KINGDOM OF BELGIUM

National Report

Established for the second meeting of the Contracting Parties in the framework of the Nuclear Safety Convention

September 2001

INTRODUCTION

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.

As soon as in 1945, a Scientific Commission in Belgium examines the possibilities of civil applications of nuclear energy, and the "Institut Interuniversitaire de Physique Nucléaire" is 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 as a private non-profit organisation the "Centre d'Etude des Applications de l'Energie Nucléaire", which was to give birth to the "Centre d'Etudes Nucléaires" (CEN/SCK) at Mol (i.e. the Nuclear Research Centre), and which in 1957 became a public interest organisation.

Research reactors are built at Mol and become operational between 1956 and 1963. These are the BR1, a uranium/graphite reactor similar to England's BEPO pile, the materials test reactor BR2 (fuel assemblies with 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 is the first Westinghouse-type pressurized 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 rods as early as 1963,…) and train the first operators of the Belgian nuclear power reactors. This plant is currently being dismantled and the wastes produced are immediately conditioned. An important step was a very extensive decontamination of the primary circuit, which reduces the doses when cutting the primary pipes, the reactor internals and the pressure vessel, operations which are nearly finished.

Apart from 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 is being extended in the framework of the PRACLAY project, an economic interest group between the Mol Centre and the Belgian Agency for Radioactive Waste and Enriched Fissile Materials (ONDRAF).

From 1950 the private industry also invests in nuclear technology and participates in the construction of reactors. “Ateliers de Constructions Electriques de Charleroi” acquires the Westinghouse licence; “Métallurgie et Mécanique Nucléaires” manufactures enriched uranium fuel assemblies, and later forms a part of “Franco-Belge de Fabrication de Combustibles” (FBFC).

As regards the fuel cycle, the Mol Centre investigates several reprocessing techniques, as a result of which the Eurochemic Consortium, formed under the aegis of the OECD, builds 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.

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

At present it specialises in manufacturing MOX fuel.

The Belgian power utilities and their architect/engineers closely follow-up the evolution in nuclear technology and, confident with their BR3 experience, they decide 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 1997 to 2000, and the total gross production since the beginning of operation. The variations among the years are linked to the fuel cycle length (between 12 and 18 months) or to large modifications (like the steam generators replacement at Tihange 3 in 1998).

Let us remark that considering an average value of 900 grams of $C0_2$ equivalent released for each kilowatt.hour produced from fossile fuels, the Belgian nuclear production has allowed not to release in the atmosphere about 750 millions tons of CO_2 (status at the end of the year 2000).

In 1971 the “Institut des Radioéléments” (IRE) is built at Fleurus, manufacturing mainly medical radioactive isotopes.

In 1981 the “Organisme National pour les Déchets Radioactifs et les Matières Fissiles Enrichies” (ONDRAF) (i.e. the national organisation for radioactive waste and fissile materials) is created, and waste treatment and storage activities are performed at the Mol-Dessel site through its BELGOPROCESS subsidiary company.

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).

2. Contents of the present Report

This Report explains point by point Belgium's response to the various Articles of the Nuclear Safety Convention.

It takes into account the recommendations made during the preparatory meeting to this Report held in 1997 between the Contracting Parties to the Convention. However, rather than identifying for each Article the particularities and characteristics of the Belgian power plants, it was found preferable to give in the Appendix 1 a detailed description of the various units, highlighting their original design and the major modifications brought to them during the ten-yearly overhauls/safety reviews which are mandatory under the Belgian regulations.

The first edition of this National Report has been discussed on April 14, 1999 during the meeting of the Contracting Parties. About 70 questions had been submitted on this Report, for which written answers had been provided at the meeting.

The present edition takes into account the facts which occurred during the last three years. In particular, the current process of regulatory modification and Safety Authority reorganization, as well as the operational startup of the Federal Agency for Nuclear Control (FANC) are presented. The answers to the previous questions as well as additional information given during the meeting are incorporated.

A list of the abbreviations used in the present Report is given in Appendix 2.

Annex 3 gives the WEB site addresses of Belgian organizations playing an important role in the nuclear field.

Annex 4 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.

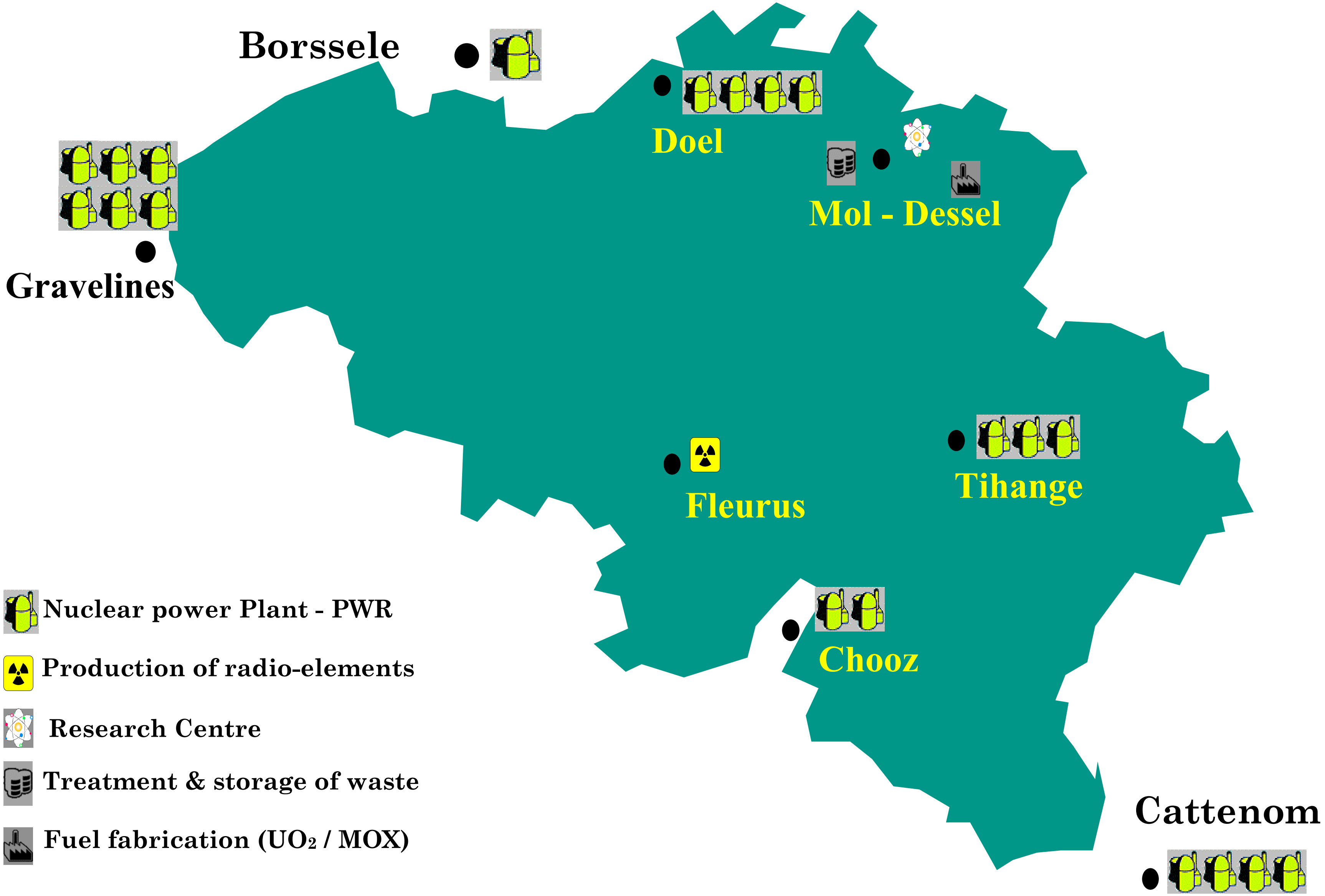

Borssele
Doel
Mol - Dessel
Gravelines
Fleurus
Tihange
Chooz
Cattenom
Nuclear power Plant - PWR
Production of radio-elements
Research Centre
Treatment & storage of waste
Fuel fabrication (UO_2 / MOX)

Table 1 – Gross production of the Belgian nuclear plants

	Gross capacity end of 2000 (MWe)	Commercial operation	Total gross production in 1997 (TWh)	Total gross production in 1998 (TWh)	Total gross production in 1999 (TWh)	Total gross production in 2000 (TWh)	Total gross production up to end 2000 (TWh)
Doel 1	412	1975	3.3	3.5	3.4	3.4	80.1
Tihange 1	976	1975	8.6	7.6	7.6	8.9	172.4
Doel 2	412	1975	3.1	3.3	3.2	3.3	72.8
Doel 3	1020	1982	8.5	8.4	8.7	8.3	134.8
Tihange 2	970	1983	7.1	8.0	8.4	7.8	130.7
Doel 4	1049	1985	8.0	8.3	8.5	8.5	117.5
Tihange 3	1070	1985	8.8	7.1	9.2	8.0	126.4
TOTAL	**5909**	**-**	**47.4**	**46.1**	**49.0**	**48.2**	**834.7**
% nuclear production	**-**	**-**	**59.6**	**59.7**	**58.3**	**55.3**	**-**

A. GENERAL PROVISIONS

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 obligation under this Convention

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

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 ths 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.

Belgium's seven nuclear generating units in operation are equipped with pressurized water reactors built either by Westinghouse or by Framatome, each time in partnership with Belgian manufacturers of the major equipments for the primary and secondary systems. These units were put into service between 1974 and 1985.

The Belgian operators and their architect/engineers had already gained experience in that technology with the BR3 reactor of the Nuclear Research Centre at Mol, and with their participation in the Ardennes Nuclear Power plant (SENA) at Chooz (France).

Belgium did not develop national nuclear safety regulations, but instead adopted the American regulations. Furthermore, for the four most recent generating units, the "Commission Spéciale Radiations Ionisantes" (the official name of Belgium's Nuclear Safety Commission) stipulated that external accidents be taken into account, such as an aircraft (civil and military) crash, a gas explosion, a major fire, the effects of toxic gases. These requirements resulted in duplication of a significant number of safety systems, installed in bunkerized 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 installations.

The way these different rules were implemented during the design and the construction of the nuclear units is explained in article 18, where the implementation of USNRC rules, and the related codes and standards (ASME code, ANSI standards, IEEE,…), are specifically discussed.

The technical characteristics of each generating 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.

One can in particular observe how the protection against accidents of external origin has been done and has 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-bunkerized building) and with 3 emergency trains to mitigate accidents of external origin (each train with a Diesel located in a bunkerized area and built by a manufacturer different from the one of the normal safety Diesels, ensuring diversity). The safety trains and the emergency trains are not designed to cope with the same accidents (of internal origin for ones, of external origin for the others) but the emergency trains provide an equipment diversity which can be very useful even for some accidents of internal origin, as the probabilistic safety studies have shown.

In Belgian law the operating licences are granted by Royal Decrees that do not impose a time limit, but the Safety Authorities can at any time suspend the licence should a major safety problem be detected.

The licence given for each unit individually makes it mandatory to conduct ten-yearly overhauls/safety reviews. These overhauls/safety reviews must "*compare on the one hand the condition 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 highlighted, 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".

The obligation to perform ten-yearly overhauls/safety reviews exists since 1975 in the Belgian regulations, making Belgium a pioneer in this respect.

During the first ten-yearly overhauls/safety reviews which took place for Doel 1 and 2 and for Tihange 1 in 1985, i.e. ten years after the beginning of their commercial operation, the objectives have been defined as follows:

- demonstrate that the unit has at least the same level of safety as it had when the licence was given to operate it at full power;
- inspect the condition of the unit, devoting more particular attention to ageing and wear and to the other factors which may affect its safe operation during the next ten years;
- justify the unit's current level of safety, taking into account the most recent safety regulations and practices and, if necessary, propose appropriate improvements.

These objectives are those that have now been recognised by all the European countries (EUR 15555 report) or that are included in the international safety guides (guide O12 of IAEA's NUSS programme).

As nuclear safety rules had substantially evolved in the 1970-1980 period, the first ten-yearly overhauls/safety reviews of Belgian generating units examined a wide spectrum of topics, including the taking into consideration of external accidents for the first three constructed units and bringing them to the level of the four most recent units.

For instance, at Tihange 1, considering a design earthquake of 0.17 g intensity (value of the Safe Shutdown Earthquake detained in the safety analysis of Tihange 2 and 3) instead of the original value of 0.1 g detained 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 treated included protection against high-energy line breaks, protection against primary system overpressure, improvement of fire protection, improvements to 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 detained for the design has an intensity of 0.056 g.

As for Tihange 1, this has led to check the resistance of buildings and equipments. Moreover, to cope with accidents of external origin, a bunkerized 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.

During the second ten-yearly overhauls/safety reviews of these units (1995) and during the first ones of the more recent units (1992 and 1995), probabilistic safety assessments were conducted systematically. The taking into account of severe accidents, for instance, resulted in the installation of (autocatalytic) hydrogen recombiners inside the reactor containment.

Shutdown states have also been considered, according to deterministic rules (for example pressurized cold thermal shock, spurious dilutions, procedures to face the loss of the residual heat removal system, procedures to manage severe accidents), as well as in the probabilistic safety analyses (e.g. mid-loop operation).

Systematic analysis of experience feedback from the Belgian units and from units abroad resulted, among other things, in improvements to systems and/or replacement of components, verification of the coherence of past modifications, and in implementation of certain large projects.

Appendix 1 gives for each nuclear installation a more detailed description of the major improvements and modifications implemented since they were first built. Appendix 4 gives also a detailed list of the topics considered during the ten year safety reviews of the Doel and Tihange units.

As a conclusion, the permanent in-service monitoring and inspection of the installations, combined with the ten-yearly overhauls/safety reviews during which are also taken into account the changes in regulations and practices, the systematic use of feedback of operating experience, ensure that the safety of the installations is maintained and even improved. Ageing is systematically investigated in order to demonstrate the safety of the installations during the next decades.

Summary of the main projects and modifications to the installations		
Year	**Unit**	**Description**
1993	Doel 3	Replacement of the 3 steam generators + power uprate
1994	Tihange 2	Introduction of MOX fuel
1994	Doel 3	Introduction of MOX fuel
1994	Tihange 2	Power uprate
1995	Tihange 1	Replacement of the 3 steam generators + power uprate
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 uprate

B. LEGISLATION AND REGULATION

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 withoug 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.**

Preamble:

When preparing the present report, the process to modify the legislative and regulatory Belgian framework is about to be completed. This process, started several years ago, is aimed at reinforcing the regulations as well as at restructuring the Safety Authority.

Regulatory framework: The main modification to the regulations concerns the "General Regulations regarding protection of the population and workers against the dangers of ionising radiation" (Royal Decree of 28 February 1963). This rule is Belgium’s basic regulation for nuclear safety and radiological protection. A new Royal Decree of 20 July 2001 replaces, from September 1 on, the one of 28 February 1963. Its scope is wider than previously 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 radioprotection 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 20 July 2001 enforces many articles of the Law of 15 April 1994 and therefore makes operational the Federal Agency for Nuclear Control created by that Law. The structure of the public organization will be explained in Article 8. Let us here mention that this organization, endowed with wide competences, constitutes the Safety Authority. It gathers in a coherent fashion the different departments of the Ministries with the competences regarding nuclear regulations.

During the second meeting of the contracting parties to the Nuclear Safety Convention, more detailed information on the ongoing process will be given. In the present report, the situation prior to the ongoing modifications is explained, along with, at the relevant places, references to the new regulations and to the involved changes. In particular, section 7 of the present article describes the main modifications, coming from the Royal Decree of 20 July 2001, to the authorization process of nuclear installations concerned by the Convention,

In Belgium Electrabel, a private utility company, operates the Doel and Tihange nuclear power plants under the supervision of the public Authorities. The relevant Ministries each oversee the nuclear activities in their field of competence (Internal Affairs, Employment and Labour, Public Health and Environment, Economic Affairs, Justice, Foreign Affairs). The legal and regulatory environment evolved in step with the evolution of nuclear science and technology.

Regulations concern the licensing of nuclear establishments, the measures to protect the health of the workers and of the public, nuclear civil liability, safeguards, nuclear materials transport, waste management, emergency plans, etc.

A brief overview of the legislation is given below in chronological order and for each main topic. After this summary the legislation 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 liable 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.

1. Nuclear safeguards (control of fissile materials)

- The law of 4 August 1955 on State security in the field of nuclear energy was enacted to establish control of fissile materials prior to being able to obtain enriched uranium for the research reactors that were then being built at the Mol Centre.
- The royal Decree of 14 March 1956 specifies the application modalities of this law and defines the safety measures imposed for “research, the materials and manufacturing methods used or applied by the institutions, establishments, individual and legal entities that possess nuclear knowledge and documents or nuclear materials which they either obtained directly from the Government or with its authorisation, and which, for reasons of defence of the territory or State security, are governed by a regime of secrecy”.
- Later, a few laws introduce in the Belgian legislation the commitments related to the international treaties signed by Belgium.
  For instance, the law of 2 December 1957 addresses the provisions of chapter VII - Safeguards - of the Euratom Treaty; the law of 20 July 1978 introduces the inspection and verification activities performed by the International Atomic Energy Agency (IAEA) and its relations with the EURATOM inspections.
  The law of February 1981 covers the implementation by Belgium of her commitments made under international agreements regarding non-proliferation of nuclear weapons : it defines the conditions for transfer of nuclear materials, equipment, technology and know how to countries that do not possess nuclear weapons, with a view to the exclusively pacific development of atomic energy. The relevant procedures were detailed in the application Royal Decrees, especially those of 12 May 1989 and of 16 July 1993.
- The Royal Decree of 12 February 1991 states precisely that it is forbidden to trespass and to stay on the grounds and in the buildings aimed at in article 19 of the Royal Decree of 14 March 1956 if one did not get a nominal authorization from the manager of the

facility. The officials in charge of the supervision are not subject to that obligation of authorization.

- The law of 11 December 1998 is relative to the classification and security licences. It applies to a very large scope of activities, including the nuclear energy field.
  It defines different classes of documents and the criteria to licence the persons who will have an authorized access to these documents. The Royal Decree of 24 March 2000 gives the implementation prescriptions of this law.

