# SCK•CEN

## Belgian Nuclear Research Centre


60 years of experience
in nuclear science and technology

SCK•CEN
STUDIECENTRUM VOOR KERNENERGIE
CENTRE D'ETUDE DE L'ENERGIE NUCLEAIRE

Editing

SCK•CEN, Belgian Nuclear Research Centre

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# Foreword

Nuclear materials science, advanced nuclear systems, environment, health and safety: for 60 years research carried out at SCK•CEN has covered a wide range of topics. However, no matter how diverse our activities might be, they all have one thing in common: they aim to benefit society. Thus we contribute to the safety of nuclear installations, the protection of mankind and the environment against radiation and the well thought-out short and long-term management of radioactive waste.

The demand for sustainability is becoming more and more pressing in today's and tomorrow's world. At SCK•CEN we are constantly looking for sustainable solutions, including new more efficient reactors, nuclear fusion and renewable energy applications. Research, innovation and state-of-the-art nuclear technology are the key topics.

The focus is on MYRRHA, a multifunctional irradiation facility that will support the development of sustainable technologies in different ways. MYRRHA enables us to carry out research into how radioactive waste with a long half-life can be converted into waste associated with much shorter term risks. At the start of 2010 the Belgian government decided to lend financial support to this pioneering international project. Just over a year later SCK•CEN achieved a world first with the construction of a nuclear system driven by a particle accelerator: a major step forward in the further development of MYRRHA.

However, we also look beyond scientific and technological research. Our knowledge and expertise provide tailor-made answers to industry, the medical sector and the authorities. For instance, we produce a quarter of the world's radioisotopes for nuclear medicine and irradiate silicon for electronic components in hybrid cars, wind turbines and solar panels.

Our consideration for the social and ethical dimensions of nuclear applications, both now and in the future, demonstrates SCK•CEN's engagement with society.

Enjoy your read.

Eric van Walle
Director-General

# 1

# SCK•CEN: the Belgian Nuclear Research Centre

## 60 years of experience

The Belgian Nuclear Research Centre was founded in 1952. This gave the Belgian academic and industrial world access to the worldwide development of nuclear energy. Ever since SCK•CEN has been playing a pioneering role with unique achievements and groundbreaking work in nuclear science and technology.

Today SCK•CEN, with laboratories in Mol and a registered office in Brussels, is one of the largest research centres in Belgium. About 700 people work on the development of peaceful industrial and medical applications of ionising radiation and study the impact on man and the environment. Our goal: to constantly strive for excellence in nuclear expertise and research.

## Fundamental and applied research

SCK•CEN conducts fundamental and applied research at an advanced scientific level and in an international context. Our core activity is to work on issues that are important to society today and tomorrow. Our studies help the nuclear sector to improve the safety and efficiency of nuclear installations. We look for solutions for the disposal of radioactive waste and have developed techniques for the decommissioning of nuclear plants. The protection of mankind and the environment against ionising radiation represents another extensive research area.

## Three scientific institutes

- The Institute for Nuclear Materials Science carries out research on materials and fuels used in present and future nuclear installations.
- The Institute for Advanced Nuclear Systems develops knowledge about the technological aspects of innovative nuclear reactors, and designs, constructs and operates experimental assemblies for various projects. It supports the nuclear industry and authorities on a national and international level.
- The Institute for Environment, Health and Safety studies the behaviour of radioactive substances in the biosphere (air, water, soil, plants, etc.) and geosphere (subterranean clay layers, groundwater, etc.) and evaluates the impact of radiation on mankind and the environment. The institute also carries out research into the disposal of radioactive waste, decommissioning of nuclear installations and the social aspects of nuclear technology.

These scientific institutes are supported by the Institute for General Services and Administration, which also, amongst other things, coordinates training activities.

# Research towards a sustainable option

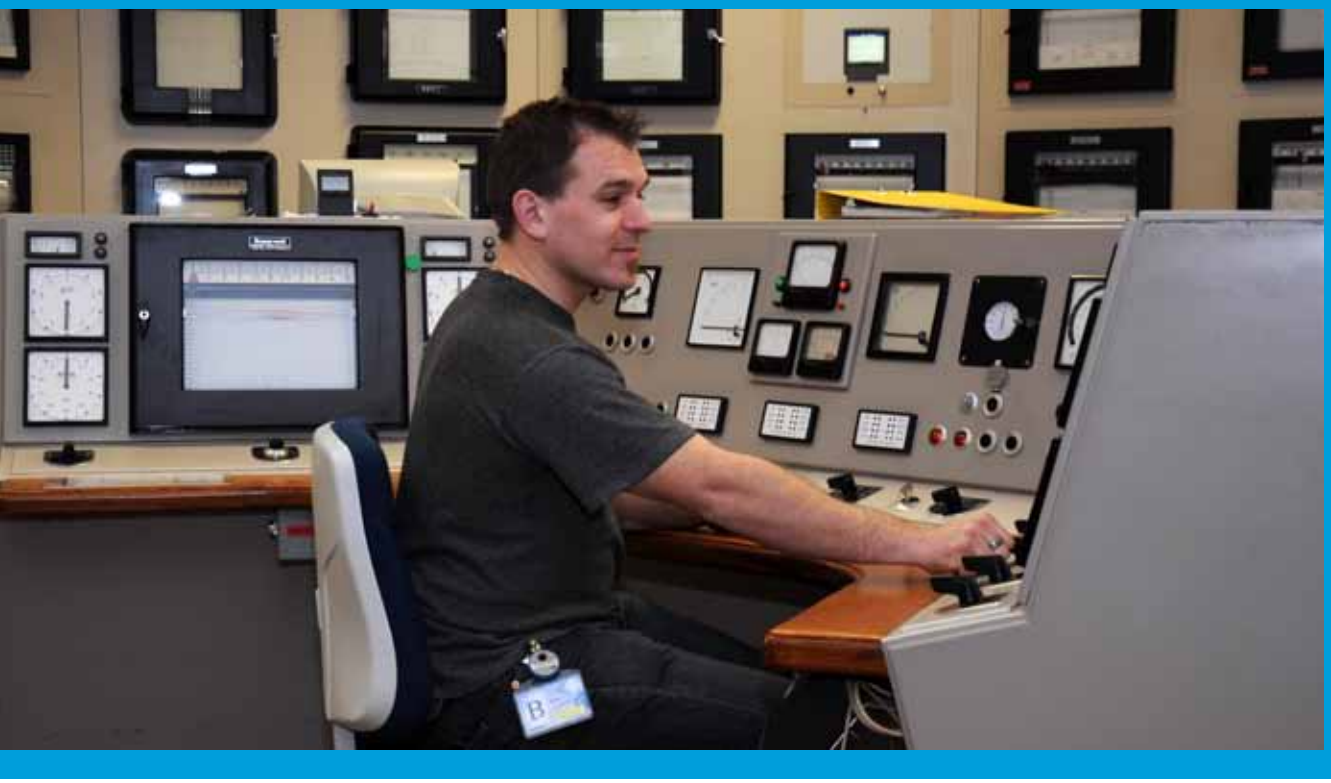
Our motto 'research towards a sustainable option' summarizes our mission completely. Global energy issues, safety of nuclear installations or innovative technologies: SCK•CEN does it all with sustainability in mind. In this way we contribute to a viable society, for ourselves and for the generations to come.

