

ANNUAL REPORT

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Message from the Chairman

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

To carry out its mission of monitoring and analysing the safety of nuclear facilities, Bel V needs to be able to draw on a multidisciplinary team of experts who have a high level of knowledge and skills, all this in a future and changing nuclear landscape. Given that experts with years of experience are gradually retiring, particular attention will be devoted to knowledge transfer for several new employees Bel V was able to recruit in 2022. A high-quality knowledge management system, a multi-year research and development programme and an annual initial and continuous training programme are key elements in this regard. To promote access to information and to the organisation's 'memory', an electronic document management system is used and has been expanded over the past few years.

For several years now, Bel V has been strengthening its capacity for evaluating licensees' safety culture and, in particular, the human and organisational aspects. This expertise has already proven its effectiveness in monitoring problems at Tihange, where the FANC has been implementing 'enhanced surveillance' since 18 October 2022. Enhanced surveillance was adopted in response to several events that occurred in 2021 and 2022, when it appeared that the procedures in place had not been fully complied with.

In 2022, special attention was paid to the issue of radioactive waste management by the various licensees. In collaboration with the FANC, Bel V has been involved in analysing the operating licence application for the future disposal site for low and intermediate level short-lived radioactive waste in Dessel. Within the framework of the long-term safety evaluations, Bel V continued its activities (using its own modelling capacity) of independent safety verification.

After the decision taken by the government in March 2022 to extend two of the seven reactors, Doel 4 (in Flanders) and Tihange 3 (in Wallonia) until 2035 (Belgium is the first European country to go back on its decision to stop nuclear power plants), the analysis of Bel V's future activities continued. As a result, the management of Bel V is continuing to roll out its strategic plan. Since the beginning of 2022, Bel V, in cooperation with international partners, is also the technical support organisation of the Dutch (ANVS) and Norwegian (DSA) nuclear safety authorities. In the United Kingdom, Bel V will also take on the role of support to the Office for Nuclear Regulation (ONR). These successes also attest to the international recognition of the quality of Bel V's technical expertise.

I would like to express - in the name of the Board of Directors - my appreciation for and gratitude to the management team and the entire workforce for the results they have achieved and for the professionalism with which they carry out their functions in these challenging circumstances.

Didier Malherbe Chairman of the Board of Directors

Preface



Editorial

Dear reader,

Again in this year's annual report, we write our preface 'in times of crisis'. In 2021, it was still the COVID-19 pandemic that laid low social and commercial life. The year 2022, in turn, kicked off with a conflict in Ukraine and was subsequently marked in economic terms by unprecedented inflation and an enormous increase in energy costs.

On 18 March 2022, the government decided to extend the life of the two newest nuclear power plants (Doel 4 and Tihange 3) by ten years. The impact of this decision (and of the end of operations at the five other nuclear power plants) on the future workload of Bel V and the associated needs in technical skills had to be thoroughly analysed. In September 2022, Bel V, in consultation with the FANC, once again launched internal preliminary studies of the long-term operation of the Doel 4 and Tihange 3 plants.

At the end of September, the first Belgian reactor was definitively shut down, when Doel 3 ceased producing electricity for good on 23 September. Since 11 October, the reactor core has been completely unloaded.

The dismantling of FBFC has now been completed and the site was released unconditionally. With the Royal Decree of 29 March 2022 (Belgian Official Journal of 2 May 2022), the dismantling permit for FBFC International was lifted and FBFC International was removed from the list of Class I facilities.



In this annual report, we offer an overview of our activities in 2022 and a first glimpse at 2023:

- Chapter 1 provides an overview of Bel V's regulatory activities, in particular the inspections and oversight activities it conducts in the Belgian nuclear facilities and the collaboration under the terms of the Nuclear and Radiological Emergency Plan for the Belgian territory.
- Chapter 2 addresses the various safety assessment files and national projects that Bel V staff have carried out this year.
- In Chapter 3 we provide more information about Bel V's international collaboration and projects.
- Chapter 4 gives a summary of our activities in the area of expertise and knowledge management, our R&D achievements and our initiatives in the area of training.
- Chapter 5 ends this annual report with the financial report.

I wish to close this introduction with a word of thanks to all staff members of Bel V, who have succeeded in moving forward a great many dossiers and to respond flexibly and effectively to the constantly evolving nuclear context in our country.

Together, we look forward to 2023, with an attitude that is critical and alert, but at the same time ambitious and hopeful.

Michel Van haesendonck, Ir General Manager



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Regulatory activities in Belgium





1.1 General assessment of nuclear installations

Nuclear power plants

As regards operational oversight, the enhanced surveillance imposed by the Federal Agency for Nuclear Control (FANC) imposed on the Tihange site on 18 October is worth noting. This enhanced surveillance was requested in response to a number of events in 2021 and 2022 for which the underlying cause given was 'failure to follow a step-by-step procedure' or 'failure to prepare activities in accordance with the appropriate procedure'. Bel V and the FANC will carry out this enhanced surveillance until the definitive unloading of the reactor core of Tihange 2 in 2023. Bel V has allocated additional resources to this enhanced surveillance.

At the end of November 2020, ENGIE Electrabel decided to put an end to the PSR/LTO G2 project for the long-term operation (LTO) of the second generation (G2) reactors. As a result, at the beginning of 2021, Bel V took a number of actions. The most important of these involved documenting the 'state of affairs at the end of 2020', with a view to being able to quickly resume the project if so decided at the end of 2021 (or later).

Bel V then continued to work on the independent identification of potential weaknesses in the design of Doel 4 and Tihange 3 in order to be able to guickly form a judgement about possible design improvements that ENGIE Electrabel may propose if the PSR/LTO G2 project were ever to be resumed. In September 2022, Bel V once again launched, at the request of the FANC, internal preliminary studies of the long-term operation of the Doel 4 and Tihange 3 plants. On the basis of those studies, consultations were conducted in late 2022 with ENGIE Electrabel regarding the design improvements. Experts at ENGIE Electrabel and experts of the FANC and Bel V each - independently of each other - drew up a list of safety concerns that could give rise to necessary or desired design improvements. These lists were combined to create a list of 51 points, on which intensive technical consultation took place. These consultations, which continued in 2023, should result in the submission by ENGIE Electrabel of a proposed action plan for carrying out a number of design improvements, if it should come to long-term operation.

The DECOM project to prepare for the definitive shutdown and dismantling of Doel 3 and Tihange 2 was continued. The activities in this regard carried out in

2022 mainly concern the definition and development of the 'nuclear islands' of both units (that guarantee the remaining safety functions after definitive shutdown) and the preparation of the dismantling such as the chemical decontamination of the primary system, the evacuation of spent fuel and the removal of the operational radioactive waste. All these activities are described in the notices of cessation of activities of these units, which were sent to the safety authority six months before the definitive shutdown (24 September 2022 for Doel 3 and 1 February 2023 for Tihange 2). For Bel V, the most important activity in this regard in 2022 was thus the analysis and validation of these notices of cessation of activities. In addition, considerable resources were also devoted to further developing an overall integrated vision and organisation of the dismantling project, including interaction with the other stakeholders (a.o. the Belgian Agency for Radioactive Waste and Enriched Fissile Materials (ONDRAF/NIRAS)).

The construction of storage buildings for the dry storage of spent fuel continued for the Doel and Tihange power plants. At Tihange, a study was also launched in 2021 on making building DE (at Tihange 3) for the wet storage of spent fuel independent, with a view to the dismantling of Tihange 3, after which that building will need to remain operational. The evolution of this project will depend on the decision about the possible long-term operation of Tihange 3.

In 2022, Bel V also devoted particular attention to the storage conditions and capacity for the various waste streams at the Doel and Tihange sites. After an audit conducted by ONDRAF/NIRAS, the authorisations for the resins and, only at the Doel site, for concentrates, were still withdrawn. A new procedure for conditioning resins has been developed. At the moment, tests are still under way.

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Other nuclear facilities

The management of the National Institute for Radioelements (IRE) continues to face important challenges. The project to convert highly enriched uranium (HEU) to low enriched uranium (LEU) for irradiated targets is completed and the LEU-based production is growing steadily, but a few other projects are still under way: the installation of a new accelerator for the production of germanium-68, the LTO project for building B6 (which has incurred substantial delay but now has received new impetus) and the new interim storage for liquid waste. Several action plans were implemented, including for the disposal of historic waste and for the periodic safety review (PSR) (which incurred some delay). The SMART project (new accelerator for the production of molybdenum-99 without uranium) has been terminated for economic reasons.

At Belgoprocess, Bel V devoted particular attention in 2021 to the licensing and monitoring of the construction of several new buildings. These projects have to address the concerns about future storage capacity at the Belgoprocess site. The PSR project, which was due to be completed in 2021, faced delays and was continued in 2022 and will further run in 2023.

On SCK CEN, various important projects are under way: prelicensing of the MYRRHA project (for which there has not been much progress in 2022, but Bel V has completed its 2021 technical analyses and held a number of technical workshops), MINERVA (which has obtained a licence and whose construction will begin in 2023) and RECUMO (for the recycling of HEU and LEU from the IRE). For RECUMO, additional discussions were carried out in 2022 – after having obtained the construction and operational licence at the end of 2021 – regarding the modalities for monitoring the construction to begin in early 2023.

For JRC-Geel, the evaluation stage of the context of the periodic safety review is currently under way, after Bel V handed over all the necessary documents at the beginning of December, including a proposed action plan with accompanying timetable.

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 2019, particular attention was devoted to the further development and implementation of the aforementioned oversight programme, consisting of inspection sheets (which document the legal framework and practical application of each inspection and which are handed over to the licensees) and inspection guidelines (which provide a guide for the inspectors and which represent the expertise of Bel V in the area of inspections). In 2022, an inspection programme was established for phases DSD 2 and DSD 3 (definitive shutdown) at units that are definitively shut down and now only hold fuel in the nuclear fuel docks. This programme was applied when determining the inspection programme for 2023, which was submitted to the licensees at the end of 2022. In 2023 and 2024, a GIC will be drawn up for the dismantling and for the disposal facilities respectively (e.g. cAt).



1.2 Overview of inspections at nuclear power plants

1.2.1 Doel 1/2

Both Doel 1 and Doel 2 were operating at nominal power during this period, except for the annual refuelling outage and during the following events.

- The annual refuelling outage took place from 10 June until 7 July at Doel 1, and from 1 April to 2 May at Doel 2.
- On 21 February, Doel 1 was automatically shut down following the drop of a control rod. The unit was restarted on 22 February without requiring any repairs after the operational readiness of the control rod was ensured.
- At the request of the network operator a power modulation of 100 MW was carried out at Doel 2 on 27 May and on 6 June.
- Doel 1 had to operate at reduced power on 19 July for around 24 hours in order not to exceed the release temperature of the water into the Scheldt River (in line with the environmental legislation). A power cutback also had to be carried out at Doel 2.
 On 6 October, there was an automatic reactor trip at Doel 2 due to the fall of a control rod. After the necessary repairs, the unit could be restarted.

1.2.2 Doel 3

Doel 3 operated at nominal power, except:

- on 1 February, when electric power was reduced by 250 MW upon Elia's request;
- from 20 July when Doel 3 entered stretch-out and power was gradually reduced to 67% on 23 September.