2. Nuclear safety (protection of the population and workers against ionising radiation)

- The law of 29 March 1958 very generally outlines the protection of population and environment against the dangers of ionising radiation (this law was modified several times, in 1963, 1969, 1983, 1989, 1992, 1993, ...)
  The detailed stipulations are given in the Royal Decree of 28 February 1963 "providing the General Regulations regarding protection of the population and workers against the dangers of ionising radiation" which is Belgium's basic regulation for nuclear safety and radiological protection, and which is permanently updated. Given its importance, this text will be detailed at the end of the present Article of the National Report.
  This Royal Decree has been incorporated as Annex D into the Regent's Decrees of 11 February 1946 which provide the "Règlement Général pour la Protection du Travail (RGPT)" (i.e. Belgium's occupational health & safety regulations) in the traditional industrial field.
- In 1975 when the decision was taken to build four more nuclear units (Doel 3-Tihange 2 and Doel 4-Tihange 3), the "Commission Spéciale Radiations Ionisantes" (i.e. the Belgian Nuclear Safety Commission, the role of which will be explained in the analysis of the Royal Decree of 28 February 1963 : see section 6 of the present Article) decided that the American nuclear safety rules would be applied, and this according to a schedule consistent with their date of issue, and that a number of external accidents be considered in a deterministic manner (crash of civil and military aircraft, gas explosion, toxic cloud, large fire, ...). The whole safety analysis of these units was conducted on these bases applying the American legislation.
  As regards pressure vessels installed in nuclear installations, a derogation (Ministerial Decree) was issued in order to replace the conventional Belgian legislation (RGPT) by the American rules; at the same time the administrative aspects of the ASME code were transposed to Belgium.
- Following the Three Mile Island accident it was decided to improve co-ordination between the Ministries competent for nuclear energy : the Royal Decree of 15 October 1979 creates the "Inter-Ministerial Commission for nuclear safety and State security in the nuclear field" composed of representatives of the Ministries of Public Health and Environment, Employment and Labour, Justice, Internal Affairs, National Defence, Economic Affairs, Foreign Affairs. This Commission establishes the co-ordination plan of the activities of all these ministerial departments.

  These arrangements do not in any way relieve the public or private companies that operate nuclear facilities from their responsibilities for the safety of nuclear installations, nor regarding State security.

- The Royal Decrees of 7 August 1981 and 14 August 1981 respectively create the "Service de Sûreté Technique des Installations Nucléaires" (SSTIN) within the Ministry of Employment and Labour, and the "Service de Protection contre les Radiations Ionisantes" (SPRI) within the Ministry of Public Health. (i.e. respectively the Technical Safety Service for Nuclear Installations, and the Service of Protection against Ionising Radiation).

  The aim is to provide a firmer organic framework and better define the areas of competence of the persons who were already involved in nuclear safety matters in these two Ministries.

  The tasks of the SSTIN comprise:

  – take care of the secretarial services of the "Commission Spéciale Radiations Ionisantes", and conduct the preliminary examination of the safety cases
  – provide support to the "Commission interministérielle de la sécurité nucléaire et de la sûreté de l'Etat dans le domaine nucléaire"
  – analyse problems relating to the technical safety and operation of nuclear installations
  – co-ordinate the tasks of the various inspection services that oversee nuclear installations as concerns worker health & safety, and provide to these services the necessary scientific assistance in that respect
  – propose the appointment of Authorized Inspection Organisations[1] to which the State entrusts specific tasks in the above field
  – follow-up the tasks entrusted in the above field to the Authorized Inspection Organisations.

  The tasks of the SPRI comprise:

  a) checking the implementation of the "General Regulations regarding protection of the population and workers against the dangers of ionising radiation", including :
     - examine the licence application files for nuclear power plants and other class I establishments, as well as for class II and III establishments operated by the State;
     - examine the licence application files for the import, transit and transport of radioactive substances, and check that the particular conditions stipulated in those licences are being met;
     - propose the approval and inspect the medical equipment that emits ionising radiation;
     - propose the approval of pharmacists and physicians who use sources of ionising radiation;
     - examine the licence application files to use radioactive substances for medical purposes, as well as for the production and distribution of such substances; check that the particular conditions stipulated in those licences are being met;

1. The Belgian regulations stipulate that tasks such as design review, supervision and inspection as required by the regulations be performed by organisations appointed by the Auhtorities especially for that purpose (the "Organismes Agréés").
   These Authorities define the conditions and criteria that these approved organisations must meet (see section 6 below and Article 8 of the present National Report).

- examine the licence application files to use ionising radiation for sterilising of medical equipment and food products, and check that the particular conditions stipulated in those licences are being met;

b) perform the secretarial tasks of the “Commission interministérielle de la sécurité nucléaire et de la sûreté de l’Etat dans le domaine nucléaire”;

c) prepare regulations and regularly review and update existing regulations concerning ionising radiation.

The practical implementation of the Royal Decrees and the collaboration between these Departments and the authorized inspection organisations are discussed in Article 8 of the present National Report.

- the law of 15 April 1994 creates the “Agence Fédérale de Contrôle Nucléaire” (AFCN) and defines the missions entrusted to this Federal Agency for Nuclear Control.

  The purpose is the integration within a single entity of both the missions and the personnel of SSTIN and SPRI, as well as some missions assigned at present to other Ministries (e.g. accompanying the inspection and verification activities performed by the IAEA in the safeguards area), and rewrite the administrative texts by incorporating into this law the portions of the Royal Decree of 28 February 1963 that have a regulatory nature.

  It is planned to gradually bring into force the various articles of that law, i.e. as and when needed, and at the same time gradually delete the texts that have become obsolete considering the present regulations. In this way any hiatus between regulations is avoided and the continuity of the missions and services is secured. The main provisions of this law are described in section 7 of this article of the National Report.

- The Royal Decree of 25 April 1997 concerns the protection of workers against the effects of ionising radiation, and transposes to Belgian law the Euratom/90/641 Directive. Among others, this R.D. stipulates the obligations of the employers, the particular obligations of the outside contractors, the particular obligations of the operator, the missions of the occupational medical inspection service, the missions of the physical control service. It imposes the keeping of an exposure and decontamination chart and the individual document for each outside-contractor worker exposed to ionising radiation. This text makes up Chapter VII of Title IV of the “Code about well-being at work” with the following headings: “’Title IV: Environmental factors and physical agents”, “Chapter VII: Ionizing radiation”.

- The Royal Decree of 2 October 1997 brings into force the Articles 3 and 49 of the law of 15 April 1994 regarding only export of nuclear materials, in order to transpose the Euratom 92/3 Directive regarding monitoring and inspection of radioactive waste transfer.

  Chapter IV (import, export, transit and distribution of radioactive substances) of the R.D. of 28 February 1963 (Articles 38 to 44) is entirely replaced by a new text in order to ensure the coherence of the legislation, after the introduction of articles transposing the Euratom 92/3 Directive referred to here above.

  Chapter VI (Medical uses of ionising radiation) of the R.D. of 28 February 1963 (Articles 50 to 55) is also replaced by a new text, which introduces among other the notion of a radiophysical expert who is in charge of optimizing the diagnosis and therapeutics techniques as regards patient protection.

These adaptations make the Belgian legislation consistent with the Euratom 84/466 Directive (fundamental measures related to the radiological protection of persons subjected to medical examinations and therapies), with the Euratom 89/618 Directive (information of the population about the applicable health protection measures and on the adequate behaviour in case of radiological emergency), and with the Euratom 90/461 Directive (operational protection of outside workers exposed to the risk of ionising radiations during their intervention in a controlled zone).

- In order to transpose the Euratom 96/29 Directive (new basic safety standards) and the Euratom 97/43 Directive (health protection of persons exposed for medical purposes, replacing the Euratom 84/466 Directive), a global project of "General Regulations regarding protection of the population, the workers and the environment against the dangers of ionising radiation" has been approved by the Belgian Government in October 2000.

  This project of Royal Decree has been submitted to the advice of the State Council. The final text has been approved by the Government on 19 July 2001 and signed by the King on 20 July 2001. Its publication in the Belgian Official Journal ("Moniteur") in August 2001 makes the Federal Agency for Nuclear Control (FANC), established by the 15 April 1994 law, legally operational on 1 September 2001.

  This new Royal Decree replaces that one of 28 February 1963 but keeps the coherence with the previous text (same topics treated in articles keeping the same numbering), introduces all the missions of the FANC instead of those of the previous Services and implements the Euratom Directives mentioned hereabove.

3. Nuclear civil liability

The Royal Decree of 28 February 1963 already mentioned the operator's commitment to subscribe an insurance policy covering his civil liabilities resulting of his nuclear activities.

The law of 18 July 1966 on civil liability in the nuclear energy field establishes a number of measures for immediate implementation of the Paris Convention and its additional protocol.

Taking into account the previous texts, the Belgian legislation is entirely contained in the law of 22 July 1985 on "Civil liability in the field of nuclear Energy", which integrates the Paris Convention and the follow-up Convention of Brussels and their additional protocols.

Consistent with the provisions of the Paris Convention and its protocols, this law establishes the principle that the operator of a nuclear facility is responsible for the damage caused by a nuclear accident.
This is an objective responsibility that waives for the victim the obligation to provide proof of a fault that had a causal effect.

The operator must seek cover for his liability through an insurance policy or an other financial guarantee. The operator's licence is conditional to the existence of adequate guarantee or cover.

The law of 11 July 2000 brings the maximum amount of the civil liability of Electrabel for damages caused by a nuclear accident to 12 billions Belgian francs (about 300 millions euros) per accident and per site (each site, Doel and Tihange, being considered as one nuclear installation).

4. Waste management

Until 1980, waste treatment and storage were taken care of by the "Waste" Department at the Mol Centre, under the contracts which the Centre had signed with the large producers of nuclear waste in Belgium.

The law of 8 August 1980 creates ONDRAF in the following terms: "A public organisation is set up to be in charge of managing the storage of conditioned radioactive waste, disposal of radioactive waste, transport of radioactive waste and enriched or plutonium-containing fissile materials, as well as storage of plutonium. The organisation is further in charge of conditioning of radioactive waste originating from installations that do not possess their own equipment to perform one or more of these operations".

The experience gained in 10 years of operation is the basis for the law of 11 January 1991 and its application Royal Decree of 16 October 1991, which extend and list all the missions of ONDRAF, which include long term research programmes to define solutions for final repositories, propose specifications for waste exemption or clearance, take charge of excess fissile materials, oversee the decommissioning of the installations.

Article 9 of the general law of 12 December 1997 relative to various provisions assigns a new mission to ONDRAF: establish and maintain up to date an inventory of all nuclear facilities and sites containing radioactive substances. The aim of these new legal clauses is to avoid the creation of liabilities by ensuring that each operator of a nuclear site or facility secures, during operation, the funds necessary to the decommissioning and the rehabilitation of facilities, sites, substances and materials when activities have ceased. The Royal Decree of 31 May 2000 fixes the amount of the fees to be paid by the operators to ONDRAF for performing that task.

5. Emergency plan

The law of 31 December 1963 defines the notion of Civil Protection, and the Royal Decree of 23 June 1971 organises the civil protection missions and the co-ordination of operations during calamities, catastrophes or disasters.

It is mandatory for nuclear installation operators to define an internal emergency plan approved by the Regulatory Body and regularly test this plan to address possible accidents. The intervention of the Authorities outside the affected installations takes place under the authority of the Interior Ministry, which oversees the Civil Protection.

Belgium signed two conventions dated of 26 September 1986 with the IAEA, one concerning prompt notification of nuclear incidents, the other regarding assistance in the event of a nuclear accident. Two laws, dated 5 June 1998, ratify these Conventions and introduce them in this way in the Belgian legislation. Belgium applies also the European Directives in these matters.

The Royal Decree of 27 September 1991 defines the national emergency plan and the tasks of each of the involved parties. The relevant infrastructure is being provided accordingly.

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

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

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

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

The present plan has been essentially designed for :

- nuclear accidents or any other radiological emergency situation arising at the Belgian nuclear power plants of Doel or Tihange or in the other Belgian nuclear installations such as the Nuclear Research Centre (CEN) at Mol, the “Institut des Radioéléments” (IRE) at Fleurus, Belgoprocess and Belgonucléaire at Dessel;
- the cases of detection of abnormal radioactivity on the Belgian territory or outside it.

This plan can also be activated in radiological emergency situations arising form accidents during transport of nuclear fuel, isotopes or radioactive waste, following re-entry of spacecraft containing radioactive products, following accidents or situations involving military equipment or in military facilities, or during accidents at Belgian nuclear installations other than those referred to above (Thetis reactor at Gent, FBFC at Dessel, IRMM at Geel,...).

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.

6. Royal Decree of 28 February 1963

This Royal Decree has provided the basic nuclear safety and radiological protection regulations and has been constantly amended and updated by the Safety Authorities in order to introduce new concepts, take into account the European directives, etc.

As said in section 2 of the present article, this Royal Decree has been replaced in August 2001 by a new Royal Decree, but the present version of the National Report still makes reference to the Royal Decree of 28 February 1963, as there are no contradictions with the new Royal Decree, in order to ensure the coherence of the text of the National Report, which must be submitted in September 2001.

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

a. Chapter I - General clauses

- Article 1: Field of application

The present regulation applies to :

1. import, production, manufacture, possession, transit, transport, utilisation 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. treatment, handling, storage, elimination and disposal of radioactive substances and waste;
4. any other activity 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 radiations, ordered by the Minister of National Defence.

These two points are covered by specific regulations.

It does not concern natural background radiation.

- Article 2 - Definitions

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

b. Chapter II - Classified establishments policy

- Article 3 - Establishment classification

  The establishments are classified in four classes :

  - class 1 comprises the nuclear reactors, the establishments 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 critical mass, the enriched or not enriched spent fuel reprocessing plants, the establishments intended for collection, treatment, conditioning, permanent storage or disposal of radioactive waste.
  - class 2 comprises the establishments where radioactive substances are produced from irradiated fissile materials and where they are packaged for sale, the particle accelerators, the establishments where are used or stored any quantities of fissile substances other than class 1 (excluding natural thorium and natural or depleted uranium), the establishments using X-ray sources operated at a peak voltage of more than 200 kV, the establishments where are used or detained quantities of radioactive nuclides of which the total activity is larger than the values X_2 given in a table of this Royal Decree.
  - Radionuclides are distributed in 4 classes (A, B, C, D) according to their relative radiotoxicity: very high radiotoxicity (A), high (B), moderate (C), small (D).
  - The X_2 values are 5 MBq for class A, 50 MBq for class B, 0.5 GBq for class C and 5 GBq for class D.
  - class 3 comprises the establishments where are used or held quantities of radioactive nuclides of which the total activity is comprised in the X_3 range of values; the establishments where are used or detained sealed sources containing

quantities of radioactive nuclides of which the total activity is higher than the maximum values of the X_3 range without exceeding the hundredfold of those values; the establishments using X-ray sources operated at a peak voltage of 200 kV or less.

The upper limits of the range of the X_3 values are the values X_2 indicated above according to the radiotoxicity class; the lower limits are equal to one thousandth of these X_2 values.

- class 4 comprises the establishments that use very low quantities of radioactive substances (i.e. below the lower limits of the X_3 range) or using equipment emitting ionising radiation at a very low rate.

  The establishments in which are used or held natural or depleted uranium and natural thorium are classified in class 4 providing the corresponding quantities are equal to or less than respectively 5 MBq and 50 kBq (otherwise they fall in class 3).

  A weighting formula is specified concerning mixtures of radionuclides, in order to determine the class of the establishment where such mixtures are used or hold.

- Article 4 - Classification of radioactive nuclides according to their relative toxicity

  Four categories are defined: very high, high, moderate and low radiotoxicity; the list is given of the radionuclides included in each of these categories.

- Article 5 - Authorisation regime - General

  5.1. Classes 1, 2 and 3 require prior licensing by the Authority as specified by this regulation.

  5.2. The operators or managers of these establishments must comply with the conditions stipulated in the licensing decree (i.e. the decree that grants the licence)

  5.3. The licences can be issued for an unlimited or for a limited time period; they cannot be issued "on trial".

  This Article further regulates possible transfer of the licence, change of operator or manager of the establishment, waiving of obligations to supply certain information.

  It is also specified that the establishments where ionising radiation is only occasionally used (e.g. for non-destructive inspection of welds, …) do not fall within a class in the sense of this regulation if such activities are performed by an outside establishment duly licensed for such activities.

- Article 6 - Licensing regime for class 1 establishments.

  6.1. The King is the competent Authority; accordingly, the licence will be issued in the form of a Royal Decree countersigned by the relevant Ministers.

  6.2. This section details the information and the documents to be supplied 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):

  - the applicant's identity,
  - the description of the planned establishment, 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 standards,

- the qualification and competence of the personnel, as well as the presumed numbers of personnel occupied in the various sections of the establishment,
- the drawing of the site and its installations,
- the demographic, topographic, seismic, hydrological and meteorological characteristics of the area situated within a 15 km radius of the site, and indications about land use in that area,
- a report describing the most serious accidents that could be incurred by the installations, and an evaluation of their probability of occurrence and their foreseeable consequences for the population and the workers,
- the proposed measures for disposal, treatment and evacuation of radioactive waste in the form of liquid effluent, solid or gaseous waste (the detailed characteristics are specified in the regulation),
- a descriptive report, with a non-technical summary of the information contained in this report, of an environmental impact evaluation,

6.3 and 6.4.

These sections relate to the opinion of the municipality and of the province.

6.5 to 6.7.

These sections deal with the intervention of the "Commission Spéciale Radiations Ionisantes" (sometimes referred to in short as "Commission Spéciale" - and in the present National Report then referred to as the "Special Commission"). This Commission examines and states its advice on the licence application, and may seek the opinions from outside experts, national or international, or foreign organisations. In the cases provided for in Article 37 of the Euratom Treaty, it seeks the advice of the Euratom Commission.

