ANNUAL REPORT 2023

BELV

Message from the Chairman

Bel V is a private foundation established as a subsidiary of the Federal Agency for Nuclear Control (FANC), which delegates to it oversight activities in the field of nuclear safety and radiation protection. On the basis of experience built up over more than 50 years, Bel V helps to protect the general public, the workers and the environment against the dangers of ionising radiation.

Bel V celebrated its 15th anniversary in 2023. The progress achieved during this period has been impressive. We can be proud of the results: we have a multidisciplinary team of high-level experts in nuclear safety and radiation protection dedicated to protecting workers and the public against the potential dangers of ionising radiation, both in Belgium and abroad.

The IRRS (Integrated Regulatory Review Service) mission for Belgium took place from 19 to 30 June. With its colleagues from the FANC, Bel V participated in a number of specific review sessions in accordance with its regulatory activities. Overall, the IRRS mission went well and a number of recommendations, suggestions, good performances and one good practice were formulated for both the FANC and Bel V.

In 2023, the federal government and ENGIE Electrabel concluded an agreement to extend the operating life of the Doel 4 and Tihange 3 nuclear reactors by ten years. In order to guarantee the security of nuclear energy supply during the winters of 2025-2026 and 2026-2027, the necessary improvements can be carried out gradually, without compromising nuclear safety.

Didier Malherbe
Chairman of the Board of Directors

The quality of Bel V's technical expertise boasts international recognition.

In this context, with the permanent shutdown of the other five nuclear reactors, the management of Bel V is working tirelessly to implement its strategic plan. In cooperation with international partners, Bel V is also the technical safety organisation (TSO) of the Dutch (ANVS) and Norwegian (DSA) nuclear safety authorities.

This reflects the international recognition of the quality of Bel V's technical expertise. For example, the general manager of Bel V has been re-elected president of the Technical and Scientific Support Organization Forum (TSOF) of the International Atomic Energy Agency (IAEA), the global network of organisations that provide technical support to their national nuclear safety authorities.

The federal nuclear emergency plan was not activated in 2023. However, in cooperation with the FANC, Bel V continued to monitor the situation in Ukraine following Russia's launch of a special military operation in early 2022, and its impact on nuclear sites and installations on Ukrainian territory.

Bel V also hosted the 2023 Conference of the European Technical Safety Organisations Network (ETSON), which took place at Bel V's premises on 11 and 12 October. It was attended by around fifty participants from several European technical safety organisations, as well as representatives of the Japanese technical safety organisation NRA. The conference explored how different decisions, focuses and changing contexts can affect the strategies TSOs should adopt in order to prepare for and respond to future threats and challenges.

On behalf of the Board of Directors, I wish to thank the management team and the entire workforce for the results they have achieved and for the professionalism with which they carry out their duties in these challenging conditions.

Didier Malherbe
Chairman of the Board of Directors

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Preface

Bel V, a private foundation established on 7 September 2007, with registered office currently at Walcourtstraat 148 rue Walcourt, 1070 Brussels, is a foundation whose purpose is to contribute at a technical and scientific level, on a non-profit basis, to the protection of the general public, the workers and the environment against the dangers of ionizing radiation.

It is governed by the Belgian Act of 23 March 2019 establishing the Belgian Companies and Associations Code, and by its own Articles of Association as filed at the registry of the Brussels Court of First Instance.

At year-end 2023, the Board of Directors was composed of:

- D. Malherbe, President
- J. Annane, Chairman of the Board of the FANC
- F. Hardeman, General Manager of the FANC
- S. Vaneycken, member of the Board of the FANC
- M. Jurisse, Ir, member

Editorial

Dear reader,

I am probably repeating myself when I write in this introduction that 2023 was a challenging year for the Belgian nuclear industry, with many fascinating moments but also uncertainties.

And yet – in a nutshell – that is an accurate description of the past year.

Until mid-2023, there was no formal signing of an agreement to extend the life of the two youngest nuclear power plants (Doel 4 and Tihange 3) by ten years – despite the fact that Bel V, in consultation with the FANC, had launched internal preliminary studies in late 2022 on the long-term operation of the two plants. Intensive work continued on those studies in 2023, with Bel V providing the FANC with the technical support needed to draw up an action plan containing design improvements.

At the end of January a second Belgian reactor was permanently shut down when Tihange 2 finally stopped electricity production on 31 January. Since 23 February, the reactor core has been completely unloaded. The combination of extensive and challenging projects for the long-term operation of Doel 4 and Tihange 3 and the dismantling of Doel 3 and Tihange 2 presents our employees with a particular challenge.

Special attention continued to be paid in 2023 to issues relating to the management of radioactive waste by the various licensees. In collaboration with the FANC, Bel V was involved in analysing the licence application for the future storage location in Dessel for low and intermediate-level short-lived radioactive waste. A licence for this facility was issued in the first half of 2023.

In the context of the evaluation of long-term safety, Bel V continued its independent safety verification activities (using its own modelling capacity).

Bel V was also very active internationally. It is clear from various international contacts that the need for technical and scientific support for the functions provided by safety authorities is more pressing than ever, and Bel V is keen to respond to this growing international interest.

Bel V welcomed several new employees in 2023, who share our belief that our organisation remains a book in which the future chapters of the nuclear industry are being written. We wish to develop on an ongoing basis the talent we have in-house, attract new talent and grow our organisation through effective collaboration. With passion and quality-driven.

Responding to the changing context and building our projects placed considerable demands on our staff in 2023. Acting decisively means making choices and implementing them consistently. When everyone is aware of the urgency and importance of our role, much can be achieved.

I am proud of the dedication, perseverance and creativity of our colleagues. Together they form the backbone of our organisation. I would therefore like to end this introduction with a word of sincere thanks to all Bel V employees.

Michel Van haesendonck, Ir
General manager

1. Regulatory activities in Belgium

1.1 Introduction

1.1.1 Nuclear power plants

As regards operational oversight, mention should be made of the enhanced surveillance that was imposed by the Federal Agency for Nuclear Control (FANC) on the Tihange site on 18 October 2022 and not discontinued until 16 November 2023. This enhanced surveillance – which was initially confined to Operations activities, but subsequently extended to other departments on the site – had the effect of raising awareness of how to carry out activities correctly (i.e. in accordance with the procedures). Bel V allocated additional resources to this enhanced surveillance.

In 2023, an agreement was reached between ENGIE Electrabel and the Belgian state on the long-term operation (LTO) of Doel 4 and Tihange 3, extending their lifespan by 10 years. This agreement contains an obligation of best endeavour to generate electricity during the winters of 2025/2026 and 2026/2027. At the end of 2022, consultation had already taken place with ENGIE Electrabel about the design improvements, based on the previous LTO exercise. ENGIE Electrabel, the FANC and Bel V then jointly drew up a list of safety concerns that might give rise to necessary or desired design improvements. After intensive consultation and arbitration by a committee of the FANC and Bel V, this list was reduced to an action plan containing design improvements that need to be implemented or for which feasibility or safety studies will be carried out. In addition to these design improvements (the 'Design' sub-programme), the following sub-programmes were also restarted in 2023: 'Pre-conditions' (concerning various management programmes that need to be in place before the power plant can restart), 'Ageing', 'Tests & Inspections' (in which large-scale tests are identified that will need to confirm that the facility is working properly before the restart), 'Knowledge, Competence & Behaviour' (concerning the human capabilities required to carry out an LTO) and the ten-yearly Periodic Safety Review (PSR). The methodology documents for these sub-programmes have been analysed and commented on and the first deliverables have already been processed.

The DECOM project in preparation for the permanent shutdown and dismantling of the various units was continued. The focus of this project in 2023 was on implementing the permanent shutdown of Doel 3 (September 2022) and Tihange 2 (January 2023), and on preparing for the permanent shutdown of Doel 1 and 2 and Tihange 1 in 2025. For Doel 3 and Tihange 2, the configuration of the new nuclear island was validated, which will perform the unit's remaining safety functions after its permanent shutdown. This configuration has already largely been implemented in the field for Doel 3, while this still needs to be done for Tihange 2. At the same time, the preparatory activities for dismantling were prepared and in some cases carried out. The most important activity for Doel 3 was the chemical decontamination of the primary system. For both units, preparations continued for the removal of spent fuel and radioactive materials during the post-operational phase. Finally, multiple discussions took place between the safety authority, the National Agency for Radioactive Waste and Enriched Fissile Material (ONDRAF/NIRAS) and ENGIE Electrabel on the waste streams that will be generated during the permanent shutdown and dismantling activities, in order to prepare the inventory and the characterisation and disposal of this waste as effectively as possible.

Work on the construction of storage buildings for the dry storage of spent fuel was completed for the Tihange site and is continuing for the Doel site.

In 2023 too, Bel V devoted particular attention to the storage conditions and capacity for the various waste streams at the Doel and Tihange sites. After an audit conducted by ONDRAF/NIRAS, the authorisations for resins and (only at the Doel site) for concentrates, remained withdrawn. A new process for conditioning resins has been developed, the testing of which is still ongoing.

1.1.2 Other nuclear facilities

The National Institute for Radioelements (IRE) completely switched its purification process for the production of medical radioisotopes from highly enriched uranium (HEU) to low-enriched uranium (LEU). At the end of March, HEU-based production was permanently discontinued. The capacity and frequency of LEU-based production continued to increase throughout 2023. The IRE's periodic safety review was successfully completed.

At Belgoprocess, Bel V paid considerable attention in 2023 to monitoring the construction of several new buildings: the new building 167X (the 'gel drum building' for the storage of non-compliant packages), the remaining aspects of the monolith production facility (IPM), and building 170X (for the dismantling of the vessels in buildings 105 and 122). With regard to the periodic safety review at Site 1, the deadline for the implementation of the action plan expired on 30 June. Belgoprocess has carried out all actions, but the Q&A is still ongoing for a number of actions. The deadline for the periodic safety review at Site 2 has also passed and all actions have been carried out, but the Q&A is still ongoing for a number of actions. In Q4, Bel V also received the methodology document for the new periodic safety review of Site 2 (scheduled for 2026). This document is being analysed.

A number of events relating to transport and transport containers were identified at SCK CEN: an interchange of containers, the incomplete unloading of a container (INES 1) and insufficiently tightened safety flanges (INES 1). The responsibilities for handling containers were therefore evaluated and adjusted.

Several important projects are in progress at SCK CEN: the pre-licensing of the MYRRHA project (on which only slight progress was made in 2023), MINERVA (for which a licence was received and construction will start in Q4 2024) and RECUMO (the recycling of HEU and LEU from the IRE, for which construction work is ongoing and being monitored by Bel V). In November, SCK CEN forwarded the methodology document for the 2026 periodic safety review to the FANC and Bel V, the latter of which started analysing this document at the end of 2023.

JRC-Geel has had a new Site Director since September 2023, as a result of which a number of non-conformities and long-standing problems have been resolved. The evaluation phase in the context of the periodic safety review has been completed. The action plan has been consolidated and the implementation phase is in progress. Bel V is monitoring this phase and noted that a number of actions have been delayed.

ONDRAF/NIRAS obtained a licence in Q2 2023, following a positive opinion from the FANC's Scientific Council. In Q4, two thematic inspections were also organised on the themes 'modification management/ Health Physics department' and 'safety culture/ training'. Inspections will also be organised in 2024 so that Bel V can conduct an (interim) evaluation of whether ONDRAF/NIRAS is organisationally ready for the start of the construction work (scheduled for late 2025/early 2026).

1.1.3 Integrated inspection and oversight strategy (GIC)

The new six-year integrated strategy for inspection (by the FANC) and oversight (by Bel V) ('Geïntegreerde Inspectie- en Controlestrategie' – GIC) was first implemented in 2018. This approach has been developed by the FANC and Bel V over the past few years in response to findings during the Integrated Regulatory Review Service (IRRS) audit in 2013.
In 2022, an inspection programme was established for phases POP 2 and POP 3 (post operational phase) at units that are permanently shut down and now only hold fuel in the spent fuel pools. This programme was applied when determining the inspection programme for 2024, which was submitted to the licensees at the end of 2023. In 2023, a GIC for dismantling was drawn up and work began on drawing up a GIC for disposal facilities (e.g. cAt) (so that inspections can be performed of ONDRAF/NIRAS as the new licensee of the cAt facility that will be built soon).

In the course of 2023, Bel V also carried out a OPEX (operational experience exercise) to provide input for the preparation of the GIC for the next period (2024-2029). Consultations were held with the FANC for this purpose, after which a number of adjustments were made to the scope and vision of the various inspection programmes to be carried out by the FANC and Bel V.

1.2 Overview of inspections at nuclear power plants

1.2.1 Doel 1/2

Both Doel 1 and Doel 2 were operating at full power during this period, except for the annual refuelling outage. For Doel 1, this was during the period from 9 June to 7 July and for Doel 2 from 17 March to 16 April.

The following points are worth noting for 2023:

- During the start-up phase of Doel 2, it was found that part of the safety injection signal was not operational. This event was classified at Level 1 of the INES scale (International Nuclear and Radiological Event Scale).
- On 26 August, an automatic emergency shutdown of Doel 1 occurred as a result of the manual switching off of a steam generator's feedwater pump. The next day, the unit was reconnected to the grid and the power was increased to 49%. After the pump had been replaced, it was possible to switch back to full power (30 August).
- On 5 December, an automatic emergency shutdown of Doel 1 occurred due to a fault during turbine testing. Following the replacement of an overspeed module, the unit was reconnected to the network on 8 December.

1.2.2 Doel 3

Doel 3 was permanently shut down on 23 September 2022 and the reactor core has been fully discharged since 11 October 2022.

The following points are worth noting for 2023:

- The chemical system decontamination (CSD) of the primary system and related circuits took place from 9 March to 12 April and proceeded without significant problems. After five decontamination cycles, an average decontamination factor of 154 was achieved.
- The dismantling of equipment in the classic section (turbine area) is ongoing.

1.2.3 Doel 4

Doel 4 was operated uninterruptedly and at full power until 7 March, after which a power reduction was initiated as part of a nuclear fuel stretch-out until the refuelling outage. That refuelling outage took place from 21 April to 28 May. During the restart, a problem was identified in the turbo-generator, which limited the power increase to 85% power, and a controlled shutdown was introduced from 2 to 12 June in order to carry out the repairs. The unit was then operated uninterruptedly and at full power once again.

