Implementing **geological disposal**

Expert engineer **Jan Gugala** discusses his work as Project Coordinator of an ambitious and important project to develop proof-of-concept installations to spearhead the first European geological disposals for high-level nuclear waste, as well as sharing his views on the needs of industries in this area

To begin, could you describe your background and position in the 'Large Underground Concept Experiments' (LUCOEX) project?

I'm a researcher and project manager with a Master's degree in Electrical Engineering, but my role in the project is that of Project Coordinator. My duties focus on planning, controlling and reporting on the activities of the project.

At present, how is long-lived nuclear waste stored?

High-level nuclear waste, which is the focus of LUCOEX, is stored in different types of intermediate facilities depending on which European country it is in. In these facilities, the waste will lose much of its thermal power and over 90 per cent of its radioactivity, which will make handling it at the final repository safer and simpler. The overall design of these facilities varies between European countries as well.

Which geographical sites and technical areas will be the focus of LUCOEX?

In brief, our proof-of-concept installations are located at sites across Europe – at Bure in France, Mont Terri in Switzerland, Onkalo in Finland and at Äspö Hard Rock Laboratory in Sweden. The geology of these sites is of central importance; the first two installations are clay formations, the latter two are crystalline hard rock.

How has communication and cooperation between LUCOEX partners been maintained throughout the duration of the project?

Communication and information sharing between project partners has primarily been achieved through technical workshops, which are also open to other stakeholders, both experts and the general public. Simultaneously, we have been running an ongoing staff exchange programme between the project partners.

What have been the major obstacles in carrying out the various work packages of the project?

Our main challenges have been linked to the fact that much of the work we are doing is being implemented for the first time in full scale. Working under authentic repository-like conditions also creates a large number of small but time-consuming challenges for both the project partners and the companies and subcontractors we are working with.

Are the results of LUCOEX disseminated in a variety of different ways?

The quality and effective use of the technical advances achieved in this project are enhanced by engaging more people in the process of tackling these important issues, beyond those actually taking a direct part in the project itself. In it, this is achieved by distributing our results and findings through workshops, conferences, our webpage, scholarships for participating in the project and – most importantly – through a direct dialogue with interested parties on site.

In light of public and political reactions to nuclear energy following the Fukushima Daiichi incident in 2011, could you discuss the importance of publicising the impact and benefits of LUCOEX?

With LUCOEX, we are showing that the construction of a final repository for high-level nuclear waste is feasible with the technology we have today. However, the construction of a repository also requires other components, such as local acceptance and proof of the long-term safety at the specific site. By sharing our experiences and knowledge both within Europe and globally through our website, publications and conferences, we hope to kick-start necessary work towards creating safe nuclear disposal facilities. We hope that this will also precipitate the construction of geological disposal facilities in other countries, which will enable them to handle their nuclear waste in a safe and efficient manner and thus reduce the impact of possible future events.

Are there any plans to build on the project deliverables in a future investigation?

The results of LUCOEX will be integrated into various national programmes as part of the stepwise development of geological disposal facilities. Based on the experiences we have gained through the proof-of-concept installations, we will now use the installed experiments to evaluate the initial behaviour of the different concepts, before continuing with the detailed facility design for final repositories in the partner countries.

Now that LUCOEX is close to completion, what would you say have been its key achievements?

The project has so far finalised two out of the four full-scale proof-of-concept installations, and we aim to have the remaining two completed before the end of the project. We have shown that we are already able to complete the gallery construction, as well as manufacturing and placement of buffers around waste canisters, placement of waste packages and sealing of a gallery. In short, we have shown that the installation of the concept works and the components integrate well with each other.

Driving radioactivity underground

A consortium including four leading waste management organisations has decided that the time is right to take practical steps towards safer and more efficient facilities for the disposal of high-level nuclear waste

IN 2015, IT is expected that work on Chernobyl's New Safe Confinement (NSC) will be complete. The purpose of this structure, which has been worked on for almost 30 years, is to contain a damaged nuclear reactor at Chernobyl in the Ukraine, often regarded as the reactor involved in the worst nuclear power accident in history. As a result of acute radiation sickness, 28 people died on the day of the accident, 26 April 1986. Moreover, with this catastrophe producing 100 times more radiation than an atom bomb and depositing radioactive material in most countries of the Northern Hemisphere, it should be no surprise that experts reported the number the lives lost from exposure to this material to be in the thousands. The NSC will replace the hastily constructed sarcophagus that was established to confine, but not contain, the solid nuclear waste still present at the site.

The Chernobyl disaster – paired with the more recent Fukushima Daiichi Nuclear Power Plant calamity in Japan in March 2011 that also released a large amount of radioactive material into the environment – has instilled fear of radiation in people across the globe, as nuclear waste is not only a threat when it is expelled into the atmosphere by explosions; it is produced and subsequently disposed of routinely in the normal running of a nuclear power station, and the methods used for accomplishing this are extremely important to public safety.

GEOLOGICAL DISPOSAL

One of the safest ways to dispose of high-level nuclear waste would be to bury it deep underground, and in Europe plans for facilities with this capability have been a long time coming. In some countries, geological disposal has been under consideration and research for more than 30 years. However, the current operational best practice is to simply transfer high-level waste to an intermediate facility where it can express the majority of its radiation and heat. This situation may be about to change, thanks to an ambitious project designed to take the next step in the development of geological disposal facilities across Europe.

