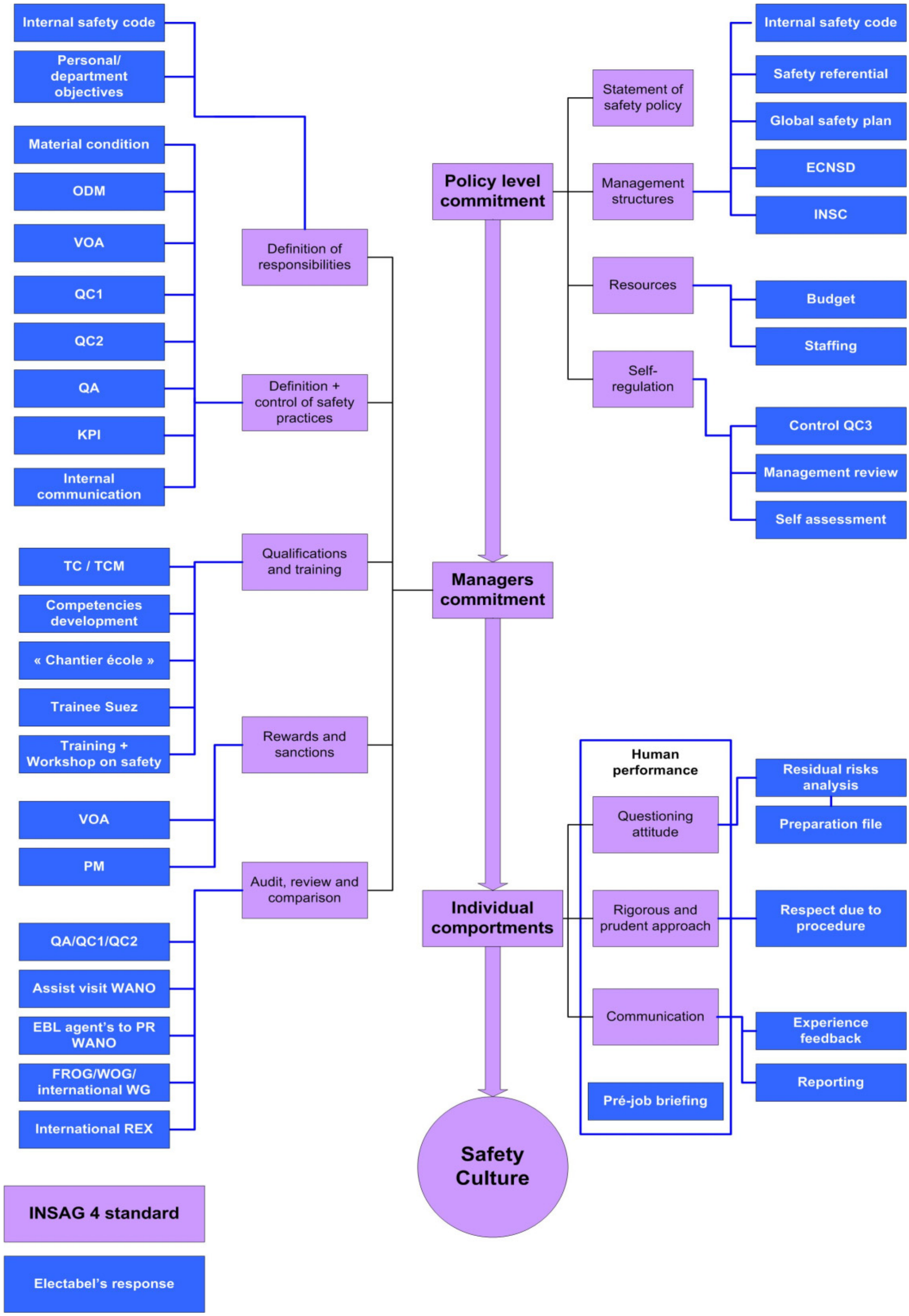
As Electrabel strives for continuously developing and improving its employees competence and performance, the Employees Performance Management process involves, in an individual and interactive way with the employee, the definition of objectives with regard to his/her competence development, job performance, the application of corporate values and giving feedback on the employee his/her way of performing.

- **Pillar 3 : Human performance policy within Electrabel**
  Tihange and Doel power plants have developed a common human performance policy which is based on two approaches:
    - A bottom-up approach, which analyses the root causes of events (including the human factor)
    - A top-down approach, which relies on human performance tools, safety culture awareness, and tasks observation.

  Efficient implementation of the human performance policy in the field requires training and coaching, as well as transparency, trust, and mutual respect (no blame culture).

- **Pillar 4 : Electrabel Global Nuclear Safety action plan**
  The Global Plan for nuclear safety is an output of the Nuclear Safety Management System. It lays down main objectives of Electrabel in nuclear safety for the coming years (from 2006 to 2010). At a forth pillar, these are aimed in particular at continuously improving the performance and the safety culture.
  These objectives are grouped in nine themes as following
    1. Management, organization, and administration
    2. Training and qualification
    3. Operation
    4. Maintenance
    5. Technical support
    6. Operating experience feedback
    7. Radiation protection
    8. Chemistry
    9. Emergency planning and preparedness

  With this Global Plan, Electrabel formally expresses clear objectives to consolidate its safety approach and improve its safety culture.
  These objectives are transposed in the annual action plan of Electrabel power plants and those of off-site organizations that carry out activities with an impact on nuclear safety.
  Action plans called “Energeia” at Doel NPP and “Energie 2010” at Tihange NPP were developed in accordance with the global plan and on the basis of a gap analysis between the situation on site against the IAEA guidelines and world-wide best practices. The structure proposed by the IAEA to illustrate the major components of Safety Culture (ref : safety series N°75-INSAG-4 Safety Culture) is used here to show the relation between the actions of Energeia and Energie 2010 and their positive effects on safety culture.



<u>Relations between INSAG-4 and actions of Energiea and Energie 2010</u>

At policy level :

- Two important documents supporting the nuclear safety policy have been published and communicated to all the personnel: the internal safety code and the Reference for Nuclear Safety. They describe clearly the quality requirements for the nuclear safety processes.
- The independent control on nuclear safety is reinforced by the activities of a specific department reporting directly to the Chief Executive Officer.
- An ambitious human resource plan is ongoing to recruit and train hundreds of young technicians and engineers in order to dispose of experienced staff to cope with the next waves of retirements and with the future projects.
- Resources and budgets allocated for housekeeping have considerably increased.
- Addition of a third level of independent nuclear control, implementation of a systematic program of self-assessment at team level and management reviews of all processes are contributing to avoid complacency and promote self-criticism and so improve nuclear safety.

At management level:

- The definition of responsibilities for the different levels of hierarchy are clearly described in the internal safety code
- Each year all departments and all individuals receive their specific objectives. They know exactly what should be their contribution to the improvement of nuclear safety.
- Systems for supervision and control upon orderliness, good housekeeping and material conditions are instituted.
- The Operational Decision Making Process is fully implemented and effectively used.
- Through a systematic program of Task Observations (systematic visits of managers on the field and coaching of workforces) and the internal controls, managers reinforce management expectations and control working practices.
- The internal communication on nuclear safety has been intensified. Numerous safety messages are given during all the year through diverse channels: public address terminals, intranet, meetings, posters…
- Two new functions have been created to assist the departments in the application of the Systematic Approach of Training (IAEA Safety Guide NS G 2.8): one Training and Competence Manager in the training department of each site and one or several Training Consultants in each department.
- Competencies developments are identified on the basis of an individual performance evaluation, the individual motivation for a specific career orientation and a gap analysis between the profile of the individual and the profile of competences defined for its job. The managers translate these competencies developments into a specific training programme for each member of their team.
- A “human performance simulator” has been built on each site to train contractors and own staff to the use of human error reduction tools and to reinforce the management expectations in nuclear safety, industrial safety, Environment and quality.
- An intensive training programme has been developed for young recruited engineers. This programme (more than 250 hours of training in one year) covers the main aspects of nuclear safety. A large focus is given on safety culture and human performance.
- The initial and refresher training programmes on nuclear safety and safety culture for the workforces and the managers have been updated and reinforced.

- The process of rewards and sanctions is supported by the Performance Management process. At least one yearly evaluation of individual performance against the objectives is performed. Safety behaviours are also evaluated
- Internal audits and reviews are performed at different levels (Quality Assurance and independent controls level 1 to 3). External audits are frequent (one WANO peer review every 3 years on each site). The sites are certified ISO 14000, OHSAS 18001, EMAS and receive every 6 months an external audit.
- Electrabel is an active WANO member. Good practices exchanged during assist visits or peer reviews are afterwards, when applicable, implemented on site and contribute to enhance nuclear safety.
- Comparison and use of Operating experience is also performed trough active participation in different international working groups (WANO, IAEA, Westinghouse Owners group, Framatome Owners Group,..).

At individual level

- Work preparation is better documented and use of "Just In Time" operating experience is enhanced. Just before the job start, a residual risk analysis is required.
- Several human error reduction tools have recently been implemented: procedure adherence, pre-job and post-job briefing, secure communication, questioning attitude…
- Reporting of errors and anomalies is encouraged during training and also during Task Observations.

II.F.1.c. Organisation

Nuclear activities within Electrabel are managed on a four level structure:

- Corporate level,
- Business Unit level,
- Nuclear Generation level and
- Nuclear Power Plant level.

The departments at **corporate level** playing a major role that are most noteworthy with regard to nuclear safety are:

- The Electrabel Corporate Nuclear Safety Department (ECNSD):
  This department is in charge of evaluating the effectiveness of the management of nuclear safety in the nuclear power plants. The six processes ECNSD is involved in are determining nuclear safety strategy, coordinating actions regarding nuclear safety according to the Electrabel Global Plan, reporting on nuclear safety, gathering expertise on nuclear safety, independent monitoring of nuclear safety and providing operational support for the nuclear power plants. The ECNSD department reports directly to the Health and Safety and Nuclear Safety Officer, who is by law the head of the Health Physics Department. Through the Health and Safety and Nuclear Safety Officer, ECNSD reports directly to the CEO.
- The Human Resources Department
  The Human Resources Department is located on the corporate level. The activities of Human Resources are mostly focused on the competency development and knowledge management of the personnel of Electrabel.

Other departments on the Corporate level that have an influence on the activities in the Nuclear Power Plants are the Finance and Controlling Department and the Purchasing and Warehouse department. The Finance and Controlling Department has 2 main activities on the nuclear sites, namely document management and information services. The Purchasing and Warehouse department takes care of all purchases on the sites (with the exception of nuclear fuel).

The creation of the position of Chief Nuclear Officer (CNO) has introduced an additional level in the organization of Electrabel: the **Nuclear Generation level**. The CNO is responsible for the safety, reliability and performance of the Nuclear Plants of Electrabel

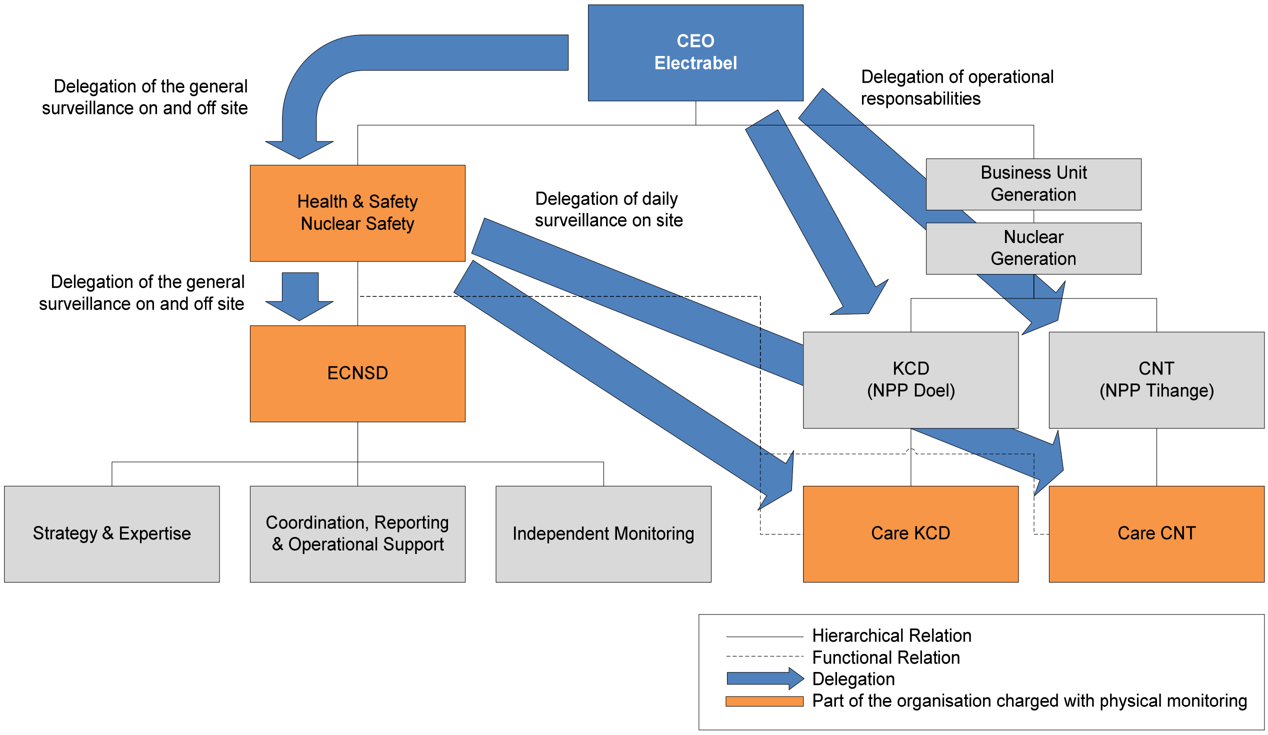
Noteworthy departments at the Nuclear Generation level are:

- 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.

At the **Nuclear Power Plant level**, the organisation is structured in 4 departments:

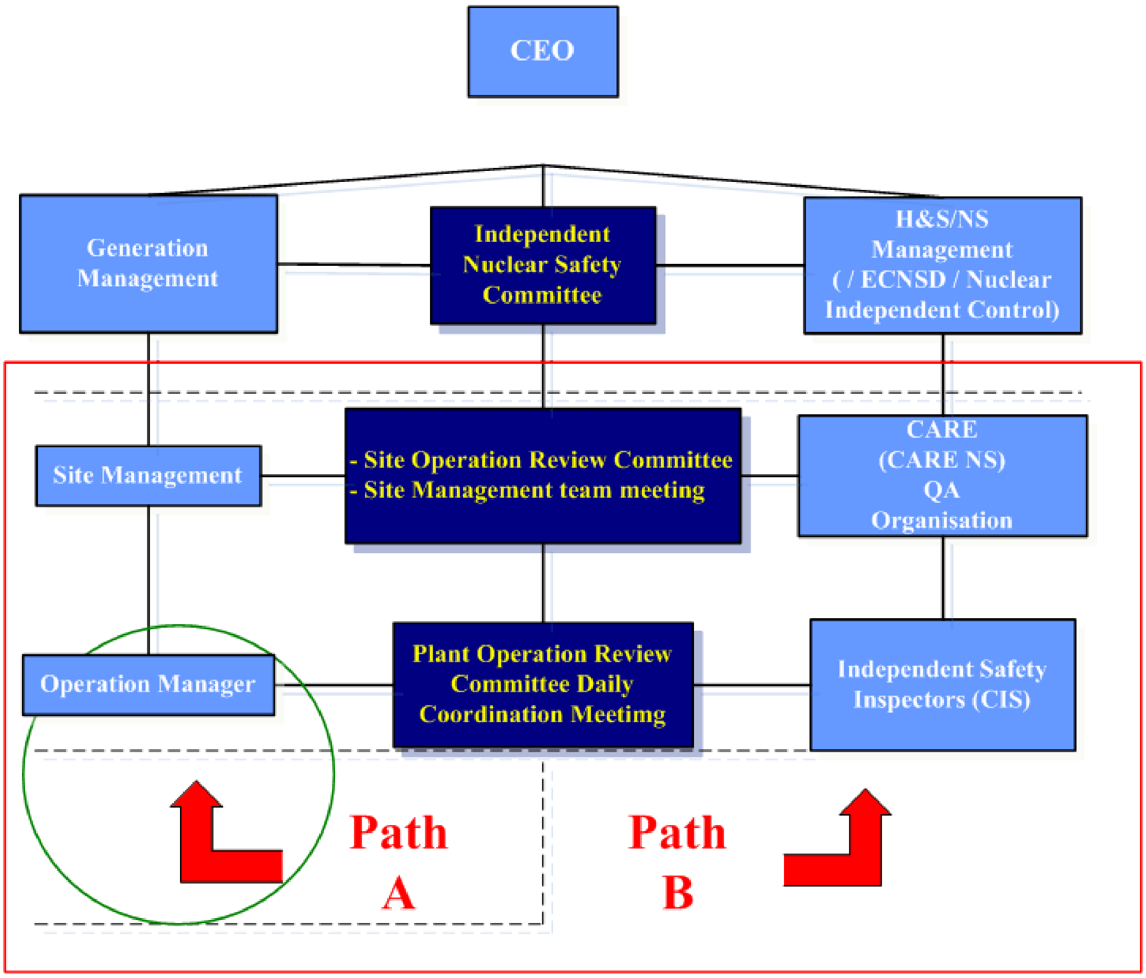
- *Maintenance*
  The Maintenance department is in charge of ensuring the short and long term availability of the installations and equipment. It is also responsible for the management of contractors.
- *Operations*
  The Operations department is in charge of the safe conduct of the generation process and of the installations.
- *Engineering Support*
  Engineering Support is in charge of the management of the modifications and projects on site and of the management of the generic issues and long-term concerns. Furthermore the Engineering Support department has the competency of Design Authority, validating the conformity of proposed changes with the overall safety design basis.
- *Care*
  The Care department is in charge of surveillance in radioprotection (Health Physics Control in the sense of the GRR-2001), measurements, protection of the workers (industrial safety), fire protection, environment and safety of the installations (including the setting up and the management of the emergency planning and preparedness). It is the local representative of the centralized Health Physics Department (as required by the regulations) and has the appropriate delegation from this department to perform the formal approvals required by the regulations. It ensures the respect of the nuclear safety culture by independent technical checks and thus forms the link with the Electrabel Corporate Nuclear Safety Department (as mentioned before).

The figure below shows the organisation of ECNSD, the functional links with the Care departments on the two sites and the corresponding delegations.



II.F.1.d. Monitoring & Assessment of safety performance

In order to ensure optimum efficiency, the internal assessment of Safety is organised into different levels of control where each level corresponds to the different levels of the operational hierarchical line.



The operational line performs its own self-assessment.

Path A represents the operational line assuming final responsibility for nuclear safety. Path B represents the path entrusted with monitoring and supervision. In order to ensure its independent control mission, Path B is hierarchically totally independent from the operational hierarchical line.

There are three independent levels of Quality Control (QC1, QC2, QC3) and one level of Quality Assurance (QA):

- **QA**: performed by QA organisation, to check compliance with the quality requirements indicated in the nuclear safety reference system and to monitor compliance with the management systems,
- **QC1**: performed by and in the operational departments, to ascertain the technical quality of interventions (Self-control Point, Witness Point and Hold Point) and to control compliance with their processes,
- **QC2**: performed by independent safety inspectors (CIS), by using the Key Performance Indicators, the internal and external Operational Feedback, benchmarking, follow-up of corrective actions, “external” data (AIO, external audits, etc.), self-assessments, etc., together with its own controls, to measure the effectiveness of Nuclear Safety management and to present proposals to further improve Nuclear Safety,

- **QC3**: performed by the Nuclear Independent Control (NICo), which uses the results of the abovementioned controls, together with its own assessments, to draw up an overall picture of Nuclear Safety of EBL and to propose areas for improvement.

II.F.2. Research reactors

The general management published a safety and security charter stating the importance of safety for the operation of the installations. The charter also promotes a positive attitude towards safety culture. Additionally, attention is asked for security and physical protection aspects. In 2010, this charter is completed by the publication of management expectation on the use of procedures.

These general statements are further put in practice by a number of actions. A short training on the aspects of safety culture was given to all members of the personnel. The aim of this training is to convince the personnel that reporting of unusual or unsafe situations, including those as a consequence of own errors, is an important way to prevent accidents. For BR2, a system to report these events (technical and non-technical) already existed. This is a complete open system. Every member of the personnel can introduce a report without restriction. The reports are discussed during the daily operators meeting and an action is defined if necessary. This reporting is already a number of years in operation and is considered as very valuable. Based on this experience, a reporting system for the rest of the installation of the SCK•CEN (including the BR1 reactor) is set up. The system is centralized by the internal safety services.

Another point of attention is the learning from operational experience feedback (OEF), both from internal and from external events. Personnel is encouraged to report facts with a potential interest for other, regardless whether these are incidents or good practices. For the external OEF, special attention is paid to the IAEA incident reporting system for research reactors. Information from incidents from power reactors is used insofar the subject is applicable to BR1 or BR2.

The training of the personnel also included ways for risk analysis, for use during the preparation of a task or just before and during the execution of the task. Operating procedures, especially the procedure for executing non-standard tasks, include a risk analysis. In case of an incident, an investigation on the causes is executed. The cooperation of the operators is solicited. Everyone is expected to add his information, which will be treated blame free.

