

Convention on Nuclear Safety

7th Review Meeting – 2017



International Atomic Energy Agency IAEA, Vienna

Country Review Report for BELGIUM

Drafted by Country Group N° 1

(Argentina, Austria, Belgium, Cyprus, Estonia, Jordan, Kazakhstan,
Malta, Mexico, Poland, The Former Yugoslav Republic of Macedonia,
United States of America)

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Version: FINAL

DISCLAIMER: Per INFCIRC 571, Revision 7, Para. 16-19 and Annex IV, Contracting Parties were invited to comment on the implementation of the CNS reporting guidance. Contracting Parties were also encouraged to submit proposed Good Practices, Challenges, and Suggestions prior to the Review Meeting. The draft Country Review Report documents the preliminary observations identified by the Contracting Parties. The Country Review Report is the result of the CNS Review Process and was agreed by consensus by the Country Group.

Glossary

A **Challenge** is “a difficult issue for the Contracting Party and may be a demanding undertaking (beyond the day-to-day activities); or a weakness that needs to be remediated.”

A **Suggestion** is “an area for improvement. It is an action needed to improve the implementation of the obligations of the CNS.”

A **Good Practice** is “a new or revised practice, policy or programme that makes a significant contribution to nuclear safety. A Good Practice is one that has been tried and proven by at least one Contracting Party but has not been widely implemented by other Contracting Parties; and is applicable to other Contracting Parties with similar programmes.”

An **Area of Good Performance** is “a practice, policy or programme that is worthwhile to commend and has been undertaken and implemented effectively. An Area of Good Performance is a significant accomplishment for the particular CP although it may have been implemented by other CPs.”

Executive Summary

Belgium has seven nuclear power reactor units, all of which are in operation. All seven of Belgium's nuclear power reactors are pressurized water reactors (PWR).

Belgium also voluntarily reported on its two research reactors.

Two out of four Challenges from the 6th Review Meeting have been closed.

The Country Group highlights the following measures to improve safety in Belgium's national nuclear programme:

- Several changes to the regulatory framework and the national nuclear programme have been made, including, among others:
 - The incorporation into Belgian regulations of the WENRA 2014 Safety reference Levels and of the European Directive 2014/87/EURATOM amending Directive 2009/71/Euratom.
 - The incorporation into Belgian regulations of the European Union's Basic Safety Standards (EU BSS).
 - The completion of the new national Nuclear Emergency Plan.
- Safety Culture Action Plan.
- Evaluation of safety of electrical systems.
- Efforts within safety research and development (R&D) focusing on: Severe Accidents Progression, Seismic Hazard Assessment and Fire Protection.
- The operator has planned several actions to improve safety for the next review period 2016-2019.

The Country Group highlights the following international peer review missions of Belgium:

- Safety Aspects of Long Term Operation (SALTO) mission took place at Tihange 1 in January 2015 and at Doel in February 2017. The missions' final reports are made available on the website of the regulatory body.
- In November 2014, Belgium hosted an International Physical Protection Advisory Service (IPPAS) mission.
- An expert, reduced SALTO mission was organized at the Doel 1 & 2 nuclear power plants (NPP) in February 2016. The mission's final report is available on the regulatory body's website.

The Country Group identified the following Challenges for Belgium:

- **Challenge 1:** The Regulatory body to complete the new national Nuclear Emergency Plan. **(new)**
- **Challenge 2:** The licensee to execute ongoing action plans (safety culture, stress tests, LTO, fire hazard analysis and PSA, WENRA 2014 safety reference levels) and the regulatory body to conduct appropriate oversight. **(new)**
- **Challenge 3:** The regulatory body and the licensee should complete preparations to support the final shutdown and subsequent decommissioning.
- **Challenge 4:** Belgium to finalize the implementation of the IRRS action plan.

In addition, the Country Group identified four Areas of Good Performance.

The Country Group concluded that Belgium:

- Submitted a National Report, and therefore complies with Article 5 and in time following

Country Review Report for Belgium

Rule 39 of INFCIRC/573 Rev. 6.

