BELV

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Annual Report 2024

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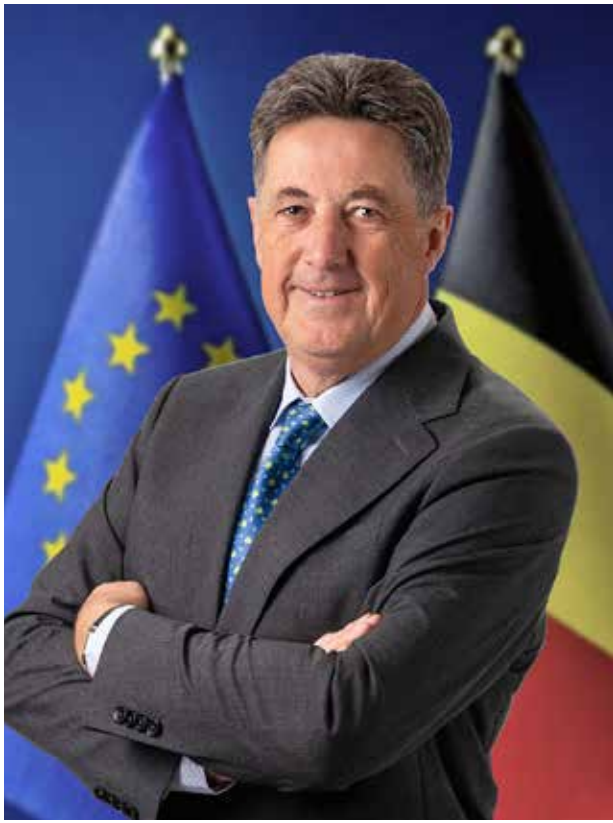
Message from the Chairman

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

Since the publication of the Royal Decree of 6 December 2018, the FANC has had formal powers to delegate the conduct of inspections and safety assessments in Class I and IIA facilities to Bel V.
The practical arrangements for the implementation of this Royal Decree are set out in the management contract between the FANC and Bel V, the most recent version of which was signed on 16 December 2024 by the chairmen of the boards of directors and the managing directors of the two organisations. The contract sets out the delegated missions, the arrangements for their implementation, and the mechanisms through which the FANC supervises their proper execution. The meeting of 16 December also marked the first meeting of the Bel V board of directors in its new composition.

To fulfil its mission of monitoring and assessing the safety of nuclear facilities, particularly in the context of an evolving nuclear landscape, Bel V continues to rely on a multidisciplinary team of experts with a high level of knowledge and skills.
With several young employees joining the organisation in 2024, particular attention was paid to knowledge transfer. An effective knowledge management system, a multi-year research and development programme and an annual programme of initial and continuing training are all essential to this effort. In addition, Bel V has for many years employed an electronic document management system, which continues to be expanded to enhance information access and preserve the organisation's collective memory.



In 2023, the federal government and ENGIE Electrabel reached an agreement to extend the operating life of the Doel 4 and Tihange 3 nuclear reactors by ten years. This agreement contains a best-effort obligation to produce electricity during the winters of 2025/2026 and 2026/2027. This means that safe operation of the reactors at the Doel and Tihange sites must be combined with major life-extension projects on the one hand, and preparations for dismantling on the other. In this context, Bel V is paying particular attention to human and organisational factors.

Although Belgium's nuclear phase-out policy remains subject to possible reversal, our current working assumption is that the other nuclear reactors will cease operation as planned. For this reason, the management of Bel V is pressing ahead with the further development of our international activities. In 2024, for example, Bel V acted as Technical Support Organisation (TSO) to the Dutch safety authority ANVS, worked alongside international partners on several European Commission-funded projects and provided technical support to the French safety authority (ASN) and its TSO (IRSN) (which have merged into ASNR as from the start of 2025).

Bel V was also prominently represented at the International Conference on Enhancing Nuclear Safety and Security Through Technical and Scientific Support Organizations (TSOs), held at the headquarters of the International Atomic Energy Agency (IAEA) in Vienna (Austria) from 2 to 6 December 2024. Organised by the IAEA's TSO Forum (TSOF), which is chaired by Bel V's Director General, the conference brought together 370 participants from 87 member states and seven international organisations, making it a clear success. Rafael Mariano Grossi, Director General of the IAEA, underscored the growing importance of TSOs, especially as more countries turn to nuclear energy to meet their environmental and energy objectives.
Bel V delivered presentations on several topics, underlining our internationally recognised technical expertise. The conference also highlighted the pivotal role of TSOs in ensuring nuclear safety and security in a context of rapidly evolving technological and environmental challenges.

On behalf of the Board of Directors, I wish to extend my sincere thanks to the management team and all our staff for the results achieved and for the professionalism they continue to demonstrate in these demanding circumstances.

Didier Malherbe
Chairman of the Board of Directors

Preface

Bel V, a private foundation established on 7 September 2007, with registered office 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 ionising 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 2024, the Board of Directors of Bel V was composed of:

- D. Malherbe, President
- V. Tanghe, Chairman of the Board of the FANC
- J. Annane, member of the Board of the FANC
- P. Absil, General Manager of the FANC
- S. Vaneycken, member of the Board of the FANC
- A. Reuter, member of the Board of the FANC
- K. Verheyen, member

Editorial

Dear reader,

Amid ongoing uncertainty surrounding Belgium's nuclear phase-out, Bel V remained steadfast in fulfilling its mission throughout 2024. In this dynamic context, our societal relevance continued to grow, along with a significant increase in our workload.

We are witnessing an international shift: more and more countries are turning to nuclear energy to meet their environmental and energy objectives. The Belgian nuclear sector as a whole – and Bel V as one of its components – has an important role to play in this changing landscape. In 2024, we were called upon to address a range of complex and demanding projects, many of which will require sustained effort over the coming years.

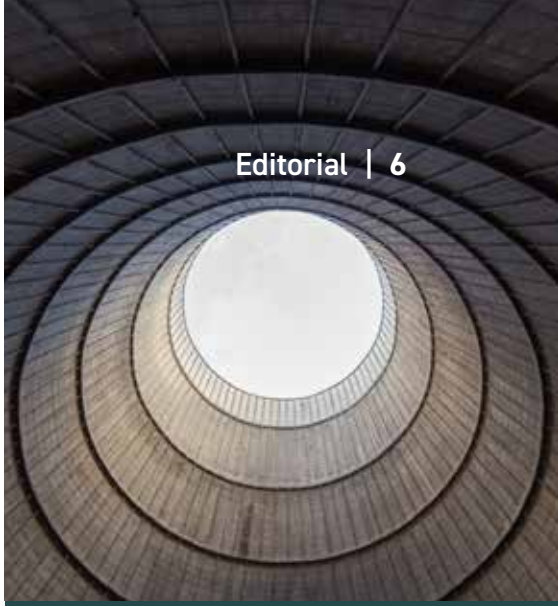
A major focus in 2024 was the project to extend the operating life of Belgium's two youngest nuclear reactors, Doel 4 and Tihange 3, by ten years. We received, reviewed and analysed numerous safety studies, engaged in technical discussions with the licensee and provided technical advice to the safety authority. Based on the findings of the studies, a series of improvement actions is now being defined for implementation between 2025 and 2028.

Meanwhile, preparations for the permanent shutdown and dismantling of several units also progressed. Our activities concentrated on the post-operational phase for Doel 3 and the preparations for the permanent shutdown of Doel 1 and 2 and Tihange 1, scheduled for 2025. At the same time, various dismantling-related activities were either prepared and already initiated (for example, at Tihange 2, where we monitored the chemical decontamination of the primary system, a key step in reducing radiological risks in the final stages of the reactor's lifecycle).

In parallel, numerous discussions took place between the safety authority, the National Agency for Radioactive Waste and Enriched Fissile Material (ONDRAF/NIRAS) and ENGIE Electrabel concerning the waste streams that will result from dismantling activities. The aim is to prepare for the inventory, characterisation and disposal of this waste in the safest and most efficient manner possible.

In light of the Belgian nuclear context, particular attention in 2024 was given to the following areas:

- Doel and Tihange: storage conditions and capacity for the various waste streams;
- Doel: monitoring of corrosion on the outer reactor building of Doel 4, identified during inspections linked to the life extension project;
- Belgoprocess: licensing and monitoring the construction of new buildings to guarantee future storage capacity;
- Belgian Nuclear Research Centre (SCK CEN): progress on the RECUMO project for recycling highly enriched uranium (HEU) from the National Institute for Radioelements (IRE), as well as planning and construction of the MYRRHA and MINERVA facilities;
- JRC-Geel: the repair of the GELINA facility (out of operation since September 2023) and the implementation phase of the periodic safety review.



Holding a steady course in turbulent times

Naturally, we also closely monitored broader developments. Artificial intelligence (AI), in particular, is poised to have a major societal and economic impact in the coming years, in terms of both its 'maturity' and the need for responsible, ethical behaviour. Our industry will not remain untouched: AI will reshape the workplace, influence required skills sets and transform the wider technical environment. It is essential that we embrace these developments.

In 2024, we once again welcomed new employees, including several talented young professionals, whose learning mindset, flexibility and adaptability make them valuable assets to our organisation and the challenges we face.

Another source of pride was our successful recertification under the ISO 9001:2015 standard, which also covers our international activities. This achievement confirms the quality and reliability of our processes. We can therefore look back on 2024 with a sense of satisfaction about the work we accomplished and with confidence as we face 2025. Thanks to the professionalism, commitment and spirit of collaboration shown by our team of around 90 colleagues, we once again delivered a wide range of activities and achieved the results we set out to deliver. These accomplishments are something we can all take pride in.

I would like to extend my sincere thanks to all our employees and stakeholders for their individual and collective contributions.
I hope you enjoy reading this annual report.

Michel Van Haesendonck,
Ir, Director General

List of acronyms

Below are the main acronyms used in this annual report.

ACRIA	Acceptance criteria
AI	Artificial intelligence
ANVS	Autoriteit Nucleaire Veiligheid en Stralingsbescherming (Netherlands)
ASN	Autorité de sûreté nucléaire (France) – *merged with IRSN into ASNR as from 2025*
ASNR	Autorité de sûreté nucléaire et de radioprotection (France)
BR	Bâtiment réacteur – reactor building
CATHARE	Code Avancé de ThermoHydraulique pour les Accidents de Réacteurs à Eau
CNRA	Committee on Nuclear Regulatory Activities (OECD)
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
EC	European Commission
ENSI	Eidgenössisches Nuklearsicherheitsinspektorat – Inspection fédérale de la sécurité nucléaire (Switzerland)
ENSREG	European Nuclear Safety Regulators Group
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
FTE	Full-time equivalent
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)
HERCA	Heads of the European Radiological Protection Competent Authorities
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 (ONDRAF/NIRAS)
IRE	National Institute for Radioelements
IRRS	Integrated Regulatory Review Service
IRS	Incident Reporting System
IRSN	Institut de radioprotection et de sûreté nucléaire (France) – *merged with IRSN into ASNR as from 2025*
IRSRR	Incident Reporting System for Research Reactors
JRODOS	Java Real-time On-line Decision Support
JSP	Junior Staff Programme (ETSON)
LEU	Low-enriched uranium
LINAC	Linear accelerator
LTO	Long-term operation
MELCOR	Multi-physics engineering-level computer code
METIS	Methodologies and Tools Innovation for Seismic Risk Assessment (EU)
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)
OECD	Organisation for Economic Co-operation and Development'
ONDRAF/NIRAS	Agency for Radioactive Waste and Enriched Fissile Materials
OSART	Operational Safety Review Team (IAEA)
PIE	Postulated initiating event
PSA	Probabilistic Safety Assessment
PSR	Periodic Safety Review
Q&A	Questions & Answers
R&D	Research & Development
RECUMO	REcovery and Conversion of Uranium from MOlybdenum production
RGPRI-ARBIS	Royal Decree on general regulations for the protection of the population, workers and the environment against the danger of ionizing radiation
RHWG	Reactor Harmonization Working Group (WENRA)
SCG	Splijtstof Container Gebouw – fuel container building (Doel)
SCK CEN	Studie Centrum voor Kernenergie – Centre d'études d'Energie Nucléaire
SF²	Spent fuel storage facility
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
T&I	Tests & inspections

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
TOSCA	TSO Self-Capability Assessment
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)
WENRA	Western European Nuclear Regulators Association
WGWD	Working Group on Waste and Decommissioning (WENRA)

1. Regulatory activities in Belgium

1.1 Introduction

1.1.1 Nuclear power plants

As regards operational oversight, Bel V continues to pay particular attention to human and organisational factors at the Tihange site. They are important considerations for this site, since the safe operation of the reactors there goes hand in hand with two major projects: extending the life of Tihange 3 (which requires specific efforts) and the preparations for the dismantling of Tihange 2. There is also close monitoring in this respect at the Doel site. One point worth mentioning for Doel in 2024 was the discovery of corrosion in the secondary containment of Doel 4 during inspections in preparation for the life extension. This led to several analyses being conducted in the context of a Justification for Continued Operation (JCO) with a view to the restart in 2024. Permanent repair work is scheduled for 2025.

In 2023, ENGIE Electrabel and the Belgian state reached an agreement on a ten-year life extension (LTO – long-term operation) of Doel 4 and Tihange 3. This agreement contains a best-effort obligation to produce electricity during the winters of 2025/2026 and 2026/2027. In 2024, ENGIE Electrabel's PSR LTO D4T3 project continued, with the publication of studies and numerous exchanges between ENGIE Electrabel and Bel V. This project has been divided into a number of sub-programmes: 'Preconditions', 'Ageing', 'Design', 'Tests & Inspections' (T&I), 'Knowledge, Competence & Behaviour' and the ten-yearly Periodic Safety Review (PSR). Among other things, Bel V analysed study documents, exchanged questions and answers with the licensee and attended technical meetings with a view to improved consultation. Improvement actions are set out in ENGIE Electrabel's Global Action List (GAL) on the basis of the results of the studies under these sub-programmes. These actions, ranging from updates of maintenance and inspection procedures to major projects and modifications, will be carried out between 2025 and 2028. Bel V received the GAL for Doel 4 and Tihange 3, together with the PSR LTO reports, in late 2024. The latter include the PSR synthesis reports, the final T&I programmes, the expected list of systems, structures and components that will have to be replaced during the LTO period and the list of non-conformities. Bel V started assessing these reports and the Global Action List in late 2024.

The DECOM project in preparation for the permanent shutdown and dismantling of the various units was continued. In 2024, the focus was on implementing the post-operational phase for Doel 3 (shut down in September 2022) and Tihange 2 (shut down in January 2023), pending the submission of dismantling licence applications in 2025 and the preparatory steps for the permanent shutdown of Doel 1 and 2 and Tihange 1, also in 2025. At the same time, various dismantling activities were prepared and in some cases carried out for Doel 3 and Tihange 2, the most important of which was the clearance of the turbine area. The other main activity after the permanent shutdown

is the chemical system decontamination (CSD) of the primary system, the purpose of which is to limit radiological risks during the final phases of the reactor's life. In 2024, Bel V closely monitored the implementation of these activities at Tihange 2, as well as preparations for them at Doel 1 and 2 (in the case of Doel 3, this had already been done in 2023). For both Doel 3 and Tihange 2, there were again numerous preparatory discussions on the removal of spent fuel and radioactive materials from the storage pools. At the same time as this technical analysis phase, strategic discussions continued with a view to optimal preparation for the transition from an operating licence to a dismantling licence for the two sites. Finally, numerous 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 flows that will be generated during the shutdown and dismantling activities. The aim is to prepare for the inventory, characterisation and disposal of this waste in the safest and most efficient manner possible.

Work on the construction of buildings for the dry storage of spent fuel has been completed for the Tihange site and is continuing at the Doel site. The storage building at Tihange has been commissioned.

In 2024, Bel V also focused on the storage conditions and capacity for the various waste streams at the Doel and Tihange sites, given that the authorisations for resins and for concentrates, continued to be withheld following an audit by ONDRAF/NIRAS. A new process has been developed for the conditioning of resins, for which tests are still ongoing.

1.1.2 Other nuclear facilities

In 2023, the National Institute for Radioelements (IRE) switched over completely to a purification process for the production of medical radioisotopes using low-enriched uranium (LEU) instead of highly enriched uranium (HEU). The production capacity and frequency of the LEU process remained stable in 2024.