Engineer Jan Gugala is Project Coordinator of the European Atomic Energy Community (EURATOM)'s 'Large Underground Concept Experiments' (LUCOEX) initiative, which aims to demonstrate the overall feasibility of constructing, manufacturing and sealing safe underground repositories for high-level nuclear waste. With participation from scientists and engineers at sites in France, Switzerland, Finland and Sweden, LUCOEX is an international effort to ensure safe disposal procedures for nuclear waste products in the years and decades to come. Initiated in 2010 funded by the EU Seventh Framework Programme (FP7) and running for a duration of four years, LUCOEX will come to an end in 2015.

TIME FOR ACTION

The vision of European waste management organisations is that the first geological disposal facility for high-level waste will be safely operating on the continent by 2025, but reaching this goal will require a number of intermediate steps to be taken. Some of these are the remit of the LUCOEX project, which has created four different proof-of-concept purpose-built installations under repository-like conditions at different underground research labs. As Gugala expresses in no uncertain terms: "It is time to put the pencils down and start to show both the decision makers and the general public how this can be done".

The proof-of-concept installations are located in partner countries, situated on a different geological arrangement and associated with a consortium partner. In Switzerland, the National Cooperative for the Disposal of Radioactive Waste maintains a test facility in opalinus clay (in Mont Terri) where scientists are developing a horizontal disposal concept for high-level nuclear waste using large disposal tunnels. The National Agency for Radioactive Waste Management in France is operating a similar facility, but in callovo-oxfordian clay, where scientists are testing a horizontal disposal concept using smaller drifts optimised for supporting possible future retrieval.

In the Äspö Hard Rock Laboratory (HRL) and Onkalo site in Sweden and Finland, which are managed by consortium partners the Swedish Nuclear Fuel and Waste Management Company (SKB) and Posiva Oy, respectively, the setting is rather different. Both facilities are on crystalline hard rock and based around a concept called KBS-3, which has been developed by both SKB and Posiva together. In the LUCOEX project, SKB is focusing on developing a horizontal concept using 300 m drifts, while Posiva in Finland is exploring the vertical KBS-3 concept with one waste canister per deposition hole in a tunnel up to 300 m long.

SURGING FORWARD

To facilitate progress, the LUCOEX project has divided its objectives into six work packages. The first is concerned with the administration of the others, project management tasks and the integration of different working teams. Packages two through five represent the experiments carried out at the individual test facilities, and the final work package focuses on external communication and the dissemination of the project's findings.

The progress of the project in its first 36 months has been excellent, with 42 of the 52 target milestones being achieved. There have been minor delays linked to procurement, machine development and the manufacture of buffer components, but the participants are confident that the main goals will be achieved before the end of the project.

SUBSTANTIAL ACHIEVEMENTS

The first work package to complete its technical work was undertaken at the French site, where the excavation, component manufacture, installation and sealing procedures were all completed without a hitch – a small seizure of the drill in the last 50 cm notwithstanding. In April 2013, the heating phase of that experiment began, which is elevating temperatures in the test cells to 90 °C over two years, to represent the thermal output of the waste. Monitoring of this facility is now ongoing.

Similarly, the proof-of-concept for horizontal disposal in crystalline rock at Äspö HRL in Sweden has reached an advanced stage, where machine development, component manufacture, installation and sealing procedures were all completed in 2013. The remaining activity of proving the feasibility of efficiently drilling the necessary drifts with very small margins will be conducted this year, fulfilling all the key goals for the work package.

SERVING THE FUTURE

Although the Swiss and Finnish installations have met more difficulties in their experiments and are currently behind schedule, they have also made substantial achievements. At the Mont Terri test facility in Switzerland, excavation work, construction of galleries and manufacture of buffer components have now been completed, and 2014 will see the Swiss engineers finalising their instrumentation and performing verifying tests with the buffer material-installation machine.

An updated technique using environmental protection containers for buffer protection and installation has been developed for the Finnish proof-of-concept installation. Two such containers have been successfully manufactured and, along with a gripping and lifting system for the installation machinery, stress tested with a 20 per cent overload. The factory acceptance tests will be completed in Autumn 2014. All that now remains is to perform the final emplacement test.

All told, LUCOEX has been an ambitious and well-managed project that is now close to successful completion. With work packages one to five close to finalisation, the consortium is turning its attention towards the dissemination of its findings – results that may prove vital to the implementation of proper nuclear waste disposal practices globally.

INTELLIGENCE

LUCOEX

LARGE UNDERGROUND CONCEPT EXPERIMENTS

OBJECTIVES

- To demonstrate the technical feasibility for safe and reliable construction, manufacturing, disposal and sealing of repositories for long-lived high-level nuclear waste
- To install four different emplacement concepts and demonstrate proof-of-concept with the goal of understanding and comparing important parameters regarding implementation and long-term safety

PROJECT PARTNERS

Swedish Nuclear Fuel and Waste Management Company (SKB), Sweden

National Agency for Radioactive Waste Management (ANDRA), France

National Cooperative for the Disposal of Radioactive Waste (Nagra), Switzerland

Posiva Oy, Finland

FUNDING

EU Seventh Framework Programme (FP7)

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JAN GUGALA is Project Coordinator of the 'Large Underground Concept Experiments' (LUCOEX) project. After running his own consultancy business until 2000, Gugala moved to HPlabs in California, USA, as a guest researcher. He held various R&D/project management posts at the Swedish power company Vattenfall, before he took a position as Project Manager and Controller at SKB in 2010, where he is responsible for the development of engineering barrier systems.