On 23 September, Doel 3 was shut down definitively. Since 11 October, the reactor core has been completely unloaded.

1.2.3 Doel 4

Doel 4 operated at nominal power without interruption, except during the period between 20 and 24 June, when the nuclear reactor was operated at half power because of works on the high voltage network.

1.2.4 Doel common (WAB, SCG, GSG)

In the context of the upgrade of the water and waste treatment facilities (WAB) and the preparation for the DSD phase of the reactor units, attention was devoted to matters such as the replacement of the concentrate tanks and the expansion of the concentrate storage capacity, the upgrade of the remote-controlled carriages and the possibilities for storing and treating the waste water from the CSD (Chemical System Decontamination) at Doel 3.

As a result of the shutdown of Doel 3, ONDRAF/NIRAS temporarily suspended the radiological licence issued for unconditioned waste.

In July, two ventilation filters were erroneously removed as 'released'. The release criteria were exceeded to a limited extent. The filters were processed by an external company. However, the impact on the environment or the population of this erroneous release can be considered negligible.

1.2.5 Doel site

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

- Inspection meetings were held with the heads of various departments (Operations, Maintenance, Care and Engineering) and services, in order to evaluate their organisation and the management of different processes related to nuclear safety or radiation protection.
- Particular attention was paid to radiation protection, safety culture, experience management, etc. with a focus on the importance of the sustainability of the improvement actions.
- Specific inspections were carried out in order to discuss topics that apply to various units (human performance, radiological discharges, release procedures, on-site nuclear transport, etc.).

Bel V provided support to the FANC within the framework of its inspections, especially the management inspection and the inspections relating to the definitive shutdown of Doel 3, the emergency plan and the licensing conditions.

1.2.6 Tihange 1

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

- from 23 April to 18 September, as part of the end of the programmed unit shutdown for maintenance and refuelling. This shutdown was extended chiefly as a result of the discovery of a significant loss of thickness on the valves of the water supply circuit and of the replacement of the valves concerned;
- from 11 to 14 November, after a reactor trip signal appeared while a diagnostic process was under way in the instrument cabinets of the trip breakers;
- from 4 to 17 December, after an automatic trip of Turbo Group North (TGN) following the fleeting appearance of an inadvertent signal.

1.2.7 Tihange 2

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

- on 20 January, due to a loss of power to about 25%
 of nominal power, for repairs to a valve of the ordinary water supply circuit (non-safety related);
- In the second quarter, with a few variations of around 3% of nominal power, because of repeated problems with a secondary circuit pump (non-safety related);
- from 23 June to 7 August, as part of the programmed unit shutdown for refuelling;
- on 19 August, after an automatic reactor trip linked to the failure to comply strictly with the procedures linked to an activity under way (recalibration of the neutron flow measurement channels) (INES 1 – International Nuclear and Radiological Event Scale).

1.2.8 Tihange 3

The unit operated at nominal power without interruption, except for:

 the period of the programmed unit shutdown that began on 17 February and ended on 4 April. Moreover, a reactor trip was triggered by a high neutron flow during the restart operations after a programmed unit shutdown;



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A period of shutdown when, following a reactor trip on 3 October, the licensee took the opportunity to move to a cold shutdown in order to perform works planned for the annular space pursuant to a modification file. The shutdown lasted 14 days;
some power modulations at the request of the network manager.

The events were rated as level 1 on the INES scale:

On 28 March, during the monthly testing of a diesel generator group, the latter was declared to be unavailable after the discovery of an isolating cable (probably during another work site) supplying its fuel transfer pump. The reserve diesel generator group was thus brought in as relief while awaiting the repairs, which were carried out within 48 hours. In the event of the loss of external electric supply, the requisite number of diesel generator groups was sufficient.

On 3 October, a defect in the pressure measurement instruments of a steam generator gave rise to an automatic reactor trip. However, during the shutdown, a malfunction in a valve was detected (of the system-bypass from the steam generator into the atmosphere) and of an auxiliary water supply turbopump of the steam generator. However, the cooling function of the core was guaranteed at all times.

1.2.9 Tihange site

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

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

Bel V lent its technical support to the FANC's inspections, including those relating to the verification of the conditions for the licence, to management, etc., and as part of the enhanced surveillance implemented as from 18 October.

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

Specifically, it should be noted that an OSART (Operational Safety Review Team) mission of the International Atomic Energy Agency (IAEA) is scheduled for May 2023 in Tihange. Two members of the IAEA staff went to Tihange on 28 and 29 September as part of a 'pre-visit' aimed at familiarising the licensee with the working method to be used by the auditors in the course of this mission. Bel V lent its active support.

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 2022 consisted of 7 cycles and 2 short cycles of 2 days in order to carry out a transient on a test assembly. Cycle 06/2022 was cancelled entirely, however, due to a problem with a missing spring hanger (see below). During the transient of cycle 03/2022B, a fuel pin failed (as expected) in dispositive PWC7.

On 17 February, there was a reactor scram due to a low flow alert in the primary circuit. After further investigation, it appears that the cause of the scram was not low flow, but rather a defect in the relay within the scram line. The defective relay was replaced and the reactor was restarted after the Xe contamination had disappeared. Despite the highest qualification level of the defective relay, which means it should be resistant to operating temperatures, an air gap was provided for between the relays as a corrective measure in order to lower the temperature.

During Cycle 02/2022A a major leak was discovered at the POSEIDON facility caused by the deterioration of a rubber seal. The irradiation at POSEIDON was stopped until another sealing method was implemented.

On 13 June, the negative pressure in the reactor building was temporarily lost because the ventilator C2 belts were all broken. The belts were replaced after about 4 hours, and during the repairs no manipulations were permitted in the reactor building.

On 26 August, a reverse took place in the reactor due to a low pressure alert on the sampling circuit. Cycle 04/2022 therefore ended 7 hours earlier than expected. Because the sampling circuit was no longer used for cooling experiments, an exemption was approved for actions to take flow and pressure in the sampling circuit out of service. As a result, a modification file was implemented in order to take the sampling circuit definitively out of service.

On 13 September, there was a reactor scram just after the start of cycle 05/2022. The cause was the failure of the relay for the manual control of the evacuation signal on the Emergency Control Panel (ECP) in the Control Room 'Machines' (KZM). The failure of the relay was similar to the one that caused the scram on 17 February. The defective relay was replaced by a spare relay and a longer-term solution will be sought in order to increase the reliability of the scram line.

On 13 September, there was a second scram at the reactor due to an erroneous manipulation by an operator. When lowering the enrichment factor, linear measuring chain L2 reached the scram threshold of 120%.

After cycle 05/2022 had stopped, it was determined that primary pump J4-402 was turning in the wrong direction. It appeared that the CVPC2 check valve had not been properly closed. When the valve was opened, it was noticed that various welds had broken off, as a result of which one of the four spring hangers had disappeared and was somewhere in the primary circuit. Cycle 06/2022 was therefore cancelled entirely. A few visual inspections were made in order to try to locate the spring hanger, but without any positive results. Therefore, the licensee carried out a thorough analysis of the situation and of potential scenarios, with the conclusion that the reactor could continue to operate safely even with the spring hanger in the primary circuit. An exemption was then submitted for the restart of the reactor with a foreign object in the primary circuit. After a thorough analysis of the final version of the dossier, Bel V and the FANC took the view that there were no further blocking points for the restart of the reactor, on condition of a number of additional measures and an enhanced surveillance during the operation of the reactor. The exemption for operating the reactor with a foreign object in the primary circuit on condition of additional measures

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was approved by the Health Physics Department and Bel V until 31 March 2023.

An initial meeting on the conversion of highly enriched uranium (HEU) into low enriched uranium (LEU) was held in order to give the FANC and Bel V an update on the situation. The irradiation of the first lead test assemblies (LTA) with LEU fuel took place during cycle 07/2022.

The VENUS reactor did not see much use in 2022. The reactor was used only for experiments for the purposes of a Master's thesis and for IAEA's annual inspection. Discussions are under way to determine the future experimental programme. Experiments with the reactor in subcritical mode are planned, for which changes to the cooling of the target may be required.

In the BR1 building, the dismantling of the Pu-lab was completed.

In the tritium lab, an experiment in cell C1 is under way for the treatment of a NaK getter contaminated with tritium.

The dismantling of the first Telix cyclotron was stopped at BR3 as a result of the unavailability of the ONDRAF/ NIRAS acceptance criteria (ACRIA) for type III monoliths. As expected, the various components of the accelerators will continue to be stored for several years at SCK CEN.

Furthermore, the FANC issued a licence for the removal of activated concrete from BR3.



In April, an outbound transport from SCK CEN received no labels or wrong labels and the description of the contents in the transport document was incorrect. This was simply a matter of administrative deviations, which had no impact on the well-being of staff members, the population or the environment. Because of an incorrect interpretation in reporting to the authorities, the INES analysis was carried out only after six months. This event was rated at Level 1 on the INES scale.

1.3.2 Belgoprocess

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

The construction of the new building 167X (the 'gel drum building') for the storage of non-compliant packages has begun, and will be monitored by Bel V with 'hold points' and 'witness points'. The construction project will include an expansion of the building for the storage of the gel drums with inactive concrete plug.

The construction of the facility for the production of monoliths (IPM) and of building 170X (for the dismantling of the vessels in buildings 105 and 122) is ongoing and on schedule, and Bel V is monitoring the hold and witness points. For IPM, the site acceptance tests of the various types of equipment are being carried out. For building 170X, the structure of the ventilation systems was verified by Bel V.

The dismantling of the Solid Waste Pond in building 102X has been carried out.

There was a leak in the Neteleiding pipe at the level of the SCK CEN site. The analysis of soil samples around the leak showed that this was above the release level for Cs-137. The contaminated soil around the leak was removed and the Neteleiding pipe was repaired. A complete breakdown of the exhaust ventilation system occurred in building 280X due to the failure of a single component in the control system. Belgoprocess is in the process of rectifying this shortcoming in the design of the ventilation circuit through the modification process (INES 1).

1.3.3 National Institute for Radioelements (IRE)

The Institute for Radioelements has completely converted its purification process for medical radioisotopes from highly enriched uranium (HEU) to low-enriched uranium (LEU). The production capacity and the frequency of production from LEU continued to increase throughout 2022.

The residues from the HEU process continued to be discharged on a regular basis to SCK CEN (see Section 2.8 on the RECUMO project). In the longer term, the residues from the LEU process will also have to be disposed of at SCK CEN.

In addition to the HEU to LEU conversion project, the IRE's infrastructure is being improved through the transfer of equipment and facilities previously operated by MDS Nordion/BMB/NTPE/ONSF.

The LTO project for building B6 had been delayed the last few years. A new engineering office has now been contracted and the works are in progress following the new schedule.

It should also be noted that the demand for radiopharmaceutical products generated by the IRE's subsidiary IRE ELiT continues to increase.

1.3.4 JRC-Geel

In the Mass Spectrometry facility, the replacement of the three extractors of MS2 was accepted by the Health Physics Department and confirmed by Bel V, and the implementation is ongoing. In addition, several filters were replaced in order to restore conformity with the operational limit regarding the minimum air extraction rate for some hoods. Lastly, the water mist extinguishing system in MS2 was repaired to restore conformity with the operational limit regarding the availability of this system.