Analysis of all the documents forming the application (including the Safety Report as regards nuclear power stations) is entrusted by the Chairperson of the Special Commission to a Rapporteur, the latter presenting his findings and conclusions to the Special Commission (see also Article 8 section 1.b of this National Report describing the work of the Regulatory Body). On these bases and after deliberation the Special Commission issues its advice.

A favourable advice of the Special Commission may stipulate particular conditions or restrictions to operation in order to ensure the safety of the establishment and mitigate its environmental impact.

The licence is not granted if the advice of the Special Commission is negative.

If the Special Commission's advice is positive, a denial of the licence must be motivated.

The Special Commission is composed of 9 representatives of the various relevant Administrations, 14 personalities selected in view of their scientific or technical knowledge in the nuclear, radiological protection and environmental fields. The three Regions that compose Belgium may each also delegate 3 representatives which have a consultative capacity but have no say in the final judgment.

- Articles 7 and 8

  These Articles deal with the licensing regime for class 2 and 3 establishments.

- Article 9

  Class 4 establishments are not subject to any licensing formalities, nor to the obligation of notification.

- Articles 10 and 11

  These Articles deal with establishments operated by the State, or mixed (State/private) establishments.

- Articles 12 and 13

  These Articles deal with significant modifications or extensions of the establishment, as well as with the additional conditions and changes to conditions laid down regarding operation.

- Article 15 - Inspection of installations of class 1 and 2 establishments.

  Prior to first start-up these installations must be inspected by an authorized inspection organisation with regard to compliance with the regulations and with the particular operation conditions set in the licence. They may be started-up only if the inspection report issued by the authorized inspection organisation is completely positive and formally authorises the start-up or, as the case may be, the industrial operation.

  The technical content of the intervention of the authorized inspection organisation designated by the Safety Authorities (see Article 7, section 2, of the present National Report) is specified in Article 8 section 1.b. of the present Report.

- Article 16

  The competent Authority may suspend or withdraw the licensing decree, after consultation of the Special Commission, when the regulations and/or the particular operation conditions set in the licence are not complied with.

- Article 17

  When the establishment ceases its activities, the radioactive substances it holds at that time must be given a destination that guarantees their reuse or disposal under satisfactory conditions. The same applies when the competent Authority refuses, suspends or withdraws the licence and its decision is definitive.

- Article 19

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

c. Chapter III - General protection

- Article 20 - Limitation of doses

  The limitation of individual or collective doses is based on the general principles of justification, of keeping the doses as low as reasonably achievable, and of compliance with the limit doses.

  These doses are specified in detail for professionally exposed people, for trainees and students, and for members of the public.

Concerted exceptional exposure, accidental exposure and emergency exposure of the workers are also discussed in this Article.

- Article 23 - Health physics
  - The establishment general manager must organise a "protective physical control department", i.e. Health Physics Department, in charge of nuclear safety and radiological protection.

    The tasks of this department are listed; they include, among other, the definition of controlled zones, the prior approval of modifications that do not require applying for a new licence, prior approval of experiments, tests, treatments and handling that it had not approved in the past, commissioning of new installations, supervision of handlings and transfer of radioactive or fissile substances inside or outside the site, the determination of the intensities of radiation and contamination, liaising with the doctor 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.

    This department must be headed by a class1-authorized expert.
  - The establishment general manager must entrust to a class 1-authorized inspection organisation the permanent supervision of the adequate implementation of the Health Physics Department's tasks, and the acceptance inspection of the installations (cf. Article 15 of this R.D.), the examination and approval of the decisions made by the head of the Health Physics Department, the monitoring of transport (see also Article 8 section 1.b. of the present National Report).

    The establishment general manager must supply to the authorized inspection organisation all the information and documents needed by that organisation to accomplish its mission.
- Articles 24 to 26

  These Articles respectively deal with the medical checks of workers professionally exposed to radiation, with information and training of workers and of people possibly exposed and with committing the workers to conform to the instructions and regulations .
- Articles 27 to 32

  These Articles relate to the general protection equipment and arrangements, including signalling.
- Articles 33 to 36

  These Articles deal with radioactive waste emitting radiation higher than the natural background radiation. They concern the collection, treatment and evacuation of liquid waste, forbidding effluent discharge to surface waters, to the sewers or in the soil as soon as the concentration in the effluent exceeds 10^{-2} to 10^{-4} (depending on the case) of the limit on the annual ingestion level by adults of the general public.

  Exceptions to these limits may be included in the licensing decrees of class 1 or 2 establishments, based on performed surveys or studies.

  The regulation deals in a similar way with gaseous effluent and solid waste.

- Article 37

  This article deals with deposits of liquid and solid radioactive wastes which may not be moved. These wastes must be contained and kept in solid and tight recipients and stored in fireproof locations.

  Deposit of these wastes on the ground or in the ground is forbidden, except authorized derogations for class I and II establishments.

  Article 37bis forbids entry of unauthorized people in the establishments mentioned in the law of 4 August 1955 (R.D. of 14 March 1956 and 12 February 1991).

  Articles 37ter, quarter, quinquies are related to the operational protection of outside workers exposed to the risk of ionising radiation when they intervene in a controlled zone.

d. Chapter IV - Import, transit and distribution of radioactive substances

These subjects are treated in the Articles 38 to 44, which take into account the Euratom 92/3 Directive.

e. Chapter V - Radioisotopes used in non-sealed form in human and animal medicine

These subjects are treated in the Articles 45 to 49.

f. Chapter VI - Medical applications of ionising radiation

These subjects are treated in the Articles 50 to 55, which take into account the Euratom 84/466, 89/618 and 90/641 Directives.

g. Chapter VII - Transport of radioactive substances

This subject is treated in the Articles 56 to 60.

h. Chapter VIII - Nuclear propulsion

Articles 61 to 63 deal with this subject, including as regards visiting/berthing permits to be applied for by foreign nuclear-propelled ships.

i. Chapter IX - Bans and authorisations

A certain number of uses of radioactive substances are specifically forbidden (Article 64). Certain applications (for example sterilisation) are subject to prior authorisation (Article 65).

j. Chapter X - Exceptional measures

Article 66 concerns the measures against 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.

k. Chapter XI - Final provisions

Article 70 concerns radioactivity monitoring of the territory, and of the doses received by the population, which is taken care of by the Ministry of Public Health.

This Article details the required monitoring and inspection activities.

Article 71 deals with the (radiological) monitoring of the population as a whole, collection of all the data, including as regards professionally exposed workers.

Article 72 deals with the emergency plan for nuclear risks and with information of the population. It specifies what the emergency plan must at least provide for and is consistent with the Euratom 89/618 Directive.

Article 73 sets all the conditions for the authorization of experts, Article 74 for the authorization of the inspection organisations, Article 75 those for authorization of doctors in charge of the medical surveillance of the workers professionally exposed to ionizing radiation.

The final Articles relate to provision of information, to certain exceptions, to supervision, to enforcement measures (closing of unlicensed establishments), to official reporting and penalising of infringements.

7. Royal Decree of 20 July 2001: modifications related to the licensing regime for class 1 establishments

The main modifications to the new general regulation, adopted by the Royal Decree of 20 July 2001, result on the one hand from the enforcement measures of the law of 15 April 1994 and on the other hand from the transposition of several European Directives. In addition to the modifications related, amongst others, to the reinforcement of the basic radioprotection norms and the new strict rules concerning the liberation or the recycling of very low level solid waste that also have an important impact at the level of the design, the operation and the dismantling of the nuclear installations concerned by the Convention, the new regulation deeply modifies the licensing procedure for those establishments.

From now on, the new procedure to obtain a construction and operation licence will have two phases, each ended with a Royal Decree, replacing the single licensing decree of the previous regime of the Royal Decree of 28 February 1963. The application file includes essentially 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 analyses,
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, and an environmental impact study.

The file is first presented for advice to the Scientific Council of the FANC (previously known under the name Special Commission). A mandatory international consultation (required by the Article 37 of the Euratom Treaty and/or required by the 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 concerned local authorities for advice, and then to the standing committee of the concerned provinces. The whole file returns to the Scientific Council for final advice. A positive advice of the Scientific Council is necessary for a positive decision with conditions. This construction and operation licence allows the applicant to realise the installations in conformity with the Authorization Decree.

The second phase aims at obtaining the decree confirming the construction and operation licence. The Federal Agency for Nuclear Control (FANC) or the authorized inspection organisation acting on behalf of the FANC proceeds to the acceptance inspection before start-up and the introduction of radioactive substances. A fully favourable acceptance report leads to the confirmation decree allowing the operation of the establishment.

The picture at the end of this Article 7 shows this licensing procedure.

The new regulation requires also a licence for the dismantling of those installations. This licence mainly covers the methods of dismantling and of elimination of active or contaminated material as well as their destination.

8. Law of 15 April 1994 creating the Federal Agency for Nuclear Control (FANC)

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

a. Chapter I - General clauses

- Article 1

  Defines a number of terms used in the text of the law: ionising radiation, radioactive substance, Competent Authorities, general regulations, Authorized Inspection Organisations, Health Physics service, the Agency.

- Article 2

  Establishes the public interest organisation having legal status, called “Federal Agency for Nuclear Control”, abbreviated as “FANC”.

b. Chapter II – Competent Authorities

- Article 3

  The King is the Competent Authority, excluding the Communal county authority, to take the measures to protect the workers, the public health or the environment. These measures apply to import, export, production, manufacture, possession, transit, sale, utilisation 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-ensuring software.

- Article 4

  The transport of substances mentioned in article 3 can only be done by persons licensed accordingly by the Agency. The King decides, after taking note of the advice of the Agency, the clauses of the licence.

- Article 5

  The competent authority can, at any time, suspend and rescind the decisions of decentralized administrations which have a direct or indirect effect on the transport of radioactive substances or equipments containing such substances.

- Article 6

  The King, excluding the communal council authority, 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, excluding the communal council authority, may also prescribe all measures in order to avert the hazards which could result from the accidental contamination of any places, materials or products by radioactive substances.

- Article 7

  The King nominates the persons in charge of supervising this law and its implementation decrees are respected, for what concerns the medical supervision of the workers and the health conditions at work.

- Article 8

  The King nominates the persons in charge of the missions mentioned in articles 7 and 14, according as it refers to the civil or military domain.

- Article 9

  The members of the supervision service of the Agency nominated by the King to supervise this law and its implementation decrees are respected are considered as judiciary police officers, auxiliaries of the King's Attorney. They search for infractions to the law and establish them by official entry.

- Article 10

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

- Article 11

  The concerned persons, societies, institutions or organizations can appeal to arbitration against the measures mentioned in article 10 by the Ministries responsible for the Agency; this appeal is not a stay. If no decision is taken within three months, the measures appealed against are no more applicable.

- Article 12

  The King can determine through a decree discussed in the Council of Ministers the fees which are collected:

  1. for the benefit of the Agency to cover its costs

2. to the benefit of the State to cover the costs resulting from article 6, in particular those related to the emergency plan for nuclear hazards.

The King fixes the amount of these fees and the way they are paid. This article also indicates the ways to attribute and use these fees.

- Article 13

The clauses of the present law are not at all detrimental to the application of the law of 4 August 1955 on State security in the field of nuclear energy and of the decrees implementing that law.

c. Chapter III– Missions of the Agency

- Article 14

The Agency is in charge of the control and the supervision, as well as accompanying when the IAEA performs inspection and verification activities on Belgian territory.

- Article 15

In a general way the mission of the Agency includes the investigations useful to define all the operating clauses and to the safety and security studies relative to the establishments where ionising radiation is used. It also includes surveillance, controls and inspections which follow, radiological protection, training and information, contacts with the Authorities and national organisations concerned and interventions in case of emergency. The Agency gives its technical support to the Minister of Foreign Affairs.

- Article 16

- § 1. The King grants or refuses the authorization of creation and operation which precedes the creation of any establishment where are present substances or equipments capable of emitting ionising radiation.

  The Agency examines the applications to obtain the authorization mentioned in the first alinea. The Agency obtains on this subject the opinion of the Scientific Council mentioned in article 37.

  The authorization determines among other ones the rules relative to the periodic safety reviews of the installations and the time of the acceptance report mentioned in § 2.

  The King determines the conditions under which the authorization mentioned in the first alinea is granted. He can modify these conditions during the lifetime of the establishment, including during its dismantling.

- § 2. The operation of an establishment mentioned in § 1 cannot start before that the King has confirmed the authorization of this establishment by ascertaining that the conditions of the authorization are respected. This confirmation is preceded by a favourable acceptance report established by the Agency. This acceptance takes place before the introduction of the radioactive substances being authorized in the installation.

- § 3. The Agency controls the respect of the conditions imposed by the authorization of creation and operation. The King can suspend or withdraw the authorization upon advice by the Agency.

- Article 17

  The King determines, via a decree discussed in the Council of Ministers, the clauses of implementation of article 16. He classifies the establishments mentioned in article 16, § 1 as a function of the hazard they present. He may not delegate the granting of the authorization for the establishment which are in the class of highest hazard.

- Article 18

  The Agency examines the documents for the transport of radioactive substances. It controls the respect of the specific clauses imposed by the authorization or acceptance acts delivered by the competent authorities.

- Article 19

  Under the conditions and within the limits and according to the modalities of article 3, the Agency:

  - grants the acceptance of equipments for medical use emitting ionising radiations and ensure their control.
  - grants the acceptance of the pharmacists and physicians using sources of ionising radiation, of the physicians in charge of the medical control of the workers professionally exposed to ionising radiation, as well as of the experts in charge of the health physics department of the establishments.
  - examines the documents for the use and grants the authorizations to use radioactive substances in the medical field, as well as those for the manufacture and the distribution of these substances. It controls the respect of the specific clauses imposed by the authorization acts.

- Article 20

  Under the conditions and within the limits and according to the modalities of article 3, the Agency examines the documents for the use and grants the authorizations to use ionising radiation in order to sterilize medical equipments and to treat foods. It controls the respect of the specific clauses imposed by the authorization acts.

- Article 21

  The Agency ensures the surveillance and the control of the radioactivity on the whole territory, in normal conditions and during emergencies. In normal conditions this mission includes the regular measurement of the radioactivity in the air, in water, of the soil and of the food chain, as well as the evaluation and the surveillance of the doses of ionising radiation received by the population.

  To this end the Agency can rely on the assistance of competent private or public organisations.

- Article 22

  The Agency provides technical assistance to the Minister of Internal Affairs for the elaboration of the emergency plans. It organizes an intervention cell for emergencies.

- Article 23

  The Agency is in charge of setting up a scientific and technical documentation in the field of nuclear safety. The Agency can ask any document, under any form, from the companies or organizations that it controls.

It stimulates and coordinates 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 concerned.

- Article 24

  The Agency makes proposals to the responsible ministers about the measures that the King imposes under the terms of this law.

- Article 25

  In the limits of its competencies the Agency controls the respect by the operators of their obligations related to training, information and protection of the workers.

- Article 26

  The Agency is in charge of delivering a neutral and objective information in the nuclear field. It circulates technical information about nuclear safety and radiological protection.

  It collaborates, on the initiative of the minister of Internal Affairs, to the information about the emergency plans that this minister works out.

  It presents an annual report about its work, to be transmitted to its overseeing authorities, to the attention of the Parliament.

- Article 27

  By derogation to article 1676 of the Judiciary Code, the Agency is competent to submit any disagreement by convention to arbitration.

d. Chapter IV – Delegation of some missions by the Agency

- Article 28

  Under its own responsibility the Agency can rely, for exercising some of its missions, to the collaboration of organisations it specifically recognizes ("organismes agréés" commonly translated into English as "authorized inspection organisations").

  Missions aimed at, totally or partially, are those relative to the permanent supervision of the adequate implementation of the Health Physics Department's tasks, the acceptance of new installations, the approval of decisions made by the Health Physics Department.

  With no prejudice to the clauses of the law of 4 August 1955 on State security in the field of nuclear energy, the Agency may also, for the transport of fissile materials, delegate to an organization it specifically recognizes the permanent supervision of the loading, the transport and the delivery of these materials.

- Article 29

  The specific recognitions mentioned in article 28 are delivered on the basis of criteria fixed by the Agency and relative especially to:

  - the qualification of the organisation's personnel
  - the necessary means the organisation must have at its disposal to accomplish its missions

- detailed rules related to the working methods of the organisation and to the execution of the entrusted missions.

The King determines, via a decree discussed in 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 granted by virtue of this law to an organisation aimed at in the present chapter is valid for a maximum of five years. That duration can be extended for a period of maximum five years.

- Article 30

The missions mentioned in article 28 are entrusted on the basis of specifications. These specifications determine in particular the way the recognized organisation will be paid for its services.

The King approves the specifications established by the Agency. The Agency selects the organisation on the basis of the specifications and the regular offers received.

e. Chapter V – Resources, budget and accounts

- Article 31

The Agency receives the fees, according to the modalities of article 12 of this law.

As the case may be, the Agency adds to the fees paid by the persons or the organisations mentioned in article 12 of this law the cost of some supplementary work mandatory for exercising its mission.

The Agency must balance its budget.

- Article 32 to 34

These articles deal with the accountancy of the Agency and its financial audit.

f. Chapter VI – Administration of the Agency

- Article 35

Describes the rules applying to the composition of the Board of the Agency.

- Article 36

Determines the length in time of the mandates of the Agency’s members of the Board.

- Article 37

A Scientific Council is established, whose mission is to advise the Agency with respect to its surveillance policy and more in particular to give, according to article 16, an opinion previous to the authorizations to be delivered for new installations or for the renewal of authorizations. The composition and the powers of the Scientific Council, a group of persons highly competent in the nuclear field and in safety, are determined by the King.

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

- Article 38

  Lists a number of incompatibilities between the mandate of member of the Agency's Board and other mandates.

- Articles 39 to 41

  Define the powers of the Board and those delegated to the Director General.

- Article 42

  The Agency is amenable to the legislation relative to public contracts for works, supplies and services.

- Article 43

  The Agency is organized so that the regulatory missions and the surveillance missions are exerted independently.

- Articles 44 to 46

  Define the statute of the Agency's personnel and of the persons transferred from existing services (SPRI, SSTIN,…) or from public interest organisations active in the nuclear sector.