Our research in the field of reactor materials and nuclear fuels is vital to closely monitor the safety of nuclear power plants in the coming decades. Our knowledge is also essential in the decommissioning of nuclear installations and to safeguard reliable surface and deep disposal of radioactive waste. We are carrying out groundbreaking research into new, more efficient reactors that will produce less waste and will be intrinsically safe. SCK•CEN's expertise is making nuclear fusion technology, which should facilitate sustainable energy production in the future, more tangible.

SCK•CEN develops advanced nuclear systems such as MYRRHA, a multifunctional experimental irradiation facility for the production of radioisotopes and doped silicon. MYRRHA will also contribute to the study of materials for innovative fission reactors and nuclear fusion, and to research on the transmutation concept to convert long-lived radioactive waste into waste that decays more quickly.

# BR1: the first reactor in Belgium still providing a service

Belgian Reactor 1 or BR1, which has been operational since 1956, is the oldest research reactor in Belgium. BR1 is air-cooled, graphite moderated and runs on natural uranium. It is a flexible test reactor for calibrating measurement equipment. SCK•CEN uses BR1 for its own research activities but the reactor is also available to other research centres, universities and industry, and plays an important role in the education and training of scientists and engineers.



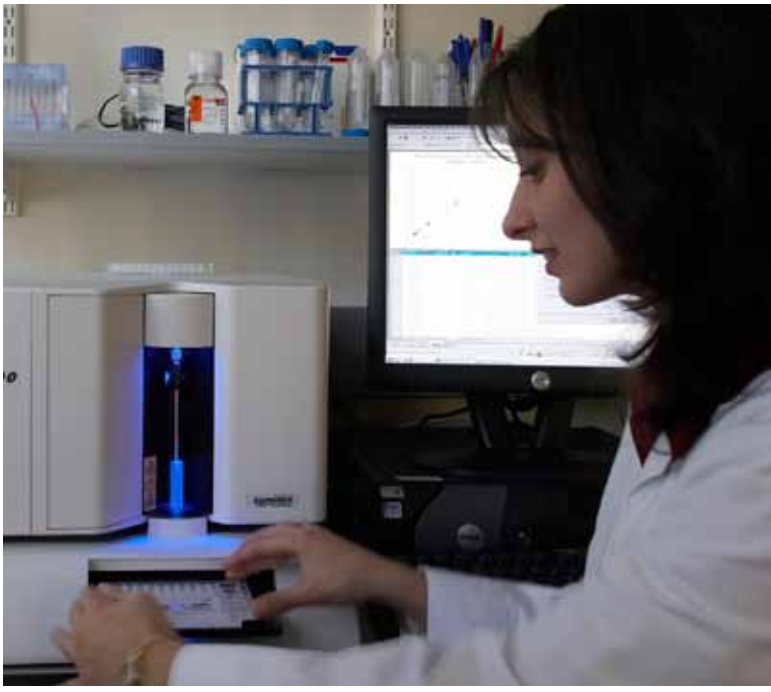
# In tune with society

As a foundation of public utility, societal relevance is key to SCK•CEN. Our knowledge is for the benefit of society as a whole: the population, government, healthcare system, industry and research.

Our expertise in radioactive substances and ionising radiation puts us in a unique position to make recommendations on the protection of mankind and the environment against ionising radiation. We produce radioisotopes that are essential for medical imaging, cancer treatment and specific industrial applications. SCK•CEN is also a specialist in the irradiation of silicon for electronic components used in high-power applications such as hybrid cars, high-speed trains, solar panels and wind turbines that generate 'green electricity'.

Science is about gathering and sharing knowledge. SCK•CEN is not only a renowned research institute in a global network of scientific institutions, it is also internationally recognised as an education and training centre, contributing substantially to the improvement of the skills of future scientists and experts. We collaborate with the academic world, industry and authorities. We also communicate our vision and expertise to the general public. In this way we broaden the support for research into nuclear applications and stimulate a culture of debate.

Whatever choices may be made in the future, questions on nuclear safety, radiation protection and the disposal of radioactive waste will remain. Hence SCK•CEN examines subjects such as sustainable development, risk perception, communication and cross-generation ethics. We aim for transparency and want to stimulate critical thinking about nuclear technology.



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# Radiation protection: care for mankind and the environment

Ionising radiation can be harmful. SCK•CEN contributes to ensuring the safety of mankind and the environment. We study how radioactivity is transferred in the biosphere (air, water, soil, plants, etc.) and geosphere (subterranean clay layers, groundwater, etc.) and assess the impact on mankind and the environment.

