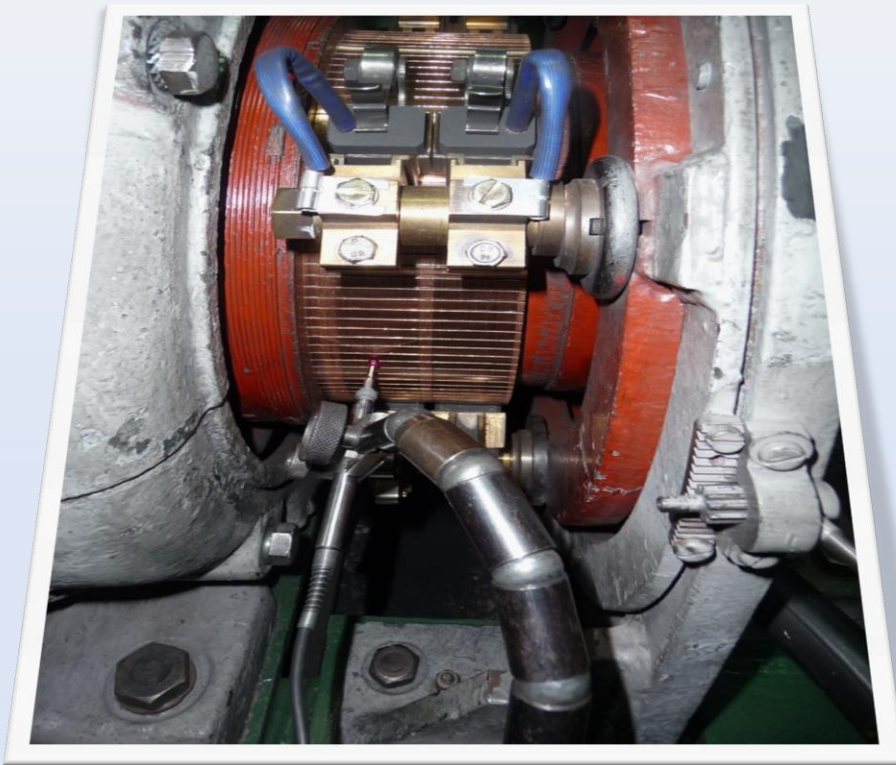


MERSEN'S SERVICES

Optimize your equipment's performance, increase productivity and reduce maintenance costs

SERVICES & MAINTENANCE



Mersen

Mersen is a **Global expert** in electrical specialties and graphite-based materials.

Mersen has been working with major electrical rotating machinery OEMs for more than 120 years, contributing to the optimal performance of your equipment. We provide **high quality engineered solutions** tailored to various operating conditions, designed and tested for **reliability** and **optimum performance**, such as carbon brushes, brush-holders, slip ring assemblies, brush gear housing.

On the 5 continents our engineers and technicians provide services, specific to the machines of each customer.



Your trustworthy partner

- Worldwide network
- Local presence
- Approved and licensed technology
- Highly qualified staff
- Safety & Health qualifications:
 - Electrical works
 - Chemical environment
 - Working in height
 - Offshore
 - Mining
 - Specific customers' safety authorizations
 - First aid / CPR
- Complete risk assessment

Mersen's solutions:

- Brush wear, maintenance and downtime reduction
- Machine performance increase
- Evaluation of the equipment condition before total or partial repairs
- All market segments
- All types of machines
- Replacement parts

Mersen: A complete range of Services



DIAGNOSTICS

On-site motor inspections

- Application
- Mechanical
- Electrical
- Engineering / Environment

TRAINING

- High quality technical training
- Customized training curriculum
- At either our location or yours
- Technical seminars



