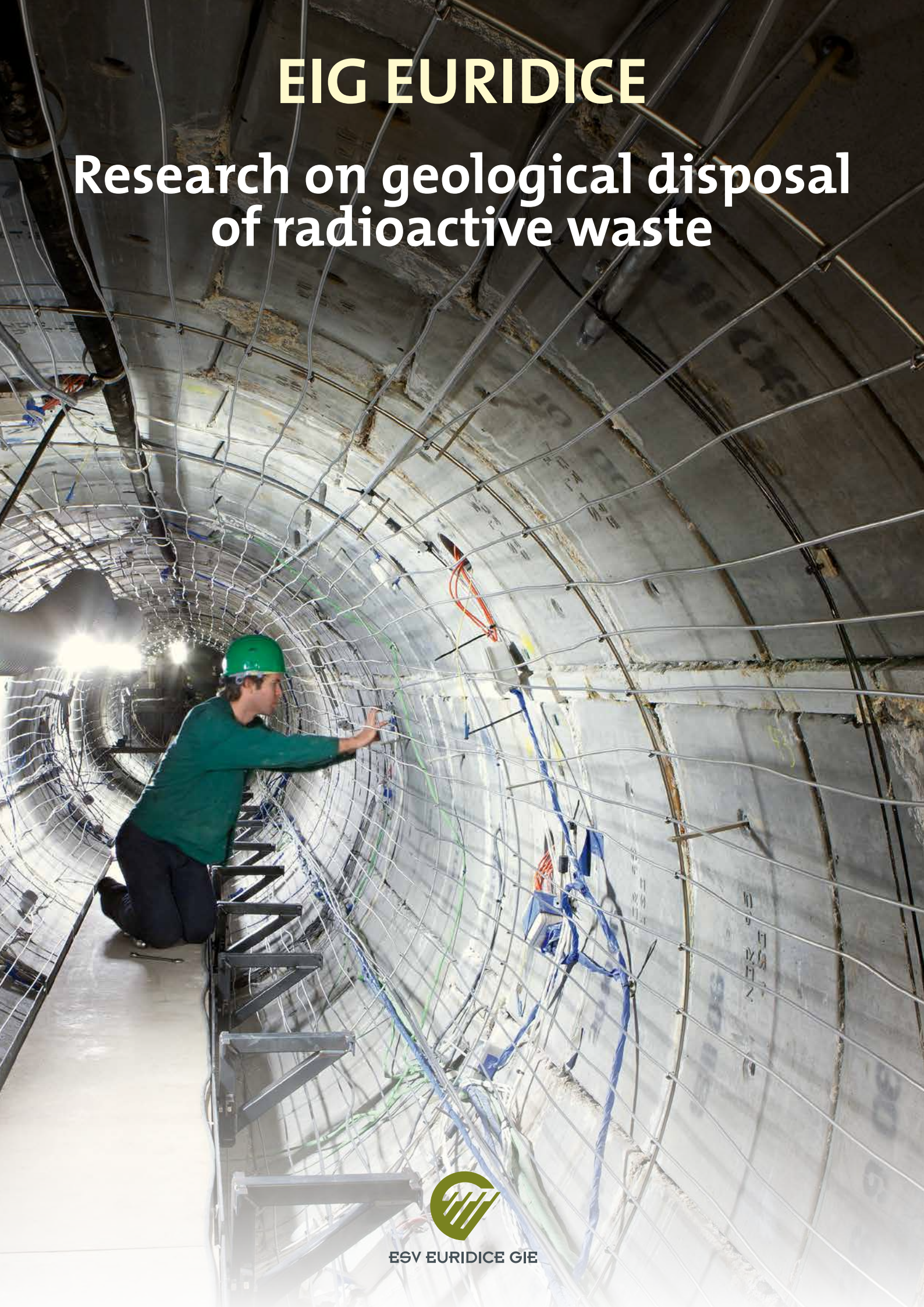
EIG EURIDICE

Research on geological disposal of radioactive waste



ESV EURIDICE GIE

EIG EURIDICE & HADES

EIG EURIDICE

EURIDICE is an Economic Interest Grouping (EIG), a joint venture between the Belgian Agency for Radioactive Waste and Enriched Fissile Materials (ONDRAF/NIRAS) and the Belgian Nuclear Research Centre (SCK•CEN). The name "EURIDICE" stands for "European Underground Research Infrastructure for Disposal of nuclear waste in Clay Environment".