In the GELINA (GEel LINear Accelerator) facility, the addition of a new beamline was commissioned by the Health Physics Department and confirmed by Bel V.

In the MONNET (MONo energetic NEutron Tower) facility, the addition of a new beamline is ongoing.

On 12 May, a worker was exposed to a neutron beam. The exposure lasted for a few seconds. The dose received by the worker was limited (6 μ Sv). Several human failures led to this event. The necessary actions were taken.

Concerning the organisation of JRC-Geel, Bel V still noticed a non-conformity regarding the number of operators in the MONNET facility and the availability of a person responsible for the management of the nuclear waste and decommissioning activities.

1.3.5 Other (class IIA) facilities

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

- The two cyclotrons at Telix were evacuated to SCK CEN for dismantling. The class IIA authorisation was lifted by the FANC.
- The dismantling licence for the cyclotron of the Vrije
 Universiteit Brussel (VUB) was issued by the FANC.
 Activated parts may be stocked for a maximum of 25 years.

- The experimental bunker and the FLASH experiment at the clinical bunker for proton therapy at the Leuven University Hospital were completed.
- A new application for a class IIA authorisation was submitted by the IRE. The construction of the building for the Ikon-30 cyclotron and the purification chain for germanium-68 is in progress. Building B20 is also in the process of transformation for the development of R&D activities associated with this new production chain.
- As part of the dismantling activities by ONSF at the Fleurus site, the decontamination of the JEDI cells has been completed. The new annex to building B14 was also accepted and the dismantling of the cyclotron can now begin.
- The dismantling of the accelerators is ongoing at Ghent University and the dismantling works are proceeding very smoothly.
- The Commscope electron accelerator is due to be shut down in May 2023.
- The accelerator for FLASH therapy at GasthuisZusters Antwerpen hospital has been completed.
- The licence application for the proton therapy introduced by ProtonW was processed by the FANC and Bel V. ProtonW lodged an appeal against one of the licence conditions set by the FANC.
- IRE ELiT submitted an amendment request to increase its generator production. A further increase in production in the future will require an amendment to the licence.
- A liquid was detected in the sump of the Sterigenics pools. Investigations showed that the water was coming from outside. Possible solutions are currently under review.
- SCK CEN submitted an application for a licence for a new Class IIA facility (CRF facility for the production of Lutetium-177).

Number of inspections performed in 2022:

> Facilities at Doel nuclear power plant



Facilities at Tihange nuclear power plant



Other Class I nuclear facilities



Class IIA nuclear facilities



1.4 Emergency preparedness and response

1.4.1 Introduction

Following on the heels of the COVID-19 pandemic and its impact on 2020 and 2021, the Russian-led military operation in Ukraine marked the year 2022. Although this situation did not lead to an actual activation of the federal nuclear emergency plan, its impact on the nuclear sites and facilities located in Ukraine required close monitoring. The FANC therefore decided to mobilise its crisis unit, in which Bel V was associated on several occasions, especially during precarious situations at the Zaporijjia nuclear power plant. Bel V's participation was also facilitated by useful contacts with the French colleagues of IRSN, which allowed to complete and validate Bel V's information and opinions.

1.4.2 Emergency response exercises

In 2022, the following emergency preparedness and response exercises were held under the supervision of the National Crisis Center (NCCN) under the Federal Public Service Interior:

- in May for the Doel nuclear power plant: partial exercise limited to the interaction between the emergency crisis cell of the licensee (on-site) and the evaluation cell CELEVAL (off-site);
- in November for the Tihange nuclear power plant: partial exercise limited to the interaction between the emergency crisis cell of the licensee (on-site) and the evaluation cell CELEVAL (off-site);
- in December for the National Institute of Radioelements (IRE) in Fleurus: a methodologically supported exercise with the participation of local authorities and emergency services, in addition to federal cells and committees (coordination committee, evaluation / information / measurement cells).

These exercises were prepared, conducted and evaluated according to the current Belgian methodology for the preparation, execution and evaluation of 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. In particular, the solutions provided during these exercises to secure the hybrid operation (on-site and remote) of the evaluation cell, the crucial importance of the alert and mobilisation phase of the cells and committees or the need for external emergency services to improve their knowledge and awareness with regard to the radiological risk.

In addition to the above-mentioned exercises, between April and June 2022 and together with other Belgian partners, Bel V participated in a project led by the European Commission to review and analyse the practical application of the emergency preparedness and response arrangements in a regional or international context to selected example emergency scenarios with cross-border consequences or where a far-off emergency situation affects European countries and requires coordinated action.

1.4.3 Other related activities

After the publication in the Belgian Official Journal of the Royal Decree of 1 March 2018 establishing the Nuclear and Radiological Emergency Plan for the Belgian territory, established under the aegis of the National Crisis Centre and with the participation of Bel V, Bel V continued to participate actively in the projects initiated in previous years (such as the support for the development of zone-based and specific emergency response plans or the further development of improvements concerning the protection of responders in radiological emergencies and related training and information activities). It should be noted that an update of the Royal Decree of 1 March 2018 establishing the Nuclear and Radiological Emergency Plan for the Belgian territory will be published in 2023.

1.4.4 Improving Bel V's role

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 participated in the Belgian emergency preparedness and response exercises, which, besides the response activities, involved extensive preparation, observation and evaluation of the response by the Bel V crisis team, the licensee and the other parties involved (evaluation cell of the National Crisis Centre).
- Limited communication and readiness exercises and tests were organised throughout the year. As in 2021, a total of 38 such tests took place in 2022.
- As part of the support to the Dutch safety authority (ANVS), IRSN and Bel V initiated a task to support the protection strategy through discussions and the development of base scenarios for the Borssele nuclear power plant. This project will continue in 2023.

1.4.5 International collaboration

Bel V took part, in a limited way and in support of the Belgian competent authorities, in the activities of the Working Group Emergencies of HERCA (Heads of European Radiological Protection Competent Authorities).





Safety assessments and national projects

2.1 Probabilistic Safety Assessment (PSA)

In 2022, ENGIE Electrabel and ENGIE Tractebel Engineering finalised the development of Probabilistic Safety Assessments for spent fuel pools (including internal events and hazards as well as external hazards, i.e. seismic and external flooding events) in order to comply with the Royal Decree of 30 November 2011 on the safety requirements for nuclear installations (as amended by the Royal Decree of 19 February 2020) incorporating the WENRA Safety Reference Levels for Existing Reactors of September 2014. Bel V closely monitors these PSA projects from a technical point of view. As a result of the Spent Fuel Pool PSA studies, ENGIE Electrabel proposed an action plan for the implementation of improvements on site. This action plan is also being monitored attentively by Bel V.

At the end of 2020, due to ENGIE Electrabel's decision to no longer target long-term operation for the post-2025 period, the Seismic PSA project was discontinued for the reactor of each nuclear power plant. Quick wins identified during walk downs performed in 2020 within the context of the Seismic PSA project (and followed up by Bel V) were nevertheless retained as potential safety improvements. Some of these improvements were implemented in 2021 and 2022.

The upgrade of the Level 2 Internal Fire PSA continued in 2022 as well, in particular for Tihange 3, for which a full scope model is being developed.

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

In particular, Bel V evaluated ENGIE Electrabel's assessment of Safety Factor 6 (Probabilistic Safety Assessment) as part of the Periodic Safety Review of Doel 3 and Tihange 2 (see Section 2.2), including the use of PSA within the context of determining the nuclear islands of these units during permanent shutdown.

Bel V's international and R&D activities on PSA methodology and PSA applications are presented in Section 4.4.

2.2 Periodic Safety Reviews (PSR)

National Institute for Radioelements (IRE)

In 2018, the National Institute for Radioelements submitted to the safety authorities the assessment reports on 15 safety factors prescribed by the IAEA methodology, as well as the overall assessment report. This allowed for a plan with 126 actions (and a timetable) to be drawn up and submitted to the Scientific Council of the FANC at the end of 2018. At the end of each action a request for completion is sent to Bel V, which verifies its accomplishment. Implementation of the action plan began in early 2019 and was scheduled for completion by the end of 2022.

At the end of 2022, however, not all actions had been completed. The FANC has agreed to postpone the end of the Periodic Safety Review to 31 March 2023.

The FANC reiterates that the closure of the second decennial review will be confirmed by a report from the IRE summarising all the actions, the progress made and the confirmation of the achievement of the objectives.

Belgoprocess

Within the framework of the periodic safety review at Belgoprocess Site 1, the deadline for implementing the action plan expired in theory on 30 June 2021, but Belgoprocess has informed the FANC in writing that a number of actions have run into delays. The new deadline for the completion of the actions is 30 June 2023. Meanwhile, Belgoprocess continues to work on implementing the outstanding actions. With regard to the periodic safety review at Belgoprocess Site 2, the deadline for implementation of the action plan was 30 June 2021. Belgoprocess has carried out all the actions, with the exception of one involving the upgrade of the internal message broadcasting system, which is shared by both sites. This action will continue to be handled via the action plan for Site 1. In addition, the Q&A for a number of actions at Site 2 is continuing.

JRC-Geel

The evaluation phase within the context of the Periodic Safety Review of JRC-Geel is ongoing. The deadline for JRC-Geel to provide all safety factor assessments was 1 December 2022. This deadline was met for all assessments except one, which was provided to Bel V shortly after the deadline. Based upon the performed assessments, JRC-Geel also provided the General Actions List, including main actions defined during the evaluation phase and their proposed deadline for implementation.

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Nuclear power plants

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

In 2022, ENGIE Electrabel performed the Periodic Safety Review of Doel 3 and Tihange 2, by assessing 14 Safety Factors based on the IAEA Specific Safety Guide SSG-25. The TEF, TEL and TDS installations at Tihange were evaluated within the context of the Periodic Safety Review of Tihange 2 and the auxiliary facilities at Doel (WAB, GSG and SCG) were assessed during a dedicated Periodic Safety Review.

In 2022, Bel V reviewed the analyses performed for the Periodic Safety Review of Doel 3 and Tihange 2 (together with the TEF, TEL and TDS installations) and submitted its conclusions to the FANC. The analyses with regard to the Periodic Safety Review of the Doel auxiliary facilities will be examined and discussed with the FANC at the beginning of 2023.

For some Safety Factors (mainly those having a strong link with the status of the components, such as SF2, SF3 and SF4), it should be mentioned that there were a number of difficulties in the assessment of the analyses due to the overlap between the PSR exercises and the determination of the nuclear islands in the POP context.

As a result of these three Periodic Safety Reviews and the Global Assessment exercises performed within the context of each Periodic Safety Review, ENGIE Electrabel developed specific action plans, which are being monitored by Bel V. These action plans contain specific improvements (hardware, processes or procedures) that will be developed within three different frameworks (continuous improvements, definitive shutdown or the Periodic Safety Review itself). It should also be mentioned that there is a strong link with the action plan defined within the context of the WENRA 2014 Safety Reference Levels project.

Through its analyses and the Safety Evaluation Reports written by Bel V for all Safety Factors in each Periodic Safety Review, Bel V also proposed amendments to the action plans drawn up by ENGIE Electrabel. These amendments are currently being incorporated.



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

In September 2022, Bel V once again launched, at the FANC's request, internal preliminary studies of the long-term operation of Doel 4 and Tihange 3.