1.2.4 Doel common (WAB)

In the context of the availability of the water and waste treatment facilities (WAB) for waste processing after the permanent shutdown of the nuclear power plants, several projects are in progress to replace or improve the WAB infrastructure. To make it possible to treat the water supply during the chemical decontamination of Doel 3, work is being carried out on the LNA tanks and evaporators. Bel V approved an NFUA request ('niet frequent uitgevoerde activiteit' – infrequently performed activity) to take a sample of the resins contained in DT/SW-RR0005.

For concentrates, work continues on the renovation and expansion of storage capacity, in addition to the development of new processes. Bel V is monitoring this closely.

1.2.5 Doel site

The Bel V oversight programme at the site was further implemented as follows:

- Meetings were held with the management and with the heads of the various departments (Maintenance, Operations, Care and Engineering) and services in order to evaluate their organisation and the management of the various processes relating to nuclear safety or radiation protection.
- Systematic and specific inspections were carried out to cover subjects relevant to several units (supervision of the construction of a new spent fuel storage building, operational experience feedback, etc.).

Bel V provided technical support to the FANC in the context of its inspections, including those relating to management, obsolescence management and maintenance, radioactive source management, radioactive waste management, etc.

A WANO follow-up mission took place in 2023.

1.2.6 Tihange 1

The unit operated at nominal power, except for the following periods:

- on 7 September, during work on the secondary system requiring a partial power reduction;
- from 4 to 13 October, during work on a main pump of the circulation water system requiring a partial power reduction (shutdown of a turbine group (50% of nominal power)).

1.2.7 Tihange 2

The unit was permanently shut down at midnight on 31 January 2023. The reactor core was permanently unloaded on 23 February.

For 2023, the following points are worth mentioning:

- The thimbles allowing instrumentation to pass through the reactor vessel were cut and extracted on 15 March.
- The control rods assemblies were sampled for characterisation.
- Work began on disassembling the non-nuclear equipment (turbine area).
- Preparations are being made for the decontamination of the primary system, which is scheduled for the end of 2024.

1.2.8 Tihange 3

The unit operated uninterruptedly at nominal power, except for:

- the period of the unit shutdown for refuelling from 19 August to 30 September – during restart operations, a turbine trip without reactor trip took place on 13 October following a loss of vacuum in the condenser;
- some power modulations at the request of the network.

1.2.9 Tihange site

The Bel V inspection programme at the site was further implemented as follows:

- Meetings were held with the management and the heads of various departments (Maintenance, Operations, Care and Engineering) and services, in order to evaluate their organisation and the management of different processes relating to nuclear safety or radiation protection.
- Systematic and specific inspections were carried out to address topics that apply to several units (follow-up of the construction of a new building to store spent fuel, experience feedback, etc.);
- Particular attention was devoted to human and organisational factors.

Bel V provided technical support to the FANC in the context of its inspections (including those relating to competence and staffing, maintenance and ageing, management, etc.) and of the enhanced surveillance implemented from 18 October 2022 to 16 November 2023.

Bel V also continued to closely monitor the management of radioactive waste, and in particular with regard to the storage of radioactive concentrates and resins, taking into account the suspension of the ONDRAF/NIRAS authorisation that allows for the evacuation of this type of waste.

An OSART (Operational Safety Review Team) mission from the International Atomic Energy Agency (IAEA) took place in Tihange from 17 April to 4 May. The mission identified a number of good practices, but also provided suggestions and recommendations with a view to improving operational safety and ensuring compliance with IAEA requirements.

1.3 Overview of inspections at other nuclear facilities

1.3.1 Nuclear Research Centre (SCK CEN)

The operating regime of the BR2 reactor in 2023 consisted of 6 cycles and 2 short cycles of 2 days in order to carry out a transient on a test assembly. During the transient of cycle 02/2023B, the reactor was stopped manually after the failure of the fuel pin cladding in the experiment.

On 12 January, there was a mix-up between two radioactive capsules. Both capsules were intended for the same addressee in France. One of the two capsules was packaged and shipped first. However, due to the mix-up, the capsule was delivered too early. The two capsules are identical in appearance, except for an identification code engraved on them. The mix-up was due to the misreading of this identification code. The sending of the first capsule resulted in incorrect information being shown on the transport labels and the transport document. In addition, the maximum permissible activity for the packaging used was exceeded, although this did not have any consequences for radiation protection and nuclear safety given the available margins. This event was rated at INES Level 1.

On 22 February, a reactor scram occurred due to a pressure difference signal across the reactor. The signal was short-lived, and no other abnormal values were recorded. After an analysis of the scram line, the possible causes were identified. As the cause had disappeared and conditions were safe, the reactor was restarted within 20 minutes. The INES analysis resulted in a Level 0.

On 12 March, a nuclear transport of five identical type-A containers set out from the BR2 reactor to a customer. When the consignment notes were being completed and the labels affixed, the containers were incorrectly identified and as a result were mixed up. The mistake was noticed by the customer on the basis of the dispatch note, which linked the containers' identification numbers to the contents correctly. This event was rated at INES Level 1.

Mechanical damage was found during the unloading of a fuel assembly from a reactor channel after cycle 02/2023A. The top of one of the outer plates is folded outwards over a width of approximately 20 mm. The most likely cause is contact between the fuel assembly and the funnel during unloading.

On 24 November, the IRE determined that the licensees of the BR2 reactor had failed to sufficiently tighten safety flanges on a container of irradiated targets. This event was rated at INES Level 1.

On 5 December, when fresh LEU targets were received from the Compagnie pour l'étude et la réalisation de combustibles atomiques (CERCA), not all targets were unloaded and the transport container left with LEU targets still in it. This event was rated at INES Level 1.

In the context of the issue to do with the presence of a foreign object (a spring hanger) in the primary system, a number of parameters were reported to the FANC and Bel V every week during the reactor cycles. Furthermore, an action plan is in progress in the context of the feasibility study for the further location and possible recovery of the spring hanger and the adjustment of the arms on the check valves. The arms on check valves CVPC1 and CVPC2 had already been replaced and during the 06/2023A shutdown a

hydrophone was installed in the east pool to try to locate the spring hanger.

The VENUS reactor was started only a few times in subcritical mode in 2023. Experiments with the reactor in subcritical mode are planned, but with an increase in the accelerator current and changes to the cooling of the target.

When the BR1 reactor was started up on 13 February, a scram occurred at low power due to a low period on the D measuring channel. After further investigation, it turned out that interference with the signal had occurred because the earthing of the measuring channel's power supply and the earthing of the measuring system were not completely separated from each other.

In the tritium laboratory, a new assembly has been installed in cell C1 for the treatment of a NaK getter contaminated with tritium. The first phase of the experiment, which consisted of the detritiation of the tritium from the NaK and collection on the molecular sieve, has been completed.

The dismantling of the BR3 reactor is in progress. A licence application for the removal of activated concrete from BR3 was submitted to the FANC.

Construction of the new MaT building has started.

The FANC granted the licence for a new class IIA facility (CRF facility for the production of Lutetium-177). Construction started at the end of 2023.

Also at the end of 2023, a project was started for the installation of a LINAC (LINear ACcelerator) in the radiotherapy room of the LNK facility (among other purposes for research in the field of waste characterisation).

In May, the transportation of 27 drums was organised between the CBZ (central buffer zone) facility and Belgoprocess. Due to human error during the collection of the drums, one of the drums that was sent was wrong.

On 8 December, an operator in a laboratory of the SCH building (chemistry building) was splashed in the eye with acid while cleaning glassware with 2% HNO3. There could have been traces of Am and Pu present in the acid. The medical service of SCK CEN was notified and it was decided to perform a gamma measurement on a sample of the eye wash. The analysis report showed that there was no contamination. The operator was transferred to the emergency department of Mol hospital, but there was no irreversible damage to her eye.

1.3.2 Belgoprocess

Periodic reports on the activities relating to the problem of the gel drums from the Doel nuclear power plant were submitted to Bel V. In this regard, inspections were carried out on packages containing concentrates and packages containing resins in buildings 150X and 151X.

After a pressure build-up was detected in a number of 220l drums of radium-containing waste that were conditioned in building 280X, accreditation of the conditioning process was suspended. Belgoprocess will determine the actions needed to tackle the pressure build-up in the drums and improve the conditioning process.

Due to the erroneous setting of the background correction in the AQ2 measurement used for release measurements, Belgoprocess released seven drums that did not comply with the release limit. However, the exceedances were slight and this incident had no impact on the environment or the population. This event was rated at INES Level 1.

Following a problem with draining a leak in a liquid system, radioactive liquid ended up in a number of rooms in building 108X via the floor drains. Belgoprocess carried out the required intensive decontamination actions. No radioactivity had escaped outside the building. This event was rated at INES Level 1.

1.3.3 National Institute for Radioelements (IRE)

The National Institute for Radioelements has completely converted its process for the purification of medical radioisotopes from highly enriched uranium (HEU) to low-enriched uranium (LEU).

At the end of March, HEU-based production was permanently discontinued. HEU residues continue to be transferred on a regular basis to SCK CEN, which is developing the RECUMO project. The capacity and frequency of LEU-based production continued to increase throughout 2023.

In 2023, there were no more delays for the LTO project for building B6. The work is now proceeding according to the new schedule. The IRE's infrastructure continues to be improved through the transfer of equipment and facilities previously operated by MDS Nordion/BMB/NTPE/ONSF.

It should also be noted that the demand for radiopharmaceutical products continues to increase. Belgian know-how in the radiopharmaceutical industry is internationally recognised and the IRE – like its subsidiary IRE ELiT – is part of the Belgium network for radiation applications in healthcare (rad4med.be).

1.3.4 JRC-Geel

In the Mass Spectrometry facility, the replacement of the three extractors of MS2 was implemented and commissioned by the Health Physics department and confirmed by Bel V.

In the GELINA (GEel LINear Accelerator) facility, the accelerator has been idle since September 2023 after two windows were broken. The required actions to repair the damaged parts are ongoing.

In the MONNET (MONo energetic NEutron Tower) facility, the addition of a new beamline was implemented and commissioned by the Health Physics department and confirmed by Bel V.

Several events relating to the loss of underpressure in a controlled area were reported to the authorities. None of these events had an impact on the workers, the population or the environment.

With regard to the organisational structure of JRC-Geel, a new Site Director has been in office since September. In addition, the non-conformity regarding the number of operators in the MONNET facility was resolved and the necessary actions were taken to hire someone to manage the nuclear waste and decommissioning activities. An Emergency Planning Coordinator was also recruited.

1.3.5 Other (class IIA) facilities

The following specific points should be noted for the class IIA facilities:

- A class IIA expert from Be.Sure took over health physics activities for Erasme following the departure of the internal expert. A new head of the Health Physics Department has been appointed internally.
- New licences to separate the class IIA and class III activities of Ion Beam Applications (IBA) were issued.
- Cobalt reloading took place at Sterigenics. Several events occurred during this process.
- A breach of the GAMMIR II logging procedure was notified by Sterigenics on 15 July. This incident was due to human error. An uncontrolled release of 500 litres of water (due to a leak from the water pit) was also notified on 25 September. The water had been measured and found to be free from contamination a short time earlier. The pit liner showed clear signs of deterioration, probably due to the corrosive products used in the water treatment process.
- Another site will be chosen for the ProtonW facility. A new licence application will be submitted in the future.
- CommScope's activities have ceased and its Class IIA licence has been revoked.
- The dismantling of the cyclotron at Vrije Universiteit Brussel (VUB) is proceeding on schedule and without any particular difficulties.
- The plans for the installation of a new cyclotron (IMAGINATION building) were presented to the FANC and Bel V.
- UZ Antwerp hospital submitted a licence application for the use of new radioisotopes. The application is being processed.
- Construction of the new building for Liège University Hospital is in progress. The arrival of the cyclotron was scheduled for mid-January 2024.
- A new licence application will shortly be submitted by IRE ELiT with a view to increase the source term.
- Work on the construction of the Ikon-30 building is in good progress at the IRE.
- The dismantling of the facilities taken over by the ONSF in Fleurus continues without any particular

difficulties. The Y cell was finally cut on the ONSF site. The Sr cell will be sent to Belgoprocess for processing. An event was notified during the period, involving a drum of waste that did not meet the contact dose rate criterion prescribed for storage in building B8. The drum was moved to building B16.

- The first level of the injector for MINERVA which had been tested at UCLouvain was disassembled for transfer to SCK CEN.
- The dismantling work at Ghent University (Campus Proeftuin) has been completed. The final dismantling report has yet to be submitted.
- A new licence for b+pharma for an increase in the source term was received.
- Full-Life Technology Europe submitted a licence application for a new Actinium-225 production facility. The application is being processed. The dossier has been sent to the municipalities and public inquiries will be launched. The licensing conditions are currently being drawn up.
- PanTera submitted a licence application for a new Actinium-225 production facility. This application is currently being analysed.

Inspections carried out

173
Doel nuclear power plant installations

130
Tihange nuclear power plant installations

180
Other class 1 nuclear installations

67
Class 2A nuclear installations

9
Emergency preparedness and response exercises

1.4 Emergency preparedness and response

1.4.1 Introduction

There was no actual activation of the federal nuclear emergency plan in 2023. However, in cooperation with the FANC, Bel V continued to monitor the situation in Ukraine following Russia's launch of a special military operation in early 2022 and its impact on nuclear sites and facilities located on Ukrainian territory. In this respect, Bel V could count on the effective support of the French Nuclear Safety and Radiation Protection Institute (IRSN) through privileged individual contacts, which allowed to complete and validate Bel V's information and opinions.

1.4.2 Emergency response exercises

2023 saw Bel V participate in a large number of emergency preparedness and response exercises: six held under the supervision of the National Crisis Centre (NCCN) under the Federal Public Service Interior (including one with a cross-border scope) and two organised jointly by the FANC and Bel V:

- in March, April, June and November for the Doel nuclear power plant, the Belgoprocess site, the Tihange nuclear power plant and the JRC-Geel site respectively – a partial exercise limited to the interaction between the emergency crisis cell of the licensee (on-site) and the evaluation cell CELEVAL (off-site);
- in September for the BR2 research reactor at SCK CEN – a methodologically supported exercise with the participation of local authorities and emergency services, in addition to federal cells and committees (coordination committee, evaluation / information / measurement cells);
- in September for the Chooz nuclear power plant in the immediate vicinity of Belgium – an exercise organised by the French authorities;
- in November for the evaluation cell CELEVAL – two internal drills organised by the FANC and Bel V.

All the exercises organised under the supervision of the NCCN were prepared, conducted and evaluated in accordance with the current Belgian methodology for the preparation, conduct and evaluation of emergency preparedness and response exercises.

