

## Zinc injection at Doel 3

### Further reducing radiation and corrosion

**Laborelec is conducting a comprehensive research program involving the injection of zinc into the primary circuit of unit 3 at the Doel Nuclear Power Plant. This research is part of the Doel continuous improvement effort. It aims to reduce radiation exposure of personnel even further and is based on international experience. Zinc also helps mitigate primary water stress corrosion cracking. Our experts will conduct laboratory tests to determine the optimal zinc concentration.**

International experience has shown that injecting small concentrations of zinc into the primary circuit of Pressurized Water Reactors (PWR) reduces deposits of radioactive isotopes. Based on this finding, the primary circuits of approximately 23% of all PWR units are currently injected with zinc.

### Belgian pilot project at Doel 3

As part of the GDF SUEZ Group's continuous improvement policy, Electrabel and Laborelec have initiated the first Belgian zinc injection program. It will be carried out in the Doel 3 PWR. 'We first collected all information regarding zinc injection, mainly from EPRI, the Electric Power Research Institute,' says Kim Schildermans, attendee at the EPRI Zinc Users Group meeting. 'Electrabel Doel will inject zinc at unit 3 by the end of 2010 and subsequently conduct measurement campaigns to monitor its effect on radiation, during both operation and overhauls. This will enable us, in close collaboration with the plant staff, to gradually optimize zinc concentration.'

### Evaluating the effect on stress corrosion cracking

In a separate research project, Laborelec is also evaluating the effect of zinc injection on primary water stress corrosion cracking. 'If the zinc injection could mitigate this issue, it would be a tremendous benefit,' observes Laire. 'However, we are not certain of the optimal zinc concentration required for unit 3 of the Doel Nuclear Power Plant and maybe we will have to modify the procedure. We intend to find out with experimental laboratory research.'

*Charles Laire, Kim Schildermans*



## Expert in nuclear energy

The GDF SUEZ Group must meet the energy demand of millions of customers worldwide. Achieving this means optimizing the entire available fuel mix spectrum, including nuclear energy. Laborelec offers the Group expert support in this domain. Our experts perform a wide array of services to ensure the efficient performance of nuclear power plants. This final 2010 edition of Laborelec News illustrates some of our recent achievements with nuclear power plants — from simulation and ageing management to condition assessment.

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*Laborelec is carrying out the first-ever Belgian zinc injection program at the Doel 3 PWR.*



## Key facts

- The Doel 3 PWR will be the first Belgian nuclear power reactor to be injected with zinc
- Zinc injection in the primary water circuit helps reduce radiation exposure of personnel
- Laborelec is conducting research to optimize the zinc concentration as well as mitigate corrosion cracking



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# NEWS: focus on nuclear technologies

## Laborelec identifies technique to detect sludge in tube support plates

Laborelec searched for a non-destructive testing (NDT) technique to detect and characterize sludge accumulation in the tube support plates of steam generators. Since visual inspections are extremely difficult to carry out on these plates, Laborelec checked whether bobbin coil probes could be used. Initial results are promising.

Tube support plates (TSPs) are used inside steam generators to keep exchanger tubes in place. The plates feature holes through which the tube passes. The holes are designed in a way that enables water to flow through the plates. Over time, however, sludge can accumulate in these holes and block the flow of water. This negatively affects heat exchange and is likely to cause flow induced vibrations.

### Bobbin coil generates encouraging results

Because of the steam generator design, TSP circulation holes are difficult to access. As a result, visual inspections are not feasible. Frédéric Rosseau: 'We therefore thought about using bobbin coil technology, which is applied for standard inspections of steam generator tubes. We simulated various situations of TSP clogging using plates, sludge and tube samples. Based on these simulations, we could test whether the bobbin coil probe was able to provide accurate results.'

## Factory and site testing on turbine controller

The Tihange Nuclear Power Plant recently replaced the steam turbine controller of unit 3. Laborelec carried out factory and site acceptance tests before the controller entered service. One of our steam turbine experts remained on site to ensure a smooth replacement.