- Attended the 7th CNS Review Meeting, and therefore complies with Article 24.1
- Held a national presentation and answered questions, and therefore complies with Article 20.3

1. Basic Information on Belgium's Nuclear Programme

Belgium has seven nuclear power reactor units, all of which are in operation. All seven of Belgium's nuclear power reactors are pressurized water reactors (PWR).

The oldest nuclear power units in Belgium, Doel I and II were planned to be shut down in 2015. According to the law of 31 January 2003 on nuclear phase out, the lifetime of Belgian reactors was limited to 40 years. The amendment of June 28th 2015 extends the lifetime of Doel I and II and the shutdown dates are now 15th February and 1st December 2025 respectively.

Belgium voluntarily reported on its two research reactors, BR1 and BR2.

2. Follow-Up from previous CNS Review Meeting

2.1 Challenges

Belgium provided the following updates on Challenges identified during the 6th CNS Review Meeting:

Challenge 1: If nuclear power will be phased out, Federal Agency for Nuclear Control (FANC) and Electrabel will need to increase the focus on decommissioning activities and the licensee will need to respond accordingly.

Belgium reported that in order to ensure the energy supply in Belgium, the government and the parliament reconsidered the definitive shut down of Doel 1 and 2, and decided in 2015 to extend the lifetime of these units by 10 years, by amending art. 4 of the law of 31 January 2003 and thus fixing the date of shutdown of all Belgian reactors. As a result, the phase out law of 2003 has been modified for the second time, on June 28th, 2015. According to Belgium's National Report, the first reactor to be shut down, will be Doel 3, in October 2022.

Follow Up Status: Open

Challenge 2: Finalize the implementation of the Fukushima lessons learned.

Belgium reported that the country, as member of the European Union, participated in the "Stress Tests" programme initiated by the European Commission after the Fukushima Dai-ichi accident.

The Belgian National Action Plan (NAcP) is closely followed-up by the regulatory body. In this respect, the FANC publishes an annual progress report on the Belgian Stress Tests action plan on its website.

In 2015, the main achievements and progresses of the Belgian action plan to note are:

- The protection against beyond design flooding is now fully operational on both sites.
- The strategy for the Complete Station Black-Out is now well-defined on both sites. The induced actions as well as the actions concerning the loss of the Ultimate Heat Sink, are ongoing at Tihange and effective at Doel.
- A new strategy for the Emergency Response Centre in Tihange (COS) has been proposed and is now under review by the regulatory body.
- The design of the filtered venting systems is completed and the realization phase has been started. The filtered vents should be operational in 2017 with the exception of Doel units 1 and 2 for which the foreseen installation date is 2019.

The FANC considers that the progress made in 2015 is satisfactory but notes delays in the implementation of the Stress Tests action plan. Most remaining actions are now beyond the time schedule of the original action plan by on average more than one year. These delays have been duly justified by the licensee for technical or procurement difficulties. They are also partly due to changes in the action plan due to the review of the feasibility and preliminary studies by the regulatory body. On both sides the workload of the Stress Tests project has probably been underestimated when setting the deadlines.

By March 2016, according to the Belgian National Report, 82% of the actions stemming from the action plan are closed (300 actions out of 366).

The regulatory body will continue to carefully monitor the progress of the stress test actions implemented by the licensee in the future years.

Follow Up Status: Closed

Challenge 3: Resolve flaw issues in the Doel Unit 3 and Tihange Unit 2 reactor pressure vessels (RPV).

Belgium reported that after the restart of Doel 3 and Tihange 2, in June 2013, Electrabel was expected to complete its mid-term action plan before the end of the planned outages of April and May 2014. However, partial and preliminary outcomes of two actions were unexpected and challenged the conclusions of the licensee's safety demonstration.