As in previous years, these exercises, which enable the relevant persons at Bel V to regularly put into practice the provisions of the operational plans and procedures, also led to a number of findings, which, after analysis, will be the subject of dedicated actions. These include, in particular, the need for structural reinforcement of the alert and mobilisation arrangements, the importance of having performant and up-to-date infrastructures (including ICT aspects), and the continued development of arrangements to secure a hybrid operation (face-to-face and remote) of the evaluation cell.

1.4.3 Other related activities

2023 was marked by the work carried out by the NCCN in updating the Royal Decree of 1 March 2018 establishing the Nuclear and Radiological Emergency Plan for the Belgian Territory, in which Bel V was involved for certain aspects. Consultations are currently ongoing with regard to this updated version of the emergency plan with a view to its consolidation for publication in the Belgian Official Journal (scheduled for the first half of 2024).

1.4.4 Improving the role of Bel V

In order to improve Belgium's emergency preparedness and response in case of a nuclear emergency, and especially the role of Bel V therein:

- Bel V staff participated in the Belgian emergency preparedness and response exercises, which, besides the response activities, involved extensive preparation, observation and evaluation of the response by the Bel V crisis team, the licensee and the other parties involved (evaluation cell of the NCCN).
- Limited communication and readiness exercises were organised throughout the year, for a total of 24 tests.
- As part of the support to the Dutch safety authority (ANVS), IRSN and Bel V continued working on the project to support the protection strategy through discussions and the development of basic scenarios for the Borssele nuclear power plant.

2. Safety assessments and national projects

2.1 Probabilistic Safety Assessments (PSA)

In 2023, Bel V continued its technical review of the Probabilistic Safety Assessments for spent fuel pools developed and carried out by ENGIE Electrabel and ENGIE Tractebel Engineering in order to comply with the Royal Decree of 30 November 2011 on the safety requirements for nuclear installations (as amended by the Royal Decree of 19 February 2020) incorporating the WENRA Safety Reference Levels for Existing Reactors of September 2014 (see Section 2.9). These models include internal events and hazards as well as external hazards (i.e. seismic and external flooding events) and were used by ENGIE Electrabel to propose an action plan for the implementation of improvements on site. These on-site improvements have also been monitored attentively by Bel V.

Due to the decision to restart the preparation for long-term operation of the units of Doel 4 and Tihange 3, the development of Seismic PSA (including seismically induced fire and flooding) for these two reactors was discussed and relaunched by ENGIE Electrabel. As a reminder, at the end of 2020, due to ENGIE Electrabel's decision to no longer target long-term operation for the post-2025 period, the Seismic PSA project was discontinued for the reactor of each nuclear power plant and a number of quick wins identified during walk-downs had been implemented by the end of 2022.

The upgrade of the Level 2 Internal Fire PSA continued in 2023 as well, in particular for Tihange 3, for which a full scope model is being developed.

The PSA applications and procedures developed on site by ENGIE Electrabel were also monitored by Bel V.

In 2023, Bel V also initiated the evaluation of the PSA developed for the post-operational phase of Doel 3 and Tihange 2 as a result of the action plan drawn up in the context of the Periodic Safety Review, and, more specifically, the assessment of Safety Factor 6 (see Section 2.2).

For more information on Bel V's international and R&D activities on PSA methodology and PSA applications, please refer to Section 4.4.

2.2 Periodic Safety Reviews (PSR)

2.2.1 Nuclear power plants

Performing Periodic Safety Reviews is a regulatory requirement as per Article 14 of the Royal Decree of 30 November 2011. Despite their not being directly applicable to a PSR for a nuclear power plant that will enter a post-operational phase in the near future, the FANC technical regulation on Periodic Safety Reviews ('Règlement technique de l'AFCN du 2 février 2021 précisant les modalités des révisions périodiques de sûreté des établissements de classe I, à l'exception des réacteurs de puissance') and the IAEA Specific Safety Guide SSG-25 on PSR for nuclear power plants provide the reference framework for performing these Periodic Safety Reviews in practice.

Bel V evaluated the PSR of the auxiliary facilities at Doel (WAB, SCG and GSG installations) and discussed it with the FANC. This dedicated PSR, applying a systematic method (performed by ENGIE Electrabel by assessing 14 safety factors based on the IAEA Specific Safety Guide SSG-25), allowed to gain interesting insights and identify specific safety improvements. Through its analyses and the Safety Evaluation Reports (SER) written by Bel V for all safety factors, Bel V also proposed amendments to the action plans drawn up by ENGIE Electrabel. These amendments have been incorporated.

Bel V also monitored the implementation of the action plans drawn up in the context of the PSR of Tihange 2 (which was assessed together with the TEF, TEL and TDS installations) and the PSR of Doel 3. These action plans contain specific improvements (hardware, processes or procedures) that are being developed within three different frameworks (continuous improvements, permanent shut-down or the Periodic Safety Review itself). It should also be mentioned that there is a strong link with the action plan drawn up in the context of the WENRA 2014 Safety Reference Levels project.

Finally, Bel V also reviewed the proposed Scope and Methodology documents for the PSR of Doel 1 and 2 and Tihange 1 (scheduled for permanent shut-down in 2025) and the PSR of Doel 4 and Tihange 3 (for which a 10-year life extension is planned). The latter PSR also includes the DE building. Moreover, as a result of this long-term operation, the PSRs of the TEF, TEL and TDS installations (originally performed in the context of the PSR for Tihange 2) and of the WAB, SCG and GSG installations (originally performed in the context of a dedicated PSR) will have to be reassessed for a series of aspects yet to be defined by ENGIE Electrabel.

2.2.2 JRC-Geel

The evaluation phase in the context of the Periodic Safety Review of JRC-Geel was completed. Bel V analysed the final version of the assessment of all safety factors, as well as the overall assessment. Bel V formulated 28 requests on the action plan submitted by JRC-Geel. In September, Bel V presented the results of its analysis to the Scientific Council. The action plan was then consolidated and is now being implemented. Bel V is monitoring this phase and noted that a number of actions have been delayed.

2.2.3 SCK CEN

In November, SCK CEN sent the methodology document for the 2026 periodic safety review to the FANC and Bel V, the latter of which started analysing this document at the end of 2023.

2.2.4 National Institute for Radioelements (IRE)

With regard to the periodic safety review at the IRE, the deadline for the implementation of the action plan expired at the end of 2022. However, as not all actions had been completed, the FANC had agreed to postpone the end of the periodic safety review to 31 March 2023. By the end of Q1 2023, all actions had been completed and the implementation report was submitted by the IRE. Bel V carried out an analysis of the report, which was submitted to the FANC in the form of a Safety Evaluation Report. The evaluation was communicated to the IRE by the FANC and after discussion with the IRE the periodic safety review could be concluded.

2.2.5 Belgoprocess

With regard to the periodic safety review at Site 1, the deadline for the implementation of the action plan expired on 30 June 2023. Belgoprocess has carried out all actions, but the Q&A is still ongoing for a number of actions.

In relation to the periodic safety review at Site 2 (2016), the deadline for the implementation of the action plan expired on 30 June 2021. Belgoprocess has carried out all actions, but the Q&A is still ongoing for a number of actions.
In Q4 2023, Bel V also received the methodology document for the new periodic safety review of Site 2 (2026). The analysis of this document was started at Bel V.

Safety assessments performed

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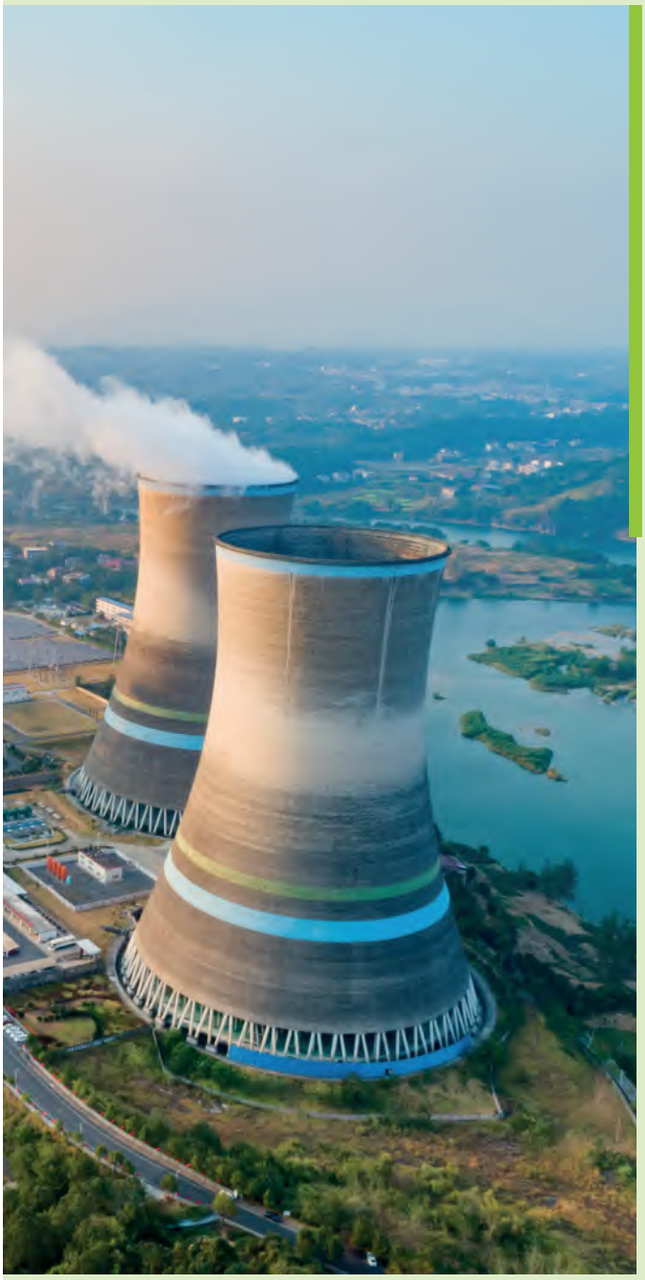
2.3 Long-Term Operation (LTO) of Doel 4 / Tihange 3



2023 saw the restart of the project of ENGIE Electrabel and the Belgian State to extend the lifetime of the Doel 4 and Tihange 3 reactors by 10 years. This project has been divided into a number of sub-programmes: 'Pre-conditions' (concerning various management programmes that need to be in place before the power plant can restart), 'Ageing', 'Design' (identifying needs and opportunities for design improvements), 'Tests & Inspections' (in which large-scale tests are identified that will need to confirm that the facility is working properly before the restart), 'Knowledge, Competence & Behaviour' (concerning the human capabilities required to carry out an LTO) and the ten-yearly Periodic Safety Review.

Following 'Design' in 2022, the other sub-programmes were started in 2023. Bel V analyses and comments on the methodology documents of each sub-programme and has already analysed the first deliverables.

Specifically for 'Design', Bel V carried out the analysis, together with the FANC, of the design improvements proposed by ENGIE Electrabel. The result of this analysis, including the requirement to add a number of extra improvements to the plan, was fed back to ENGIE Electrabel.

2.4 DECOM

The objective of the DECOM project is to prepare for the permanent shutdown and dismantling of the Doel and Tihange nuclear reactors. The focus of the project in 2023 was on implementing the permanent shutdown of Doel 3 (September 2022) and Tihange 2 (January 2023), and on preparing for the permanent shutdown of Doel 1 and 2 and Tihange 1 in 2025.

Several activities were carried out in 2023 in relation to the permanent shutdown of Doel 3 and Tihange 2. At Doel 3, after the configuration of the new nuclear island (which has provided residual safety functions at the unit since its permanent shutdown in 2022) had been validated, attention was focused on the practical implementation of the island. This involved the reclassification – administratively at first, and then technically on site – of all the unit's Systems, Structures and Components (SSCs) in order to keep the SSCs that contribute to the unit's safety fully operational during the period of evacuation of the spent fuel. At Tihange 2, after the foundations of the nuclear island had been validated, attention was focused on finalising the identification of the SSCs still contributing to the unit's safety in the post-operational phase and on beginning their administrative declassification. Discussions continue with a view to updating the safety analysis report and technical specifications to reflect the residual safety functions that need to be ensured.

2023 also saw the start of preparations for the permanent shutdown of Doel 1 and 2 with the definition of the design bases for their nuclear island in the post-operational phase; Bel V monitored these preparations closely. This activity had also been planned for Tihange 1, but ENGIE Electrabel ultimately decided not to modify the design bases of this unit's nuclear island, which meant that no activity was carried out in 2023.

At the same time, the preparatory activities for dismantling were prepared and in some cases carried out. The most important activity for Doel 3 was the chemical decontamination of the primary system. The evacuation of the turbine area was also started at Doel 3. At Tihange 2, preparations are still being made for these activities. For this unit, an important activity was the cutting up of the reactor thimbles.
In both units, preparations continue for the evacuation of spent fuel and radioactive substances during the post-operational phase. All these activities had to be described in the notices of termination of activities for these units, which were analysed in 2022. In 2023, an important activity was the monitoring of the conditions set by the safety authority for the approval of the notices of these permanent shutdowns.

The chemical decontamination of the primary system is one of the main activities carried out after the permanent shutdown and evacuation of fuel from the reactor building, and its purpose is to reduce radiological risks in the final stages of the reactor's life. In 2023, Bel V carefully monitored the carrying out of these activities at Doel 3 and it monitored the preparations for carrying out these activities at Tihange 2 and the start of preparations for Doel 1 and 2.

At both Doel 3 and Tihange 2, multiple discussions continued with a view to preparing for the evacuation of spent fuel and radioactive substances present in the pools. Repairing damaged rods, licensing containers for these substances and spent fuels, constructing new buildings and other activities were subject to several analyses by Bel V in 2023, so that the first assemblies can be evacuated at the end of 2024.

Apart from this intensive phase of technical analyses, strategic discussions continued in 2023 with a view to optimising the transition from operating licence to dismantling licence at Doel 3 and Tihange 2. Progress was made on several strategic aspects and discussions were held on the future dismantling waste management facilities. 2023 also saw the preliminary analysis of the safety reports prepared by ENGIE Electrabel to support the licence application for the dismantling of Doel 3 and the application for the construction of new waste management units (WMUs).

Finally, multiple three-way discussions took place between the safety authority, ONDRAF/NIRAS and ENGIE Electrabel on the waste streams that will be generated during the shutdown and dismantling activities, in order to prepare the inventory and the characterisation and disposal of this waste as effectively as possible.