At Belgoprocess, the focus in 2024 was on monitoring several construction projects. Among other things, Bel V monitored progress on building 167X (the 'gel drum building' for the storage of non-compliant packages), the remaining points in the installation for the production of monoliths (IPM), and building 170X (intended for the dismantling of the vessels in buildings 105 and 122). The commissioning of the last two buildings is scheduled for 2025.
All actions in relation to the periodic safety review at Sites 1 and 2 (2016) have been delivered, but a limited Q&A is still ongoing for a number of actions. Bel V analysed the implementation report and submitted comments to Belgoprocess in a letter from the Federal Agency for Nuclear Control (FANC).
For the periodic safety review at Site 2 (2026), Bel V analysed the adapted methodology document, which took into account previous comments from Bel V in the evaluation report for the first quarter of 2024. These comments were discussed with Belgoprocess.

Several events relating to nuclear safety were recorded at the SCK CEN site, including a fall involving a fuel assembly, failure to meet technical specifications in connection with a fan failure, problems with the movement of control rods and scrams at the Venus and BR1 reactors.
Several important projects are in progress at SCK CEN. For the MYRRHA project, SCK CEN provided a series of documents at the beginning of 2024 so that the safety authority could give its opinion on the progress of the pre-licensing process. Bel V analysed the most important documents. SCK CEN's approach was explained in

several workshops. In late 2024, Bel V provided the FANC with its input for the compilation of the official opinion on the progress of the pre-licensing.
For MINERVA, the preparation of the construction site started in the fourth quarter of 2024. Construction work is underway at RECUMO, a facility for the recycling of HEU and LEU from the IRE, and is being monitored by Bel V.
In November 2023, SCK CEN submitted the methodology document for the 2026 periodic safety review to the FANC and Bel V. After analysis, Bel V concluded that the document is of good quality and generally meets expectations, provided that some important comments are taken into account. Several exchanges on this subject took place in 2024. The internal evaluation at SCK CEN has now started and the first deliverables and responses to Bel V's comments are expected in early 2025.

One event of note at JRC-Geel was the departure of a member of the Health Physics Department. A vacancy has been advertised for a replacement. In operational terms, the repairing of the GELINA facility is worth reporting. It has been out of service since September 2023, with a planned restart in the first quarter of 2025. The implementation phase of the periodic safety review is still running behind schedule. Measures were taken to improve performance, including periodic follow-up meetings and the formation of a support group.

Following the issuing of a positive opinion by the FANC's Scientific Council, ONDRAF/NIRAS obtained a licence in the second quarter of 2023 for the construction of a facility for the storage of short-lived radioactive waste (cAt). 2024 saw the delivery by ONDRAF/NIRAS of revised chapters of the safety report, which were analysed by Bel V. In addition, Bel V carried out four systematic inspections to monitor the modification files and a thematic inspection relating to safety culture, training, the organisation of the Health Physics Department and change management. Inspections are also planned for 2025 to enable Bel V to assess (provisionally) whether ONDRAF/NIRAS is organisationally ready to start construction work in early 2026 as planned.

1.1.3 Integrated inspection and oversight strategy (GIC – 'Geïntegreerde Inspectie- en Controlestrategie')

The new six-year integrated strategy for inspection (by the FANC) and oversight (by Bel V) 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 the course of 2023, Bel V also carried out a Return of Experience (REX) exercise, which provided input for the GIC for the next period (2024-2029). Following consultation with the FANC, a number of adjustments were made to the scope of and vision for the various inspection programmes to be carried out by the FANC and Bel V. The inspection programmes for all facilities – in power operation, in the post-operational phase (POP) and the cAt project – were drawn up for 2024 in line with this renewed GIC.

1.2 Overview of inspections at nuclear power plants

1.2.1 Doel 1/2

Both Doel 1 and Doel 2 were operated at full power during this period, except for the annual refuelling outage. For Doel 1, this was during the period from 24 May to 21 June and for Doel 2 from 6 April to 17 May. In addition, there were some limited power modulations during the summer period at the request of the grid operator ELIA.

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 2024:

- One of the two high-voltage power lines was taken out of service.
- The dismantling of equipment in the classic section (the turbine area) is ongoing.
- The sampling (for characterisation with a view to waste treatment) of the reactor vessel and the reactor internals has started.
- Preparations have started for the removal of the non-fissile material from the spent fuel pools.

1.2.3 Doel 4

Doel 4 was operated without interruption and at full capacity until the start of the outage for maintenance work and refuelling on 29 August. This refuelling outage took longer than expected and was only completed on 7 October. Among other things, it was due to an unexpected problem with a concrete joint in the secondary containment. The licensee and Bel V had to carry out additional resistance analyses in order to assess the situation. After a Justification for Continued Operation (JCO) for the containment, the unit was restored to full capacity operation on 13 December. A permanent solution is planned during the LTO outage in 2025.

In addition, ENGIE Electrabel detected a defect in the transfer system between the storage tank and one of the three diesel generators of the Doel 4 reactor on 7 August. The cause turned out to be an assembly error during a check of the fuel level measurement, which was carried out from 15 to 17 July. Since then, the switching mechanism has not worked correctly. This event was rated at INES Level 1.

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 still in progress to replace or improve the WAB infrastructure.

For concentrates, work is taking place on both the expansion of storage capacity and the development of new processes. Bel V is monitoring this closely.

In addition, Bel V approved the application for the conditional release of $Al(OH)_3$ powder from Doel 1 and 2. The $Al(OH)_3$ powder was removed to a category 1 landfill (Vanheede Landfill Solutions in Roeselare) on 18 January in accordance with FANC licence reference LIB-0304385 (conditional release under RGPRI/ARBIS Article 18).

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. A number of planned inspections were postponed to early 2025.

- 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, operating experience feedback, etc.).

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

1.2.6 Tihange 1

The unit operated at nominal power throughout the year with the exception of the period of the programmed unit shutdown from 1 March to 19 April, when load was resumed.

1.2.7 Tihange 2

Preparations for the dismantling of Tihange 2, which was definitively shut down on 31 January 2023, continued in 2024.

The main activities in 2024 were as follows:

- the completion on 11 December 2024 of the decontamination of the primary circuit (the CSD project);
- the administrative decommissioning of several items of equipment located in the controlled area that are no longer important for nuclear safety;
- the modification of the technical specifications for decommissioned equipment;
- continuing work on the dismantling of the non-nuclear equipment (turbine area).

1.2.8 Tihange 3

The unit operated uninterruptedly at nominal power, except for a shutdown from 4 to 6 May due to a fire in an electrical panel in the bunker. The unit returned to 100% nominal power at around 18:00 h on 6 May.

1.2.9 Tihange site / waste

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.

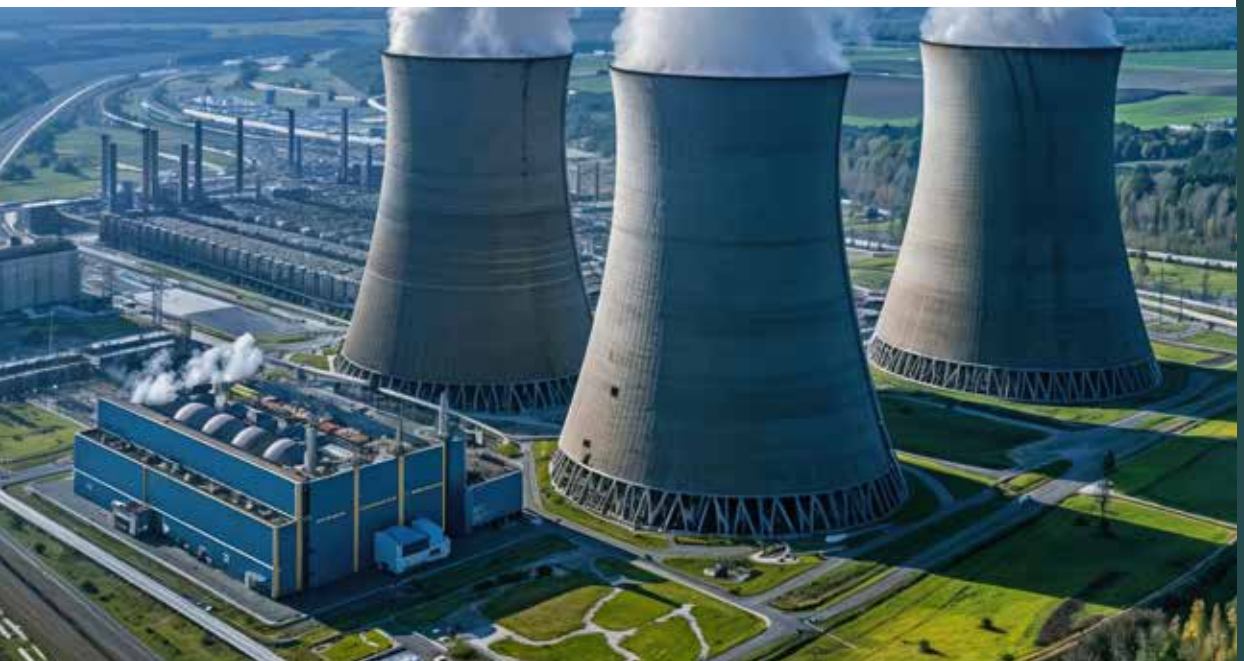
- Systematic and specific inspections were carried out to address issues applicable to several units (operating experience, management of external hazards such as flooding, etc.).

- Particular attention was devoted to human and organisational factors. This aspect is particularly important at the site, where it is necessary to reconcile the safe operation of the reactors, a project to extend the operation of Tihange 3 (which requires specific activities) and preparations for the dismantling of Tihange 2.

Bel V provided technical support to the FANC during its inspections, including those relating to staffing and competence management, the acceptance of the new SF² spent fuel storage building, outage management, etc.

Bel V also continued its close monitoring of radioactive waste management, in particular with regard to the storage of radioactive concentrates and resins, taking into account the suspension of the ONDRAF/NIRAS authorisation that allows this type of waste to be removed.

An International Atomic Energy Agency (IAEA) Operational Safety Review Team (OSART) follow-up mission took place in October 2024, following the initial mission in 2023. After this follow-up mission, the IAEA confirmed that the recommendations and suggestions made to increase operational safety and ensure compliance with IAEA requirements had either been fully implemented or were well on their way to being implemented.



Inspections carried out in 2024:

Doel nuclear power plant installations	187
Tihange nuclear power plant installations	114
Other class I nuclear facilities	155
Class IIA nuclear facilities	74
Emergency preparedness and response exercises (10 employees involved)	5 exercises
	7 alert drills

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 2024 consisted of seven cycles. There was no small cycle to carry out a transient on a test assembly.

During the loading of the reactor for cycle 01/2024, a fuel assembly fell out of the gripper as a result of a problem with the locking system. The operators had not carried out the necessary checks. The fuel assembly incurred mechanical damage, but no fission product emissions were detected.
At the start of the same cycle, the cycle was stopped because the control rod was moving stiffly. It was replaced, after which the reactor was restarted and the cycle was completed successfully.

On 5 February, it was found that the flow rate of the scrubber fans had been lower than normal since 19 January. This was due to a failed thermal protection on a scrubber fan. As a result, the technical specifications were not met, as no fan may be unavailable for more than 24 hours.

During cycle 02/2024, a significant leak occurred in a bellows after secondary pump J5-405. This led to the pump room being completely flooded. The defective bellows was replaced by a spare one and after measurement by the radiation monitoring officer the water was pumped away to the lagoon.

After the completion of cycle 03/2024 the 1,000 m³ containment tank under the ventilation building overflowed during the emptying of the reactor pool. The cause was a problem with the level gauge in the tank. Some slightly contaminated demineralised water flowed into the basement of valve VBT10 and into the ventilation building. The contaminated floors were cleaned.

During cycle 07/2024, control rod S6 became stuck during both upwards and downwards movement. The minimum available anti-reactivity was re-evaluated on the assumption that the control rod would be stuck in its current position and would therefore not fall over in the event of a scram. The available anti-reactivity was higher than required, so it was decided to continue the cycle with the stuck control rod in its position. After the cycle, the cause was found to be water infiltration in the head of the control rod mechanism, which had caused the motor to stop working.

In the context of the issue to do with the presence of a foreign object (a spring hanger) in the primary system of the BR2 reactor, 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 locating and possible recovery of the spring hanger. The arms of the four check valves after the primary pumps were also replaced.

The VENUS reactor was started up in subcritical mode in 2024 as part of the CORREX programme. Two experimental assemblies with boron carbide cylinders in the central section and with fission chambers were loaded into the reactor.
On 6 February a scram occurred in the VENUS reactor, caused by a malfunction in the position measurement of safety rod SR1. As a result, the system incorrectly reported that not all safety rods had been retracted.
On 20 March, a second scram occurred, caused by a malfunction in measuring channel LOG-1. The cause was found to be a defective high-voltage cable of the ionisation chamber. This problem has now been resolved.
The BR1 reactor underwent three scrams in 2024. The first, on 22 January, was caused by a fault in the signal cable of the period on the D measuring channel (< 5 s).

Two additional scrams occurred on 27 and 29 May, as a result of a fault in the high voltage on the SR measuring channel's ionisation chamber. The potentiometers of the defective modules were replaced.

A glove box was installed in the tritium laboratory in connection with the processing of sodium-potassium (NaK) waste. This box was placed under overpressure in a tent under negative pressure.

The dismantling of the BR3 reactor continues. SCK CEN received the licence for the conditional release of waste. The concrete blocks from the bioshield were removed.

On 8 November, the BR3 reactor's building ventilation system failed due to a technical defect. As the ventilation system could not initially be restarted, work in the controlled and supervised zone was immediately stopped. After the necessary work had been done, the ventilation system became operational again and work in the controlled and supervised zone could be resumed.

The construction of the MaT (Material Treatment Project) building is ongoing. The aim is to transfer a number of activities from BR3 to the new building at the beginning of 2025.
In the LHMA (Laboratory for High and Medium Activity) facility, a number of rooms are being completely renovated in preparation for the production of actinium-225 (Ac-225) based on thorium-229 (Th-229). The production is scheduled to start in 2025.

Several changes have been made in the SCH (chemistry) facility, including the installation of a 'cement lab' and of glove boxes for experiments in connection with the RECUMO project.

In the LNK (Laboratory for Nuclear Calibrations) facility, modifications are being made for the installation of a new linear accelerator (LINAC – LINear ACcelerator). This is scheduled to be brought into use in March 2025.

The HAF (Hot Animal Facility) (Class II) was brought into use.

The licence application for a new Class IIA facility, the CRF (Centralised Radiochemistry Facility) for the production of lutetium-177 (Lu-177), was approved by the FANC. Construction started at the end of 2023.

1.3.2 Belgoprocess

In connection with optimising the use of storage capacity, the storage of conditioned waste from the Doel and Tihange nuclear power plants in building 151E was justified and approved.

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 context, inspections were carried out on packages containing concentrates and packages containing resins in buildings 150X and 151X.

In 2023, pressure build-up was detected in a number of 220-l drums of radium-containing waste that were being conditioned in building 280X. As a result, accreditation of the conditioning process was suspended. Belgoprocess is conducting an investigation into the cause of this in order to take the necessary actions for the affected drums and to improve the conditioning process.

Following work, a valve in Site 2's fire-fighting water circuit was left in the closed position. As a result, the fire-fighting water circuit was unavailable for a long time on part of the site and in building 280X. This incident did not have any serious consequences.

A defect was found in the cooling system for the storage of Na/NaK packages, as a result of which these packages were no longer being stored in a frozen state. Belgoprocess noted in justification that storage in a thawed state does not entail any additional risks.

1.3.3 National Institute for Radioelements (IRE)

The capacity and frequency of LEU-based production remained stable throughout 2024.

A series of handling operations were carried out on the 'non-standard' HEU boxes to allow their continued evacuation to SCK CEN. However, the continuation of residue evacuation at the initially planned rate has been called into question due to difficulties encountered in the development of the RECUMO project.

Remediation and refurbishment work is ongoing on shielded cells C27 and C28, which were previously used for HEU-based production. Plans are also in place to improve the LEU 2.0 process to be installed in these cells.