In February 2014, tests performed on the ultrasonic testing (UT) inspection device suggested that the flaw indications had not been accurately characterized. In March 2014 a test on the VB395 material (a material containing hydrogen flakes from a rejected Areva steam generator shell) showed that irradiation had a bigger impact on the embrittlement of that material than expected. As these outcomes raised questions about the extent and the understanding of the flaking phenomenon and hence also about the conservatisms of the safety cases, it was decided in March 2014 to advance the planned outages of both reactors and to immediately shut down the reactors.

Assisted by external experts, the licensee started an investigation of the impact of these unexpected outcomes on its safety demonstration and made an analysis whether or not the affected units could safely resume operation. The results of this analysis were recorded in two new 2015 safety case reports, which were supported by a number of technical documents.

In November 2015, the FANC completed its safety assessment of the Doel 3 and Tihange 2 RPVs and came to its conclusion based on the licensee safety case reports, which were approved by the Licensee's Nuclear Safety Department, and the independent review and evaluation reports of Bel V, Association des Industriels de Belgique AIB-Vinçotte, the International Review Board, Oak Ridge National Laboratory (ORNL), and the National Scientific Expert Group. The different reports have been published on the FANC web site.

The FANC can confirm that all the safety concerns that were at the origin of the short-term and mid-term requirements have been solved in a satisfactory way. After a detailed evaluation of the potential impact of the unexpected outcomes from February and March 2014, the FANC has concluded that the new 2015 safety case reports provide an adequate demonstration of the structural integrity of the Doel 3 and Tihange 2 reactor pressure vessels up to 40 years of operation.

As a result, the FANC authorized the Doel 3 and Tihange 2 reactor units to resume operation until they reach the age of 40 years. After an extended shutdown of 20 months, Tihange 2 and Doel 3 units were put back into operation in December 2015 and January 2016 respectively.

The FANC requires the licensee to perform follow-up UT-inspections, using the qualified procedure on the RPV core shells wall thickness at the end of the next cycle of Doel 3 and Tihange 2, and thereafter at least every three years.

UT investigations were performed in Doel 1, 2 and 4 in 2015. No indications were detected. UT investigations of the RPV core shells were performed in Tihange 1 and Tihange 3 in 2013 with the 2013 UT procedure. No indications were detected. However, the FANC requested to perform new UT inspections on all forgings of the RPVs. This was done in 2015 for Tihange 3 and was planned in 2016 for Tihange 1.

Follow Up Status: Closed

Challenge 4: Implement the Integrated Regulatory Review Service (IRRS) action plan.

Belgium reported that soon after the IRRS mission in December 2013 the FANC drew up an action

plan to address the recommendations and suggestions. This action plan not only addresses these, but includes also the self-assessment and its corresponding action plan in preparation of the IRRS mission, the FANC's strategic plan, taking into account the upcoming challenges such as the phase-out of nuclear energy and the implementation of the European BSS and specific demands from the operational departments of the FANC.

The resulting action plan is composed of three main "programs":

- Management System.
- Future of the Regulatory Body (strategy).
- Specific Actions.

The regulatory body intends to receive the IRRS follow-up mission in the second half of 2017. The first steps for this follow-up mission have already been taken.

Follow Up Status: Open

2.2 Suggestions

No Suggestions were identified for Belgium during the 6th CNS Review Meeting.

3. Measures to improve safety

3.1 Changes to the regulatory framework and the national nuclear programme

Since the last Review Meeting, the Country Group took note of the following changes to the regulatory framework and the national nuclear programme:

- Amendment of the law of 31 January 2003 on nuclear phase out and the decisions on lifetime extension of the Tihange 1 (2012) and Doel 1 & 2 (2015).
- Development of Probabilistic Safety Analysis (PSA):

Since the last report of 2013, an important effort was done on PSA Level 2: Level 2 PSA studies for internal events have been completed for the 4 representative units (Doel units 1, 2 and 3 as well as Tihange units 1 and 3) including for low power and shutdown states. Containment failure frequency, relative contributions of different containment failure modes and FP release frequencies (as a function of amplitude, timing and FP class) were some of the main results obtained.