2.5 Radioactive waste management

Since the licence application by ONDRAF/NIRAS on 31 January 2013, Bel V, in collaboration with the FANC, has been closely involved in the licensing process for the future facility for the disposal of low- and medium-level short-lived radioactive waste (category A waste) in Dessel.

During the meeting of 24 February 2023, the FANC's Scientific Council issued a positive opinion, partly on the basis of an evaluation report drawn up by Bel V. In this report, Bel V set out its assessment that ONDRAF/NIRAS had provided an adequate response to all requested points prior to the Scientific Council's second session, apart from the request to determine the geosphere transfer factor for the water well and seepage areas for the western tumulus. ONDRAF/NIRAS is currently unable to respond to this request, but according to Bel V this does not impede the project's schedule as currently envisaged, as there are no plans to use the western tumulus before 2040. Furthermore, the evaluation report also identified several points that still need to be implemented and/or communicated by ONDRAF/NIRAS, concerning among other things the revision of the safety report and the ready-for-construction hold point.

Following the positive opinion from the Scientific Council, ONDRAF/NIRAS obtained a licence in Q2 2023. In Q3/Q4, the first revised chapters of the safety report were submitted and analysed by Bel V. In Q4, two thematic inspections were also organised, on 'change management/HPD' and 'safety culture/training'. These inspections will also be organised in Q4 2024 and should enable Bel V to assess (provisionally) whether ONDRAF/NIRAS is organisationally ready to start construction (scheduled for late 2025/early 2026).

As part of the investigation into whether waste intended for near-surface disposal is suitable for this purpose, Bel V analysed a number of conformity files in 2023 and provided feedback on required adjustments to ONDRAF/NIRAS. The aim of these conformity files, created by ONDRAF/NIRAS, is to show that radioactive waste from a specific (sub-)family or (sub-)variety is in conformity with the criteria for near-surface disposal. These files are drawn up in several steps, with Bel V's approval being required for each step to proceed to the next step.

In 2023, Bel V also participated in the analysis of the ONDRAF/NIRAS proposal for two new ACRIA documents (describing the ONDRAF/NIRAS acceptance criteria for a specific waste type). After the publication of the relevant Royal Decree, these ACRIAs must be approved by the FANC. In this context, the FANC has asked Bel V to check whether the ACRIAs meet the licence conditions (including specifications in the safety report) of the various facilities where the waste will end up at later stages in the treatment process.

In 2014, the FANC and Bel V initiated cooperation on the activities relating to the long-term management of high-level and/or long-lived waste (category-B and C waste). These activities concern the evaluation of safety studies by ONDRAF/NIRAS, consultation on safety aspects with the FANC and ONDRAF/NIRAS and the development of expertise (including through collaboration with other TSOs: see Section 3.3.3).

2.6 MYRRHA / MINERVA

2.6.1 MYRRHA

MYRRHA (Multi-purpose hYbrid Research Reactor for High-tech Applications) is a project for a multi-purpose irradiation facility coupling a 600 MeV proton accelerator with a fast spectrum reactor using lead-bismuth eutectic coolant. The pre-licensing phase of the MYRRHA project, initiated in 2011, in order to analyse the eligibility of the facility for licensing, continued in 2023.

After the federal government had announced in September 2018 that it would continue to support the MYRRHA project, and the year of transformation that followed in 2019, the year 2020 served to consolidate the project and set the foundations for the further development of MYRRHA into the decisive stages of the project.

At the end of 2020, in consultation with the federal government through the MYRRHA group, SCK CEN made several important decisions. In order to make more efficient use of resources taking into account all other important projects being carried out at SCK CEN, the license application date was set at December 2028 and the current pre-licensing period was extended to the end of 2024. At that date, the safety authority is expected to render an opinion on the status of MYRRHA.

As SCK CEN had set itself the objective of providing all the documents required for the safety authority to give this opinion at the beginning of 2024, not many documents were submitted and therefore analysed in 2023. The work focused on preparing for certain workshops in order to clarify some of these safety guidelines and on analysing supporting documents.

2.6.2 MINERVA

MINERVA (Myrrha Isotopes productioN coupling the linEar acceleRator to the Versatile proton target fAcility) is a LINAC (LINear ACcelerator) characterised by a maximum proton beam energy of 100 MeV and a beam intensity of 4 mA. In 2022, MINERVA was granted a Class IIa licence by the FANC. The construction of the MINERVA facility is scheduled for Q4 2024, which the commissioning scheduled for 2026. SCK CEN has recruited all staff needed for the construction, commissioning and operation of the MINERVA facility and discussions with the FANC and Bel V about the construction phase have been initiated.

2.7 SF² – spent fuel storage facilities

The current temporary storage facilities for spent fuel in Doel and Tihange will soon be full. A new temporary storage facility for spent fuel (SF²) is therefore being built at both sites. For both facilities, the dry storage concept with dual purpose containers (transport and storage) was selected.

The licences for the SF² facility were obtained on 26 January 2020 for the Tihange site and on 1 July 2021 for the Doel site. In 2023, technical meetings continued to be held between the FANC /Bel V and the licensee ENGIE Electrabel in order to discuss the details of the various licensing conditions. Bel V continued to monitor the construction phase with the identified hold points and witness points. ENGIE Electrabel is aiming for completion in Q2 2024 for Tihange and in Q4 2025 for Doel.

2.8 RECUMO

Construction work for the RECUMO project (REcovery and Conversion of Uranium from MOlybdenum production) at SCK CEN is in progress and being monitored by Bel V.

The FANC, in consultation with Bel V, has defined hold points and witness points that have been included in the construction programme for the RECUMO facility. SCK CEN is currently developing the list of hold points and witness points for the fine envelope (process) with a number of safety criteria relating to the RECUMO process.

At the end of 2023, the FANC and Bel V received a notification of a non-conformity regarding concrete strength. The Health Physics Department stopped the concreting work during the investigation, which found that the drill cores meet the acceptance criteria. The Health Physics Department subsequently issued a positive opinion on restarting the concreting work, and this opinion was approved by the FANC and Bel V.

2.9 WENRA (2014) Safety Reference Levels

The WENRA 2014 Safety Reference Levels were incorporated (via the Royal Decree of 19 February 2020) as additional safety requirements in the Royal Decree of 30 November 2011 on the safety requirements for nuclear installations. The WENRA RL2014 project, which was initiated in 2016, aims to ensure the timely implementation of these safety requirements, which are based on the WENRA 2014 Safety Reference Levels, in the Belgian nuclear power plants at the Doel and Tihange sites.

In the context of the WENRA RL2014 project, ENGIE Electrabel has performed a large number of safety studies, in particular with regard to design extension conditions (DEC) for both the reactors and the spent fuel pools, natural hazards (mainly earthquakes, external flooding, meteorological hazards and combinations of hazards), postulated initiating events for spent fuel pools (SFP PIE) and spent fuel pool PSA (SFP PSA) including external hazards.

As a result of these safety studies, several safety improvements (mostly modifications in existing hardware or procedures, a number of new fixed or mobile systems, etc.) have been recommended and are being implemented in the Belgian nuclear power plants. The studies for these safety improvements and their implementation in the plants continued in 2023 and are being monitored by Bel V from a technical point of view.

From the start of the project until the end of 2023, more than 1000 documents, representing the whole set of safety studies and a considerable number of safety improvements, were submitted to and evaluated by Bel V. In 2023, Bel V discussed a number of remaining issues that were identified during these evaluations with ENGIE Electrabel and the FANC, and started drawing up safety evaluation reports in order to summarise the main achievements of the WENRA RL2014 project and Bel V's evaluation of ENGIE Electrabel's safety studies and improvement actions.

2.10 Belgoprocess construction projects

The construction of buildings 167X and 170X and of the monolith production facility (IPM) is ongoing and is being monitored by Bel V by means of hold and witness points.

The civil engineering work for building 167X has been completed and the implementation of the various technologies (travelling cranes, ventilation, radio monitoring, skids) is ongoing. In this context, Bel V carried out five inspections in 2023. The facility is scheduled for delivery in 2024.

For IPM, the construction work had already been completed in 2022, with the necessary semi-industrial commissioning tests (SIBS) also being carried out. In 2023, Bel V carried out two inspections, during which the outstanding points from the SIBS, the final safety report and the licensing conditions were among the subjects discussed. All are necessary for the final delivery of the facility.

The construction of building 170X (for the dismantling of the vessels in buildings 105 and 122) is proceeding on schedule and Bel V is monitoring the hold and witness points. Bel V approved the test programmes for the ventilation and radio monitoring systems.

2.11 Making building DE independent

The project for the independence of building DE at Tihange (MIB.DE), which started in 2021 after ENGIE Electrabel's decision to discontinue studies for the long-term operation (LTO G2) of Tihange 3, aims to make building DE independent of Tihange 3. The aim is to be able to autonomously operate the spent fuel pools from building DE as from the permanent shutdown of the last support systems of Tihange 3 (currently scheduled for 2030) until at least 2075. The long-term storage of spent fuel at the nuclear power plant will thus be ensured by the SF^2 (dry storage via containers, see section 2.7) and by the independent building DE (storage in pools).

As part of the consultation process set up by the FANC for this project, the latest feasibility studies and the various designs envisaged for the MIB.DE project were presented in greater detail by ENGIE Electrabel to the safety authority. At the same time, technical meetings were held in order to examine in greater depth or clarify certain points (flooding protection design, mechanical and seismic classification of the new cooling systems (ZEB and ZRI), definitions and procedures for classification for the MIB.DE project, etc.).

All documents received during the project, the latest revisions of the NSRD (Nuclear Safety Reference Document) and the safety guidelines for the proposed technical configurations of the independent building DE were finally the subject of a Bel V safety evaluation report setting out the final evaluation of the overall design of the MIB.DE project.

In this context, Bel V took the view that the decision to retain building DE and make it independent is in general terms an appropriate and suitable solution in the context of ENGIE Electrabel's overall strategy for the long-term management of spent fuel and therefore did not raise any major objections to this modification.

However, Bel V identified in its safety evaluation report one serious problem (the need to consider a seismic design for the structures housing the new ZEB/ZRI systems) and various points for attention (the importance of an ageing management programme for the lifespan of the independent building DE (and in particular for the liner), studies that still need to be carried out for the Control Room, the evaluation of the risk of recirculation in the ventilation system, qualification of the level and temperature sensors in the pools, assessment of the explosion risk due to hydrogen (radiolysis), the scope and depth of the combined events study, etc.).

This safety evaluation report was attached to the FANC's final opinion following consultation prior to the MIB.DE project and was ultimately presented to ENGIE Electrabel during a closing meeting for the project in July 2023. In conclusion, ENGIE Electrabel indicated that it would take account of the safety authority's comments, although no immediate action is required in the short term, taking account of the confirmation of the long-term operation of Tihange 3 and of the placing on hold of the MIB.DE project.

3. International activities and projects

3.1 Cooperation with international organisations

OECD and IAEA activities

Bel V continued to participate in the activities of the various committees, working groups and meetings organised by the Organisation for Economic Co-operation and Development (OECD):

- the Committee on Nuclear Regulatory Activities (CNRA);
- the Committee on the Safety of Nuclear Installations (CSNI);
- the Nuclear Science Committee (NSC);
- the CNRA Working Group on Reactor Oversight (WGRO);
- the CNRA Expert Group on Operating Experience (EGOE);
- the CNRA Working Group on Leadership & Safety Culture (WGLSC);
- the CNRA Working Group on the Safety of Advanced Reactors (WGSAR);
- the CSNI Working Group on Fuel Cycle Safety (WGFCS);
- the CSNI Working Group on Fuel Safety (WGFS);
- the CSNI Working Group on Risk Assessment (WGRISK);
- the CSNI Working Group on Analysis and Management of Accidents (WGAMA);

- the CSNI Working Group on the Integrity and Ageing of Components and Structures (IAGE), and its subgroups on the integrity of metal components and structures and on the ageing of concrete structures;
- the CSNI Working Group on Human and Organisational Factors (WGHOF);
- the CSNI Working Group on Electrical Power Systems (WGELEC);
- the CSNI Working Group on External Events (WGEV);
- the RWMC Integration Group for the Safety Case (IGSC);
- the CDLM Committee on Decommissioning of Nuclear Installations and Legacy Management (CDLM);
- the Incident Reporting System Coordinators' activities (IRS, IRSRR, FINAS).

For more information on the participation of Bel V in specific OECD projects, please refer to Section 4.4 on research and development.

Bel V's activities in relation to the International Atomic Energy Agency (IAEA) cover a number of standing committees as well as specific events.

Concerning the standing committees:

- The General Manager of Bel V, elected in 2020 as chair of the Technical and Scientific Support Organization Forum (TSOF) of the IAEA, participated in the activities of the Steering Committee of the TSOF.
- A Bel V representative is a member of the Steering Committee on Regulatory Capacity Building and Knowledge Management (coordinated by the IAEA) and he continued his activities in this committee.
- Bel V participated in the meetings of the Steering Committee of the Regulatory Cooperation Forum and support meetings with the European Commission.

Concerning the specific events, Bel V experts participated in several IAEA conferences, workshops, technical committee meetings and webinars, mainly on the following subjects:

- systematic assessment of regulatory competence needs;
- effective operating experience and continuous performance improvement programmes at nuclear power plants;
- Integrated Regulatory Review Service (IRRS) missions;
- reliability assessment of passive heat removal systems used in advanced reactor designs;
- computer security in the nuclear world;
- geotechnical aspects in site evaluation and design of nuclear installations;
- deep geological repository programme;
- safety implications of the use of artificial intelligence in nuclear power plants;
- safety of radioactive waste management, decommissioning, environmental protection and remediation: ensuring safety and enabling sustainability;
- probabilistic safety assessment of nuclear installations in relation to external events and their combinations.

3.2 Cooperation with safety authorities

3.2.1 Western European Nuclear Regulators Association (WENRA)

Reactor Harmonization Working Group (RHWG)
Bel V participated, in support of the FANC, in the three RHWG meetings held in 2023.

The RHWG continued the benchmark study on the implementation of 2014 Safety Reference Levels (SRL) and reasonably practicable safety improvements for design extension conditions (Issue F) at the nuclear power plants. Bel V provided the requested additional information for the Belgian nuclear power plants and contributed to the benchmarking of country responses. At the end of 2023, the RHWG finalised the summary report of this benchmark study.