EIG EURIDICE conducts research on the **safety and feasibility** of geological disposal of high-level and/or long-lived waste in an underground clay formation in Belgium; in doing so, it makes a significant contribution to the national disposal programme of ONDRAF/NIRAS.

In 1974 SCK•CEN embarked on a research project to assess the possibility of deep geological disposal of radioactive waste in clay. Back then the Boom Clay formation, situated between 190 and 290 metres below the SCK•CEN site in Mol, was already considered a potentially suitable geological host rock. To investigate the safety and feasibility of geological disposal in poorly indurated (i.e. not hardened) clay at great depth, SCK•CEN began building an underground research facility in 1980 at a depth of 225 metres: **HADES** (High-Activity Disposal Experimental Site). This laboratory was gradually extended over the years and has been managed and operated by EIG EURIDICE since 2000.

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

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ONDRAF/NIRAS

HADES

The HADES underground laboratory provides the **ideal setting** for researching the safety and feasibility of geological disposal.

Experts use it to develop and test **industrial technologies** for building, operating and closing a waste repository in deep clay.

Scientists conduct large-scale **experiments under realistic conditions** in the underground clay formation over a long period of time. This enables them to acquire detailed knowledge of the processes that are essential for assessing the safety and feasibility of geological disposal in poorly indurated clay. The research results are used to reliably analyse how the disposal system will evolve in both the short and the long term.

Since HADES is a licensed **nuclear research facility**, scientists are able to use a wide range of radioactive tracers and sources there.

Renowned worldwide, HADES is the **oldest underground laboratory** in Europe built in a deep clay formation for the purpose of researching the possibility of geological disposal in clay. The International Atomic Energy Agency (IAEA) recognises it as a **centre of excellence** for waste disposal technologies and scientific training.

Besides its role in the geological disposal research programme, HADES has an important **societal function**. Visitors to HADES can gain an understanding and appreciation of the research conducted there and come away with a more concrete idea of what a geological repository might actually look like.

HADES is and always will be a research facility and will **never be used as a final repository for radioactive waste**.

BUILDING ON MORE THAN 30 YEARS' EXPERIENCE

Scientists and engineers from Belgium and abroad have been conducting experiments in the HADES underground research laboratory since the early 1980s. This research is supplemented by laboratory and other on-surface tests. A total of more than 100 people are actively involved in the geological disposal research programme coordinated by ONDRAF/NIRAS. The EIG EURIDICE team contributes in the three specific areas outlined below.

Excavation and construction techniques

The extension of the HADES underground research laboratory since the late 1990s using **industrial excavation techniques** has demonstrated that it is possible to **build** a waste repository on an industrial scale. In other words, it is economically and technically feasible to excavate access shafts and several kilometres of galleries in a poorly indurated clay formation like the Boom Clay, with minimal damage to the host rock.

It must also be possible to **seal off** a repository once it has been filled with nuclear waste. A sealing of insufficient quality would make it easier for radioactive substances to escape. HADES experiments have shown that bentonite clay, which has similar properties to Boom Clay, can be used to hermetically seal off shafts and galleries.