A last important action is the keep the knowledge of the installation. The SCK•CEN has an operation history of more that 50 years, which means that people involved in the design and building of the installations are no longer available. In this way it is very important to keep all documentation about the installations in good condition in such way that it is readily available. A special action is started about this issue.

II.F.3. Regulatory Bodies

The FANC is responsible (amongst other duties) for the supervision and control of all the activities concerning radiological protection and nuclear safety.

Inspections and controls are exercised by the FANC (inspections) and by Bel V (controls), under the responsibility of the FANC.

Radiological protection, and implicitly nuclear safety, is emphasised in the general principles of the GRR-2001. However, special emphasis has been put on safety by the FANC.

End 2003, the FANC established its "*General Inspection and Control Policy*". This document is quite explicit regarding priority to safety, and is reproduced hereafter:

"The basic principles of the General Inspection and Control Policy

The inspections and controls serve to verify that the activities performed by the operator/company are undertaken in a safe manner. For this purpose, it is necessary that:

1. *the operator/company has a management and a policy aimed at safety and its improvement, pursued in a fairly continuous manner. The necessary measures have to be taken, on the one hand, to prevent accidents and, on the other, to limit the consequences of possible accidents;*
2. *the operator/company disposes of competent and well-trained personnel;*
3. *the operator/company pursues (and preserves) safety, reliability and quality while designing, constructing, operating, maintaining, closing down and dismantling his/its facilities/installations;*
4. *the operator/company is able to prove at all times that he/it complies with all of the provisions of the regulation and the operating conditions stipulated in the licences;*
5. *the operator/company disposes of a system enabling him/it to draw lessons from internal and foreign experiences.*

The operational measures for the implementation of the General Inspection and Control Policy

The inspections and controls are thus a targeted assessment of the activities of the operator/company in order to bring to light the possible problems, shortcomings or violations of the operator with regard to the above-mentioned obligations. However, these inspections and controls shall in no way release the operator/company from his/its fundamental and entire obligation and responsibility to guarantee the safety of his/its facilities/installations and the protection of his/its workers, the population and the environment. The inspections and controls may include the following: analyses, studies, assessments, observations, measurements, tests taken by, or on behalf of the FANC/Bel V in order to verify if materials, components, systems and structures, as well as operational activities, processes, procedures, competences and performances of the persons involved are in conformity with the prescriptions of the regulation on ionising radiation, the operating conditions stipulated in the licences and safety in general. Within the framework of continuous improvements, the services of the FANC and Bel V which perform the inspections and controls, will obtain a quality certification.

…

Bel V elaborates control strategies for the implementation of this general policy of the FANC. The FANC will establish, in consultation with Bel V, objectives (which Bel V will have to pursue) and indicators (specifying the extent to which Bel V is achieving the intended objectives).

The FANC will periodically evaluate its general inspection and control policy."

In application of these basic principles, since January 2009, FANC and Bel V developed a common strategy for inspection (by FANC) and control (by Bel V) of the nuclear installations. This strategy guarantees a still more integrated approach in the field of nuclear safety and radiation protection. A 3 years based programme is defined and communicated to the licensees. An annual planning for inspections and controls is established, based on this programme. A revision of the programme is foreseen each year, to take into account experience feedback from the preceding years.

As a matter of fact, on the basis of its large inspection experience as well as of its well-established know-how in collecting and interpreting operation feedback data, Bel V has, in the course of the years, developed an inspection and safety assessment strategy aiming at the assessment of how the licensees manage safety, with specific emphasis on the implementation of the GRR-2001 and of the licenses of the various installations.

This strategy contains the implementation of a permanent monitoring of the licensee and of conformity checks of the installations, general objectives and an inspection programme with various types of inspections. This strategy is evolving with time and safety concerns (e.g. human and organisational performances), and supported by strong programmes of expert initial training and retraining, of operating experience data collection and analysis, of specific research and development activities.

This strategy is imbedded in the various processes of the ISO-9001:2008 quality system of Bel V (certification obtained in the beginning of 2010), which is based on expert assessment and judgement. The system allows a clear definition of responsibilities and a better tracing of the performances. Process assessments, which are difficult to be realised in the field of expertise, exist.

From the origin, AVN (now Bel V) was aware of the necessity to make the best possible use of feedback from foreign incidents. Some historical elements can be found in the previous editions of this report.

After the TMI accident, AVN (now Bel V) systematised experience feedback and created databases for Belgian and foreign incidents, grouping similar types of incidents and recording the implemented corrective action taken. A link can easily be established between these databases and the structure of the Safety Analysis Reports, to take the events into account in the safety analysis. All this information is made available to the operators.

Since many years, Bel V also makes incident analysis with the help of the probabilistic safety studies available for the units (PSA-based event analysis) and discusses the results with the licensees to assess the need for corrective measures.

Bel V shares also the feedback of operating experience through its participation to international organisations (IAEA, OECD/NEA, Working Party on Nuclear Safety-WPNS of the EU) and in smaller groups of Regulatory Bodies (NERS, FRAREG, bilateral collaborations). Bel V, in collaboration with FANC, actively participates to the WENRA harmonisation groups as well as to the task force on safety critical software.

Since November 2001, monthly coordination meetings are held between FANC and Bel V to discuss current issues and safety priorities in the Belgian NPPs. In addition, in order to improve the cooperation between the FANC and Bel V and to optimise the information flows between the FANC and Bel V, the FANC has elaborated a Directive towards Bel V, officially issued by the end of 2003. Twice a year, there are also meetings between the management of the FANC, Bel V and the operator of the Belgian NPP’s.

II.G. Article 11. Financial and Human Resources

1. **Each Contracting Party shall take the appropriate steps to ensure that adequate financial resources are available to support the safety of each nuclear installation throughout its life.**
2. **Each Contracting Party shall take the appropriate steps to ensure that sufficient numbers of qualified staff with appropriate education, training and retraining are available for all safety-related activities in or for each nuclear installation, throughout its life.**

II.G.1. NPPs

II.G.1.a. Operator's Financial and Human Resources to use the Installation throughout its Industrial Life

The Doel and Tihange power plants are operated by Electrabel, a member of the GDF-Suez group that was created after the merger in 2008 of 2 groups "Gaz de France" and "Suez". The share of the company in electricity generating capacity in Belgium amounts to 64% in 2010.
Main activities of Electrabel are the generation and commercialisation of electricity and gas in Europe. In Belgium, Electrabel is the owner of the twin units 1 and 2 (100%) and the units 3 and 4 (89.8%) of Doel, and of the unit 1 (50%) and of the units 2 and 3 (89,8 %) in Tihange. 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 all electricity produced in Belgium (see table 1 of the Introduction of this Report).

About 1900 people are devoted to nuclear power plant operation among Electrabel's total workforce in Belgium of 7447. In September 2002, the company Elia System Operator was appointed by the Belgian Government as the Manager of the electricity distribution network. This activity is now completely separated from the activity of electricity generation. Electrabel has signed specific connection contracts with Elia. In accordance with the legislation on deregulation of the electricity sector in Europe, all distribution activities in the three regions of Belgium have been separated and turned into independent companies.

The GDF-Suez group has also an Engineering division, Tractebel Engineering, which is the Architect-Engineer of the Belgian nuclear power units (and of most of the fossil fired plants) and which houses know-how accumulated over fifty years of nuclear technology, which started with the construction of the first research reactors at the Mol Research Centre.

II.G.1.b. Financing of Safety Improvements during Operation

Major safety improvements to the Belgian nuclear power stations emanate from the periodic safety reviews (ten-yearly) and are financed through annual provisions (1/10th each year). In addition, mid-term provisioning over a time frame of five year is continuously carried out for the financing of specific projects and for replacement of aged or obsolete components.

II.G.1.c. Financial and Human Provisions for Future Decommissioning and for Management of the Waste produced by the Installations

The existing mechanisms are described in the Belgian report for the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. More details can be found in that report, available on the FANC web site.

II.G.1.d. Rules and Requirements for Qualification, Training and Re-training of Personnel

The Safety Analysis Report (chapter 13) deals particularly with personnel qualification, training and re-training. Qualification of the personnel (at the origin or later replacement) 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, proof of qualification of all the operating personnel is available to Bel V). The functions and qualifications prescribed by the US regulations are transposed in function of the educational system structure and curricula existing in Belgium.

The training programmes are defined in the Safety Analysis Report, which includes a "function-programme" correlation chart. Chapter 13 of the Safety Analysis Report lists exhaustively all posts for which an license is required. This license is granted based on the positive opinion expressed by an Assessment Committee, which examines the candidate's knowledge. This qualification is reviewed every two years or, if a licensed person has ceased during four months or more performing the function for which he/she was qualified. It is renewed on the condition of, among other, a favourable advice of the Assessment Committee on the basis of the individual's training and activity file.

Bel V is member of the Assessment Committee, with veto power.

A knowledge re-training programme for all licensed personnel is defined in function of the occupied position. The contents of this programme which is discussed with Bel V, is essentially operation-focused and includes, among other, 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 ("Maintenance" department, see next section).
For all the personnel of the plant, there are training and retraining plans which are adapted according to the functions of the personnel.

Note that the GRR-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 that give the training are qualified for the particular subjects they teach, and possess a formal instructor certification.

In addition to the individual training and retraining, 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 in this design are an important part of the knowledge.

II.G.1.e. Training at Electrabel

II.G.1.e.1) Electrabel training policy

The Electrabel policy statement on competency development and personnel training recognizes that the training of personnel and the continuous development of their skills are essential for the ongoing safety and optimal performance of both the on-site plant staff and the installation.
Through this policy, the Doel and Tihange NPP management ensures that every employee receives appropriate training and only qualified personnel are assigned to tasks involving risks.

A Job Atlas Handbook has been developed at the Electrabel Corporate level. The Job Atlas Handbook lists all of the functions within Electrabel Corporate, as well as the corresponding competency and skills required. A detailed description has been defined for each function and a link has been made with the competences necessary to carry out each of these functions.
Every new employee follows an initial training programme that is aligned with their job description.

Every staff of Electrabel has an individual development plan. The content and implementation of this plan follows a four-step approach:

1. Analysis of the gaps between the competences required in the Job Atlas Handbook and the level as assessed by the individual and their manager
2. Creation of individual development plans
3. Implementation of development actions
4. Coaching and monitoring, evaluation and feedback

Managers regularly check that the aims of the training courses are being met and suggest improvements. To do so, they participate in training, perform verifications and/or gather feedback and evaluation results.

II.G.1.e.2) Training Facilities

There are a number of training facilities on the nuclear power plant sites:

1. Each of the reactor units has a meeting room that is equipped with the necessary IT tools for training courses
2. A training room for hands-on training on pump and valve maintenance
3. A room for the initial training of operators featuring a large number of demonstration tools
4. Each site has a Training Center (on site or off-site). It includes:
    - Training rooms equipped with blackboards, PCs, etc.
    - A miniature size version of a reactor unit
    - A field simulator for work practices and human performance tools (the Human Performance Simulator)
    - A room for hands-on training, for instance on the operation of pneumatic valves and PID controllers
    - Simulators (full-scope or multifunctional):
      Both Doel and Tihange have full-scope simulators.

In Tihange, the full-scope simulator is a precise replica of Tihange Unit 2. Extensions such as additional hardware panels and screens have been added to the equipment in order to provide the best possible training of Unit 1 and Unit 3 operators.
A second simulator, with a non-replica man-machine interface, is used to illustrate specific aspects related to regulations, primarily through the projection of images. The three units being simulated on this "Multifunction simulator", it suits as a complement for the training of units 1 and 3.
Doel has two full-scope simulators: these are precise replicas of Doel Unit 1 and unit 4. The full-scope simulator of Unit 4 can be used in Unit 3 mode.

II.G.1.e.3) Training Requirements

The training cycle is subdivided into two parts:

1. Initial safety training
2. Refresher safety training

Initial safety training includes course on nuclear safety, health and safety and environmental issues and must be completed by every NPP employee before they start their job. The initial training programme is tailored to the nature of function that will be occupied by the employee. Three levels have been defined accordingly.

Refresher safety training is given on a annual basis and is mandatory. It keeps employees informed about changes and operating experience in the areas of nuclear safety, industrial safety, radiological protection, environmental safety, human performance and management expectations. For technical functions, an additional refresher course has been developed but runs over 5 years.

II.G.1.e.4) Training programs

Training programs have been developed for Operations personnel, Maintenance personnel, technical and support personnel and management and supervisory personnel.

More details are given below on the training programs for Operations and Maintenance personnel:

1. Operations personnel:
   Members of staff who are directly responsible for the operation of the reactor units must receive an operator's authorisation. This certification must be obtained before the person is nominated for a position.
   The training programme for authorised operators (Shift Supervisors and Control Room Operators) is in line with legal requirements. It comprises a basic training package, training in emergency procedures, and complementary training courses. The training programme includes:
   - Control room training under the supervision of a Shift Manager.
   - Hands-on training through integration in a team of Shift Supervisors and/or Control Room Operators
   - Simulator training given by the Operations Support Service
   - Training on specific installations, covering aspects such as fire fighting and first aid.

The periodic retraining of authorised operators also meets legal requirements. It is established by the Operations Service and comprises the following elements:

- One week refresher course, per year, in classroom and in other installations suited for exercises, in line with the function.
- Two week internal team training, per year, under the supervision of the Shift Supervisor
- Two weeks of full-scale simulator training, per year, given by the Operations Support Service.

As with certified operators, the training program for Field Operators is in line with legal requirements. It also comprises a basic training package, training in emergency matters, and complementary training courses. The training program includes:

- Classroom training under the supervision of a Shift Supervisor. This training covers thermodynamics, electrical and electrotechnical principles, systems and components, circuits, instrumentation, and safety principles
- Hands-on training through integration in a team of Field Operators
- Training on specific installations, covering aspects such as fire fighting

The annual retraining programme of Field Operators is established by the Operations Service and is based on a two day refresher course in a control room and in other installations suited for exercises, in line with the function.

2. Maintenance personnel:
After the initial generic training course, future technicians follow a specific training programme. This programme specifically addresses mechanical, electrical and I&C technicians. It lasts approximately one year. Other team-specific training courses are provided in addition to this programme.
The switch from a technician to a first technician and further to team leading function requires completion of specific training courses.

II.G.1.e.5) GDF-Suez Nuclear Training Programme

In 2005 GDF-Suez decided to develop its nuclear activities and created a dedicated Nuclear Activities Division. One of its missions is to:

1. Anticipate needs in junior engineers (max. 2 years experience) for replacing retiring managers and for staffing new nuclear projects
2. Build up a **Nuclear Training Programme (NTP)**:
    a. for **junior engineers** by giving them a general view on all the aspects of the nuclear activities and to help them build a strong network through the GDF-Suez Group.
    This programme consists in different types of trainings in order to to improve 3 types of competencies (métier – behavioral – functional)
    b. a similar training programme was launched in April 2010 for **senior engineers** coming from several entities of the Group, but having no specific nuclear knowledge
    c. a training programme for junior engineers accessible only for **young foreign** students.

II.G.1.e.6) Contractor Training and Qualifications

Contractors 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. An intensive training programme for all personnel of contractors has been put in place, focussing on nuclear safety and work in a nuclear environment. The successful completion of this training is mandatory before being allowed to work on the site of the nuclear power plants.

A general training programme is set up for all contractors. This general training programme focuses on safety culture (both nuclear and industrial safety), is carried out partly on a theoretical basis and partly on a hands-on approach using the Human Performance Simulator (see also II.H.1.f). It covers the 4 tools for the effective application of the human performance principles, as the adherence to procedures (stressing the need for a strict respect of prescribed steps), the interrogative attitude (the principle to correctly apply the instructions using the STAR methodology: Stop – Think – Act – Review), the use of secured communication and the use of the pre-job briefing methodology.

II.G.2. Research Reactors

II.G.2.a. Financial resources

The SCK•CEN, the Belgian Nuclear Research Centre is a "Fondation of Public Utility " (FPU) with a legal status according to private law, set up according to the law on non profit organisations, under the tutorial of the Belgian Federal Minister in charge of Energy. From the first of January 2005 the SCK•CEN, like any other non- profit organization has to apply the principles and rules prescribed by Belgian accounting rules. The turnover and the operating profit of the previous years are defined in accordance to this law. The adequacy of the SCK•CEN's financial system and internal controls is assessed by an external auditor. According to the safety and security charter, the management hereby is committed to provide all necessary financial means to enhance safety and to ensure all required security measures.

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

II.G.2.b. Human resources

The minimum requirements for operating personnel are detailed in the safety analysis report both for BR1 and BR2. These requirements are the necessary education and training of the personnel. The minimum number of personnel necessary for operating the reactor is also specified. For BR2 additional requirements for training are defined. Each reactor operator has to receive two weeks training every year. The initial authorisation as a reactor operator is given on advice of a committee, in which the department of health physics and safety and of the FANC (Bel V), are represented with veto power. Reauthorisation is necessary every three year or after a longer period of non activity as an operator. The requirements for BR1 personnel are less formalized.

The appointment of the BR1 reactor manager has to be confirmed by the health physics and safety department. The training of the operators is defined by the BR1 reactor manager case by case. This is acceptable due to the limited number of operators for BR1

II.G.3. The Belgian education programme in nuclear engineering

As a joint effort to maintain and further develop a high quality programme in nuclear engineering in Belgium, the Belgian Nuclear Higher Education Network (BNEN) has been created in 2001 by five Belgian universities and the SCK•CEN.

In the framework of the new architecture of higher education in Europe, the BNEN created a 60 ECTS "Master of Science in Nuclear Engineering" programme. To be admitted to this programme, students must already hold a university degree in engineering or equivalent education

The BNEN programme is given in the table below:

	ECTS
Nuclear energy: introduction	3
Introduction to nuclear physics	3
Nuclear reactor theory en experiments	8
Nuclear thermal-hydraulics	6
Operation and control	3
Reliability and safety	3
Nuclear fuel cycle and applied radiochemistry	3
Nuclear materials I	3
Nuclear materials II	3
Radiation protection and nuclear measurements	6
Advanced courses	4
Project and internship:	15
Total	**60**

(ECTS stands for "European Credit Transfer and Accumulation System", 1 unit corresponds to approximately 10 learning hours)

More information can be found on the BNEN Internet site:
http://www.sckcen.be/bnen/index.html

The courses are given at the SCK•CEN in Mol. This gives the students the opportunity to see the installations. A number of practical exercises are performed with the BR1 reactor. The SCK•CEN is also responsible for the secretariat of BNEN.

The SCK•CEN offers two more specialized courses for nuclear operators. One is a course in radiological protection and health physics instrumentation intended for operating personnel. This course is regularly followed by personnel of the Belgian nuclear power plants. The second course is an advanced course on nuclear emergency planning. This course is organized annually. The current edition of this course is set up in collaboration with the main European actors and in the framework of developing a supranational training programme as formulated by the European platform on emergency and post-accident preparedness and response initiated by the partners in the FP6 project EURANOS (European approach to nuclear and radiological emergency management and rehabilitation strategies, (www.eu-neris.net). One of the objectives of this platform is to maintain and enhance knowledge and competence through emergency exercises, training and education, thus fostering best practice in emergency response.

Parallel efforts were also made to create a European network of academic institutions active in nuclear engineering education, to establish links with the International Atomic Energy Agency (IAEA), with the Nuclear Energy Agency of the OECD (NEA), and other international bodies like the World Nuclear University (WNU).

Today, the European network has been established as an international association of about twenty universities co-operating with the European stakeholders (industry, regulators, research centres), and is strongly supported by the European Commission. Its name is ENEN (European Nuclear Education Network). It is legally based at the premises of the "Institut National Supérieur des Sciences et Techniques Nucléaires" (INSTN) at Saclay, and BNEN is the Belgian pole of this network. Students registering to any of the participating institutions are offered the opportunity to coherently take a part of their basic nuclear education at different places in Europe while cumulating credit units. Practical laboratory sessions and advanced subjects taught in a modular way are also offered to enrich the programmes. Thanks to ENEN, several courses organised by the BNEN consortium are taken by a significant number of foreign students.

II.H. Article 12. Human Factors

Each Contracting Party shall take the appropriate steps to ensure that the capabilities and limitations of human performance are taken into account throughout the life of a nuclear installation.

Accounting for human factors at the design stage is discussed in Article 18 of the present National Report. The text below is centred on human factors during the operational period of the power plants.

II.H.1. <u>NPPs Licensee (Electrabel) Human Performance Programme</u>

II.H.1.a. Double approach for Human performance

As already mentioned in article 10, the human performance policy is based on two approaches:

- A bottom-up approach:
  Analysing errors and malfunctions is a basis for continuous improvement. Root cause analysis cover both technical aspects and human factors in order to reinforce defence barriers. Such an analysis therefore:
    - Highlights and explains all deviations linked to an event
    - Identifies the real and potential consequences of these deviations
    - Defines the corrective actions to be implemented to avoid recurrence of the event
- A top-down approach:
  The top-down human performance approach is based on leadership, values, change management and organisational behaviour.