With regard to the next update of the WENRA Safety Reference Levels for existing nuclear power plants, the RHWG identified the Issues for which an SRL update is needed and started updating Issues A, B and C.

For the 2023 Topical Peer Review (TPR) on 'Fire Protection', the RHWG discussed the experiences with the technical specifications and the reporting in national reports.

Bel V also participated in RHWG discussions on safety objectives and potential RHWG activities related to new reactors and small modular reactors (SMR), and on experiences for high-quality industrial grade items.

Working Group on Waste and Decommissioning (WGWD)
The 49th WGWD meeting was held in Cologne (Germany) from 20 to 24 March. Bel V participated in support of the FANC.

Among other things, the WGWD discussed the current status of benchmarking progress (on storage, disposal and decommissioning), as well as the status of the guidelines for harmonising the nuclear regulatory systems of the WENRA countries using the Safety Reference Levels.

3.2.2 French-Belgian Working Group on the safety of nuclear installations

This working group is composed of the regulatory authorities of France and Belgium (respectively ASN and IRSN, and the FANC and Bel V). One or two meetings are held each year, alternately in Paris and in Brussels (the latter chaired by Bel V). The working group meetings cover a large range of topics on nuclear safety.

An online meeting was held on 7 April, in which the following topics were discussed:

- Regulatory aspects and projects
  - France
    - Revival of nuclear power with six new European pressurised reactors (EPR)
    - Periodic Safety Review of the 900 and 1300 MWe nuclear power plants
    - Start-up of the Flamanville EPR
    - Small modular reactors
    - Operation after 60 years
    - Stress corrosion cracking in several nuclear power plants
    - The French government's plan to bring ASN and IRSN closer together
  - Belgium
    - Status of the long-term operation of Doel 4 and Tihange 3

- Myrrha project and financing of SMR research by the Belgian government
- Definitive shutdown of Doel 3 and Tihange 2 and results of the chemical system decontamination of Doel 3

- Overview of events in nuclear facilities

- Emergency exercises and post-accident management of nuclear accidents
  - Bel V / FANC – situation / review of the 2022 crisis exercises and outlook for 2023

- Validation of the reviewed Terms of Reference of the French-Belgian working group on 'Installations nucléaires de base' (WG-INB)

3.2.3 Belgian-Swiss Working Group

This working group is composed of the regulatory authorities of Switzerland and Belgium (respectively ENSI, and the FANC and Bel V). One meeting is held each year, alternately in Brugg and in Brussels.

In 2023, the meeting was held online, on 19 October. The following topics were discussed:

- Exchange of information
  - Situation of the nuclear facilities
  - Changes in the regulatory framework
  - Overview of recent events

- Long-term operation
  - Back-fitting projects
  - Ageing
  - Impact on the regulator

- Update on decommissioning projects
  - Dismantling Mühleberg – current situation – experience feedback
  - Definitive shutdown of Doel 3 and Tihange 2
  - Chemical system decontamination of Doel 3

- Status of disposal projects in Belgium and Switzerland – update

- Peer review missions
  - Integrated Regulatory Review Service (IRRS) Belgium – results

3.2.4 Autoriteit Nucleaire Veiligheid en Stralingsbescherming (ANVS – Netherlands)

This working group is composed of the regulatory authorities of the Netherlands and Belgium (respectively ANVS, and the FANC and Bel V). One meeting is held each year, alternately in The Hague and in Brussels.

In 2023, the meeting was held in Brussels on 26 October. The following topics were discussed:

- Recent developments in both countries
  - Regulatory developments
  - Safety situation of nuclear power plants and nuclear facilities
  - New organisational structure at ANVS
  - Current topics at ANVS and the FANC
- Inspections / exercises / communications: evaluation of last year and planning
  - Joint inspections
  - Crisis preparation and emergency plan exercises
  - Cross-border information in licensing procedures
  - Communication and exchange of information
- Peer reviews
  - IAEA missions: IRRS, ARTEMIS, IPPAS, OSART and INSARR
  - TPR-II (Topical Peer Review)

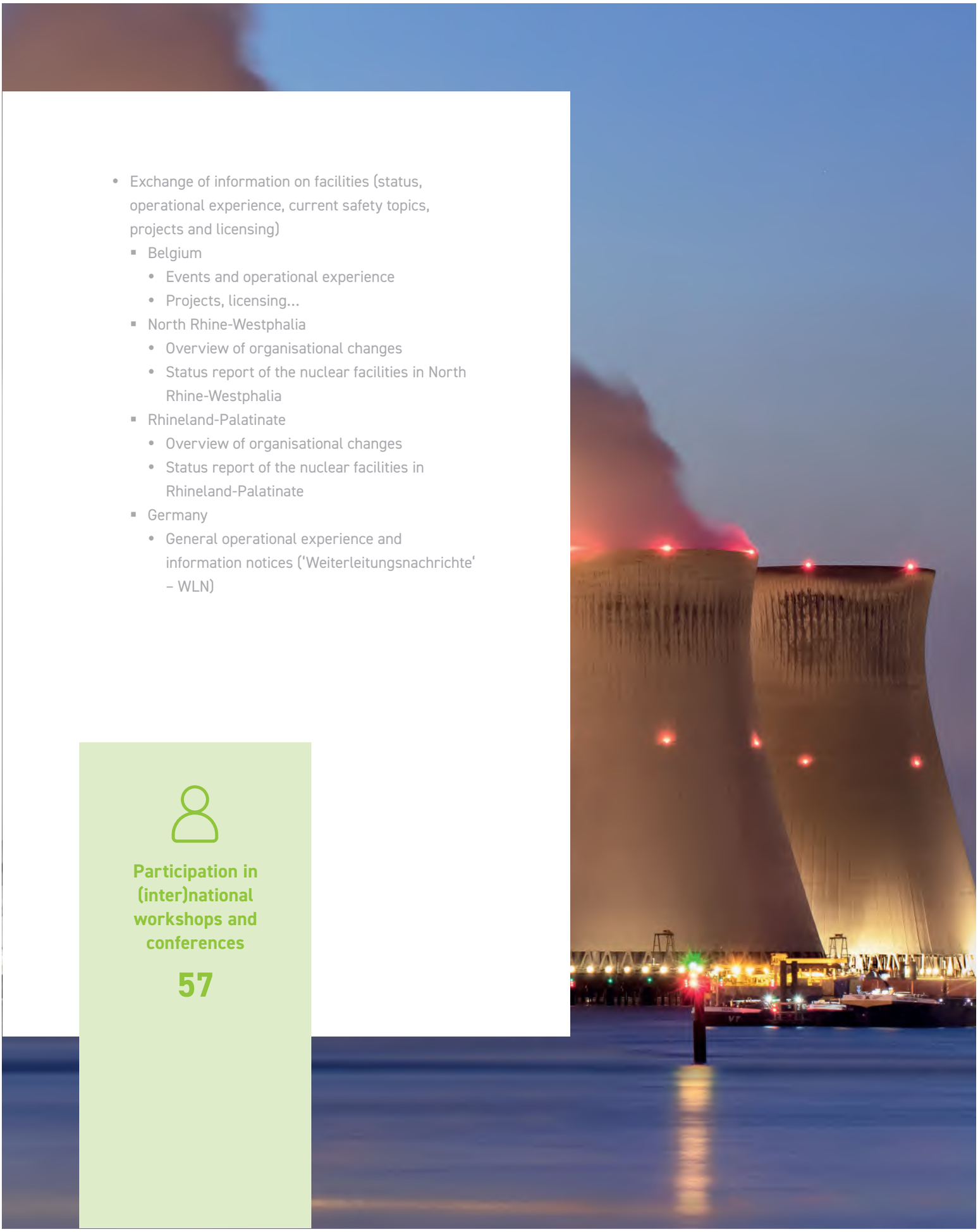
3.2.5 Deutsch-Belgische Nuklearkommission (DBNK)

The 2023 meeting, which was held on 10 May, was the seventh meeting of the German-Belgian Nuclear Commission (Deutsch-Belgische Nuklearkommission – DBNK) as provided for in the bilateral agreement concluded between Belgian Minister for Security and the Interior Jambon and German Minister of the Environment Dr Hendricks on 19 December 2016.

The following topics were discussed:

- General exchange of information regarding recent regulatory topics
  - Belgium
    - Overview of changes in the regulatory framework
    - Status of decommissioning
    - Current status of long-term operation in Belgium
    - IRRS mission to Belgium
  - Germany
    - Overview of organisational changes
    - Extended operation of German nuclear power plants
    - Next steps for the last three nuclear power plants
    - Update on decommissioning and dismantling
    - Maintaining competence and research
    - IAEA missions to Germany
    - Update on the selection of a disposal site

- Exchange of information on facilities (status, operational experience, current safety topics, projects and licensing)
  - Belgium
    - Events and operational experience
    - Projects, licensing...
  - North Rhine-Westphalia
    - Overview of organisational changes
    - Status report of the nuclear facilities in North Rhine-Westphalia
  - Rhineland-Palatinate
    - Overview of organisational changes
    - Status report of the nuclear facilities in Rhineland-Palatinate
  - Germany
    - General operational experience and information notices ('Weiterleitungsnachrichte' – WLN)



Participation in (inter)national workshops and conferences

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3.3 Collaboration with technical safety organisations

3.3.1 ETSON Conference 2023 on TSO challenges in a rapidly moving environment

Bel V hosted the 2023 conference of the European Technical Safety Organisations Network (ETSON). The conference was held on 11 and 12 October at Bel V's offices and welcomed around 50 participants from different European technical safety organisations (TSO), as well as a representation on behalf of the Japanese technical safety organisation NRA.

Building on the 2022 conference organised by GRS, and following on from the IAEA conference held in February in Abu Dhabi and the ETSON Board's statement of 22 February on renewed interest and initiatives in nuclear energy, the 2023 conference examined how different decisions, orientations and evolving contexts might impact the strategies TSOs need to adopt to prepare themselves for and address the threats and challenges ahead.

The conference was kicked off by an impulse speech from OECD/NEA on 'Nuclear renaissance (with special focus on SMR): issues & challenges', followed by a round-table discussion and a Q&A session. The conference also included four dedicated sessions on 'Competence & expertise management and capacity-building', 'ETSON Common Safety Research project', 'Interaction & dialogue with stakeholders' and 'Interaction & collaboration with international organisations and groups'. As is customary for the ETSON conferences, the first day ended with the ETSON Award Science Slam organised by the ETSON Junior Staff Program, followed by the award distribution ceremony. The first prize went to a young colleague from GRS for the topic 'Joint Modelling of VVER-1000/320 Containment Specifics for Simulating Pressure Build-Up: A COCOSYS Study'.

During the closing remarks, the following main outcomes of the 2023 conference were highlighted:

- the challenge regarding attracting (and especially retaining) new talents, and associated factors (e.g. education and training, funding and rapid development of technologies like AI);
- the importance of data science and AI, including the need to connect with the (non-nuclear) data science community;
- ETSON's roles and initiatives regarding the assessment and licensing of small and advanced modular reactors (SMR and AMR), actually combining the two previous challenges. This also includes the need and the importance for ETSON to interact, communicate and collaborate with various stakeholders (R&D, academic, civil society, regulator networks...).

3.3.2 European Technical Safety Organisations Network (ETSON)

The European Technical Safety Organisations Network (ETSON), which was founded in 2006 (among others by Bel V), serves as a shared platform for its member organisations:

- to provide a suitable forum for voluntary exchanges on safety analyses and R&D in the field of nuclear safety by sharing experiences and exchanging technical and scientific opinions;
- to contribute to fostering the convergence of technical nuclear safety practices within the European Union and beyond;
- to further the planning of nuclear safety research programmes and facilitate their implementation;
- to facilitate the application of the European Nuclear Safety Directive;
- to work together in safety assessment and research projects funded separately and organised by the respective members in dedicated consortia.

From 2015 to October 2018, the then General Manager of Bel V was President of ETSON. Since October 2019, the present General Manager of Bel V is Vice-President of ETSON.

To pursue its objectives, ETSON established the Technical Board on Reactor Safety (TBRS) and its supporting Expert Groups. Bel V representatives took an active part in these groups, where experts from member organisations exchange information and work together on various topics of nuclear safety assessment and research, ranging from generic aspects (e.g. safety concepts or emergency preparedness and response) to specific technical fields (e.g. safety fluid systems, mechanical and electrical systems or data science). A major output of the Expert Groups' activities are the so-called Technical Safety Assessment Guides (TSAG), which are part of ETSON's publications (available at http://www.etson.eu/publications). In addition, workshops on specific technical and scientific issues are organised by individual member organisations on behalf of the network.

At the request of the ETSON Board, the TBRS and its Expert Groups are drafting a technical report on the challenges and opportunities for safety assessment of light water-cooled small modular reactors from the point of view of technical safety organisations. A first draft of this report was used to support presentations and discussions at the ETSON Conference 2023 mentioned in the previous section.

Bel V also takes an active part in the ETSON Research Group (ERG) and has chaired the ERG since 2018. For more information, please refer to Section 4.4.2.

A Junior Staff Programme (JSP) Summer Workshop on 'Small modular reactor technology' was held in Manchester (UK) in October. Bel V presented a general overview of the different types of small modular reactors and the associated designs. Bel V also chaired a dedicated session on modelling.

The exchanges and collaboration with the TSO peers during these activities allow Bel V's staff to strengthen their technical and scientific expertise and to consolidate the quality of their safety assessments and positions.

3.3.3 Collaboration with technical safety organisations on waste management

Bel V collaborates closely with other technical safety organisations, among others within the SITEX.Network association (mainly aimed at strengthening TSO expertise in the field of radioactive waste management and currently chaired by Bel V) and through its active involvement in the European Joint Programme on Radioactive Waste Management (EURAD) (focusing on R&D, strategic studies and knowledge management-related activities). The first implementation phase of EURAD started in 2019 and is scheduled to be completed in 2024. In 2023, Bel V contributed to the submission of a proposal for a second implementation phase, which should start in 2024.

Finally, Bel V is also involved in the TENOR partnership led by IRSN, aimed at fostering TSO collaboration in its experimental underground research laboratory at Tournemire (France).

3.4 International assistance projects

As part of a consortium, Bel V offers its technical support services to safety authorities in a number of Western countries, including the Netherlands (ANVS), France (ASN), Norway (DSA) and the UK (ONR). The most significant activities in 2023 are described here.

3.4.1 Autoriteit Nucleaire Veiligheid en Stralingsbescherming (ANVS)

Bel V, as leading entity of a consortium with IRSN and Bureau Veritas, supports the Dutch safety authority ANVS as a technical safety organisation. A contract for at least five years was signed, starting at the beginning of 2022.