We use our expertise in radiological protection to provide services and policy support. SCK•CEN gives advice and practical recommendations to nuclear companies, the medical sector, the authorities and the International Atomic Energy Agency (IAEA).

The societal aspects of nuclear technology are also being investigated, with emphasis on public participation in the decision making process. The focus is on three major areas: radioactive waste management, nuclear risks and energy management.

## Radioactive substances: distribution and impact

SCK•CEN studies the behaviour of radioactive materials in the biosphere and geosphere, and develops models to predict their distribution so that the consequences of exposure for mankind and the environment can be assessed. We examine a wide range of situations, from waste disposal and the operation of nuclear installations, to emergency situations and situations involving increased concentrations of naturally occurring radioactive materials. We use our knowledge to propose measures to limit the impact of radiation on mankind and the environment and we develop techniques for environmental remediation.

In the event of a nuclear accident it is vital to take appropriate protective measures. SCK•CEN, together with the Belgian authorities and the Federal Agency for Nuclear Control (FANC-AFCN) is a key player in the Belgian emergency plan organisation. We employ state-of-the-art laboratories to measure radioactive substances and radiation in various materials ranging from nuclear fuels to biological and environmental samples. We are able to evaluate the dose and, where applicable, internal contamination in people and are optimising methods to define the dose following accidental exposure even more accurately.

To prevent nuclear terrorism proper management of nuclear fuels and other strategic materials is crucial. SCK•CEN is active in the field of non-proliferation, which aims to prevent the uncontrolled distribution of nuclear materials around the world.

# Focus on radiation impact

Multidisciplinary radiobiological research lies at the heart of nuclear medicine and radiological protection. Among many other activities in this field, SCK•CEN investigates the impact of ionising radiation on developing life and studies the cancer and non-cancer related health effects of radiation on the heart and blood vessels, or the brain. We try to understand the impact of radiation at cellular and molecular level in order to better assess the potential risks of low doses with a focus on sensitivity to ionising radiation in man and mammals and individual radiation sensitivity.

In addition, we analyse the impact on health of diagnostic imaging and try to limit the damaging effects of radiotherapy. We design models and control techniques for enhanced evaluation of doses in order to reduce the exposure of both patients and medical staff without affecting the medical benefits. Because they are particularly sensitive the emphasis is on the treatment of babies and small children. We are developing new methods to define doses more accurately. We also check the dosemeters used by employees in the nuclear and medical sectors.

SCK•CEN uses the latest molecular biology techniques to study the mechanisms associated with radiation sensitivity or resistance in bacteria and plants, thus contributing to the development of a system to protect fauna and flora from the potential damaging effects of radiation where heavy metals may, or may not, be present.

Together with international partners SCK•CEN also studies the impact of cosmic radiation on man, bacteria and plants, in conjunction with micro-gravity in space. In cooperation with the European Space Agency, we are developing biological systems to purify water and recycle waste into oxygen and food for long-term space missions, e.g. to Mars.

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# Technological innovation: making the impossible possible

Fundamental and applied scientific research is the engine of technological progress. SCK•CEN cooperates in the development of innovative experimental nuclear installations.

## Fourth generation reactors: Gen IV

SCK•CEN tests materials and fuels for fourth generation (Gen IV) nuclear reactors and participates in European projects focused on their design and safety. These future installations make more efficient use of nuclear fuels thereby delivering higher performance: they can produce up to 50 times more electricity with the same amount of natural uranium, which results in less radioactive waste.

## Accelerator Driven System: MYRRHA as a prototype

At an international level SCK•CEN is developing MYRRHA (Multipurpose hYbrid Research Reactor for High-tech Applications), a multifunctional experimental irradiation facility. MYRRHA is the world's first prototype of a nuclear system driven by a particle accelerator. This method is referred to as Accelerator Driven System or ADS - a very safe and easily controllable nuclear technology. Contrary to a conventional reactor, an ADS has a subcritical core, i.e. there is not enough fissile material to maintain the chain reaction. To prevent the reactor from stopping it has to be 'fed' continually with neutrons generated by a particle accelerator. When the latter is disconnected the chain reaction ceases in a fraction of a second and the reactor stops working.

The MYRRHA project started in 1997 and the aim is to become fully operational by 2023. The system will guarantee services to, and the training of, a new generation of scientists and engineers. In addition to demonstrating the ADS concept, MYRRHA facilitates the study of the transmutation of long-lived radioactive waste into a state that decays more quickly. This will reduce the amount and radiotoxicity of the waste and decrease the necessary disposal time from a few hundred thousand years to less than a thousand years.

In time MYRRHA will replace the BR2 reactor for the production of radioisotopes and doped silicon. The installation will also contribute to sustainable energy production with the development of materials and fuels for innovative fission systems and fusion technology. In addition MYRRHA will enable fundamental research in various scientific disciplines.

## From VENUS to GUINEVERE: a world first for SCK•CEN

The VENUS research reactor, which stands for Vulcan Experimental Nuclear Study, has been operational since 1964. This flexible facility has already been renovated and modernised several times. VENUS was initially used to study the optimal nuclear fuel configuration for various nuclear reactors. As a result of the flexibility of VENUS we were able to simulate different fuel compositions.

In 2008 SCK•CEN began modifying the VENUS reactor in preparation for the GUINEVERE project that started in 2010. GUINEVERE, which stands for Generator of Uninterrupted Intense NEutrons at the lead VEnus Reactor, was developed as an accelerator driven system or ADS.

The particle accelerator and research reactor were successfully linked together in 2011 – a world first! SCK•CEN thus created the first scale model of a subcritical system consisting of a reactor with a total lead core driven by a particle accelerator. A significant step forward in ADS associated research and the realisation of MYRRHA.

# Nuclear fusion: the technology of the future?

Unlike fission reactors, fusion reactors are safer and produce no long-lived radioactive waste. Moreover, the supply of fuel (deuterium and tritium produced from lithium extracted from seawater) is virtually inexhaustible. This technology is, therefore, recommended as the energy source of the future.

