[NEWS :
Condition assessment, non-destructive testing, and materials technology

SIMILAR COUPLING SHAFT FAILURES IN TWO DIFFERENT POWER PLANTS
Root cause analysis reveals high cycle fatigue

Following two flexible coupling shaft failures at two GDF SUEZ power plants, the Material and Vibration divisions of Laborelec undertook an investigation to find the root cause of the failures. The tests revealed that the failures were initiated by high cycle fatigue due to misalignment in both cases. Laborelec provided the plants with a series of recommendations to avoid similar occurrences in the future.

The incidents happened in two gas-fired power plants at opposite ends of the world: one in South-East Asia and one in Latin America. In both cases, a failure occurred in the contoured diaphragm flexible coupling shaft between the turbine and the alternator gearbox. The failures occurred at the load coupling diaphragm located on the turbine side, with cracks propagating from the inside to the outside.

[Material investigation reveals no faults

"Because the incidents had many similarities, we decided to inspect both shafts in parallel," notes Frédéric Vanderlinden. "When we received the faulty coupling shafts from the plants, we started by examining their history, as well as the installation plans." Laborelec then carried out a full metallurgical examination. "We first undertook a full range of non-destructive and destructive material analyses, including a red dye penetrant inspection and a full radiography check to detect cracks and evaluate the welds," says Steve Nardone. None of these examinations revealed any fault in the materials. A subsequent visual inspection, combined with scanning electron microscopy revealed that both incidents were initiated by high cycle fatigue.

[Additional analyses indicate cause of failure

In parallel to the material investigation, an alignment data analysis was carried out. In both cases, there were contradicting figures indicating that misalignment was the most probable cause for the fatigue failures. "After detecting the root cause of the failures, we made a number of recommendations to the plants regarding shaft installation and alignment," says Vanderlinden. "These recommendations will also be made to other GDF SUEZ plants using similar shafts."

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[In short

- Laborelec analyzed two distinct but similar failures involving flexible coupling shafts
- Extensive metallurgical tests in our laboratory revealed high cycle fatigue in both cases
- Our vibration experts made a series of recommendations to the plants regarding shaft installation and alignment

A NEW YEAR, A NEW BEGINNING

First of all, we wish you a happy and successful New Year. In 2009, we will continue to keep you informed on our projects and services. We have given Laborelec News a new look to offer you a more enjoyable and efficient read. But content-wise, we haven't changed anything. In this issue we focus on some of our most recent activities in condition assessment, non-destructive testing, and materials technology of energy equipment.

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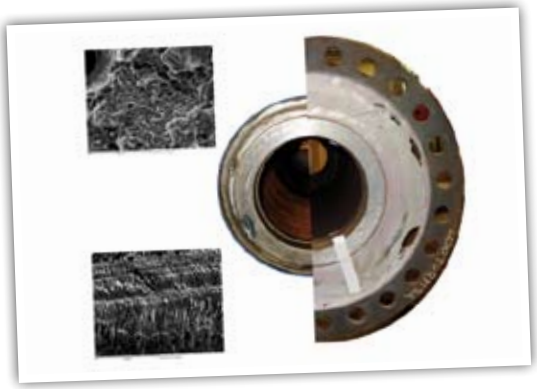
"LABORELEC COMBINED METALLURGICAL AND VISUAL INSPECTIONS WITH AN ALIGNMENT ANALYSIS TO DETECT THE CAUSE OF THE INCIDENT"



Laborelec undertook a full range of metallurgical tests to identify the root cause of the breakages.

LABORELEC GROWS 14% IN 2008

We are proud to announce that 2008 was a very successful year for Laborelec. Our turnover increased by 14% to reach EUR 40 million. The main factor in this success was the increased international demand for our services. Last year, our activities took us to 25 countries and in 25% of the cases to customers outside the GDF SUEZ Group.

This positive result confirms that our customers acknowledge the value of the breadth and depth of our competency. We will continue on the same path in 2009, striving for maximum customer satisfaction by quickly and efficiently answering their needs. In the prevailing economic downturn, our service offering will remain a strong source of value creation and economies.

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NEWLY ACQUIRED POWER PLANTS THOROUGHLY INSPECTED

Paving the way for regular maintenance and investment planning

The acquisition of a power plant by the GDF SUEZ Group marks the beginning of a series of inspections and support actions by Laborelec. The goal is to thoroughly analyze the condition of the plant's boilers, turbines, condensers, and generators. This information is used to establish an investment and maintenance plan that will help the plant achieve maximum efficiency and reliability within a safety framework.

When the GDF SUEZ Group acquires a power plant, Laborelec experts are called in to assess the overall condition of the plant and to determine the remaining lifetime of its main components. Due diligence reports are used as a starting point, but the inspections go much further than that.