No additional delays have been reported so far for the LTO B6 project. Buildings B6E and B6F have been demolished. At the end of December, the regulator lifted a new 'hold point' related to the concreting of the intermediate slab on which the lead (Pb) cover will be placed.

An event report dated 12 November 2024 was received on 7 January 2025 concerning the erroneous release of a drum of Am-241 fire detector casings. A deviation procedure was initiated and corrective actions will need to be defined. At first sight, this appears to be a logistical error, not a measurement error.

1.3.4 JRC-Geel

The Mass Spectrometry facility operated without major issues in 2024. New operators were recruited to replace staff who retired during the year. The nuclear activities of the main building (B010) are being transferred to the Mass Spectrometry building (040). A formal decision is expected from JRC-Geel regarding the future of building 010 (denuclearisation, decommissioning...).

The MONNET facility also operated without major issues throughout the year.

At the GELINA facility, the accelerator has been out of service since September 2023, following the breakage of two windows. Several cleaning and repair activities were carried out in 2024. The conditioning of the accelerator started at end of the year, with a view to resuming operation in the first quarter of 2025.

A significant event was reported on 18 January. Smoke was observed around building 180, which houses the site's heating systems managed by Vito. The smoke was caused by a technical malfunction that led to a hot water leak and the production of large volumes of water vapour. The issue was resolved through a technical intervention. There was no radiological impact for workers, the public or the environment.

With regard to the organisation of JRC-Geel, a Qualified Expert trainee left the Health Physics Service. A vacancy has been published and the recruitment process is currently underway.

Belgoprocess

National Institute for Radioelements

JRC-Geel

1.3.5 Other (class IIA) facilities

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

- The dismantling at Vrije Universiteit Brussel (VUB) is proceeding on schedule and without any particular difficulties. A licence application for the conditional release of waste containing bismuth-207 (Bi-207) is being processed by the FANC.

- The head of the Health Physics Department will leave Erasme at the end of March 2025. A successor has yet to be appointed. The interim manager is not yet known. The cyclotron is currently in shutdown due to a radio frequency failure.

- VUB's licence for the use of new radioisotopes was issued by Bel V and confirmed by the FANC.

- Work on the construction of the Ikon-30 building is proceeding to plan on the IRE site.

- Dismantling work at the ONDRAF/NIRAS site in Fleurus is continuing without any major difficulties. The transporting of the Strontium (Sr) cell to Belgoprocess went smoothly. A license application for the conditional clearance of activated concrete under Article 18 of RGPRI/ARBIS will soon be submitted to the FANC.

- The first stage of the injector for MINERVA, which was tested at the Catholic University of Louvain (UCLouvain), has been dismantled and transferred to SCK CEN. UCLouvain has submitted a new license application for a new cobalt-60 (Co-60) irradiator.

- The Sterigenics cobalt sources were reloaded in August.

- The cooling circuit of the deflector of the CGR MeV cyclotron at the University of Liège (ULiège) was perforated, causing the cyclotron's vacuum chamber and a section of a transport line to be partly submerged. The affected components must be completely dried out before they can be brought back into use.

- An incident occurred in a cell during the production of fluorine-18 (F-18) using the 18/9 cyclotron at ULiège. An IBA employee ordered an F-18 cyclotron firing for an activity of 7 to 8 Ci. Before the activity transfer, in accordance with the current operating procedure, the synthesis cell interlock was engaged and locked. Approximately 20 to 30 minutes after the transfer and the start of production, the IBA employee reacted to a synthesis problem by asking a ULiège technician to open the synthesis cell in order to perform checks on the automated system. Although the technician was initially reluctant for the cell to be opened, as he considered it dangerous, he was persuaded by the reasoning that was put forward and proceeded to open the synthesis cell, mechanically bypassing the safety features. The IBA employee then worked manually on the synthesis device, exposing herself to a significant dose rate. Following this incident, a FANC decree was issued requiring an action plan and increased monitoring until June 2025. IBA workers' activities at other Belgian facilities will also be subject to specific inspections.

- The dismantling work at Ghent University (UGent) has been completed. The final dismantling report has yet to be submitted.

- Construction of a new building is in progress on the site of the University Hospital of Liège, where a new cyclotron will be installed. During the filling of the cyclotron's self-shielding water casings, inadequate monitoring led to water overflowing onto the cyclotron and the ground. In addition, solutes were present in the water to prevent corrosion of the steel bearings in the self-shielding. As the water evaporated, traces of chemicals damaged the epoxy coating, giving rise to salt deposits and potential chemical corrosion in the accelerator's dead spaces. Furthermore, it was found that once it had been added, the water in the self-shielding casings was outgassing. Chemicals had been dissolved in this water to prevent corrosion. The exact origin of this chemical reaction remains to be confirmed, but it poses a significant challenge for the future commissioning of the cyclotron.

- The FANC has issued a licence to Full Life Technology for a new actinium-225 (Ac-225) production facility. Construction of the building is progressing well and is being monitored by Bel V.

- A licence application has been submitted to the FANC by PANTERA for a new Ac-225 production facility. The application is being processed.

- Telix has submitted a licence application to the FANC for the installation of two new cyclotrons in the existing casemates. The municipality was consulted as part of this procedure and made several important comments.

1.4 Emergency preparedness and response

1.4.1 Introduction

There was no actual activation of the federal nuclear emergency plan in 2024.

The year saw the completion of the updating of the 'Nuclear and Radiological Emergency Plan for the Belgian Territory' conducted by the National Crisis Center (NCCN) together with its partners, including Bel V. This updated version, now entitled 'Nuclear and Radiological Emergency Plan for the Belgian Territory, its Territorial Waters and the Exclusive Economic Zone', was published in the Belgian Official Gazette on 30 July in the form of a royal decree.

The Paragon national security portal was also implemented and rolled out in 2024. This online platform aims to facilitate preparation, coordination and information-sharing between the relevant emergency services, authorities and partners in an emergency situation. The evaluation cell also continued to roll out the JRODOS model as its own means of assessing radiological consequences.

1.4.2 Emergency response exercises

In 2024, Bel V took part in the following emergency response and intervention capacity exercises:

- in May and November for the Doel nuclear power plant and the IRE respectively, in the form of a partial exercise that was confined to the interaction between the licensee's crisis unit (on-site) and the evaluation cell (off-site), organised under the supervision of the NCCN, which is part of the Federal Public Service for the Interior;
- three internal drills of the evaluation cell organised by the FANC and Bel V in September.

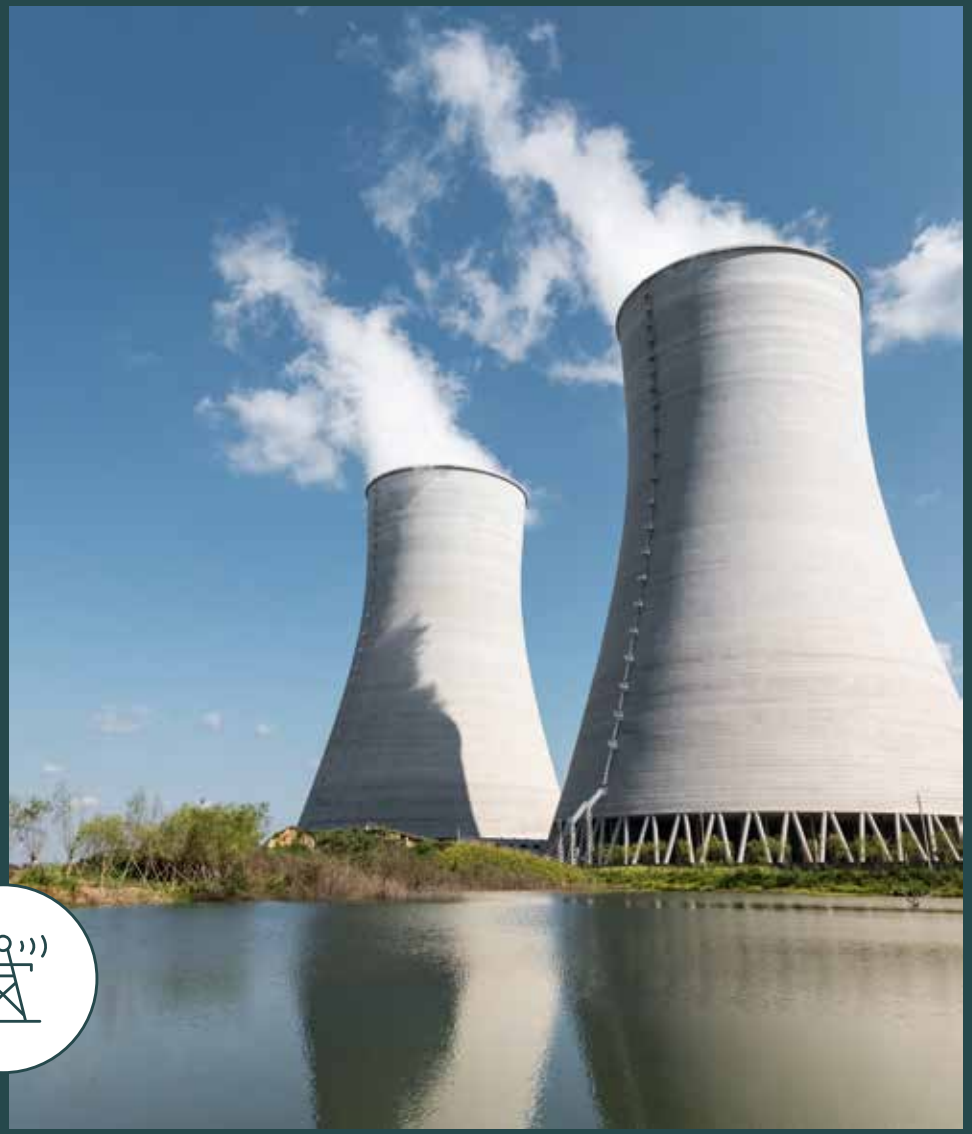
All the exercises organised under NCCN supervision were prepared, conducted and evaluated in accordance with the current Belgian methodology for emergency preparedness and response exercises.

As in previous years, these exercises, which allow the relevant persons at Bel V to regularly put into practice the provisions of the operational plans and procedures, also allowed for a number of findings to be made that will, after analysis, be subject to specific actions. They confirmed the importance of alerting and mobilisation procedures and mechanisms, the need to avoid exercise biases that could significantly impact the realism of the exercises, and the importance of continuing action to continue the hybrid (in-person and remote) operation of the evaluation cell.

1.4.3 Improving the role of Bel V

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

- Bel V staff took part in the Belgian emergency preparedness and response exercises. Besides the response activities, these involved extensive response preparation, observation and evaluation activities by the Bel V crisis team, the licensee and the other parties involved (NCCN evaluation cell).
- Smaller communication and preparedness exercises and tests were organised throughout the year – a total of 28 tests.
- As part of their provision of support to the Dutch safety authority (ANVS), IRSN and Bel V continued working on the protection strategy support project through discussions and the development of basic scenarios for the Borssele nuclear power plant.



2. Safety assessments and national projects

2.1 Probabilistic Safety Assessment (PSA)

In 2024, Bel V continued its technical discussions with the licensee regarding the Probabilistic Safety Assessments developed by ENGIE Electrabel and ENGIE Tractebel Engineering as part of the WENRA RL2014 project (see Section 2.9). These efforts aim to ensure compliance 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. The discussions specifically address PSAs related to spent fuel pools and cover both internal events and hazards, as well as external hazards such as seismic events and external flooding. Bel V closely monitored the implementation of on-site improvements included in the action plan, as well as PSA applications and procedures developed on site.

Due to the decision to restart the preparation for long-term operation of Doel 4 and Tihange 3, the development of Seismic PSAs (including seismically induced fire and flooding) for these two reactors was 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 and only quick wins identified during walk-downs had been implemented by the end of 2022.

Also in 2024, Bel V finalised the evaluation of the PSA developed for the post-operational phase of Doel 3 and Tihange 2, as defined in the action plan established within the framework of the Periodic Safety Review, more specifically the review of Safety Factor 6 (see Section 2.2). In addition, Bel V and ENGIE Electrabel discussed the reorientation of PSA policies (regarding further development, maintenance and application) in light of the LTO context.

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

2.2 Periodic Safety Reviews (PSR)

2.2.1 Nuclear power plants

Performing Periodic Safety Reviews (PSR) is a regulatory requirement as per Article 14 of the Royal Decree of 30 November 2011. 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.

In 2024, Bel V continued monitoring the implementation of the action plans defined as part of the PSRs for Tihange 2 (reviewed together with the TEF, TEL and TDS installations), the PSR for Doel 3 and the PSR for the Doel auxiliary installations (WAB, SCG and GSG installations).

These action plans contain specific improvements (relating to hardware, processes or procedures) being implemented under three different frameworks: continuous improvement, definitive shutdown, or as part of the PSR itself.

Throughout the year, discussions took place between Bel V and ENGIE Electrabel to finalise the proposed scope and methodology documents for the PSR for Doel 1 and 2 and Tihange 1 (all scheduled for permanent shut-down in 2025), as well as the PSR for Doel 4 and Tihange 3 (for which a 10-year life extension is planned). The latter PSR also includes the DE building. As a consequence of the LTO plans, the PSRs for the TEF, TEL and TDS installations (originally carried out in the context of the PSR for Tihange 2) and for the WAB, SCG and GSG installations (originally addressed in a dedicated PSR) will have to be reassessed for a series of aspects yet to be defined by ENGIE Electrabel.

Bel V also reviewed the various deliverables received in the context of the PSR for Doel 4 and Tihange 3 in preparation for the final assessment of the PSR exercise, which is to be completed in 2025.

2.2.2 JRC-Geel

The implementation phase is ongoing but remains behind the initial schedule set by JRC-Geel. Regular progress meetings are held to monitor developments. To enhance coordination among all stakeholders involved in the PSR 2022 and to ensure adherence to the approved action plan deadlines, a dedicated support group has also been established by the JRC-Geel site manager. Bel V continues to urge JRC-Geel to assign the necessary priority to this project. In parallel, Bel V is organising technical meetings with the licensee to expedite the ongoing Q&A process for certain actions.

2.2.3 SCK CEN

On 29 November 2023, SCK CEN submitted the methodology document for the 2026 periodic safety review to the FANC and Bel V. After analysis, Bel V concluded that the document is of good quality and generally meets expectations, provided that some important comments are taken into account. As Bel V had not yet received a response to these important comments, a meeting was held with SCK CEN in the fourth quarter of 2024. The internal evaluation at SCK CEN has now started and the current situation was discussed during this meeting. The first deliverables and responses to Bel V's comments are expected in early 2025.

2.2.4 Belgoprocess

For Site 1, the deadline for implementing the action plan expired at the end of the second quarter of 2023. While Belgoprocess has delivered all actions, a Q&A is still ongoing for several actions.

For the periodic safety review for Site 2 in 2016, the deadline for implementing the action plan expired at the end of the second quarter of 2021. Again, Belgoprocess has delivered all actions, but a Q&A is still ongoing for one action. Bel V analysed the implementation report and submitted comments to Belgoprocess in a letter from the FANC.

For the periodic safety review at Site 2 in 2026, Bel V evaluated the adapted methodology document, which took into account the comments formulated by Bel V in the evaluation report of the first quarter of 2024. These comments were discussed with Belgoprocess.

Number of safety assessments treated in 2024

more than 550

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

In 2024, ENGIE Electrabel's PSR LTO D4T3 project continued with the publication of numerous studies and extensive exchanges with Bel V. This project aims to support the extension of the lifetime of the Doel 4 and Tihange 3 nuclear power plants by 10 years.

The project is structured into several subprogrammes, with the main developments summarised below:

- 'Pre-conditions': The licensee completed self-assessments for all relevant IAEA plant programmes and Q&A exchanges were held with Bel V and the FANC. Discussions also took place on the action plans for specific programmes such as ASME OM and OPTIMOV. In addition, the approach for resolving Justifications for Continued Operation (JCO) and Non-Conformance Reports (NCR) was agreed upon between ENGIE Electrabel and the FANC / Bel V.