But, there are still major technical and practical challenges to overcome: at present fusion technology is still a pipe dream. Research centres throughout the world are currently combining their expertise to fine tune this technology. The construction of the ITER test fusion reactor in Cadarache in southern France is one important outcome of this cooperation.

SCK•CEN is studying the effects of radiation on equipment and material properties, and developing methods to recycle nuclear fusion fuel and limit radioactive waste. We also take into account the societal and economic aspects of nuclear fusion.

Japan and the European Union have decided to formulate a 'broader approach' to nuclear fusion aimed at developing technologies and carrying out research that cannot be conducted in ITER, including materials that will have to withstand heavy radiation damage and extremely high temperatures.

SCK•CEN coordinates the Belgian participation in this international cutting edge R&D programme. Our expertise in the design of experimental assemblies is used to develop specific modules for a new irradiation installation to test fusion materials. This will provide vital information for the construction of commercial fusion reactors after ITER.

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# Nuclear safety: the present under control, the future secured

## Material testing

Ionising radiation can affect the materials in a reactor, cause small cracks and weaken components. In order to deal with this issue, SCK•CEN irradiates materials in extreme conditions in the BR2 reactor. The damage and ageing processes are analysed in our Laboratory for High and Medium level Activity (LHMA). Material compositions and chemical processes are analysed in specialist radiochemical laboratories.

Based on the test results, SCK•CEN develops models to predict the development and lifetime of materials and nuclear fuels. In this way we contribute to safer and more efficient nuclear reactors for the production of electricity.

We also examine the pressure vessel steel of Belgian and foreign nuclear power plants. Our analyses have demonstrated that the pressure vessels in Belgian nuclear power plants will last for quite a few more years so in this respect there are no technical-scientific reasons to close the power plants after 40 years' operation.

## BR2: one of the world's most powerful and flexible research reactors

Belgian Reactor 2 or BR2 is one of the most powerful materials testing reactors in the world. Since its introduction in 1962, the reactor has operated on uranium with pressurised water as a coolant and moderator.

BR2 plays a prominent part in international research into the effects of ionising radiation on reactor components and is used by SCK•CEN to irradiate materials and fuels for various reactor types and for the European nuclear fusion programme.

Together with four other reactors, BR2 is responsible for the production of 90 % of the radioisotopes that are used worldwide in nuclear medicine for diagnosis and treatment. Other radioisotopes are used in industry, for example in sensors used to determine the density and moisture content of materials.

In BR2 we also irradiate silicon. This yields a high-grade semiconductor material that is used, amongst others, in electronic components for hybrid cars, solar panels and wind turbines.

## LHMA: focus on material properties

In the Laboratory for High and Medium level Activity (LHMA), SCK•CEN studies irradiated reactor materials and nuclear fuels in shielded cells. These so called hot cells are equipped with remote manipulators for radioactive components.

Using mechanical, chemical and microstructural research instruments, we analyse the damage and ageing processes of the materials. Using this information and computational models it is possible to predict the behaviour and lifetime of components. This is essential for a correct assessment of the service life of both existing and new nuclear reactors.

## Fuel qualification

To qualify fuels for nuclear power plants, one must show that a new design performs safely at normal and extreme conditions. SCK•CEN has contributed for many years to the continuous improvement of nuclear fuels. In the BR2 reactor we can simulate the conditions in nuclear power plants. We examine fuel rods from nuclear reactors and carry out irradiation tests, following which we study the radiation impact in the Laboratory for High and Medium level Activity.

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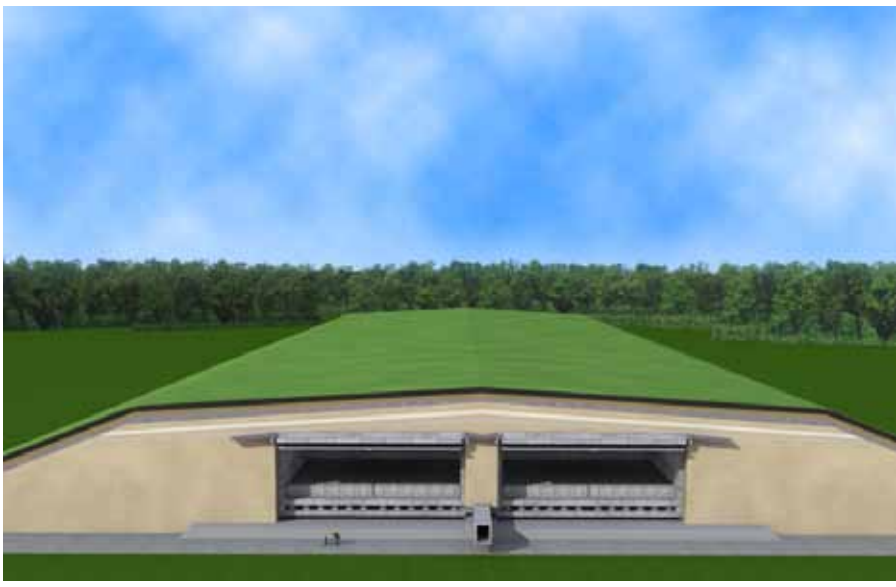
# Radioactive waste and decommissioning: searching for sustainable solutions

## Disposal of radioactive waste

There is no getting around radioactive waste from nuclear applications. In collaboration with the Belgian Agency for Radioactive Waste and Enriched Fissile Materials (ONDRAF/NIRAS), we are studying how radioactive waste can be stored safely. We develop and evaluate solutions for the surface disposal of low-level radioactive waste and the deep disposal of long-lived medium and high-level radioactive waste.