The activity related to this topic at the end of 2022 consisted of consultations among ENGIE Electrabel, the FANC and Bel V on the design improvements to be implemented in the event of long-term operation of these two units. Experts from ENGIE Electrabel, the FANC and Bel V each – independently of each other – drew up a list of safety concerns that could give rise to necessary or desirable design improvements. These lists were combined to form a list of 51 points, about which intensive technical consultations were initiated. These consultations, which continued in 2023, should result in the submission by ENGIE Electrabel of a proposed action plan for carrying out a number of

design improvements, if it should come to long-term operation.

2.4 **DECOM**

The objective of the DECOM project is to prepare for the definitive shutdown and dismantling of the Doel and Tihange nuclear reactors. The focus of the project in 2022 was to prepare for the definitive shutdown of Doel 3 in September 2022 and of Tihange 2 in January 2023.

With a view to the preparation for the definitive shutdown of these two units, various activities were carried out in 2022. On the one hand, the configuration of a new nuclear island, which is to provide residual safety functions for the unit after its definitive shutdown, had to be validated by the safety authority, which required an analysis of the basic design proposals, the proposed adjustments to the different programmes (maintenance, ageing, etc.) as well as the proposed adjustments to the safety reports. On the other hand, the preparatory activities for dismantling had to be validated. This consisted of the preparations for the chemical decontamination of the primary circuit and for the evacuation of spent fuel and of radioactive substances during the post-operational phase. All of these activities had to be described in the notice of termination of activities in these units, to be handed over 6 months before their definitive shutdown. The principal activity in 2022 was thus the analysis and validation of the notices of termination of activities.

After validating the definition of the nuclear island and of the activities in preparation for dismantling, efforts in 2022 and subsequent years will concentrate on the analysis of modification files putting into practice the principles described in the notices of termination of activities.

The chemical decontamination of the primary system circuit is the first activity to be carried out after the definitive shutdown and the removal of the fuel from the reactor building, and is intended to reduce the radiological risks for the final life stages of the reactor. In 2022, Bel V analysed the first technical documents related to the implementation of the chemical decontamination, the modifications to be made to the existing systems for that activity and the treatment of the generated radioactive waste.

Beyond this intensive stage of technical analysis, strategic discussions continued in 2022 to best prepare the transition from the operating licence to a dismantling licence. ENGIE Electrabel finally made progress in 2022 on a number of key strategic decisions related to the final shutdown and decommissioning.





2.5 Radioactive waste management

Since the licence application by ONDRAF/NIRAS on 31 January 2013, Bel V, in collaboration with the FANC, has been closely involved in the licensing process for the future facility for the disposal of low- and medium-level short-lived radioactive waste (category A waste) in Dessel. On 3 October 2019, the FANC's Scientific Council issued, at one of its sessions, a positive provisional prior opinion based partly on a safety inspection conducted by the FANC and Bel V. In this provisional prior opinion, the Scientific Council identified a number of elements which ONDRAF/NIRAS was asked to develop before the second session of the Scientific Council. ONDRAF/NIRAS started working on them in 2020 and continued to do so in 2022. In 2022, the FANC and Bel V therefore conducted an independent analysis of the documents submitted by ONDRAF/NIRAS to develop those elements. At the end of 2022, Bel V started drawing up an assessment report for the second session of the Scientific Council, which is scheduled or 24 February 2023.

In the context of the investigation of the disposability of the waste intended for near-surface disposal, Bel V analysed a number of conformity files in 2022. The aim of these conformity files, created by the ONDRAF/ NIRAS, is to show that radioactive waste from a specific (sub-)family or (sub-)variety is in conformity with the criteria for near-surface disposal. These files are drawn up in several steps, with Bel V's approval being required for each step before one can move on to the next step.

In 2014, the FANC and Bel V initiated a cooperation on the activities of the FANC and ONDRAF/NIRAS within the framework of the long-term management of highlevel and/or long-lived waste (category B and C waste). In 2022, the ONDRAF/NIRAS, the FANC and Bel V drew up and published a convergence note on reversibility and retrievability in a geological disposal facility.

In 2022, Bel V also participated in discussions on the convergence note of ONDRAF/NIRAS, the FANC and Bel V on 'monitoring of a geological disposal facility'. The note will be finalised in 2023.

2.6 MYRRHA / MINERVA

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 leadbismuth eutectic coolant. The pre-licensing phase of the MYRRHA project, initiated in 2011, in order to analyse the eligibility of the facility for licensing, continued in 2022.

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

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

The year 2022 was marked by some progress in the project, with the analysis of several technical notes, but Bel V's work consisted mainly in completing the analyses started in 2021, i.e. the analysis of the safety guidelines for MYRRHA. Technical workshops were conducted between the safety authority and SCK CEN in order to clarify some of those safety guidelines, such as taking into account single fault or external events.

In terms of R&D, Bel V started working on modelling the experimental installations of SCK CEN, in order to create a benchmark for the existing codes for thermo-hydraulic calculation and to develop direct experience of the thermo-hydraulic problems arising in a reactor as complex as MYRRHA. This work will facilitate the license application process by providing Bel V staff with the solid technical knowledge required to assess the positions taken by the applicant in the safety case.

MINERVA

MINERVA (Myrrha Isotopes productioN coupling the linEar acceleRator to the Versatile proton target fAcility) is a LINAC (LINear Accelerator) characterised by a maximum proton beam energy of 100 MeV and a beam intensity of 4 mA.

The latest version of the Preliminary Safety Analysis Report (PSAR) was finally accepted by the regulator. As a result MINERVA was granted a Class IIa licence by the FANC in 2022. The construction phase of MINERVA will start in 2023.

2.7 SF²

Spent fuel storage facilities

The current interim spent nuclear fuel storage facilities at Doel and Tihange will be saturated by 2023. 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 2022, technical meetings continued between the FANC /Bel V and the licensee ENGIE Electrabel in order to discuss the technical details of various licensing conditions.

Dual Purpose Cask Post 2020

The safety reviews (TSAR - Topical Safety Analysis Report) of five types of containers (by two manufacturers, ORANO and GNS) that are to be used in the spent fuel storage in buildings SF² at Doel and Tihange are now being analysed by Bel V:

- The ORANO TN24 XLH L+ and TN24 DH+ containers were validated in 2021.
- In 2022, the TSAR for the GNS Castor geo24B container, intended to evacuate the spent fuel from the pools in the deactivation building of Doel 3, was validated by Bel V.
- The analyses of the TSARs of the latter two types of container will continue in 2023 (ORANO TN24 XLH S+ and GNS Castor geo21b).

Bel V handles the follow-up of the new humid container provided for the internal transfer of spent nuclear fuel between Tihange 2 and building DE (HI-STAR 120). It is concentrating on the increase of the capacity of the load (from 15 kW to 32 kW) and the production of the container. Due to fears of delayed delivery of the container, Bel V analysed a dry alternative (TN12/2 by ORANO) in 2022. Validation of the dossier and completion of the guestions/answers are scheduled for January 2023.

2.8 **RECUMO**

The RECUMO (REcovery and Conversion of Uranium from MOlybdenum production) project at SCK CEN consists in purifying HEU and LEU residues coming from the medical radio-isotope purification process at the National Institute for Radioelements (IRE). Since SCK CEN obtained a construction and operating license in late 2021, several meetings have been organised between the licensee and the regulator to determine the construction specifications of the future building. The construction phase itself will start in early 2023.

2.9 Smart 4F

The SMART (Source of MedicAl RadioisoTopes) project of the National Institute of Radioelements (IRE) aims to develop an alternative route for the production of molybdenum-99. Molybdenum-99 by decay generates technecium-99, which is a radioisotope used in nuclear medicine departments throughout the world.

The IRE carried out a research and development programme in Fleurus and at European research centres in order to validate the theoretical concepts implemented in the SMART project. As the SMART project progressed, it became increasingly complex from a technical perspective and its financial profitability was compromised. As a result, the IRE decided to terminate the project.

2.10 WENRA (2014) Safety Reference Levels

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

Within the context of the WENRA RL2014 project, ENGIE Electrabel has performed a large number of safety studies, in particular for design extension conditions (DEC) for both the reactors and the spent fuel pools, natural hazards (mainly earthquakes, external flooding and meteorological hazards), postulated initiating events for spent fuel pools (SFP PIE) and spent fuel pool PSA (SFP PSA) including external flooding and seismic hazards. As 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 many of them are being implemented in the Belgian nuclear power plants as part of the so-called WENRA Implementation Plan. The studies for these safety improvements and their implementation in the nuclear power plants continued in 2022 and are being monitored by Bel V from a technical point of view.

From the start of the project until the end of 2022, more than 800 documents, representing the whole set of planned studies and a considerable number of safety improvements, were submitted to Bel V. In 2022, Bel V continued its analysis of these documents and discussed the outcomes of these evaluations with ENGIE Electrabel and the FANC during technical meetings.

2.11 Belgoprocess construction projects

The construction of building 167X and of the facility for the production of monoliths (IPM) is in progress. The concrete structure of building 167X is nearly completed. The installation of the travelling cranes, the ventilation and the electrical works is ongoing. For the IPM, semiindustrial commercial operation tests (SIBS) were carried out.

The construction programmes were monitored by Bel V via hold points and witness points.

2.12 Making building DE independent

The project for the independence of building DE at Tihange (MIB.DE), which started in 2021 after ENGIE

Electrabel's decision to discontinue studies for the longterm operation (LTO G2) of Tihange 3, aims to make building DE independent of Tihange 3. The aim is to be able to autonomously operate the spent fuel pools from building DE from the the final shutdown of the last support systems of Tihange 3, currently planned for 2030, until at least 2057. The long-term storage of spent fuel at the nuclear power plant will thus be ensured by the SF² (dry storage via containers, see section 2.7) and by the independent building DE (storage in pools).

As part of the consultation process set up by the FANC for this project, the feasibility studies and the various designs envisaged for the MIB.DE were presented in greater detail by ENGIE Electrabel to the safety authority. The safety guidelines for the proposed technical configurations of the independent building DE were thus the subject of detailed analyses by Bel V. In parallel, many technical meetings were held to go into greater depth or to clarify certain points (overall design envisaged, and the proposed frame of reference, security on the site, control room, classification of the ordinary cooling source, concentration of boron in the pools, etc.). In addition, ENGIE Electrabel provided responses to Bel V's safety assessment report of October 2021, which were subject to a new specific analysis by Bel V resulting in a new review of the NSRD (Nuclear Safety Reference Document).

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At this stage, many concepts were clarified by ENGIE Electrabel and validated by the safety authority (status of 'Significant Modification' validated by Bel V, application of Article 3/2 of the Royal Decree of 30 November 2011, list of the PIEs (Postulated Initiating Events), anticipating the SF1 of the future PSR, level of protection, etc.). Alongside these, other aspects have yet to be clarified and/or discussed with ENGIE Electrabel in the first half of 2023 (seismic qualification and mechanical classification of cold sources, use of a PSA, impact of the combinations of events on the modifications, protection against external flooding, habitability of the control room, etc.).

As part of its final safety evaluation report on the possibility of licencing the project, Bel V will in any case carefully monitor the safety demonstration of the independent building DE and to the essential principles applied in that demonstration.