The contract consists of three lots:

- Lot 1 – Assessments
- Lot 2 – Inspections
- Lot 3 – Information gathering and advice for new developments

Bel V contributed among others to the following activities that were completed in 2023:

Lot 1

- P1-2022-002 – Safety and security culture
- P1-2022-004 – Overview of the regulatory supervision of waste management by IRSN and Bel V
- P1-2022-006 – Qualification of operators
- P1-2022-007 – Review of the planning for the construction of a new installation related to HOF matters
- P1-2022-011 – Assessment 'explosie veiligheidsdocument' and inspection
- P1-2022-012 – Knowledge transfer from ANVS and COVRA to CSN about HABOG
- P1-2022-013 – Ageing management programme
- P1-2022-016 – Regulatory framework for decommissioning
- P1-2022-017 – Assessment 'wijzigingsvoorstel vernieuwing regelelementen EPZ'
- P1-2023-005 – Feedback from Bel V and IRSN on operational experience feedback
- P1-2023-006 – EPZ – 'jaarrapport vermoeiing'

Lot 2

- P2-2022-004 – Aiding regulatory oversight and enforcement during the construction of PALLAS
- P2-2023-004 – Knowledge exchange – tactical level

Lot 3

- P3-2022-001 – Research on SMR
- P3-2022-002 – Research on ATF
- P3-2022-003 – Research on Gen IV reactors
- P3-2022-004 – Theme-oriented knowledge exchange – 'Plan van Aanpak'
- P3-2022-005 – Lecture on nuclear safety
- P3-2022-006 – Exchange about methodology safety culture within regulatory body
- P3-2023-001 – Seclore platform for sharing and protecting data within the consortium
- P3-2023-004 – State-of-the-art radioactive discharge monitoring at storage facilities

3.4.2 Autorité de sûreté nucléaire (ASN)

Bel V was selected to assist the French safety authority ASN for the project 'Prestations d'appui dans le cadre de l'instruction des analyses de sûreté soumises par le CEA à l'Autorité de sûreté nucléaire (ASN) relatives à l'installation nucléaire de base n° 24 (CABRI) localisée à Cadarache'. Bel V was awarded four subcontracting tenders (one at the end of 2021, two in 2022 and one in 2023). The third of those subcontracts was completed in February 2023, and the fourth in December 2023.

3.4.3 Assistance projects of the European Commission

The objective of the European Instrument for International Nuclear Safety Cooperation (INSC) is to support the promotion of a high level of nuclear safety, radiation protection, the safe management of spent nuclear fuel and radioactive waste, and the application of effective and efficient safeguards of nuclear materials in third countries.

This is achieved by cooperating with key stakeholders and in particular with the nuclear regulatory authorities in charge, with the aim of transferring EU expertise.

The nuclear safety programme is implemented through projects that are contracted after international calls for tenders in restricted and negotiated procedures managed by the European Commission based on specific technical expertise.

For Bel V, it is a clear opportunity to share and apply its experience and practices at the international level.

Ukraine

In 2023, Bel V was involved in two INSC projects to support the regulator (SNRIU) and its technical safety organisation (SSTC-NRS).

The INSC project in which Bel V participated was reoriented following the Russian invasion of Ukraine. In this reoriented project, Bel V (as task leader) was accompanied by IRSN in working on a task aimed at supporting the Ukrainian authorities in their authorisation process for medical facilities using radiation sources and at comparing these practices with the Belgian and French practices in particular, and European practices in general. This project was ended in May 2023.

In September, a new 42-month project started, in which Bel V participates in a task related to ageing and fire safety in Ukrainian nuclear power plants.

Serbia

Bel V is engaged in a three-year project, in a consortium led by ENCO. The beneficiaries are the Serbian safety authority SRBATOM and PCNFS, the operator of the Vinča site, which houses radioactive material storage and former nuclear facilities of the Vinča Institute of Nuclear Sciences (VINS).

Bel V contributed in supporting SRBATOM in the transposition of EU acquis in the field of radiation protection and nuclear safety into Serbian national legislation.

The 36-month project will end in May 2024.

Nigeria

A new 24-month project to support the Nigerian Nuclear Regulatory Authority (NNRA) started in September 2023.

Bel V is involved (as project manager) in supporting human resources management within the NNRA, with the aim of improving resource development and the training plan for nuclear safety regulation and of moving closer to European best practices.

4. Expertise management

Reports of national events analysed and documented

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4.1 Domestic experience feedback

Bel V performs a systematic screening of events at all Belgian nuclear facilities, as well as an in-depth analysis of a number of events with emphasis on root causes, corrective actions and lessons learned. In 2023, about 70 events were registered into the domestic experience feedback database.

For a number of events, a more detailed event analysis was performed with the aim of identifying lessons learned which are potentially applicable to a wider range of nuclear facilities. In 2023, these analyses resulted in the publication of one IRS report (IRS 9178) regarding the significant loss of material on bodies of bypass valves of the main feedwater system due to flow-induced erosion at Tihange 1.

2023 was marked by several events in particular, which were analysed in depth by Bel V and for which appropriate analysis, regulatory inspection and follow-up of corrective actions were carried out.

From these events, some lessons learned were identified, among others for the following topics:

- correct application of human performance tools;
- importance of carrying out cross-checks;
- proper communication within the organisation during the lockout-tagout process;
- clear and complete operation-related procedures;
- adaptation of the work when events do not go to plan;
- for a unit in definitive shutdown, upholding, in the teams in question, the quality of the monitoring of parameters and of the identification of the risks inherent in their activities, particularly the risks associated with lineage due to the absence of fuel in the reactor building;
- need of rigorous and formalised monitoring of waste packages in the storage areas;
- appropriate knowledge of the operation of regulators and their requalification when testing/replacing;
- importance of adhering to the work schedule.

4.2 Foreign operating experience feedback

In addition to screening domestic events, Bel V also performs a screening of events at foreign nuclear facilities as well as potential generic issues that are safety-significant, require technical resolution by licensees or require generic communication to the licensees.

In this context, the analysis by Bel V of selected events may result in formal Operating Experience Examination Request Letters (OEERL) or Operating Experience Information Letters (OEIL) or requests to provide clarification on the extent to which the operating experience was taken into consideration by licensees, or in the conduct of specific inspections.

The licensee of the Belgian nuclear power plants was invited to provide answers to specific questions after analysis of the following reports:

- IRS 9126 – 03/03/2023 – Anomalies in programmable multi-functional protection relays (universal protection relays) – closed after a satisfactory answer from the licensee;
- Counterfeit, Fraudulent and Suspect Items (CFSI): feedback from IAEA training on IRS for national coordinators (23-26/10/2023) + IRS 9194 and IRS 9203 – Bel V will monitor the topic of CFSI through a dedicated inspection program – closed;
- IRS 9198 – 30/11/2023 – Non-compliance with technical specifications due to incorrect procedural guidance for radiation monitors – IAEA Event Review Group requested a feedback about possible measures taken with regard to this event – Bel V is analysing the report and plans to send an answer;
- IRS 9100 – 30/11/2023 – Unintentional manual shutdown of detector surfaces of whole body contamination monitors – closed after a satisfactory answer from the licensee.

Based on the exchanges mentioned below, a further follow-up was performed for:

- IRS 8725 – 10/11/2018 – Inadequate emergency operating procedure guidance for asymmetric natural circulation cooldown – The licensee provided a complete answer about the work performed – Bel V is analysing the answer;
- OEF ASN – SCC France 28/01/2022 – Stress corrosion cracking (SCC) in pipes of the Emergency Core Cooling System – A task force has been set up within ENGIE Electrabel to examine the issue. Based on the information gathered, no significant risk of SCC has been identified so far. Additional inspections during 2022 and 2023 outages did not reveal any SCC – Bel V continues to closely monitor this topic;
- REVE PORC – 01/07/2022 to 26/10/2022 – Tihange 1 – IAEA IRS report 9178 was released: 'Significant loss of material on bodies of bypass valves of the main feedwater system' – closed;
- Japan Steel Works, CFSI – 22/12/2022 – Several cases of 'misconduct' in the quality inspections of products, data falsification and counterfeits at the Muroran plant (JSW M&E Inc branch) – closed after a satisfactory answer from the licensee.

Reports of international events analysed and documented

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4.3 Knowledge management

For several reasons (one of them being that over the next few years several experienced Bel V staff members will retire), Bel V is attaching great importance to knowledge management. Various tools are used to generate, capture, transfer, use and store knowledge.

The Technical Responsibility Centres (TRC) continue to play a key role in knowledge management within Bel V. There are about 20 Technical Responsibility Centres, acting as 'centres of competence' for all important fields of expertise of Bel V. Whenever needed to keep up with developments in nuclear issues, new Technical Responsibility Centres are set up (the latest examples concern decommissioning or security). Moreover, TRC management and operation are fully embedded in Bel V's Quality System.

In 2023, several new engineers were recruited. This requires considerable efforts on the part of the more experienced engineers to ensure an adequate transfer of knowledge. A coach is assigned to every newly recruited person, to facilitate their integration. This knowledge transfer approach is combined with, among other things, on-the-job training and cross-functional activities. The recruitment of a high number of new people also requires customised training (see Section 4.5).

Mention should also be made of Bel V's focus on knowledge transfer from retiring experts to younger staff. A Knowledge Transfer Form is used for this purpose. In addition, we also use a Knowledge Critical Grid, which aims to identify and reduce the risk of knowledge loss. Other knowledge transfer tools (such as the Knowledge Books) have been developed.

Knowledge management is also closely linked to the R&D programme aimed at generating new skills, better ideas or more efficient processes (see Section 4.4).

The continuous implementation of the Bel V adapted Electronic Documentation Management software (KOLIBRI, based on Hummingbird DM) is an important tool for efficient retrieval of information, good knowledge sharing and easier integration of new members of staff. To this end, a specific committee known as the DOCumentation USers group (DOCUS) focuses on user needs analysis and on improvements. In 2020, Bel V also reinforced its capacity to retrieve documents by acquiring and implementing a more powerful search tool.

4.4 Research and development

4.4.1 Introduction

Research and development (R&D) activities are fundamental for the development of independent and informed safety positions. Continuous efforts are made to develop, enhance and consolidate the expertise of Bel V's technical team in relevant technical domains of nuclear safety, radiation protection and security. In addition, R&D activities performed or supported by Bel V are becoming increasingly important in supporting the business development strategy. In the following sections, you will find an overview of the main results of R&D activities carried out in 2023.

The total effort in R&D activities in 2023 amounted to 8,776 hours, which represent 7.4% of the total working time of Bel V's technical staff.

In accordance with the R&D strategy, the following actions were taken:

- Bel V participated actively in the OECD/NEA ETHARINUS, ATLAS3, FIRE, HEAF2, FAIR, ROSAU and THEMIS projects.
- Bel V participated actively in the EURATOM projects MUSA, ASSAS, HARPERS, HARMONISE and R2CA, as well as in the management and various activities of the European Joint Programme on Radioactive Waste Management (EURAD).
- Bel V joined the EU consortium aimed at proposing an EU/H2027 EASI_SMR project related to the safety and design of light water small modular reactors.
- Bel V hosted the ETSON conference, during which a number of R&D topics and cooperation issues were addressed.

A number of presentations were given at various conferences and many papers were published in international journals.

In addition, Bel V continued its collaboration with a number of European organisations in the context of different consortiums for joint projects. Interaction with IRSN, universities and research institutes also continued.

4.4.2 R&D on nuclear installation safety

Thermal hydraulic phenomena

Most of the thermal-hydraulic R&D activities scheduled in 2023 were carried out successfully. Firstly, these activities concerned the OECD/NEA ETHARINUS project, in which accidental scenarios are experimentally investigated in PKL and PACTEL test facilities. A Bel V proposal to carry out an experimental test related to the impact of a delayed main coolant pump trip during a small break loss of coolant accident (SBLOCA) on the peak cladding temperature was scheduled in 2023. Secondly, Bel V participated also in the OECD/NEA ATLAS3 project related to experiments performed in the ATLAS/CUBE test facilities. In 2023, the joint ATLAS3/ETHARINUS analytical workshop was held and a Bel V member was designated to the organising committee. Bel V presented the CATHARE code predictions of the ETHARINUS experiment J6.1 related to the impact of a pump trip on the cladding temperature during a small break loss of coolant accident.

Within the framework of the H2020/R2CA European project, the CATHARE radioactivity transport model was used to assess the radioactivity release to the environment under Design Basis and Design Extended SGTR accident scenarios. The CATHARE calculation results were documented in dedicated project deliverables. Two additional deliverables were achieved by Bel V: a synthesis about the use of the CATHARE radioelement transport model and its impact on the prediction of radioactivity release, and a general synthesis of the work done for the project.

Bel V continued its participation in the OECD/NEA WGFS/WGAMA working group related to drafting a technical report about 'Technical Bases and Guidance for Analyses of Design Extension Condition without Significant Fuel Degradation (DEC-A)'. Within this working group, Bel V has the lead for the drafting of Chapter 3 of the report.

Bel V participated in the ICAPP 2023 conference in Korea with two presentations and two related papers. At this conference, the participating member of Bel V chaired one technical session.

Bel V participated in the IAEA Technical Meeting on Reliability Assessment of Passive Heat Removal Systems Used in Advanced Reactor Designs. At this conference, Bel V presented the R&D activity related to the code capabilities in performing assessments of passive systems. A related paper was also submitted and accepted for publication in a dedicated IAEA TECDOC.

In 2023, a number of international papers and deliverables as well as internal reports were also produced.

Mechanical safety

Bel V actively participated in the In-Vessel Melt Retention (IVMR) working group of the OECD, attended several of its meetings, and was the main contributor of Chapter 2 of the report, related to the application of the Finite Elements Methods on the study of IVMR.

A first section of this chapter discusses a number of important aspects to be considered in the analysis of IVMR applied to large nuclear power plants. A second section identifies the main parameters to consider in the numerical analysis. A third section discusses the importance of performing parametrical studies, and the need to determine the safety margins. Finally, a fourth section provides conclusions as well as a number of recommendations when deciding to investigate IVMR.

In 2023, Bel V was also involved in the Leak Before Break working group of the OECD, attending several progress meetings. In preparation of its participation, Bel V performed several test cases with the ABAQUS code. However, at the end of the year, Bel V scaled back its involvement in the working group given the current priorities for the licensing aspects related mainly to long-term operation.