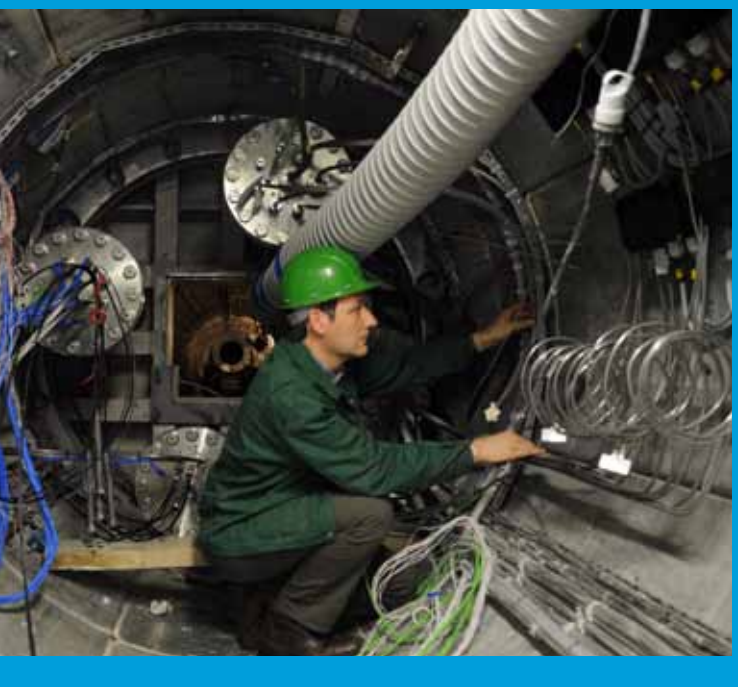
SCK•CEN assists ONDRAF/NIRAS with studies for the safety dossier of the surface disposal installation for low-level waste in Dessel. We are analysing the installation's performance and assess the concrete structure's long-term sustainability. This includes the characterisation and modelling of groundwater flows and development and testing of biological, geological and chemical process simulation models.



# HADES: deep disposal of radioactive waste unravelled

HADES stands for High Activity Disposal Experimental Site and is by no means coincidentally the name of the Greek god of the underworld. The laboratory is located in the Boom clay layer 225 meters beneath the SCK•CEN site. EIG EURIDICE (European Underground Research Infrastructure for Disposal of nuclear waste In Clay Environment) is the economic cooperation between ONDRAF/NIRAS and SCK•CEN. It actively contributes to the feasibility studies into the disposal of radioactive waste in clay layers. The partnership is involved in international research programmes and its geological experiments are renowned worldwide.

The construction of HADES was based on several stages. Excavation of the first access shaft began in 1980. In subsequent phases the excavation techniques were improved and methods were developed to limit disturbance of the clay layer. At the beginning of this century the infrastructure was extended with an extra gallery to demonstrate the possibility of safely disposing high-level heat emitting radioactive waste in clay.



The HADES underground research facility in the clay layer 225 meters beneath the SCK•CEN site plays an important part in the disposal of long-lived medium and high-level radioactive waste. Its construction has long since proven that it is technically and financially feasible to excavate shafts and galleries in deep geological clay layers. Using computer simulations and extensive laboratory research we study the development of waste properties, artificial barriers (metal or concrete containers) and the natural geological barrier (the clay and its environment). This also includes research into the potential impact of microbial populations in these clay layers.

An understanding of all these processes provides an insight into the disposal concept's long-term safety. Many years of experience and extensive laboratory studies show that disposal in this type of clay layer is both feasible and safe.

# Decommissioning: safe, technically feasible and economically justified

When a nuclear installation is shut down the infrastructure must be decontaminated and dismantled to ensure that there is no longer any elevated radioactivity. The safety authorities can then release the terrain as a 'green field' site to be used for new purposes.

SCK•CEN started to decommission its BR3 reactor in the late eighties. In order to minimise the quantity of radioactive waste we developed new techniques to cut, decontaminate and measure reactor components. We have also introduced specific methods to protect workers from ionising radiation and limit their exposure.

This scientific and technical knowledge, which provides an insight into the financial cost and radiological impact of decommissioning nuclear installations in the future, is already applied in projects outside SCK•CEN. The information also acts as a guideline in the design of new installations in order to ensure that, when they have reached the end of their service life, they can be decommissioned fairly easily.

## BR3: the key to research on decommissioning

Belgian Reactor 3 or BR3, which was a prototype pressurised water reactor, was operational between 1962 and 1987. It was Western Europe's first reactor of this type and it was also the first to be decommissioned. The pressurised water reactor is the most common in nuclear power plants, not only in Belgium, but also worldwide.

The European Commission selected BR3 as a pilot project to study the technical and economic feasibility of decommissioning a reactor. SCK•CEN developed new techniques to guarantee safety throughout the entire process. The knowledge acquired with respect to radiation protection, waste and decommissioning techniques helps to predict the economic and radiological impact of new projects.

The decommissioning of a reactor consists of several stages. With BR3 the first stage involved the removal of high-active components. The second stage covered the dismantling of various contaminated circuits. This was followed by the decontamination and dismantling of the concrete infrastructure. By 2020, BR3 will be fully decommissioned.

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# Extensive options: technology and services based on a reliable scientific foundation

## Our statutory mission

Scientific research within SCK•CEN is the very basis of its existence: it is the driving force for technological developments and services. Our main objective is to maintain and extend a centre of excellence for research on peaceful nuclear science and ionising radiation applications.

To this end SCK•CEN will:

- in terms of priority conduct research on the safety of nuclear installations, safe treatment and management of radioactive waste, protection of mankind and the environment from radiation, management of fissile and other strategic materials;
- conduct research into the social implications of pursuing sustainable development;
- develop, gather and disseminate the necessary knowledge through education and communication;
- provide all the services which are asked of it in the specific field, in particular by the nuclear industry, medical sector and the government;
- make the necessary multidisciplinary scientific contacts concerning energy issues.

SCK•CEN is active in three different areas, i.e. scientific research, technological development and services. This enables us to accrue and apply newly acquired knowledge and anticipate the requirements of our stakeholders and customers.