3.1 Cooperation with international organisations

OECD and IAEA activities

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

- the Committee on Nuclear Regulatory Activities (CNRA);
- the Committee on the Safety of Nuclear Installations (CSNI);
- the Nuclear Science Committee (NSC);
- the CNRA Working Group on Inspection Practices (WGIP);
- the CNRA Working Group on Operating Experience (WGOE);
- the CNRA Working Group on Safety Culture (WGSC);
- the CNRA Working Group on the Safety of Advanced Reactors (WGSAR);
- the CSNI Working Group on Fuel Cycle Safety (WGFCS);
- the CSNI Working Group on 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);
- the RWMC Integration Group for the Safety Case (IGSC);

- the CDLM Committee on Decommissioning of Nuclear Installations and Legacy Management (CDLM);
- the Incident Reporting System Coordinators' activities (IRS, IRSRR, FINAS).

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

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

Concerning the standing committees:

- The former General Manager of Bel V (who retired in 2018) is a member of the International Nuclear Safety Group (INSAG) of the IAEA, and attended the virtual meeting organised in March 2022.
- The current General Manager of Bel V, elected in 2020 as chair of the Technical and Scientific Support Organization Forum (TSOF) of the IAEA, participated in the activities of the Steering Committee of the TSOF.
- A Bel V representative is a member of the Steering Committee on Regulatory Capacity Building and Knowledge Management (coordinated by the IAEA) and he continued his activities in this committee.
- Bel V participated in the meetings of the Steering Committee of the Regulatory Cooperation Forum and support meetings with the European Commission.

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

- · reliability of passive safety systems in advanced reactors:
- instrumentation and control and computer security for small modular reactors and microreactors;
- generic user requirements and criteria of SMR technologies for near-term deployment;

- strengthening safety of evolutionary and innovative reactor designs;
- · common cause failures in nuclear power plant instrumentation and control systems;
- · software reliability of digital instrumentation and control systems for nuclear power plants;
- ARTEMIS peer review mission;
- ex-vessel molten corium behaviour and coolability;
- · structural behaviour of fuel assemblies in watercooled reactors;
- open-source modelling and simulation tools for nuclear reactors;
- joint convention on nuclear safety;
- capacity building and competence assessment for regulatory bodies;
- achievements and challenges in radioactive waste characterisation;
- decommissioning.

3.2 Cooperation with safety authorities

3.2.1 Western European Nuclear **Regulators Association (WENRA)**

Bel V representatives participated, in support of the FANC representatives, in the WENRA plenary meetings.

Reactor Harmonization Working Group (RHWG)

Bel V participated, in support of the FANC, in two of the three RHWG meetings held in 2022.

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

With a view to the next update of the WENRA Safety Reference Levels for Existing Reactors, which is scheduled for 2024, Bel V contributed (for a number of Issues) to the gap analysis performed to identify differences between the SRL published in 2020 and other high-level safety standards or national regulations. The gap analysis results were discussed by the RHWG in order to identify the Issues for which an SRL update is desirable. Some cross-cutting issues, e.g. plant configuration management and the safetysecurity interfaces, were also discussed.

For the 2023 Topical Peer Review (TPR) on 'Fire Protection', Bel V participated in the RHWG's dedicated working group for the preparation of the technical specifications for this Topical Peer Review.

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

Working Group on Waste and **Decommissioning (WGWD)**

The 48th WGWD meeting was held in Brussels from 26 to 30 September. Bel V participated in support of the FANC.

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

During the meeting, a technical visit was organised to the HADES underground research laboratory, the Tabloo exhibition centre and the Category A site (including the monolith production facility (IPM) building).



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

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

A virtual meeting took place on 18 March, in which the following topics were discussed:

- Regulatory aspects and projects
- » France
- Recent safety developments
- Continued operation of the French 900 MWe nuclear power plants
- 4th periodic safety review of the 1300 MWe nuclear power plants
- Small modular reactors
- Stress corrosion cracking in several nuclear power plants

- » Belgium
- Regulatory developments and projects (LTO, SF², stress test)
- General news on facilities and notable events
- Overview of events in nuclear facilities
- Emergency exercises and post-accident management of nuclear accidents
- » Recent developments in post-accident management of nuclear accidents – Exercises and inspections in 2021
- » Bel V / FANC situation / review of the 2021 crisis exercise and outlook for 2022
- Joint review of the 'Terms of Reference' of the French-Belgian working group on 'Installations Nucléaires de Base' (WG-INB)

3.2.3 Belgian-Swiss Working Group

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

In 2022, the meeting was held in Belgium, on 28 and 29 November. The following topics were discussed on 28 November:

- Exchange of information
- » Situation of the nuclear facilities
- » Changes in the regulatory framework
- Update on the status of the disposal project in Belgium and Switzerland
- Update on decommissioning projects
- » Status of the decommissioning projects in Switzerland
- » Status of the decommissioning projects in Belgium
- Other topics
 - » Discussion on current situation with corrosion in French nuclear power plants
 - Involvement of each country in assisting France in their work
 - Conclusions for further investigation for Belgian nuclear power plants

- Safety culture issues
 - Tihange
 - Update for Swiss nuclear power plants
- Experience feedback on peer review missions
- » Preparation of back-to-back Integrated Regulatory Review Service (IRRS) missions for ARTEMIS
- » Feedback on IRRS for Switzerland

On 29 November, a visit to Belgoprocess was organised. The following facilities were visited:

- treatment facility CILVA ('Centrale Infrastructuur voor Laagactief Vast Afval');
- interim storage buildings 151 (LLCW) and 137 (HLCW);
- Tabloo;
- monolith production facility IPM ('Installation Production Monoliths').

3.2.4 Autoriteit Nucleaire Veiligheid en Stralingsbescherming (ANVS – Netherlands)

Due to a railway strike, the meeting scheduled for 30 November was replaced by a brief virtual meeting the same day. The following topics were discussed:

- · long-term operation projects in both countries;
- knowledge building and management: opportunities for cooperation.

3.2.5 Deutsch-Belgische Nuklearkommission (DBNK)

The 2022 meeting, which was held on 11 and 12 May, was the sixth meeting of the German-Belgian Nuclear Commission (Deutsch-Belgische Nuklearkommission – DBNK) as provided for in the bilateral agreement concluded between Belgian minister for Security and the Interior Jambon and German Environment Minister Dr Hendricks on 19 December 2016. The following topics were discussed:

General exchange of information regarding recent regulatory topics

- » Belgium
- Overview of changes in the regulatory framework
- Status of decommissioning
- Discussions on long-term operation in Belgium
- Small modular reactors
- Update on the Belgian selection process for a disposal site
- » Germany
- Overview of organisational changes
- Overview of changes in the regulatory framework
- Status of decommissioning
- Discussions on long-term operation in Germany
- German's position on nuclear safety post-2022 (including strategy for competence building)
- Update on the German selection process for a disposal site

 Exchange of information on installations (status, operational experience, current safety topics, projects and licensing)

- » Belgium
- Events and operational experience
- Experience regarding COVID-19 impact and measures
- Projects, licensing...
- » Germany
- General operational experience and information notices ('Weiterleitungsnachrichte' – WLN)
- Experience regarding COVID-19 impact and measures
- Safety-security interface

Miscellaneous

- » Exchange of information regarding the type of follow-up of the nuclear installations in Ukraine
- » Cross-inspections

3.3 Collaboration with technical safety organisations

3.3.1 ETSON Conference 2022

The European Technical Safety Organisations Network (ETSON) is co-organiser of the Technical and Scientific Support Organizations (TSO) Conference of the IAEA. The 2022 TSO Conference was scheduled to take place in St. Petersburg (Russia). As a result of the special military operation carried out by Russia in Ukraine, however, it was postponed and the ETSON members decided at short notice to organise a so-called ETSON Conference instead, hosted by GRS in Garching (Germany).

The conference kicked off with an impulse speech of our Ukrainian partner on the topic of 'nuclear safety in challenging times'. This speech was followed by a round-table discussion on this up-to-the-minute topic, with interventions from senior representatives of the IAEA, the European Commission and ETSON. Fruitful exchanges on strategic topics such as critical nuclear infrastructures and research programmes in nuclear safety, together with the upcoming challenges in nuclear safety cooperation in Europe, were at the heart of the debate.

In preparation for the upcoming challenges in nuclear safety in Europe, a series of presentations and discussions on joint ETSON efforts, in particular through the various ETSON Expert Groups (see Section 3.3.2 below), allowed to intensify the technical and scientific cooperation between the ETSON members and to continue organising and strengthening nuclear research, cooperation and networking. In these presentations and discussions, particular attention was drawn to the following topics:

 requirements and approaches for the assessment of external hazards impacting the safety of nuclear power plants;

- how TSOs are facing passive systems implementation in present and future reactors – new developments concerning small modular reactors have been widely introduced by multiple TSOs;
- operational rechnical report on concrete cases with regard to human and organizational factors;
- lessons learned on, from and for probabilistic safety assessments (PSA);
- current nuclear safety challenges in ETSON Member States.

In 2023, Bel V will organise the second edition of the ETSON Conference in Brussels.

3.3.2 European Technical Safety Organisations Network (ETSON)

The European Technical Safety Organisations Network (ETSON), which was founded in 2006 (among others by Bel V) and has been an independent legal entity since 2011, serves as a common platform for its member organisations:

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

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



From 2012 until Spring 2018, a Bel V representative chaired the ETSON Technical Board for Reactor Safety (TBRS) to oversee the technical activities of ETSON, such as the functioning of the ETSON Expert Groups and the publication of Technical Safety Assessment Guides (available at http://www.etson.eu/reports-andpublications). Since 2018, the chair has been held by a representative of IRSN. Bel V representatives took an active part in the ETSON Expert Groups, aimed at sharing views and experiences with colleagues of other technical safety organisations. The Chair of the ETSON Technical Board for Reactor Safety took initiatives in 2020 to propose collaboration with the WENRA Reactor Harmonization Working Group.

To pursue its objectives, ETSON established the Technical Board on Reactor Safety (TBRS) and its 14 supporting Expert Groups. In these groups, experts from member organisations exchange information and work together on various topics of nuclear safety assessment and research, ranging from generic aspects such as safety concepts or emergency preparedness and response to specific technical fields like safety fluid systems or mechanical and electrical systems. A major output of the Expert Groups' activities are the so-called Technical Safety Assessment Guides (TSAG), which are part of ETSON's publications. In addition, workshops on specific technical and scientific issues are organised by individual member organisations on behalf of the network.

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

A Junior Staff Programme (JSP) Summer Workshop on 'Radioactive material dissemination – sea and atmosphere – Radioactive waste' was organised in Cherbourg (France) in October. Bel V gave a presentation on the surface disposal facility in Belgium. The exchanges and collaboration with the TSO peers during these activities allow Bel V's staff to strengthen their technical and scientific expertise and to consolidate the quality of the safety assessments and positions.

3.3.3 Collaboration with technical safety organisations on waste management

Bel V collaborates closely with other technical safety organisations, among others within the SITEX_Network association (mainly aimed at strengthening TSO expertise in the field of radioactive waste management) and through its strong involvement in the European Joint Programme on Radioactive Waste Management (EURAD) (established in 2019 with a focus on R&D, strategic studies and knowledge management-related activities).