Some sensitivity studies have also been performed to better understand the behaviour of the plant and the relative importance of different severe accident management measures. The analysis of the results of the PSA Level 2 studies led to a list of recommendations for improvement which has been translated into an action plan. An evaluation of the applicability of this action plan to the other Belgian units (Doel 4 and Tihange 2) has also been performed.

- Periodic Safety Reviews (PSR) 2012-2015

The operators of nuclear power plants are obliged under the Royal Decree of 31 November 2011 and the provisions of their license to conduct a PSR every 10 years.

Since 2007 the FANC has required that plant operators perform this periodic safety review following a methodology based on the 14 safety factors described in the Periodic Safety Review for Nuclear Power Plants, Specific Safety Guide No. SSG-25.

This process has already been applied for the third PSR of the Doel 3 & Tihange 2 units, whose action plan is currently being implemented. For the other Belgian nuclear power plants, the evaluation phase has started end 2015 (3rd PSR for Doel 4, Tihange 3 and 4th PSR for Tihange 1).

Planned measures to improve safety for the next review period 2016-2019, according to the Belgian National Report, for the regulatory body, are:

- Legal framework improvement:
 - The incorporation into Belgian regulations of the WENRA 2014 Safety reference Levels and of the European Directive 2014/87/EURATOM amending Directive 2009/71/Euratom establishing a Community framework for the nuclear safety of nuclear installations.
 - The incorporation into Belgian regulations of the EU BSS.
 - The completion of the new national Nuclear Emergency Plan.
- Oversight of the timely implementation and the completion of the different actions plans of the licensee includes, but is not limited to:
 - The “Rigueur et Responsabilité” action plan, corrective actions to reinforce the safety culture.
 - The action plan resulting from the new Fire Hazard Analysis.
 - The Stress-tests action plan (BEST).
 - The LTO action plan for the concerned units.
 - The action plan that will result from the benchmarking with the WENRA 2014 Safety Reference Levels.
- The completion of the 2013 IRRS action plan and the IRRS follow up mission planned end 2017.
- The participation in the European Topical Peer Review organized in 2017-2018.
- Continuation of international activities and cooperation.

3.2 Safety improvements for existing nuclear power plants

The Country Group took note of several implemented and planned safety measures for existing nuclear power plants in Belgium. These include, but are not limited to:

- Safety Culture Action Plan was initiated for Tihange in 2015. In addition, the FANC asked the Electrabel Corporate Management and the other nuclear power plant of Doel to analyse the situation, as well, taking into account the feedback from Tihange and to define action plans in order to improve the safety culture as appropriate.
- Evaluation of safety of electrical systems: After the so-called Forsmark 1 incident, the design of the safety electrical systems was further evaluated and enhanced as appropriate, on the basis of the studies made and the final recommendations of the Committee on the Safety of Nuclear Installations (CSNI) Task Group related to Defence in Depth of Electrical Systems and Grid Interaction.
- Since the last report of 2013, the main efforts within safety research and development (R&D) program have been focused on: Severe Accidents Progression, Seismic Hazard Assessment and Fire protection. Bel V has also increased sponsoring R&D within nuclear safety in the last few years.

The operator, for the next review period 2016-2019, has planned following actions to improve safety:

- Installation of reactor pit injection means and alternative sprays at the Tihange Plants (in the framework of BEST).
- Alternative seismically robust electrical power supply at Tihange (in the framework of BEST).

- Installation of filtered vents by 2017 on Tihange 2 and 3, and Doel 3 and 4 (in the framework of BEST).
- Installation of filtered vents in Tihange 1 and Doel 1 & 2 by 2017 and 2019 respectively (in the framework of LTO).
- Commissioning of the SUR-Etendu in 2019 (in the framework of LTO Tihange 1).
- Reinforcement of the fire protection at Tihange 1 by 2019 (in the framework of LTO).
- Reinforcement of the Ultimate systems of the GNS (in the framework of LTO Doel 1 & 2).