This applied approach is made possible by our highly experienced and expert workforce, which has access to an extensive research and production infrastructure, including high performance multi-purpose research reactors, various pilot installations, well equipped hot cells and laboratories.

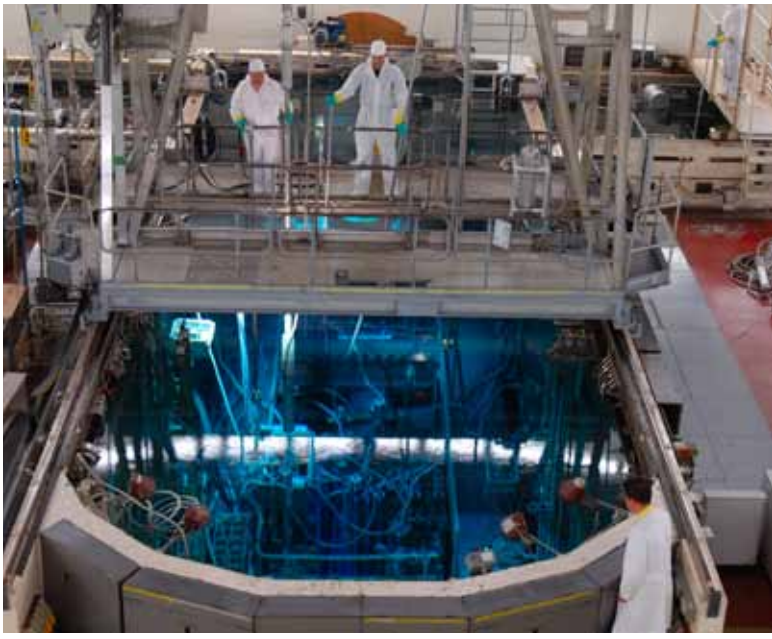
SCK•CEN invests a considerable amount of money each year in maintaining, improving and extending its infrastructure. An important milestone is MYRRHA, a unique and innovative research reactor that will make a substantial contribution to new nuclear technology applications.

# Technology and services

SCK•CEN is working on a range of different nuclear technologies and provides various services to government, industry and the medical sector. Examples include:

- Reactors: development and construction of irradiation equipment, systems development, safety studies and inspection.
- Testing of structural materials (e.g. steel for nuclear reactor vessels) and nuclear fuels;
- Decommissioning and decontamination of nuclear installations.
- Recommendations on the management and disposal of radioactive waste.
- Advice on the remediation of radioactive contaminated soils.
- Monitoring the effects of nuclear incidents on mankind and the environment.
- Modelling exposure to radiation for man, flora and fauna.
- Dosimetry of staff working in nuclear companies and the medical sector.
- Measurement of low-level radioactivity (alpha, beta, gamma radiation).
- Performing radiochemical analyses.
- Production of doped silicon and medical and industrial radioisotopes.
- Education and training across all fields of nuclear technology.

Clearly, we have experience in both routine and highly specific tasks. SCK•CEN ensures continuous innovation and aims to achieve quality and recognition on the basis of national and international standards.

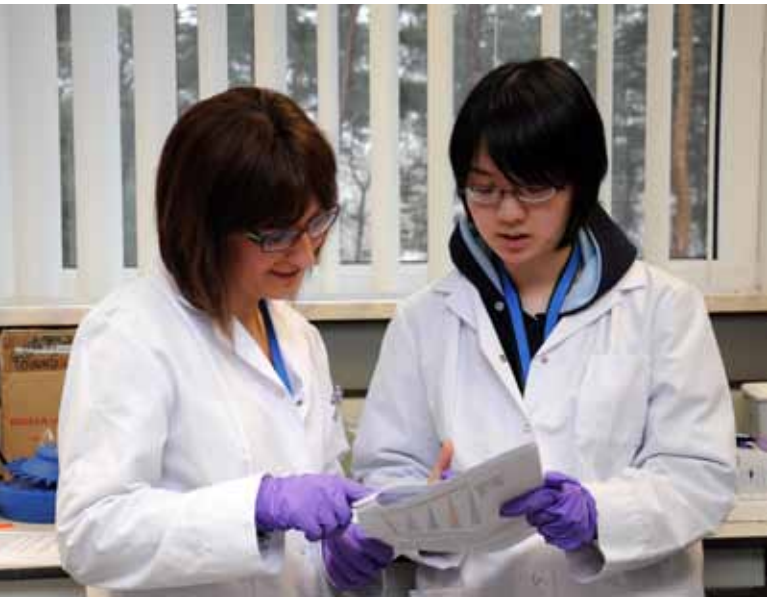


# Education and training: transferring knowledge

Dissemination of knowledge is one of our core activities. Our long-standing experience based on knowledge and practical application has given us an enviable reputation as a training centre. The Academy for Nuclear Science and Technology was established in 2012 to combine and further develop our activities in this field. The SCK•CEN Aacademy focuses on four important principles.

## Providing guidance to young scientists

Each year we offer newly graduated scientists and engineers the possibility to undertake their doctoral or post-doctoral research at SCK•CEN, on a subject covered by one of our priority research areas. Our experts also advise those taking bachelor and masters diplomas on their dissertations. Our laboratories and installations are made available to them.



## Organising training courses

SCK•CEN organises training courses for employees in national and international nuclear companies, the medical sector and governmental organisations. Modular training programmes are tailored to the needs of the target audience and their duration and level are adjusted accordingly. Training sessions ideally take place in Mol, so that theoretical classes can be combined with practical exercises and a tour of the technical installations.

All our research fields, such as radiological protection, emergency planning, radioactive waste management, decommissioning of nuclear installations, nuclear technologies and materials, etc. are covered by our training programmes.

At the academic level SCK•CEN is cooperating with Belgian universities and higher education institutions. We founded the Belgian Nuclear higher Education Network (BNEN) and contribute significantly to training for radiation experts.