  The focus is to ensure the integration of good safety behaviour and use of human error reduction tools (HU tools):
    - <u>Management expectations</u>: The HU tools are embedded in the Management Expectations booklets, specific procedures and execution aids (e.g. pre-job documents, work permit, observation forms, etc.). Films were made to clarify specific expectations (e.g. for alarm management in the control room).
    - <u>Tasks observation</u> : Managers and supervisors frequently conduct task observation in the field in order to:
        - Reinforce management expectations, including human performance, by valuing the appropriate behaviour and correcting deviations.
        - Identify and correct deviations.
        - Reinforce contacts with the field
    - <u>Communication:</u> Specific HU communication is achieved by using electronic Public Address display, newsflashes, films, magnetic posters and during training sessions.
    - <u>Training</u>: Workshops and training for leaders and teams have been delivered to enhance leadership and coaching skills. After the initial Human Performance training, the HU training was embedded into initial training, control room training and field simulator training. HU also became part of the improved self assessment approach, making the link with operating experience thus closing the learning loop (with special attention for using observation results).

While the HU tools are common at site level, the way to apply them in practice has been described specifically for the main jobs (operator, chemist, electrician,…).
Both Electrabel NPP Staff and contractors are trained in the use of the Human Performance Tools and are coached in the use of these tools both in the field and on the human performance simulator that relies on human performance tools, safety culture awareness and tasks observation.

II.H.1.b. Human performance action plan

Doel NPP and Tihange NPP have established a human performance (HU) improvement plan for the period covering 2006-2010. This plan is built around three elements:

- Clarifying Management expectations: the HU tools are embedded in the Management Expectations, specific procedures and execution aids (e.g. pre-job documents, work permit, observation forms, etc.). Films were made to clarify specific expectations (e.g. for alarm management in the control room).
- Execution support: coaching in the field was originally organized for supervisors and teams to facilitate the application of HU tools in practice. There will be a gradual transition from coaching by external experts to coaching by internal supervisors and managers.
- Consolidation: after the initial Human Performance training for leaders and teams, the HU training was embedded into initial training, control room training and field simulator training (the human performance simulator). HU also became part of the improved self assessment approach, making the link with operating experience thus closing the learning loop (with special attention for using observation results).

Specific HU communication is achieved by using electronic Public Address display, newsflashes, films, magnetic posters and during training sessions.

While the HU tools are common at site level, the way to apply them in practice has been described specifically for the main jobs (operator, chemist, electrician…).

Both Electrabel NPP Staff and contractors are trained in the use of the Human Performance Tools and are coached in the use of these tools both in the field and on the human performance simulator.

II.H.1.c. Use of human error reduction tools (HU tools)

The focus is to ensure the integration of good safety behaviour and use of human error reduction tools (HU tools):

- Situation awareness: includes workplace screenings, questioning attitude, anticipation and time-outs (pause before starting an activity if anything is uncertain)
- Self-control: revolves around the STAR concept of 'Stop-Think-Act-Review'..
- Pre-job briefings: interactive dialogues that cover the task to be carried out – taking into account experience, risks and error precursors, as well as the worst-case scenarios. In some cases Pre-job briefings are referred as "Tool box meetings".
- Post-job debriefings: reporting that a task is completed, notifying any abnormality, reviewing the paperwork fully and highlighting lessons learned (input for operating

experience and optimization of procedures).

- External verifications on practices: peer checks, concurrent and independent verifications to safeguard quality and safety
- Effective communication: taking into account basic principles of good communication (such as informing all parties involved), favouring direct dialogues, securing understanding by three-way communication, phonetic alphabet.
- Careful decision-making: includes anticipating, evaluating options, checking assumptions, conservative decision taking and thinking as a team.
- Intelligent use of procedures: making sure that procedures are correctly understood and applied in practice. In case of doubt, one stops and changes are only made after appropriate consultation and red-marking.

II.H.1.d. Operating experience feedback

Operating experience feedback is communicated as extensively as possible and integrated as soon as possible into the relevant training courses.

II.H.1.e. Task observations

In addition, task observations are held in order to:

- Reinforce management expectations, including human performance, by valuing the appropriate behaviour and correcting deviations.
- Identify and correct deviations.
- Reinforce contacts with the field.

II.H.1.f. Human Performance Simulator

Tihange and Doel NPP are equipped with their own "human performance simulator". This training facility is considered among worldwide nuclear operators as an excellent training tool to model safety behaviours (good practice OSART). This training model comprises essentially all important parts that are typical for an intervention in a nuclear installation like:

- A dressing room: to prepare entrance and exit of a nuclear zone with appropriate suits, including clothes, dosimeter, and contamination checking before and after intervention.
- A briefing space: where teams can prepare preliminary works or give some orders before an intervention exercise.
- A tool store: to store necessary tools, or spare pieces
- A radioprotection room: located next to the entrance of the nuclear zone, where staff can find a radioprotection supervisor, and contamination monitors..
- An electrical room: local with electrical board and batteries.
- A control room: with control panel from which staff can operate equipments.
- A mechanical room: where mechanical equipment such as pumps, valves, tanks, etc… is present.

Trainees enhance their safety attitudes and behaviour by responding to simulated problems and changing conditions being encountered during an intervention. Different scenarios of intervention have been developed for training purposes. Trainees are recorded on video and followed by instructors to coach them and improve their safety behaviours.

II.H.2. Research Reactors

In 2007 a number of events occurred at the SCK•CEN, mostly at BR2, which indicated weaknesses in safety culture. The SCK•CEN reported these precursor events to the authorities and ordered an internal and external audit on safety culture. Based on both audits, an action plan for improvement of safety culture was launched. The main themes of the action plan concentrated on safety training, knowledge management and organizational aspects. The content of the action plan was discussed with the authorities and a regular follow-up was foreseen.

Organizational aspects

Training programmes and knowledge management are centralized in one service, the expert group communication, education and knowledge management. Training programmes with safety aspects are defined in cooperation with the health physics and safety expert group.

Training

According to the action plan on safety culture, training was given on safety, with special attention on reporting of incidents and unusual events. Most of the training is given in-house, but external training is possible. For BR2 operators, two weeks training per year is foreseen. Training on a simulator, as is the practice in power plants is not possible for BR1 or BR2. However, even BR2 has at least 5 to 6 reactor starts per year. Meanwhile, there are regularly measurement programmes for which the reactor is made critical. In this way operators are for a great deal trained on the job. During the last years, practical training for the BR2 operators was given at foreign research reactors (AZUR in Cadarache, France and the TRIGA reactor of the technical university of Vienna, Austria). In 2009 the operators received also a number of training days at the nuclear power plant of Doel. Training requirements for personnel of BR1 is less formalized. The number of operators for BR1 is very limited and the reactor is not operated outside normal working hours or during holiday periods

Knowledge management

For an organisation with an operating experience of more than 50 years, knowledge management is an important issue. People present at the start of the installations are no longer available. Being a research environment, a number of modifications are made and new experiments are set up. An action is taken to collect all design documentation of the installation and make it readily available. For person with a key function a replacement person must be available, with an equivalent knowledge or with capacity to get this knowledge quickly.

II.I. Article 13. Quality Assurance

Each Contracting Party shall take the appropriate steps to ensure that quality assurance programmes are established and implemented with a view to providing confidence that specified requirements for all activities important to nuclear safety are satisfied throughout the life of a nuclear installation.

II.I.1. NPPs

As the USA safety rules were applied for the 4 most recent Belgian units as early as at their design stage, 10 CFR50 Appendix B requirements were adopted for these units, as well as the ASME code quality-assurance stipulations for pressure vessels. Also taken into account were the 50-C-QA codes and the resulting safety guidelines (including 50-SG-QA5) developed in the scope of the IAEA's NUSS programme.

At the time of putting into service the Doel 1 and 2 and Tihange 1 units, i.e. 1974-1975, that level of quality-assurance formalism was not yet required. However, during the 1st periodic safety review of these units, the request was formulated to apply to them the same quality-assurance rules as were applied to the more recent units: accordingly, any new installations, modifications, repairs and replacement at the earlier units were from 1985 on made consistent with the formal QA requirements.

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 their start-up tests.

While following the evolution of the international practices, Electrabel evolved from its quality assurance system during operation to a quality management system, in September 2006. This management system includes the previous applicable quality assurance system. The elaboration of the quality management system was based primarily on a general safety requirement published by the AIEA (GS-R-3: "The management System for Facilities and Activities", 2006).

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

II.I.1.a. 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.

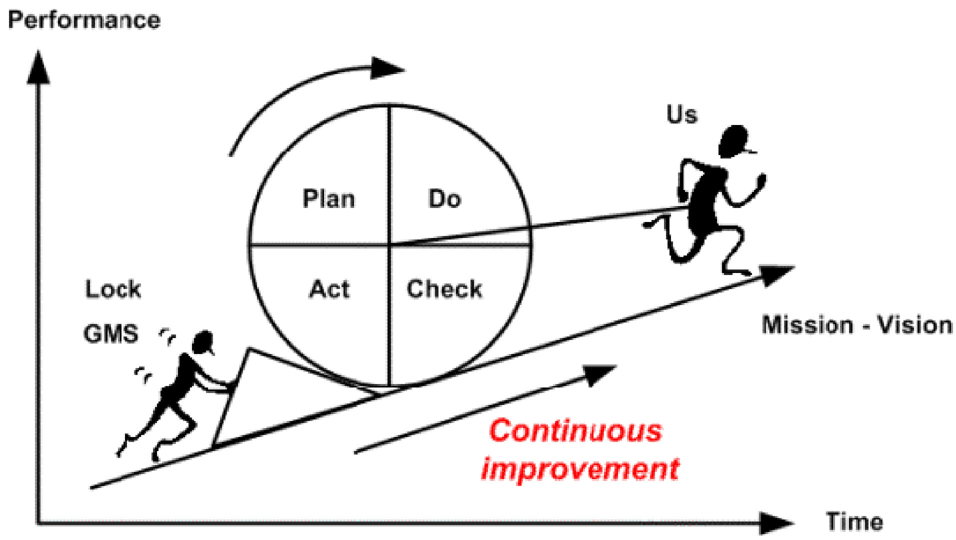
These equipment, components, structures and activities are known as Quality Monitored items. Quality Monitored items are identified in the Safety Analysis Report of each unit.

II.I.1.b. Quality Management System

II.I.1.b.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.



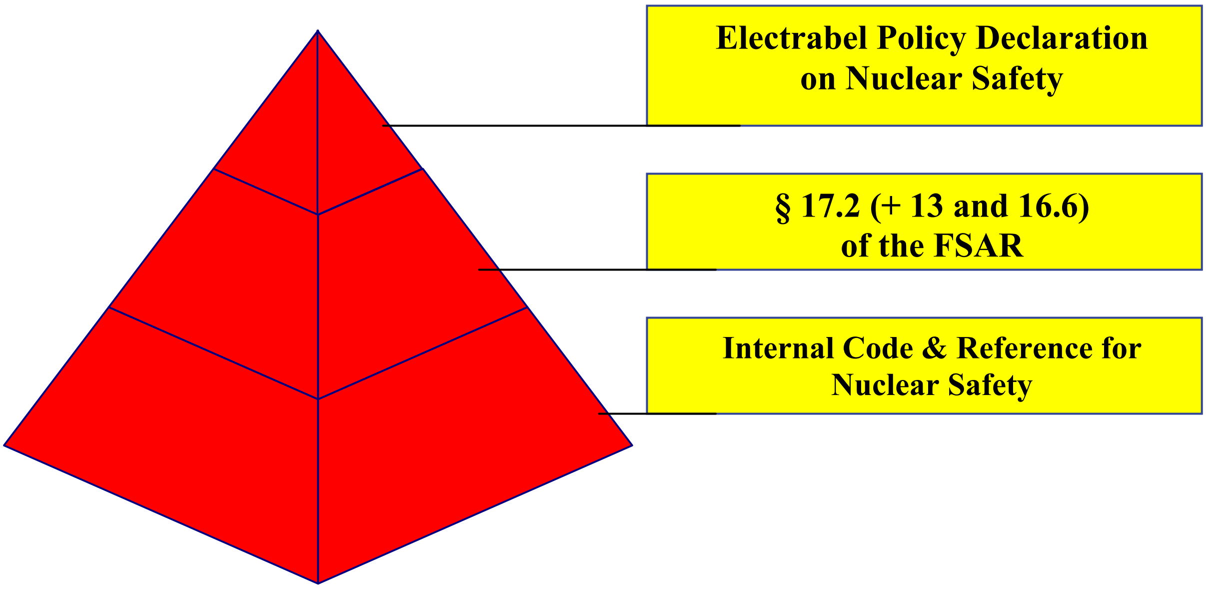
The management system also integrates the provisions of the following regulatory requirements and guidance:

- 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

II.I.1.b.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



II.I.1.b.3) Nuclear Safety Policy Chart

Protecting all staff members involved in the operation of a power plant, as well as the surrounding population and environment, is of the utmost importance. That is why a power plant actively promotes a strong nuclear safety policy at all levels of the plant.
Electabel Policy for Nuclear Safety follows the Plan-Do-Check-Act principles of continuous improvement. It is implemented in collaboration with the site's partners, suppliers and contractors. This policy is detailed in Article II.F.1

II.I.1.b.4) 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

II.I.1.c. 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.

II.I.1.d. 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.

II.I.1.e. Periodic Evaluation

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 Agency (AIA) 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.

II.I.2. Research Reactors

The SCK•CEN has a formal quality assurance system which includes a number of services such as the production of radioisotopes and the irradiation of silicon for which the system is certified. However the formal QA plan is introduced up to level of the operation of the reactors. From the point of view of QA, all operational procedures are considered as work instructions. This has the advantage that procedures can updated more quickly

II.J. Article 14. Assessment and Verification of Safety

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

(i) comprehensive and systematic safety assessments are carried out before the construction and commissioning of a nuclear installation and throughout its life. Such assessments shall be well documented, subsequently updated in the light of operating experience and significant new safety information, and reviewed under the authority of the regulatory body;

(ii) verification by analysis, surveillance, testing and inspection is carried out to ensure that the physical state and the operation of a nuclear installation continue to be in accordance with its design, applicable national safety requirements, and operational limits and conditions.

II.J.1. Licensing Process

As mentioned in section II.B (Article 6) of this report, the process applied for licensing of the Belgian nuclear power plants was described in previous reports for the Convention. Since the process would no longer be the same today and since many organisations and committees that played a role in this process do no longer exist (being replaced by other organisations and committees), it was judged no longer appropriate to describe this historic information in this report. However, if needed, the reader can find the information in the 2007 report for the Convention (in particular in paragraphs II.B, II.D en II.J.1).

In section II.B.1 of this report, more information can be found concerning an important outcome of the original licensing of the NPPs, being the high level of protection against external accidents (airplane crash, explosion, large fire, toxic gases).

Furthermore, it is worthwhile to note that the Safety Analysis Report (SAR) of all plants are drawn up according to the standard format and content as applied in US, i.e. in accordance to Regulatory Guide 1.70 (revision 2 or 3). This was the case from the very beginning for the four more recent units (Doel 3 and 4, Tihange 2 and 3), while for the older units (Doel 1and 2 and Tihange 1) the SAR was rewritten in this format afterwards, although minor deviations from the standard table of content of RG 1.70 may exist.

More recently, the table of content of the SAR was extended:

- To include a new section (in Chapter 3) on the Probabilistic Safety Assessment performed for that plant (a consequence of the periodic safety reviews).
- To include a new section (in Chapter 3) on the Ageing Management Programme (a consequence of the WENRA Action plan, in particular WENRA Reference Level N.2.8).

The license of the NPPs stipulates that the SAR shall be kept updated throughout the life of the installation so that the SAR exactly reflects its present state.

II.J.2. NPPs

II.J.2.a. Main Results of Continuous and Periodical Safety Monitoring

a. The Decrees of Authorisation of each Belgian unit require a ten-yearly periodic safety review. The general objectives of these periodic safety reviews are as follows:

- to demonstrate that the unit has at least the same level of safety as it had when the licence was granted to operate it at full power, or since its latest periodic safety review;
- to inspect the condition of the unit, devoting more particular attention to ageing and wear and to 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, to propose appropriate improvements.

The first of these periodic safety reviews took place in 1985 for the Doel 1 and 2 and Tihange 1 units. At the time of design of these units, i.e. in the early 1970s, the safety rules were less numerous and less detailed than they were for the later Belgian units that were started between 1980 and 1985. For instance, physical separation was less strictly applied, seismic and post-accidental qualification were less developed, the notion of high-energy line break did not apply to all systems, external accidents were not systematically considered.

The different subjects examined during these periodic safety reviews are detailed in Appendix 5.

These 1st periodic safety reviews were conducted very comprehensively and were an in-depth review of the safety of the nuclear power plants. This made it possible to identify coherent solutions and, at times, to simultaneously solve several problems (an example is the emergency building, i.e., the bunker, of Doel 1 and 2). It also demonstrated that it is even possible to improve strongly design- and lay-out dependent systems of the nuclear power plant: taking into account a higher-intensity earthquake, protection against external accidents, a new reactor protection system...

For instance, at Tihange 1, considering a design earthquake of 0.17 g acceleration (value of the Safe Shutdown Earthquake defined in the safety analysis of Tihange 2 and 3) instead of the original value of 0.1 g used in the design of unit 1, resulted in recalculating with much more elaborate methods the seismic behaviour of all the buildings, and strengthening a number of structures. Also, the resistance to earthquake of many equipment and components had to be reviewed, based on feedback from experience with equipment which had undergone a real earthquake. Similarly, external accidents due to human activity were considered. Other fields included protection against high-energy line breaks, protection against primary system overpressure, improvement of fire protection, improvements of the reliability of systems, more effective training of operators (training centres with several simulators), improvements to the man-machine interface, systematic utilisation of both national and international feedback of operating experience.

Similar steps were followed for Doel 1 and 2. In the design and during the construction of Doel 1 and 2, earthquakes had not been considered as a factor influencing the design requirements, due to the weak seismic activity of the region. For Doel 3 and 4, applying the USNRC rules has imposed a minimum of 0.1 g for the Safe Shutdown Earthquake (SSE). For Doel 1 and 2, the same methodology for defining the SSE has been followed, except the requirement of a minimum value of 0.1 g. The resulting SSE retained for the design has an acceleration of 0.056 g.

As for Tihange 1, this led to a check of the resistance of buildings and equipments. Moreover, to cope with accidents of external origin, a bunkerised and seismically resistant building has been erected, containing so-called emergency safeguard systems, which allow maintaining primary water inventory, ensuring reactor sub-criticality and residual heat removal and coping with accidents like a fire in the electrical auxiliaries building (including the loss of the main control room), the total loss of electric power (external grid and the safety Diesels), the SSE, a high-energy line break.

In this way the safety level of these units was raised towards a level closer to that of the most modern units. All the analyses were conducted according to deterministic safety rules and complemented with reliability analysis of the various systems.

The 1st periodic safety review of the most recent units (Doel 3 and 4, Tihange 2 and 3) and the 2nd periodic safety review of Doel 1 and 2 and Tihange 1 did not require reviewing the design bases, since post-TMI actions had already been taken into account and there had been no major evolution in the regulations during that period.

During these safety reviews, national and international feedback were examined; the results of probabilistic safety studies made for power operation or for shut down states were taken into account, the severe accident consequences were analysed in order to infer prevention and mitigation measures, structural and equipment ageing were evaluated, as well as qualification problems, and the field of accidents that are considered as design-basis accidents was broadened. The PSAs and the analyses of severe accidents resulted in the installation of (autocatalytic) hydrogen recombiners inside the reactor containment for all units.

The second periodic safety reviews of the most recent units (Doel 3 and 4, Tihange 2 and 3), and the third periodic safety review of the oldest ones (Doel 1 and 2, and Tihange 1) include two sets of topics: the first one is made of topics common to all units ("fleet approach"), the second one addresses aspects specific to one unit.

All these periodic safety reviews include two parts: one part "studies", another part "implementation" of the results of the studies.

A large number of modifications have been made on the first Belgian units. The most important modifications resulting from these periodic safety reviews are indicated in Appendix 1 of this Report, in the description of each unit.

b. During operation of the installations, experience feedback leads the operator to envisage modifications of the installations or launch major projects such as replacement of the steam generators or power increase. These activities are carried out in addition to those related to the periodic safety reviews.

The proposals for modifications to the installations are examined by the Health Physics Department of the operator, who discusses them with the Bel V inspector. Each proposal is classified into one of the three following categories:

- Major modifications that change the basic characteristics of the unit. These modifications are subject to the application for a licence under the provisions of Article 6 of the GRR-2001. A major modification requires a new license application, and follows a licensing scheme similar to that described section II.C.8 : The safety analysis performed

by Bel V is presented to the FANC. The results of this analysis are presented to the FANC's Scientific Council, who will produce its conclusions on the acceptability of the modification and will propose additional operational conditions. A new Royal Decree of Authorisation is prepared by the FANC and finally signed by the Minister of Home Affairs and the King. The implementation of that modification will be authorised by the Health Physics Department. Bel V verifies the conformity with the Royal Decree of Authorisation.
Examples of such modifications are a power increase of the reactor, steam generator replacement, utilisation of MOX fuel.