- 'Ageing': With a few exceptions, ENGIE Electrabel submitted the majority of the documentation related to ageing (more than 1,000 documents), which Bel V reviewed using a graded approach. The process included Q&A exchanges and a series of specific and technical meetings to improve the interactions and exchanges. Bel V's review and assessment work in this area will continue into 2025.

- 'Design': This subprogramme mainly focused on in-depth assessments of the feasibility and safety studies related to the design improvements from the Proposed Design Upgrades. Bel V reviewed documents and participated in several technical meetings throughout the year.

- 'Tests & Inspections' (T&I): ENGIE Electrabel presented its final methodology to select candidate tests and inspections (the so-called 'Fit, Gap, Risk and Feasibility' method) in the final Tests & Inspections programme. Bel V challenged the proposed choices and raised a number of Q&A, primarily questioning the relevance of the selected tests. Eventually, the FANC and Bel V requested the inclusion of three additional topics: a one-time containment leakage test at accident pressure, endurance testing of low-pressure safety injection pumps and a supplementary inspection plan for ASME III Class I welds in the reactor coolant system.

- 'Knowledge, Competence & Behaviour': Discussions took place regarding the human resources and competencies needed to support long-term operation. ENGIE Electrabel submitted several deliverables, which were discussed in dedicated meetings.

- 'Periodic Safety Review': In 2024, Bel V evaluated several studies related to the various Safety Factors.

Based on the results of the studies carried out in the context of these subprogrammes, improvement actions are defined and incorporated into ENGIE Electrabel's Global Action List (GAL). These actions range from updates to maintenance and inspection procedures to major projects and design modifications. Implementation is scheduled between 2025 and 2028.

At the end of 2024, Bel V received the Global Action List for Doel 4 and Tihange 3, along with the PSR LTO reports. These included the PSR summary reports, the final T&I programmes, a forecast list of systems, structures and components to be replaced during the LTO period, a list of non-conformities and more. Bel V began its evaluation of the reports and the Global Action List at the end of 2024.

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. In 2024, efforts focused on implementing the post-operational phase for Doel 3 (shut down in September 2022) and Tihange 2 (shut down in January 2023), pending the submission of dismantling licence applications scheduled for 2025, and on preparing for the permanent shutdowns of Doel 1 and 2 and Tihange 1, also scheduled for 2025.

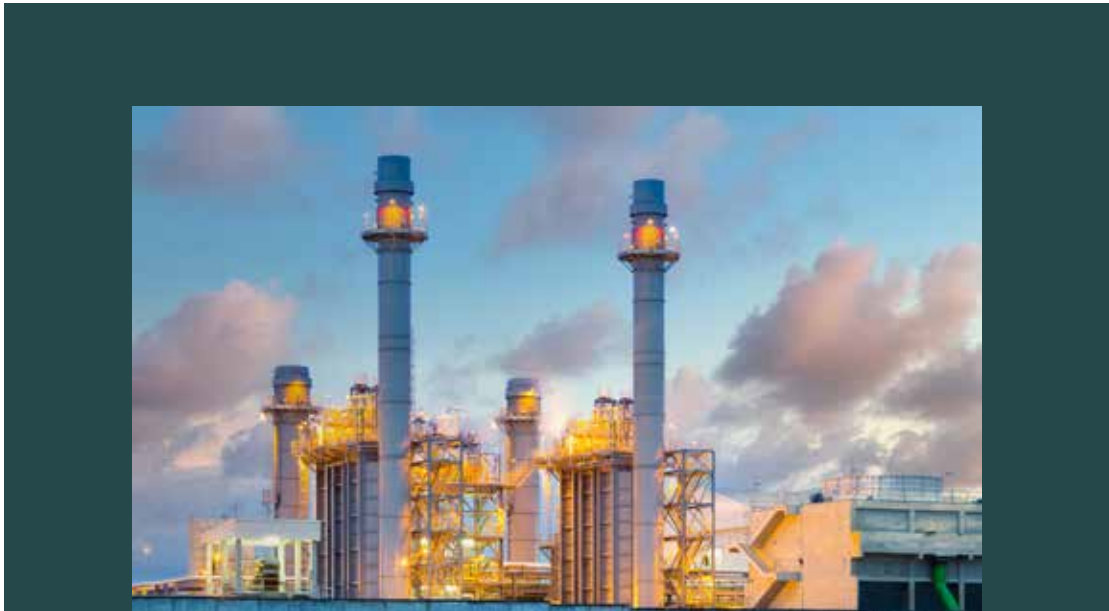
2024 also saw the start of preparations for the permanent shutdown of Doel 1 and 2, with the definition of the design bases for their nuclear island in the post-operational phase and the analysis of the systems required to ensure residual functions. The main focus for Tihange 1 was analysing the (limited) proposal for a nuclear island in the post-operational phase.

At the same time, several activities in preparation for the dismantling of Doel 3 and Tihange 2 were planned, and in some cases carried out. Evacuation of the turbine area was the main activity in 2024. The other main activity carried out after permanent shutdown is the chemical decontamination of the primary system, the purpose of which is to reduce radiological risks in the final phases of the reactor's life. In 2024, Bel V closely monitored the performance of this activity at Tihange 2 and preparations for it at Doel 1 and 2 (having already done so for Doel 3 in 2023).

At both Doel 3 and Tihange 2, there was intensive discussion with a view to preparing for the removal of spent fuel and radioactive substances present in the pools. The repair of damaged rods, the licensing of containers for these substances and spent fuels and the construction of new buildings were subject to numerous analyses by Bel V in 2024, so that the first assemblies can start to be removed in 2025.

Apart from this intensive phase of technical analyses, strategic discussions continued in 2024 with a view to optimising the transition from operating licence to dismantling licence at Doel 3 and Tihange 2. Progress was made on the main points of discussion, paving the way for the submission of dismantling licence applications in 2025.

Finally, numerous 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. The purpose of these discussions is to prepare the inventory, classification and removal of this waste as effectively as possible.



2.5 Radioactive waste management

2.5.1 Radioactive waste management (incl. cAt BB)

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 2024 and provided feedback on required adjustments to ONDRAF/NIRAS. These conformity files are prepared by ONDRAF/NIRAS to demonstrate that waste from a particular (sub-)family or (sub-)variety meets the criteria for near-surface disposal. The preparation of these files follows a stepwise process, with Bel V's approval required before moving on to each subsequent stage.

In 2024, Bel V also contributed to the analysis of the ONDRAF/NIRAS proposal for two new ACRIA documents, describing the acceptance criteria for a specific waste type as defined by ONDRAF/NIRAS. Once the relevant Royal Decree is published, these ACRIAs must be approved by the FANC. In this context, the FANC tasked Bel V with verifying that the ACRIAs comply with the licensing conditions (including specifications in the safety report) of the various facilities where the waste will be managed at later stages of the treatment process.

In 2024 the FANC and Bel V continued their cooperative effort related to the programme for the safe long-term management of high-level and/or long-lived waste (category B and C waste). This involves the review of safety studies submitted by ONDRAF/NIRAS, consultation on safety aspects with the FANC and ONDRAF/NIRAS, and the development of expertise, including through cooperation with other technical safety organisations (see Section 3.3.3).

2.5.2 cAt (construction and licensing – excl. cAt BB)

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.

Following the positive opinion from the Scientific Council, ONDRAF/NIRAS obtained a licence for the establishment and operation of the near-surface disposal facility in Dessel in the second quarter of 2023. In 2024, the revised chapters of the safety report were submitted to and analysed by Bel V. In addition, Bel V carried out four systematic inspections to monitor the modification files and a thematic inspection relating to safety culture, training, the organisation of the Health Physics Department and management of modifications. A thematic inspection in these areas will also be organised in the fourth quarter of 2025. The aim is to enable Bel V to assess (provisionally) whether ONDRAF/NIRAS is organisationally ready for the start of construction work in early 2026 as planned.

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 for the project, which was initiated in 2011 in order to analyse the facility's eligibility for licensing, continued in 2024.

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 licence application date was set at December 2028 and the current period prior to the application was extended to the end of 2024, at which time an opinion from the safety authority concerning the status of MYRRHA was expected.

In early 2024, SCK CEN submitted a set of documents that were required so that the safety authority could issue an opinion on the state of progress of the pre-licensing process. Bel V analysed the key documents received, such as the description of the installation design and the safety approach as well as various supporting documents. Several workshops were held in order to clarify the approach taken by SCK CEN. At the end of the year, Bel V submitted its input to the FANC for drafting the opinion on the state of progress of the pre-licensing process.

2.6.2 MINERVA

MINERVA (MYRRHA Isotopes productioN coupling the linEar acceleRator to the Versatile proton target fAcility) is a linear accelerator (LINAC) 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.

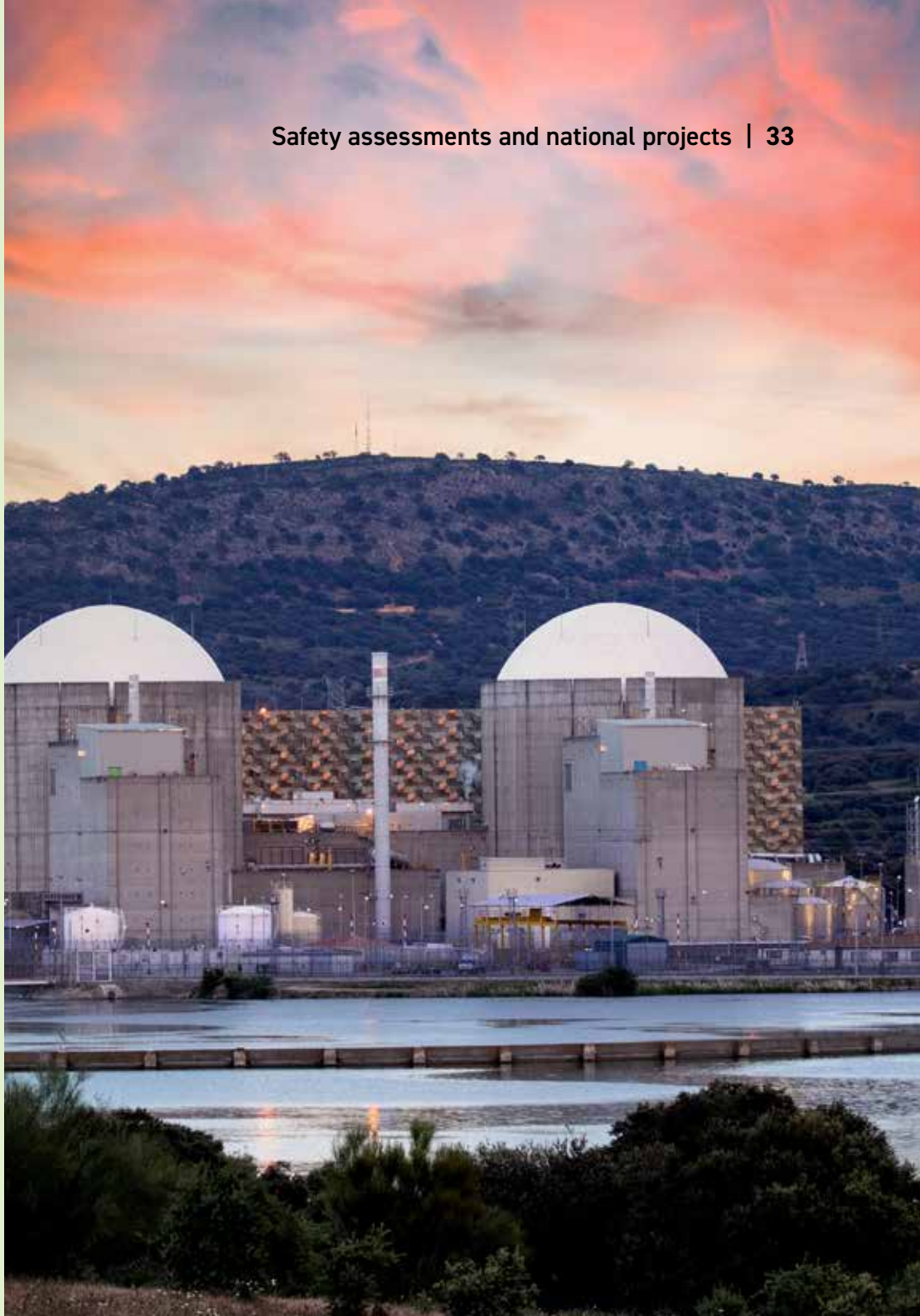
Ground preparation for the construction of the MINERVA facility began in the fourth quarter of 2024. While the commissioning of the facility was initially planned for 2026, delays have already been encountered. The updated schedule for the construction and commissioning of the nuclear part of the facility is yet to be confirmed by SCK CEN.

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 2024, Bel V delivered a commissioning report for the facility on the Tihange site. Loading the first fuel containers is scheduled for 2025.

For the installation on the Doel site, technical meetings continued between FANC / Bel V and the licensee ENGIE Electrabel concerning the satisfaction of the various licence conditions. The construction of the facility is ongoing and is being monitored by Bel V via the defined hold points and witness points. ENGIE Electrabel aims to commission the facility in the fourth quarter of 2025.



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, defined hold points (HPs) and witness points (WPs) that have been included in the construction programme for the RECUMO facility. With regard to the HP and WP for the fine envelope, SCK CEN submitted a document setting out the various tests and experiments that will be carried out and the relevant criteria and expected results. After discussion, the FANC and Bel V did not formulate any additional questions. The FANC and Bel V will decide on their HP and WP for the fine envelope.

A number of defects were found in the concrete walls in 2024. The document setting out the treatment techniques was analysed and approved by Bel V. In addition, Bel V asked all parties involved to take the necessary actions to improve the surface quality of the walls in the future.

In 2024, SCK CEN performed a number of actions relating to the removal and processing of highly radioactive liquids. Consultations with third parties are ongoing and a licence application for a container has been submitted. SCK CEN is currently investigating various options for the use of the end product.

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 2024 and are being monitored by Bel V from a technical point of view.

With a view to concluding the discussions related to the implementation of the WENRA RL2014 requirements, ENGIE Electrabel submitted in 2024 a list of outstanding issues that still require consideration – either in the immediate term under the WENRA RL2014 framework, or in the context of other ongoing projects, in particular the various subprogrammes of the LTO PSR project for Doel 4 and Tihange 3. Within this framework, discussions continued on a number of technical aspects identified during the evaluation process and, for some topics, ENGIE Electrabel provided additional information or clarifications.

Bel V continues to closely monitor these final stages of the project in cooperation with the FANC.