3.3 Response to international peer review missions

The Country Group took note of the following international peer review missions:

- Safety Aspects of Long Term Operation (SALTO) mission took place at Tihange 1 in January 2015 and at Doel in February 2017. Belgium did, in its National Report and Presentation, give information of the results of the missions. The missions' final reports are made available on the regulatory body's website.
- In November 2014, Belgium hosted an IPPAS (International Physical Protection Advisory Service) mission.
- An expert, reduced SALTO mission was organized at the Doel 1 & 2 nuclear power plants (NPP) from 1 to 9 February 2016. Belgium did not, in its National Report, give any detailed information of the results of this mission. The mission's final report is available on the FANC website.

4. Implementation of the Vienna Declaration on Nuclear Safety (VDNS)

On 9 February 2015, the Contracting Parties adopted INFCIRC 872, "Vienna Declaration on Nuclear Safety", which is a commitment to certain principles to guide them in the implementation of the CNS' objective to prevent accidents and mitigate their radiological consequences, should they occur. The Contracting Parties agreed to discuss the principles of the Vienna Declaration on Nuclear Safety in their National Reports and in the subsequent Review Meetings.

Belgium addressed the VDNS principles in its National Report and Presentation.

4.1 Implementation of the VDNS's principle on new nuclear power plants

The first principle of the VDNS is:

"New nuclear power plants are to be designed, sited, and constructed, consistent with the objective of preventing accidents in the commissioning and operation and, should an accident occur, mitigating possible releases of radionuclides causing long-term off site contamination and avoiding early radioactive releases or radioactive releases large enough to require long-term protective measures and actions."

Belgium does not define a new nuclear power plant as the nuclear energy phase out law prohibits the building of new nuclear plants.

Belgium reports, though, that its national requirements and regulation incorporate appropriate technical criteria and standards to address the objective of preventing accidents in the commissioning and operation of new nuclear power plants.

The Country Group made the following observations:

- The Belgian National Report provided generic level information on how the country meets the safety objective of the VDNS.

4.2 Implementation of the VDNS's principle on existing nuclear power plants

The second principle of the VDNS is:

“Comprehensive and systematic safety assessments are to be carried out periodically and regularly for existing installations throughout their lifetime in order to identify safety improvements that are oriented to meet the above objective. Reasonably practicable or achievable safety improvements are to be implemented in a timely manner.”

Belgium reports, that its national requirements and regulation address the application of the principles and safety objectives of the Vienna Declaration to existing nuclear power plants. For instance, the Belgian national regulatory framework requires the performance of periodic comprehensive and systematic safety assessments of existing nuclear power plants, according to the Royal Decree of November 2011, Chapter 3, Generic Requirements Section IV – Verification of Nuclear Safety.

The Belgian national regulatory framework requires reasonably practicable/achievable safety improvements to be implemented in a timely manner, according to the Royal Decree of November 2011, Chapter 3, Generic Requirements Section III – Operation. Belgium has reported safety improvements implemented at existing nuclear power plants as mentioned in chapter 3.2.

The Country Group made the following observations:

- The Belgian national legislation requires Periodic Safety Reviews to be conducted.
- The Belgian national regulatory framework requires safety improvements to be implemented in a timely manner on existing nuclear power plants.

4.3 Taking into account IAEA Safety Standards and other international Good Practices in the national requirements and regulations addressing the VDNS principles

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

The legislative and regulatory framework comprises, among others, a set of laws and regulations, including safety requirements based on the WENRA reference levels, which are based on the IAEA Safety Standards. The regulatory body actively participates in the development and the promotion of the IAEA Safety Standards and will continue these activities in the future.

On the basis of nuclear Stress Tests carried out from 2011, the lessons learned from the Fukushima nuclear accident and the safety requirements of the Western European Nuclear Regulators Association (WENRA) and the International Atomic Energy Agency, the European Union amended its first Nuclear Safety Directive (2009/71/Euratom) in 2014. To be compliant, this directive will be fully implemented in the Belgian regulations by mid-2017.