3.4 International assistance projects

3.4.1 Office for Nuclear Regulation (ONR)

Bel V was part of a consortium (composed of Jacobs as tier 1 and Bel V and Tecnatom as tier 2) that was selected to support the United Kingdom's safety authority ONR (Office for Nuclear Regulation) in a Technical Services Framework. The scope included service provision across a wide range of technical disciplines. This contract expired in 2022. A new call from ONR was launched in 2022 and a new consortium (with Jacobs as leading entity and Bel V as subcontractor) was selected by ONR.

3.4.2 Direktoratet for strålevern og atomtryggleik (DSA)

Bel V, as leading entity and member of a consortium composed of Bel V, IRSN, ARPANSA and the Norwegian University of Life Sciences (NMBU), supported the Norwegian radiation and nuclear safety authority DSA through various review activities:

- an agreement between Norway and the US to down-blend highly enriched uranium mixed with thorium oxide in Norway;
- the Institute for Energy Technology (IFE)'s update of a new management system document and process for carrying out a safety assessment and developing a safety assessment report;
- IFE establishment of a 'design authority' in its management system and organisation;
- IFE requirements for the safety committee and the safety committee secretariat and process;
- IFE program for human resource development.

3.4.3 Autoriteit Nucleaire Veiligheid en Stralingsbescherming (ANVS)

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

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

After a start-up period in the first six months, several so-called 'assignments' have been received from ANVS. As such, Bel V contributed amongst others to the following activities:

- assessment of decommissioning plan EPZ (Borssele);
 safety and security culture;
- overview of the state-of-the-art waste characterisation processes;
- overview of regulatory supervision related to waste management by IRSN and Bel V;
- · presentation on qualification of operators;
- presentation on regulatory experience feedback on SHINE Janesville, Wisconsin;
 - assessment of explosion safety document and inspection;
- knowledge transfer from ANVS and COVRA to the Spanish nuclear safety council CSN about our operations and regulatory activities related to licensing, assessment and inspection of the HABOG building;
- scenarios for emergency preparedness and response for the Borssele nuclear power plant;
- regulatory framework on decommissioning;
- research on small modular reactors;
- research on accident tolerant fuels (ATF).

3.4.4 Autorité de sûreté nucléaire (ASN)

Bel V has been selected to support the French safety authority ASN for the umbrella project 'Prestations d'appui dans le cadre de l'instruction des analyses de sûreté soumises par le CEA à l'Autorité de sûreté nucléaire (ASN) relatives à l'installation nucléaire de base n° 24 (CABRI) localisée à Cadarache', for which Bel V won the first three subcontracts.

The duration of each subcontract is four months. The first work subcontract was completed in June. The others are in progress.



3.4.5 Institut de Radio-protection et de Sûreté Nucléaire (IRSN)

In 2021, Bel V signed a contract to provide expertise to the French technical support organisation IRSN in order to assess the validation of the SCANAIR software to be used by the French licensee EDF. The objective of this software is to simulate the thermomechanical behaviour of a fuel rod during a reactivity insertion accident in a pressurised water reactor.

In 2022, Bel V performed the assessment of the validation of this software. This included an analysis of the supporting documents and a technical discussion with EDF. Bel V submitted its final conclusions to IRSN at the end of 2022.

3.4.6 Assistance projects of the European Commission

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

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

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

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

Ukraine

The INSC project in which Bel V participates has been reoriented following the Russian invasion of Ukraine. In this new context, Bel V, accompanied by IRSN, participates in a task aimed at supporting the Ukrainian authorities in their authorisation process for medical facilities using radiation sources and at comparing these practices with the Belgian and French practices in particular, and European practices in general. It is clear that these medical facilities have an essential role in diagnostics and care for war-wounded.

Bel V also participates with IRSN in a task related to the evaluation of feedback experience from nuclear power plants in Ukraine.

Morocco

The INSC project in which Bel V participated ended in June 2022. The aim of this project was to support the Moroccan regulatory body AMSSNuR in the execution of its missions of inspection and oversight of nuclear and radiological installations, in its regulatory responsibilities, and in the organisation of its internal structure.

The duration of the project, initially planned for four years, was extended by six months to compensate for delays caused by the COVID-19 pandemic.

Serbia

The consortium led by ENCO and also comprising SCK CEN, the IRE, HAEA and Bel V was selected for a cooperation project in Serbia. The beneficiaries are the Serbian safety authority SRBATOM and PCNFS, the operator of the Vinča site, which houses radioactive material storage and former nuclear facilities of the Vinča Institute of Nuclear Sciences (VINS).

The project aims to:

- continue the transposition of EU acquis in the field of radiation protection and nuclear safety into Serbian national legislation;
- contribute to the further development of the nuclear regulatory body SRBATOM by providing assistance in regulating radiation protection, nuclear safety and radioactive waste management;
- provide assistance in the decommissioning of selected facilities at the Vinča site.

The 36-month project will end in May 2024.

Number of participations in (inter)national workshops & conferences 92



Expertise management



4.1 Domestic experience feedback

Bel V performs a systematic screening of events at all Belgian nuclear facilities, as well as an in-depth analysis of a number of events with emphasis on root causes, corrective actions and lessons learned. In 2022, more than 60 events were registered into the domestic experience feedback database.

For a number of events, a more detailed event analysis was performed with the aim of identifying lessons learned which are potentially applicable to a wider range of nuclear facilities. In 2022, these analyses resulted in the drafting of one IRS report regarding the loss of material that was detected on the low-flow control valve on the by-pass line of the Main FeedWater System (MFWS) lines at Tihange 1.

2022 was marked by several events in particular, which were analysed in depth by Bel V and for which appropriate analysis, regulatory inspection and follow-up of corrective actions were carried out.

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

- proper handling of SSC (Structures, Systems & Components) availabilities during outages and start-up phases;
- correct implementation of the modification process;
- proper evaluation of all consequences of a configuration change, even if temporary;
- importance of adequate pre-job and post-job briefings;
- · clear and appropriate communication;
- importance of considering operational experience feedback and recurrence analyses in the processes and activities;
- correct procedure management and follow-up;
- importance of preventive maintenance;
- valve corrosion follow-up;
- proper sorting and caution when handling historical waste.

4.2 Foreign operating experience feedback

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

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

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

- OEF ASN SCC France 28/01/2022 'Stress corrosion cracking in pipes of the safety injection system' – *A first answer was provided on 24/02/2022, followed by additional information on 13/06/2022 and 17/08/2022. The topic is being monitored closely;*
- IAEA IRS national coordinators' meeting 29/11/2022
 'Anomalies in programmable multi-functional protective relays' *Investigations have been initiated by the licensee*;
- Japan Steel Works CFSI 22/12/2022 'Several cases of 'misconduct' in the quality inspections of products, data falsification and counterfeits in the Muroran plant (JSW M&E Inc branch)' *Investigations have been initiated by the licensee*.

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

 NRC RIS 2013-09 and IRS 8381 – 'Guidelines for effective prevention and management of system gas

- accumulation' <u>closed</u> after a satisfactory answer from the licensee;
- IRS 8890 'EDGs robustness in seismic conditions (generic issue at EDF NPPs)' – <u>closed</u> after satisfactory inspections;
- NRC IN 2007-21 S1 'Pipe wear due to interaction of flow-induced vibration and reflective metal insulation'
 <u>closed</u> after a satisfactory answer from the licensee;
- IRS 8984 'Electronic transmitter component heat rise and the impact on qualified life' – <u>closed</u> after a satisfactory answer from the licensee;
- IRS 8996 'Damage to wheels of the containment polar cranes at nuclear power plants' – <u>closed</u> after a satisfactory answer from the licensee;
- IRS 8725 'Inadequate Emergency Operating Procedure Guidance for Asymmetric Natural Circulation Cooldown' – the licensee provided a partial answer about the work on the development of asymmetric natural circulation guidance revision – waiting for additional information after finalisation of this revision.

Experience Feedback

Number of reports of national events analysed and documented

Number of reports of international events analysed and documented 107

4.3 Knowledge management

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

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

In 2022, several new engineers were recruited. This requires considerable efforts on the part of the more experienced engineers to ensure an adequate transfer of knowledge. A coach is assigned to every newly recruited person, to facilitate their integration. This knowledge transfer approach is combined with, among other things, on-the-job training and cross-functional activities. The recruitment of a high number of new people also requires customised training (see Section 4.5).

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

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

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

4.4 Research & Development

4.4.1 Introduction

Research and development (R&D) activities are fundamental for the development of independent and informed safety positions. Continuous efforts must be made to build up, enhance and consolidate the expertise of Bel V's technical team in various relevant technical domains of nuclear safety. In addition, R&D activities performed or supported by Bel V are becoming increasingly important with a view to supporting the business development strategy.

The total effort in R&D activities in 2022 amounted to 5,916 hours, which represents 5.4% of the total working time of Bel V's technical staff.

The R&D activities in 2022 were in line with the milestones of the R&D strategy 2020-2024 (revised in 2022), with several interactions with international organisations being organised within the framework of the OECD Nuclear Energy Agency (NEA), the EURATOM H2020 programme and ETSON. In particular:

 Bel V participated actively in the OECD/NEA ETHARINUS, ATLAS3, PRISME3, HEAF2, ROSAU and THEMIS projects.

- Bel V participated actively in the EC/H2020 projects
 MUSA and R2CA, as well as in the management and
 various activities of the European Joint Programme
 on Radioactive Waste Management (EURAD).
- Bel V joined the EC/H2020 projects ASSAS, HARPERS and HARMONISE.
- Bel V signed the USNRC's Thermal-Hydraulic Code Applications and Maintenance Program (CAMP) agreement and became the Belgian official representative. Discussions are underway with the Belgian partners for the use of CAMP codes.

It should be also emphasised that collaboration with universities and research institutes was pursued and remained an essential part of Bel V's R&D strategy. The R&D activities carried out by Bel V in 2022 are described in the following sections.

4.4.2 R&D on nuclear installation safety

Thermal hydraulic phenomena

Most of the thermal-hydraulic R&D activities scheduled in 2022 were carried out successfully. Firstly, these activities concerned the OECD/NEA ETHARINUS project in which accidental scenarios are experimentally investigated in PKL and PACTEL facilities. A Bel V proposal to carry out an experimental test related to the impact of a delayed main coolant pump trip during a small break loss of coolant accident (SBLOCA) on the peak cladding temperature (PCT) was endorsed by the consortium. Secondly, Bel V participated in the OECD/ NEA ATLAS3 project related to experiments performed in ATLAS/CUBE test facilities. In 2022, an analytical blind benchmark related to the assessment of code capabilities in simulating a DEC-A experimental test was carried out. The Bel V CATHARE calculation results were presented at the regular project meetings.

Bel V also participated in the OECD/NEA Rod Bundle Heat Transfer (RBHT) project, for which Bel V's contribution was limited to providing technical support for the interpretation of the simulated test matrix. With regard to the French DENOPI project, dedicated to the development of an experimental test matrix in the scaled-down MIDI pool test facility, Bel V received the final project report documenting the results of the MIDI tests. CATHARE calculations using the obtained test data will be carried out in 2023.