The Laborelec Steam Turbine Simulator (LSTS) enables to test turbine controllers before installation by simulating the electrical grid and the power plant processes. 'The tool can simulate multiple types of incidents in order to safely and efficiently test controller response,' states Alexandre Perdaens. 'These tests enabled us to carry out minor debugging and to validate control programs, among other things.'

### On-site support for smooth replacement and start-up

In addition to the acceptance tests, Laborelec put a steam turbine expert at the full-time disposal of the plant for six months. 'This allowed us to optimally assist the unit in preparing the turbine controller replacement right up to its entry into service,' adds Perdaens. 'This close interaction in the field enabled us to carry out all the necessary fine-tuning as the project progressed, thus ensuring a better equipment start-up.'

Alexandre Perdaens

Detection results proved positive despite limited characterization capabilities. Laborelec will now use bobbin coil technology in the field to identify which TSPs are most affected in nuclear plant steam generators.

Frédéric Rosseau



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Laborelec tested the potential of bobbin coil technology in identifying sludge accumulation in tube support plates.



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Using LSTS, Laborelec simulates multiple types of incidents before the turbine controller is actually installed.

## Can Belgian nuclear power plants operate longer than planned?

### Thorough assessment of plant component ageing

**GDF SUEZ has initiated the Long-term Operation (LTO) Project to prove that the lifetime of Belgium's oldest nuclear power plants can be extended. The assessment of Ageing Management Programs (AMPs) is an important aspect of this project. Laborelec is contributing its nuclear expertise and plant knowledge to help draw up AMP reports.**

The LTO Project covers the Doel 1, Doel 2, and Tihange 1 units. The goal of the AMPs is to determine whether ageing topics are being efficiently managed to ensure nuclear safety during long-term operation. These include aspects as diverse as loose parts monitoring, boric acid corrosion, tank and reservoir ageing, bolting integrity, and closed cooling circuits. A full report is being prepared for submission to Belgian authorities in 2011.

#### Reviewing ageing management

'GDF SUEZ is establishing a detailed report describing, among other things, the ageing mechanisms for each area,' explains Pascale Absil. 'This report also indicates how efficiently ageing mechanisms are dealt with and contained.' Points of attention include determining if inspection procedures are carried out according to schedule and if the inspection methods are appropriate.

For a number of topics, Laborelec prepares the AMP reports based on meetings with power plant staff. For others, our experts act as reviewer. Separate reports are made for Doel and Tihange.

#### Recommendations for further improvement

'Whenever appropriate, we also provide recommendations,' adds Absil. These may concern the installation of additional sensors or the improvement of maintenance guidelines to ensure the unit remains in line with best practices. 'Our role also includes identifying any additional inspections that may be needed.'

#### A multidisciplinary project

The project calls upon Laborelec's expert knowledge in niche areas, including fuel oil chemistry, coating, component fatigue, loose parts monitoring systems, and neutron noise (see also article on page 4).

'Our experience in ageing issues as well as our historical knowledge of the Doel and Tihange Power Plants enable us to contribute valuable information to this project,' concludes Absil.

*Pascale Absil*



#### In short

- GDF SUEZ has initiated the LTO Project to prove that the Doel 1, Doel 2, and Tihange 1 Nuclear Power Plants are fit to operate longer than originally planned
- The Ageing Management Programs (AMPs) are a key area of assessment within the LTO Project
- Laborelec helps establish AMP reports based on its ageing expertise and knowledge of the plants involved



*Belgium's oldest nuclear units were built in the early seventies. The LTO Project will prove that they can safely and efficiently operate at least ten more years.*



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## Qualifying component repair by structural weld overlay

**Certain nuclear power plants have carried out component repairs using structural weld overlay. The qualification of the non-destructive inspection procedures of the repair process was performed by the Electrabel Qualification Body at Laborelec.**

'The qualification ensures that the inspection reaches its objectives in terms of detection and sizing of indications that could be present in the weld', reports Dominique Moussebois. The plants used the structural weld overlay technique to repair welds. This repair method uses the application of multiple layers of welding in order to recreate the full integrity of the structure. It can be applied without dismantling the piping.