- Article 47

  The Agency's personnel takes all necessary measures to secure the confidentiality of data he gets knowledge of.

- Article 48

  Determines the Ministers responsible for the Agency.

g. Chapter VII – Penal clauses

- Articles 49 to 50

  Define the amount of the fines and of prison sentence which can be applied in case of infringement to the present law and which clauses of the Penal Code are applicable.

h. Chapter VIII – Final modalities

- Article 51

  Modifies article 10 of the law of 20 July 1978 in order to give to the Agency's personnel the mission of accompanying the IAEA inspectors.

- Article 52

  Rescinds the law of 29 March 1958 and its subsequent modifications in order to replace it by the present law.

  The Royal Decrees implementing the previous law remain applicable as long as they have not been modified or abrogated by virtue of the present law.

- Article 52bis

  § 1. The operators of nuclear installations must entrust to the authorized inspection organisations ("organismes agréés") for an indefinite period, by virtue of the law of

29 March 1958 relative to the protection of the population against the dangers of ionising radiation, the specific missions mentioned in article 28, alinea 2, up to the moment these missions are taken, either by the Agency itself according to articles 15 and 16, or by an authorized inspection organisation, according to articles 28 to 30.

§ 2. The existing authorized inspection organisations must carry on, in total independence, the above mentioned missions which are entrusted to them, up to the moment these missions are taken, either by the Agency itself according to articles 15 and 16, or by an authorized inspection organisation, according to articles 28 to 30.

For this purpose they keep their existing recognition. Notwithstanding article 29, their recognition and their missions come legally to an end at the moment these missions mentioned in article 28, alinea 2 are performed either by the Agency itself according to articles 15 and 16, or by an authorized inspection organisation, according to articles 28 to 30.

§ 3. The period during which this transitory regime is applicable is limited to a maximum of 2 years. The King can determine, via a decree discussed in the Council of Ministers, conditions and more detailed rules for the transfer of specific control missions.

He can in the same way extend the duration of this transitory regime, by a maximum of one year at each time.

- Article 53

  The King can modify the existing legal clauses to adapt them to the clauses of the present law.

- Article 54

  The King determines, via a decree discussed in the Council of Ministers, the date at which the clauses of the present law come into force.

9. Conclusions regarding the provisions of Article 7

- There has been in Belgium a legal and regulatory framework for safety of nuclear installations since more than 40 years.

  10.The laws are permanently 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 the above 8 sections),

  ii. a nuclear installation licensing system and the interdiction to operate an installation without a licence (cf. R.D. of 28.02.1963 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 installations, for verifying compliance with the regulations and conditions set in the licence (cf. R.D. of 28.02.1963, among other its Articles 6, 12, 13, 15, 16, 23, 78),

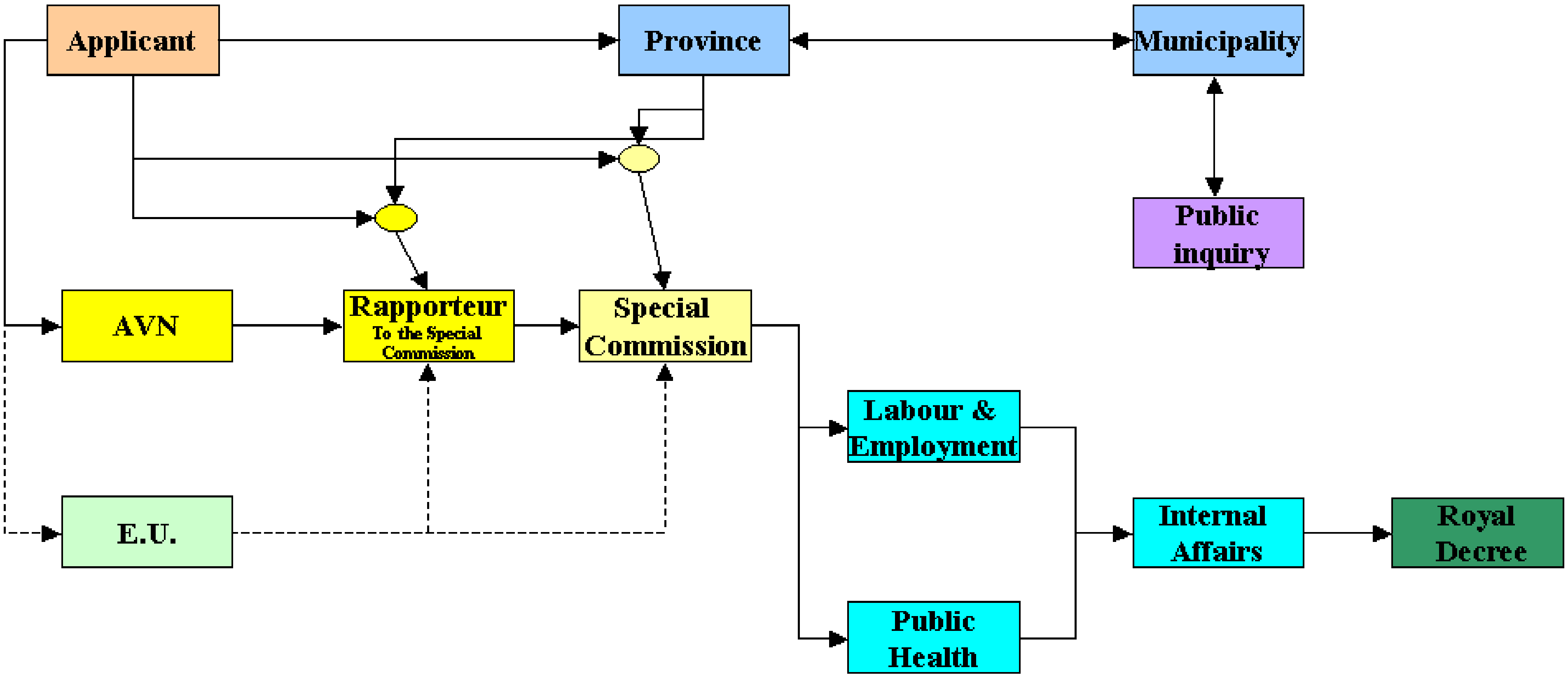
  iv. measures intended to enforce compliance with the relevant regulations and the conditions set in the licence, including as regards the suspension, amendment or withdrawal of licence (cf. R.D. of 28.02.1963, among other its Articles 5, 12, 13, 16).

- A summary of the licensing process of the nuclear installations, as dictated by the Royal Decree of 28 February 1963, is depicted on the following picture.

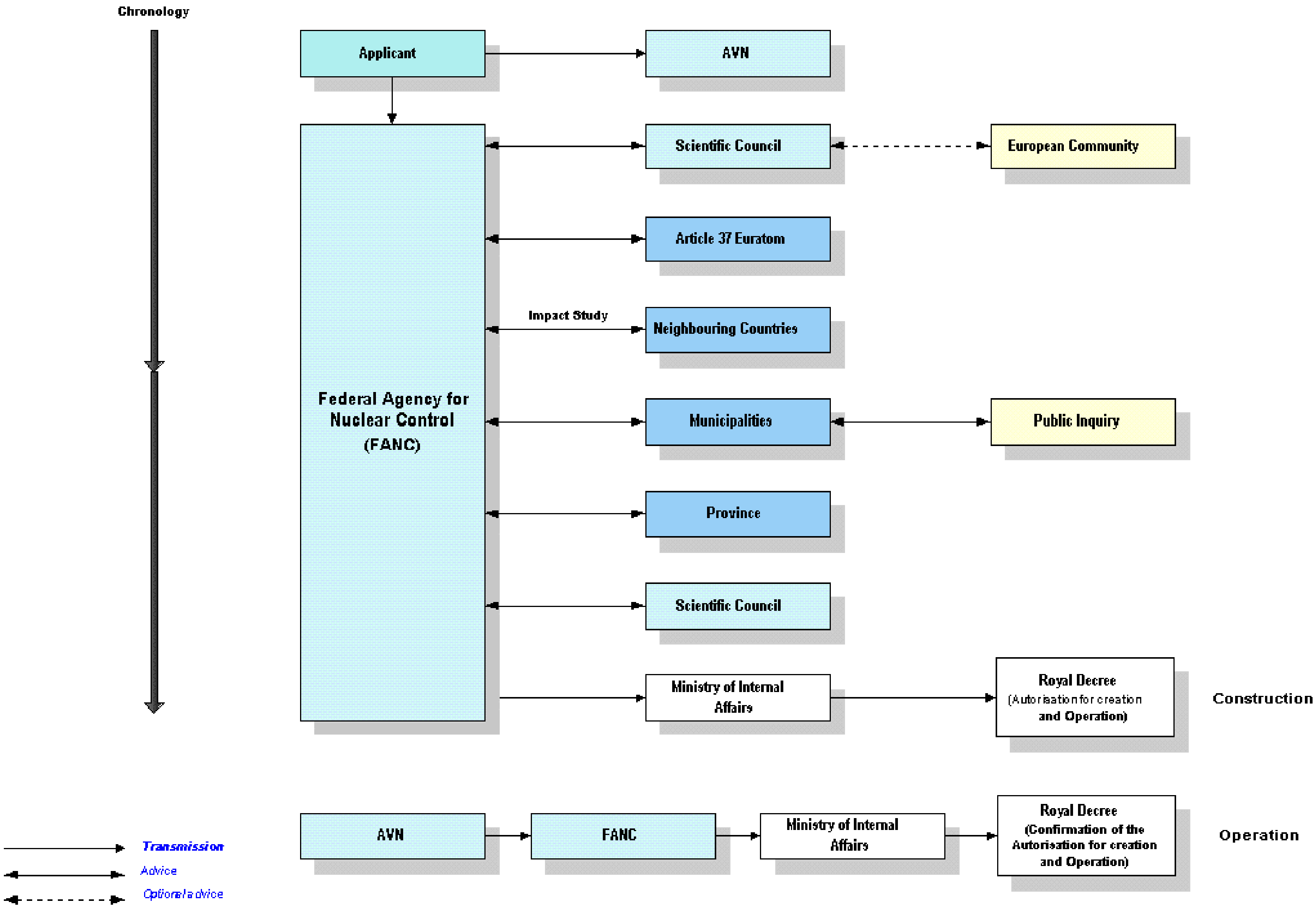
  The Commission of the European Communities is indicated in dotted lines because its opinion had formerly been asked for the safety analysis of the first nuclear power plants; it intervenes to-day only in the frame of Article 37 of the Euratom Treaty.

  Since it is operational, the FANC takes over the tasks performed previously by the SSTIN (Ministry of Labour and Employment) and by the SPRI (Ministry of Public Health and Environment) which enter in the frame of its enlarged competencies, mentioned in the Law of 15 April 1994 and aimed at reinforcing the protection of the population and the environment.

Licensing process in Belgium (up to 31 August 2001)



Licensing process in Belgium (from Septembre 1st 2001 on)



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 organization concerned with the promotion or utilization of nuclear energy.**

Preamble:

As already mentioned at the beginning of Article 7, at the time of the preparation of the present report, the process to modify the legislative and regulatory Belgian framework is about to be completed. At the end of this process, started several years ago, the Safety Authority is reorganised in a single and coherent structure regrouping all official services and the required competences to fulfil its missions.

That organisation, the Federal Agency for Nuclear Control (FANC) created by the law of 15 April 1994 and made operational by the Royal Decree of 20 July 2001, has at its disposal specialised personnel coming from either own recruitment or the availability of agents and experts belonging to different Ministries (Ministry of social affairs, public health and environment, Ministry of labour and employment, Ministry of foreign affairs and Ministry of justice). The SSTIN and SPRI services are therefore integrated in the FANC. This public organisation, endowed with wide competences, has a statute and a working mode ensuring a large autonomy and independence from any external influence.

In this context, the present control structure with 3 levels (first by the licensee, then by an independent authorized inspection organisation and finally by the Safety Authority) will be maintained. The authorized inspection organisation for the establishments concerned by the Convention (AVN) performs a number of inspection and regulatory tasks. In the future, those tasks will be delegated by the FANC, with limited adjustment.

Similarly as for Article 7, during the second meeting of the contracting parties to the nuclear safety convention, more detailed information on the new structure of the Safety Authority will be presented. In the present report, the situation prior to the ongoing modifications is explained, along with, at the relevant places, references to the new organisation of the Safety Authorities.

Traditionally, in Belgium’s non-nuclear industrial sector, regulatory inspections are not performed directly by the competent Authorities, but are delegated by these to inspection organisations they have delegated for these tasks. A similar approach has been adopted in the nuclear field, where the Safety Authority delegates a number of these tasks to authorized inspection organisations (“organismes agréés”).

The authorization conditions and the duties of these organisations are dealt with in Article 74 of the R.D. of 28 February 1963. The authorized inspection organisation must perform its tasks and duties with experts that have to be authorized as stipulated in Article 73 of the same Royal Decree.

As regards the nuclear installations covered by this National Report (nuclear power stations), the authorized inspection organisation is Association Vinçotte Nuclear (AVN). Let us bear in mind that other class 1 establishments are watched over in a similar way by AVN.

The description below is based on the previous situation, in which SPRI and SSTIN are the Safety Authorities and in which AVN, the authorized inspection organisation, is in charge of many regulatory tasks.

The FANC created by the law of 15 April 1994 (see Article 7, preamble and section 2 of the present Report) regroups the personnel of SPRI and SSTIN and is the Safety Authority; AVN's contribution to the regulatory tasks will have to be precised in order to keep intact its knowledge of the installations and its expertise developed over all these years, as expressly recommended by the colleagues of the other Contracting Parties when the Belgian National Report was examined during the first meeting of the Parties to the Nuclear Safety Convention.

This description is centred 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.

1. Mandate and function of the Regulatory Body

For the class 1 nuclear installations (which include nuclear power stations), the R.D. of 28 February 1963 stipulates that the King is the competent Authority, and therefore the relevant ministerial departments and their administrations; it also specifies a number of tasks to be performed by the authorized inspection organisation.

The Royal Decrees of August 1981 which created the SSTIN and the SPRI entrust to these the mission of appointing and overseeing the authorized inspection organisation.

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

a. at the level of general regulation and overseeing:

The Safety Authorities are in charge of updating the general regulations, of introducing in them 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 overseeing of the operating organization, the Safety Authorities are informally informed of the organization's operational problems and projects through the meetings of a "Contact Committee" formed of representatives of the Safety Authorities, of the operator and of the authorized inspection organisation, which Committee meets twice a year on the 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, …), specific meetings are held between the Safety Authorities, AVN and the operator in order to assess the technical problems and consider and decide remedial action; these actions are in this way approved by the Safety Authorities.

As a result, if necessary, the latter are in a position to inform the political world or the general public about the technical situation.

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

Since it is operational, the FANC takes over all the functions of the Safety Authority.

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

- When a licence for a nuclear power station is applied for, AVN's Director is designated as Rapporteur to the "Commission Spéciale Radiations ionisantes" according to the authorization process described in article 7. In consequence, AVN is in charge of conducting the safety analysis, based on the Safety Report presented by the applicant, and of presenting its conclusions to the "Commission Spéciale Radiations Ionisantes" (R.D. of 28 February 1963, Article 6.5).

  For the four most recent units the Safety Analysis Report was established strictly to the standard format and contents prescribed by Regulatory Guide 1.70 of USNRC, since in 1975 the decision had been taken to adopt the US safety rules.

  The safety analysis was performed according to the Standard Review Plans, verifying the manner in which the safety standards and guides had been followed, and also whether satisfactory answers had been supplied to all the questions raised.

  This process took about five years per unit; the safety analysis conclusions were the subject of a Safety Evaluation Report that comprised a number of recommendations.

  This Safety Evaluation Report written by AVN has been referenced in the Royal Decree of Authorization of the unit, Decree which has requested that a follow-up be given to all AVN's recommendations, and has put AVN in charge of judging the adequacy of the answers and of closing afterwards the recommendation.

  For the first units (Doel 1 and 2, Tihange 1) the US rules had not yet been made strictly mandatory. However, since these units were of either Westinghouse or Framatome design their Safety Analysis Reports were similar to those of US nuclear power plants. During the first ten-yearly overhauls/safety reviews of these first units the completeness of these reports was checked and the Safety Analysis Reports were presented in standard format. For these first units the Belgian Safety Authorities did ask the advice of the Euratom Commission, which convened experts from the Euratom member countries to examine the safety. For the next units the Belgian Safety Authorities again asked the opinion of European experts but their analysis focused on a number of specific subjects (bunkerized systems to cope with external accidents, accident analysis, …).

  These experts formulated a number of recommendations.

  AVN presented a synthesis of the European experts' conclusions to the Special Commission, as well as its own evaluations, and proposed a set of particular conditions to be included in the licence. These proposals were discussed within the Special

Commission, amended where appropriate, then approved and finally introduced in the Royal Decree that granted the licence.

- The next phase concerns the commissioning of the installations.

  The installations are subject to an acceptance inspection, i.e. an in-depth verification of their conformity, according to Article 15 of the R.D. of 28 February 1963.

  These acceptance inspections and conformity checks are performed by AVN.

  During the safety analysis, the general principles of the commissioning tests have been approved (chapter 14 of the Safety Analysis Report). The overall programme of the tests and the test procedures are examined by AVN, as well as the tests themselves. If the results are satisfactory, AVN issues the successive operating licences that allow to proceed to the next steps : core loading, criticality, increasing steps in power up to nominal power.

- 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 AVN (R.D. of 28 February 1963 - 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 for each visit.

  All modifications are notified to AVN. However, AVN and the Safety Authority will follow-up only the safety-related modifications.

  This follow-up includes step by step acceptances, i.e. assessments and inspections that authorise proceeding with the next step in the modification implementation process.

  Major modifications (power increase, utilisation of MOX fuel, steam generator replacement, …) require substantial safety analysis and AVN must present a report to the Special Commission, according to a procedure similar to that of the initial licensing, and sanctioned by a new Royal Decree of Authorization.

  For the new configuration of the core after each core refuelling, either the previous safety analyses remain valid or new studies have to demonstrate that the safety criteria are complied with.

  After verifying that the new configuration is acceptable, AVN follows-up the start-up tests, assesses their results, and authorises (through its acceptance report) operation at nominal power.

