DIRIS® Air Gap Robot
Diagnostic Inspection

Supporting your maintenance strategy

Remote inspection with the rotor in situ: Alstom’s DIRIS® (Diagnostic Inspection with Rotor in Situ) provides modern robotic instrumentation and tooling to allow fast and reliable remote inspection of the Turbogenerator. Fully embedded in Alstom’s modular diagnostics solution portfolio, DIRIS® is a technology offering effective Turbogenerator inspections, reducing the risks related to rotor dismantling while giving complete confidence in continued machine operation between major outages.

New ultra lean design: Due to its advanced design, the DIRIS® inspection technology can be used for almost all Turbogenerator sizes and all Original Equipment Manufacturers (OEM) in the industry and utility business.

Reliable solutions
DIRIS® airgap robots not only support your maintenance strategy, but also include the following benefits:

HIGH TURBOGENERATOR RELIABILITY
DIRIS® enables early detection of faults that could compromise the reliability. Operators have confidence in Turbogenerator integrity between overhauls, and in the reduced risk of failures.

FLEXIBILITY
DIRIS® gives the ability to perform the test while the rotor remains in place. If the rotor has been removed, please refer to our other DIRIS® solutions. The system can be used in nearly all Turbogenerators from different manufacturers.

RISK REDUCTION
As no rotor removal is required during outages, the risk of disassembly or transportation damage is eliminated.

FAST AND EASY
With the rotor in place, one engineer can perform the inspection within as little as two days. This includes installation and removal of the test equipment.

EXPERIENCE
The customer’s staff works with experienced Alstom engineers to review machine condition and assess future maintenance requirements based on trend analyses. Customers receive a comprehensive report with inspection results and recommendations for further operation.

Alstom is a global leader in power generation, setting the benchmark for innovative technologies that provide clean and efficient power solutions.
A high-tech, fast and **precise inspection**

**Enormous time savings:** The DIRIS® robotic equipment is installed on one retaining ring and drives circumferentially and axially in the airgap. The whole arrangement can rotate 360° around the rotor body. With this setup, every spot of the stator and rotor surface is accessible for the measurement sledge. It requires only the opening of one end of the machine, which results in huge time savings. The system is remotely controlled by diagnostic engineers outside the Turbogenerator.

**Modular design:** Depending on the inspection scope, the measurement sledge is either equipped with a stator wedge probe, a low flux probe, a camera system or a combination of all.

» **The DIRIS® robotic equipment advances robotic inspections to a new generation.«

**DIRIS® robotic inspection key features**

- **Thorough condition assessment** without rotor removal.
- **Comprehensive visual evaluation** of the Turbogenerator’s condition when the rotor is installed, even in areas that are not accessible for humans.
- **Fully automated condition assessment** of key components accessible through the air gap. The focus is placed on the stator wedge tightness and stator core integrity, which are crucial for the reliability of the machine. These assessments can also be performed when the rotor is removed.
- **Highly accurate and reproducible test results** are delivered through the use of a finely calibrated measurement system. Trending of the results enables well-founded and transparent maintenance decisions.
DIRIS® inspection supports condition-based and time-based maintenance strategies with the profound knowledge about the condition of your Turbogenerator.

From research to robot

Alstom joint venture picks up the European Technology Transfer Award: Alstom Inspection Robotics Ltd, a joint venture between Alstom and the Swiss university ETH Zürich, has won the most prestigious European Technology Transfer Award in robotics for its work in converting the latest robotics technology research into practical tools to better service power plants. Awarded by two peer organisations – the European Robotic Research Network and the European Robotics Technology Platform, Alstom Inspection Robotics Ltd showed the ability to demonstrate the close collaboration between itself, the university and the industrial application of the inspection robots.

As a result of this close partnership, several mobile robots and tools have made it into industrial application, all of which have cut inspection times considerably.

DIRIS® enables reliable inspection of:

Air gap inspection: the DIRIS® video probe allows the detection of any foreign objects located in the air gap.

Stator active part surface: the DIRIS® video probe allows the detection of hot spots, scratches and flaking paint.

Stator core condition: The DIRIS® low flux iron core test allows a reliable condition assessment of the stator core.

Stator wedge tightness: With the DIRIS® stator slot wedge assessment, loose wedges can be identified and so the risk of vibration and stator ground faults can be reduced.

Rotor active part surface: The DIRIS® video probe allows the detection of hot spots, scratches, flaking paint and foreign objects.

Rotor wedges condition: The DIRIS® video probe allows the detection of wedge movement, pollution and hot spots.

Balancing bolt fixation: with DIRIS®, rotor balancing bolts can be inspected for looseness to prevent catastrophic damages to the rotor body itself, the magnetic core and the stator winding.

Potential blocking of ventilation ducts and the cooling path: the DIRIS® video probe allows the detection of potential blocking of rotor and magnetic core ventilation ducts that might affect the performance of the generator.
A flexible portfolio for efficient assessments

The DIRIS® robotic diagnostic portfolio offers customers a complete package of efficient Turbogenerator inspections and assessments.

**DIRIS® visual (video) inspection**

Flexible visual condition assessment: Visual inspection is the most important methodology for the assessment of the Turbogenerator’s condition. The DIRIS® video probe is used to inspect areas in the Turbogenerator that are inaccessible for humans while the rotor is kept in situ. The probe consists of a small video camera, a light source and a mirror that enables the inspection of the stator and rotor surfaces. The visual inspection provides a clear 360° view of the stator core laminations, stator winding and wedges, rotor surface and wedges, balancing weights and the inboard ends of the retaining rings.

**DIRIS® stator slot wedge assessment**

Reliable trending of the wedge tightness: The DIRIS® stator slot wedge assessment is performed to quantify the stator wedge tightness and is used to assess the need for wedge re-tightening or replacement. Due to natural settling and ageing processes of the wedge and winding insulation material, the wedges can come loose. If a certain amount of tightness is lost, the bars will start to vibrate in the slots and this will lead to accelerated ageing of the bar insulation with a subsequent failure of the machine. The stator wedge assessment delivers highly accurate and reproducible results and is therefore an excellent basis for trending the wedge tightness. It enables long-term planning for wedge re-tightening or replacement during a suitable major overhaul.

**DIRIS® low flux iron stator core test**

Efficient stator core short detection: The stator core consists of stacked laminations, which are insulated from each other. The aim of this construction is to minimise eddy currents in the stator core. The DIRIS® low flux core test is an economical and accurate method of testing whether there are laminations that are short-circuited. In case that several laminations are short-circuited, eddy currents will occur and lead to local overheating of the core. If this is undetected and not corrected, this may lead to core burning and result in very costly and time-consuming repairs. The key benefit of the low flux core test is a reliable assessment to define whether corrective actions on the core are required.

Thanks to an extensive R&D program leading to a new ultra lean design, a new DIRIS® generation is now suited for small generator inspections, performing high-quality assessments with the rotor in situ.