Within the framework of the H2020/R2CA European project, Bel V performed a CATHARE simulation of DBA and DECA scenarios including the code feature to assess the amount of radioactivity released to the environment. The CATHARE calculation results were documented in a dedicated deliverable of the project.

In 2022, Bel V started its participation in the OECD/ NEA WGFS/WGAMA initiative to write a technical report about 'Technical Bases and Guidance for Analyses of Design Extension Condition without Significant Fuel Degradation (DEC-A)'. Within this working group, Bel V gave two presentations and participated in the drafting of several chapters of the report.

Mechanical safety

Several years ago, IRSN, CEA and Bel V decided to launch biaxial tensile and bending experiments on test samples containing hydrogen. The purpose of these tests was to investigate the influence of the biaxial loading with respect to the mono-axial loadings. Two follow-up meetings were held in 2022 between IRSN, CEA and Bel V about this project. A report about the last test will be issued by CEA, and a global report about the whole project is expected in 2023.

Bel V participated in several ORIENT-NM meetings in 2022. ORIENT-NM is a European project whose objective is to produce a strategic research agenda for materials for all nuclear fission reactor generations, projected until 2040. The aim of the meetings held in 2022 was to introduce the project to the various stakeholders, and then to identify how these stakeholders, having perhaps different interests and constraints, could efficiently collaborate on this project. Bel V participated in these meetings as an ETSON representative.

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In 2022, Bel V was also an active contributor for WGAMA activities organised by OECD/NEA, especially in finite element analyses. In particular, Bel V participates in the Leak Before Break (LBB) and In-Vessel Melt Retention (IVMR) working groups, as a task lead member.

Fire protection

Bel V took part in the OECD/NEA PRISME3 project, in collaboration with the OECD/NEA FIRE database. The goal of this project is to compare fire modelling codes and practices between PRISME3 members and associated organisations, as well as to assess the predictive capabilities of these codes by ultimately simulating a real fire event from the FIRE database. Bel V will continue its participation in the OECD/NEA High Energy Arcing Fault Events (HEAF-2) project.

Probabilistic Safety Assessment (PSA)

Bel V participated in the annual OECD\WGRISK working group meeting and attended the OECD WGRISK Symposium on PSA for Reactors of Singular Designs (small modular reactors, MYRRHA, etc.). Bel V also attended a workshop organised within the framework of the End User Group of the EC/H2020 METIS project 'Methods and Tools Innovation for Seismic Risk Assessment' about extended seismic PSA approaches to be developed in METIS (presentation of Andromeda – SCRAM application to seismic PSA). Bel V also attended a webinar on Seismically-Induced Fire and Flooding (SIFF) organised by RELSAFE.

Severe accidents

The efforts in developing and improving severe accident simulation capabilities with the MELCOR code at Bel V continued in 2022, aimed at strengthening Bel V's capabilities for independent severe accident safety assessment of the Belgian nuclear power plants, but also at increasing its international visibility and experience. The following activities were carried out:

 Participation in the H2020 MUSA project by establishing a viable framework for performing uncertainty assessments using MELCOR code and statistical post-processing of the results.

- Bel V joined another H2020 project in 2022: Artificial intelligence for the Simulation of Severe AccidentS (ASSAS). Within this framework, Bel V was granted the license of the ASTEC code.
- Participation in the MELCOR Code Assessment Program (MCAP) meeting and the 14th European MELCOR User Group (EMUG) meeting, which provided valuable support to Bel V's severe accident modelling activities, including information on the capabilities of the MELCOR and SNAP codes.
- Contribution to the OECD/NEA ROSAU and THEMIS joint projects.

Finally, Bel V obtained an agreement to join the End User Group of another project funded by EURATOM: SASPAM-SA, led by ENEA. This project is aimed at investigating the possible severe accidents associated with small modular reactors. Bel V will formally join the End User Group of SASPAM-SA in the course of 2023.

Several papers and deliverables on the R&D activities carried out were produced during 2022.

Concrete ageing

Bel V participated in the annual technical meeting of the ODOBA project, which was held with all partners to discuss the status of the project, the ongoing results and the next steps of the project. The ODOBA project aims to conduct an experimental study of concrete ageing and degradation mechanisms. In 2022, Bel V presented the analyses and findings linked to the ageing and degradation mechanisms observed in the test walls at the Belgian surface disposal site.

ETSON collaboration and Expert Groups

As in previous years, Bel V continued contributing to the activities of the Technical Board on Reactor Safety (TBRS) and related ETSON Expert Groups, aimed at sharing views and experiences with colleagues from other technical safety organisations. The following activities and achievements can be highlighted:

- preparation of and active participation in the first ETSON Conference held in Garching (Germany) in October 2022, including the preparation of the ETSON Award contest organised by the ETSON Junior Staff Programme;
- contribution to the development of the TBRS report on challenges and opportunities for licensing process and safety assessment of small modular reactors;
- active participation in the TBRS meetings and contribution to the implementation of the TBRS work plan 2020-2025 through active involvement in the dedicated Expert Groups and their outcomes and activities;
- participation in an ETSON workshop on data science and artificial intelligence for nuclear safety assessments, held in Switzerland in October 2022;
- continuation of the Bel V contribution to the initiatives and tasks of the ETSON Communication Group (ETSON News, etc.).

MYRRHA

Within the framework of the MYRRHA project, the RELAP5-3D computer code was used to support pre-licensing safety assessment activities. This involved simulating pre-licensing accident transients. In addition, a preliminary simulation of the operation of the SCK CEN experimental facilities was performed using a RELAP5-3D model of the facilities. A review and study of technical information received from SCK CEN for use in the development of RELAP5-3D models of COMPLOT and E-SCAPE was carried out. Finally, a preliminary testing of the RELAP5-3D R&D for waste and decommissioning uses was performed.



4.4.3 R&D on waste and decommissioning

Near-surface disposal of category A waste

In 2022, the following activities were carried out:

- · screening of the literature on non-destructive/ destructive techniques for radioactive waste characterisation in order to complete the internal Bel V note;
- development of a tool for an independent verification of waste storage plans by drafting a list of the criteria, which will be taken into account for the development of the tool;
- participation in the 5th CHANCE project meeting (European Commission), during which the latest results of the ongoing experiments related to characterisation techniques such as tomography, calorimetry and laser spectroscopy were presented and discussed.



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Geological disposal of category B&C waste

The programme for 2022 mainly included progress on the Deployment Plan of the B&C Strategic Research Needs (SRN) and performing contractual and co-funded EURAD activities. Contributions to the strategic development within the framework of EURAD and SITEX.Network were also foreseen.

Concerning the EURAD project, Bel V's contribution to ROUTES was completed. With regard to its contribution to ACED and UMAN, Bel V limited its participation to:

- organising four WP Board meetings;
- contributing to a paper presenting UMAN results at the EURADWASTE conference;
- organising a UMAN course in February 2023 at Bel V.

Moreover, in 2022, Bel V played a key role in the strategic development of EURAD as Bel V coordinated



as Chair of the EURAD Bureau) the implementation of the update process for the EURAD Strategic Research Agenda. As a consequence of the involvement of Bel V in EURAD activities and the resource issues mentioned above, Bel V's contribution was mainly focused on activities dealing with:

- the development of modelling tools and their use for the screening of radionuclides considered as critical for the long-term safety of a disposal facility.
 Bel V, together with IRSN, prepared a benchmark activity regarding such modelling tools, including the IRSN code MELODIE and the Bel V code based on OPENFOAM. The benchmark preparation is well advanced and should be started in 2023;
- the organisation of a Pathway Evaluation Process (PEP) session in collaboration with ONDRAF/NIRAS and the NEA Forum on Stakeholders Confidence (FSC). The PEP is developed by SITEX.Network to structure constructive exchanges about the safety of radioactive waste management between different actors (including civil society).

In 2022, Bel V also signed a collaboration agreement with IRSN to perform joint R&D experiments in the IRSN underground laboratory.

Finally, Bel V's SITEX.Network activities in 2022 mainly including chairing the network.

Decommissioning and clearance

Within this framework, the following activities were carried out:

- A paper on the results of applying the SuDoQu methodology for deriving clearance levels for re-use of objects for 413 radionuclides was finalised, submitted to the Journal of Radiological Protection and reviewed by the Journal.
- Bel V attended some meetings as a member of the End User Group of the Laser Dismantling Environmental and Safety Assessment (LD-SAFE) project. In this role, it has pointed out the safety requirements for the dismantling activities that participants must be aware of in the development of the laser-cutting technology for the dismantling of the most challenging components of nuclear power reactors in air and under water.
- Bel V participates in the HARPERS project, which started in September with the inception meeting.

4.4.4 R&D on cross-cutting issues

Safety culture assessment

Bel V has a continuous focus on a better integration of the safety culture within the oversight practices, staff behaviour and its management system. With regard to R&D activities a technology / regulatory monitoring has been set up to maintain and improve processes in place.

Cybersecurity

The R&D activities in 2022 focused on a research programme dedicated to cybersecurity for industrial control system applications. Discussions are ongoing about the development of a small laboratory for the qualification of cybersecurity aspects of computer-based systems.

A collaboration with the Université libre de Bruxelles (ULB) is envisaged in the future in order to carry out these activities through proposals for a Master thesis subject sent to potential students of the CYBERUS Erasmus Mundus Master in Cybersecurity programme. Bel V received internship requests. A trainee will be selected and a starting set of equipment will be ordered in 2023.

Small modular reactors

The R&D activities with regard to small modular reactors (SMR) aim to maintain and develop expertise in the field of safety-related SMR features and designs through the review of related publications (including already developed foreign regulations) and through the participation in and the follow-up of the various ongoing international initiatives and efforts (IAEA, OECD/NEA, WENRA, etc.) aimed at facilitating the harmonisation of the licensing process and the study of safety and regulatory issues.

Within this framework, Bel V participated in:

 IAEA Technical Meeting on Instrumentation and Control and Computer Security for Small Modular Reactors and Microreactors;

- IAEA Technical Meeting on Generic User Requirements and Criteria of Small Modular Reactor Technologies for Near Term Deployment (August 2022);
- ETSON Expert Group: challenges and opportunities for licensing process and safety assessment of LW-SMRs;
- OECD/NEA Expert Group on Small Modular Reactors (EGSMR).

Fusion safety and licensing

The HARMONISE project was approved by the European Commission. Bel V participates in this project and attended the kick-off meeting as well as the first project workshop. This project aims to contribute towards the development of distinct performance-based licensing methodologies for innovative fission as well as fusion designs.

Accelerator-driven systems

In this field, the validation of assumptions (primarily with respect to the dismantling of proton accelerators with energies below 30 MeV) has resulted in a series of presentations and a number of recommendations following the analysis of the safety file of the new accelerator facility project. This work has also been incorporated into the IAEA Mirdec project, for which several publications and presentations were produced.



4.4.5 R&D collaboration

2022 saw the continuation of a number of R&D collaborations with Belgian universities and research institutes as well as with other organisations, mainly within the framework of OECD/NEA and European Commission projects. Some of these collaborations were completed in 2022.

R&D collaboration with Belgian universities

Ghent University

Bel V continued its partial funding of a PhD research at Ghent University about improving the modelling of transient effects of fires in confined and mechanically ventilated enclosures. The research funding by Bel V at Ghent University ran until the end of 2022. Ghent University will pursue the research work in 2023, using remaining budget and own funding.