2. Powers and attributions of the Regulatory body

After the Royal Decree of Authorization has been signed and after AVN has approved the successive steps to nominal power, the Safety Authority and AVN permanently supervise whether the operator complies with the conditions set in the licence.

The findings of the inspection visits and the observations made are recorded in the reports established by AVN and transmitted to the operator, the latter then implementing any necessary corrective action.

At this stage AVN 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, these having the power to suspend or withdraw the licence (R.D. of 28 February 1963, Article 16).

As explained in the previous section, AVN approves the implementation of modifications to the installations and the re-starting after core refuelling outages, only after having verified that the results of the safety analysis and of the tests are satisfactory.

3. Structure of the regulatory body, financial and human resources

a. Safety Authorities

The Safety Authorities are at present composed of the Services SSTIN and SPRI officialized in 1981. These Services are part of the Administration, and their personnel has civil-servant status and their staffing (number of people in each category of personnel) has been defined by the Royal Decrees that created these Services.

The financial resources of the two Services consist of a fund fed by the application fees paid by the applicants for licences and by the nuclear operating organizations. These fees are fixed by Royal Decree and, in the case of the nuclear power stations, are proportional to the net electrical power installed.

The Agence Fédérale de Contrôle Nucléaire (AFCN) will take over the SSTIN and SPRI personnel which will then have the (more flexible) status of that of a semi-public institution, which would also make recruitment easier (articles 44 to 46 of the law of 15 April 1994). Financing will be from the fund referred to here above, as the AFCN fully replaces SPRI and SSTIN (article 12 of the law of 15 April 1994).

The organization chart of the FANC must take into account the law of 15 April 1994 and in particular article 43 which requires that the regulatory missions and the surveillance missions be exerted independently.

Below the Board assisted by an audit Committee and below the General Direction, it is foreseen a General Secretariat, the Department “Authorizations and Regulations”, the Department “Control and Surveillance”, the Department “Finances and Administration” in charge of financial aspects, human resources, informatics and logistics.

The Department “Authorizations and Regulations” will have three poles of activity:

- the classified establishments (classes 1, 2 and 3 according to chapters 2 and 3 of the R.D. of 28 February 1963)
- the transport, import and export of radioactive substances (chapters 4 and 7 of the R.D. of 28 February 1963)
- the medical applications (chapters 5 and 6 of the R.D. of 28 February 1963)

The Department “Control and Surveillance” will have five poles of activity:

- the 3 poles cited above for the Department “Authorizations”
- the operation of the Telerad network measuring the radioactivity on the Belgian territory
- the implementation of the agreements on “physical protection” and “safeguards”.

b. Authorized inspection organisation: overall organisation

Being an authorized inspection organisation, AVN meets the requirements of Article 74 of the R.D. of 28 February1963.

These requirements include, among other :

- have the status of a non-profit organisation possessing legal personality according to the law of 27 June 1921.
- quarterly report on its activities to a "Commission de Surveillance" (i.e. a watchdog) chaired by a representative of the "Administration de la Sécurité du Travail" (i.e. Belgium's equivalent of the Occupational Health & Safety Executive) and comprising representatives of the employers' organisations and of the workers' organisations (trade unions). This report is discussed at the quarterly meetings and summarised in an annual report.
- to perform its missions, use only experts that have been authorized (Article 73 of the R.D. of 28 February1963).

  Note is made that an expert must have at least three years' experience in the nuclear field before he can be authorized as a class 1 expert. AVN's personnel training budget amounts to about 8 % of its overall budget.
- be covered for civil liability for all the objects that do not fall within the application field of the law of 18 July 1966 on nuclear civil liability.

AVN's General Management reports to a Board whose members are mainly composed of professors of Belgian Universities, and quarterly reports to the "Commission de Surveillance".

Furthermore, AVN took itself the initiative to establish a "Scientific and Technical Committee" composed of representatives of most of the Nuclear Safety Authorities of the European countries and of international organisations (IAEA, OECD/NEA, EUC), as well as Belgian University professors active in the nuclear field.

An annual activity report is prepared for this Committee and discussed at its annual meeting. The Committee assesses AVN's work and formulates recommendations. It exists since 1991 and is an application of the peer-review principle.

Below the General Direction, AVN is composed of 4 Divisions, three of them dealing with technical matters (divisions described below) and one in charge of human resources and logistic support (organisation and management of human resources, policy with regard to the personnel, communication, public relations, informatics, accounting and finances, secretariat).

AVN's technical personnel is composed of some 50 university graduates (engineers and physicists), and recruitment is in step with the foreseeable workload. The workload consists of a more or less constant portion relating to inspection of installations, and a more variable load in time relating to the progress of the applicants' projects and the number of studies to be examined, and also to the assessment of incidents or specific safety problems taking place in the installations (steam generator tubes corrosion, incomplete insertion of control rods,…).

The inspections and analyses carried out by AVN are invoiced to the operator on the basis of hours actually devoted. 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 future it is planned that remuneration of AVN's activities will be through the FANC.

Due to AVN 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.

c. Authorized inspection organisation: technical activities

Before the completion of the most nuclear recent units, AVN was composed of an Inspection Department and a Safety Studies Department which was in charge of safety analysis of the units under construction and of analysis in support of inspections of the units already in industrial operation.

After all nuclear units had become operational and with the development of many projects, the organisation had to be adapted: a more project-oriented structure was adopted, the technical sections of the Safety Studies Department were dissolved, and AVN's technical personnel, regardless of what Department they hierarchically belonged to, have been attached to "Technical Responsibility Centres" (TRC) "horizontal" cells in charge of maintaining the knowledge in the various technical specialities. These technical responsibility centres are the counterpart of USNRC's "Technical Branches".

At the end of the year 2000, AVN's technical personnel and the technical activities have been distributed into 3 divisions named respectively "Nuclear Installations Inspections (NII)", "Projects and Experience Management (PEM)", "Studies, Research and Development (SRD)", in order to more delegate the responsibilities of technical follow-up.

Moreover each TRC has been attached to a Division, in order to give it better support in case of possible organisation problems.

- The NII Division is in charge of inspections in all nuclear installations supervised by AVN.

  For the nuclear power plants, one AVN 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 for all the units.

  With the opening of the electricity market and the deregulation, supplementary efforts are devoted to the reorganisation problems by the licensee, in order to verify that all previous safety requirements (described in Chapter 13 of the Safety Analysis Report) are still met (for example licensing of the control room operators, composition of the shift teams, qualification of the personnel, guard role for the emergency preparedness plan,…).

  The NII Division is also in charge of inspections in installations other than nuclear power plants: the Mol Nuclear Research Centre (two research reactors, many laboratories, the first PWR built in Europe with a 11.5 MWe power presently in the course of dismantling), the MOX fuel fabrication plant of Belgonucléaire, the conditioning and storage of wastes done by Belgoprocess, the Institute of Radio-elements (IRE), the Thetis research reactor at the Ghent University, as well as class 2 and 3 establishments (universities, hospitals,…).

The NII Division organizes the AVN activities in the frame of its participation to the national emergency plan at the level of the evaluation cell (see article 16, paragraph 2.3). It also participates to the emergency plan exercises taking place in the Belgian nuclear installations (nuclear power plants and other facilities), as well as to the exercises of foreign nuclear power plants located near the Belgian border, through bilateral or international collaborations.

- The PEM Division is in charge of the follow-up of all national and international projects linked to the operation of the installations.

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

  At the international level it is mainly the assistance to the Safety Authorities of Eastern European countries (bilateral aid or Phare-Tacis contracts of the European Commission) or specific collaborations with Western Europe safety organizations.

  The PEM Division is also responsible for the analysis of feedback of operating experience from Belgian and foreign nuclear power plants (DIANE and ARIANE data bases) and from other installations (ANCES data base), and collaborates with the NII Division for actions that may result for the Belgian installations.

  In the frame of the ten-yearly safety reviews, AVN 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.

  The PEM Division also helps the NII Division for the follow-up of the modifications in the installations.

- The SRD Division is in charge of analyses of a more general character: generic studies valid for all nuclear power plants, probabilistic safety analyses developed specifically for each unit but where the analysis methodologies must be identical, applications of these probabilistic studies in particular to the analysis of initiating events, severe accident management, safety requirements for future reactors, safety analyses for the disposal of high level or low level radioactive waste.

  This Division leads also all Research and Development activities to which AVN participates (international projects, bilateral and own developments in AVN)

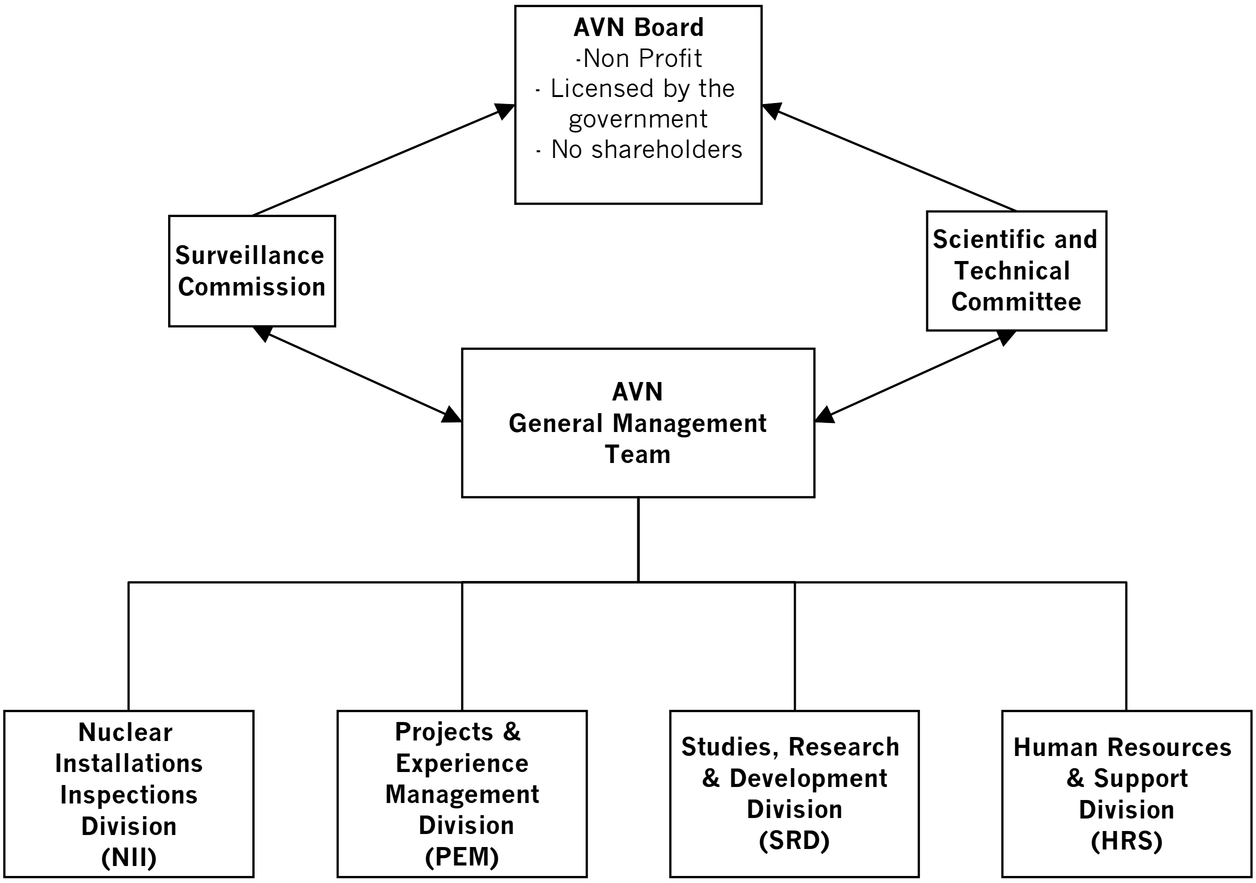
  The SRD Division also watches over the consistency of the working methods of the TRC's and monitors the safety analysis process.

  A brief organization chartof AVN is given below.

Alongside its own experts, AVN only very exceptionally calls on services from outside specialists (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. A recent example of AVN's calling on outside expertise concerns the evaluation of neutron-ageing of an aluminium reactor vessel.

In addition to the activities related to the nuclear installations, AVN participates in numerous international committees. For instance, AVN is the national co-ordinator for the Incident Reporting System (IRS) of OECD/IAEA, the FINAS system of OECD regarding the fuel cycle, the International Nuclear Event Scale (INES) of IAEA.

AVN 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 Nuclear Regulators Working Group (NRWG) and the reactor safety Working Group (ENIS-G) within the E.U., of IAEA's NUSSC and WASSC Committees.



4. Position of the Regulatory Body in the governmental structure

- The Safety Authorities (SSTIN and SPRI) are part of the Administration and report to their Competent Ministry.

  They answer any questions and requests for information received from the Government, Members of Parliament or from others.

  It is planned, i.e. when it will be fully operational, that the FANC annually presents its activities report to the Parliament. This obligation did not exist in the past.

- AVN is a private organisation that is not part of the Administration. It is designated by the Public Authority and quarterly reports to its "Commission de Surveillance", chaired by a representative of the Administration as stipulated in the regulations. This quarterly report is also sent to the FANC.

AVN also annually reports to its Scientific and Technical Committee and edits an annual activity report available on its WEB site.

5. Relations between the Regulatory Body and the organisations in charge of nuclear energy promotion and use

In Belgium the nuclear power stations are operated by a private operator, and there is not really any particular organisation in charge of promoting nuclear energy.

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

As said before, the Safety Authorities report to the Ministry of Internal Affairs.

The Safety Authorities and the Regulatory Body play no part in nuclear energy promotion.

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.

The Royal Decree (R.D.) of 28 February1963 indicates that the establishment general manager (i.e. the person who applied for the licence) is responsible for complying with the conditions set in the licence (Article 5.2). For the nuclear power stations the Royal Decree of Authorization stipulates conformity to the Safety Analysis Report and to the document established consistent with 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 US format, describes not only the overall installations, but also refers to specific documentation during operation such as operation procedures during normal, incidental or accidental operation, and to the Quality Assurance Manual. The Technical Specifications are also part of the Safety Analysis Report.

The operator must organise a Health Physics Department generally 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 R.D. of 28/2/1963, and the main duties are recalled in Article 7 section 6 of the present National Report. The operator must also take out an insurance cover for his nuclear civil liability (Article 6.2.5 of the R.D. of 28 February1963); the law of 22 July 1985 which ratifies the conventions of Paris and Brussels and their additional protocols and the law of 11 July 2000 set at BEF 12 billion (i.e. some Euro 300 million) per site and per nuclear accident the maximum amount of the operator's liability for the damage (see also article 7, section 3 "Civil liability" of the present Report). 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 R.D. of 28 February1963).

The Belgian law also requires that the Regulatory Body permanently control the proper implementation of the duties of the operator's Health Physics Department. Article 23.8 of the R.D. of 28 February1963 indicates a number of specific tasks in that respect.

As referred to in Article 8 of the present National Report, an AVN inspector is assigned to each nuclear unit. The inspection visits 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 the AVN 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 generating units. In this way the AVN inspector can daily verify how the operator assumes his obligations and responsibilities.

C. GENERAL SAFETY CONSIDERATIONS

ARTICLE 10. PRIORITY TO SAFETY

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

A. Licensee and his contractors

Consistent with Belgian legislation the operator has a Health Physics Department (see Article 9 of the present National Report) which deals with safety and radiological protection matters. The Head of this Service reports directly to the site Manager, making him independent with respect to the other departments.

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

"The Production of Electrabel attaches much importance to the environment, the health and the security of its fellow-workers, of its neighbourhood, of the population and of any other person involved in the operation of its nuclear park. For this reason Electrabel aims at excellency in the domain of nuclear safety, as this one is an integral part of an efficient management.

With that aim, we organize our activities in adequacy with the following principles:

- *Establish concrete objectives and action plans which bring a continuous improvement in the nuclear safety domain. Reassess these regularly in a proactive manner. Involve all fellow-workers in this process and check that they know and understand the objectives.*
- *Integrate nuclear safety in all operational processes. Optimize the processes in order to integrate the resources as much as possible in them.*
- *Determine and put at disposal the resources, the training and the staffing so that every one gives the appropriate attention and priority to nuclear safety.*

  Promote the appropriate safety culture.

  Through the involvement of the staff, its exemplary role and an explicit communication, make known the expectations in matter of nuclear safety in the whole organisation so that everyone be conscious of his (her) contribution to nuclear safety.
- *Measure permanently the efficiency of this policy: evaluate and compare it to the standards in evolution. Draw the appropriate lessons of its own results and of external operational feedback and regularly submit oneself to external benchmarking. Correct the policy and the objectives on the basis of these lessons.*
- *Maintain a constructive and open dialogue between the clusters[2] as well as with the regulatory authorities and other concerned parties."*

[2] The clusters are defined in Article 11, point 4

A Safety Evaluation Committee has been set up at each site (Doel and Tihange). This committee comprises the managers of the various services and a few persons who do not belong to the nuclear power plant. It meets a few times a year to examine the operational record of the unit and possibly draw lessons from it for safety improvements, which it then recommends to the Site Manager.

As regards experience feedback, this is organised at each site, and the work is examined by the Safety Evaluation Committee.

The Belgian power stations are members of INPO, WANO and of the Owners Groups set up by Framatome and Westinghouse, which provide a valuable source of information.

The Authorization decrees of the Belgian power stations also stipulate that the feedback from experience be taken into account and, in particular, the USNRC's Bulletins (or other equivalent documents).

As Belgium participates in the Incident Reporting System (IRS), AVN as the national co-ordinator transmits all the IRS reports to the Doel and Tihange sites.

All the information is available at the two sites, and the operator analyses its applicability to his own units.

Any incident incurred at a Belgian power station is the subject of a deeper (root cause) analysis in order to determine possible corrective action.

In case of incidents or accidents there are of course procedures that the operator must follow in order to bring the plant to a safe condition.