- Less important modifications that have a potential impact on safety. In a first phase, the requesting department of the licensee, indicating the justification for the intervention, presents a proposal for modification. In a second phase, the proposal is examined on its technical merits, and later on also by a multidisciplinary team including a.o. the Health Physics Department. After approval by the departments involved, the proposal is submitted to the management of the licensee, who can decide to continue final studies for the proposed modification. In the next phase, studies are completed and approval of both the Health Physics Department and of Bel V is sought to prepare the implementation of the modifications. The proposal is thus also examined by the inspector of Bel V, and by Bel V's technical responsibility centres, which may result in amendments being requested to the modification file. Further activities then imply the implementation, and testing of the modifications. Commissioning of the completed modification is subject to a positive delivery report, issued after validation of the modification and re-qualification of the portion of the installation that was modified, plus updating the operational documents. The Health Physics Department formally approves of the modification when all the files, procedures and the Safety Analysis Report have been adequately updated and Bel V can then issue a final delivery report. Such modification can either be hardware modification or organisational modification.

- Modifications without impact on safety, that usually do not imply modification of the Safety Analysis Report and which comply with all the safety rules of the installation.
  These modifications have to be approved only by the Health Physics Department of the unit, without formal involvement of Bel V, except for the possible pages of the Safety Analysis Report to be updated.

c. Certain studies relating to the modifications or initiated in the scope of the periodic safety reviews were so substantial that they had to be tackled as projects having their own specific structure.

- Severe accident analysis addressed several aspects: ultimate strength of the containment in case of internal overpressure, installation of autocatalytic recombiners to prevent containment hydrogen build-up (installed in all the Belgian units), feasibility studies to install containment venting systems, reactivity accidents during operation and during shut down states.
- Power increase and burn-up cycle extension studies led to redefining the key parameters for the power capacity studies and accident analysis.
  Mixed core composition (presence in the core of fuel assemblies from different suppliers) also had to be taken into account, requiring detailed studies regarding mechanical, neutronic and thermal-hydraulic compatibility. Fuel cycle extension led to higher burn-up

and made it necessary to obtain more in-depth studies of the thermal-hydraulic behaviour of fuel rods in normal operation and during limiting transients.
In case of significant power increase, the capacity of the various systems also needs to be re-assessed.

- Studies related to the utilisation of MOX fuel consider the same questions as those involved in the power increase mentioned here above.
- Replacement of the steam generators, whether or not linked to a power increase, often implies a larger heat exchange surface between the primary and secondary systems, a modification of the primary and secondary inventories, and changes in piping layout.
  This requires review of the analyses of transients, accidents and capacities of the systems. In case of a power increase, all the above mentioned studies also have to be repeated.
- Replacement of technologically obsolescent systems mainly addresses the instrumentation and control systems, as new equipment most often includes software the qualification of which has to be demonstrated for safety-related functions.
- The utility has set up an integrated ageing management system, in order to assure that, among other, safety related structures, systems and components remain qualified within their defined service life. Main issues are maintaining the qualification and anticipation of the loss of qualified suppliers and spare parts. The utility uses a methodology which follows the recommendations of the IAEA. The ageing management produces recommendations which are used to define the needed investments in the middle and long term.
- The probabilistic safety analyses (PSAs) for the Doel and Tihange nuclear power plants (NPPs) are performed by Tractebel Engineering (TE), on behalf of the utility Electrabel. Bel V is performing an "on-line" review of the development and the updating of the PSA models and discusses its findings with TE and the utility on an interactive basis. After the issue of the final report by TE, Bel V establishes a PSA evaluation report. At present the PSA level 1 includes power and non-power states, covering about 99% of the operating profile of the NPPs. A wide scope of internal initiating events is covered, including LOCAs, secondary line breaks, transients and loss of particular functions (electric sources, heat sink, etc.). PSA for internal hazards (fire and flooding) has been started recently (in response to the WENRA Action Plan).
  In the past, all level 2 analyses performed for the Belgian NPPs were limited to the analysis of the containment response, with the aim to investigate dominant containment failure modes. No source term analyses have been performed and only power states were covered. In the on-going update of the PSA-studies, a full Level 2 analysis (including analysis of the source term) will be performed, as well for power as for shutdown states.
  The main applications of the PSA are the evaluation of the design as a complementary tool to the deterministic safety analysis, the evaluation of the accident management and the PSA-based event analysis.
  As an example of the results of the first level 1+ PSAs performed for the Doel 3 and Tihange 2 plants, one can mention the installation of catalytic hydrogen recombiners in the containment, for all 7 nuclear power plants.
  Since many years, PSA-based event analysis has been integrated in Bel V's operational experience feedback process, focussing on the quantitative importance of well-selected operational events and on the subsequent identification of potential safety issues, using the best-estimate case as well as relevant what-if questions. More recently, also the licensee has started to perform such analyses of operational events.
  An action plan for the further development of PSA applications for all nuclear power plants has been set up on the basis of the WENRA reference levels and its implementation is going on.

- Taking into account the evolution of knowledge and of the available analysis tools, a framework of generic studies has been defined. The aim is to define in detail analysis methodologies that can be applied to all units. Topics of interest are for example the calculation of radiological consequences of a feedwater line break accident, of a steam generator tube rupture, of a steam line break accident, or the analysis of the risk linked to sump strainers clogging. In the frame of these generic studies, a position paper on the practical application of the single failure criterion in safety analysis has been produced.

II.J.2.b. Verification Programmes

The technical specifications (chapter 16 of the Safety Analysis Report) were examined at the time of the licensing process; their amendment during operation falls under the prescriptions for less important modifications that are subject only to approval by the operator's Health Physics Department and by Bel V. These technical specifications are reviewed in the frame of the period safety reviews. They have been completely rewritten at least once during the life of each nuclear power plant.

These specifications indicate 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 inspections and tests to be performed and their periodicity.

Specific programmes are established, in particular for:
- examinations and tests required by the ASME Code.
- inspection and repair of the steam generator tubes.
- fire protection.
- tests of ventilation filters.
- inspection of the primary pump fly-wheels.
- examination of irradiation samples of the pressure vessel.

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 or experience feedback of similar equipment, so defining the qualified life of the equipment. The qualified life determines the frequency of replacement of that equipment, which can be re-assessed in function of the real operation conditions and location of that equipment.

The reactor coolant pressure boundary is treated in a specific way. It was originally designed to ensure a minimum useful life taking into account a limited number of transients during normal, incidental and accidental operation. As for the reactor vessel, it is monitored according to the transition temperature evolution (NDT) based on an irradiated samples withdrawal programme. The occurrence rate of the design transients is strictly recorded under the close supervision of Bel V.

With regard to all passive components important to safety on one hand, and the components important for the availability of the plant on the other hand, it is foreseen to make the component inventory and to follow in a systematic way all phenomena which have an impact on the lifetime of these components.
An In-Service Inspection programme is permanently implemented by personnel specifically qualified for these inspections, which are carried out during power operation of the unit or in shut down states.

All these tests and inspections are performed under fully detailed documented procedures.

II.J.3. Research reactors

II.J.3.a. Main Results of Continuous and Periodical Safety Monitoring

During the operational lifetime of the installation modifications may be deemed necessary.

A specific procedure has been established that describes the entire process for the treatment of proposals for modifications. A proposal for modification is first submitted to the Health Physics Department for examination. If the proposal is acceptable for the Health Physics Department, the proposal will be classified as an important modification, a non-important modification or a small modification. Except for the small modifications the Health Physics Department will propose the attributed classification to Bel V for approval.

Small modifications will be approved solely by the Health Physics Department but will be reported to Bel V on a regular basis. Major modifications are subject to the application for a license under the provision of article 6 of the Royal Decree of July 20th 2001. Non-important modifications will be examined and approved by both the Health Physics Department and Bel V. The Safety Authorities will be informed of this approval by Bel V.

Experimental devices are not considered as modification of the reactor. A dedicated step wise approval system is developed. The experiment is at first discussed in an internal advisory committee. Based on the advice, the experiment has to be approved by the Health Physics Department and Bel V has to confirm this decision.

The installations of the SCK•CEN are also subject to periodic safety reviews.

According to the licence for operation of the SCK•CEN installations, the reactors BR1 and BR2 have to undergo a 5 yearly safety review. The result of this review has to be reported to the authorities. In 2009 the periodicity of the safety reviews was changed by royal decree to 10 years, as is the practice for nuclear power plants.

II.J.3.b. BR1

The last safety review of BR1 included four topics:

- A programme for the modernization of the fixed radiation monitoring systems has been defined.
- A seismic qualification has been performed. The reactor can withstand an earthquake that is expected with a frequency of one every 10.000 years. The main issue was to prove that the loose staked graphite pile would remain intact and would not show displacements that could prevent the fall of a control rod. This point could be proven.
- A few years ago an increased iodine release, still within operating limits, was observed. A number of fuel channels were unloaded and some failed fuel elements were found. An investigation programme was started in order to find the root cause of these failures. These can be attributed to the long time slow interaction between the metallic uranium and the aluminium cladding.

- The study of the consequences of a full electrical black out. Although the reactor needs no active cooling after scram, one loses the readings of the instrumentation and it is difficult to have a good knowledge about the situation. Therefore the number of instruments connected to the battery back up system will be increased.

II.J.3.c. BR2

BR2 underwent from 1995 to 1997 a thorough refurbishment. The second beryllium matrix was nearing its end of life at that time and it was decided to replace it. A matrix was available from a zero power mock-up of BR2, called BR02, which was no longer in use. This BR02 matrix was fully qualified for use in BR2 and could be used for BR2 without any problem. According to the licence the matrix has to be inspected on regular intervals to follow cracking. Due do neutron irradiation gases (helium and tritium) are formed in the beryllium. This causes swelling and the initial space between the beryllium blocks will be consumed and blocks will make contact between each other. The cracks are caused by deformation and mechanical stresses. The licence specifies that the beryllium matrix must be replaced if the inspection indicates that there is a risk of losing material. At the latest, the replacement must be done if the fluence reaches 6.4×10^{22} fast neutrons per cm^2 for the most irradiated channel.

In case of replacement of the matrix, an inspection of the vessel is also required by the licence. In fact, this is the only occasion when the vessel wall is accessible. For the inspection of 1996, a fracture mechanical calculation of the vessel was made. However, the vessel is made of aluminium 5052-0 alloy. Knowledge about this material in irradiated condition is limited. Therefore it was decided to cut a number of samples out of the shroud, which is made of the same material and has received nearly the same irradiation dose. Out of these samples, tensile and fracture toughness test pieces were made. Some samples were immediately tested. The others were loaded in irradiation baskets in the reactor and a number of them will be tested on predefined time intervals. In this way a material follow-up programme for the vessel is established. The latest tests were done in 2006. The conclusion of these tests was that the material of the vessel has a sufficient mechanical resistance to at least mid 2011. A that time a set of new samples need to be unloaded and tested.

During the lifetime of BR2 various systems were replaced. The last important modernization was the replacement of the control rod drive mechanisms with the position indicators included and the replacement of the cadmium neutron absorbers by hafnium.

II.K. Article 15. Radiation Protection

Each Contracting Party shall take the appropriate steps to ensure that in all operational states the radiation exposure to the workers and the public caused by a nuclear installation shall be kept as low as reasonably achievable and that no individual shall be exposed to radiation doses which exceed prescribed national dose limits.

II.K.1. Regulations

Chapter III of the GRR-2001 deals with radiological protection.

Article 20 of this Royal Decree sets among others the fundamental principles: justification if the practice, optimisation of protection and individual dose limits. Other Articles of that chapter are described in Article 7, section II.C.3 of the present National Report.

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 radiological protection.

II.K.2. Design

Chapter III "General Protection" of the GRR-1963 introduced from the very beginning in Belgian law the radiological protection principles.

Belgian nuclear power plants design was done according to that legislation and, furthermore, consistent with the US regulations and in particular 10 CFR50 Appendix I and the related Regulatory Guide 1.21. In fact, as demonstrated in the Safety Analysis Reports of Belgium's units, the objectives of the US regulations were amply met, considering that the doses to the population computed according to the US rules are smaller by a factor of at least 3 than the criteria prescribed by these rules.

The releases limits, in annual average or in instantaneous value, were presented in the Report to the European Commission (application of article 37 of the Euratom Treaty) and are discussed in the Safety Analysis Report (chapter 11). Let us bear in mind that at the Belgian units the liquid effluents are released via one single pipe that groups the primary and secondary effluents and which is redundantly and automatically isolated in case an instantaneous limit is exceeded.

II.K.3. NPP Operation

II.K.3.a. ALARA Policy

Operational radiological protection programmes are inspired from chapter III of the GRR-2001 and from IAEA NS-G-2.7 (2002). Those programmes cover among others:
- Protective clothing and equipment,
- Training,
- Monitoring of individuals and workplace,
- Emergency plan,

- Health surveillance,
- Optimisation of protection,
- Etc.

The evolution has been taken into account, e.g. the introduction of the recommendations of the ICRP documents and the implementation of the Directive 96/29/Euratom into the Belgian regulations.

To anticipate the implementation of these regulations the licensee has, on a voluntary basis, limited the individual worker dose at about the half of the dose limit (20 mSv for 12 consecutive months, in accordance with the GRR-2001).
Protection of the public is assured through limitation of the radioactive liquid and atmospheric releases. Those limits are presented in the Report for the European Commission (application of article 37 of the Euratom Treaty) and are discussed in the Safety Analysis Report (chapter 11), allowing to get maximum dose to the individuals of the critical group well below 1 mSv per year.

II.K.3.b. Implementation of radiation protection programmes

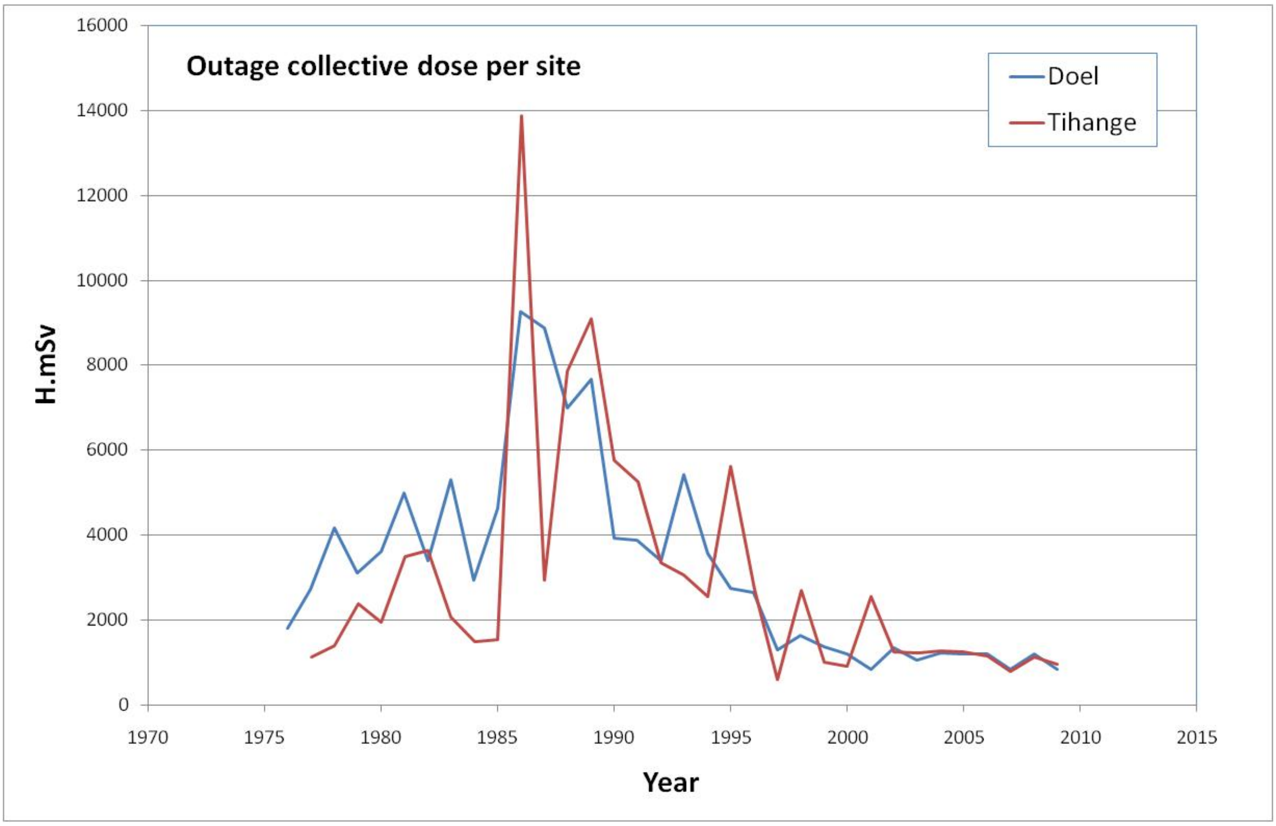
Dosimetric results

Various measures have been taken over the years to reduce the annual collective dose: the average value for the 7 Belgian units has been reduced by a factor of more than 4 during the 1990-2009 period.

The figure below represents the evolution of the outage collective doses of the Doel and Tihange sites since 1974.

The rise between 1974 and 1985 corresponds to the progressive start-up of the new units. The Tihange peak in 1986 is due to the extensive works linked to the first periodic safety review.

As the Tihange units operate along cycles up to 18 months, the number of refuelling outages varies from one year to the other, what introduces variations on the annual collective doses. Another factor of variation is the cumulated dose due to the replacement of steam generators. The introduction of an outage cycle of 18 months for Doel 4 in 2009 did not induce any significant variation in annual doses for the Doel NPP.



With those dose figures, Doel NPP ranks amongst the WANO best quartile for the Key Performance Indicator (KPI) Collective Dose Exposure (CRE) since a long time ago. Additional effort provided by Tihange NPP allowed to join this group late 2008.

Individual exposure amounts to an average of ~ 0.5 mSv per year. The dose constraint of 10 mSv was not exceeded anymore since 2006.

Good radiation protection performances are achieved through the optimisation of several parameters, whose main ones are briefly discussed below:

- The source term (dose rate and contamination),
- The time of exposure,
- The monitoring of working places and individuals,
- The distance from the source term,
- The protective means (shielding and protective clothes).

Reduction of the source term

The primary system chemical conditioning procedure applied in preparation of the core refuelling outages proved to be very effective to reduce the dose rates induced by the contaminated systems: a continuous decrease in mean dose rates has been recorded for the primary loops. This procedure was developed thanks to operational experience feedback from pressurised water reactors.
During the period 2007 – 2009, Electrabel investigated the possibility to decrease the source term of plants characterized by higher figures than the average. Therefore Doel NPP plans to initiate Zinc injection into the primary fluid of Doel 3 from 2010.

Since the year 2000, statistics of fuel failures seems to indicate a slight increasing trend with time. Therefore Electrabel decided to put additional effort aimed at preserving the integrity of the 1st and 2nd barrier :

- Pay a special attention to the fuel assemblies quality,
- Develop an intensive Foreign Material Exclusion (FME) programme ,
- And develop an intensive programme of leakages tracking.

Finally, still during the period 2007 – 2009, special effort was put on the improvement of the radiological cleanliness of the workplaces, connected to the associated monitoring (see below).

Monitoring of the working places and individuals

Systematic measurement is done daily of the surface contamination of the floors in representative locations during the outage. Immediate decontamination action is taken should a problem be detected. Effectiveness of the housekeeping activities inside the controlled area is pursued. Additional portable means for measuring the volumic activity (aerosols, iodine, gases) are placed at the pool floor of the reactor building and at the access locks to the steam generators.
During the period 2007 – 2009, Electrabel improved the monitoring of the radiological cleanliness, covering the monitoring of the radiological cleanliness of the (un)clean working areas, monitoring of the contaminated individuals at the exit of radiation controlled area (RCA) and the tracking and elimination of the cause of contamination.

Signalling of the hot points and the ambient dose rates informs the workers about the ambient radiological conditions in which they will carry out the work: access is denied to certain locations without specific permission of the Radiological Protection Department, specific ALARA signals that forbid remaining stationary, signalling of very low dose-rate areas (“green” area) which the workers may use as an identified falling-back station.
Personal dosimetry of the workers is achieved through the simultaneous wearing of a passive and an active (electronic) dosimeters. The latter one is set up in order to alert the worker in case excessive dose and dose rate, depending on the type of work. Throughout the outage period, the actual-versus-estimated dosimetry trends are monitored daily, and any significant deviation is analysed and may result in corrective actions.

Protective means
Shielding is systematically installed at various locations during core refuelling outages: primary pump cell floor, between steam generator and primary pump, around pressure vessel-head on its stand, vessel-well decompression piping, corridor at the hot penetrations, places of passage and waiting (access locks to the steam generators...), hand-holes of the steam generators...

Specific shields are also installed when dictated by the size of the work: pressuriser dome, valves, detected hot points...
Protective clothing is foreseen for both regular entrance in radiologically controlled areas and for work requiring breath protection clothing.

Reducing time of exposure

Reducing the time of exposure is achieved through appropriate :

- training in radioprotection and in nuclear safety, making the workers aware of the radiation protection principles,
- pre-job briefing,
- training on make-up facilities,
- experience feedback,
- etc.

Distance from the source

Keeping distance from the radiation source considered in the work preparation and supported by the monitoring system and the related databases (e.g. see above about the "green area").

Large Works

Very substantial work such as relating to steam generator replacement is prepared several years in advance, accurately planning all the operations; any modification to the planning envisaged during execution of the work is translated in terms of estimated dose, and is taken into account in the decision process.