[From history review to destructive tests

"Onsite inspections generally start with an analysis of historical data and overhaul reports regarding plant design and operation," explains Fabien Thielemans. "We then propose an extensive non-destructive inspection programme that includes ultrasonic tests, replication prints, hardness measurements, and material determination. This enables to clear up unknown areas."

"We also take pipe samples for additional laboratory investigations such as tensile tests, creep tests, and oxide analyses," adds Michael Dutoit. "By analyzing a pipe's oxide layer, we can gather additional historical data on operational conditions. In this respect, choosing the right samples among the kilometres of piping in a power plant is critical for the reliability of the tests results."

[Assessing remaining lifetime

Based on the information collected during the inspections, the remaining lifetime is assessed for each boiler and turbine component. "The goal of this report is to provide a technically objective overview of the condition of each component," specifies Nico Breuls. "We also provide recommendations on the timing of inspections, replacements, and maintenance. Our support helps plants to develop a regular maintenance practice and to use adequate inspection techniques. We also identify what needs to be done to achieve maximum efficiency, availability, and reliability."

[Training local staff members

"With Laborelec serving a growing number of power plants throughout the world, the training of local staff is also important to ensure consistent levels of inspection and maintenance. We provide them with good practices and safety recommendations," adds Fabien Thielemans. "We also determine whether appropriate technical support is available from local companies or laboratories."

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[In short

- After a GDF SUEZ power plant acquisition, Laborelec experts thoroughly assess the condition of the plant
- Tests are carried out on site and in our laboratory to determine the remaining lifetime of components
- The resulting recommendations help the plant to draw up a maintenance, inspection, and investment plan

"LABORELEC'S RECOMMENDATIONS HELP PLANTS ESTABLISH A MAINTENANCE PLAN AND SCHEDULE REGULAR ADEQUATE INSPECTIONS"

[Boiler inspection at Calacca, Philippines

The GDF SUEZ Group recently acquired the Calacca coal-fired power plant in the Philippines. Laborelec experts inspected both of the plant's boiler units on site. The plant's monitoring programmes were compared with those normally in use within the GDF SUEZ Group. "We also assessed the steam piping between the boiler and the turbine," says Michael Dutoit. "Samples of pipes were selected for in-depth analysis in our laboratory, where we assessed the material condition, undertook hardness and creep tests, analyzed the chemical composition, and checked for any additional corrosion issues."

Onsite spot checks are carried out on power components.

INCREASING PARTICIPATION OF LABORELEC IN AGEING PROJECT

An opportunity for applying new inspection techniques

The Ageing Project, which was started up in 2006, has now been extended to Electrabel's conventional power plants in Belgium. With Laborelec's plant inspection methodology now fine-tuned and with a growing volume of data available, generic problems can be identified. The project also provides opportunities to validate new inspection techniques.

Initially limited to nuclear power plants, the Ageing Project now covers all of Electrabel's gas, coal, and biomass-fired power plants in Belgium. Laborelec focuses primarily on the boiler, condenser, and steam turbine components.

[A proven methodology

"The methodology followed by Laborelec first involves an extensive discussion with plant operators and maintenance teams," explains Fabien Thielemans. "This discussion covers equipment condition, as well as the operational potential until the planned end of life. This is followed by a visual inspection of the plant. We perform wall thickness spot checks and replication techniques on the most critical components. These inspections are carried out as much as possible during maintenance outages or week-end stops. In case of doubt, samples are transmitted to Laborelec for material analysis and failure assessment."

[Sharing knowledge among plants

"Following each plant inspection, we produce a status report quantifying any short, medium, and long-term risks involving critical components," adds Michael Dutoit. "Whenever a specific problem is encountered in a unit, the issue is taken up in the inspection scope of other similar plants. Similarly, all useful knowledge and best practices related, for instance, to maintenance are transferred from one plant to the others." Laborelec is compiling available historical data to reveal generic problems. It is also trying, as much as possible, to explicitly document the implicit knowledge of staff on site.

[New applications of inspection techniques

"Ageing induced problems also represent an excellent opportunity to develop new applications for recent inspection techniques," notes Nico Breuls. "We have, for instance, used infrared thermography to rapidly detect local erosion of coal piping that might otherwise go unnoticed during normal boiler operation. Laborelec has also started to rely on small punch tests (SPT) to test turbine piping. This destructive testing method enables to test samples of just 8 mm in diameter and 0.5 mm in thickness to verify how long equipment can still remain in service." The successful testing of these techniques will enable their broader use during future inspections.