After each reactor or turbine trip, a procedure lists the conditions to be fulfilled before resuming operation (the cause has been identified, the sequence of events understood, the evolution of the main parameters understood, the required safety functions have been fulfilled or the anomalies have been corrected and tested, unacceptable damages on the installation did not exist or have been repaired) and, in case of need, long term corrective actions have been defined.

The Technical Specifications also list the organisations to be informed by the operator in case of incidents; for example the AVN's inspector receives information about each trip of the unit he inspects.

The organisations which work for Electrabel (Contractors) are selected on the basis of past experience and/or more formal certification according to the missions they are in charge of. These organisations must follow the quality assurance programmes (cf. article 13), and the rules applicable to the design and construction (article 18) and during operation (article 19).

B. Regulatory Bodies

Priority to safety is the basic principle of work of the Regulatory Bodies, as indicated in articles 7 and 8.

With regard to feedback of operating experience, AVN also analyses the incidents incurred at the Belgian power stations and compares his conclusions to those of the operator as regards both root causes and the lessons to be drawn. Possibly, he asks that the operator implement additional corrective action. Of the incidents that are of a more particular interest regarding safety, AVN issues an IRS report, which will be transmitted to the operator and to the Safety Authorities (SPRI et SSTIN) for possible remarks prior to official issue.

From the origin, AVN was aware of the necessity to make the best possible use of feedback from foreign incidents. For instance, at Chooz A a spurious opening of a pressurizer relief valve took place: the operator diagnosed the incident and controlled it within minutes by closing the blocking valve upstream. AVN (which at the time was the nuclear safety department of Association Vinçotte) reacted by requesting in the safety analysis to consider a break in the steam phase of the pressurizer. This was in 1971.

During the start-up of Doel 1 and 2 and Tihange 1 in 1975, certain modifications were introduced in order to address this postulated accident. For example safety injection was initiated by the signal low pressure in the pressurizer instead of coincidence low pressure/low level. That modification was introduced by the USNCR a few years after the Three Mile Island accident, of which the Chooz A incident was a precursor.

Other events worth mentioning are the Browns-Ferry fire, which led to a number of fire prevention measures, the Salem ATWS event, the degradation of a 48 V board at Bugey 5 which led in Tihange 1 to the addition of two 115 V D.C. boards and four 220 V A.C. boards and complete separation between the control and the protection functions (modifications made in 1986 during the first periodic safety reassessment), the TMI accident with the implementation of the post-TMI actions (new accident procedures, organizational measures, not many hardware changes), the Chernobyl accident with the consideration of severe accident mitigation measures (hydrogen autocatalytic recombiners).

After TMI, AVN systematised experience feedback and created databases (Diane and Ariane) for Belgian and foreign incidents, grouping similar types of incidents and recording the implemented corrective action taken following them. These data banks have been completed later on by "Ances" for the installations which are not nuclear power plants.

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 a few years, AVN also makes incidents analysis with the help of the probabilistic safety studies available for the units (PSA Event Analysis) and discusses the results with the licensees to estimate the interest of corrective measures.

AVN shares also the feedback of operating experience through its participation to international organisations (IAEA, OECD/NEA, Nuclear Regulators Working Group of the E.U.) and in smaller groups of Regulatory Bodies (NERS, FRAREG, bilateral collaborations).

ARTICLE 11. FINANCIAL AND HUMAN RESOURCES

1. **Each Contracting Party shall take the appropriate steps to ensure thate 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.**

1. Operator's financial and human resources to use the installation throughout its industrial life

The Doel and Tihange power stations are operated by the "Société Anonyme" (i.e. plc) ELECTRABEL which itself is part of the TRACTEBEL group. ELECTRABEL generates some 85% of all electric energy consumed in Belgium; this utility also distributes heat (via cogeneration units), gas and television signals (cable television). It is the owner of the units 1 and 2 of Doel, of 96% (4% being held by the "Société Publique d'Electricité") of the units 3 and 4 of Doel, the units 2 and 3 of Tihange, and is the 50% owner of Tihange 1 (France's EdF holding the remaining 50%). The installed power of Belgium's nuclear generating units accounts for some 40 % of all installed power in Belgium. Nuclear electricity accounts for some 60% of all electricity consumed in Belgium (see table 1 of the Introduction of this Report).

About 1700 personnel are devoted to nuclear power station operation among the 5000 personnel working for electricity generation and transmission as a whole, of ELECTRABEL's total workforce of 13000. The TRACTEBEL group, of which ELECTRABEL is a part, also has an Energy Engineering division which is the Architect-Engineer of the Belgian nuclear power stations (and of most of the fossil fired plants) and which houses know-how of over forty years of nuclear technology, which started with the construction of the first research reactors at the Mol Research Centre.

2. Financing of safety improvements during operation

The major safety improvements to the Belgian nuclear power stations are implemented during the ten-yearly overhauls, financed through annual provisions (1/10th each year). Replacement of equipment aimed at improving plant availability (e.g. steam generator replacement, turbine rotor replacement) are financed through investment and depreciation.

3. Financial and human provisions for future decommissioning and for management of the waste produced by the installations

Since 1985 the nuclear electricity generators have been setting up provisions for the dismantling and decontamination of the Doel and Tihange nuclear power station sites. The basic principles for calculating these provisions are the subject of an agreement between the Belgian State and ELECTRABEL. Taking into account the degree of uncertainty remaining when estimating the decommissioning cost, it has been agreed to periodically reassess the question (every five years) to see whether the provisions that are being set up need to be revised considering the most recent information that has become available. The setting up of these provisions has been phased in time according to the principle of capitalisation: on the one hand, annuities are deposited and, on the other hand, capitalisation interests are generated by the cumulated amounts as at the end of the previous year.

Moreover the licensee must submit his initial decommissioning plans to ONDRAF who must approve them in the frame of his legal missions.

These decommissioning plans are reviewed and approved every five years.

The total amounts intended to finance these decommissioning must be available 30 years after the beginning of commercial operation.

4. 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 the Regulatory Body (AVN). 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 a licence is required. This licence is granted based on the positive opinion expressed by an Assessment Committee, which examines the operator's knowledge. This qualification is reviewed every two years or, if an operator has ceased during four months or more performing the function for which he was qualified. It is renewed conditional to, among other, a favourable advice of the Assessment Committee on the basis of the individual's training and activity file.

Note that AVN is member of the Assessment Committee, with veto power.

A knowledge re-training programme for all qualified personnel is defined in function of the occupied position. The contents of this programme which is discussed with AVN, 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 (cluster "Servicing", see next section).

For all the personnel of the plant, there are training and retraining plans which are adapted according to the missions of the personnel.

Note that the Royal Decree of 28 February 1963 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.

Contractors are responsible for the training of their own personnel; more over a training on 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 site.

In addition to the individual training and recycling, 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.

Electrabel, Tractebel Energy Engineering, Laborelec and AVN, all organisations which have a good knowledge of the Belgian nuclear power plants from different viewpoints, have decided to put together all the information they possess in order to anchor the knowledge.

The goal of this project is to establish a common structure giving access to the design bases.

5. NUC 21 organisation

At the end of 2000, Electrabel, which operates the two Belgian nuclear sites, has decided a re-engineering as a matrix structure more in conformity with the main professions and with the collaboration relationship existing between the different actors in the operation and the management of a nuclear power plant.

This new organisation is of the matrix type: vertical per plant and horizontal per profession (that horizontal structure is called “cluster”).

The different clusters are: “Operation”, “Servicing”, “Fuel”, “Care” and “Asset”.

The profession of the “Operation” cluster is the conduct of the installations, the operation. That one of “Servicing” is the maintenance of equipments and installations.

The “Fuel” cluster is in charge on the sites of all the fuel handling operations, as well as the follow-up of the cycles, while Synatom remains in charge of all aspects concerning procurement of new fuel and the back-end of the cycle.

“Care” is in charge of all controls (Health Physics in the sense of the Royal Decree of 28.02.1963), measurements, protection of the workers (classical security including fire protection) and safety of the installations (including the setting up and the management of the emergency preparedness plans).

“Asset” manages the production installations and all the goods attached (as “owner” of the installations).

Each of the last three clusters (Fuel, Care and Asset) is composed of a local organisation per nuclear site (Doel and Tihange) and of centralized organisation for both sites.

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

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 operation period of the power stations.

1. Improvement of control room procedures and information

- In order to avoid human factor related incidents, a great number of the operation, test and maintenance actions are documented in procedures that explain the initial conditions, the various steps to be accomplished and the final status to be achieved.

  As a result, these procedures avoid hasty or insufficiently thought-through actions, and the (operation, test, maintenance) personnel is trained in the application of the procedures either in real situations or with the simulator.

  Similarly, when an incident or an accident arises, the operator is guided to the appropriate procedure so as to prevent him making a wrong diagnosis.

  The originally established accident procedures were completely reviewed following the TMI accident; their contents and formats developed within the Westinghouse Owners Group (WOG) were adopted. Also, symptom-based procedures (using the concept of critical functions) were introduced.

  A set of procedures was developed for the shutdown state (i.e. when the cooling of the reactor is performed by the shutdown cooling circuit); for reasons of consistency and user-friendliness these procedures were drawn up in the same format as the procedures used for power operation of the reactor (of the Westinghouse ARG type).

  These procedures cover as well the loss of the residual heat removal system (RHRS) as the loss of primary coolant (LOCA), in particular during the phases when the level of the primary coolant corresponds to mid-loop operation.

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

  A file is related to 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.

As a result of post-TMI review, a mimic panel has been added to follow-up the reactor's critical parameters (SPDS: Safety Parameter Display System). Another option is to better regroup the main parameters without having to add an accidental situation panel. The qualified PAMS (Post Accident Monitoring System) instrumentation has also been specifically identified in the control room.

- In case of unavailability of the main control room (for example uninhabitability) 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).

2. Training

The normal operation procedures, the incidental and accidental operation procedures are used on the full-scope simulator by the operators and staff who hold an operator licence. Each time the procedures are modified following changes to the installations or experience feedback, the procedures are re-validated on the simulator, and the latter itself modified, if necessary, so that it always precisely reflects the installations.

Training on simulators is only part of the operator training programme, as described in chapter 13 of the Safety Analysis Report (see also section 4 of Article 11 of the present Report). It also comprises courses dedicated to explaining the modifications made to the installations and changes made to the procedures.

All procedures are periodically updated. Each procedure is evaluated at each use of it and the comments of the users are formalized. A periodical review is formally made at least every two years; during this review, all the comments are taken into account and a new revision is issued.

For the plant modifications, a special file is established for each one: this file is approved by the Operation Committee of the unit or of the site, depending on the fact it is specific to one unit or applicable to all the units of the site (see article 13). This special file contains all the pertinent information for the realisation and update of the documentation of the modified system: Technical Specifications, procedures, fluid and electric systems diagrams, logic charts, set-points, etc.

The review of the modification by the Regulatory Body is explained in Article 14 section 2.a.

Specific training is also given to operators concerning, for example, how to improve collaboration and task distribution within the operator team (team-building) and how to correctly apply the instructions (STAR: Stop - Think - Act - Review).

3. Organisation

After the TMI accident the organisation of the Operation Department was reviewed, and the "Shift Technical Advisor" (STA) function was introduced..

This function is assumed by a team of engineers so as to permanently have available the requisite operational competence at the power station. The function is mainly aimed at having independent operational supervision during normal operation of the unit and closer supervision of the safety critical functions in accidental situations.

The organisation of the Doel and Tihange sites slightly differs with respect to the implementation of the STA notion.

4. Experience feedback

At each site an experience feedback system has been organised (see also Article 10 of the present Report). This system comprises two parts:

- An internal experience feedback programme

  This mainly features:

  - a report written immediately for any operating incident, even minor;
  - the quick and adequate examination of any signalled problem;
  - the information of personnel on the implemented response/action.

  For operating incidents of some importance the report describes the circumstances of the incident, the initial conditions of the plant, the incident chronology, the causes according to the ASSET (Assessment of Safety Significant Event Team) or equivalent methodology, the consequences, the identified anomalies and the lessons that can be drawn. The lessons drawn from these analyses are fed into the feedback of operating experience system and included in the training and recycling programmes.

  There is no specific follow-up of the performance of the operators, but each one has his own training file, containing an evaluation of the training and simulator sessions.

  New approaches of Human Factors during events are under development.

  - A first "Methodology for event analysis taking into account human factors" is in course of implementation and validation. Its purpose is to improve the feedback of operating experience by introducing an investigation tool better adapted to the collect of information taking place during the event (dysfunctioning symptoms)
  - A second method to approach Human Factors during events, complementary to the first one, is also under development. That method called "Multiple Barrier Analysis" leads to an analysis of the basic reasons which have allowed to cross the multiple intrinsic defence barriers resulting in a significant (or not) event.
  -

- An external experience feedback programme

  This mainly features:

  - the collection of information originating from various sources (see Article 10 of the present Report);
  - the analysis of the applicability to Belgian units,
  - the lessons to be drawn, and elaboration/implementation of preventive measures;
  - informing of all the relevant personnel.

On the Regulatory Body side, AVN also examines the influence of Human Factors during plant operation and during the post-incident analysis phase. These analyses are incorporated into the data bank relative to the incidents which have occurred in the Belgian nuclear power plants.

One AVN expert is member of SEGHOF (Special Expert Group on Human and Operational Factors) of the CSNI, which succeeded the “Expanded Task Force on Human Factors” of Principal Working Group 1 of CSNI, to which this expert also participated.

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.

As the US safety rules were applied for the 4 most recent Belgian generating 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 safety rules 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 ten-yearly 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.

An example of an important modification subject to quality assurance was the construction during the 1st ten-yearly safety review of Doel 1 and 2 of the "bunker" housing the emergency systems (see Appendix 1 paragraph 2.4.1.1)

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.

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 assurance programme is applied during operation; the Tihange site is considered below as an illustration of this point, but the organisation is nearly identical at the Doel site.

1. Concerned equipment and activities

The quality assurance programme must apply to any safety-related equipment and components as well as to any activities that may affect their Quality. It must apply also to the safety-related activities, e.g. radiological protection, radwaste management, fire detection and protection, environmental monitoring, nuclear fuel management and emergency intervention.

These equipment, components and activities are known as Quality Monitored (Q.M.)

Quality Monitored items are identified in the Safety Analysis Report of each unit.

2. Quality Assurance programme

The quality assurance programme is based on a three-tiered system of stipulations, comprised of:

- a description of the quality assurance programme (i.e. chapter 17 of the Safety Analysis Report + the Manual),
- administrative procedures,
- written instructions.

2.1. The quality assurance programme description establishes the conformity of that programme to the requirements of the reference code (10 CFR 50 Appendix B of USNRC and 50-C-QA of IAEA).

Chapter 17.2 of the Safety Analysis Report describes the key-principles of the quality assurance programme during power station operation.

On these bases the Manual defines the requirements regarding establishment and implementation of the quality assurance programme.

2.2. The administrative procedures specify for each type of activity the policy and objectives that are defined in the quality assurance programme description.

These administrative procedures detail the functions, the authority and the responsibilities of the departments and individuals within each unit. For the individuals, this is done through job descriptions, and for the departments through internal organisation procedures.

These define the responsibilities and the internal and external interfaces in each unit and in each department per activity domain, e.g. the management of modifications, or of feedback of operational experience.

They specify in which way or by what means the regulatory or contractual requirements will be implemented, and they determine the quality level of the Quality Monitored items (equipment, components, activities).

2.3. The written instructions constitute a considerable number of documents established by the departments of the units; if necessary these are standardised or harmonised at site level, especially as regards safety, classical security, radiological protection and environment. These documents define in detail the duties or tasks of individual personnel or groups of personnel.

3. Organisation

3.1. Organisation principles

The principals and instruments of the quality assurance organisation during operation for the Tihange Nuclear Generation Site (TNGS) as a whole are:

- The Site Director, who manages all the units and departments of the site, depends directly on the Production General Direction of Electrabel. He formally endorses and supports the quality assurance policy established for the TNGS. He approves the Manual and orders its application to be enforced by each of the departments and support groups.

- The Head of the Department “Audit Qualité REX” supervises quality assurance at the level of the Business Unit Production.
- The Head of the Service “Audit Qualité ZPNT”. The Service “Audit Qualité ZPNT » comprises the personnel entrusted with quality monitoring.
- Three Committees examine more particularly the safety problems: the Operation Committee of each unit, the Operation Committee of the site and the Safety Evaluation Committee. They are directly involved in organising the quality assurance activities, and the last mentioned of these Committees exercises independent control over quality assurance organisation. Their composition and functions are described in section 13.4 of the Safety Analysis Report (see also Article 10 of the present National Report).

3.2. Distribution of responsibilities

The Head of a service or a support group, for what concerns its quality monitored activities at the TNGS, is responsible for having the whole of the quality assurance programme and the quality assurance related activities implemented.

The Department Heads are in charge, each in their own department, for having the quality assurance programme implemented in accordance with the relevant documents.

Verification of work and checking of its conformity to the written procedures (Quality Control) are performed by individuals who are not those who directly carried out the work themselves. For reasons of efficiency and specialisation, these individuals are part of the same sections as those who carry out the work. In the fields that they address these controllers must have the appropriate qualification.

Control may be performed during the execution of the work and/or by tests prior to re-starting the equipment and/or by a system for checking the performed work.

The Head of the department “Audit Qualité REX” reviews the Manual and proposes it to the TNGS Site Director. He follows-up the quality assurance standards codes and guides.

The Head of the service “Audit Qualité ZPNT” is responsible for monitoring the proper implementation of the stipulations defined in the quality assurance programme relating to all the Quality Monitored activities. He is a member of the Operation Committee of the site.

His duties in this respect include:

- preparation and updating of the Manual;
- verification of the Quality Monitored instructions for consistency with the Manual;
- performance of formal audits in the various services and support groups; for these he bases himself on possible remarks formulated in the reports drawn up by the personnel of the service “Audit Qualité ZPNT”;
- drafting of the audit reports to be submitted to the Site Director, to the heads of the services and support groups, and to the Head of the Department “Audit Qualité REX”;

- follow-up of the quality-action requests issued following these audits;
- taking the necessary initiatives with a view to proposing quality improvements.