Finally, Bel V participated in the ORIENT-NM progress meetings to remain informed about the activities that will be carried out in the context of this project.

Fuel and neutronics aspects

The Halden activities are continuing, albeit with some delay. In 2023, a Halden Program Group (HPG) meeting was held in Prague. An Enlarged Halden Program Group meeting is scheduled in Loën in May 2024 to officially close the project. A Belgian invited paper (SCK CEN, Tractebel Engineering, and Bel V) has been drafted to be presented at this Enlarged HPG meeting.

Fire protection

Bel V continued its involvement in the OECD/NEA projects that address topics related to fire issues. In this context, Bel V participated actively in several PRG/MB annual meetings within the framework of the OECD/NEA:

- Fire risk Assessment through Innovative Research (FAIR) project: an Analytical Working Group (AWG), Program Review Group (PRG) and Management Board (MB) were set up during the meetings held at IRSN, and further activities will start in 2024.
- FIRE Database project: Bel V contributed to inputting past events in the database, which has been released with 602 fire events.
- HEAF2 project: the experimental programme was finalised and the final work meeting was held at the US NRC premises. In 2024, the activities will be limited to finalising the project's final report.

Probabilistic Safety Assessment (PSA)

In 2023, Bel V's R&D activities related to PSA issues were limited to participation in international meetings and events such as:

- 25th meeting on probabilistic safety assessment event analysis hosted by US NRC;
- 24th WGRISK meeting hosted by the OECD;
- plenary meeting of the METIS project;
- PSA conference in Knoxville (US);
- workshop on combination of external hazards in Paris (at the IRSN premises);
- technical meeting on PSA in relation to external events and their combinations at IAEA;
- METIS workshop on site-specific seismic hazard assessment in Bergamo (Italy).

Severe accidents

The efforts in developing and improving severe accident expertise and simulation capabilities with the MELCOR code at Bel V continued in 2023, aimed at strengthening Bel V's capabilities for independent severe accident safety assessment of the Belgian nuclear facilities, as well as increasing international visibility and experience. In 2023, significant progress was made on the severe accident simulations, with a focus on uncertainty quantification within the H2020 MUSA project. Bel V used its MELCOR input deck for a generic three-loop pressurised water reactor in order to perform, for the first time, the full plant uncertainty quantification, focused on uncertain parameters associated with fission product release and transport. Statistical analysis of the obtained results was performed, including the analysis of correlation between figures of merits and uncertain parameters.

The knowledge gained from the use of MELCOR, as well as the results of its calculations, is fundamental in support of the evaluations of the licensees' studies.

The Cooperative Severe Accident Research Program (CSARP) agreement between the US Nuclear Regulatory Commission and Bel V was renewed in 2023 and continued to support the development of Bel V expertise. Bel V contributed to the CSARP meeting held in 2023, and also participated in the MELCOR Code Assessment Program (MCAP) meeting and the 14th European MELCOR User Group (EMUG) meeting. This provided valuable support to Bel V's severe accident modelling activities, including information on the capabilities of the MELCOR and SNAP codes.

Bel V continued its involvement in the H2020/MUSA, H2020/R2CA and Horizon Europe ASSAS projects funded by the European Commission, as well as the OECD/NEA ROSAU and THEMIS joint projects. Following the completion of the H2020/MUSA project in 2023, Bel V joined another consortium for the follow-up of this project, called INNOMUSA.

Finally, Bel V also joined the End User Group of the H2020 AMHYCO project and participated in its first open workshop.

Concrete ageing

Within the framework of the ODOBA project, the following activities were carried out:

- The last 'ODOBA natural ageing test report' regarding the natural ageing of ODOBA full-size concrete blocks affected by delayed ettringite formation was received. This report mentions that UA1 (dedicated to the investigation of one of the concretes used in the Belgian surface waste disposal facility) concrete containing calcareous filler behaves normally at early age and natural ageing.
- Participation in the 8th ODOBA Technical Group (OTG) meeting in Tournemire (France), which provided a global overview of the status of the DEF and ASR experiments performed on the ODE platform (Cadarache) on different concrete blocks with dimensions from 2 to 4 m^3 under natural or accelerated ageing. The presentations at the meeting allowed Bel V to get an update on the progress of the experiments and the latest outcomes.

In 2023, Bel V participated in the third ACES End User Group meeting.

ETSON Collaboration and Expert Groups

In 2023, Bel V continued its activities for and contributions to the Technical Board on Reactor Safety (TBRS) and related ETSON Expert Groups, aimed at sharing views and experiences with colleagues from other technical safety organisations. The following activities and achievements can be highlighted:

- preparation of and active participation in the second edition of the ETSON conference hosted by Bel V in October, including preparing and actively participating in the ETSON Award contest organised by the ETSON Junior Staff Programme. The conference welcomed about 50 participants from different European technical safety organisations, as well as representatives of the Japanese technical safety organisation NRA;
- together with the other ETSON members, organisation of the 2023 ETSON conference, which – building on the 2022 ETSON conference organised by GRS, as well as the IAEA conference held in February in Abu Dhabi and the ETSON Board's statement on renewed interest and initiatives in nuclear energy – examined how different decisions, orientations and evolving contexts might impact the strategies TSOs need to adopt to prepare themselves for and address the threats and challenges ahead. The following main outcomes were identified:
  - the challenge regarding attracting (and especially retaining) new talents, and associated factors (education and training, funding and rapid development of technologies like AI);
  - the importance of data science and AI, including the need to connect with the (non-nuclear) data science community;
  - ETSON's roles and initiatives regarding the assessment and licensing of light water small modular reactors and later on advanced modular reactors as well, actually combining the two previous outcomes/challenges. This includes the need and the importance for ETSON to interact, communicate and collaborate with various communities (academic, civil society, regulator networks...).
- further contributing to the development of the TBRS report on challenges and opportunities for the licensing process and safety assessment of small modular reactors;
- continuation of Bel V's contribution to ETSON News;
- active participation in the TBRS meetings and contribution to the implementation of the TBRS work plan 2020-2025 through active involvement in the dedicated Expert Groups and their outcomes and activities (development of Technical Safety Assessment Guides, workshops, and other publications).

MYRRHA

In 2023, Bel V mainly investigated the possibility of using the TRACE code to simulate transients, both in MYRRHA and in relevant test facilities (e.g. E-SCAPE and COMPLOT), while a number of tests were performed to assess the possibility of using the CATHARE code to simulate those transients.

4.4.3 R&D on waste and decommissioning

Near-surface disposal of category A waste

The R&D activities in this context mainly concerned the following:

- With respect to the 'bergbaarheid' aspect, Bel V participated in the events performed within the framework of EURAD, e.g. the EURAD course on uncertainty management (UMAN) (for which Bel V delivered a presentation) and the UMAN workshop dedicated to the management options and preferences of different actors regarding near-field uncertainties.
- With respect to the impact of cellulose on sorption in cementitious materials issue, Bel V participated in the third annual EURAD event, where the latest results of the ongoing experiments in CORI were presented.

Geological disposal of category B&C waste

The R&D activities related to EURAD were carried out mainly to execute the Bel V contractual issues. This included leading a task related to the UMAN project, as well as contributing to the ACED project. Contributions to the strategic development within the framework of EURAD and SITEX.Network were also planned. In 2023, the following activities were carried out:

- Bel V followed up the ACED project. The first results of the BACUCE experiment (evolution of a concrete/metal interface at 80°C), in which Bel V participates with IRSN, were obtained and discussed among the partners. The interpretation of these results is in progress.
- Bel V organised two UMAN events at its premises: a course on uncertainty management in waste management activities in Bel V, and a seminar on near-field uncertainty management.
- Bel V played a key role in EURAD's strategic development by coordinating (as Chair of the EURAD Bureau) the final steps of the update process for the EURAD Strategic Research Agenda. As Chair of SITEX.Network, Bel V also played a key role in coordinating TSO input into strategic EURAD decisions and the preparation of EURAD-2.
- Within the framework of the SITEX.Network activities, Bel V contributed in the development, together with IRSN, of a benchmark activity regarding modelling tools for radionuclide transport, including the IRSN code MELODIE and the Bel V code based on OPENFOAM. The benchmark preparation was finalised, presented to the SITEX.Network partners, and included in the SITEX.Network programme of activities for 2024.

In 2023, several international papers and deliverables as well as internal reports were produced.

Decommissioning and clearance

In 2020, Bel V acquired a gamma spectrometer (AEGIS) to perform non-destructive analyses and strengthen Bel V's clearance oversight by performing additional independent non-destructive measurements. To prepare for the operational deployment of these controls with the AEGIS, the following activities were carried out:

Percentage of total working time dedicated to R&D

Q1	Q2	Q3	Q4
3.68%	4.85%	4.75%	16%

- A measurement campaign was organised at Tihange to compare the characterisation of radioactive material by the licensee with a characterisation performed by Bel V with AEGIS.
- A guideline for clearance inspections possibly using the AEGIS was drafted.
- Bel V participated with its AEGIS in an inter-comparison exercise of radioactive sample characterisation by class I facilities.
- At the end of 2023, the objectives of the R&D programme devoted to the use of the AEGIS were achieved and Bel V initiated the roll-out of its inspection programme with the AEGIS.
- With regard to the EU HARPERS project, aimed at harmonising practices, regulations and standards in waste management and decommissioning, Bel V's contribution concerned the following two phases:
  - Bel V participated in two online workshops for phase 1, devoted to addressing the main conditions and opportunities for promoting circular economy approaches when managing materials and waste arising from nuclear decommissioning across Europe.
  - For phase 2, Bel V, together with UJV and ENEA, developed a questionnaire related to the criteria used by the EU Member States for recovering materials from nuclear installations that are being decommissioned and that meet the conditions for being reused or recycled. The goal is to identify regulatory discrepancies and differences in practices between the EU Member States in order to assess the benefits of better aligning regulations and practices and thus optimising the use of resources in the context of circular economy.

4.4.4 R&D on cross-cutting issues

Safety culture assessment

A technology / regulatory monitoring has been set up to maintain and improve processes related to the integration of the safety culture within the oversight practices, staff behaviour and the management system. On that basis, Bel V tried to share its developments through a number of publications in scientific journals. In this context, a paper entitled 'Responsive Regulation, Trust and Intrinsic Motivation within the Nuclear Industry: Impacts of a Safety Culture Tool' was drafted and submitted for publication to the Regulator-Regulate Relationship in High-Hazard Industry Sectors.

Cybersecurity

2023 saw the important start of the development of a laboratory for industrial network based on a hybrid environment (virtual and physical). Most testing environments are entirely modelled and require simulating the physical conditions. Such simulations are computing-intensive with results sometimes far from real constraints. For this reason, Bel V started building a hybrid environment integrating simulated and real industrial components.

The first internship in cybersecurity took place, providing initial positive results by allowing the manipulation of Modbus frames bypassing physical security into a simplified environment containing two programmable logic controllers (PLC). The collaboration between the CYBERUS authorities, the Université Libre de Bruxelles (ULB) and Bel V is strengthening, and it was proposed to duplicate the environment at the ULB to continue progressing on the research subjects even when there are no internships. The collaboration should continue in 2024 because the master thesis is scheduled to be completed in 2024. The purpose of the activity is to increase the number of PLCs, to use the new protocol prototype and to create human-machine interfaces (HMI) in order to simplify the simulated process control.

Small modular reactors

The R&D activities in this context mainly concerned the following:

- development of a working document related to the applicability of the Belgian regulatory framework for SMRs;
- presentation for the ETSON JSP summer workshop in Manchester about the technology and issues related to SMRs;
- development and presentation of a Bel V internal training session on SMRs;
- participation in a number of international events and working groups such as NEA-OECD EGSMR, ETSON EG, TANDEM SMRs and the WENRA Reactor Harmonization Working Group (RHWG).

Fusion safety and licensing

With regard to the EU HARMONISE project, aimed at harmonising the licensing of future nuclear power technologies in Europe, Bel V performed a review of the use of risk insights (RI) and the application of performance-based (PB) requirements in the regulatory processes in order to license nuclear installations and oversee their operation, maintenance, and equipment configuration changes. The work was completed on the deliverable for Sub-Task 3.1 as envisaged in the project work programme:

- analysis of EU experience in the use of risk insights in the regulatory framework for nuclear reactors,
- analysis of EU experience in the use of performance-based activities in the regulatory framework for nuclear reactors.

A draft report was completed and sent for review to the relevant HARMONISE project participants.

Accelerator-driven systems

In 2023, Bel V participated in the 2023 MIRDEC Group meeting (Decommissioning Small Medical, Industrial and Research Facilities) held in Copenhagen. A chapter of the MIRDEC programme on the regulatory framework is currently being drafted by the project partners.

4.4.5 R&D collaboration

2023 saw the continuation of a number of R&D collaborations with Belgian universities and research institutes as well as other organisations within the framework of ETSON and the OECD/NEA and European Commission projects. Some of these collaborations ended in 2023, such as the EURATOM R2CA project.

R&D collaboration with Belgian universities

Ghent University

Bel V continued its supervision of a PhD research at Ghent University about improving the modelling of transient effects of fires in confined and mechanically ventilated enclosures. The research funded by Bel V at Ghent University ended in 2022. The research work will be defended in 2024.

Université catholique de Louvain (UCL)

Bel V continued its collaboration with the UCL by proposing research subjects for PhD and/or Bachelor students. The subjects mainly concern issues related to cooling aspects under accidental conditions in the spent fuel storage pools.

Université Libre de Bruxelles (ULB)

The first internship in cybersecurity took place without any issues and the collaboration between the CYBERUS authorities, the ULB and Bel V is intensifying. This collaboration will continue in 2024.

R&D collaboration with other technical safety organisations, research entities and regulatory bodies

Institut de radioprotection et de sûreté nucléaire (IRSN)

Bel V collaborates with the French technical safety organisation IRSN within the framework of the ODOBA project aimed at performing experiments on concrete ageing and degradation mechanisms conducted by IRSN in Cadarache (France). The aim is to develop a predictive tool to estimate the durability of reactor containment buildings of nuclear power plants or waste repository facilities.

European Technical Safety Organizations Network (ETSON)

As in previous years, Bel V continued its activities in the Technical Board on Reactor Safety (TBRS) and related ETSON Expert Groups (EG), aimed at sharing views and experiences with colleagues from other technical safety organisations.

