

## **Preventive Maintenance: The Key to Protect Your Plant Against Electrical Machine Breakdowns**

The inspection and diagnosis of electrical rotating machine performance are key tools in ensuring the continuous operation and performance of production equipment.

Electrical machines play a significant role in all industrial applications. Ensuring their output, their optimal availability and their durability, as well as their energy efficiency are basic requirements of industry.

An in-depth knowledge of electrical machines, their applications, their operating environments, besides monitoring of the facilities operation and machine proactive maintenance, are therefore essential elements of a successful operation.

**Early detection of defects** and an **efficient diagnosis** allow owners to minimize downtimes and maintenance times, and, therefore, to reduce costs related to these operations.

Let's have a closer look at **direct current machines**, which are wrongly considered by some as more demanding as regards their maintenance. It is true that electrical brush machines comprise "wear" parts (carbon brushes, brush-holders), but this apparent inconvenience may, in fact, turn out to be an **asset**.

The **carbon brush** is a sliding mechanical contact, which transmits electrical current between the rotating part of a machine and its fixed external circuit and, in the case of direct current machines, ensures commutation without sparking. Carbon brushes are guided and maintained in permanent contact with the commutator or the rings by the **brush-holders**.



*Example of commutator with presence of significant ridges and flat spots*

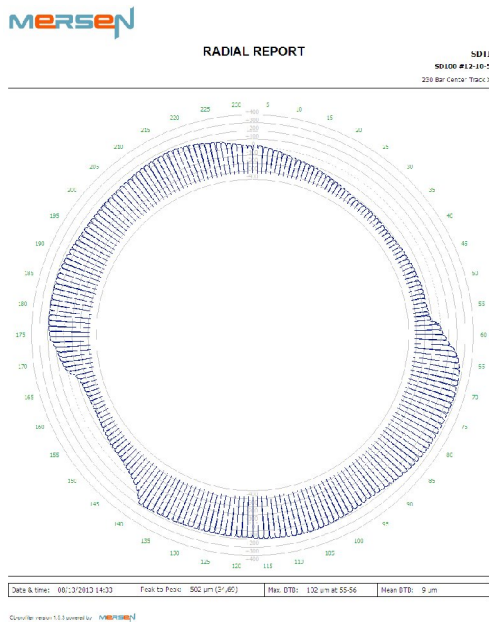
Carbon brushes and brush-holders must be checked regularly and changed as required, but if monitoring is regular and preventive, maintenance proves to be inexpensive, easy and schedulable. On the other hand, **a simple inspection of the commutator (or slip-ring) film may enable a diagnosis to be made on the state of "health" of your rotating electrical machine before serious problems occur.**

On direct current machines, breakdowns are easily identifiable and defects can often be seen with the naked eye. *"Operators or technicians will, for instance, notice sparks or burn marks on the commutator, or increased brush wear. Most often, this diagnosis does not require any specific knowledge of motors. Thereby, maintenance operations may be scheduled according to the development and importance of these indicators"*, notes Stéphane Boullager, technical manager of the Motor Maintenance Service Division at Mersen.

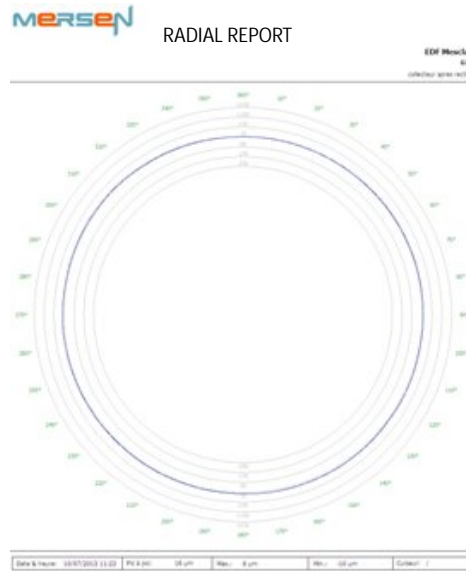


The global operation of the machines is affected by many kinds of defects: electrical, mechanical, thermal and environmental. When the machine does not perform satisfactorily, **several factors must be taken into account for an efficient basic diagnosis**:

- Study of the machine, application and its operating cycle, functional analysis of the carbon brush (also called "motor brush"), design of the brush and brush-holder, film analysis.
- Mechanical diagnosis of the commutator / rings with surface roughness measurements, control of out of round and brush-holder inspection (visual analysis of their condition, checking of carbon brush movement in holders and the pressure applied to them). The use of measurement instruments such as the roughness meter (surface condition measurement device), CL-Profilor (Mersen solution to measure profiles of commutators and rings), or dynamometer (carbon brush pressure measurement device) are all necessary to obtain relevant results.



*Commutator radial chart before machining  
(As measured with a CL-Profilor)*



*Commutator radial chart after machining  
(As measured with a CL-Profilor)*

- In the presence of vibration, specific attention must be paid to the bearings, balancing, machine fixing and shaft alignment.

To ensure smooth operation of the machine, an **electrical assessment** by an 'expert' is required when the following situations arise:

- commutator appearance defect (wear, deformation, electrical marking)
- significant vibration accompanied by sparking and shunt connection failure
- shunt discolouration from overheating
- poor current distribution (selective action)
- "flash-over" on the commutator (more serious)

Depending on failure, there are two possible solutions:

- Basic electrical diagnosis through visual observation of the commutation or sparking on the application in operating conditions, followed by checking and adjustment of the neutral line (i.e., the area where sparking is minimal).

Specific electrical diagnosis consisting of measurements and control of the integrity of the insulation:

- insulation resistance
- flash tests (dielectric tests until insulator breakage)
- polarization index (test to establish the pollution level or moisture uptake of the winding insulation at surface level) electrical discharge tests (test to establish the intrinsic quality of the insulation)
- winding continuity test (ohmic resistance measurement of a circuit to establish the resistance value or check the absence of conductor open or short circuits)
- measurement and analysis of leakage currents

The control of electrical machine power supplies is sometimes also required.

Electrical machines must often operate in difficult environments: pollution (oil, dust, acids), or else in hot or cold, wet or dry atmospheres, with absent or insufficient ventilation.

The presence of pollutants may cause more significant wear of the carbon brushes and/or the commutator/rings. Certain signs may be detected and addressed to prevent failures. Oxidation and discolouration of shunts, brush-holders or commutator is a sign, for instance, of an acid attack. In this case, a **specific environmental study** must be considered.

Electrical, mechanical or environmental failures may cause mechanical damage to commutators (deformation, electrical marking, grooving), that must be, in this case, corrected by in-situ machining or grinding, mica undercutting, bar bevelling.

These measurements and analyses require the services of **professional teams** specialised in motor technical maintenance. Performing an electrical expert assessment requires the use of **specific equipment** and, therefore, the services of **specialists** in the sliding contact and electrical rotating machines field.

**In-situ solutions** are to be preferred, since they allow machining without disassembling the machine and, therefore, significantly reduce machine downtime. For instance, the machining of a commutator, with equipment especially developed by Mersen, takes a few hours, against more than one day with manual stone machining.

The maintenance of direct current machines is often entrusted to external service providers, this does not help the internal teams to master this technology and corresponding diagnosis techniques.

Producers of electrical machines, of solutions for electrical machines, and companies in charge of their own maintenance may call on Mersen to train and accompany their users. For instance, Mersen offers **training courses** on its site (Stagelec) or at the customer's site (Extelec) to allow trainees to learn how to make the diagnosis on the operation of carbon brushes in electrical machines and how to perform a predictive and preventative maintenance.

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