The Head of the service "Audit Qualité ZPNT" is formally empowered to order any work to be stopped or suspended, after having informed the Head of the responsible service or support group, when he deems such decision is necessary to prevent a quality problem developing. He is entitled to report directly to the Site Director in case of difficulty or serious anomaly.

The service "Audit Qualité ZPNT" personnel - at their level - verify the implementation of the quality assurance programme by the various services. They issue verification reports to the head of the service "Audit Qualité ZPNT".

The anomalies identified by the service "Audit Qualité ZPNT" are processed according to their potential safety impact: immediate notification to the relevant Service Head (possibly with a hold on the commenced work), or notification via the hierarchical channels. The Site Director, the head of the service or support group and the Head of the Department "Audit Qualité REX" all receive a copy of these notifications.

3.3. Approval of the organisation

The quality assurance programme description is approved successively by:

- the Head of the Department "Audit Qualité REX"
- the Site Director.

3.4. Delegation and subcontracting

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

4. Training regarding quality assurance objectives

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

5. Periodic evaluation

The Safety Evaluation Committee and the Site Operation Committee perform a six-monthly assessment of the quality assurance effectiveness, the way it is implemented, the possible improvements to be brought to the programme,….. The written report of this assessment is presented to the Site Director for comments and possible approval of the recommended improvements, … .

As regards the regulatory control activities, AVN examined in the frame of the licensing process of each unit the quality assurance programme to be implemented during the design, construction and operation phases (chapter 17 of the Safety Analysis Report, quality assurance manuals,...) and verified the practical implementation of the various regulations (10 CFR50 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 Authorized Inspection Agency (AIA) is required as an independent inspection organisation, and AVN has taken into account the results of those inspections.

During power station operation, AVN 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.

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.

1. Licensing process

The legislative and regulatory framework has been described in Article 7, and the licensing process under point 1 of Article 8 of the present Report.

As said before, the applicant for the licence supplies the information required by Article 6 of the Royal Decree of 28 February1963, as well as the Safety Analysis Report drawn up according to the US standard format (Regulatory Guide 1.70 revision 2 or 3).

These documents, together with the numerous technical supporting documents are examined by AVN and give rise to an intense exchange of questions and answers, the resulting information and data being used to update the Safety Analysis Report until it eventually becomes the "Final Safety Analysis Report " (FSAR).

The report which AVN presents to the "Commission Spéciale Radiations Ionisantes" gives the conclusions of the performed safety analysis and proposes a number of conditions to be stipulated in the Royal Decree of Authorization.

These conditions include, among others:

- conformity to the FSAR as it was at the date of its presentation to the Special Commission (this will be the reference version of the FSAR),
- conformity to the report established under Article 37 of the Euratom Treaty,
- the possibility to modify the installations if the modifications have no adverse impact on safety,
- updating of the FSAR, which throughout the life of the installations has to exactly reflect these,
- the obligation to perform ten-yearly overhauls/safety reviews,
- the following-up of all the recommendations made in the "Safety Evaluation Report" established by AVN and which gives a synthesis of the performed safety analysis. AVN

is responsible for assessing the satisfactory nature of the responses of the operator to those recommendations,

- specific identification of the recommendations that must be met at specified stages of the commissioning process (core loading, criticality, various levels of power rise, reaching of nominal power),
- a time-schedule for meeting the other recommendations, and the obligation to annually report on the progress made in implementing those recommendations.

Indeed, a number of recommendations relate to the commissioning tests programmes or the acceptance criteria of the tests, and therefore these recommendations have to be satisfied before the tests may be started. Other recommendations are more long term. For instance, at the time of starting-up the Doel 3 and Tihange 2 units in 1982, the Decree of Authorization stipulated that qualification programmes be established for equipment due to operate during accidents, which at the time was a new requirement. The results of these programmes, i.e. the proof of the qualification of these equipments, were expected within the next few years. Considerable investments were made in post-accidental test and qualification facilities, so that prototype tests could be performed.

Another example relates to simulators. Initially, Belgian power station operators were trained on simulators abroad, and these foreign simulators did not exactly reflect the Belgian units. As a result the decision was taken to install at each site simulators that truly mimicked the characteristics of the units at the Belgian sites. The recommendation further specified that the validity and the extent of the simulations of these simulators be demonstrated, so that its limitations would be known as well as their consequences on operator training.

These simulators have been subjected to an acceptance inspection procedure similar to that applied to the nuclear power plant, including examination of the simulation models and their results when simulating major transients and certain accidents. The results of the simulations were compared either to the results of real tests at the units (major transients) or to the results generated with thermal-hydraulic codes (RELAP5 or equivalent).

Experience has shown the interest of such simulator validation approach. Later, when modifications are made to the installations and the simulator is updated accordingly, non-regression tests prove the correct nature of the actions taken.

After having been discussed at the Special Commission, the text of the Decree of Authorization is drafted by the Safety Authorities and presented to the King for signature.

The later phases of the conformity examination, the start-up tests and gradual rise to full power are conducted under the acceptance inspection procedures and after conformity checks of the installations by the Regulatory Body as explained in Article 8 of the present Report.

2. Main results of continuous and periodical safety monitoring

a. During operation of the installations, experience feedback leads the operator to envisage certain modifications to the installations or launch major projects such as replacement of the steam generators or power uprate.

   The nuclear power plant is also subject to ten-yearly overhauls/safety reviews.

The proposals for modifications to the installations are examined by the Health Physics Department of the operator, and the Regulatory body (AVN) is informed. The 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 application for a licence under the provisions of Article 6 of the R.D. of 28 February1963. The safety analysis performed by AVN is presented to the "Commission Spéciale Radiations Ionisantes", and a rider will be established to the Royal Decree of Authorization. The implementation of that modification will be authorised by the unit's Health Physics Department and by AVN.

Examples of such modifications are a power increase of the reactor, steam generator replacement, utilisation of MOX fuel.

- the less important modifications that do have a potential impact on safety. The modification file is established by the requesting department, possibly with outside help, is presented for approval to the Unit or Site Operation Committee and is examined by the Health Physics Department. After this, it is examined by AVN's inspector, and if necessary by AVN's technical responsibility centres, which may result in amendments being ordered to the modification file. When AVN deems that the file is acceptable, it approves the modification request, and implementation may commence. Commissioning of the completed modification is subject to a positive acceptance report, issued after validation of the modification and re-qualification of the portion of the installation that was modified, plus updating of the operation documents. AVN delivers a final acceptance report (operating licence) when all the files, procedures and the Safety Analysis Report have been adequately updated.
- 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 AVN, except for the modified pages of the Safety Analysis Report.

b. The Decrees of Authorization of each Belgian unit make mandatory its ten-yearly overhaul/safety review. The general purposes of these ten-yearly overhauls/safety reviews are discussed in Article 6 of the present Report.

   The first of these ten-yearly overhauls/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 taken into account.

   This is why during the first ten-yearly overhauls/safety reviews of Doel 1 and 2 and Tihange 1 in 1985 a great number of subjects had to be addressed, involving for each unit about 800,000 engineer-hours and a cost of the order of Euro 100 million.

   The different subjects examined during the first ten-yearly safety reviews are detailed in Appendix 4.

These 1st ten-yearly overhauls/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 of a higher-intensity earthquake, protection against external accidents, new reactor protection system.

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

The 1st ten-yearly overhauls/safety reviews of the newer units (Doel 3 and 4, Tihange 2 and 3) and the 2nd ten-yearly overhauls/safety reviews 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 has been no major evolution in the regulations in 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 different subjects examined during these ten-yearly safety reviews are also detailed in Appendix 4.

The second ten-yearly safety reviews of the most recent units (Doel 3 and 4, Tihange 2 and 3) will include two phases: the first one is made of topics common to all units, the second one addresses aspects specific to one unit. The first phase only has begun.

The different topics which will be examined during these next ten-yearly safety reviews are also detailed in Appendix 4.

All these periodic safety reviews (first and second) have included two parts: one part “studies”, one part “implementation”, that one relying on 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 ten-yearly safety reviews are indicated in Appendix 1 of this Report, in the description of each unit.

c. Certain studies relating to the modifications or initiated in the scope of the ten-yearly overhauls/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), containment venting systems, reactivity accidents during operation and during shut down states.

- Power increase and burn-up cycle extension studies led to the redefining of the key parameters for the power capacity studies and accident analyses.

  Mixed core composition (presence in the core of fuel assemblies from different suppliers) had also 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 necessary 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 relating to the utilisation of MOX fuel consider the same questions as those involved in the power increase mentioned here above.
- Steam generator tube degradation called for extensive research and evaluation of the detection methods and their accuracy, for predicting the evolution in time of the degradation process, and for defining tube plugging criteria. Accident reanalysis had to be done taking into account much higher plugging rates than those envisaged at the time of the original design.
- Replacement of the steam generators, whether or not linked to a power increase, more often than not implies a larger heat exchange surface between the primary and secondary systems, a modification of the primary and secondary inventories, and changes in piping lay-out.

  This requires reviewing of the analyses of transients, accidents and capacities of the systems. In case of a power increase, all the above studies also have to be repeated.
- Replacement of technologically obsolescent systems mainly addresses the instrumentation and control systems, as new equipment most often includes new software of which the qualification in safety-related functions has to be demonstrated.
- 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 which can be applied to all units. Topics of interest are for example the redefinition of the release limits due to accidents, 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 clogging.

3. 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 stipulations for the less important modifications that are subject only to approval by the operator's Health Physics Department and by the Regulatory Body.

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:

- inspections 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 pumps 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 limit number of transients during normal, incidental and accidental operation. As for the reactor vessel, it is monitored according to the transition temperature evolution (NDTT) based on an irradiated samples withdrawal programme. The occurrence rate of the design transients is strictly recorded under the close supervision of the Regulatory Body.

With regard to all passive components important to safety at one hand, and the components important for the availability of the plant on the other hand, it is foreseen to 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.

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.

1. Regulations

Chapter III "General Protection" of the Royal Decree of 28 February1963 introduced from the very beginning in Belgian law the radiological protection and ALARA-policy notions.

Article 20 sets among others the general principles for justifying and keeping as low as reasonably achievable the exposure, and for compliance with the dose limits. Other Articles of that chapter are described in Article 7 section 6 of the present National Report.

2. Design

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 generating 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 release limits, in annual mean or in instantaneous value, were presented in the Article 37 - Report 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 a single pipe that groups the primary and secondary effluents and which is redundantly and automatically isolated in case an instantaneous limit is exceeded.

3. Operation

a. ALARA policy

In addition to the Belgian regulations and the conditions set in the licence for each unit and which are the bases for monitoring these installations during operation, the evolution in regulations has been taken into account, e.g. the introduction of the recommendations of the ICRP documents and the implementation of the Euratom 96/29 Directive.

To anticipate the implementation of this Directive the licensee has, on a volutary basis, limited the individual dose at 15 mSv (Tihange) or 10 mSv (Doel).

For example, the ALARA policy which has been adhered to in the nuclear power plants for many years is applied versus the following criteria :

- work under an average dose rate higher than 1 mSv/h,

- estimated total integrated dose higher than 4 man.mSv.

When any of these two criteria is reached, the procedures stipulate:

- an initial dosimetric estimate,
- consulting between the work supervisor and the radiological protection agent in order for them to jointly agree about the protective means to be used,
- a new dosimetric estimate that takes into account the decided protective means,
- a dosimetric monitoring of the work, with check points or hold points at 75% and 125% of the estimated dosimetry,
- feeding back of experience.

For substantial or unusual works, there is a specific safety/radiological protection preparation of the work, through consultation between the Head of the Safety - Radiological Protection Section and the work supervisor, well ahead of the planned date of the work.

b. Follow-up of the doses

Various measures have been taken over the years to reduce the collective annual dose: the mean value for the 7 Belgian units has been reduced by a factor of about 3 during the 1990-2000 period.

For instance, the primary system chemical conditioning procedure applied in preparation of the core refuelling outages proved 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 pressurized water reactors.

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: pressurizer dome, valves, detected hot points, ...

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.

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.

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 signalling that forbids remaining stationary, signalling of very low dose-rate areas (“green” area) which the workers may use as an identified falling-back station.

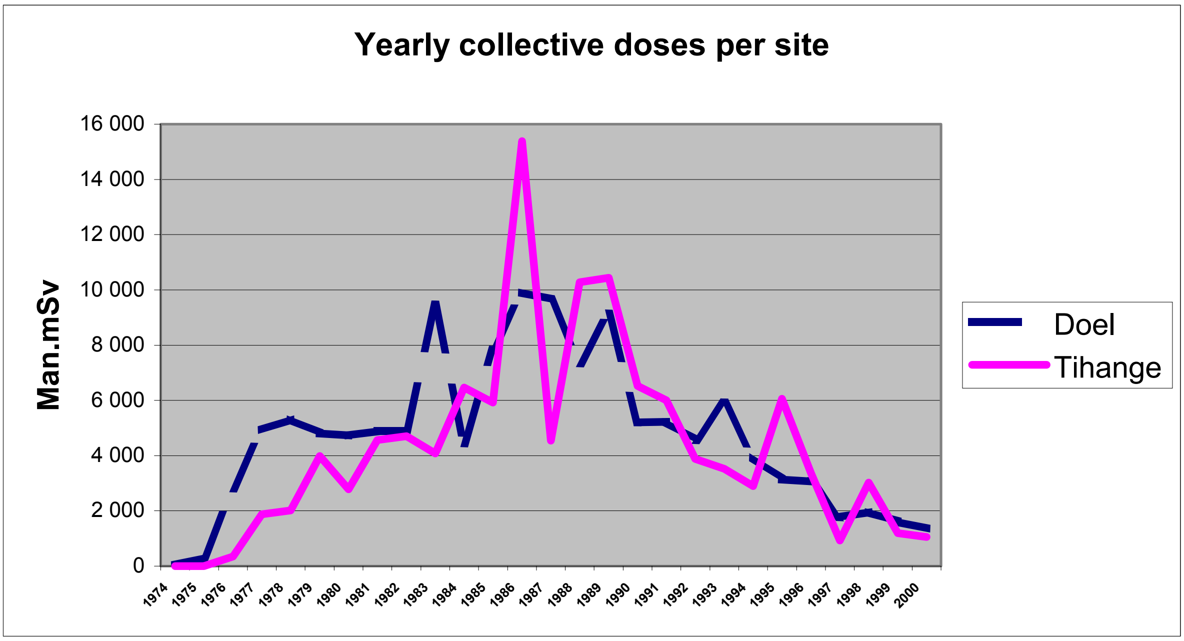
Throughout the outage period, the actual-versus-estimated dosimetry trends are monitored daily, and any significant deviation is analysed and may result in corrective action being taken.

For sizeable works, more detailed estimates are made, per phase of work or per equipment worked on.

The figure below represents the evolution of the 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 ten-yearly 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 yearly collective doses. Another factor of variation is the replacement of steam generators.



c. **<u>Large works</u>**

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 of replacing the Doel 3 steam generators amounted to some 1.9 man.Sv in 1993; for the same work in 1998 at Tihange 3 it was 0.625 man.Sv; i.e. lower by a factor more than 3.

More details are given in the following table:

	Doel 3	Tihange 1	Doel 4	Tihange 3
Year	**1993**	**1995**	**1996**	**1998**
Injuries	0	0	0	0
Outage duration (days)	96	93	92	77
SGR duration (days)	>40	31	27	20
Dose due to SGR (man.mSv)	1955	1637	633	625
Outage total dosis (man.mSv)	3169	3089	1231	1086

d. <u>Radioactive releases</u>

The limits mentioned in the authorizations of the both sites and the effective liquid and gaseous releases since 1985 are given in the tables next page. The release limits were determined so that the radiological consequences be lower than:

- gaseous releases: 50 µSv/year whole body dose
  150 µSv/year equivalent dose to any organ or to the skin
- liquid releases: 30 µSv/year whole body dose
  100 µSv/year equivalent dose to any organ

One can see that 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.

4. International exchanges

The Safety Authorities (SSTIN) and the Belgian operators participate actively since 1991 in the ISOE (Information System on Occupational Exposure) programme of OECD's Nuclear Energy Agency.

		TIHANGE NUCLEAR POWER PLANT				
		Gaseous releases			Liquid releases	
		Noble gases GBq	iodine MBq	aerosols MBq	beta-gam GBq	tritium GBq
	Limit:	2220000	14800	111000	888	148000
1	1985	17900	159	29.9	50.1	46300
2	1986	46000	610	75	57.2	54000
3	1987	30300	144	62	62.4	59000
4	1988	49500	1360	95	66.3	69200
5	1989	13000	316	72	77	49500
6	1990	34300	295.7	135.9	45.6	56600
7	1991	16700	86.4	76.6	55.4	37100
8	1992	10900	38.5	16.9	53.7	34900
9	1993	40500	26.6	20	41.1	35200
10	1994	11700	15.7	31.6	30.74	38574
11	1995	4100	5.5	51.4	26.9	41200
12	1996	14600	51.6	33.1	73.5	44700
13	1997	9800	15.9	15.3	29.6	47300
14	1998	7800	4.6	28.7	24.1	32889
15	1999	4300	5.9	13.8	15.9	66600
16	2000	3500	0.6	4	18.9	33060
Yearly average		19681	196.0	47.6	45.5	46633

		DOEL NUCLEAR POWER PLANT				
		Gaseous releases			Liquid releases	
		Noble gases GBq	iodine MBq	aerosols MBq	Beta-gam GBq	tritium GBq
	Limit:	2960000	14800	148000	1480	103600
1	1985	77800	560	326	14.0	46700
2	1986	18500	222	529	21.9	46400
3	1987	8000	41.8	182	3.7	49400
4	1988	16900	152.7	123.5	10.9	72800
5	1989	3400	179.3	34.9	22.4	56800
6	1990	15600	485.3	162	15.5	63000
7	1991	31271	657	99.7	30.2	38067
8	1992	26440	192	74.9	4.6	45200
9	1993	5186	97	8	23.6	34325
10	1994	971.5	9.5	6	9.3	33922
11	1995	4116	31.7	3.6	37.8	47020
12	1996	2050	8.2	2.8	18.9	31311
13	1997	73.8	5.7	1.5	26.4	38383
14	1998	3311.5	13.7	2.4	16.1	47135
15	1999	2664	3.1	0	27.8	48425
16	2000	95	8.5	0	15.0	30905
Yearly average		13524	166.7	97.3	18.6	45612

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.**

1. Regulatory framework

The Royal Decree of 28 February1963 in its Article 72 has from the beginning stipulated an emergency plan for the regulated installations potentially presenting a serious radiological risk. This Article of the regulations was modified in 1991 to take into account the Royal Decree of 27 September 1991 defining an emergency plan for nuclear risks on the Belgian territory.