## Providing policy support

A coherent approach to nuclear training is crucial in a world where the economy and industry are constantly changing and workers are becoming increasingly mobile. By networking and through participation in specific programmes SCK•CEN contributes to improved harmonisation of education, training practices and skills recognition at a national and international level.

Within the European Commission's framework programmes we participate in several education and training projects and coordinate a radiation protection project, in which harmonisation of training is achieved with the establishment of international standards for specific professions. We also advise the European Commission on the review of the Basic Safety Standards and changes to European legislation via the European Training and Education in Radiation Protection foundation (EUTERP).

Last but not least, from the very outset SCK•CEN has been a major partner in the European Nuclear Education Network (ENEN), which brings together all major European academic institutions and training centres for nuclear engineering.

## Towards a cross disciplinary approach

Understanding the benefits and risks of radioactivity not only requires technical insight and training, but also an insight into the social context and an appreciation of the social and philosophical aspects. Together with the academic world we examine how aspects such as risk perception, stakeholder involvement and communication can be integrated as smoothly as possible into information and training programmes for professionals and students.

## Belgian Nuclear higher Education Network (BNEN)

The BNEN brings together the nuclear expertise and experience of six Belgian universities and SCK•CEN. It offers a unique Master-after-Master programme in nuclear technology. All tutorials take place in Mol. SCK•CEN's installations and laboratories are made available for practical sessions.

BNEN

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CENTRE D'ETUDE DE L'ENERGIE NUCLEAIRE

UNIVERSITEIT GENT

KATHOLIEKE UNIVERSITEIT LEUVEN

ULB

Vrije Universiteit Brussel

Université de Liège

UCL Université catholique de Louvain

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# International cooperation: cross border research

SCK•CEN is a prominent partner in an international network of scientific institutions. We have cooperation agreements with many research centres, universities, companies and organisations in different countries. A number of our research projects are performed within the framework of European Commission programmes, but SCK•CEN also has partners outside European Union borders.

SCK•CEN fosters the international exchange of knowledge and experience. Our staff attend congresses and forums worldwide to present their research findings and gather new knowledge. SCK•CEN itself organises conferences and training, nationally and abroad. Our experts also regularly provide advice at the request of leading bodies such as the International Atomic Energy Agency (IAEA), the United Nations and the OESO Nuclear Energy Agency.

The numerous foreign students and experts that work at SCK•CEN are proof of the international nature of our research centre. The new MYRRHA project also attracts researchers and engineers from all over the world. Our national and international activities and guests encourage scientific and technical innovation in various fields, which in turn promotes Belgium, Flanders and the Kempen region.

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# Building a future based on 60 years of experience

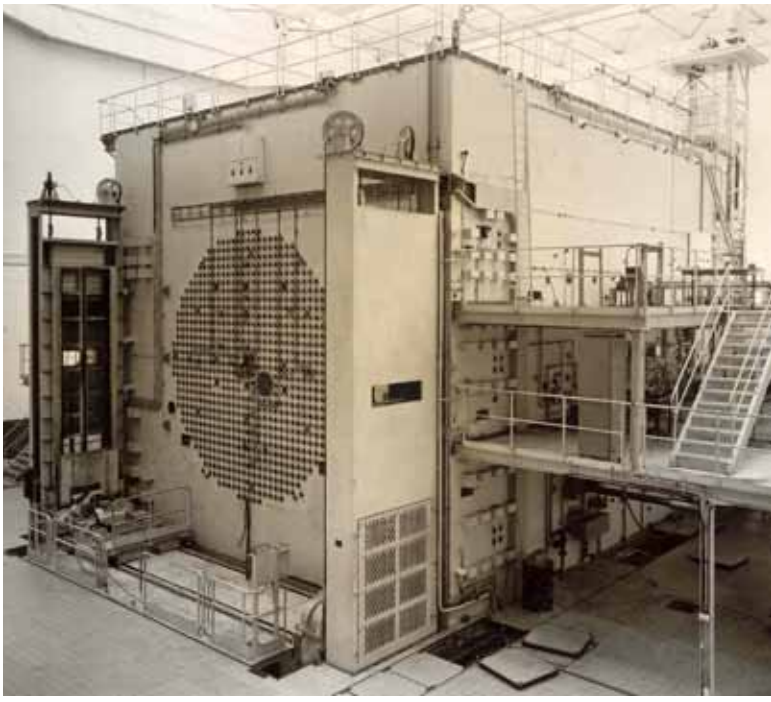
Most of SCK•CEN's history is rooted in the second half of the last century. A period not only of scientific optimism, economic development and prosperity, but also growing interest in sustainability. With SCK•CEN a small country such as Belgium achieved global firsts at a very high technological level. All this was made possible by the vision and enthusiasm of pioneers and input from thousands of employees.

We are particularly pleased to be able to celebrate SCK•CEN's 60th anniversary in 2012. However, this is by no means the end of it. Using our extensive expertise and unique research installations we aim to continue the work of our illustrious predecessors and help build a sustainable future for the whole of society.

The knowledge and expertise gathered by SCK•CEN as a result of building these installations has proved its worth in many peaceful international medical and industrial applications. Reactor materials, fuels, decommissioning and decontamination, dosimetry and calibration, … SCK•CEN has researched and developed them all and always with the aim of contributing to society. Technological innovation, nuclear safety and the protection of mankind and the environment were the guiding principles that still define our objectives today.

## Looking back at 60 years of pioneering efforts

Since its establishment in 1952 SCK•CEN has been a pioneer in nuclear science and technology. During the mid-fifties the Mol terrain soon developed into one of the largest post-war building sites in Belgium. In a period of less than eight years SCK•CEN built the first three Belgian nuclear reactors: BR1, BR2 and BR3, which meant that from the outset it was involved in the global development of nuclear energy and research.