Experience feedback is of great importance to such work: the collective dose that resulted from the replacement of the Doel 3 steam generators amounted to some 1.9 man.Sv in 1993; for the same work in 2001 at Tihange 2 it was 0.648 man.Sv;, i.e. lower by a factor more than 3. A further important reduction has been observed during the Doel 2 replacement where the collective dose due to the steam generator replacement has been limited to 0.195 man.Sv, and finally the recent steam generator replacement of Doel 1 with 0.244 man.Sv.
More details are given in the following table for the different steam generators replacements that took place in Belgium:

	Doel 3	**Tih. 1**	**Doel 4**	**Tih. 3**	**Tih. 2**	**Doel 2**	**Doel 1**
Year	**1993**	**1995**	**1996**	**1998**	**2001**	**2004**	**2009**
Injuries	0	0	0	0	0	1	2
Outage duration (days)	96	93	92	76	63	65	75
SGR duration (days)	>40	31	27	20	17	15	-
Dose due to SGR (man.mSv)	1 955	1 637	633	624	648	195	244
Outage total dosis (man.mSv)	3 169	3 089	1 231	1 086	1 446	409	474

II.K.3.c. Radioactive Releases

Discharges are defined as authorised and controlled releases into the environment, within limits set by the Authority. In addition there are operational release limits (limiting the release on time based assumptions), related with a scheme to notify the operators, the Health Physics Department, Bel V and the FANC.

Following Article 81.2 of the GRR-2001, the existing authorised discharge limits (gaseous and liquid releases) have been re-evaluated since 2002. The evaluation has been formally agreed by the Scientific Council of the FANC in December 2006. These discharge limits, based on this evaluation, respect at least the annual dose to the public of 1 mSv.

The radiological impacts of the releases are given in the following table:

	Calculation of the annual exposure to the most exposed individual resulting from the authorized release limits :			Calculation of the annual exposure to the most exposed individual resulting from the average actual release between 1991-2000 :		
	Gaseous	Liquid	**Total (*) maximum**	Gaseous	Liquid	**Total (*) maximum**
Tihange Site (3 units)	190µSv	80µSv	**210µSv**	47 µSv	2.5 µSv	**49 µSv**
Doel Site (4 units)	180µSv	230µSv	**370µSv**	18µSv	2.3 µSv	**19 µSv**

(*) the Total maximum is not the sum of the dose due to the gaseous release and the dose due to the liquid release because the most exposed individual by each type of release in not in the same age category.

The releases that took place effectively are only a few percent of the limit values, except for tritium where the limit values had been chosen based on the operational experience of similar plants.

	Tihange Nuclear Power Plant				
	Gaseous releases			Liquid releases	
	Noble Gas GBq	Iodine MBq	Aerosols MBq	βγ GBq	Tritium GBq
Annual limit	2 220 000	14 800	111 00	888	148 000
2007-09 average	24 933	62	7	18	48 067
% of the limit	**1.12**	**0.42**	**0.01**	**2.01**	**32.5**

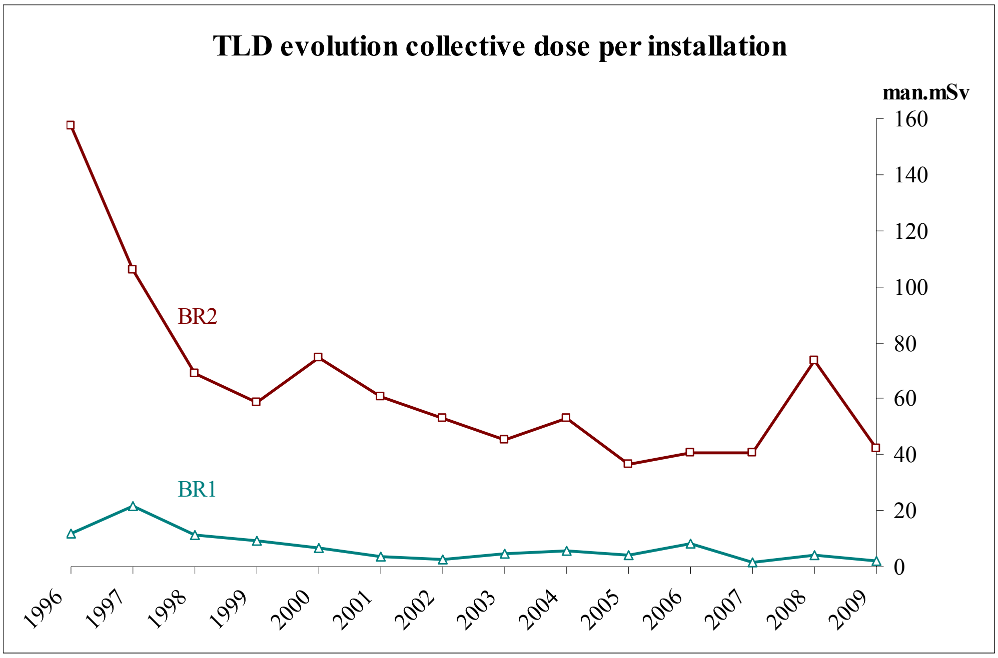
	Doel Nuclear Power Plant				
	Gaseous releases			Liquid releases	
	Noble Gas GBq	Iodine MBq	Aerosols MBq	βγ GBq	Tritium GBq
Annual limit	2 960 000	14 800	148 000	1 480	103 600
2007-09 average	15	52	5	3	49 511
% of the limit	**0.001**	**0.35**	**0.004**	**0.21**	**47.8**

Radiation monitoring of the environment and assessment of public health impact is assured by a programme set up and managed by the FANC, as stipulated in Article 71 of the GRR-2001.

II.K.4. Research reactors

II.K.4.a. Radiation doses to the personnel

The management of the SCK•CEN introduced 10 mSv per year as a dose constraint for the personnel. Beside this constraint the SCK•CEN has an active ALARA policy. Each task with a potential radiation dose is analysed before starting and dose optimisation is performed. Afterwards, the predicted doses are compared with the real measured dose, in order to learn from the experience such that predictions for future tasks can be improved. Due to this ALARA policy, the radiation dose for the personnel has been reduced. During the last years, the total collective dose per year is about 130 man.mSv, for about 600 persons. More important, the maximum individual dose during the last years always has been lower than 10 mSv per year. A collective dose of about 70 man.mSv can be attributed to the operation of BR2. This figure remains fairly constant during the last years. The collective dose for BR1 operation is between 2.5 and 3 man.mSv per year. The main contribution to the dose is the handling of experiments, such as neutron activation analysis and reactor dosimetry



II.K.4.b. Gaseous releases

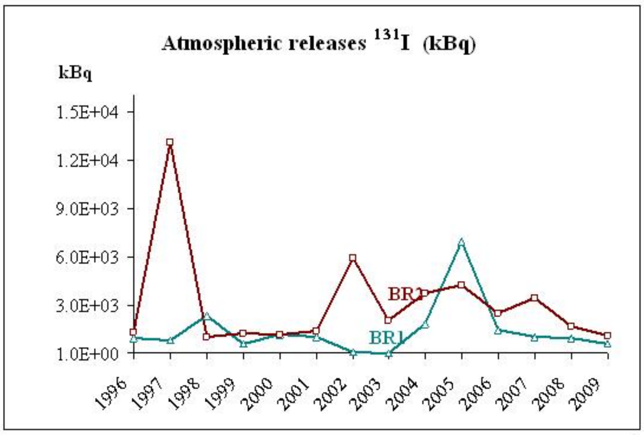
The limits for radioactive gaseous releases were reviewed in 2002, following the implementation of the GRR-2001. The proposal was accepted by the FANC and the limits are integrated in the SCK•CEN Safety Analysis Report. The limits for the releases are defined such that the most vulnerable person in the environment could receive an effective dose of 100 µSv per year due to the operation of the SCK•CEN installations. 10 µSv per year is assigned to the operation of BR1 and 20 µSv per year to the operation of BR2.

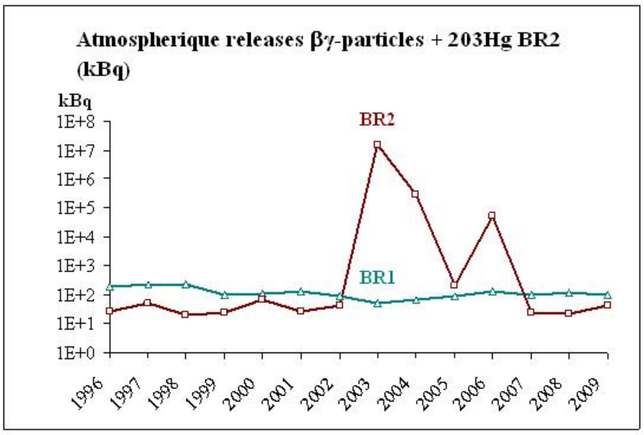
The following gaseous releases are considered:

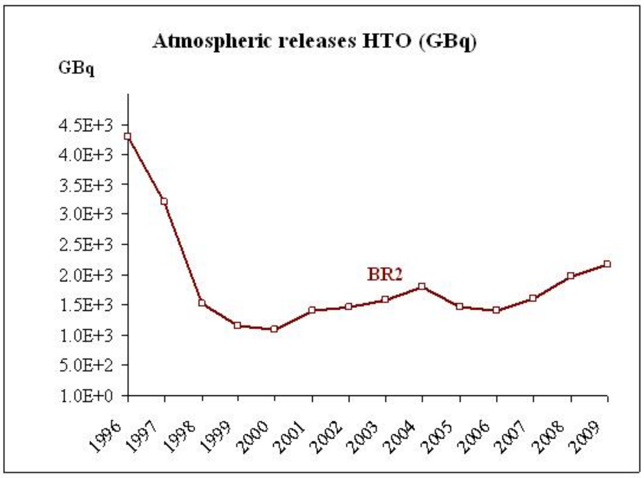
- For BR1: βγ activity of aerosols and I-131.
- For BR2: α activity of aerosols, βγ activity of aerosols, I-131, tritium and noble gases.

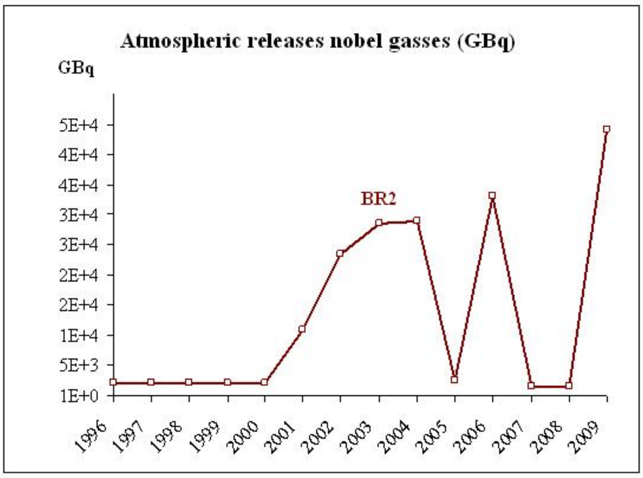
The releases of the last years are indicated in the following figures. The following comments could be made on the releases:

- From mid 2004 an increased release of I-131 was measured at the stack of BR1. This could possibly be an indicator for failed fuel cladding. Fuel channels with the highest thermal load were unloaded and the fuel was inspected. A number of failed fuel elements were discovered. All failed elements were replaced by new ones and since then releases of I-131 have fallen back to normal background levels.
- From end 2002 to 2004, a sharp increase in βγ activity of aerosols from BR2 was measured, although no legal limits have been exceeded. The released isotope was mercury 203, which came from a quartz irradiation ampoule in the hot cell. The ampoule contained fresh irradiated mercury.
- The release level of noble gases in BR2 is normally below detection level. However, there have been a number of air cooled experiments. These caused the release of argon-41 as an activation product.
- The release of gaseous tritium is due to an old experimental device were helium-3 was used as a variable neutron screen. Irradiation with neutrons of helium-3 results in tritium. The installation is still present at the moment, but screens are no longer used with helium-3. However, they give still rise to a release of tritium.
- The years with higher level of iodine release of BR2 were due to periods with a higher failure rate of fuel plates. During the last years the number of fuel plate failures has become very low.









II.K.4.c. Liquid releases

The SCK•CEN has no direct releases of liquid radioactive waste. All potentially contaminated water is sent to the waste treatment installation of Belgoprocess, where the water is treated before release to environment.

II.K.4.d. Environmental control

In addition to the direct stack measurements, 6 air measurement points are available around the site of the SCK•CEN. The α- and β- activity of air samples is continuously measured. Air samples of one of these measurement points is analysed monthly by spectrometry, in order to have an absolute measurement of the air contamination.

Possible water contamination is checked in four different situations: surface water (running water and water from lakes), ground water and drinking water. In routine, the total α- and β-activity and the concentration of tritiated water is measured. On request other measurements are possible.

Regular samples of milk and grass of a neighbouring farm are taken and measured by spectrometry for potential radioactive contamination

II.K.5. <u>International Exchanges</u>

The regulatory body and the Belgian operators participate actively since 1991 in the ISOE (Information System on Occupational Exposure) programme of OECD's Nuclear Energy Agency.
The Belgian NPPs operator is also participant in the working groups of the VGB (Germany).

II.L. Article 16. Emergency Preparedness

1. **Each Contracting Party shall take the appropriate steps to ensure that there are on-site and off-site emergency plans that are routinely tested for nuclear installations and cover the activities to be carried out in the event of an emergency. For any new nuclear installation, such plans shall be prepared and tested before it commences operation above a low power level agreed by the regulatory body.**

2. **Each Contracting Party shall take the appropriate steps to ensure that, insofar as they are likely to be affected by a radiological emergency, its own population and the competent authorities of the States in the vicinity of a nuclear installation are provided with appropriate information for emergency planning and response.**

3. **Contracting Parties which do not have a nuclear installation on their territory, insofar as they are likely to be affected in the event of a radiological emergency at a nuclear installation in the vicinity, shall take the appropriate steps for the preparation and testing of emergency plans for their territory that cover the activities to be carried out in the event of such an emergency.**

II.L.1. Regulatory Framework

The GRR-1963 in its Article 72 has from the beginning required an emergency plan for the regulated installations potentially presenting a serious radiological risk. This document was updated and replaced by the GRR-2001. The Royal Decree of 17 October 2003 defines a nuclear and radiological emergency plan for the Belgian territory.

This text has already been described in Article 7, § II.C.5 of the present National Report.

II.L.2. Implementation of Emergency Organisation in the Event of an Emergency

II.L.2.a. Classification of Emergency

The Royal Decree of 17 October 2003 defines three levels for the notification of emergencies, which are in ascending order of seriousness N_1 to N_3, which the operator must use when warning the "Centre Gouvernemental de Coordination et de Crise - CGCCR" (i.e. the Governmental Centre for Co-ordination and Emergencies) which assembles under the authority of the Minister of Home Affairs. In addition, a fourth notification level ('reflex' level or N_R) has been considered to cope with events with fast kinetics. In case that an emergency situation is quickly developing (fast kinetics) and might lead within 4 hours to a radiation exposure of the population above an intervention reference level, immediate protective actions for the off-site population – without any assessment – are taken by the local authorities (Governor of the Province), waiting for the full activation of the emergency cells. The "automatic" protective actions taken under this "reflex"-phase are limited to **warning**, **sheltering** and **keep listening** within a predefined **reflex zone**. Once the crisis cells and committees are installed and operational, the Emergency Director of the authorities will decide to cancel the reflex phase and to replace it by the proper alarm level. In such case the governor of the province hosting the nuclear site is immediately notified in parallel to the warning message to the CGCCR. For each of these 4 notification levels (N_1 to N_3 + N_R) the notification criteria are defined in the Royal Decree of 17 October 2003. In addition, for each nuclear installation concerned, a set of particular types of events is established for each of the notification levels. In the specific case of the ‘reflex’ notification level, the activation criteria are based on predefined scenarios.

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 environment of the site. Radioactive releases, if any, are still limited and there is no immediate off-site threat (no action requested to protect the population, the food chain or drinking water). Actions to protect workers and visitors on site might be necessary.”

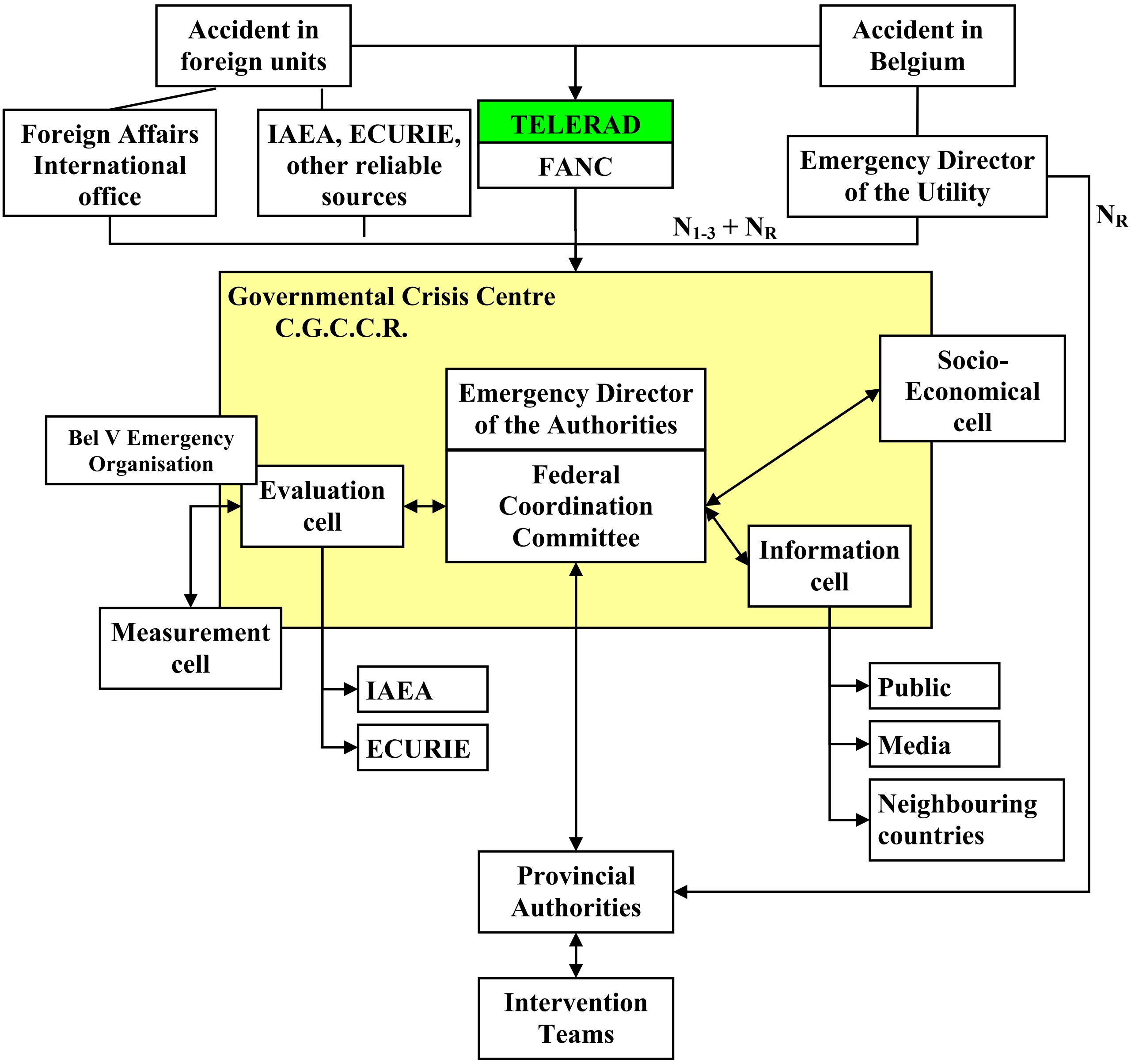
Each of these 4 notification levels (N_1 to N_3 + N_R) activates the federal emergency plan. In addition to these four levels, a “N_0” level is defined for notifying the Authorities in case of an operational anomaly. This last level does not activate the emergency plan.

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

The “Emergency Director” of the Authorities transforms the notification level into an alarm level (U_1 to U_3), putting into action the corresponding phase of the National Emergency Plan. In the case of N_R, the U_R alarm level is automatically triggered and the Governor of the province hosting the nuclear site immediately takes the ‘reflex’ protective actions (warning, sheltering and keep listening) in a pre-defined ‘reflex’ zone around the affected site. As soon as all the CGCCR’s cells are in place and operational, the UR alarm level will be converted to an appropriate alarm level by the emergency director of the authority according to the evaluation of the situation and possible consequences. At that time the responsibility of the conduct of the operations returns to the Federal Minister of Home Affairs (or his representative).