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

2. Implementation of emergency organisation in the event of an emergency

2.1. Classification of emergencies

The Royal Decree of 27 September 1991 defines four levels for notification of emergencies, which are in ascending order of seriousness N1 to N4, 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 Internal Affairs.

For each of these 4 notification levels (N1 to N4) the notification criteria are defined in the Royal Decree of 27 September 1991. In addition, for each concerned nuclear installation, a set of particular types of events is established for each of the notification levels.

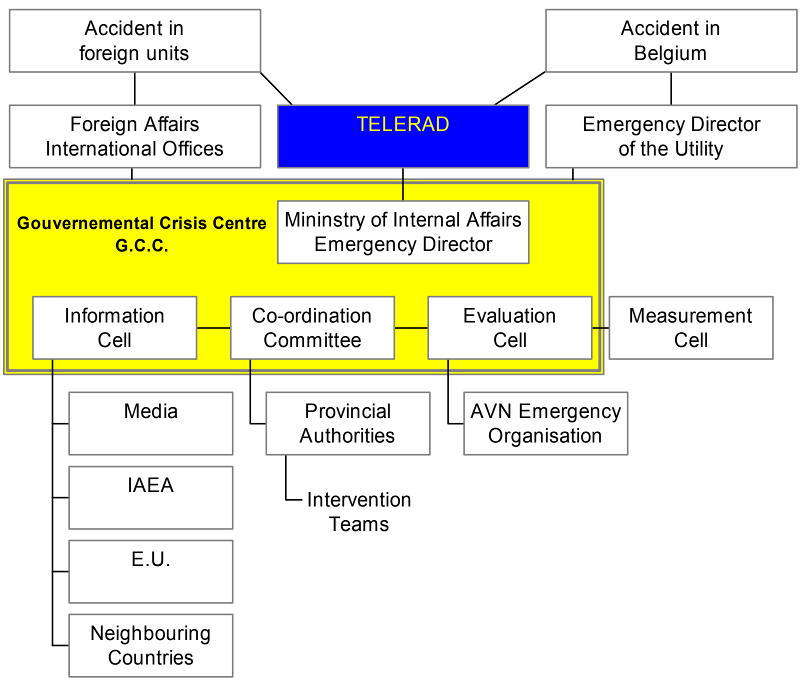
For example, the criterion associated with the N1 level is defined as follows: "Event which implies a potential or real degradation of the safety level of the installation and which could further degenerate with important radiological consequences for the environment of the site. Radioactive releases are still small and there is thus no danger for the environment of the site. The on-site alarm "internal nuclear accident" is declared."

In addition to these four levels, a "N.O" level is defined for notifying the Authorities in case of an operational anomaly. This level does not activate the emergency plan.

The "Emergency Director" of the Authorities transforms the notification level into an alarm level (U1 to U4), putting into action the corresponding phase of the National Emergency Plan.

2.2. National master plan for organisation in the event of emergencies

The "Centre Gouvernemental de Coordination et de Crise" (CGCCR) is composed of the "Emergency and Co-ordination Committee" chaired by the Emergency Director, of the evaluation cell, of the measurement cell and of the information cell, as indicated in the figure below.



In case of an accident abroad, the information is channelled to the Ministry of Foreign Affairs which informs the CGCCR. In addition the quick exchange of information systems in case of nuclear accident developed by the IAEA and by the European Union (Ecurie) are another source of information of the CGCCR. In case of an accident at 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 principal aim to measure routinely the immissions and make measurements in case of an accident occurring in a Belgian nuclear site or abroad (183 measurements of ambient radioactivity in air and water are collected, treated and sent to the computer located at the FANC). The monitoring of the territory consists in a measurement network having a 20 km mesh (76 air dose rate counters, 7 initiating alarms stations measuring activity α and β and iodine in aerosols, 9 meteorological masts). Around the Belgian nuclear sites, the network consists in two rings: the first ring is on the site border and measures ambient radioactivity around the site, the second ring covers the near residential zone, between 3 and 8 km from the site, depending on the direction.

In addition to the square lattice, there are measurements along the Belgian border, in the vicinity of foreign plants (Chooz B, Gravelines, Borssele).

The evaluation cell is composed of representatives of the relevant departments (in particular SPRI, SSTIN, "Institut Scientifique de Santé Publique Louis Pasteur"), and of experts of the Mol Nuclear Research Centre, the "Institut de Radioéléments", and of AVN as the authorized inspection organisation that supervises these installations, as well as of a representative of the operator of the installation. This cell is to evaluate the situation in radiological terms and advise the Emergency and Co-ordination Committee about protective measures for the population and the environment. The recommendations about the measures to be taken to protect the population and the environment are elaborated on the basis of pre-established intervention guide-levels. These guide-levels are given in the text of the Royal Decree of 27 September 1991. The evaluation cell receives the information originating from the operator, from the measurement cell and from the institutions that are part of the evaluation cell and which can help it understand the actual situation and its probable evolution.

The measurement cell co-ordinates all the activities aimed at collecting the radiological information, based on ambient radiological measurements in function of the various exposure modes. It rapidly transmits the collected and validated information to the evaluation cell.

The information cell is the CGCCR's communication channel with the public, the media, the international organisations (EU Commission, IAEA), the neighbouring countries.

The Emergency and Co-ordination Committee immediately meets as soon as the Emergency Director decides a U2 (or higher) alarm level. Based on the information from the evaluation cell the Committee decides about the necessity of protection measures for the population and/or the food chain or drinking water supply, and manages the (federal and provincial) Authorities intervention during the accident. These decisions are sent to the Provincial Emergency Centre to be implemented by the different intervention teams (fire brigade, police, emergency medical services,…).

The cells which compose the CGCCR (Emergency and Coordination Committee, Evaluation Cell, Measurement Cell and Information Cell) participate in the annual exercises of the emergency plans at the relevant installations.

The Royal Decree of 27 September 1991 defines the emergency planning zones relative to the direct measures to protect the population (evacuation, sheltering, iodine prophylaxis). These zones have a 10 km radius around the nuclear plants.

The National Emergency Plan is still being developed as concerns the infrastructures: Telerad put into service, sirens installed around the nuclear installations, iodine tablets distributed, the working procedures of the evaluation and measurement cells developed, investments made at local level.

2.3. 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, section 3) and has been approved at the time of licensing. In complement an "internal emergency plan" details the instructions for all the actors.

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

In case of accident the unit's "Centre Opérationnel de Tranche" (COT) (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) (i.e. the Emergency Operations Facility) manages the environmental consequences, liaises with the "Centre Gouvernemental de Coordination et de Crise", and informs the media.

The nuclear power plant conducts internal exercises several times a year, and the Internal Affairs Ministry's General Direction of Civil Protection organises an internal and external exercise yearly for each nuclear site.

Consistent with the intended objectives, the Ministry involves in these exercises the various disciplines (fire brigade, medical help, police force, measurement teams, ...).

The operator is requested to build 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 simulator may in certain cases also be used as a source of information.

Information exchange at international level is performed through the "Centre Gouvernemental de Coordination et de Crise", which has contacts with the competent Authorities of the neighbouring countries, and which is the "national contact point" for Nuclear Accident Early Notification Convention (IAEA) 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 level 2 notification is decided. This direct line is also used when certain accidents occur in the chemical industry (installations subjected to 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 French Republic Government and the Kingdom of Belgium Government about the Chooz nuclear power plant and the exchange of information during incidents or accidents, a mutual alarm is foreseen between the two countries in case of an accident occurring in the nuclear plants at 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 (June 2000) and of Gravelines (May 2001) that transborder collaboration was tested at the local and national levels. In addition a direct exchange of technical and radiological informations took place between the organisations in charge of the expertise (IPSN on the French side, AVN on the Belgian one) and of the advice (Nuclear Safety Authority in France, Evaluation Cell of CGCCR in Belgium) and was quite successful.

That bilateral direct exchange of information in emergency situations will be translated in an official protocol between the concerned parties.

As regards independent evaluation in the event of an emergency, the Regulatory Body (AVN) which oversees the affected installation sends a representative to that site, a representative to the evaluation cell of the "Centre Gouvernemental de Coordination et de Crise", 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 which it has at its head office, AVN proceeds with a technical analysis of the situation, evaluates 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 AVN, so as to allow a validation of the results furnished by the licensee. These various computer codes have been compared in terms of assumptions and calculation methodologies.

2.4. Information of the public

The Royal Decree of 28 February1963 specifies in its Article 72 all the obligations regarding training and information of the public pursuant to the Euratom 89/618 Directive.

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

D. SAFETY OF INSTALLATIONS

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.

a. Characteristics taken into account in the sites selection

The Doel and Tihange nuclear power station sites were originally evaluated according to the requirements set by the US rules (Chapter 2 of the Safety Analysis Report, Standard Review Plan, 10 CFR 100).

These requirements apply to the phenomena of natural origin (earthquakes, floods, extreme temperatures,…) and to the phenomena of human origin (industrial environment, transports,…).

With regard to the natural phenomena:

- The geological and seismic characteristics of the sites and their 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 sizing 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 evaluate the impact on 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 the local industrial activities may have on the power stations, specific requirements were adopted in 1974 : 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 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 "bunkerized 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.

b. Periodic reassessment of the site characteristics

These reassessments are systematically performed during the ten-yearly safety reviews of each unit.

During the 1st ten-yearly 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 intensity. 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 ten-yearly 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 remote.

During the ten-yearly safety reviews 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 of transport-, aircraft- and industrial activities.

c. <u>International agreements</u>

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 Royal Decree of 28 February 1963). The reports drawn up to meet this requirement have been transmitted to the Commission of the European Union in the scope of the licensing procedures for the Belgian power stations. After discussion with its “Article 37” 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 Euratom 85/337 Directive about the evaluation of the consequences on the environment due to some private or public projects.

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 of the Belgian nuclear power plants is described in Appendix 1 to the present Report, as well as the major modifications brought during the successive ten-yearly safety reviews.

1. Rules followed during design and construction

As described in Article 7 of the present Report, the "Commission Spéciale Radiations Ionisantes" (i.e. the Belgian nuclear safety Commission) 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 authorization of the units.

The whole design and safety analysis of these units have been done applying 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.

Article 8 of the present Report describes the licensing process. 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 pointed out and fully justified. The second appendix deals with the non mandatory rules and explains how they have been implemented, respecting 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 basic safety standards, which is obligatory for all countries members of the European Union.

For pressure vessels which are part of the nuclear installation, a ministerial Decree of derogation has been established in order to replace 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 Authorized 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 the nuclear safety regulatory body (AVN).

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 bunkerized 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 bunkerized structures was smaller than 10^{-7} per reactor year.

Similar verifications have been performed for the 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.

2. Rules followed during the ten-yearly safety reviews

As mentioned in Article 6 of this Report, the Royal Decree of Authorization of each nuclear unit makes it mandatory to conduct ten-yearly 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 highlighted, 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 ten-yearly 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 ten-yearly safety reviews.

The topics to be studied in these safety reviews are detailed in a report submitted jointly by the licensee and the regulatory body AVN to the Safety Authorities; in this way the rules retained become obligatory.

The feedback of operational experience of nuclear power plants at the internal level is also considered; in this respect the "Bulletins" and the "Generic Letters" of the USNCR 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 ten-yearly 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 ten-yearly 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 ten-yearly safety reviews is given in extenso in Appendix 4 of this Report.

As new topics introduced in the ten-yearly safety reviews corresponding to international practices, two examples are the probabilistic safety studies and the analysis of severe accidents.

For the latter AVN had in September 1986 requested the licensees 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 ten-yearly 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.

3. 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 pressurized water reactor nuclear power plant, the additional systems installed to mitigate the consequences of an external accident in fact add an extra level of defence in depth as they can help during certain internal accidents which might develop unfavourably.

4. 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 return the plant 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 900 to 1000 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 latest ten-yearly safety reviews, probabilistic safety studies were carried out for all the Belgian units. These studies were either level 1 with analysis 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.

5. 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 the Regulatory Body (AVN) to verify the qualification file and examine the experimental bases on which are founded the models and correlations of the code.

Particular attention is given to verifying and validating the software itself and the quality assurance programme applied to software production.

6. Requirements of reliable, stable and easily controllable operation, taking into account human factors and the man-machine interface

In order to make easier the operation of their power stations and 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.

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 no-load states). Furthermore, guidelines have been established to mitigate the consequences of severe accidents.

The participation of various Belgian organisations (CEN/SCK, Tractebel, the regulatory body AVN) in the HALDEN project allows to gain from international experience in man-machine interface matters.

ARTICLE 19. OPERATION

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

(i) **the initial authorization 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 organizations 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.**

1. Initial authorization and commissioning

The licensing process and the related safety analysis have been described in Articles 8 and 14 of the present National Report. The Royal Decree of Authorization is signed by the King after it has been examined in detail by the Regulatory Body(AVN), the “Commission Spéciale Radiations Ionisantes” and the Safety Authorities (SPRI and SSTIN).

The commissioning test programme is discussed and approved by the regulatory body, which follows-up the tests, evaluates the test results, verifies the conformity to the design and issues the successive operating licences that allow to proceed with the next step of the test programme.

This process is complete when the regulatory body (AVN) authorises the operation of the unit at full power.

2. 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.

There are procedures related to the respect of the Technical Specifications (T.S.) for maintenance activities during plant outage and plant operation. Each maintenance procedure has its own paragraph dedicated to T.S. requirements and limitations. During plant outages, some safety engineers are monitoring the requirements of the Technical Specifications. This monitoring is not only related to equipment but also to functions, like the integrity of the containment during refuelling, verification of the redundancy of the heat removal ways during RHR operation,…

Each modification that may have an impact on safety must be approved by the regulatory body before it can be implemented as explained in Article 14, section 2.a. In this respect, modifications to procedures, to the Technical Specifications and to the Safety Analysis Report are identified and discussed.

3. Operation 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 acceptance of the installations by AVN.

During the commissioning tests, the relevant procedures that were used by the operators were verified for adequacy.

4. Incident and accident procedures

A full set of incident management procedures ("I" procedures) and accident management procedures ("A" 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 power operations and shutdown modes.

These procedures are validated on a simulator and are used for operator training. This point was already discussed in section 1 of Article 12 to the present National Report.

Severe accident management procedures, inspired by the "Severe Accident Management Guidelines" developed by the Westinghouse Owners' Group, are being implemented, adapted to the specificities of each unit. The training programme of the control room operators is developed in parallel.

5. Engineering and technology support

The organisation and know how of the operator, defined 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. From the point of view of engineering the licensee gets the help of Tractebel Energy Engineering (TEE). TEE has indeed an excellent knowledge of the installations as it was the Architect-Engineer during the construction. Moreover TEE has been in charge of the studies and their implementation during the ten-yearly safety reviews, of the steam generators replacement projects and of a large part of minor modifications projects, which allowed to maintain competence and knowledge of the installations.

The advice of TEE is also asked by the licensee when the latter wants to proceed to even a minor modification of its installation. TEE is also in charge of the follow-up of the provisioning of fuel reloads and of core management. Through its R and D projects, training actions and technological surveys, TEE maintains a high competency in conformity with the state of the art. In order to reach these goals, TEE participates to many 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.

Electrabel, Tractebel Energy Engineering, Laborelec and AVN have decided to put together all the information they possess in order to anchor the knowledge. The goal of this project is to establish a common structure giving access to the design bases.

6. Notification of significant incidents

Section 16.6 of the Safety Analysis Report lists the events that must be notified to the Regulatory Body and to the Safety Authorities, indicating for each notification within what delay it must be notified.

The same section also specifies the cases where incident reports must be supplied to the Regulatory Body, and within what time period.

For each incident, a classification with reference to the INES international scale is proposed by the operator discussed with AVN, and decided by the Safety Authorities.

The IRS reports are established by the Regulatory Body (AVN) for the incidents this body considers interesting (see Article 8 section 3.b).

7. Operational experience feedback

Application of experience feedback has always been considered essential to plant safety, both by the operators and the regulatory body. In Article 10 and in section 4 of Article 12 of the present Report, the organisations set up within the operator and within AVN have been described.

It shall be borne in mind that the decrees of authorization redundant stipulate that experience feedback from the Belgian and foreign units be considered. Incident analysis includes root cause evaluation, the lessons learnt and the corrective actions taken.

Databases have been developed — in particular by AVN — to systematise experience feedback and facilitate its links with the safety analysis.

With respect to the Y2K problematic and the possible software problems associated to it, AVN had asked the licensees to define an action plan. The different softwares have been classified according to their safety significance and the adaptations judged necessary have been implemented. No incident, even a minor one, took place in the Belgian installations on that occasion.

8. Generation of radioactive waste

As indicated in Article 15 of the present National Report, the gaseous and liquid effluent treatment systems have been designed to limit the doses to the population, consistent with 10 CFR50 Appendix I, using conservative assumptions. The release limits are specified in the Technical Specifications.

Solid waste is dealt with according to the conditions set by ONDRAF, the Federal Agency in charge of radioactive waste collection, treatment and storage.

These wastes are classified in 3 categories: A (low activity), B (intermediate activity or high with a limited heat production) and C (high activity and high heat production). This classification is consistent with IAEA documents.

9. Temporary storage of used fuel

For the storage of used fuel, the dry storage building at Doel contains (June 2001) 31 containers in which 834 fuel assemblies are stored (74 from Doel 1 and 2, 448 from Doel 3, 312 from Doel 4), corresponding to about one fifth of the present storage capacity.

The fuel pool building at Tihange contains (June 2001) 635 fuel assemblies (227 from Tihange 1, 252 from Tihange 2 and 156 from Tihange 3), corresponding to about one sixth of the total capacity.