The quality of a structural weld overlay is assessed by means of ultrasonic phased array inspection technology. This technique enables, among other things, the detection of small indications in piping and welds. The results were satisfactory.'

*Dominique Moussebois*

## Nuclear core vibration monitoring and diagnosis through neutron noise analysis

**Laborelec performs ex-core neutron noise analyses to monitor and diagnose the core vibration pattern in nuclear power plants. This technique enables to detect abnormal vibrations of core internals without disturbance.**

During operation of the pressurized water reactor, the core barrel containing the fuel assemblies slightly vibrates inside the pressure vessel. These vibrations, which are generated by the turbulent moderator flow, are normal but must remain within certain limits.

Laborelec monitors these vibrations by means of periodic neutron noise analyses, without shutting down the reactor unit or disturbing reactor core activity. 'The ionization chambers located around the reactor release a current that is proportional to the neutron flux travelling through them,' explains Marc Van Caillie. 'The neutron flux variation due to the vibrations of core internals, also called neutron noise, induces a change in this current, consequently allowing the detection of the originating vibrations. Changes in the neutron noise spectrum are hence representative of changes in the core vibration pattern.'

*Marc Van Caillie*

## Facilitating selection of joints in Tihange

**Circuits at the Tihange Nuclear Power Plant use multiple joint types and materials. Every joint must be selected based on the specific requirements of its location and purpose. Laborelec developed a didactic poster that facilitates this selection and speeds up maintenance interventions.**

The poster features a table that lists all circuits of the three Tihange units. It indicates what types of gaskets, O-rings, fittings, and packings must be used for each circuit. It also indicates appropriate joint materials depending on their resistance to high temperatures and chemical aggressions.

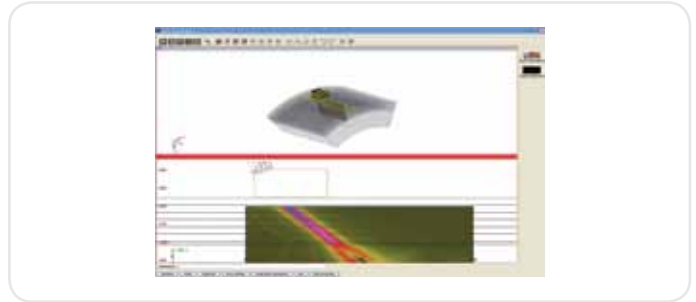
'The poster has been placed in the spare parts storage rooms and a paper copy handed to each department head,' explains Anne-Françoise Vaessen. 'Initial feedback from the Tihange 3 staff was very positive after the September 2010 overhaul.'

A copy of this poster is available in the sealing guidelines prepared with the project coordinator at the Tihange Power Plant. It facilitates the right material selection for each seal assembly.

*Anne-Françoise Vaessen*



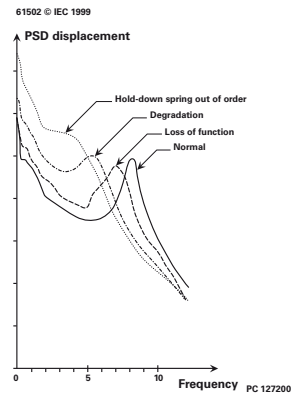
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A structural weld overlay enables repairs without dismantling the piping or disturbing ultrasonic testing principles.



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The neutron noise power spectral density indicates abnormal vibrations within a pressurized water reactor.



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Unit	Température / Pression	Température / Pression	Température / Pression	Température / Pression	Température / Pression
Jonghe's 400°C/40bar	Jonghe's 500°C/150bar	Jonghe's 200°C/16bar	Jonghe's 200°C/40bar	Jonghe's 400°C/40bar	Jonghe's 500°C/150bar
CHAMBRAN	BRASS	FRIST à l'eau de sulfate	PTFE	TRICE de multigras	GRAPHITE
Type de matériaux	Type de matériaux	Type de matériaux	Type de matériaux	Type de matériaux	Type de matériaux

Numerous types of joints are available on the market. The poster helps nuclear power plant staff select the right joints for each situation.