II.L.2.b. National Master Plan for Organisation in the Event of Emergencies

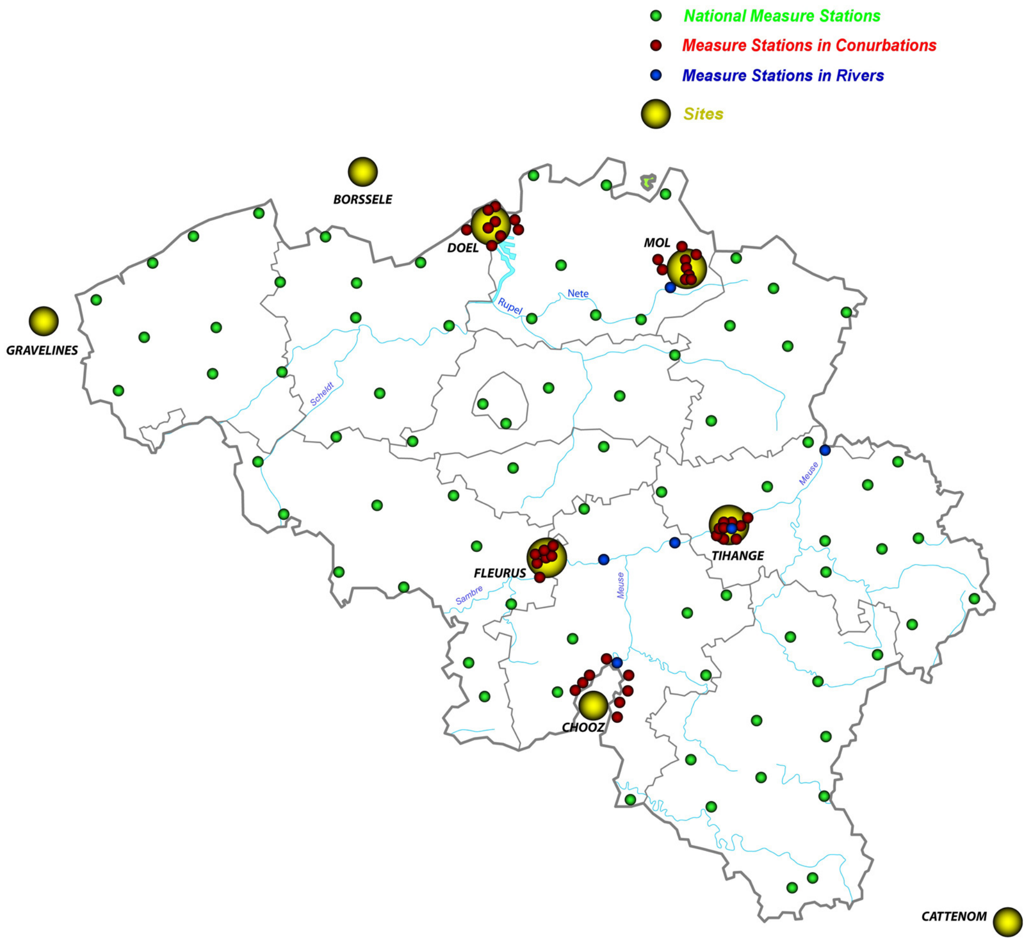
The CGCCR is composed of the “Federal Co-ordination Committee” chaired by the Emergency Director of the Authorities, of the evaluation cell, of the measurement cell, of the information cell and the socio-economical cell, as indicated in the figure below.



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

The data received through Belgium's Telerad network for automatic radiological monitoring can also be accessed by the CGCCR. Telerad is a network with the principal aim to measure routinely the radioactivity and to make measurements in case of an accident occurring in a Belgian nuclear site or abroad. The monitoring of the territory consists in a measurement network having a 20 km mesh, measurement stations in the vicinity of the Belgian nuclear installations and along the Belgian border in the vicinity of nuclear power plants in neighbouring countries. Around the Belgian nuclear sites, the network is arranged in two rings: the first ring 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. Beginning of 2010 there were 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; 13 stations are complemented with a meteorological mast.

The figure below depicts the TELERAD network :



TELERAD network: location of the measuring stations

The TELERAD network is in the process of being completely refurbished in 2010. New GM detectors will replace the old detectors in the existing dose rate measuring stations except around the installation (first ring) where the existing detectors will be replaced by NaI scintillators. A number of stations will be added to the network in order to have a better coverage of the second ring around nuclear sites.
The Federal Co-ordination Committee is the official leader of the conduct of the operation in case of an emergency. It defines the general strategy to deal with the

emergency, takes the basic decisions (need and extent of direct protective actions for the population and/or for the food chain or the drinking water supply) and assumes the political responsibilities. The Decision cell leans notably on the advices of the Evaluation and Socio-economical cells. The decisions taken are then transmitted for practical implementation and execution to the Provincial Crisis Centre, managing all the multidisciplinary intervention teams (fire brigades, civil protection, police, medical emergency services ...).

The evaluation cell is composed of representatives of the relevant departments (in particular the FANC which chairs the cell), the Federal Public Service of Public Health, the Federal Public Service of Foreign Affairs (for accidents abroad), the Department of Defence, the Royal Institute of Meteorology, and of experts of the Mol Nuclear Research Centre, the "Institut des Radioéléments", and of Bel V that supervises these installations, as well as of a representative of the operator of the facility. This cell gathers and evaluates all information received from the affected installation, the off-site radiological measurement results received from the Measurement Cell and information from institutions represented in the evaluation cell. It evaluates the installation status and its estimated time evolution in order to assess the real or potential impact of the event. Then, it advises the decision cell on protective actions for the protection of the population and the environment. This advice is elaborated on the basis of intervention reference levels, issued by the FANC (24 November 2003). The evaluation cell is also responsible for the preparation of the relevant information to be communicated to neighbouring countries and to the international organisations (European Commission, IAEA) in accordance with the Convention on Early Notification of a nuclear Accident and the "Ecurie" convention.

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

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

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

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

The Royal Decree of 17 October 2003 defines the emergency planning zones relative to the direct actions to protect the population (evacuation, sheltering, iodine prophylaxis). These evacuation and sheltering zones have a 10 km radius around the nuclear plants; the stable iodine tablets pre-distribution zones extend to 20 km around the nuclear plants.

The intervention reference levels are set in the Decision of the FANC of 24 November 2003. They are 5 to 15 mSv expected total effective dose integrated over 24 hours e.g. taking into account all direct exposure pathways (cloudshine, inhalation and groundshine) for sheltering, 50 to 150 mSv expected total effective dose integrated over 7 days (1 week), i.e. by taking into account all direct exposure pathways (cloudshine, inhalation and groundshine) for evacuation. For intake of stable iodine, the intervention reference levels are 10 to 50 mSv thyroid equivalent dose for children less than 18 years and pregnant or breastfeeding women and 50 to 100 mSv for adults.

For off-site radiological calculations, focusing on the urgent protective actions, the licensee has to implement a radiological assesment model. For that purpose a dose/dispersion model developed by the Belgian Nuclear Research Centre (SCK•CEN) is used. The model is a segmented Gaussian plume model, based on the Belgian (also called Bultynck-Malet or SCK•CEN) turbulence typing scheme and the associated dispersion ('sigma') parameters [8]. These parameters were obtained using extended tracer experiments on each site during the sixties/seventies. The calculation domain extends up to 50 km around the release point. For the Tihange site empirical correction factors were introduced to take the more complex topography into account. Calculations are done per time step of 10 minutes, extrapolations (projections) over time can be made as well. In addition to the dispersion model, a set of standard scenarios has been developed in order to perform quick assessments at early stages. In the latest version of the diffusion model [9], the parameters associated with the standard scenarios have been stored in a database allowing rapid projections for any of the pre-defined scenarios. In addition, in its emergency room, Bel V uses simple user-friendly prediction tools elaborated on the basis of standard scenarios and/or pre-calculated standard releases.

The exposure pathways considered for urgent protective actions are cloudshine dose, inhalation dose and groundshine dose (instantaneous and integrated up to one day and two weeks). Ingestion pathway would be covered by implementing measures on the food chain (food ban...).

Effective doses for adults and thyroid doses for adults and children are calculated. Deposition of iodine (limited to I-131) and caesium (limited to Cs-137) are also calculated. Related to forecasts, the total doses as well as the projected doses are calculated.

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

II.L.2.c. Internal and External Emergency Plans for Nuclear Installations, Training and Exercises, International Agreements

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

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

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

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

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

The nuclear power plant conducts internal exercises several times a year, and the General Directions of Civil Safety and of Crisis Centre of the Home Affairs Federal Public Service (FPS) organise one internal and one external exercise annually for each nuclear power plant and every two years for other sites.

Consistent with the intended objectives, the FPS involves in these exercises the various disciplines (fire brigade, medical help, police force, civil protection, measurement teams ...).
The operator is requested to draw up a scenario with which the objectives can be tested.

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

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

Agreements also exist at local and provincial level. 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 station of Roosendaal (The Netherlands) and that of Antwerp, informing it as soon as the notification level N_2 is decided. This direct line is also used when certain accidents occur in the chemical industry (installations within the scope of the European post-Seveso Directive). A direct information exchange can also take place between the alarm station of Vlissingen (The Netherlands) and that of Ghent should an accident occur at the Borssele nuclear power plant. For the Chooz B and Tihange power stations, 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.

The following table gives an overview of some exercises performed during the period 2008-2010 (only for the installations falling under the scope of the CNS) :

Date	Site	Type	Objectives
03/06/2008	NPP Tihange	National	Global exercise directed by controllers, with the participation of most response organisations, deployment of field intervention teams Scenario: Complete loss of all electrical supplies (including diesel generators) and of the reactor cooling systems. Mobilisation in real time. Use of actual meteorological conditions. Duration of the exercise about 5 hours.
09-10/07/2008	Convex-3	International	Table Top exercise aiming at testing international information exchanges between IAEA-IEC and NWP, NCA(A) and NCA(D). Use of ENAC web-platform. Scenario: severe nuclear emergency at Laguna Verde NPP (Mexico). Mobilisation in real time. Use of actual meteorological conditions. Duration of the exercise: 43h.
16/09/2008	NPP Doel	National	Partial exercise, limited to the interaction and information exchange between the site emergency management team of the licensee and the federal evaluation cell CELEVAL. Scenario: break of a vapour canalisation followed by tube break in the steam generator. Mobilisation at a given time (pre-announced convening time). Use of historical meteorological conditions. Duration of the exercise: about 4h.
29/05/2009	NPP Tihange	National	Partial exercise, limited to the interaction and information exchange between the site emergency management team of the licensee and the federal evaluation cell CELEVAL. Scenario: IS LOCA. Mobilisation at a given time (pre-announced convening time). Use of historical meteorological conditions. Duration of the exercise: about 4h.
27/11/2009		Local	Table Top exercise for the local authorities (Province & Municipalities) to evaluate the police response (isolation of and access control to a sector where the population had to shelter) based on the decisions taken by the federal decision makers during the first part of the exercise (on 29/05).
19-20/10/2009	NPP Doel	National	Global exercise directed by controllers, with the participation of most response organisations, deployment of field intervention teams and interaction with the IAEA-IEC and Dutch local and national Authorities. Particular focus was placed on the management of the media pressure, with the contribution of teachers and last year students of a journalist school, simulating the media and the public. Scenario : LOCA + IS LOCA

Date	Site	Type	Objectives
			Alarm and mobilisation of CELEVAL in real time. Use of historical meteorological conditions. Duration of the exercise: about 36h (test of changing teams).
12/11/2009	ECURIE level 3	International	Table Top exercise aiming at testing information fluxes between EC and NWP, NCA(A) and NCA(D). Use of CoDecS-ECURIE. Scenario: elevated radiation measured by an automatic monitoring station in Corfu. Duration of the exercise: 8h.
20/11/2009	SCK•CEN	National	Partial exercise, limited to the interaction and information exchange between the site emergency management team of the licensee and the federal evaluation cell CELEVAL. Scenario: fire in a hot cell. Mobilisation in real time. Use of actual meteorological conditions. Duration of the exercise: about 4h.
21/04/2010	NPP Doel	National	Partial exercise, limited to the interaction and information exchange between the site emergency management team of the licensee and the federal evaluation cell CELEVAL. Scenario: LOCA. Mobilisation in real time. Use of actual meteorological conditions. Duration of the exercise about 6 hours.
27/04/2010	NPP Doel	Local	Evacuation test for the population around Doel NPP. About 500 volunteers were moved to a resort belonging to the Province East-Flanders where they (and their vehicles) were controlled for contamination, decontaminated when needed and registered. With the participation of the means and personnel of the civil protection, army, police, fire brigades, red cross …
06/05/2010	NPP Chooz	International	Participation to a French exercise in order to test the bilateral agreement on information exchanges at different levels. Limited engagement of the Belgian measuring teams on the field. Scenario: IS-LOCA. Mobilisation in real time. Use of fictive meteorological conditions. Duration of the exercise about 8 hours.
08/07/2010	ECURIE level 3	International	Table Top exercise aiming at testing information fluxes between EC and NWP, NCA(A) and NCA(D). Use of CoDecS-ECURIE. Scenario: Nuclear emergency at Brokdorpf NPP (Germany). Mobilisation in real time. Use of actual meteorological conditions.

Date	Site	Type	Objectives
			Duration of the exercise: 8h.
15-19/11/2010	NPP Tihange	National	Partial exercise, limited to the interaction and information exchange between the site emergency management team of the licensee and the federal evaluation cell CELEVAL. Scenario: under construction.

II.L.2.d. Information of the Public

The GRR-2001 specifies in its Article 72 all the obligations regarding training and information of the public pursuant to the Directive 89/618/ Euratom.

During the accident itself, information is supplied to the media by the information cell of the CGCCR. At local level the provincial emergency plan includes the ways to inform the population (sirens, police equipped with megaphones, radio and television) and to follow-up the instructions given to the population (iodine tablets, sheltering, evacuation ,…).

II.L.3. SCK•CEN (research reactors)

The general rules for emergency preparedness for the SCK•CEN installation are the same as for the nuclear power plants. The SCK•CEN has a central emergency control room, equipped with the necessary information and communication systems and is located in a building without major nuclear infrastructure. The SCK•CEN has one vehicle fully equipped for radiation measurements in emergency situations. The measurement capacity can be increased using a second vehicle with manual measurement equipment. These measurement teams are available for the national crisis centre.

The organisation of the internal emergency plan is described in a general procedure. For each of the groups involved in the emergency plan a task description is available. Standard accident scenarios are developed for the major nuclear installation. These must allow to recognize and communicate the essential information and the potential consequences to the national crisis centre. Exercises are held, in cooperation with the authorities and the other nuclear facilities in the neighbourhood. Every year, another company simulates the accident and takes the lead in the exercise. The measurement teams take also part in the exercises of the nuclear power plants.

Beside the internal emergency plan, the SCK•CEN is also involved in the national crisis centre. Experts participate in different evaluation cells.

II.M. Article 17. Siting

Each Contracting Party shall take the appropriate steps to ensure that appropriate procedures are established and implemented:

(i) for evaluating all relevant site-related factors likely to affect the safety of a nuclear installation for its projected lifetime;

(ii) for evaluating the likely safety impact of a proposed nuclear installation on individuals, society and the environment;

(iii) for re-evaluating as necessary all relevant factors referred to in sub-paragraphs (i) and (ii) so as to ensure the continued safety acceptability of the nuclear installation;

(iv) for consulting Contracting Parties in the vicinity of a proposed nuclear installation, insofar as they are likely to be affected by that installation and, upon request providing the necessary information to such Contracting Parties, in order to enable them to evaluate and make their own assessment of the likely safety

(v) impact on their own territory of the nuclear installation.

II.M.1. <u>NPPs</u>

II.M.1.a. Characteristics taken into Account in the Sites Selection

The Doel and Tihange nuclear 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, transport…).

With regard to the natural phenomena:

- The geological and seismic characteristics of the sites and their environment were specifically investigated so as to identify the soil characteristics and the earthquake spectrums in order to define the design bases to be considered when dimentionning the structures and systems.
- The hydrological characteristics of the rivers Meuse (Tihange) and Scheldt (Antwerp) were surveyed, 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 assess the dilution of released liquid effluent.
- Meteorological and climatic surveys allowed to define the atmospheric diffusion and dispersion models to be used when assessing the short-term and long-term environmental impacts of atmospheric releases taking into account 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 in 1975 : protection against external accidents such as civil or military aircraft crash, gas explosion, toxic gas cloud, major fire.
- The Tihange 2 and 3 and Doel 3 and 4 units were equipped with ultimate emergency systems aimed at automatically tripping the reactor, keeping it in hot shutdown during three hours so that after that period of time it may be possible to bring the unit to cold shutdown and to remove residual heat, after a design basis external accident as referred to above, or during any loss of the normal control room or any of the systems that are controlled from it.
  These ultimate emergency systems are called "bunkerised systems" as they are installed in specifically reinforced buildings. They comprise an autonomous protection and instrumentation system supplied with electric power from dedicated emergency diesel-generator sets, as well as primary make-up (water with boric acid to control the reactivity) and steam generator feedwater systems.
  Measures were also taken to guarantee the emergency heat sink. At the Tihange site, the preferred option was to bore wells from where groundwater can be pumped, whereas at Doel three artificial lakes were created.
- Following the 2001 September 11 events, Electrabel and the Safety Authorities were brought to:
  - consider the eventuality of a voluntary aircraft crash on the Belgian Nuclear Power Plants,
  - identify which type of impact these plants would encounter,
  - determine the potential consequences of such impact,
  - consequently, adapt the in-depth defence strategy.

  From the studies performed on the potential consequences of an impact on each of the buildings of the plants of Doel and Tihange, it appears that:
  - the initial design of the last four units is good: no perforation of the external containment even with a Boeing 767 at a speed of 150 m/s,
  - the initial design of the reactor buildings of Tihange 1 and Doel 1-2 is less resistant than those of the more recent units: partial perforation of the external containment but without any consequence on the safety systems, even with a Boeing 767.
  - it is necessary to be able to fight a kerosene fire in order to avoid any damage at the structure of the building due to high temperature exposure. In accordance with the fire department and Bel V, new equipments were bought and are now operable (special fire fighting truck with high pressure foam pumps) and are approved by the regulatory body.

II.M.1.b. Periodic Reassessment of the Site 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.

II.M.1.c. International Agreements

The necessity to inform the neighbouring countries when planning a nuclear installation is stipulated by Article 37 of the Euratom Treaty, and as a consequence is mandatory in Belgium (cf. Article 6 of the GRR-2001). The reports drawn up to meet this requirement have been transmitted to the European Commission as provided for in the licensing procedures for the Belgian power plants. After consultation of 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.

II.M.2. SCK•CEN (research reactors)

The installations of the SCK•CEN are located in the north-east of the province of Antwerp, which is one of the lesser populated regions of the northern part of Belgium. This was one of the major reasons for the choice of the location, together with the availability of sufficient free terrain.

The site has a low risk for the occurrence of natural phenomena.

- The site is located far from major rivers or from the sea, in a flat sandy area, such that the risk of flooding is very limited.
- The closest active seismic fault is located at a distance of about 80 km. However due to the fact that the underground consists of a thick sandy layer (about 500 m), there is a large ground damping. A quantitative evaluation of the risk for an earthquake was made on the occasion of the safety review of 1996. An earthquake with an intensity of V on the MSK scale can be expected once in 10000 years.

The main risks for human external phenomena are the crash of an airplane and a major forest fire. The risk of an airplane crash is reassessed during the safety review of 2006. The site is surrounded by pinewood trees. A forest fire during dry periods is considered as a risk. The forest around the area is foreseen with additional fire hydrants such that the fire brigade can have sufficient water in the neighbourhood. Special precautions are taken during long dry periods

II.N. Article 18. Design and Construction

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

(i) the design and construction of a nuclear installation provides for several reliable levels and methods of protection (defense in depth) against the release of radioactive materials, with a view to preventing the occurrence of accidents and to mitigating their radiological consequences should they occur;

(ii) the technologies incorporated in the design and construction of a nuclear installation are proven by experience or qualified by testing or analysis;

(iii) the design of a nuclear installation allows for reliable, stable and easily manageable operation, with specific consideration of human factors and the man-machine interface.

The design, as well as the major modifications following the successive periodic safety reviews of the Belgian nuclear power plants is described in Appendix 1 to the present Report.

II.N.1. NPPs

II.N.1.a. Rules followed during Design and Construction

The "Commission Spéciale des Radiations Ionisantes" (i.e. the Belgian nuclear safety Commission, now replaced by the Scientific Council of the FANC) decided in 1975 that the USNRC rules should be followed for the construction of the next four units (Doel 3 and 4, Tihange 2 and 3) and that some accidents of external origin should be considered in the design.

The complete text of that decision was incorporated in Chapter I of the Safety Analysis Report of each unit; it thus becomes mandatory through the Royal Decree of authorisation of the units.

The whole design and safety analysis of these units have been done following the US rules and all the associated documentation (regulatory guides, standard review plans, ASME Code, IEEE standards, ANSI, ANS, etc.) in order to ensure a consistent approach.

In order to show how the US rules had been followed, two appendices were created in Chapter 3 of the SAR, in addition to the standard format of Regulatory Guide 1.70. The first appendix explains how the mandatory rules have been followed and any deviation is identified and fully justified. The second appendix deals with the non mandatory rules and explains how they have been implemented, in compliance with the safety objectives.

All the US technical rules have been followed, except 10 CFR 20, because the corresponding topics are covered by the Euratom Directive on the basic safety standards, which is mandatory for all member States of the European Union.

For pressure vessels which are part of the nuclear installation, a ministerial Decree of derogation has been elaborated in order to replace the Belgian pressure vessel regulations ("Règlement général pour la protection du travail") by the US rules (ASME Code sections III and XI). A few components not covered by the ASME specifications but covered by the Belgian regulations had still to comply with the Belgian regulations.