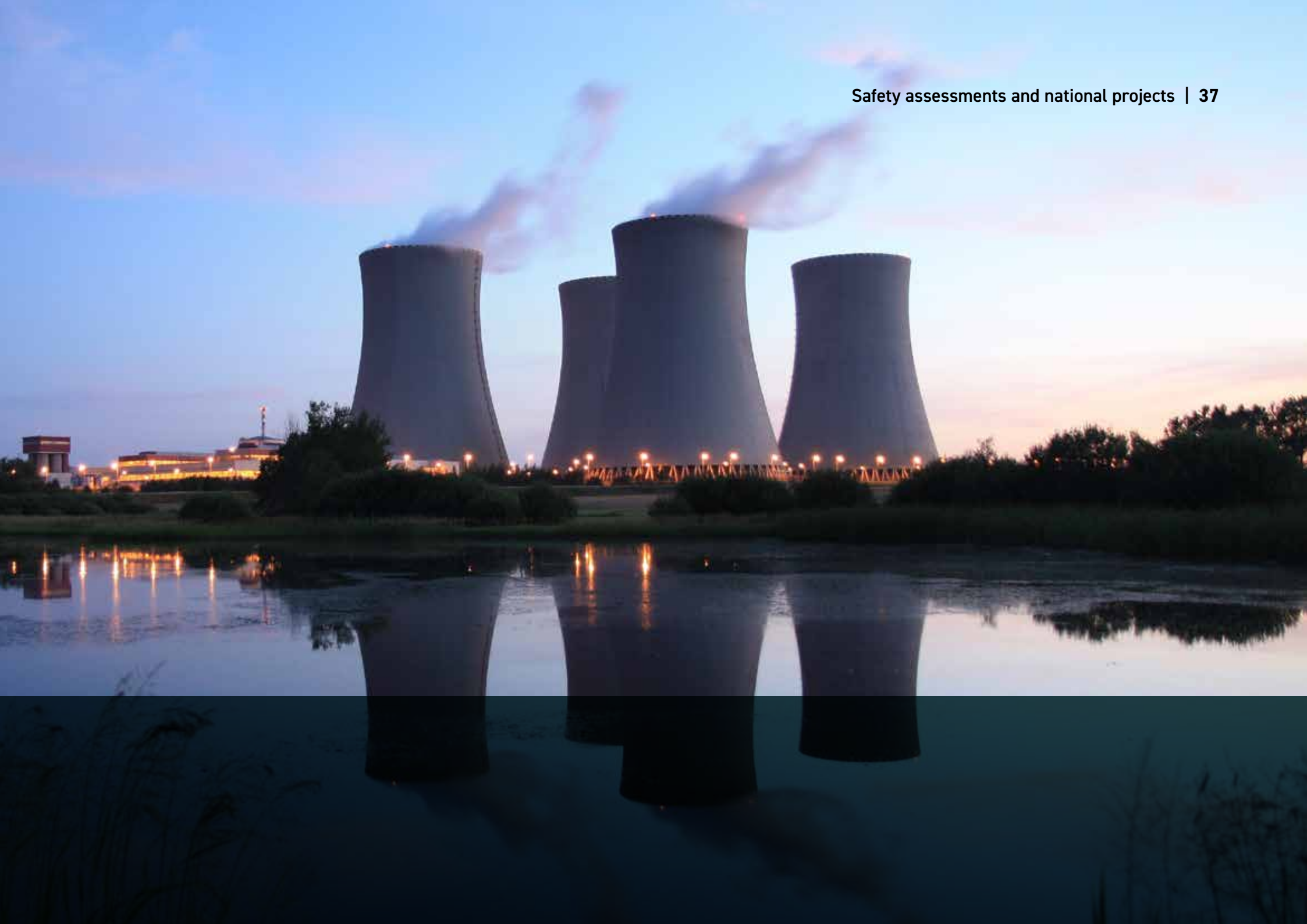
2.10 Belgoprocess construction projects

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, as has most of the installation of the various technical elements (bridge cranes, ventilation, radio monitoring, skids). In this context, Bel V carried out five inspections in 2024. The facility is scheduled for commissioning in 2025.

The IPM construction work had already been completed in 2022, with the necessary semi-industrial commissioning tests (SIBS) also being carried out. In 2024, Bel V did not carry out any inspections in relation to this. However, it did analyse a draft version of the final safety report. Comments were submitted to the licensee on the basis of this. Belgoprocess expects the facility to be commissioned in 2025.

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.



3. International activities and projects

3.1 Cooperation with international organisations

OECD and IAEA activities

Bel V continued its active involvement in the activities of **various committees**, working groups and meetings organised by the **Organisation for Economic Co-operation and Development (OECD)**, including:

- 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 and Safety Culture (WGLSC);
- the CNRA Working Group on the Safety of Advanced Reactors (WGSAR);
- the CSNI Working Group on Fuel Cycle Safety;
- the CSNI Working Group on Fuel Safety;
- 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 Fuel Safety (WGFS);
- the CSNI Working Group on Electrical Power Systems (WGELEC);
- the CSNI Working Group on External Events (WGEV);
- and activities of the Incident Reporting System Coordinators (IRS, IRSRR, FINAS).

Further details on Bel V's involvement in specific OECD projects can be found in Section 4.4 on research and development.

Bel V also continued to contribute to various standing committees and specific events coordinated by the **International Atomic Energy Agency (IAEA).**

Standing committees

- Bel V's Director General, elected in 2020 as Chair of the IAEA's **Technical and Scientific Support Organization Forum (TSOF**), participated in the activities of the TSOF Steering Committee. In December 2024, the TSOF organised an international conference on 'Enhancing Nuclear Safety and Security through Technical and Scientific Support Organizations' at the IAEA headquarters in Vienna (Austria). More information about this event is available in Section 3.3.1.

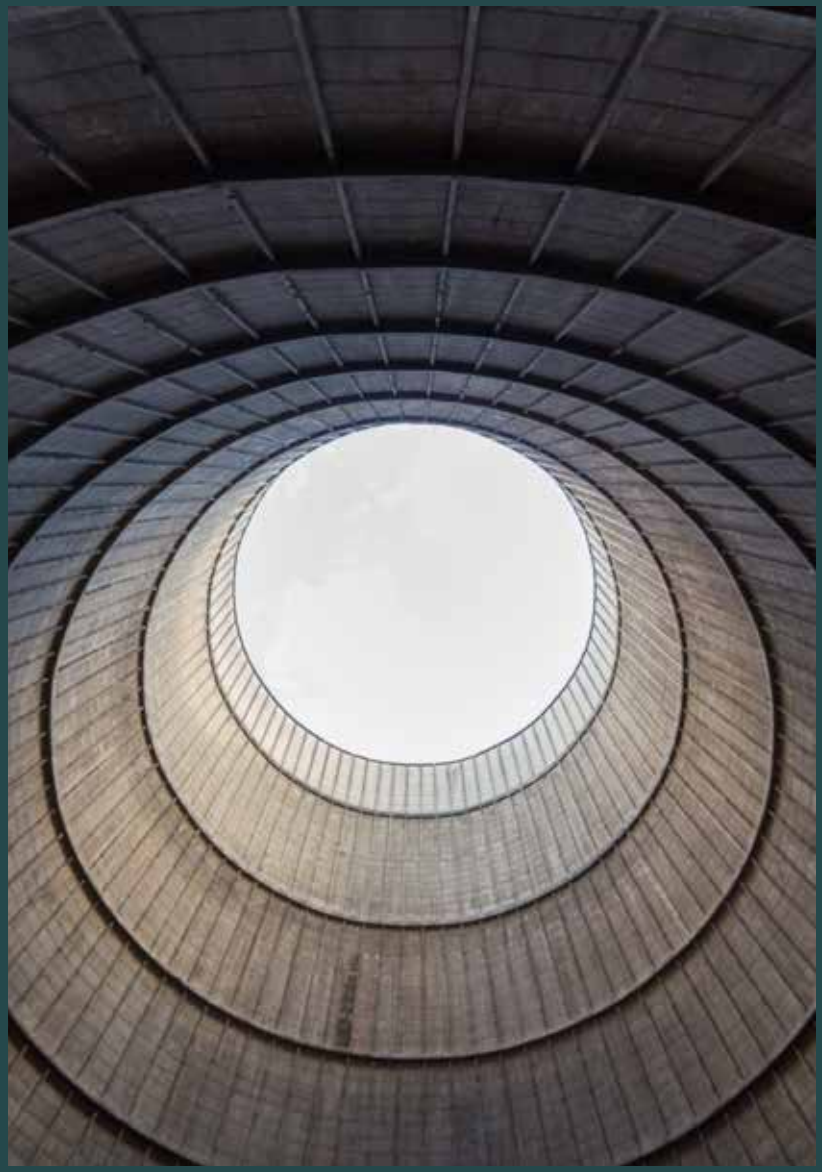
- A Bel V representative continued to contribute as a member of the Steering Committee on Regulatory Capacity Building and Knowledge Management, coordinated by the IAEA.

- Bel V also took part in meetings of the Steering Committee of the Regulatory Cooperation Forum, as well as in support meetings with the European Commission.

Participation in specific IAEA events

Bel V experts attended various **IAEA conferences, workshops, technical committee meetings and webinars**, focusing on topics including:

- safety aspects of small modular reactors;
- core and plant simulation, with an emphasis on fuel behaviour in light water reactor-based small modular reactors;
- mitigation of insider threats;
- waste acceptance criteria across all stages of the waste lifecycle;
- leadership in a changing nuclear landscape;
- equipment qualification for decommissioning nuclear power plants;
- operational radiation protection programmes for nuclear fuel cycle facilities;
- methods for radiological and environmental impact assessment;
- management of spent fuel from nuclear power reactors;
- recent advances in seismic and fault displacement hazard assessment for nuclear installations;
- fundamental aspects of computer security in nuclear security;
- decommissioning of small medical, industrial and research facilities;
- and periodic safety review of research reactors.



3.2 Cooperation with safety authorities

3.2.1 Western European Nuclear Regulators Association (WENRA)

Reactor Harmonization Working Group (RHWG)

In support of the FANC, Bel V participated in the three RHWG meetings held in 2024.

The RHWG launched a **benchmark study on the implementation of the 2020 Safety Reference Levels** (SRLs) within national regulatory frameworks. Working closely with the FANC, Bel V contributed to the Belgian benchmark exercise.

Bel V also took part in discussions on safety objectives and potential future RHWG activities related to new reactors and small modular reactors (through the dedicated Working Group on New Reactors), and on experiences with high-quality industrial grade items.

Working Group on Waste and Decommissioning (WGWD)

The 51st meeting of the WGWD was held in Helsinki (Finland) from 18 to 22 March. Bel V participated in support of the FANC.

Key topics included the current status of benchmarking activities related to processing, storage, disposal and decommissioning, as well as the development of guidelines aimed at harmonising nuclear regulatory systems across WENRA countries, based on the Safety Reference Levels.

In 2024, Bel V also contributed to the pre-benchmarking activities concerning waste processing.

3.2.2 French-Belgian working group on the safety of nuclear installations

This working group is composed of the regulatory authorities of France (ASN and IRSN, merged into ASNR as from 2025) and Belgium (the FANC and Bel V). One or two meetings are held each year, alternating between Paris and Brussels (with the latter meeting chaired by Bel V). The working group meetings address a broad range of topics related to nuclear safety.

An online meeting was held on 18 April, during which the following topics were discussed:

- **Regulatory aspects and projects**

  France
  - Overview of the French nuclear landscape
  - Operational issues in French nuclear installations, including stress corrosion cracking and recurring problems related to water resources during heatwaves
  - Process for the long-term operation of nuclear power plants and fuel cycle facilities Issues concerning counterfeit, fraudulent and suspect items (CFSI)
  - Progress of the ASN-IRSN merger into ASNR

  Belgium
  - Status of the long-term operation of Doel 4 and Tihange 3
  - Definitive shutdown of Doel 3 and Tihange 2, including feedback from the chemical decontamination of Doel 3
  - Update on the MYRRHA project

- **Overview of events in nuclear facilities**

- **Exchanges on emergency preparedness and response arrangements and exercises**

3.2.3 Belgian-Swiss Working Group

This working group brings together the regulatory authorities of Switzerland (ENSI) and Belgium (the FANC and Bel V). One meeting is held each year, alternating between Brugg and Brussels.

In 2024, the meeting took place in Brugg on 22 April, followed by a plant visit to the Mühleberg boiling-water reactor (currently undergoing dismantling) on 23 April. The following topics were discussed:

- **Exchange of information**
  - Current status of nuclear facilities
  - Changes in the regulatory framework
  - Overview of recent events

- **Update on disposal projects in both countries**

- **Discussion on the WENRA Reference Levels**

- **Update on decommissioning projects in both countries**

- **Long-term operation of the Gösgen, Leibstadt and Beznau reactors**

- **Long-term operation Doel 4 and Tihange 3 – status update**

- **Qualification of spare parts, including those from new suppliers and 'off-the-shelf' components**

- **Focus session on regulatory oversight during decommissioning**

3.2.4. Autoriteit Nucleaire Veiligheid en Stralingsbescherming (ANVS – the Netherlands)

This working group comprises the regulatory authorities of the Netherlands (ANVS) and Belgium (the FANC and Bel V). One meeting is held each year, alternating between The Hague and Brussels.

The 2024 meeting was held in The Hague on 14 October. The following topics were discussed:

- **Evaluation of agreements made**
  - Joint inspections
  - Emergency preparedness and response exercises
  - Cross-border information sharing in licensing procedures
  - Communication and information exchange

- **Governance aspects**
  - Review of the 68th session of the General Conference
  - Recent developments: new build, small modular reactors, long-term operation
  - Gender, diversity and inclusion
  - Capacity building and knowledge development
  - Developments within international organisations (WENRA, ENSREG, HERCA)
  - Cooperation between ANVS and the FANC
  - ANVS strategy
  - Organisation of ANVS (in terms of FTEs, resources, training, etc.) for future new activities and developments in the Netherlands (action point 2023-5 from previous bilateral consultations)

3.2.5. Deutsch-Belgische Nuklearkommission (DBNK)

The eight meeting of the German-Belgian Nuclear Commission (Deutsch-Belgische Nuklearkommission – DBNK) was held on 23 May, in accordance with the bilateral agreement concluded on 19 December 2016 between Belgian Minister for Security and the Interior Jambon and German Minister of the Environment Dr Hendricks.

The following topics were discussed:

- **General exchange of information on recent regulatory developments**

  Belgium
  - Overview of organisational changes
  - Overview of updated regulations
  - Update on waste disposal in Belgium

  Germany
  - Overview of organisational changes
  - Overview of updated regulations
  - Working group on emergency communication strategies
  - Update on waste disposal in Germany, including the site selection process

- **Exchange of information on nuclear facilities, including status, operating experience, current safety topics, projects and licensing**

  Belgium
  - Recent events and operating experience
  - Update on projects, licensing etc. (LTO, SF2, etc.)

  North Rhine-Westphalia
  - Overview of organisational changes
  - Status report on the nuclear facilities in the region

  Rhineland-Palatinate
  - Overview of organisational changes
  - Status report on the nuclear facilities in the region

  Germany
  - General operating experience and information notices, including 'Weiterleitungs-nachricht' (WLN 2024/01) regarding 'Non-performed locking and securing of transportation trunnions during CASTOR handling'

3.3 Collaboration with technical safety organisations

3.3.1 TSO Conference 2024 on 'Enhancing Nuclear Safety and Security through Technical and Scientific Support Organizations'

The **International Conference** on 'Enhancing Nuclear Safety and Security through Technical and Scientific Support Organizations' was held at the IAEA headquarters in Vienna (Austria) from 2 to 6 December. The event was organised by the IAEA's TSO Forum (TSOF), chaired by Bel V's Director General. The conference was a clear success, attracting **370 participants** from **87 Member States** and **7 international organisations**. Numerous members of ETSON, including a strong delegation from Bel V, took part in the event.

Contributions by Bel V

As the Belgian TSO, Bel V had the opportunity to **present several topics**:

- Long-term operation of Doel 4 and Tihange 3: Bel V outlined the TSO's role in this challenging project, highlighting the importance of a graded approach to the technical review of ageing issues, especially under tight time constraints.
- Leadership development within TSOs: Bel V presented strategies for developing leadership skills — from evaluation to performance expectations — with a focus on better integrating leadership competencies into performance appraisals and safety culture assessments.
- Capacity building for independent compliance verification: Bel V described its efforts to develop capacity for independently verifying compliance with clearance levels set by the Belgian regulatory framework, thus enhancing Bel V's oversight capability in light of the expected increase in clearance volumes from future decommissioning activities.

Key highlights

- IAEA Director General Rafael Mariano Grossi emphasised the increasing importance of TSOs, as more countries turn to nuclear energy to meet environmental and energy objectives.
- The conference focused on building and strengthening technical and scientific capabilities to support enhanced nuclear safety and security.
- Special attention was given to operational legacy issues and emerging challenges such as small modular reactors (SMRs) and fusion technology.

- SITEX.Network presentation: In collaboration with IRSN (now merged with ASN into ASNR) and PSI, Bel V contributed to a presentation on SITEX.Network, which aims to foster high-quality, sustainable expertise in the field of radioactive waste safety through a dynamic international network.

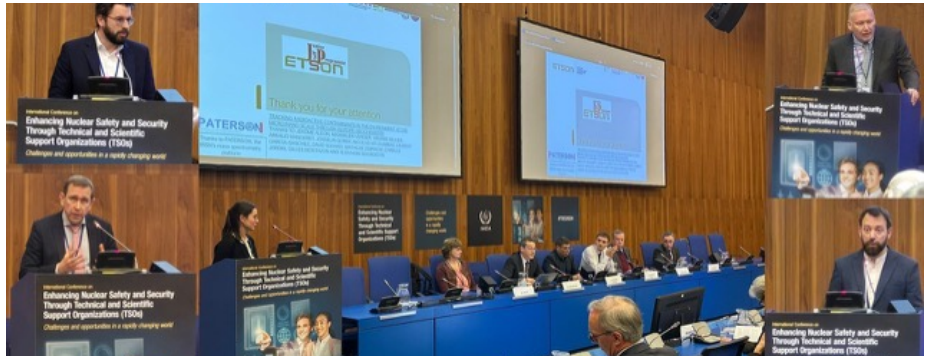
- Full system decontamination at Doel 3 and Tihange 2: Bel V reported on the successful decontamination of the primary circuits at both units, noting a higher-than-expected decontamination factor, an acceptable volume of radioactive waste generated, and an overall level of safety throughout the operations. The experience provided valuable lessons for similar activities planned in the near future.