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[In short

- Within the overall Electrabel Ageing Project, Laborelec - in collaboration with Tractebel - assesses the condition of Electrabel's conventional power plants in Belgium
- Laborelec focuses on the boiler, condenser, and steam turbine components
- The project is an opportunity to develop and apply specific destructive and non-destructive techniques

"AVAILABLE HISTORICAL DATA IS COMBINED WITH INPUT FROM OPERATORS AND ONSITE INSPECTIONS TO GIVE A COMPLETE OVERVIEW OF A PLANT'S CONDITION"

The Ageing Project

The Ageing Project was initiated in 2006 by Electrabel, Tractebel, and Laborelec. Its goal is to analyze ageing phenomena in power plants and to identify the actions required to extend their useful remaining life. The project fosters the sharing of knowledge among plants and helps operators make the right decisions in terms of plant lifetime extension.

Laborelec has used infrared thermography at the Ruien power plant to locate erosion in very small areas.

DEFINING THE MOST APPROPRIATE PROBE FOR EACH TYPE OF TUBE DEGRADATION

What is the comparative performance of existing expertise probes when inspecting nuclear power steam generator tubing for degradation? That is the question Laborelec set out to answer by evaluating six types of eddy current expertise probes. The final report provides valuable guidelines for plant inspections.

Tubing in the steam generator of a nuclear power plant must be absolutely tight to ensure that contaminated water remains within the primary circuit. Different types of probes exist to verify a tube's structural integrity.

[Six types of expertise probes evaluated

Laborelec has compared the performance of six types of probes including rotating probes, bobbin coil probes, and X-probes. Some probes are able to precisely detect differently oriented cracks, while others are more particularly designed for cracks in one specific direction.

[Close-to-reality testing

For the purpose of this study, Laborelec has had a variety of faults spark-machined onto pieces of tubing material identical to those used at the Doel and Tihange nuclear power plants. This enabled our experts to obtain situations as close to reality as possible. The results of the tests have been gathered in a report that is available to nuclear plant operators. The report provides guidelines on the most appropriate probe to use in terms of the expected tube degradation phenomenon.

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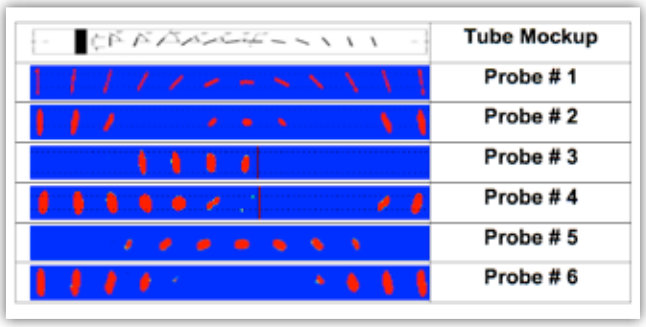
[In short

- Laborelec has analyzed and compared the performance of six eddy current expertise probes
- The goal of the study was to determine what type of tube degradation could best be detected with what probe
- The results of the study will help improve the reliability of steam generator inspections



Comparative figures show that certain types of probes are better than others in identifying differently oriented cracks.

LOCATING LEAKS USING ULTRASONIC TESTING

How to detect a single leak in a water circuit consisting of hundreds of pipes? Laborelec was able to locate just such a leak in less than two hours using its portable ultrasonic testing (UT) device. Without having to shut down normal operations.

A power plant water circuit was leaking more than 30 litres of water per hour. Temperature measurements enabled the operator to rule out leaks in some of the pipes. Still, the defect was not found even after a careful visual inspection of the entire circuit. In the meanwhile, the leakage rate had risen to 145 litres per hour. The operator contacted Laborelec to quickly locate the problem.

[Quick detection without interrupting operations

"Our portable UT device enables us to determine the water level inside a pipe, without having to open it. By holding the probe against the exterior of the pipe, we can determine if the pipe is empty or full or even the precise fluid level inside," explains Alain Braeckman. "We were able to track down the leak in less than two hours, without interrupting operations. This non-destructive technique proved to be the most economical and effective solution for this specific situation."

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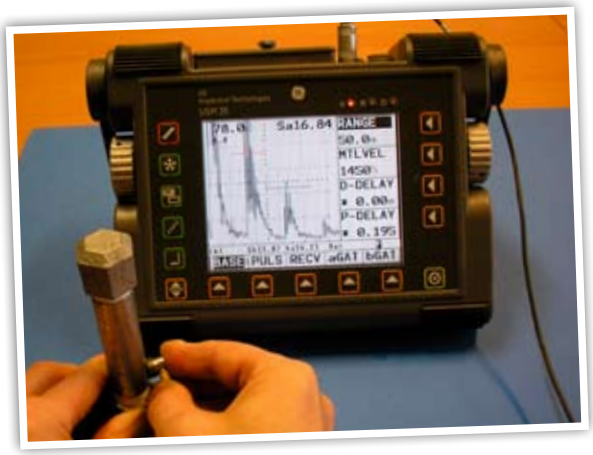
[In short

Ultrasonic testing can locate leaks in pipes, vessels, etc.:

- Without having to stop operations
- Quickly



The ultrasonic testing device can determine the level of any substance in a tube, without disturbing operations.

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