A transposition of the ASME Code has been written to cover organisational aspects like the definition of an inspector, of the Authorised Inspection Agency (AIA), etc…

That transposition of the ASME Code clarifies also the conditions under which other construction or in service inspection codes (like French or German codes) can be used. Their equivalence must be justified, justification which must be agreed by the AIA and by Bel V.

The document of the Special Commission has also required that accidents of external origin be considered (i.e. aircraft crash, gas explosion, toxic gases, large fire).

The protection against explosions has been based on German rules.

For the aircraft crash the bunkerised structures have been designed to resist the impact of a civil airplane of about 90 tons at a speed of 85 m/s.

It was afterwards verified that these structures resisted also the impact of a military aircraft of about 13 tons at a speed of 150 m/s.

Taking into account the characteristics of air traffic along the US rules methodology, it was checked that the probability to go beyond the design criteria of the bunkerised structures was smaller than 10^{-7} per reactor year.

Similar verifications have been performed for the other accidents of external origin.

It has been shown that the probability to exceed the design criteria was, for each family of external accidents, smaller than 10^{-7} per reactor year, and 10^{-6} per reactor year for all external accidents together.

The residual risk is a fortiori smaller, as exceeding the design criteria does not imply, with a probability equal to one, unacceptable radiological consequences.

II.N.1.b. Periodic Safety Reviews

II.N.1.b.1) Rules followed up to 2007

The Royal Decree of Authorisation of each nuclear unit makes it mandatory to conduct periodic safety reviews. These safety reviews must "compare 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".

The differences found must be identified, together with the necessity and possibility of remedial action and, as the case may be, the improvements that can be made and the time-schedule for their implementation".

Hence one of the topics of the periodic safety reviews is to examine the new rules, codes and practices at the international level and to decide which ones will be considered in the periodic safety reviews.

The topics to be studied in these safety reviews are detailed in a report submitted by the licensee to the FANC; in this way the rules retained become obligatory.

The feedback of operational experience of nuclear power plants at the international level is also considered; in this respect the “Bulletins” and the “Generic Letters” of the USNCR, as well as information available from other regulatory bodies, are examined, if their follow-up has not yet been required in the frame of the permanent supervision during operation of the installation.

From this, one can conclude that all the new rules of the USNRC are not automatically applied in the Belgian plants, and that non-American rules, guides and practices can also be retained for implementation in Belgium. The corresponding topic of the periodic safety review must look after the consistency of the new requirements between themselves and with those of the original design.

The formal requirement to follow the U.S. rules for the construction of the nuclear units did not formally exist at the time of construction of Doel 1 and 2 and Tihange 1. However these units were designed respectively by Westinghouse and by Framatome, in the early seventies, and the U.S. rules have been applied de facto.

During their first periodic safety review in 1985, their state has been compared to the latest Belgian units which had just come into operation and in which the U.S. rules were implemented.

The Safety Analysis Reports of Doel 1 and 2 and Tihange 1 have been revised to put them in conformity to the U.S. standard format (R.G. 1.70) and harmonize in this way the information supplied for all Belgian nuclear units.

The list of technical subjects examined during the successive periodic safety reviews is given in extenso in Appendix 5 to this Report.

Two examples of new topics introduced in the periodic safety reviews corresponding to international practices are the probabilistic safety studies and the analysis of severe accidents.

in September 1986, the licensees were requested to study severe accidents and consider in particular containment ultimate strength versus internal overpressure and identify weak points, hydrogen production problems, containment venting mechanisms and reactivity accidents. For the ultimate strength of the containment, margins were evaluated and some weak points eliminated. The studies on hydrogen production, on the means to counter it and on containment venting concluded that the installation of autocatalytic recombiners was the most adequate solution for these combined issues. The number and location of the recombiners were determined, with an extra margin for uncertainties. That topic of severe accidents was introduced in the periodic safety reviews, and it became in this way an obligation for the licensees to install these types of recombiners, a measure which is now effective in all Belgian plants.

II.N.1.b.2) Rules followed from 2007 onwards

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.

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

II.N.1.c. Application of the Defence in Depth Concept

The defence in depth concept is an integral part of the Framatome or Westinghouse nuclear power plants designs, and is also found in the US safety rules.

Accordingly, this concept has been systematically applied in all the Belgian nuclear power plants.

Furthermore, the design of all the additional systems to address external accidents adhered to the same principles, and in particular the single-failure criterion was applied. Compared to a conventional-design pressurised water reactor nuclear power plant, the additional systems installed to mitigate the consequences of an external accident in fact strengthen considerably the third level of the defence in depth approach, as they can help during certain internal accidents which might develop unfavourably.

In the framework of periodic safety reviews, for all units, a global evaluation of the safety during low-power and shutdown states is being performed.

II.N.1.d. Accident Prevention and Mitigation of Consequences

Accident prevention and mitigation of consequences are basic principles adhered to in the design of Belgian nuclear power plants, in accordance with the USNRC regulations.
In case of disturbance in the operation parameters of the plant, the control system will respond in order to bring the plant back to its nominal operation point.
In case of risk of reaching the safety limits, the reactor protection system will shut down the plant.

The engineered safety systems are activated to address the design basis accidents and achieve the safe shut down of the plant.

Consistent with the standard format of the Safety Analysis Reports, all the instrumentation and control systems are described in chapter 7, and incident and accident analyses are discussed in chapter 15.

We shall bear in mind that the four more recent Belgian units (Doel 3 and 4, Tihange 2 and 3) are three-loop 1 000 MWe units that are designed with three independent safety trains (instead of two interconnected trains in a traditional design).

Apart from the Doel 1 and 2 units, in which the primary containment is a metal sphere, the primary containment of all other units is a prestressed concrete structure with on the inside a steel liner. The secondary containment is in reinforced concrete at all units. The annular space between the two containments is put at negative pressure after an accident, so as to collect possible leaks. There is an internal recirculation and filtration system in the annular space and the air is filtered again prior to release via the stack.

Here again the Belgian nuclear power plants present a significantly greater defence in depth than the traditional designs.

During the 90's, probabilistic safety studies were carried out for all the Belgian units. These studies were either level 1 with analyses of scenarios that could present a risk to the containment integrity, or level 2 studies (in this case with no source term calculation).

These studies considered reactor operation at power as well as in shut down states.

The results showed, among other, the value of having protection systems against external accidents. Indeed, these systems can act also in the event of failure of the traditional engineered safety systems; this considerably reduces the probability that certain initiating events could develop to the point of contributing to a core melt.

The on-going update of all PSAs will lead to full Level 2 analyses for all plants, for power and shutdown states.

II.N.1.e. Application of Proven or Qualified Technologies

The safety-related structures, systems and components are subject to qualification programmes to the environment in which they are situated and operated (normal, test, incident, accident). The same is applied regarding seismic qualification. The programmes are described in the sections 3.10 and 3.11 of the Safety Analysis Report, and are consistent with the relevant US rules. Significant efforts have been made in this field, with tests in large qualification loops or on high-capacity seismic tables.

The results of all these tests are included in the "Manufacturing Records" of the qualified equipment, and are summarised in synthetic reports for later use.

For the design codes used by vendors or architect-engineers, audits are conducted by Bel V to verify the qualification file and to examine the experimental bases on which the models and correlations of the code are founded.

Particular attention is given to verifying and validating the design code itself and the quality assurance programme applied to the use of the code

II.N.1.f. Requirements of Reliable, Stable and Easily Controllable Operation, taking into Account Human Factors and the Man-Machine Interface

In order to make the operation of their power stations easier and to increase their availability, the Belgian operators frequently apply the redundancy principle even to the normal control functions, so as to avoid spurious signals in the event of a failure. Similarly, they install additional components in standby that can be quickly started or connected, so as not to have to shut down the power station in the event of significant unavailability of the first components.

In the control room there are many display and alarm windows to inform the operator as soon as possible of any operational anomaly of the power station. The alarm windows have been colour-coded according to their importance.

Alarm fiches exist for each alarm, indicating to the operator the significance of the alarm, its origin (and possible causes), the automatic actions possibly initiated and the manual response, if any, that is required of the operator.

A process computer exists, that displays a greater number of alarms and information on a display or as a print-out, supplying the control room team with additional information.

In case of unavailability of the main control room (for example inacceptable habitability) a Remote Safety Panel, located in the bunker control room for the last four units or in an appropriate building for the former ones, is fitted with all the controls of the main systems necessary for bringing the reactor to cold shutdown. A specific set of procedures for the remote panel is present in the bunker control room (or equivalent location)

Moreover the bunker control room and the bunker specific equipments have the capability to bring the reactor to a safe state (fallback state) and to go safely to cold shutdown, in case of accident of external origin (aircraft crash, explosion and/or large fire,…). Procedures covering these cases are also available in the bunker control room (or equivalent location).

As a post-TMI action, following NUREG 0737, the control room and its ergonomics were reassessed. The instrumentation used for post-accidental operation was identified more clearly, and the notion of SPDS (Safety Parameter Display System) was implemented in the control room (or in a room adjacent to it).

In the probabilistic safety studies, the tasks expected of the operators are detailed and modelled during the accident as well as during the post-accidental phase when the safe status of the unit is being restored. Following this critical review the existing procedures are possibly amended to increase their efficiency and ease of use, or new procedures are written (for instance for the non-power states). Furthermore, guidelines have been established to mitigate the consequences of severe accidents.

II.N.2. Research Reactors

The reactors BR1 and BR2 were designed and constructed between 1952 and 1962, before a dedicated nuclear regulation existed in Belgium. The reactors were licensed according the regulations on industrial installations. This licence was amended several times, with specific requirements for nuclear installations. In 1986 the old licence was replaced by a new one, a royal decree based on the actual nuclear safety regulations.

The design of the BR1 is based on the reactors X-10 of ORNL, USA and BEPO of UKAEA, Harwell. The reactor was designed for a thermal power of 4 MWth. After 1965, the maximum thermal power has not exceeded 1 MWth. This allows working with the auxiliary ventilation only and avoids the accumulation of Wigner energy in the graphite. A power level of 4 MWth is still possible. However, this would require a requalification of the main ventilation and would require, after a certain time of irradiation, the thermal annealing of the graphite. During the lifetime of the reactor no major modifications were made.

The design of BR2 is rather unique. The reactor is designed to have a high neutron flux (thermal and fast), without being a fast sodium cooled reactor. The design has never been repeated. A reactor that is comparable is the ATR reactor of Idaho National Laboratory, USA. The original design thermal power of BR2 was 50 MW. In 1973 the primary heat exchangers were replaced in order to allow a thermal power of more than 100 MW. However, this thermal power is not the limiting factor as long as the heat can be evacuated without a too high temperature on the fuel plates. The power of the reactor is limited by the fact that the maximum heat flux on the fuel plates must be lower than 470 W/cm² in routine operation and 600 W/cm² for special experimental conditions.

II.O. Article 19. Operation

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

(i) the initial authorisation to operate a nuclear installation is based upon an appropriate safety analysis and a commissioning programme demonstrating that the installation, as constructed, is consistent with design and safety requirements;

(ii) operational limits and conditions derived from the safety analysis, tests and operational experience are defined and revised as necessary for identifying safe boundaries for operation;

(iii) operation, maintenance, inspection and testing of a nuclear installation are conducted in accordance with approved procedures;

(iv) procedures are established for responding to anticipated operational occurrences and to accidents;

(v) necessary engineering and technical support in all safety-related fields is available throughout the lifetime of a nuclear installation;

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

(vii) programmes to collect and analyse operating experience are established, the results obtained and the conclusions drawn are acted upon and that existing mechanisms are used to share important experience with international bodies and with other operating organisations and regulatory bodies;

(viii) the generation of radioactive waste resulting from the operation of a nuclear installation is kept to the minimum practicable for the process concerned, both in activity and in volume, and any necessary treatment and storage of spent fuel and waste directly related to the operation and on the same site as that of the nuclear installation take into consideration conditioning and disposal.

II.O.1. <u>NPPs</u>

II.O.1.a. Initial Authorisation and Commissioning

For the 7 operating NPPs, the Royal Decree of Authorisation was signed by the King after it has been examined in detail by the AIO (AVN), the "Commission Spéciale Radiations Ionisantes" (replaced by the Scientific Council of the FANC) and the Safety Authorities (now the FANC).

The commissioning test programme was discussed and approved by the AIO (AVN), which followed the tests, evaluated the test results, verified the conformity to the design and issued the successive permits that allowed proceeding with the next step of the test programme.

This process was complete when AIO (AVN) authorised the operation of the unit at full power.

II.O.1.b. Operational Limits and Conditions

As described before, the Technical Specifications are approved in the frame of licensing (chapter 16 of the Safety Analysis Report). They specify the operational limits and conditions, the availability requirements of the systems, the tests and inspections, and the actions to be taken if the acceptance criteria are not met. This applies to any state of the nuclear power plant. Extensive backgrounds of the Technical Specifications exist and are available to the personnel.
There are procedures related to compliance with the Technical Specifications (T.S.) for maintenance activities during plant outage and plant operation. T.S requirements and limitations are explicitly addressed in the maintenance procedures. Independent checks of the strict compliance with of T.S during outages are carried out, both in the preparatory outage activities (work planning) as well as during the outage itself. These checks relate to equipment as well as to safety-related functions, like the integrity of the containment during refuelling, verification of the redundancy of the heat removal systems during RHR operation…

Modifications of the installations with a potential impact on nuclear safety must be approved by the Health Physics department before it can be implemented as explained in Article 14, section II.J.2.a.. In this respect, changes of procedures, of the Technical Specifications and of the Safety Analysis Report are identified and discussed.

II.O.1.c. Operation according to Approved Procedures

A general description of the operation procedures is given in section 13.5 of the Safety Analysis Report.

The completeness (in format and contents) of the procedures has been examined based on Regulatory Guide 1.33 which lists the subjects for which procedures must be established. This examination was conducted in the scope of licensing and delivery of the installations by AVN (now Bel V).

During the commissioning tests, the relevant procedures that were used by the operators were verified for adequacy.

II.O.1.d. Procedures for operation, maintenance, inspection and testing

A general description of the operation procedures is given in section 13.5 of the Safety Analysis Report.

The completeness (in format and contents) of the procedures has been examined based on Regulatory Guide 1.33 which lists the subjects for which procedures must be established. This examination was conducted in the scope of licensing and delivery of the installations by AVN.

During the commissioning tests, the relevant procedures that were used by the operators were verified for adequacy.

Document management is based on Electrabel guidelines and on the Internal Code for Nuclear Safety. Documents are classified into the following categories: policy-related procedures, operational procedures, instructions, supporting documents, help documents and witness documents. For policy-related procedures, operational procedures and instructions, more strict handling requirements have been established

II.O.1.e. Incident and Accident Procedures

A full set of incident and accident management procedures has been developed by the operator, with the help of the Architect Engineer and the designer of the Nuclear Steam Supply System. These procedures cover both power operations and shutdown modes.

These procedures are validated on a simulator and are used for operator training. Procedures are periodically reviewed and relevant experience feedback is integrated. Procedures backgrounds have been developed for some normal and incident procedures.

The Belgian NPPs, except Tihange 1, have implemented the Emergency Response Guidelines (ERG) approach developed by the Westinghouse Owners Group (WOG). These standard procedures have been adapted to the plant-specific elements and systems, especially the systems for protection against external events.

The ERG procedures are composed of 3 major elements: (1) the optimal recovery procedures (ORG : optimal recovery guidelines) which are event-based, (2) the critical safety function status trees and (3) the function restoration procedures (FRG : function restoration guidelines) which are both symptom-based, i.e. independent of the event scenario.

The ORG procedures, based on event scenarios with a probability of occurrence greater than 10^{-8}/y, have as main objective to recover the plant and to bring it back to a known safe state (in general the cold shutdown with the RHR system connected). ORG procedures are characterized by a response directly connected to event scenarios, by a preliminary diagnostic and by a constant diagnostic within each specific procedure in order to allow possible reorientation.

The critical safety function status trees explicitly identify the status of the safety functions independent of the event scenario. The trees prioritize challenges to these functions and identify the appropriate FRG procedure to be used to respond to these challenges. The 6 defined critical safety functions are: subcriticality, core cooling, heat sink, integrity of the primary system, containment and primary water inventory.

The FRG procedures are used to restore any challenged critical safety function.

The ORG on one hand and the status trees and the FRG on the other hand are applied in parallel during an event: the first procedures are used by the operators crew (even-based approach) whereas the second ones are applied independently by a Shift Technical Adviser (symptom-based approach).

In conclusion, event-based and symptom-based procedures are used in parallel in Belgium by the NPP staff. The combination of a redundant approach (ORG <> FRG) associated with a human redundancy (operators crew <> shift technical adviser) allows to cover a larger scope of events, ensuring an optimized response for simple event scenarios.

Specific procedures have been written to give guidance to the operators after an earthquake that could occur during normal operation or in shutdown state.

Severe accident management procedures, inspired by the "Severe Accident Management Guidelines" developed by the Westinghouse Owners' Group, were implemented, adapted to the specificities of each unit. The training programme of the control room operators was developed in parallel.

For Tihange 1 the Framatome approach has been followed. The accident management procedures combine event-based and symptom-based approaches, using the surveillance of key safety functions or parameters.
Severe accident management procedures were developed like in the other units, on the basis of the Westinghouse Owner's Group Guidelines.

II.O.1.f. Engineering and Technology Support

The organisation and know-how of the operator, described in chapter 13 of the Safety Analysis Report, must be maintained throughout the useful life of the power station, and even after its definitive shutdown as long as this new status is not covered by a new licence.
The Engineering Support Department has the overall responsibility for the Technical Support Process. However, technical support activities are decentralized into several surveillance programmes, each programme being under the leadership of the department having the most comprehensive knowledge of the particular process. The allocation of technical support functions between the different site departments and external organizations is clearly established. The Engineering Support Department also acts as design authority.

On the corporate level, the sites receive technical support from the Asset Management and Strategy (AM&S) department. This department is, amongst others, in charge of the management of the periodic safety review, of large-scale projects common to Doel and Tihange and their coordination, of the monitoring of the ageing projects and of specific safety projects.

Some technical support activities are carried out in partnership with Tractebel Engineering (TE). The partnership translates into three levels of cooperation:

- Core assist: this is a strategic, permanent and structural partnership. In this framework, Electrabel entrusts activities to TE as its natural partner. Examples are safety and licensing (including studies, follow-up, ..), fuel management, regulatory watch, FSAR update management. TE acts as responsible designer.
- Core support: this is a close cooperation that applies to projects for which similar quality levels cannot be obtained form other suppliers. Examples are general assistance in operations and management of nuclear installations, plant life management studies
- Valuable supplier: This is an operational competitive customer/supplier relationship for activities that are outsourced to an external supplier, but not necessarily to TE.

The particular relationship between Electrabel and TE originates from the construction of the Doel and Tihange plants, where TE acted as the Architect-Engineer. In addition, TE has been in charge of the studies and their implementation during the periodic safety reviews, which take place on a periodic basis, of the steam generators replacement projects, power increase projects and of a large part of minor modifications projects, which allowed to maintain competence and knowledge of the installations. 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 competency in conformity with the state of the art. In order to reach these goals, TE participates in international research projects and is a member of various networks (or competency 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.

II.O.1.g. Notification of Significant Incident

Section 16.6 of the Safety Analysis Report lists the events that must be notified to Bel V and to the Safety Authorities, indicating the deadline for each notification.

The same section also specifies the cases where incident reports must be supplied to Bel V, and within which time period. In function of the significance of the events, the time period ranges from immediately to a month.

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 it considers interesting (see Article 8, § II.D.3.b) for the international community.

Near misses are handled through the operational experience feedback process.

II.O.1.h. Operational Experience Feedback

At Electrabel, Operating Experience is supported in all activities and at all levels of the organization. Operating Experience is part of the Electrabel's continuous improvement programme.
A policy for operating experience has been established at Electrabel. Comprehensive programmes have been set up for detecting, processing and communicating operating issues in order to optimize the use of international, national and local experiences in operating nuclear power plants.

The Operating Experience (OE) process can be initiated by different input triggers:

- An event inside or outside the operating organization. An event is defined as any unwanted, undesirable change in the state of plant structures, systems, or components or in human/organizational conditions (health, behaviour, administrative controls, environment…) that exceeds established significance criteria.
- Findings from audits and self assessments
- Findings from the task observation programme

- Findings from post job debriefings
- Ideas, insights with a potential to significantly improve plant performance.

The OE programme results in:
- Immediate corrective actions,
- Medium and long-term corrective actions and/or improvements.

The OE feedback programme interacts on different levels of issues, events and ideas throughout the organization:
- Events and near misses: these are events and issues that require a stringent, formal approach by means of event reports.
- Low level events: these are events, issues and good practices that are revealed during the task observation programme and post job debriefings. These inputs are used for immediate actions as well as for annual self assessments.