Special sessions

Several special sessions were held during the conference. One session in particular focused on the **TSO Self-Capability Assessment** (TOSCA) methodology. It explored the main challenges associated with the implementation of TOSCA and featured experience feedback from recent national workshops held in Ghana and Armenia. The session underlined that TOSCA, as a 3D management tool (covering regulatory functions, national priorities and development pathways), is mature and adaptable for use in various contexts and thus in various member states.

ETSON Awards

The conference also included the ETSON Awards, recognising young professionals for outstanding papers in the field of nuclear safety research.



Key conclusions

The main conclusions drawn from the conference were:

1. Research infrastructure is essential to the advancement of nuclear safety.

2. TSOs must play a key role in supporting the safety of innovative technologies, including AI, fusion and SMRs.

3. International collaboration among TSOs is increasingly important.

4. Stronger relationships between TSOs and regulatory authorities are needed.

5. Attracting and retaining younger generations in the field is a critical priority.

6. Knowledge exchange between well-established TSOs and those in embarking countries is vital.

In conclusion, the conference highlighted the essential role of TSOs in ensuring nuclear safety and security, particularly in a rapidly evolving technological and environmental landscape.

3.3.2 European Technical Safety Organisations Network (ETSON)

The European Technical Safety Organisations Network (**ETSON**), founded in 2006 (with **Bel V as one of the founding members**), serves as a **collaborative platform** for its member organisations to:

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

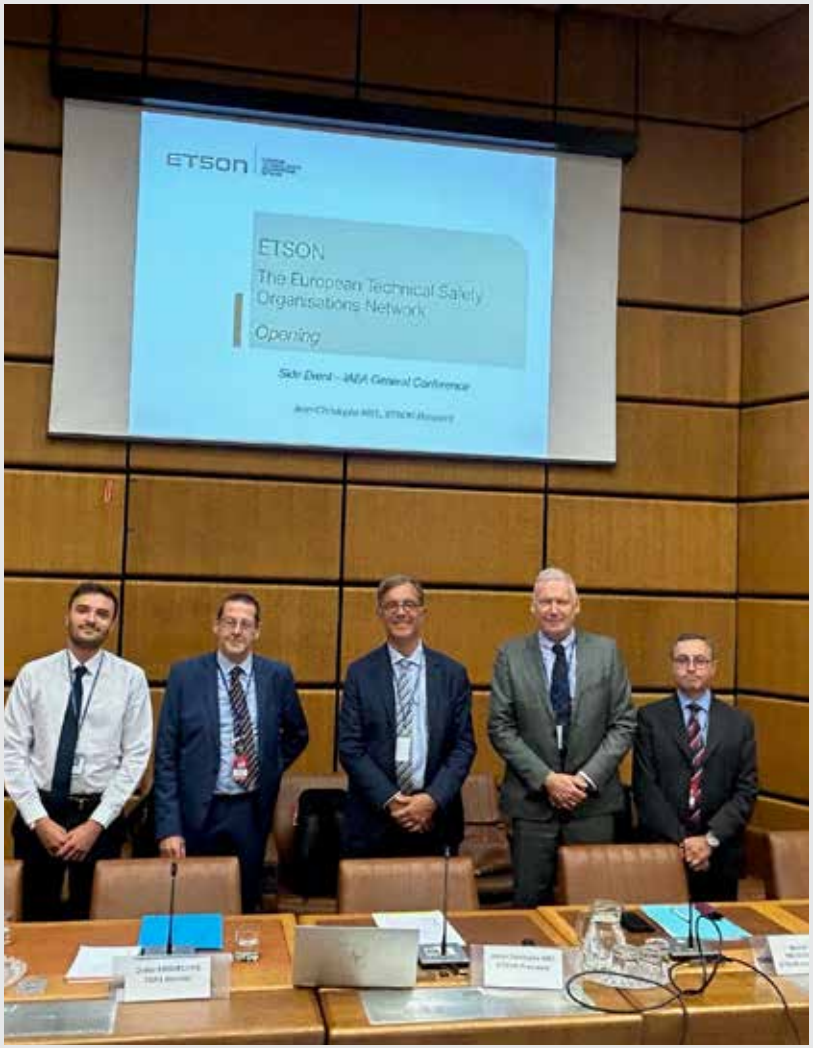
From 2015 to October 2018, Bel V's then Director General served as President of ETSON. Since October 2019, the current Director General of Bel V has held the position of ETSON Vice-President.

Through these activities and interactions with TSO peers, Bel V staff further develop their technical and scientific expertise, thereby consolidating the quality of their safety assessments and positions.

ETSON side event at the 68th IAEA General Conference

As part of its longstanding cooperation with the International Atomic Energy Agency (IAEA), ETSON hosted a side event at the 68th IAEA General Conference (16–20-September in Vienna).

Following opening remarks and an introduction to ETSON, Bel V delivered a presentation on the work of ETSON´s **Technical Board on Reactor Safety (TBRS)**. This Board, through its **15 expert groups**, addresses issues ranging from operating experience feedback and probabilistic safety assessments to severe accidents, emergency preparedness, decommissioning and waste management. The TBRS aims to harmonise sound safety assessment principles and methodologies across Europe and to identify and explore generic safety issues. In addition to the ETSON **Safety Assessment Guide**, offering core recommendations to expertise bodies on reviewing and assessing safety questions raised in nuclear activities, the TBRS groups produce complementary **Technical Safety Assessment Guides** (TSAGs) and **Technical Reports**. Current TBRS activities include the development of a TSAG on hydrogen and other combustible gases, as well as a number of Technical Reports on topics such as implementation of passive systems, lessons learned from PSA, fuel assembly bowing and the challenges and opportunities related to the licensing and safety assessment of light-water SMRs. All TSAGs and Technical Reports are publicly available on the ETSON website.



Leopold Khalfi (JSP), Didier Degueldre (TBRS Member), Jean-Christophe Niel (ETSON President), Michel Van Haesendonck (ETSON Vice-President) and Federico Rocchi (ERG Member) (from left to right). (© ETSON)

The current activities of the **ETSON Research Group (ERG**) were also presented. The ERG focuses on identifying and prioritising safety research needs for Generation II-III+ nuclear power plants, sharing information on relevant R&D projects and launching new initiatives for related research. Recent and ongoing internal ETSON research projects include benchmarking exercises on hydrogen-related events (such as deflagration or flame propagation) and assessments of radiological consequences.

The ETSON **Junior Staff Program (JSP)** continues to be a longstanding and vital part of the network´s activities. It serves as a platform for young experts from ETSON member organisations to build personal networks, exchange knowledge and experience and strengthen their ability to work in an international context through collaboration on practical case studies. The cornerstone of the programme is the annual JSP **Summer Workshop**, an intensive, week-long event where young experts from ETSON members present their work, engage in case studies and take part in site visits to nuclear power plants and other nuclear facilities. Recent workshop themes have included ageing management of human resources and equipment (2024), SMR technologies (2023) and the dispersion of radioactive materials in the sea and atmosphere (2022). Additionally, the JSP organises the annual **ETSON Award**, a competition for scientific papers authored by young experts – ideally in collaboration with multiple ETSON members – which are presented in a 'science slam' format at events such as the EUROSAFE Forum, the ETSON Conference, or the IAEA TSO Conference.

Michel Van haesendonck, ETSON Vice-President and Chair of the IAEA´s TSO Forum (TSOF), presented the **TSO Self-Capacity Assessment (TOSCA)** methodology. Co-developed by the IAEA and the TSOF, TOSCA is supported by a dedicated web tool that allows organisations to assess their knowledge and expertise and to gain essential insights into their specific national context. In addition, the tool enables to provide, update and exchange knowledge on the various regulatory functions, e.g. through case studies, development steps and national workshops. Through ETSON's leadership in the TSOF Steering Committee, significant milestones have been achieved, such as the establishment of the TOSCA Core Group (dedicated to the implementation and improvement of TOSCA), the delivery of multiple national and regional workshops and the development of future cooperation activities promoting TOSCA and ETSON´s broader vision among TSOF members.

3.3.3 Collaboration with technical safety organisations on waste management

Bel V maintains close collaboration with other technical safety organisations, notably through its involvement in the **SITEX.Network** association, an initiative primarily aimed at strengthening TSO expertise in the field of radioactive waste management. The association is currently chaired by Bel V.

Bel V also plays an active role in the **European Joint Programme on Radioactive Waste Management (EURAD)**, which focuses on R&D, strategic studies and knowledge management. The first implementation phase of EURAD, launched in 2019, was completed in 2024. A second phase (EURAD-2) has been developed, with Bel V contributing actively.

In addition, Bel V is engaged in the **TENOR** partnership, led by IRSN (now merged with ASN into ASNR), which seeks to enhance collaboration among TSOs through experimental research activities conducted at the Tournemire underground laboratory in France.

3.4 International assistance projects

3.4.1 Autoriteit Nucleaire Veiligheid en Stralingsbescherming (ANVS)

Bel V, as the lead entity in a consortium with IRSN (now merged with ASN into ASNR) and Bureau Veritas, supports the Dutch nuclear safety authority ANVS in its role as a technical safety organisation. A contract covering a minimum period of five years was signed, commencing at the start of 2022. The contract consists of three work packages:

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

Under this framework, several assignments have been undertaken across various domains, including radiation protection, training, waste management and civil and mechanical engineering.

3.4.2 Autorité de Sûreté Nucléaire (ASN)

Bel V was selected to support the French nuclear safety authority ASN (now merged with IRSN into ASNR) in analysing **feedback from the construction of Flamanville 3**, with the aim of informing the organisation of the EPR2 project. As part of this initial contract, Bel V prepared a guidance note to support ASN's subsequent discussions with EDF. This note was based on the information available to ASN and the contractor's expertise gained from other relevant projects.

3.4.3 European Commission assistance projects

The **European Instrument for International Nuclear Safety Cooperation (INSC)** aims to promote 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 for nuclear materials in third countries.

This objective is pursued through **cooperation** with key stakeholders – particularly **nuclear regulatory authorities** – in order to **transfer EU expertise.**

The nuclear safety programme is implemented through projects awarded via international calls for tender, using restricted and negotiated procedures managed by the European Commission and based on specific requirements with regard to technical expertise.

For Bel V, participation in these projects represents a valuable opportunity to share and apply its knowledge and operating experience at the international level.

Ukraine

Since September 2023, Bel V has been involved in a 42-month project to **support the Ukrainian regulator (SNRIU)** and its **technical safety organisation (SSTC-NRS)**. The overall objective is to align the Ukrainian regulatory framework more closely with the EU acquis and to strengthen the regulator's capacity to perform its functions effectively, in accordance with international standards and best practices.

Bel V is contributing specifically to the task related to **ageing management** and **fire safety** in Ukrainian nuclear power plants.

Serbia

Since May 2021, Bel V has participated in a 36-month INSC project as part of a consortium led by ENCO. The project beneficiaries are the **Serbian safety authority** SRBATOM and PCNFS, the operator of the Vinča site, which includes radioactive material storage and former nuclear facilities of the Vinča Institute of Nuclear Sciences (VINS).

Bel V supported SRBATOM in **transposing the EU acquis** on **radiation protection and nuclear safety** into Serbian national legislation.

The project was completed in May 2024.

Nigeria

Since September 2023, Bel V has been involved in a 24-month INSC project to support the **Nigerian Nuclear Regulatory Authority (NNRA)**. The overall objective is to enhance the capacity and competencies of the NNRA and to align its safety culture and standards in radiation protection and nuclear safety with those of the European Union.

Bel V is acting as the project leader and is responsible for supporting the NNRA in **human resources management**, with a focus on improving resource development and the safety training plan, in line with European best practices. Bel V is also contributing to a task involving the update of the regulatory framework for research reactors.

Armenia

Since September 2024, Bel V has been involved in a 24-month INSC project to support the **Armenian Nuclear Regulatory Authority (ANRRA)** and its **technical safety organisation (NRSC)**. The project aims to assist in aligning Armenian practices with EU stress test initiatives and with relevant EU and WENRA regulations.

Bel V is contributing to the **transfer of knowledge related to EU harmonisation** and to the regulatory review of safety improvements at Armenian Nuclear Power Plant (ANPP).

3.4.4 Fusion for Energy (F4E)

Within the framework of the ITER project, Fusion for Energy (F4E) acts as an external intervener responsible for supervising and providing evidence that its organisation and supply chain comply with the French Installation Nucléaire de Base (INB) Order. This includes ensuring that the relevant documentation reflects and propagates the requirements of the INB Order.

To fulfil these responsibilities, staff from F4E's Nuclear Safety Unit carry out **nuclear safety inspections**. F4E launched an open tender for the provision of support for implementing these inspections. Under this contract, Bel V performed a nuclear safety inspection in November, focusing on a supplier involved in the design and manufacturing of a mechanical component.

Number of participations in (inter)national workshops & conferences

73

4. Expertise management

Number of reports of national events analysed and documented 51

4.1 Domestic operating experience feedback

Bel V conducts systematic screening of events at all Belgian nuclear facilities and carries out in-depth analyses of selected events, with particular focus on root causes, corrective actions and lessons learned. In 2024, approximately 51 events were recorded in the domestic experience feedback database.

For a number of events, a more detailed event analysis is performed to identify insights potentially applicable across a broader range of nuclear facilities. These analyses led to the publication of two reports in 2024: one IRS report (IRS 9236) on an event involving electromagnetic interference from a mobile phone that triggered a scram at Tihange 3, and one FINAS report (FINAS 310) on an event involving a gas release during the opening of a concrete container containing legacy waste.

Several noteworthy events in 2024 were subject to in-depth analysis by Bel V. This included regulatory inspections and the follow-up of corrective actions. From these events, a number of key lessons were identified, notably for the following topics:

- The importance of robust change management, encompassing modification files, plant modifications and organisational changes;
- The need for effective quality control following work on safety-critical components;
- Ensuring adequate electromagnetic shielding and proper insulation of cables and connectors;
- The rigorous execution of acceptance tests for new components prior to commissioning and the importance of carrying out cross-checks;
- The appropriate requalification of equipment following interventions or maintenance activities;
- The importance of adequate maintenance and testing of relays in electrical boards and of electrical protection systems of machinery;
- The importance of the application of human performance tools and strict adherence to procedures;
- Providing control room operators with a clear, complete and real-time view of plant circuit alignments by maintaining strict control over valve positions in line with validated block (functional) diagrams;
- Thorough verification of the conformity of safety equipment placed in a locked-out condition with the applicable technical specifications.

4.2 Foreign operating experience feedback

Bel In addition to screening domestic events, Bel V also reviews events at foreign nuclear facilities, along with potentially generic issues that may impact safety, require technical resolution by licensees or warrant generic communication to the licensees.

Based on the analysis of selected events, Bel V may issue formal Operating Experience Examination Request Letters (OEERLs), Operating Experience Information Letters (OEILs) or requests for clarification from licensees on the extent to which operating experience has been taken into consideration. It may also conduct specific inspections.