The Country Group made the following observations:

- The Belgian national regulatory framework takes into account the relevant IAEA Safety Standards.

4.4 Issues faced by Belgium in the implementation of the VDNS

Belgium did not report facing any specific issues in applying the Vienna Declaration principles and safety objectives to its existing fleet or new builds of nuclear power plants.

5. Results of the Review

5.1 General Quality of the National Report

Contracting Parties and officers were invited to provide general comments on the Belgium’s implementation of the obligations of the CNS (e.g., report submitted on time), addressed all articles, addressed the Vienna Declaration on Nuclear Safety, and addressed all Challenges and Fukushima lessons learned, the general quality of its National Report, transparency issues, and the compliance with the CNS guidance documents and special peer review topics identified in the previous CNS Review Meeting or specified by the President of the CNS (reporting on the management of spent fuel on site and radioactive waste on site - especially for CPs not signatories of the Joint Convention and if

relevant on the use of the templates for articles 17 and 18).

Belgium addressed VDNS principles in its National Report and Presentation. The National Report provided generic level information on how the country meets the safety objective of the VDNS.

Belgium has ratified the Joint Convention and the country did report on management of spent fuel and radioactive waste on site in its National Report.

With regards to the general quality of the National Report and transparency issues, the members of the Country Group made the following observations:

- The Report is qualified to be comprehensive and reader friendly

With regards to the compliance with the requirements of the CNS and its Guidelines, the members of the Country Group made the following observations:

- The Report was submitted before the deadline of 15 August 2016.
- The content and structure of Belgium's National Report complies with the CNS guidance.
- The directions of the Summary Report of 6th Review Meeting were taken into consideration.
- The directions given by the President of the 7th Review Meeting were mostly followed.

5.2 Participation in the Review Process

With regards to Belgium's participation in the Review process, the members of the Country Group made the following observations. Belgium

- posted questions to Contracting Parties.
- delivered answers to the questions of Contracting Parties on time.
- delivered its national presentation.

5.3 Challenges

The Country Group identified the following Challenge(s) for Belgium.

- **Challenge 1:** The Regulatory body to complete the new national Nuclear Emergency Plan. **(new)**
- **Challenge 2:** The licensee to execute ongoing action plans (safety culture, stress tests, LTO, fire hazard analysis and PSA, WENRA 2014 safety reference levels) and the regulatory body to conduct appropriate oversight. **(new)**
- **Challenge 3:** The regulatory body and the licensee should complete preparations to support the final shutdown and subsequent decommissioning.
- **Challenge 4:** Belgium to finalize the implementation of the IRRS action plan.

5.4 Suggestions

The Country Group identified no Suggestions for Belgium.

5.5 Good Practices and Area of Good Performance

During the peer review of Belgium's National Report, the Contracting Parties were invited to recommend Good Practices and to highlight Areas of Good Performance.

The Country Group identified no Good Practices.

The following Areas of Good Performance of Belgium were commended by the Country Group:

- **Area of Good Performance 1:** Process for addressing Doel 3 and Tihange 2 RPV flaws issues by engaging international scientific organisations and regulators in the decision making process and by providing open access to information to all interested parties.

- **Area of Good Performance 2:** Conduct of cross-inspections with neighbouring countries.
- **Area of Good Performance 3:** Additional level for the notification of emergencies, dealing with fast kinetics (General emergency reflex mode).
- **Area of Good Performance 4:** LTO process including the actions plan enforcement and continuous safety improvement through several actions plans in NPPs.

6 Fulfilment of CNS Review Requirements

The Country Group concluded that Belgium

- Submitted a National Report, and therefore complies with Article 5 and in time following Rule 39 of INFCIRC/573 Rev. 6.
- Attended the 7th CNS Review Meeting, and therefore complies with Article 24.1
- Held a national presentation and answered questions, and therefore complies with Article 20.3