Maintaining the emphasis on nuclear activities SCK•CEN also ventured outside the sector during the seventies. At the request of the government, science and industry we carried out research into the quality of our environment, energy applications, materials, IT, fuel cells and hydrogen production. This success story resulted in 1991 in the establishment of the Flemish Institute for Technological Research (VITO), which has since also become an international operator in research and development.

In the mid-seventies SCK•CEN was one of the first to undertake research into the disposal of radioactive waste in clay layers, which included the construction of an underground laboratory. In 1995 this project really took off as a result of the economic cooperation agreement with NIRAS, the National Institute for Radioactive Waste and Enriched Fissile Materials. Now, following more than 35 years of studying the clay, concrete, waste and its packaging materials, we are able to conclude, on the basis of extensive scientific data and models, that the long-term disposal of high-level radioactive waste in clay is feasible.

# Our contribution to today's society

SCK•CEN has a long-standing tradition of philosophical and social/scientific research. We study the social, political and ethical aspects of the use of nuclear technology in our society.

SCK•CEN maintains a neutral position in the social debate on nuclear energy and other nuclear applications. It is up to society, and not us, to decide to what extent these technologies should be given a chance to provide solutions for future challenges.

Also within SCK•CEN we encourage critical reflection of our own position as a scientific institute and the role of each scientist and policy maker therein. We are convinced that critical research starts (and ends) with critical self examination.

The accident at Chernobyl in 1986 resulted in a greater focus on nuclear safety and the development of measures to limit the impact of potential accidents throughout the sector. The natural disaster in Fukushima, which inflicted enormous damage on a number of nuclear reactors with far reaching consequences for the population and environment, has made us aware that safety cannot be taken for granted. A research centre such as SCK•CEN does not ignore these problems but contributes to future prevention. We are a significant partner for the Belgian authorities when it comes to optimum preparation for such nuclear emergencies.

In order to guarantee continual radiological safety, thousands of food, air and water samples are taken each year across Belgium. SCK•CEN handles a large number of these and is thus part of the government's radiological monitoring programme.

At SCK•CEN regular inspections and maintenance are an integral part of the operation of all our installations. Continual improvement and innovation keeps us abreast of state-of-the-art technology. We also focus on the decommissioning of our own and others' infrastructures. The knowledge and techniques we developed for the decommissioning and decontamination of the BR3 reactor is the basis for new nuclear decommissioning projects. Furthermore, our experience also provides valuable information for the design of new installations to ensure that they in turn can be decommissioned safely and efficiently at a later date with a minimum of radioactive waste.

In 2004 SCK•CEN opened its radiobiology, radioecology and space exploration laboratories, which are used for various research into the impact of ionising radiation on mankind and the environment. This knowledge enables us to formulate recommendations for improved personnel and patient protection in the medical sector. We also develop models of the biosphere to define appropriate measures for the environment. We support space exploration by studying the behaviour of bacteria and the health of astronauts during space missions. All this expertise has international ramifications.

# Looking ahead

In 2006 the Belgian Nuclear Research Centre underwent a major reorganisation to enable us to respond even better to relevant problems within society and deploy our skills to maximum effect to deal with the challenges of the future.

The production of radioisotopes in the BR2 reactor has greatly increased in recent years in order to provide the growing nuclear medicine sector with the necessary radioisotopes for patient diagnosis and treatment. We also doubled the irradiation capacity for silicon, which is an ideal semi-conductor for high-power applications. All this enables SCK•CEN to make an ever increasing contribution to the success of renewable energy.

In the nuclear energy field we are working on materials and fuels for reactors that can generate up to 50 times more electricity from the same amount of fuel whilst producing less radioactive waste. Another technological challenge involving SCK•CEN in research for more than 35 years is nuclear fusion, a potential energy source with almost inexhaustible fuel stocks that does not produce high-level radioactive waste. The ultimate goal is to safeguard access to sustainable energy for as many people as possible across the world.

SCK•CEN considers large research installations essential to guarantee the continuity of our activities, which is why we welcome the Belgian government's support for the MYRRHA project with open arms. This flexible experimental installation is set to replace the BR2 reactor in the long term and should offer us even more opportunities to participate in promising sustainable technologies. For example, MYRRHA will facilitate research into transmutation, a process to convert high-level radioactive waste into waste having risks over a much shorter term. This transmutation can be achieved safely in a subcritical nuclear system driven by a particle accelerator. MYRRHA will be the first prototype in the world to demonstrate this concept. We took a major step forward in 2011 with the successful construction of GUINEVERE. This scale model of MYRRHA is also a world first!

With its extensive experience, innovative projects, major nuclear installations and specialist laboratories SCK•CEN is perfectly placed to take on the role of education and training centre. The transfer of knowledge is one of our key tasks. The Academy for Nuclear Science and Technology was established specifically to combine and develop all these activities. Thanks to SCK•CEN a new generation of nuclear engineers and scientists will help shape our future society.

SCK•CEN's research and knowledge acquisition remain vital to ensure that nuclear power plants are operated safely until the end of their service life and subsequently decommissioned correctly. Further studies into the disposal of radioactive waste and protection of mankind and the environment from ionising radiation are a must.

Innovative research is essential in order to be able to utilise the social applications of nuclear science to their full potential. As an independent knowledge centre we try to support society so that it can make the right choices. We have been around for 60 years and we want to deploy our extensive expertise built up over these years in various ways to safeguard a viable future for all of us.

SCK•CEN – Belgian Nuclear Research Centre
SCK•CEN is a foundation of public utility, with a legal status according to private law,
that operates under the tutorship of the Belgian Federal Minister of Energy.

Laboratories
SCK•CEN, Boeretang 200, BE-2400 MOL

Registered office
SCK•CEN, Herrmann-Debrouxlaan/Avenue Herrmann-Debroux 40, BE-1160 BRUSSELS

Publisher
Eric van Walle
Director-General

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Contact
SCK•CEN
Boeretang 200
BE-2400 MOL
Tel. +32 14 33 25 86
Fax +32 14 33 25 84

info@sckcen.be
**www.sckcen.be**