Clay behaviour

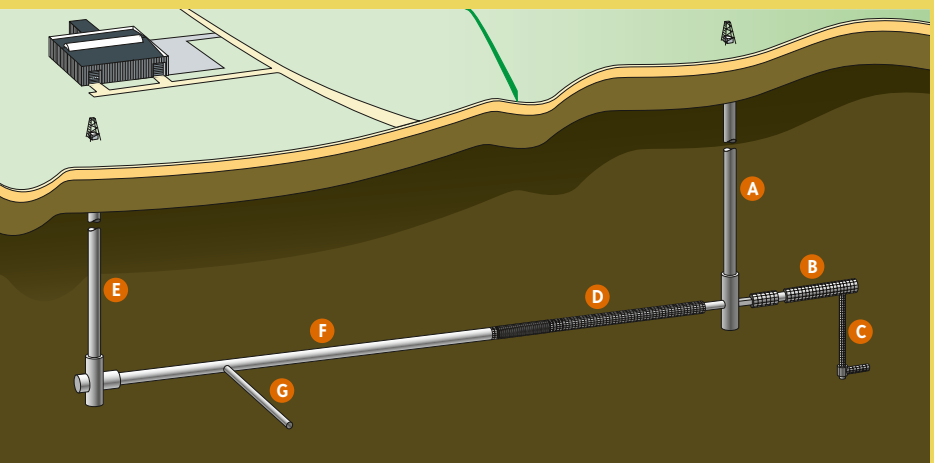
It is impossible to dig tunnels in clay without causing local disturbance of the rock. A systematic study carried out during the construction of the Connecting gallery indicated that this disturbed area only extends a limited distance into the clay. It was also found that the fissures in the disturbed area close by themselves due to the plastic behaviour of clay, as a result of which it retains its low permeability. This is known as **"self-sealing".**

High-level waste generates heat. When placed in a repository, after a cooling period, it will cause the clay around the disposal galleries to heat up initially. This heat input also affects the hydraulic, mechanical and chemical properties of clay. HADES experiments have made it possible to determine the clay's thermal conductivity and to study and model its combined thermal, hydraulic, mechanical and chemical behaviour. The purpose of the ongoing **PRACLAY experiment** is to confirm and refine this knowledge on a scale that is representative for a real repository. This entails heating the PRACLAY gallery for 10 years, bringing it to a temperature similar to what might be expected in a real repository in clay.

Instrumentations and monitoring

EIG EURIDICE has more than 30 years' experience using various measuring instruments and observation methods in the underground research laboratory, and in the Boom Clay formation in particular. These measurements and observations are performed as part of an extensive series of experiments, some of which have been monitored for the past 25 years or more and are conducted on a scale that is representative of a real disposal facility. EIG EURIDICE also draws on this expertise to support surface testing designed to demonstrate the technical feasibility of constructing a disposal container for high-level waste (supercontainer), and to contribute to the preparatory tests for surface disposal of low- and medium-level short-lived waste (cAt project). The know-how acquired regarding the use of these instruments and observation methods will ultimately help ONDRAF/NIRAS to develop a monitoring programme for a real radioactive waste repository.

The construction of HADES (-225m)



Pioneering work – manual excavation

1980-1982	First shaft A
1983-1984	First gallery excavated in frozen clay B
1984	Experimental shaft and gallery excavated without freezing the clay C
1987	Second gallery D

Industrial phase and demonstration tests

1997-1999	Second shaft E
2001-2002	Connecting gallery using industrial excavation techniques F
2007	PRACLAY gallery G
2015-2025	PRACLAY Heater experiment