In 2024, the licensee of the Belgian nuclear power plants was invited to provide answers to specific questions after analysis of the following reports:

- IRS 9195 – Reactor trip following undervoltage on safety related bus – *Bel V assessed that the design deficiency as described in the report could also affect Belgian units. Response from the licensee pending.*
- IRS 9227 – Unit 1 Protection and Monitoring System (PMS) Division D Cabinet lost power and Steam Generator (SG) narrow range level decreased to low 2, actuating auto scram and safety injection – *Bel V considered the design update as described in the report as potentially beneficial for the Belgian units. Response from the licensee pending.*
- EU Clearinghouse – NINE MILE POINT 2 – Automated reactor scram on low level due to partial loss of feedwater – *Bel V assessed that the weak valve design as described in the report could also affect Belgian units. Response from the licensee pending.*
- IRS 9235 – The failure of the regulating valve in the condensate system caused automatic reactor shutdown – *Bel V assessed that the valve design issue as described in the report could also affect Belgian units. Response from the licensee pending.*
- IRS 9238 – Reactor trip during operational switching of electrical supplies – *Bel V assessed that the single point vulnerability as described in the report could also affect some of the Belgian units. Response from the licensee pending.*
- IRS 9239 – Inadvertent injection of non-borated water into the reactor coolant system – *Bel V assessed that the incorrect implementation of the procedure as described in the report could also occur in some Belgian units. Response from the licensee pending.*

Bel V also performed further follow-up based on earlier exchanges concerning the following events:

- IRS 8725 – Inadequate Emergency Operating Procedure Guidance for Asymmetric Natural Circulation Cooldown – *The licensee provided a full response detailing the work performed – Bel V analysed the response and received further clarification, which is currently under review.*
- OEF ASN – SCC France – Stress Corrosion Cracking in pipes of the safety injection of the NPP – *A task force was set up within ENGIE Electrabel to assess the issue. Based on the information gathered, no significant risk of SCC has been identified to date. Additional inspections conducted in Belgian nuclear power plants since 2022 did not reveal any SCC. Bel V continues to monitor this issue closely.*
- IRS 9198 – Non-compliance with technical specifications due to incorrect procedural guidance for radiation monitors – *The IAEA Event Review Group requested feedback about possible measures taken with regard to this event. Bel V confirmed that the Belgian approach is aligned with the report, mentioning a specific point of attention at the Belgian level and concluding that the report will serve as a useful reference for future inspections. This case was closed.*

Number of reports of international events analysed and documented **73**

4.3 Knowledge management

Bel V places strong emphasis on knowledge management, particularly in view of the upcoming retirement of several experienced staff members over the coming years. A variety of tools is used to generate, capture, transfer, apply and preserve knowledge across the organisation.

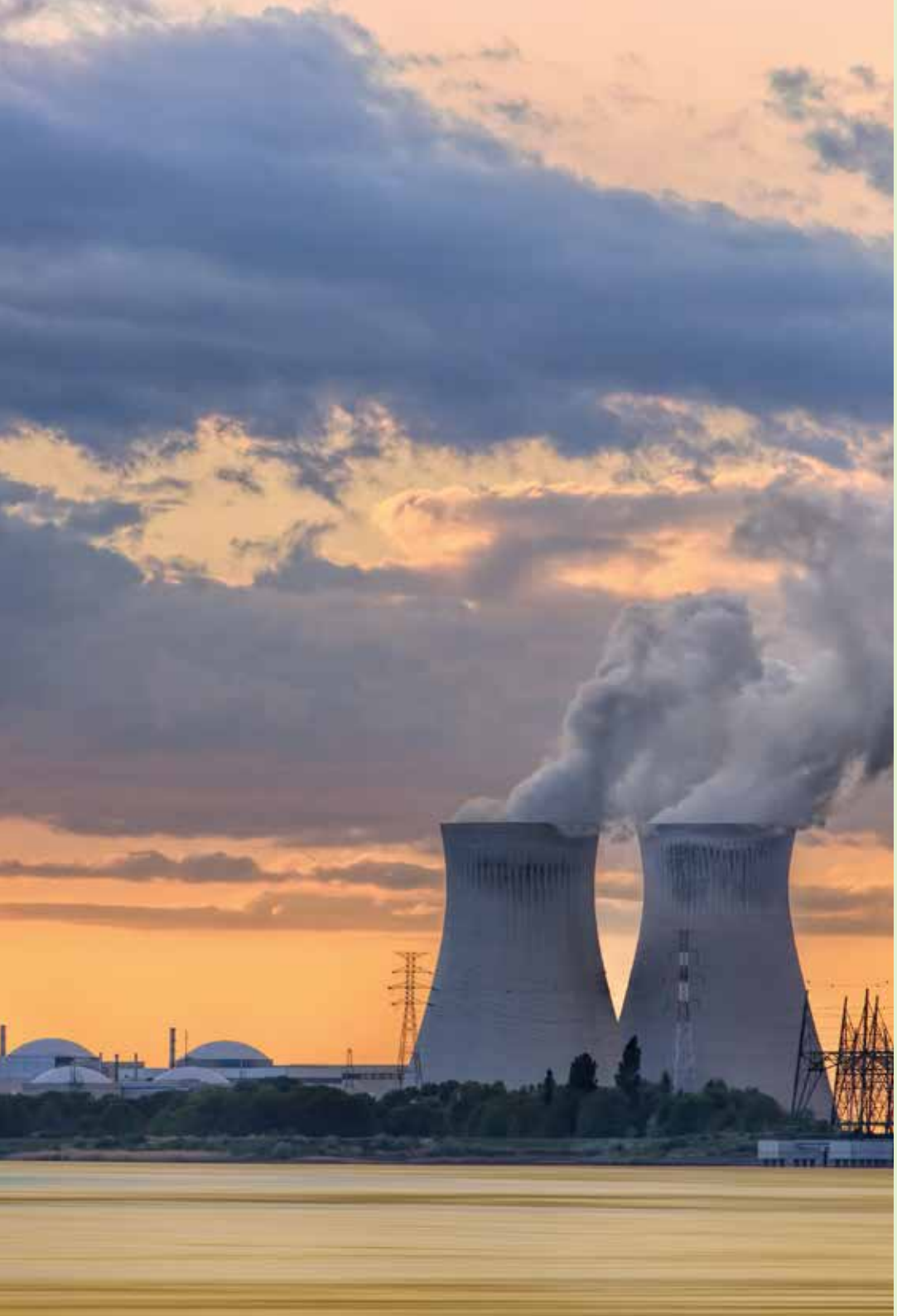
At the core of Bel V's knowledge management approach are the **Technical Responsibility Centres (TRCs)**, which serve as '**centres of competence**' for all key fields of expertise within the organisation. Currently, there are around 20 TRCs. New centres are established as needed to reflect developments in the nuclear field (for example, recent additions cover decommissioning and security). The management and operation of the TRCs are also fully integrated into Bel V's Quality System.

In 2024, Bel V recruited several new engineers, requiring significant effort from more experienced staff to ensure adequate **knowledge transfer**. Each new recruit is assigned a coach to support their integration and this is complemented by (among other things) **on-the-job training** and **cross-functional activities**. The onboarding of a larger number of new staff also necessitates **tailored training programmes** (see Section 4.5).

Special attention is also given to transferring knowledge from retiring experts to younger staff. For this purpose, Bel V uses a **Knowledge Transfer Form** and applies a **Knowledge Critical Grid** to identify and mitigate the risk of losing critical expertise. Other tools (such as **Knowledge Books**) have also been developed to support this process.

Knowledge management is closely **linked to Bel V's R&D activities**, which aim to generate new skills, improve methods and enhance process efficiency (see Section 4.4).

Another key enabler is the ongoing implementation of Bel V's adapted **Electronic Documentation Management software (KOLIBRI)**, based on Hummingbird DM. This tool supports efficient information retrieval, facilitates knowledge sharing and eases the integration of new staff members. To optimise the use of KOLIBRI, a dedicated **DOCumentation USers group (DOCUS)** has been established. This committee is responsible for analysing user needs and driving continuous improvement.



4.4 Research and development

4.4.1 Introduction

Research and development (R&D) activities are essential to the formation of Bel V's independent and informed safety positions. Ongoing efforts are dedicated to maintaining, strengthening and consolidating the expertise of Bel V's technical team in relevant areas of nuclear safety, radiation protection and security. In addition, the R&D activities performed or supported by Bel V are playing an increasingly important role in advancing the business development strategy.

The following sections provide an overview of the main outcomes of R&D activities carried out in 2024.

In total, Bel V dedicated 7,217 hours to R&D in 2024, representing 6.2% of the total working time of its technical staff.

Throughout the year, Bel V delivered a number of presentations across various projects, meetings and conferences. A significant number of project deliverables were produced and several papers were published in international journals.

Bel V also continued to engage in valuable collaborations with various European organisations (through joint project consortiums), as well as with IRSN (now merged with ASN into ASNR), GRS, universities and research institutes.

4.4.2 R&D on nuclear installation safety

Thermal hydraulic phenomena

Most of the thermal-hydraulic R&D activities scheduled in 2024 were successfully completed. These activities primarily involved participation in the following projects:

- OECD/NEA ETHARINUS, aimed at the investigation of DEC-A accident scenarios using the PKL and PACTEL experimental test facilities. The project concluded in 2024, with Bel V contributing to the drafting of the final integration report;
- OECD/NEA ATLAS-3, focused on experiments conducted at the ATLAS and containment CUBE test facilities. This project aimed to carry out additional experiments concerning accident phenomena in DEC-A scenarios involving natural circulation flows and the assessment of the passive system performance. The project also concluded in 2024;
- OECD/NEA POLCA, a new project dedicated to investigating accident phenomena in spent fuel pools. The use of advanced computational tools as CATHARE and CFD codes is planned, both to strengthen the expertise of Bel V's CFD Forum Group and within the framework of bilateral cooperation with UCL in the area of spent fuel storage safety;
- International Standard Problem (ISP) 52 on PKL experiments on multiple steam generator tube rupture. The CATHARE2 and RELAP5 codes were used for the analytical assessments;
- International Standard Problem (ISP) 53 based on COAL experiments. This project involves the analysis of loss-of-coolant accident (LOCA) reflood and aspersion phenomena. A 3D CATHARE model of the COAL test facility was developed.

In 2024, Bel V also produced several international papers, project deliverables and presentations.

Mechanical safety

Bel V actively contributed to the OECD In-Vessel Melt Retention (IVMR) working group, which focuses on the application of finite element methods to the study of IVMR phenomena. Bel V was involved in drafting the project report, which is expected to be published shortly.

Bel V also participated in ORIENT-NM progress meetings to stay informed about the project's forthcoming activities.

Fuel and neutronics aspects

The Halden activities concluded in 2024. Bel V published an invited joint paper (together with SCK CEN and Tractebel Engineering), which was presented at the Enlarged Halden Programme Group (EHPG) 2024 meeting.

Fire protection

Bel V continued its participation in OECD/NEA projects addressing fire safety issues. In this context, Bel V was actively involved in various annual meetings of the Programme Review Group (PRG) and Management Board (MB) under the OECD/NEA framework:

- FAIR project (Fire risk Assessment through Innovative Research): An Analytical Working Group (AWG), Programme Review Group (PRG) and Management Board (MB) were established during the meetings held at IRSN;

- FIRE Database project: Bel V was involved in inputting historical event data in the database.

Probabilistic Safety Assessment (PSA)

Bel V's R&D activities in the area of Probabilistic Safety Assessment (PSA) in 2024 were primarily focused on participation in international meetings and events. These include the IAEA event on PSA for non-reactor facilities and the PSAM 17 conference.

As part of the METIS project, Bel V took part remotely in the technical training session and contributed to the peer review of project deliverables. The aim is to have a better focus on the current challenges related to seismic methodology development (e.g. seismic hazard analysis, fragility analysis and ground motion selection).

Severe accidents

In 2024, Bel V continued to develop and enhance its expertise in severe accident analysis, with a particular focus on simulation capabilities using the MELCOR code. These efforts support Bel V's ability to conduct independent severe accident safety assessment for the Belgian nuclear facilities, and enhance its international visibility and experience.

Bel V also remained involved in the H2020 ASSAS project, funded by the European Commission, which explores the use of artificial intelligence (AI) and machine learning (ML) to support severe accident assessments with codes such as ASTEC.

In addition, Bel V participated in the OECD/NEA joint projects ROSAU and THEMIS, both of which concluded in 2024.

Concrete ageing

For the ODOBA project, the project status report was finalised. This report outlines the main achievements related to the development of measurements using non-linear acoustic techniques, the analysis of accelerated ageing, and ageing of concrete samples for deep geological storage exposed to highly saline water.

Bel V also participated in the 4th ACES End User Group meeting, as well as the annual meeting of the ACES project, the last event being organised by the French partner IRSN.

Percentage of total working time dedicated to R&D in 2024

Q1:	Q2:	Q3:	Q4:
4 %	**5 %**	**3 %**	**5 %**

ETSON Collaboration and Expert Groups

Bel V continued to actively contribute to the European Technical Safety Organisations Network (ETSON), which facilitates the exchange of views and experience among technical safety organisations. Notable activities and contributions in 2024 included:

- Active involvement in a side event at the IAEA General Conference, focused on presenting ETSON's activities and achievements;
- Preparation for and participation in the ETSON Award competition, organised by the ETSON Junior Staff Programme (JSP). This 'science slam'-style competition was held during the TSO Conference in Vienna (Austria);
- Ongoing contributions to ETSON activities, in particular within the Technical Board on Reactor Safety (TBRS) and its Expert Groups, the ETSON Research Group (ERG) (currently chaired by Bel V) and the Junior Staff Programme (JSP);
- Launch of a new Expert Group on Artificial Intelligence and Data Science for nuclear safety, in which Bel V has taken and will continue to take an active role.

MYRRHA

In 2024, Bel V explored the feasibility of using the CATHARE code to simulate transient scenarios in MYRRHA as well as in relevant SCK CEN test facilities, such as E-SCAPE and COMPLOT. As part of this effort, a CATHARE model for the COMPLOT test facility was developed and finalised. This was followed by simulations of the COMPLOT test matrix experiments. The post-processing of the data and the documentation of results are scheduled for completion in 2025.

4.4.3 R&D on waste and decommissioning

Near-surface disposal of category A waste

R&D activities in this area during 2024 focused primarily on the following:

- Bel V participated in the CORI meeting, as well as in the EURAD annual event, which addressed the impact of cellulose on sorption processes in cementitious materials.
- A new activity was launched in 2024 involving the development of a verification tool by a ULB master's student, as part of his thesis project. Bel V prepared a roadmap outlining the objectives and expectations for the project, which aims to deliver a tool for the independent verification of waste emplacement plans.

Geological disposal of category B&C waste

The 2024 programme was originally designed to focus primarily on Bel V's contractual and co-founded EURAD activities, including its role as task leader and contributor to the UMAN project, as well as its participation in the ACED project. Contributions were also planned in the area of strategic development within the framework of EURAD and SITEX.Network.

The following activities were carried out in 2024:

- ACED: Bel V adopted a more passive role towards the end of the project compared to earlier phases. Final results of the BACUCE experiment, in which Bel V collaborated with IRSN, were obtained and discussed among the project partners.
- UMAN: Bel V led the development of a deliverable that compiled the views of the various EURAD stakeholders regarding the identification, characterisation and significance of uncertainties related to spent fuel.

Bel V was also instrumental in EURAD's strategic activities in 2024, serving as Chair of the EURAD Bureau. In parallel, as Chair of SITEX.Network, Bel V played a prominent role in the coordination of the TSO input to EURAD's strategic decisions, as well as in the preparations for EURAD-2.

Additionally, Bel V contributed to the development of a benchmarking activity on modelling tools for radionuclide transport, including both the MELODIE code of IRSN (now merged with ASN into ASNR) and the Bel V code based on OpenFOAM. Finally, Bel V actively contributed to the presentation of SITEX.Network activities at the 2024 IAEA TSO Conference.

Decommissioning and clearance

In 2024, the following activities were carried out:

- LD-SAFE User Group: Bel V was invited to provide its view on the safety assessment of laser cutting technology through responses to questionnaires and participation in the annual meetings.
- AEGIS: The tool was deployed for the first inspection campaign. The operational phase continued, bringing the number of licensees monitored using AEGIS to five: SCK CEN, JRC, IRE, Doel and Belgoprocess. A document was produced on the evaluation of new methodologies for uncertainty management in AEGIS measurements, which – together with the action review report – will guide the follow-up of this project in 2025.
- EU HARPERS project: Bel V was involved in Work Packages 4 and 6. It participated in the project's annual meeting, during which updates and future steps for the work packages were presented and discussed. Bel V also contributed to the drafting of the position paper for Work Package 4.