Université catholique de Louvain (UCL)

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

University of Antwerp

A PhD started in 2018 related to the management of the 'insider threat' in sensitive industries. The focus is on the need for 'after-care' and follow-up of those individuals who can pose a threat after having received a safety certificate / clearance. The fourth year of the PhD was mainly dedicated to the drafting and issuance of the Delphi study report, the organisation of a table-top exercise to validate the Delphi study and the organisation of a workshop to compare security screenings in different European countries.

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

Institut de Radioprotection et de Sûreté Nucléaire (IRSN)

Bel V collaborates with the French technical safety organisation IRSN within the framework of the following activities:

- the ODOBA project aimed at performing experiments on concrete ageing and degradation mechanisms conducted by IRSN in Cadarache (France). The aim is to develop a predictive tool to estimate the durability of reactor containment buildings of nuclear power plants or waste repository facilities;
- the DENOPI project managed by IRSN. The project is aimed at acquiring experimental data on the physical phenomena associated with spent fuel pool loss-ofcooling and loss-of-coolant accidents. The project consists of a number of experiments, the results of which will serve as a basis for model development and validation of numerical simulation tools;
- a joint project aimed at performing experiments on test samples containing hydrogen flakes.

Rijksinstituut voor Volksgezondheid en Milieu (RIVM)

Bel V collaborates with the Dutch national institute for public health and the environment RIVM within the framework of the Surface Dose Quantification (SuDoQu) model development. The aim of this collaboration is to publish a paper in the Journal of Radiological Protection.

Sustainable Nuclear Energy Technology Platform (SNETP)

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

ETSON collaboration and Expert Groups

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

SITEX.Network

BelV is actively involved in the activities and management of SITEX.Network (Sustainable network for Independent Technical EXpertise of radioactive waste disposal). The purpose of SITEX.Network is to enhance and foster cooperation at the international level in order to achieve a high-quality expertise function in the field of safety of radioactive waste management, independent from organisations responsible for the implementation of waste management programmes and waste producers, aimed at supporting the nuclear regulatory bodies as well as civil society. SITEX.Network is open to any institution or individual party having interest in independent regulatory assessment of radioactive waste management activities (technical safety organisations, regulatory bodies and civil society organisations).

European Joint Programme on Radioactive Waste Management (EURAD)

BelVisactively involved in the activities and management of EURAD. This includes participation in the Bureau and General Assembly of the programme, as well as in several projects. The aim of EURAD is to implement a joint strategic programme of research and knowledge management activities at the European level. This programme brings together and complements EU Member State programmes in order to ensure cuttingedge knowledge creation and preservation in view of delivering safe, sustainable and publicly acceptable solutions for the management of radioactive waste across Europe now and in the future. EURAD gathers



mandated waste management organisations, technical safety organisations and research entities from EU Member States and associated countries.

OECD/NEA working groups

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

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

OECD/NEA Joint Projects

In 2022, Bel V participated in the following OECD/NEA projects:

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



European Commission projects

In 2022, Bel V participated in the following EC/H2020 projects:

- Reduction of Radiological Consequences of DBA and DEC-A (R2CA);
- Management and Uncertainties of Severe Accidents (MUSA);
- EURAD projects:
 - » Uncertainty Management Multi-Actor Network (UMAN) (Bel V acts as Lead of this project);
 - » Assessment of Chemical Evolution of Intermediate Level Waste (ILW) and High Level Waste (HLW) Disposal Cells (ACED);
 - » Waste management routes in Europe from cradle to grave (ROUTES).

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

- Characterisation of Conditioned Nuclear Waste for its Safe Disposal in Europe (CHANCE);
- Methods and Tools Innovation for Seismic safety assessment (METIS);
- Laser Dismantling Environmental and Safety
 Assessment (LD-SAFE);
- Organisation of the European Research Community
 on Nuclear Materials (ORIENT-NM).

Bel V received the green light to join the SASPAM-SA project, led by ENEA. This project is aimed at investigating the possible severe accidents associated with small modular reactors.



4.5 Training

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

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

A key element of the initial training of new members of staff is the programme of internal training sessions conducted by the Technical Training Manager with the help of experienced experts (mainly from Bel V) as lecturers. This programme comprises 35 training modules: 8 sessions took place in 2019, 6 in 2020, 7 in 2021 and 7 in 2022:

Percentage of total working time dedicated to training of staff in 2022



- · Q2-INST-1 Class I installations (nuclear power plants) / Q2-INST-2 Class I installations other than nuclear power plants;
- Q1-REG-5 Introduction to Safety Analysis Reports: TecSpec;
- Q1-REG-4 Quality Management System;
- Q3-RB-8 Decommissioning and Dismantling;
- Q2-RP-1 Radiation Protection Basics (Art. 25);
- · Q2-SPE-2 Ageing and Mechanical Analysis;
- · Q1-REG-2 DEC 'Design Extension Condition' A accident studies.

In addition, Bel V organises so-called 'Internal Technical Sessions' aimed at disseminating the R&D results to the Technical Responsibility Centres. In 2022, 1 Internal Technical Session was held.

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

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

In total, more than 28 training activities took place in 2022. Overall, the time dedicated to training represents approximatively 71 hours per individual per year.

6%



Balance sheet as at 31 December 2022

(amounts in € 1,000)

	2022		2021	
ASSETS		17,160		15,925
FIXED ASSETS		4,126		4,339
II. Intangible fixed assets		15		0
II.I. Tangible fixed assets		4,109		4,336
A. Land and buildings	3,657		3,819	
B. Plant, machinery and equipment	360		396	
C. Furniture and vehicles	92		121	
IV. Financial fixed assets		2		2
CURRENT ASSETS		13,034		11,586
VII. Amounts receivable within one year		4,029		3,293
A. Trade receivables	3,884		3,174	
B. Other amounts receivable	145		119	
IX. Cash at bank and in hand		8,847		8,073
X. Deferred charges and accrued income		158		220

	20	22	20	21
LIABILITIES		17,160		15,925
EQUITY		13,769		13,254
I. Capital	4,732		4,732	
IV. Reserves	2,868		2,868	
V. Result carried forward	6,169		5,654	
DEBTS		3,391		2,671
VII. Amounts payable after more than one year				
IX. Amounts payable within one year		3,387		2,667
A. Current portion of amounts payable within one year				
B. Trade debts	680		441	
D. Advances received on contracts in progress	483		200	
E. Taxes	2,224		2,026	
F. Other amounts payable				
X. Deferred charges and accrued income		4		4

Profit and loss account as at 31 December 2022

(amounts in € 1,000)

	2022	2021
Turnover	13,676	12,941
Other operating income	264	290
Total operating income	13,940	13,231
Services and other goods	2,109	1,491
Wages and social security costs	10,862	10,735
Depreciation	309	306
Write-downs on trade receivables		
Other operating charges	124	102
Total operating charges	13,404	12,634
Operating result	536	597
Financial charges and income	-22	-22
Profit on ordinary activities	515	575
Profit for the financial year	515	575

Profit and loss account: notes

Operating income

Income in 2022 was 5% higher than in 2021. This increase is partly the result of price indexation and partly the result of an increase in non-regulatory activities.

Turnover

The largest part of the turnover of Bel V (90%) was related to the regulatory inspections and safety assessments at Class I facilities, which are invoiced to the licensees on the basis of a fixed rate set by law. 2022 was marked by the customary inspections within the framework of the facility operations, the preparation for the shutdown of five nuclear power plants and the proposed lifetime extension of two nuclear power plants, the activities relating to the temporary on-site storage of spent fuel (SF² project), the inspections and analyses carried out under the licence application for a near-surface disposal facility, the activities for the MINERVA/MYRRHA project.

2022 also saw an increase in non-regulatory activities. Given the shutdown of several Belgian nuclear power plants, Bel V is diversifying its activities, including by acting as the technical safety organisation (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 is not actual revenue, but 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 16% of total operating charges. Some of the non-regulatory activities are being outsourced. This explains the relative increase in the share of 'Services and other goods' in total operating charges. Transport and travel costs reflect a level of activity similar to the years before the COVID-19 pandemic.

Wages and social security costs

Staff expenses represented 81% of the costs, including training expenses. Proportionally, this represents a slight increase compared to 2021. However, the absolute value of staff costs in 2022 is slightly higher than in the previous financial year.

Operating result

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

List of abbreviations

ANVSAutoriteit Nucleaire Veiligheid en Stralingsbescherming (Netherlands)
ASNAutorité de Sûreté Nucléaire (France)
CEA Commissariat à l'énergie atomique et aux énergies alternatives (France)
CNRACommittee on Nuclear Regulatory Activities (OECD)
CSNI Committee on the Safety of Nuclear Installations (OECD)
DECOMDecommissioning
DSADirektoratet for strålevern og atomtryggleik (Norway)
ECEuropean Commission
ETSON European Technical Safety Organisations Network
EUEuropean Union
EURADEuropean Joint Programme on Radioactive Waste Management
FANC Federal Agency for Nuclear Control
FBFCFranco-Belgian Fuel Fabrication
FINAS Fuel Incident Notification and Analysis System
GICGeïntegreerde Inspectie- en Controlestrategie – integrated inspection and control strategy
GRSGesellschaft für Anlagen- und Reaktorsicherheit (Germany)
HERCA Heads of European Radiological Protection Competent Authorities
IAEAInternational Atomic Energy Agency
INESInternational Nuclear and Radiological Event Scale
INSCInstrument for Nuclear Safety Cooperation (European Commission)
IRENational Institute for Radioelements
IRRSIntegrated Regulatory Review Service
IRSIncident Reporting System
IRSNInstitut de Radioprotection et de Sûreté Nucléaire (France)
IRSRRIncident Reporting System for Research Reactors
LTO Long-Term Operation
MINERVA Myrrha Isotopes productioN coupling the linEar acceleRator to the Versatile proton target fAcility
MYRRHAMulti-purpose hYbrid Research Reactor for High-tech Applications
NCCN National Crisis Centre of the Federal Public Service Interior
NEANuclear Energy Agency (OECD)
NRCNuclear Regulatory Commission (US)
OECDOrganisation for Economic Co-operation and Development
ONDRAF/NIRAS Agency for Radioactive Waste and Enriched Fissile Materials
ONR Office for Nuclear Regulation (United Kingdom)
POPPost-Operational Phase
PSA Probabilistic Safety Assessment
PSAR Preliminary Safety Analysis Report
PSR Periodic Safety Review
R&DResearch & Development
RECUMO REcovery and Conversion of Uranium from MOlybdenum production
RIVMRijksinstituut voor Volksgezondheid en Milieu (Netherlands)

SCK CEN	. Studie Centrum voor Kernenergie – Centre d
SITEX.Network	. Sustainable network for Independent Techni
SMART	. Source of MedicAl RadioisoTopes
SNETP	. Sustainable Nuclear Energy Technology Platf
SRL	. Safety Reference Levels
TBRS	. Technical Board for Reactor Safety (ETSON)
TRC	. Technical Responsibility Centre (Bel V)
TSAR	. Topical Safety Assessment Report
TSO	. Technical Safety Organisation
TSOF	. Technical and Scientific Support Organization
WENRA	. Western European Nuclear Regulators Assoc

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