Sustainable Nuclear Energy Technology Platform (SNETP)

Bel V collaborates with other R&D actors of the European nuclear community through its membership of the Sustainable Nuclear Energy Technology Platform (SNETP) and NUGENIA (which is now embedded in SNETP). The purpose of NUGENIA is to advance the safe, reliable and efficient operation of nuclear power plants by facilitating collaboration among its members for applied R&D of the nuclear community.

SITEX.Network

Bel V is actively involved in the activities and management of SITEX.Network (Sustainable network for Independent Technical EXpertise of radioactive waste disposal). The purpose of SITEX.Network is to enhance and foster cooperation at the international level in order to achieve a high-quality expertise function in the field of safety of radioactive waste management.

SCK CEN

Bel V continued its collaboration with SCK CEN within the framework of the MYRRHA project. This relates to the simulation of experiments performed in the SCK CEN test facilities (e.g. E-SCAPE and COMPLOT) using RELAP3D and CATHARE code.

OECD/NEA working groups

Bel V participated in a number of OECD/NEA working groups such as:

- the WGFS/WGAMA working group aimed at drafting a technical report about 'Technical Bases and Guidance for Analyses of Design Extension Condition without Significant Fuel Degradation (DEC-A)'. In this working group, Bel V contributes to drafting several chapters of the report;
- the WGAMA working group related to In-Vessel Melt Retention (IVMR), for which Bel V is a task leader member;
- the WGIAGE working group related to Leak Before Break (LBB);
- the WGRISK working group on risk assessment and PSA for singular reactors;
- the EGSMR Expert Group on small modular reactors.

OECD/NEA joint projects

In 2023, Bel V participated in the following OECD/NEA projects:

- ETHARINUS;
- ATLAS3;
- Rod Bundle Heat Transfer (RBHT);
- Fire Propagation in Elementary, Multi-room Scenarios (PRISME-3);
- Fire Incidents Records Exchange (FIRE);
- High Energy Arcing Fault Events (HEAF-2);
- Experiments and Analysis for the Reduction of Severe Accident Uncertainties (ROSAU);
- THAI Experiments on Mitigation measures and source term issues to support analysis and further Improvement of Severe accident management measures (THEMIS).

European Commission projects

In 2023, Bel V participated in the following EC/H2020 projects:

- Reduction of Radiological Consequences of DBA and DEC-A (R2CA);
- Management and Uncertainties of Severe Accidents (MUSA);
- EURAD projects:
  - Uncertainty Management Multi-Actor Network (MAN) (Bel V acts as Lead of this project);
  - Assessment of Chemical Evolution of Intermediate Level Waste (ILW) and High Level Waste (HLW) Disposal Cells (ACED);
  - Waste Management routes in Europe from cradle to grave (ROUTES).
- Towards Harmonisation in Licensing of Future Nuclear Power Plant Technologies in Europe (HARMONISE);
- Harmonized Practices, Regulations and Standards (HARPERS);
- Artificial intelligence for the Simulation of Severe AccidentS (ASSAS).

Bel V continued its participation in the Advisory Board, the End User Group or the Support Group of the following H2020 projects co-funded by the European Commission:

- Methods and Tools Innovation for Seismic safety assessment (METIS);
- Organisation of the European Research Community on Nuclear Materials (ORIENT-NM);
- Investigating the possible severe accidents associated with small modular reactors (SASPAM-SA);
- LD-SAFE related to decommissioning and dismantling with a laser cutting solution;
- AMHYCO related to hydrogen combustion, safety and recombination, from a micro-scale level to a plant containment level;
- Towards Improved Assessment of Safety Performance for Long-Term Operation of Nuclear Civil Engineering Structures (ACES).

R&D deliverables

9	3	11	25
papers	abstracts	reports	presentations

4.5 Training

A structured training approach has been adopted on the basis of the Systematic Approach to Training (SAT) of the International Atomic Energy Agency (IAEA). Training programmes are developed for all staff members, and in particular for new hires, on the basis of the job descriptions and the relevant competencies needed. In this respect, Bel V has implemented the IAEA SARCoN model in order to properly assess the competence level of new members of staff and therefore to fine-tune our competence needs analysis. In this regard, Bel V plays a leading role in the field of competence management, regularly providing support to other regulatory bodies through IAEA channels.

The training programmes are implemented using different methods, depending on the availability of training materials and the adequacy of external courses: self-study, internal training sessions, external courses or on-the-job training.

A key element of the initial training of new members of staff is the programme of internal training sessions conducted by the Technical Training Manager with the help of experienced experts (mainly from Bel V) as lecturers. This programme comprises 35 training modules: 6 sessions took place in 2020, 7 in 2021, 7 in 2022 and 10 in 2023:

- Q2-INST-1 Class I installations (nuclear power plants);
- Q2-INST-2 Class I installations other than nuclear power plants;
- Q1-REG-1 Belgian legal and regulatory framework: evolution of rules (Art. 11 / 12 ARBIS/RGPRI);
- Q1-REG-4 Quality management system;
- Q2-NS-1 Basic safety concepts;
- Q2-NS-2 Deterministic safety analysis,
- Q2-RP-1 Radiation protection basics (Art. 25);
- Q3-RB-8 Decommissioning and dismantling
- Q4-FUND-1 Bel V fundamentals;
- Q1-REG-1 Belgian legal and regulatory framework: libération-vrijgave.

In addition, Bel V organises so-called 'Internal Technical Sessions' aimed at disseminating the R&D results to the Technical Responsibility Centres. In 2023, 4 Internal Technical Sessions were held.

Non-technical training is offered on an as needed basis (languages, IT, soft skills, leadership, etc.).

Also worth mentioning is the participation of Bel V members of staff in numerous specialised or refresher training activities, and in several working groups, seminars and conferences at the international level.

In total, approximatively 50 training activities took place in 2023. Overall, the time dedicated to training represents approximatively 85 hours per individual (member of technical staff) per year.

Percentage of total working time dedicated to staff training

Q1	Q2	Q3	Q4
5.4%	3.6%	5%	21.1%

5. Financial report

Balance sheet as at 31 December 2023

(amounts in € 1,000)

	2023		2022	
ASSETS		**18,508**		**17,159**
FIXED ASSETS		**3,985**		**4,126**
II. Intangible fixed assets		13		15
III. Tangible fixed assets		3,970		4,109
A. Land and buildings	3,495		3,657	
B. Plant, machinery and equipment	352		360	
C. Furniture and vehicles	80		92	
F. Assets under construction and advances	43		0	
IV. Financial fixed assets		2		2
CURRENT ASSETS		**14,523**		**13,033**
VII. Amounts receivable within one year		4,050		4,028
A. Trade receivables	3,994		3,884	
B. Other amounts receivable	56		144	
IX. Cash at bank and in hand		10,282		8,847
X. Deferred charges and accrued income		191		158

	2023		2022	
LIABILITIES		**18,508**		**17,159**
EQUITY		**15,596**		**13,769**
I. Capital	4,732		4,732	
IV. Reserves	2,868		2,868	
V. Result carried forward	7,996		6,169	
DEBTS		**2,912**		**3,390**
VII. Amounts payable after more than one year				
IX. Amounts payable within one year		2,912		3,386
A. Current portion of amounts payable within one year				
B. Trade debts	366		680	
D. Advances received on contracts in progress	283		483	
E. Taxes	2,263		2,223	
F. Other amounts payable				
X. Deferred charges and accrued income		0		4

Profit and loss account as at 31 December 2023

(amounts in € 1,000)

	2023	2022
Turnover	15,866	13,676
Other operating income	280	264
Total operating income	**16,146**	**13,940**
Services and other goods	2,135	2,109
Wages and social security costs	11,848	10,862
Depreciation	289	309
Write-downs on trade receivables		
Other operating charges	145	124
Total operating charges	**14,417**	**13,404**
Operating result	**1,729**	**536**
Financial charges and income	148	-22
Profit on ordinary activities	**1,877**	**515**
Income taxes	**-50**	**0**
Profit for the financial year	**1,827**	**515**

Profit and loss account: notes

Operating income

Income in 2023 was 16% higher than in 2022. This increase is partly the result of price indexation and partly the result of an increase in both the regulatory and non-regulatory activities.

Turnover

The largest part of the turnover of Bel V (90%) was related to the regulatory inspections and safety assessments at Class I facilities, which are invoiced to the licensees on the basis of a fixed rate set by law. 2023 was marked by the customary inspections within the framework of the facility operations, the preparation for the shutdown of five nuclear power plants and in particular the lifetime extension of two nuclear power plants, the activities relating to the temporary on-site storage of spent fuel (SF² project), the inspections and analyses carried out under the licence application for a near-surface disposal facility and the activities for the MINERVA/MYRRHA project.

2023 also saw an increase in non-regulatory activities. Given the shutdown of several Belgian nuclear power plants, Bel V is diversifying its activities, including by acting as the TSO for foreign safety authorities, including ANVS in the Netherlands.

A small portion of the turnover derives from contracts with the European Commission for support to nuclear safety authorities in emerging countries, as well as from regulatory inspections carried out at Class II facilities.

Other operating income

Other operating income consists of contributions by staff for the private use of company cars and for meal vouchers. In addition, part of the payroll tax is also recovered as part of R&D activities.

Operating charges

Services and other goods

Services and various goods accounted for 15% of total operating charges. Some of the activities for non-regulatory clients are outsourced. This explains the not insignificant share of 'Services and other goods' in the total operating charges. Transport and travel costs reflect a level of activity similar to the years before the COVID-19 pandemic.

Wages and social security costs

Staff expenses represented 82% of the costs, including training expenses. Proportionally, this represents a slight increase compared to 2022. However, the absolute value of staff costs in 2023 was just slightly higher than in the previous financial year.

Operating result

Operating result for the financial year has been allocated to the result carried forward.

List of abbreviations

ACRIA ..... Acceptance criteria
AI ..... Artificial intelligence
ANVS ..... Autoriteit Nucleaire Veiligheid en Stralingsbescherming (Netherlands)
ASN ..... Autorité de sûreté nucléaire (France)
BR ..... Bâtiment réacteur – reactor building
CATHARE ..... Code Avancé de ThermoHydraulique pour les Accidents de Réacteurs à Eau
CDLM ..... Committee on Decommissioning of Nuclear Installations and Legacy Management (NEA)
CEA ..... Commissariat à l'énergie atomique et aux énergies alternatives (France)
CELEVAL ..... Cellule d'évaluation – evaluation cell of the National Crisis Centre
CNRA ..... Committee on Nuclear Regulatory Activities (OECD)
CSARP ..... Cooperative Severe Accident Research Program
CSD ..... Chemical system decontamination
CSNI ..... Committee on the Safety of Nuclear Installations (OECD)
DBNK ..... Deutsch-Belgische Nuklearkommission
DE ..... Building for the storage of spent fuel in pools (Tihange)
DECOM ..... Decommissioning
DSA ..... Direktoratet for strålevern og atomtryggleik (Norway)
DSZ ..... Definitieve stopzetting – permanent shutdown
EC ..... European Commission
EPR ..... European pressurised reactor
ERG ..... ETSON Research Group
ETSON ..... European Technical Safety Organisations Network
EU ..... European Union
EURAD ..... European Joint Programme on Radioactive Waste Management
FANC ..... Federal Agency for Nuclear Control
FINAS ..... Fuel Incident Notification and Analysis System
GELINA ..... GEel LINear Accelerator
GIC ..... Geïntegreerde Inspectie- en Controlestrategie – integrated inspection and control strategy
GRS ..... Gesellschaft für Anlagen- und Reaktorsicherheit (Germany)
GSG ..... Gebouw Stoomgeneratoren – steam generator building (Doel)
HEU ..... High-enriched uranium
IAEA ..... International Atomic Energy Agency
INES ..... International Nuclear and Radiological Event Scale
INSC ..... Instrument for Nuclear Safety Cooperation (European Commission)
IPM ..... Installatie voor de Productie van Monolieten – monolith production facility (NIRAS)
IRE ..... National Institute for Radioelements
IRRS ..... Integrated Regulatory Review Service
IRS ..... Incident Reporting System
IRSN ..... Institut de radioprotection et de sûreté nucléaire (France)
IRSRR ..... Incident Reporting System for Research Reactors
JSP ..... Junior Staff Programme (ETSON)

LEU	Low-enriched uranium
LINAC	Linear accelerator
LTO	Long-term operation
MELCOR	Multi-physics engineering-level computer code
MIB.DE	Mise en indépendance du bâtiment DE – independence of building DE (Tihange)
MINERVA	Myrrha Isotopes productioN coupling the linEar acceleRator to the Versatile proton target fAcility
MONNET	MONo energetic NEutron Tower
MYRRHA	Multi-purpose hYbrid Research Reactor for High-tech Applications
NCCN	National Crisis Centre of the Federal Public Service Interior
NEA	Nuclear Energy Agency (OECD)
NRC	Nuclear Regulatory Commission (US)
OECD	Organisation for Economic Co-operation and Development
ONDRAF/NIRAS	Agency for Radioactive Waste and Enriched Fissile Materials
ONR	Office for Nuclear Regulation (United Kingdom)
OSART	Operational Safety Review Team (IAEA)
PSA	Probabilistic Safety Assessment
PSR	Periodic Safety Review
R&D	Research & Development
RECUMO	REcovery and Conversion of Uranium from MOlybdenum production
RHWG	Reactor Harmonization Working Group (WENRA)
RWMC	Radioactive Waste Management Committee (NEA)
SCG	Splijtstof Container Gebouw – fuel container building (Doel)
SCK CEN	Studie Centrum voor Kernenergie – Centre d'études d'Energie Nucléaire
SER	Safety Evaluation Report
SITEX.Network	Sustainable network for Independent Technical EXpertise of radioactive waste disposal
SMR	Small modular reactor
SNETP	Sustainable Nuclear Energy Technology Platform
SRL	Safety Reference Levels
TBRS	Technical Board for Reactor Safety (ETSON)
TDS	Traitement des déchets solides – solid waste treatment (Tihange)
TEF	Traitement des effluents – effluent treatment (Tihange)
TEL	Traitement des effluents liquides – liquid effluent treatment (Tihange)
TENOR	TournemirE coNsORtium
TRC	Technical Responsibility Centre (Bel V)
TSO	Technical Safety Organisation
TSOF	Technical and Scientific Support Organization Forum (IAEA)
WAB	Water- en afvalbehandeling – water and waste treatment (Doel)
WANO	World Association of Nuclear Operators
WENRA	Western European Nuclear Regulators Association
WGWD	Working Group on Waste and Decommissioning (WENRA)
WMU	Waste management unit

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BELV