4.4.4 R&D on cross-cutting issues

Safety culture assessment

Bel V continues to place strong emphasis on the integration of safety culture within its oversight practices, staff conduct and management system. A technology and regulatory monitoring process has been established to support the ongoing development and refinement of these processes. Bel V has also shared its progress and insights through various publications in scientific journals.

Cybersecurity

In 2024, significant progress was made in developing a laboratory for industrial networks based on a hybrid environment. Research efforts focused on the integration of authentication and key generation mechanisms, with backward compatibility testing planned for future internships.

The use of software virtualisation via containers is now being considered as an alternative approach, but this will require refactoring of key elements.

A potential partnership with KU Leuven is under consideration and recent internship proposals in this area have attracted notable interest.

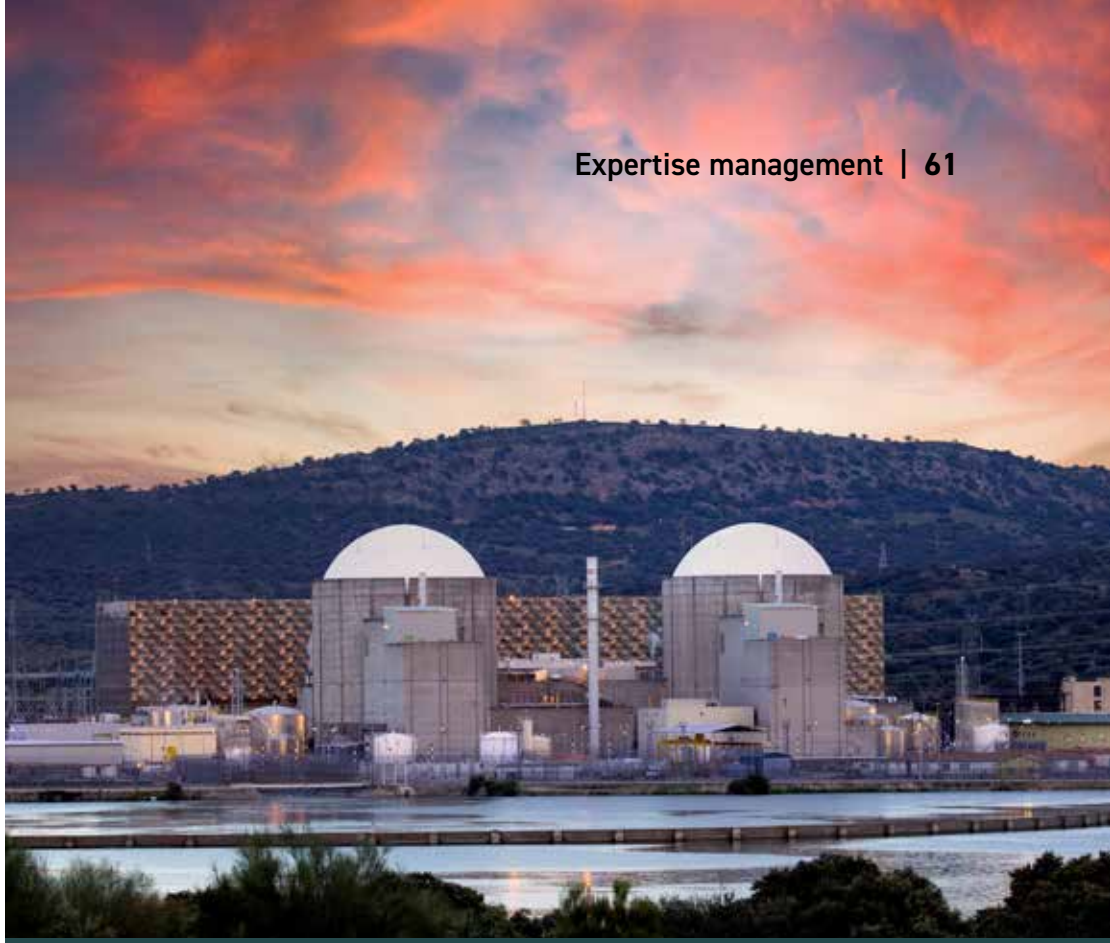
Small modular reactors

In 2024, Bel V continued its analysis of the applicability of Belgian regulations to small modular reactors (SMRs) and shared its findings with the FANC. This led to the publication of a dedicated document. Bel V also participated in several international activities, including the IAEA Interregional Training Course on the safety aspects of SMRs, the 7th Expert Group on SMRs (EGSMR) and other related meetings and working groups.

In addition, Bel V began its involvement in the newly launched EU EASI-SMR project (Ensuring Assessment of Safety Innovations for SMRs), which aims to address key safety challenges linked to light water-cooled SMR (LW-SMR) innovations and to provide technical insights for future European LW-SMR projects. As part of this project, Bel V is contributing to three work packages, covering approaches to licensing of LW-SMRs, waste management, hybrid energy system simulation using RELAP5, passive system simulation using CATHARE, Identification of unique LW-SMR features with a focus on control room supervision, and LW-SMR safety through the lens of the interface between security and cybersecurity. In 2024, Bel V participated in the kick-off meeting and the first meeting of Work Package 5.

Number of R&D deliverables

7	3	14	23
papers	abstracts	reports	presentations



Fusion safety and licensing

As part of the EU HARMONISE Project, which aims to harmonise the licensing framework for future nuclear power technologies in Europe, Bel V conducted a review of the use of risk insights and the application of performance-based requirements in regulatory processes in order to license nuclear installations and oversee their operation, maintenance and equipment configuration changes. In line with the project's work programme, the deliverable for Sub-task 3.1 was completed, which included:

- An analysis of EU experience in integrating risk insights into the regulatory framework for nuclear reactors;
- An analysis of EU experience in using performance-based activities within the regulatory framework for nuclear reactors.

A draft report was finalised and submitted for review by the relevant HARMONISE project participants.

Use and applications of artificial intelligence and machine learning

The year 2024 marked the beginning of AI tool deployment at Bel V, with initial efforts focused on exploring the capabilities of ChatGPT. Other solutions were also assessed, including Gladia, which was tested for the transcription of non-sensitive audio. While Gladia show promise, its implementation would require on-premise infrastructure, such as a dedicated server.

4.4.5 R&D collaboration

In 2024, Bel V continued several R&D collaborations with Belgian universities, research institutes and other organisations within the frameworks of ETSON, OECD/NEA and European Commission projects. Some of these collaborations concluded during the year, including the EURATOM EURAD project and the AECD/NEA projects ROSAU and ETHARINUS.

Collaboration with Belgian universities

Ghent University

Bel V supervised a PhD research project at Ghent University focused on improving the modelling of transient effects of fires in confined and mechanically ventilated enclosures. The research was completed in 2024.

Université catholique de Louvain (UCL)

Bel V continued its collaboration with UCL by proposing research topics for PhD and/or Bachelor students. In 2024, UCL joined the AECD/NEA POLCA project as a third party member under Bel V, with the aim of complementing Bel V's analytical work through the use of advanced Computational Fluid Dynamics (CFD) tools.

Université Libre de Bruxelles (ULB)

Bel V developed a roadmap for a master's thesis by a ULB student, focused on creating a tool for the independent verification of waste emplacement plans. In addition, Bel V and ULB maintained their ongoing collaboration in the area of cybersecurity.

Collaboration with other technical safety organisations, research entities and regulatory bodies

Institut de radioprotection et de sûreté nucléaire (IRSN)

Bel V collaborates with IRSN (merged with ASN into ASNR as from 2025) within the framework of the ODOBA project, which involves conducting experiments on concrete ageing and degradation mechanisms at the facilities in Cadarache (France). The project aims to develop a predictive tool for estimating the durability of reactor containment buildings and waste repository facilities.

Gesellschaft für Anlagen- und Reaktorsicherheit (GRS)

At the 2024 annual Bel V / GRS meeting, Bel V gave a presentation on its R&D activities. Topics included the use of safety codes in areas such as thermal-hydraulics, severe accidents, fuel behaviour and fire protection. Possibilities for getting a license of GRS-developed codes (such as ATHLET and SUSA) were also explored.

European Technical Safety Organisations Network (ETSON)

As in previous years, Bel V actively participated in ETSON's Technical Board on Reactor Safety (TBRS) and its associated Expert Groups (EGs). These activities facilitate the exchange of views and experience among technical safety organisations.

Sustainable Nuclear Energy Technology Platform (SNETP)

Bel V maintained its membership in the Sustainable Nuclear Energy Technology Platform. The platform aims to foster cooperation among its members to support applied R&D within the nuclear community.

SITEX.Network

Bel V remains actively involved in both the activities and management of SITEX.Network (Sustainable network for Independent Technical EXpertise of radioactive waste disposal). The network seeks to enhance international cooperation and promote high-quality expertise in the safety of radioactive waste management.

SCK CEN

Bel V continued its collaboration with SCK CEN in the context of the MYRRHA project. This collaboration focuses on simulating experiments conducted in SCK CEN's test facilities (such as E-SCAPE and COMPLOT), primarily using the CATHARE code.

OECD/NEA working groups

Bel V participated in several OECD/NEA working groups in 2024, including:

- The WGFS/WGAMA working group, tasked with drafting a technical report entitled 'Technical Bases and Guidance for Analyses of Design Extension Condition without Significant Fuel Degradation (DEC-A)'. Bel V contributed specifically to the drafting of Chapter 3;
- The WGAMA working group on In-Vessel Melt Retention (IVMR), where Bel V acts as a task leader;
- The WGRISK working group, focused on risk assessment and PSA for singular reactors;
- The EGSMR Expert Group on small modular reactors.

OECD/NEA joint projects

In 2024, Bel V actively participated in the following OECD/NEA projects:

- Experimental Thermal Hydraulics for Analysis, Research and Innovations in Nuclear Safety (ETHARINUS);
- Advanced Thermal-hydraulic Test Loop for Accident (ATLAS-3);
- Pool during Loss of Cooling Accident (POLCA);
- International Standard Problem (ISP) 52, related to the simulation of a DEC-A scenario in the PKL test facility involving multiple steam generator tube ruptures in all steam generators of the facility;
- International Standard Problem (ISP) 53, related to the simulation of IRSN reflooding experiments;
- The Halden Reactor project, an NEA joint project;
- FAIR, related to cable fire propagation in multi-source and multi-room scenarios;
- Fire Incidents Records Exchange (FIRE);
- ROSAU, aimed at experiments and analysis to reduce uncertainties in severe accident scenarios;
- Experiments on Mitigation measures and source term issues to support analysis and further Improvement of Severe accident management measures (THEMIS).

European Commission projects

In 2024, Bel V actively participated in the following European Commission Horizon 2020 (EC/H2020) projects:

- EURAD and EURAD-2:
  - Uncertainty Management Multi-Actor Network (UMAN) – Bel V acts as project lead;
  - 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);
- Ensuring Assessment of Safety Innovations for Small Modular Reactors (EASI-SMR).

Bel V also continued to contribute to the Advisory Board, End User Group or 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);
- Safety Analysis of SMRs with PAssive Mitigation strategies – Severe Accident (SASPAM-SA);
- LD-SAFE, focused on decommissioning and dismantling using laser cutting technologies;
- AMHYCO, addressing hydrogen combustion, safety and recombination from the micro-scale level to the plant containment level;
- Towards Improved Assessment of Safety Performance for Long-Term Operation of Nuclear Civil Engineering Structures (ACES).

4.5 Training

Bel V has adopted a structured training approach based on the Systematic Approach to Training (SAT) developed by the International Atomic Energy Agency (IAEA). Training programmes are designed for all staff members – particularly new recruits – based on job descriptions and the competencies required for their roles. To support this approach, Bel V has implemented the IAEA SARCoN model to assess the competence levels of new staff members. This enables more accurate competency needs analysis and allows training programmes to be tailored accordingly. In this area, Bel V plays a leading role, regularly supporting other regulatory bodies through IAEA-coordinated initiatives.

Training is delivered using a variety of methods (self-study, internal training sessions, external courses and on-the-job training) depending on the availability of training materials and the adequacy of external courses.

A key element of initial training of new staff is the internal training programme delivered by the Technical Training Manager, supported by experienced subject matter experts, primarily from Bel V. This programme consists of 35 training modules: 7 sessions took place in 2021, 7 in 2022, 10 in 2023 and 10 in 2024.

Percentage of total working time dedicated to training of staff in 2024

Q1:	Q2:	Q3:	Q4:
7 %	**7 %**	**5 %**	**6 %**

Modules delivered in 2024 included:

- Q2-INST-1 – Class I Installations (nuclear power plants) and Q2-INST-2 – Class I Installations other than nuclear power plants;
- Q1-REG-4 – Quality management system;
- Q2-INST-1 – Class I installations (EPR design);
- Q2-NS-10 – Operational safety;
- Q2-NS-3 – Probabilistic safety analysis;
- Q2-NS-3 – Probabilistic safety analysis case studies;
- Q1-REG-1 – Belgian legal and regulatory framework (overview of new regulations);
- Q1-REG-4 – FANC review and assessment processes;
- Q2-NS-8 – Emergency planning and response (EPR);
- Q2-RP-1 – Basics of radiation protection (Art. 25 of the RGPRI-ARBIS).

In addition, Bel V organises so-called Internal Technical Sessions aimed at sharing R&D results with the Technical Responsibility Centres. In 2024, four such sessions were held.

Non-technical training (such as language courses, IT skills, soft skills and leadership development) is offered on an as-needed basis.

Bel V staff also participated in a wide range of specialised and refresher training activities, as well as in working groups, seminars and international conferences.

In total, approximatively 50 training activities took place in 2024. On average, each member of the technical staff dedicated around 98 hours to training during the year.

5. Financial report

Balance sheet as at 31 December 2024

(amounts in € 1,000)

	2024		2023	
ASSETS		**19,821**		**18,508**
FIXED ASSETS		**3,848**		**3,985**
II. Intangible fixed assets		12		13
III. Tangible fixed assets		3,836		3,970
A. Land and buildings	3,332		3,495	
B. Plant, machinery and equipment	373		352	
C. Furniture and vehicles	130		80	
F. Assets under construction and advances	0		43	
IV. Financial fixed assets		0.5		2
CURRENT ASSETS		**15,973**		**14,523**
VII. Amounts receivable within one year		3,387		4,050
A. Trade receivables	3,333		3,994	
B. Other amounts receivable	55		56	
IX. Cash at bank and in hand		12,386		10,282
X. Deferred charges and accrued income		199		191

	2024		2023	
LIABILITIES		**19,821**		**18,508**
EQUITY		**16,962**		**15,596**
I. Capital	4,732		4,732	
IV. Reserves	2,868		2,868	
V. Result carried forward	9,362		7,996	
DEBTS		**2,858**		**2,912**
VII. Amounts payable after more than one year				
IX. Amounts payable within one year		2,858		2,912
A. Current portion of amounts payable within one year				
B. Trade debts	372		366	
D. Advances received on contracts in progress	244		283	
E. Taxes	2,240		2,263	
F. Other amounts payable				
X. Deferred charges and accrued income		1		0

Profit and loss account as at 31 December 2024

(amounts in € 1,000)

	2024	2023
Turnover	16,016	15,866
Other operating income	409	280
Total operating income	**16,425**	**16,146**
Services and other goods	2,396	2,135
Wages and social security costs	12,337	11,848
Depreciation	294	289
Write-downs on trade receivables		
Other operating charges	161	145
Total operating charges	**15,189**	**14,417**
Operating result	**1,237**	**1,729**
Financial charges and income	188	148
Profit on ordinary activities	**1,424**	**1,877**
Income taxes	**-58**	**-50**
Profit for the financial year	**1,367**	**1,827**

Profit and loss account: notes

Operating income

Income in 2024 was 1.73% higher than in 2023. This increase is mainly the result of an increase in international 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. Among other things, 2024 was marked by the customary inspections in the context of the facility operations, (preparations for) the shutdown of five nuclear power plants and in particular the lifetime extension of two nuclear power plants, and the activities for the MINERVA/MYRRHA project.

As in 2023, we recorded an increase in non-regulatory activities in 2024. 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 approximately 16% 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. The transport and travel costs reflect the higher level of activity compared to 2023.

Wages and social security costs

Staff expenses represented 81% of the costs, including training expenses. Proportionally, this represents a status quo compared to 2023. The absolute value of staff costs in 2024 was slightly higher than in the previous financial year.

Operating result

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