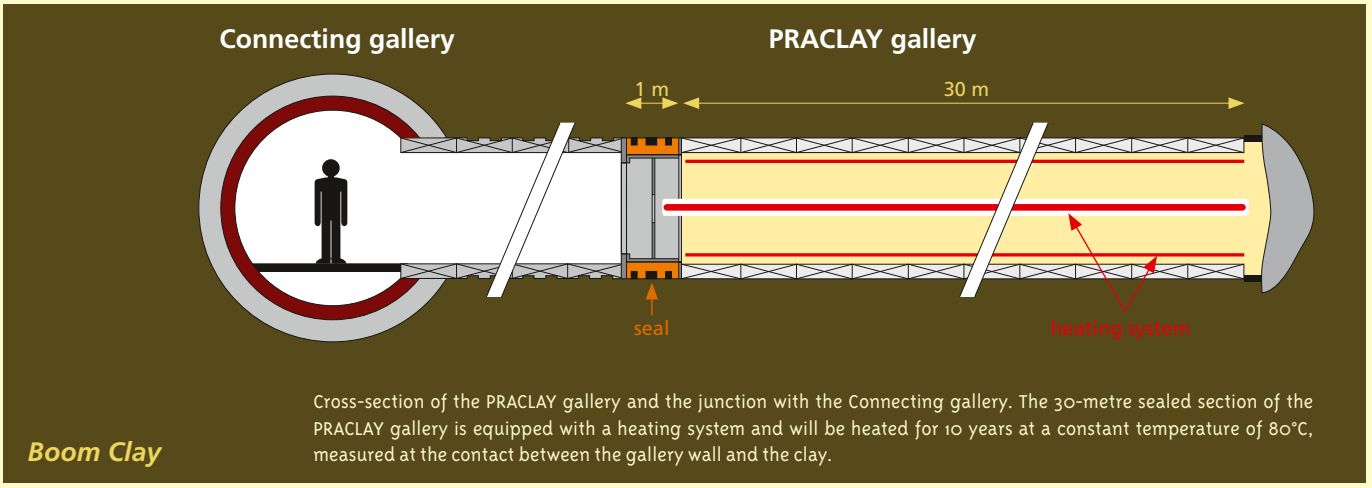
The PRACLAY Heater experiment

Work on extending the HADES underground research laboratory began in 1997. The researchers' aim was to prove that geological disposal of high-level waste in poorly indurated clay is feasible and safe by carrying out a number of large-scale demonstration tests. High-level waste generates heat and will be stored on the surface for at least 60 years, until it has cooled sufficiently for disposal. However, when placed in a waste repository, it will still cause the clay around the disposal galleries to heat up initially. It will take several hundred to several thousand years for the waste to cool completely.

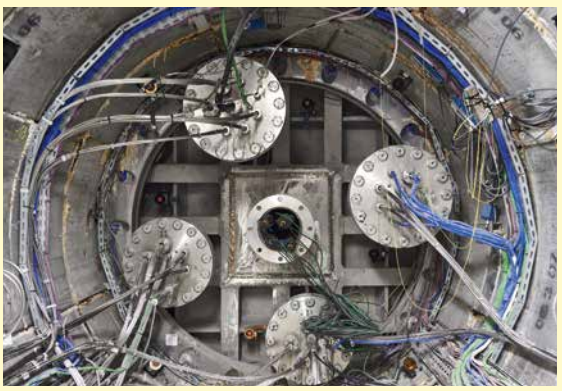
The techniques used for the construction of the second access shaft (1997-1999), the Connecting gallery (2001-2002) and the PRACLAY gallery (2007) demonstrated the feasibility of building an industrial-scale real repository. The researchers have since installed a heating system in the PRACLAY gallery to study the impact of heat on the underground clay strata on a large scale, over a long period of time and at temperatures similar to those that might be expected in a repository for high-level waste. This is known as the PRACLAY Heater experiment. As part of this experiment, a 30-metre section of the PRACLAY gallery will be heated for 10 years at a constant temperature of 80°C, measured at the contact between the concrete wall of the gallery and the Boom Clay. The main focus of the experiment will be the combined effect of disturbance of the Boom Clay caused by heating and excavation. Scientists are seeking to confirm and, if necessary, refine existing knowledge about clay behaviour on a scale that is representative of a real disposal facility.

A good understanding of this disturbance of the Boom Clay is essential for determining how the repository will influence the ability of clay to contain radioactive waste. Acquiring certainty that this ability will not be impaired is important to confirm that disposal of heat-emitting high-level waste in a deep clay formation can be a safe solution in the long term.

At the end of the 10-year heating phase, the experiment will be dismantled to examine the condition of the gallery wall and the clay.



Cross-section of the PRACLAY gallery and the junction with the Connecting gallery. The 30-metre sealed section of the PRACLAY gallery is equipped with a heating system and will be heated for 10 years at a constant temperature of 80°C, measured at the contact between the gallery wall and the clay.



VISIT to EIG EURIDICE

EIG EURIDICE has an exhibition about research on the geological disposal of radioactive waste in clay strata and, work permitting, its HADES underground research laboratory is also open to visitors.

Visits are only possible on weekdays for groups of no more than 17 people. Visitors must be at least 18 years old and will be escorted by an experienced guide.

You can find further information about visiting EIG EURIDICE at www.euridice.be.

Visits must be requested in advance by sending an e-mail to: info@euridice.be

www.euridice.be

ESV EURIDICE GIE

ESV EURIDICE GIE
Boeretang 200
2400 Mol
Belgium
+32 14 33 27 84
info@euridice.be