In parallel, different learning cycles exist to ensure learning from internal and external faults and strengths. Operating experience input coming from different sources is bundled in order to reveal relationships that lead to identifying and eliminating error precursors and flawed defences and their underlying organizational weaknesses. The main goal of this exercise is not merely counting events but pattern recognition. This OE feedback occurs in five loops and findings of lower loops are used as input for higher loops:
- Loop 1: immediate feedback, corrective actions, direct solutions and coaching.
- Loop 2: tri-monthly feedback of the performed observations (number, spread, quality) to different teams and services.
- Loop 3: annual self-assessments by the operational and maintenance teams. This bottom-up approach, supported by the immediate management, aims to define the next year's focus on different domains (technical, training, human performance, …).
- Loop 4: annual self assessments and management reviews on intermediate level (within departments and/or services) aim to identify improvement areas on a (sub)process or organizational level and to identify weak points by systematically comparing real process outputs with management expectations, requirements of the regulator and authorities, and expectations from the nuclear sector. Per department a more hierarchical or transversal, horizontal approach is chosen.
- Loop 5: annual management reviews on plant level of each process.

The information related to operating experience is accessible to all plant personnel, both on the intranet and in the document management system. The use of the available operating experience information is integrated into the different department processes and methods, in order to evaluate their own performance, to identify hidden weaknesses and to pro-actively avoid events

II.O.2. Research Reactors

II.O.2.a. Operational Limits and Conditions

The operational limits and conditions are described in the respective safety analysis report. A number of basic OLC's are defined in the licence.

These are for the BR1:

- The maximum temperature of the cladding of the fuel,
- The maximum temperature of the graphite,
- The maximum Wigner energy,
- The maximum burn up of the fuel and
- The maximum death time of the control rods.

These are for the BR2:

- the tightness of the containment building,
- the maximum allowed fluence of the control rod guide tubes,
- the maximum allowed heat flux on the fuel plates and
- the maximum allowed fluence of the beryllium matrix.

Further OLC's are detailed in the safety analysis report of the reactors. There is a significant difference between these two types of OLC's. Those mentioned in the licence can not be changed without a licence amendment. This requires a royal decree. An OLC formulated in the safety analysis report can be changed according to the designated procedures for modifications

II.O.2.b. Modifications

In 2008, the FANC published guidance about the treatment of modifications. Based in this guidance, the SCK•CEN developed a procedure for the practical treatment of modifications. This procedure is valid for all the installations, including the reactors BR1 and BR2. However, experimental devices are not considered as modifications. Special procedures exist for the approval of experiments.

Three types of modifications are possible:

- The minor modification has no influence on the safety of the installation and is approved by the head of the health physics and safety department. The information is then transmitted to Bel V.
- A non significant modification can have influence on the safety. The design must be approved by Bel V. Before the modification can be put into operation, the approval of the health physics department must be countersigned by Bel V.
- A significant modification requires a licence amendment and must be licensed by the FANC according to the procedures set in the GRR-2001.

The number of modifications for the BR1 is very limited. The general SCK•CEN procedure for modifications is used. An important modification must be submitted to the internal SCK•CEN advisory committee for the safety of installations. For modifications of the BR2, there is a dedicated procedure. All requests are submitted to an internal committee for approval. During the meeting, the decision whether the modification is significant or not is also taken.

Experiments are not considered as modifications and a dedicated approval procedure exists. For the BR1, new experiments are approved by the health physics department, in some cases following an advice of the SCK•CEN committee on the safety of installations. All information is transmitted to Bel V. The experiments for the BR2 have to follow a specific three stage approval (principle, design and construction). A fourth stage is also foreseen to discuss the return of experience and possible problems.

II.O.2.c. Reporting of Events

For reporting unusual events a convention with the authorities exists. A number of criteria about the delay time for communicating events are defined. Belgium is also member of the Incident Reporting Systems for Research Reactors. A number of events regarding the BR1 and the BR2 are reported in the IRSRR. Besides this reporting, there is also guidance of the FANC on the use of the INES scale for the SCK•CEN installations.

II.O.2.d. Documentation

The design and construction of both the BR1 and the BR2 date from more than 50 year ago. All persons having knowledge about the original design of the reactors have gone. During the last periodical safety review it was recognized that an action was necessary to keep the design documentation and the corresponding knowledge in good state. This action is going on for the moment.

II.O.2.e. Maintenance

For the BR1 a yearly maintenance plan is foreseen. This maintenance is mainly focused on the control rod mechanisms, the ventilation system, including the air filters, and the diesel generator. Beside this maintenance a two monthly inspection plan is executed. For BR2, the maintenance is done during the longer shutdowns. For every shutdown a detailed task plan is made. The list of tasks comprises repairs, preventive regular maintenance and modernization of components which were approved as modification. A very profound maintenance programme was executed during the replacement of the second matrix.

II.O.3. Generation of Radioactive Waste

See the Belgian report in the frame of the Joint Convention.

II.O.4. Temporary Storage of Used Fuel

See the Belgian report in the frame of the Joint Convention.

III. APPENDIX 1 - DESCRIPTION OF THE NUCLEAR INSTALLATIONS: POWER PLANTS

Not included in this version

IV. APPENDIX 2 - DESCRIPTION OF THE NUCLEAR INSTALLATIONS: THE BR1 AND BR2 RESEARCH REACTORS

Not included in this version

V. APPENDIX 3 - LIST OF ACRONYMS

AIA	Authorised Inspection Agency.
AIO	Authorised Inspection Organisation.
ALARA	As Low As Reasonably Achievable.
ANS	American Nuclear Standards.
ANSI	American National Standards Institute.
ASME	American Society of Mechanical Engineers.
ASSET	Assessment of Safety Significant Events Team (IAEA).
AVN	Association Vinçotte Nuclear.
BS	Basic Standards.
CGCCR	Comité Gouvernemental de Coordination et de Crise, (i.e. the Governmental. Centre for Co-ordination and Emergencies).
CIPR/ICPR	Commission Internationale de Protection Radiologique (i.e. International Commission for Radiological Protection).
CNRA	Committee of Nuclear Regulatory Activities (NEA/OECD).
CNT	Centrale Nucléaire de Tihange (i.e. Tihange Nuclear Power Plant)
CSNI	Committee on the Safety of Nuclear Installations (NEA/OECD).
ECURIE	European Community Urgent Radiological Information Exchange.
EDF	Electricité de France.
ENSREG	European Nuclear Safety Regulators Group
EU	European Union.
FANC	Federal Agency for Nuclear Control.
FBFC	Franco-Belge de Fabrication de Combustible (i.e. Franco-Belgian Company for Fuel Manufacturing).
FINAS	Fuel Incident Notification and Analysis System (NEA/OECD).
FPS	Federal Public Service
FRAREG	FRAmatome REGulators
FRG	Function Restoration Guidelines.
FSAR	Final Safety Analysis Report.
GRR-2001	General Regulations regarding the protection of the public, workers and the environment against the hazards of ionizing radiation, laid down by Royal Decree of 20 July 2001
GRR-1963	General Regulations regarding the protection of the public, the workers and the environment against the hazards of ionizing radiation, laid down by Royal Decree of 28 February 1963..
HPD	Health Physics Department.
IAEA	International Atomic Energy Agency.
IEEE	Institute of Electrical and Electronics Engineers.
INES	International Nuclear and Radiological Event Scale (IAEA).
INPO	Institute of Nuclear Power Operations.
INSAG	International Nuclear Safety Advisory Group.
IRE	Institut des Radio-éléments.
IRRT	International Regulatory Review Team (IAEA).
IRS	Incident Reporting System (NEA/OECD-IAEA).
KCD	Kerncentrale Doel (i.e. Doel Nuclear Power Station).
MOX	Mixed-oxide U02-Pu02.
NDA	Non Destructive Analyse.
NDTT	Nondestructive Testing Technology.
NEA (OECD)	Nuclear Energy Agency (OECD).

NERS	Network of Regulators of countries with Small nuclear programmes
NORM	Naturally Occurring Radioactive Material.
NPP	Nuclear Power Plant.
NRWG	Nuclear Regulators Working Group.
NUSS	Nuclear Safety Standards programme (IAEA).
NUSSC	Nuclear Safety Standards Committee (IAEA).
OEF	Operational Experience Feedback.
ONDRAF/NIRAS	Organisme National pour les Déchets Radioactifs et les Matières Fissiles Enrichies/ Nationale Instelling voor Radioactive Afval en verrijkte Splijtstoffen (i.e. Belgian Agency for Radioactive Waste and Enriched Fissile Materials).
ORG	Optimal Recovery Guidelines.
OSART	Operational Safety Review Team (IAEA).
PAMS	Post Accident Monitoring System.
PSR	Periodic Safety Review
Q.M.	Quality Monitored.
RASSC	Radioprotection Safety Standard Committee.
R.D.	Royal Decree.
RGPT	Règlement Général pour la Protection du Travail (i.e. Belgium's Occupational Health & Safety Regulations).
RHR	Residual Heat Removal.
RHRS	Residual Heat Removal System.
SCK•CEN	Studiecentrum voor Kernenergie, Nuclear Research Centre / Centre d'Etude de l'Energie Nucléaires, situated at Mol, Belgium.
SENA	Société d'Energie Nucléaire Franco-Belges des Ardennes.
SPDS	Safety Parameter Display System.
SPRI	Service de Protection contre les Radiations Ionisantes (i.e. Department of Protection against Ionising Radiation).
SSE	Safe Shutdown Earthquake.
STA	Shift Technical Advisor.
STAR	Stop-Think-Act-Review.
TE	Tractebel Engineering.
TMI	Three Mile Island.
TRANSSC	Transport Safety Standard Committee.
TRC	Technical Responsibility Centre (Bel V).
USNRC	United State Nuclear Regulatory Commission
VGB	Vereinigung der Grosskesselbetreiber
WANO	World Association of Nuclear Operators.
WASSC	Waste Safety Standards Committee (AIEA).
WENRA	Western European Nuclear Regulator's Association.
CNT	Centrale Nucléaire de Tihange (i.e. Tihange Nuclear Power Plant Site).

VI. APPENDIX 4 - LIST OF THE WEB SITES OF THE DIFFERENT NUCLEAR ACTORS IN BELGIUM

1. Regulatory Body

Federal Agency for Nuclear Control:	http://www.fanc.fgov.be	(site in French and Dutch)
Bel V	http://www.belv.be	(site in French, Dutch and English)

2. Licences, Architect-engineers, Research Centres

Electrabel:	http://www.electrabel.com	(site in French, Dutch and English)
Tractebel Engineering:	http://www.tractebel-engineering.com	(site in English)
SCK•CEN:	http://www.sckcen.be	(site in English)
Belgonucleaire:	http://www.belgonucleaire.be	(site in French, Dutch and English)
Belgoprocess:	http://www.belgoprocess.be/	(site in English)
ONDRAF/NIRAS:	http://www.nirond.be	(site in French, Dutch, English and German)

3. Associations

Belgian Nuclear Society:	http://www.bnsorg.eu/	(site in English)
Belgian Association for Radiation Protection (BVS/ABR)	http://www.bvsabr.be	(site in French and Dutch)

4. Others

WENRA (Western European Nuclear Regulators Association): http://www.wenra.org
ENSREG (European Nuclear Safety Regulators Group) : http://www.ensreg.eu/

VII. APPENDIX 5 – SUBJECTS EXAMINED DURING THE PERIODIC (TEN-YEARLY) SAFETY REVIEWS

VI.A. Subjects examined during the First Safety Reviews of the Doel 1, 2 and Tihange 1 Units

The following subjects have been examined:

1. protection against accidents of external origin and industrial risks
2. re-definition of the design earthquake
3. high-energy line break
4. fire protection
5. flooding, of internal or external origin
6. high winds and extreme climatic conditions
7. differential settlement between structures
8. systems having safety-related functions to shut down the reactor, for core cooling and for evacuation of residual power:
    - reactor protection system
    - safety systems: emergency feedwater supply to the steam generators,
    - shutdown cooling system, safety injection, spray or internal ventilation inside containment, emergency control room and auxiliary shutdown panel.
    - steam relief to atmosphere
    - ultimate heat sink
    - safety compressed-air
    - emergency electrical power
    - resistance and integrity of various systems
    - safety systems instrumentation
    - primary system leak detection
    - detection of inadequate core cooling
    - seismic and environmental qualification of safety systems
9. primary system integrity:
    - protection against cold and hot overpressure
    - protection against pressurised thermal shock
    - pressure vessel venting
    - integrity of primary pump seals
    - leak detection
    - boric-acid induced corrosion
    - list of actually incurred transients
10. nuclear auxiliary building: protection against post-accident radiation
11. inspection of structures and equipment (mechanical, electrical, civil works)
12. test programme
13. technical specifications
14. operation organisation
15. quality management
16. spent fuel handling and storage
17. gaseous effluent treatment and ventilation systems
18. isolation and leak-tightness of primary and secondary containments

19. hydrogen control inside containment
20. operation experience feedback
21. accident analysis review
22. radiation protection and ALARA
23. post-accident sampling in the reactor building
24. updating of documentation, including amendment of the Safety Analysis Report.

VI.B. Subjects examined during the First Safety Reviews of the Doel 3, 4 and Tihange 2, 3 Units, and Second Safety Review of Tihange 1

1. conformity to the design bases: re-evaluation of the environment
2. protection of electric safety circuits against lightning
3. verification of extreme climatic conditions
4. impact of the modifications made to the installations on the original "High Energy Line Break" (HELB) study
5. loadings combinations on the structures
6. anchorage of safety equipment
7. use of the results of the qualification of mechanical equipments : components with a limited lifetime
8. verification of the post-accident operability of pneumatic actuators
9. dimensioning of miniflow lines of safety related centrifugal pumps
10. post-TMI II.D.1 recommendation (mechanical resistance of the pressuriser discharge line)
11. instability of the pressuriser safety valves during passage of the water plug
12. qualification of the relief and block valves of the pressuriser
13. taking into account secondary effects in the calculation of pipe supports in "Level D"
14. thermal environment of electric equipment
15. qualification of electric connectors: containment penetrations
16. post-TMI II.F.2 recommendation (RM chains)
17. follow-up of the US rules and practices
18. general procedure for reloads safety justification
19. follow-up of operational transients
20. shift of the setpoint of the pressuriser safety valves
21. pressure vessel embrittlement
22. thermal ageing of stainless steel
23. primary pumps: re-evaluation of the axial bearing
24. risk of recirculation sump clogging during accidents
25. containment spray water chemistry
26. measurement of the containment free volume
27. depressurisation of the safety injection accumulators
28. availability of the LHSI pumps during recirculation
29. manual initiation of the primary containment spray
30. subcooling measurement with core thermocouples to be qualified in the context of post-TMI II.F.2 recommendation
31. verification of the response time of sensors
32. protection of diesel groups in case of emergency signal
33. availability of diesel groups during the sequence "SI signal followed by the complete loss of external electric grid"
34. overspeed protection of the emergency diesels
35. availability of motors under degraded voltage conditions
36. verification of the diesels loads

37. loss of low voltage busses: procedures
38. evaluation of the tightness of pool joints
39. evaluation of the fire detection and protection
40. ALARA policy
41. post-TMI II.B.2 recommendation (post accident accessibility)
42. revision of the programme for the training and licensing of the personnel
43. re-evaluation of the tightness tests of the recirculation lines
44. functional tests of the shock-absorbers
45. assessment of the periodic tests of pumps, valves and check-valves
46. test console for logic and analogic protection signals
47. global tests
48. welding of the safe-ends on the pressure vessel nozzles
49. pressure vessel inspection: underclad defects in the nozzles
50. impact of the stainless steel cladding on the pressure vessel inspections with u.s.
51. wear of the control rods
52. corrosion of the reactor baffle screws
53. corrosion of the guide tube pins
54. follow-up of the internal structures of the pressure vessels by analysis of neutronic noise
55. inspection of the steam generators: tube sheet — evacuation of the risk of underclad cracks
56. welding of the partition plate on the water box on the tube sheet and the bottom of the steam generators
57. steam generators: weld between the upper ring and the transition cone
58. corrosion problems of valve bolts
59. control of the pipe whip restraints
60. internal corrosion of the SI accumulators
61. post-earthquake procedure
62. evolution of the ASME Code section XI
63. ASME code section XI: appendices 7 and 8 (ultrasonic inspections)
64. steam generator problems: limitation of the primary/secondary leak
65. evaluation of the conclusions of generic studies of accidents not considered in the original design
66. consideration of severe accidents
67. probabilistic safety analysis
68. re-evaluation of the Technical Specifications
69. assessment of the implementation of the Q.A. programme
70. software quality assurance
71. quality management: Safety Evaluation Committee
72. feedback of operating experience from Belgian and foreign plants
73. assessment of incidents and synthesis of their causes
74. evaluation of the modifications which can impact safety
75. analysis of the influence of the emergency systems
76. evaluation of voluntary inspections
77. operator aids: shutdown mode

78. operator aids during accidents
79. primary breaks in modes 3 and 4
80. thermal stratification in the pressuriser surge line
81. thermal stratification in the main feedwater lines and their connection on the steam generator
82. check valves: generic problems

VI.C. Subjects examined during the Second Ten-yearly Safety Reviews of Doel l and 2

1. ageing of electric equipment
2. ageing of mechanical equipment
3. ageing of the pressure vessel and of the primary circuit
4. ageing of concrete structures
5. ageing of the steam generators
6. pressure vessel irradiation
7. availability of the recirculation function
8. antisiphoning system of the fuel pools
9. seismic qualification
10. qualification of safety related equipments
11. qualification of high energy lines
12. thermal stratification in the pressuriser surge line
13. classification of safety-related equipments
14. thermal stratification of feedwater lines
15. qualification of the auxiliary feedwater system
16. secondary overpressure
17. loadings combinations in the reactor building cells
18. implementation of ASME 1992
19. re-evaluation of the Technical Specifications
20. fire protection re-evaluation
21. toxic gases protection reassessment
22. improvement of the availability of the safety diesels
23. dismantling
24. ALARA
25. software QA
26. overlapping of tests for safety instrumentation
27. quality assurance
28. valving systems
29. corrosion due to boron
30. lightning protection
31. operational transients
32. protection of motors (undervoltage)
33. response time of radiological protection chains
34. integrity of underground lines
35. shielding of the radiological protection chains
36. feedback of operating experience
37. in service inspection
38. procedures after earthquakes
39. post accident procedures
40. severe accidents
41. probabilistic safety analysis
42. reassessment of accidents
43. transport container for spent fuel assemblies

44. setpoint statistical study
45. re-evaluation of the environment
46. inter-systems LOCA
47. radiological consequences
48. operational problems: follow-up of the pressure vessel internals

VI.D. Subjects examined during the Second Safety Reviews of Doel 3 and Tihange 2, subjects to be examined during the Second Safety Reviews of Doel 4 and Tihange 3, and subjects to be examined during the Third Safety Reviews of Doel 1 and 2, and Tihange 1

1. follow-up of US rules and practices
2. definition of a source term for the reference accident
3. post-'92 evolution of ASME XI Code OM
4. re-evaluation of the conformity of the Single Failure Proof cranes with current standards
5. re-evaluation of the Technical Specifications for the waste treatment building (WAB) at the Doel site
6. re-evaluation of the Technical Specifications of Tihange 1
7. re-evaluation of the Technical Specifications of Doel 1-2
8. evolution of the environment and its impact
9. re-evaluation of the impact of extreme climate conditions
10. re-evaluation of the seismic level on the basis of recent investigations
11. risk related to external flooding
12. risk related to internal flooding
13. systematic approach to assess the fire and explosion risk
14. re-evaluation of ultimate heat sink (wells) at the Tihange site
15. update of the PSA models
16. safety analysis for shutdown modes
17. follow-up of knowledge with respect to severe accidents
18. analysis of the safety impact of flow dissymmetry between primary loops
19. evaluation of main discrepancies with respect to the Position Paper on the application of the single failure criterion for the oldest units only :
    - electrical support systems (Doel 1 and 2)
    - safety related systems (Doel 1 and 2)
    - heat sink (Tihange 1)
    - plant air (Tihange 1)
20. updating accident procedures
21. procedure for incidents during fuel handling
22. procedure for loss of ultimate heat sink
23. updating of incident procedures
24. evaluation of PAMS measuring uncertainties
25. availability of safety related components
26. leak tightness of feedwater isolation valves
27. follow-up of prestressing of the primary containment
28. re-evaluation of the safety related ventilation
29. reassessment of containment isolation
30. pressurizing, of isolated piping in containment during accident conditions
31. reassessment of ventilation for emergency building (Tihange 2)
32. reassessment of ventilation for waste treatment building
33. structural integrity reassessment of emergency buildings

34. tests and criteria for safety related valves pumps, and diesels (Doel 1 and 2, and Tihange 1).
35. evaluation of radiation exposure of plant operators during an accident
36. isolation of normal feedwater (Tihange 1)
37. optimization of containment spray lay-out (Tihange 1)
38. containment spray additive (D12)
39. application of ASME XI, Appendix OM to liquid discharging spring loaded safety valves
40. verification of the efficiency of safety related heat exchangers
41. follow-up of the pressure vessel embrittlement and protection against cold overpressure
42. follow-up of ageing of guide tube split pins, of radial guides of the reactor vessel internals, of baffle bolts, of cast elbows, of safety related equipment, of temperature measurement probes in the primary loot by-pass, of CVCS heat exchangers and of elastomer supports
43. follow-up of equipment fatigue (including thermal stratification)
44. follow-up of corrosion phenomena in piping and line mounted equipment
45. renovation of I/C systems and safety related components
46. renovation of structures and buildings
47. renovation of fire protection systems
48. training of personnel and knowledge management
49. design basis retrieval
50. optimisation of ALARA policy
51. qualification of software systems against smoke

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