R&D EXPERTISE

- Rental & development of test benches
- Material analysis



IN SITU MACHINING

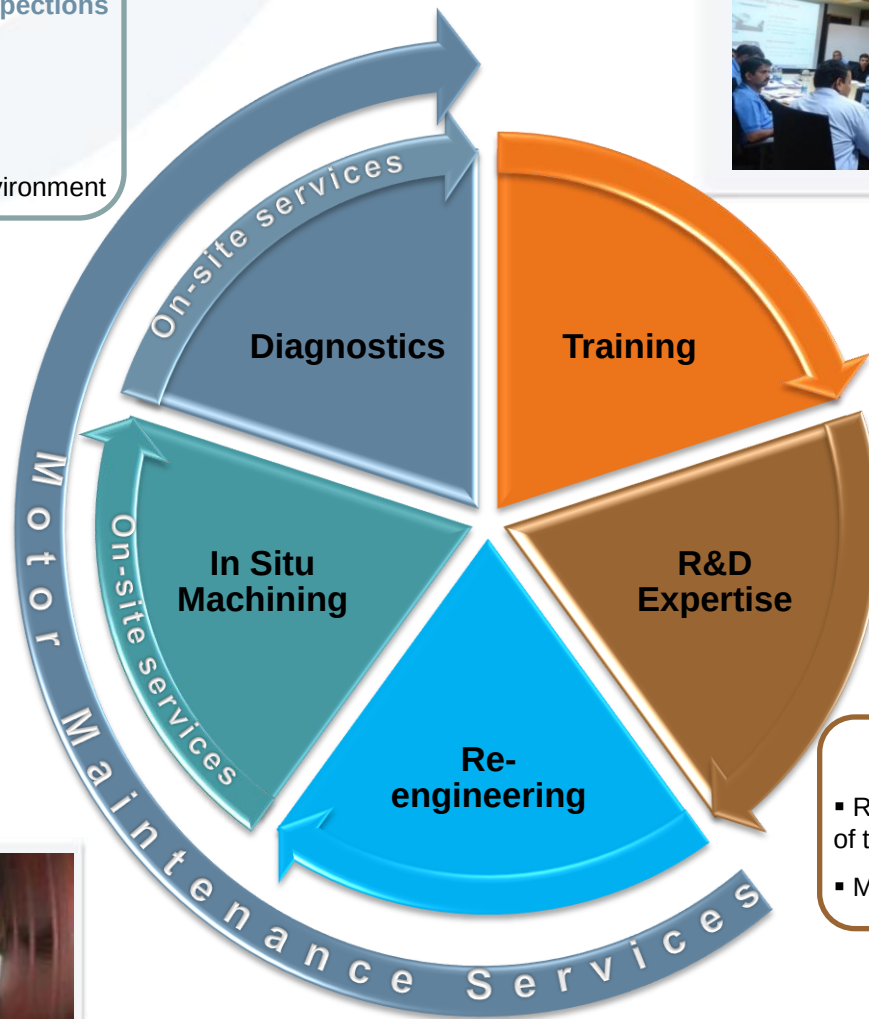
Machining and refurbishment of your slip ring assemblies and commutators



RE-ENGINEERING

Design and re-engineering of components

- Re-design
- Complete retrofit solutions



Mersen's complete range of Services



#	Services & Training	Description
1	On-site services - Diagnostics	Standard machine inspection
2		Comprehensive inspection
3		Specific electrical machine inspection
4		Machine environment inspection
5	On-site services – In Situ Machining	In situ machining and refurbishment of slip ring assemblies and commutators
6	Re-engineering	Design and re-engineering of components
7	Windtracker™ services offer	Complete service offer & Technical expertise in signal and power transfer
8	Training	At our location
9		At your location
10		Technical seminars
11	R&D expertise	Testing capabilities
12		Material analysis



1 → 4. On-site services – Diagnostics

	MACHINE INSPECTION		SPECIFIC ELECTRICAL INSPECTION	SPECIFIC ENVIRONMENT INSPECTION
	STANDARD PACKAGE	COMPREHENSIVE PACKAGE		
Operating condition assessment	●	●		
Carbon brush function and design analysis, identification and choice of the grade	●	●		
Slip ring assemblies and commutator film analysis	●	●		
Commutator and slip ring assemblies: surface roughness	●	●		
Commutator geometry	●	●		
Diameter measurement of commutators, slip ring assemblies or rolling stock wheels		●		
Vibration control		●		
Brush-holders pressure measurement, visual analysis and adaptation	●	●		
Complete machine study		●		
Carbon brush arm position equidistance control		●		
Neutral line adjustment			●	
Machine environment condition analysis	●	●		
Evaluation of the heat exchange level				●
Temperature measurement of carbon brushes, slip rings, commutator and winding	●	●		
Commutation measurement			●	
Measurement of the shaft and grounding current			●	
Insulation measurement and control			●	
Electric circuit control			●	
Cooling flow calculation				●
Analysis of pollutants				●
Calculation of losses connected to the carbon brush and commutator/slip ring assemblies				●
Technical report	●	●	●	●



1. On-site services – Diagnostics: Standard machine inspection

Technical issues:

- Carbon brush dusting
- High carbon brush wear
- Sparking
- Abnormal commutator or slip ring assemblies appearance (striation, deformation, electric marking etc)
- Vibrations with fringed, cut, ripped off cables or glazed surface of carbon brush
- Cable discoloration
- Broken spring of the brush-holder
- Slip ring threading
- Selective action



Standard machine inspection

Mersen's solutions:

	Description
1	Commutators and slip ring assemblies
	→ Surface roughness
	→ Commutator geometry
	→ Vibration control (bearings, balancing, frame inspection, shaft alignment)
2	Brush-holders
	→ Brush-holder pressure measurement
	→ Brush-holder clearance to carbon brush measurement
	→ Brush-holder condition visual analysis
3	Diameter measurement of commutators, slip ring assemblies and rolling stock wheels
4	Technical report



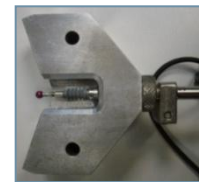
Vibration control



Vibration analyser



CL-Profiler



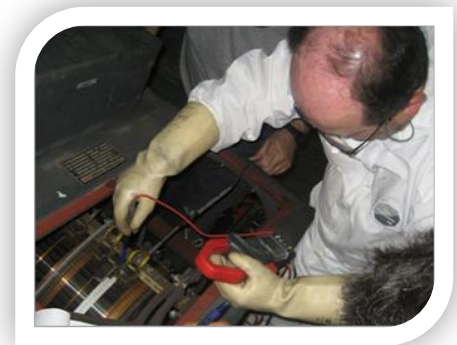
DiaMeter



2. On-site services – Diagnostics: Comprehensive inspection

Technical issues:

- Carbon brush dusting
- High carbon brush wear
- Sparking
- Abnormal commutator or slip ring assemblies appearance (striation, deformation, electric marking etc)
- Vibrations with fringed, cut, ripped off cables or glazed surface of carbon brush
- Cable discoloration
- Broken spring of the brush-holder
- Flash over
- Slip ring threading
- Selective action



Potential under brush reading

Mersen's solutions:

	Description
1	Static
	→ Complete machine study (operating conditions, patina analysis)
	→ Carbon brush arm position equidistance control
	→ Neutral line adjustment
	→ Carbon brush function analysis
	→ Brush-holder adaptation
2	Dynamic
	→ Environment conditions evaluation
	→ Evaluation of the heat exchange level
	→ Temperature measurement of carbon brushes, slip ring assemblies and commutator
	→ Winding temperature measurement
	→ Commutation measurement
	→ Vibration control (shaft line)
	→ Measurement of the shaft and grounding current
3	Technical report



3. On-site services – Diagnostics: Specific electrical machine inspection

Technical issues:

- Electrical marking on commutator strips, on slip ring assemblies or on the carbon brushes
- Sparking
- Vibrations
- Turbo-alternator: current distribution problems



Specific electrical machine inspection

Mersen's solutions:

	Description
1	Insulation: Rotating electrical machinery insulation measurement and control
	→ Machine environment analysis
	→ Winding temperature measurement
	→ Insulation resistance
	→ Capacity measurement in low and high frequency
	→ Absorption current measurement
	→ Polarization index
	→ Discharge test
2	Electric circuit control
	→ Ohmic resistance measurement
	→ Impedance measurement
	→ Capacity measurement
3	Technical report



Insulation control
with Megger measuring device



Harmonics control



LCR Meter



Measurement of
shaft currents



4. On-site services – Diagnostics: Machine environment inspection

Technical issues:

- High carbon brush or commutator wear
- Oil presence in the carbon brush compartment
- Coloration of the cable, brush-holder or commutator due to acid attack



Control of the operating conditions

Mersen's solutions:

	Description
1	Temperature measurement at vent inlet and outlet
2	Cooling flow calculation
3	Analysis of pollutants
4	Calculation of losses connected to carbon brushes and commutator / slip ring assemblies design
5	General advice on components and materials (winding, insulation materials...)
6	Technical report



Thermometer
hygrometer



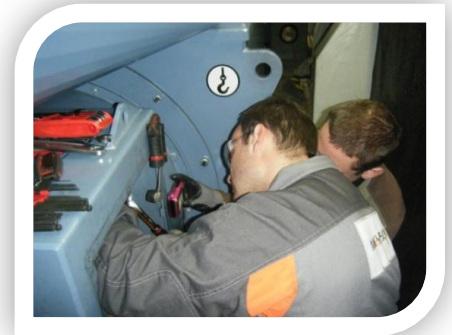
Infrared camera



5. On-site services – In Situ Machining: In situ machining and refurbishment of slip ring assemblies and commutators

Technical issues:

- High carbon brush wear
- Sparking
- Abnormal commutator or slip ring assemblies appearance (striation, deformation, electric marking etc)
- Vibrations with fringed, cut, ripped off cables or glazed surface of carbon brush
- Cables coloration
- Broken spring of the brush-holder
- Flash over
- Slip rings threading



Mersen's solutions:

	Description
1	Diamond or ceramic machining of commutators and slip ring assemblies
2	Stone grinding of commutators and slip ring assemblies
3	Mica undercutting
4	Bar edge chamfering
5	Commutator and slip ring assemblies profile measurement
6	Commutator and slip ring assemblies diameter measurement
7	Replacement of the carbon brushes
8	Replacement and adjustment of brush-holders
9	Contact surface seating
10	Final dimensional inspection
11	Technical report





6. Re-engineering: Design and re-engineering of components

Technical issues:

- High carbon brush wear
- Electromechanical failures
- Old design electrical parts
- Flash over
- Slip rings threading
- Over/under-loaded brush design

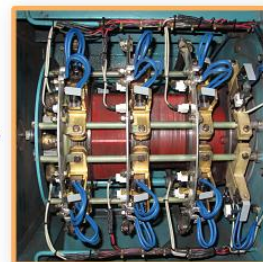
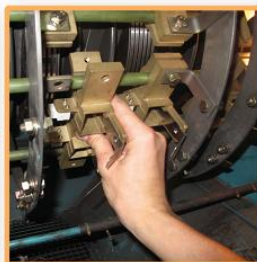


Retrofit kit for Hitachi generator

Mersen's solutions:

- Re-design to reduce brush wear, maintenance and downtime
- Complete retrofit solutions (carbon brushes, brush-holders, slip ring assemblies, brush gear housing)
- Plug & play solutions
- No machine modifications required

	Description
1	Complete field diagnostic
2	Report to R&D
3	Analysis and recommendations
4	Prototype
5	Tests in the field (or test benches)
6	Tool design and manufacturing
7	Reengineered solution manufacturing
8	Follow up in the field and after sales
9	Technical report





7. Windtracker™ services offer: Complete service offer & Technical expertise in signal and power transfer

Technical issues:

- High carbon brush wear
- Sparking
- Abnormal slip ring assemblies appearance (striation, deformation, electric marking etc)
- Vibrations with fringed, cut, ripped off cables or glazed surface of carbon brush
- Cables coloration
- Broken spring of the brush-holder
- Flash over
- Slip rings threading or grooving



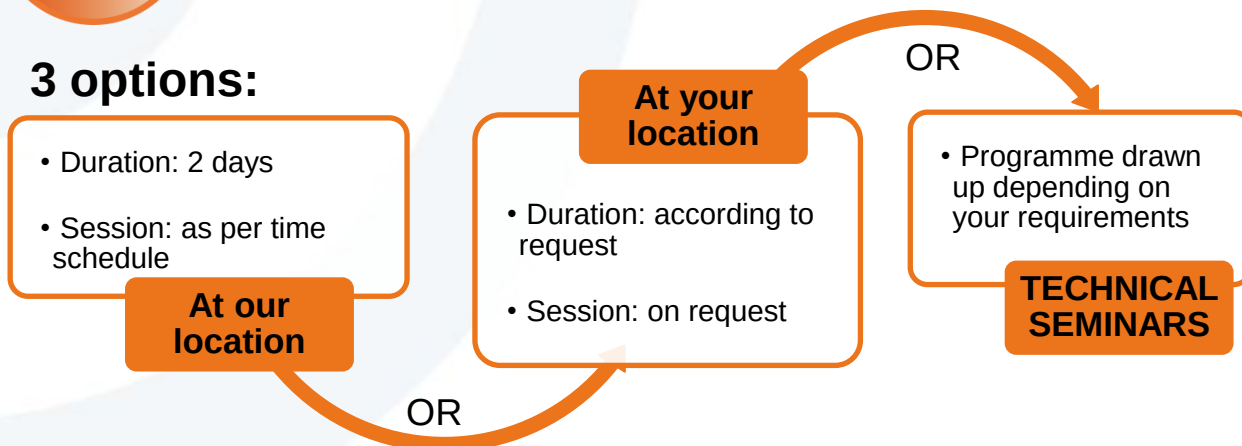
Mersen's solutions:

	Description
1	Complete service offer:
	→ Uptower support according to the industry's safety standards
	→ In situ machining of the generators' slip ring assemblies
	→ Training: Stagelec or Extelec
	→ "Green" programs : dedicated carbon brush recycling program
2	Technical support & expertise in signal and power transfer:
	→ Diagnostics
	→ Re-engineering
	→ Redesign to Cost
3	Offshore wind turbines Signal Transfer Systems maintenance service
4	Technical report



8 → 10. Training

3 options:



- **High quality Technical Training** to help you to maximize the efficiency of your staff while minimizing the costs
- With a **variety of training solutions** and highly qualified Mersen specialists, we can customize a learning solution that works for you
- **Customized Training Curriculum:** dedicated program specially for your staff needs and experience level to optimize your time and learning
- Training at customer's site or in our **Training facilities** located in Europe, India and USA



- **Who should participate:**
 - Engineers, technicians and electrical maintenance personnel

	Description
1	Introduction → Production of raw materials → Manufacture of carbon brushes and brush-holders → Brush grade groups and corresponding applications
2	Understanding the basic rules and functions of the carbon brush.
3	Parameters influencing the carbon brush behaviour
4	Analyzing motor malfunctions by observing the condition of the carbon brushes, commutators and slip ring assemblies
5	Using diagnostic and control equipment
6	Practical examples to improve preventive and corrective maintenance



11. R&D Expertise : Testing capabilities

Technical issues:

- Development of electric machines for new applications
- Application difficulties , extreme climate conditions, speed or current variations etc.



Mersen's solutions:

- Support for new development projects
- Support for electrical machines diagnostics
- Large range of existing test benches
- New test bench development
- According to the customer's specifications

	Description
1	Environmental chamber
	to validate prototypes in all kinds of configurations: → Temperature: - 40°C / + 150°C → Humidity: 5% RH to 98% → Altitude: 0 to 2000 m = 790 mbar Dimensions : (2.70 x 2.40 x 2.20 m / 9 x 8 x 7 ft)
2	Slip ring test bench
	→ Speed: 0 to 2900 rpm → Maximum weight: 500 kg → Maximum current: 1200 A AC (according to the current density and number of carbon brushes)
3	Turbo generator test bench
	→ Ring diameter: 19.0" (480 mm) → Ring grooves: 0.12" wide with 0.5" pitch → Ring material: 4140 Alloy steel → Ring peripheral speed: 0 to 100 m/s → Current density: 0 to 1200 A DC → Carbon brush dimensions: t x 25 x r mm (t x 1" x r)
4	Corrosion test bench
5	Development of new test benches



12. R&D Expertise: Material analysis

Technical issues:

- Inconsistent material performance
- Incorrect grade selection
- Brush safety: lead, other hazardous components

Mersen's solutions:

- In addition to other Mersen diagnostics
- Support for new development project
- Support for electrical machines diagnostics
- Large variety of material analysis
- According to the customer's specifications
- Comprehensive reports



	Description
1	Carbon brush grades
	→ Physico-chemical analysis → Micrographic structure
2	Metal products
	→ Mechanical properties → Microstructure and chemical composition



Services & Training: Main customer references

RENEWABLE ENERGY

Wind Energy: Maia Eolis, Vestas, REpower, Gamesa, La Compagnie du Vent, GE Energy, Enel Green Power
Hydro: EDF (France), Santo Antônio, Jirau, Electronorte (Brazil), Cahora Bassa (Mozambique), EdiPower, Enel Green Power (Italy)

Training made for REpower (France, Germany, USA), GE Energy (USA), Suzlon (USA), Gamesa (Germany, USA), Iberdrola (USA), VOITH (Germany), Enertrag (Germany), E-On (Germany), Hydro Quebec (Canada), Noble Power (USA), Next Era Energy (USA), GE Power & Water (USA), National Hydro (NHPC) (India) etc.

CONVENTIONAL ENERGY

Thermal and Nuclear Energy: EDF, E.ON (Italy)

Mining: Cleveland Potash, PowerFuel (UK)

Offshore, Oil & Gas: MP Saipem (Eni Group) (Italy, Spain), Bourbon (Brazil)

Training made for EDF (France), Electrabel (Belgium), GDF Suez (France), Hinkley Point (UK), Belkalyi Mines (Belorussia), P&H Mine Pro – Joy Global (USA), Coal of India Ltd (India) etc.

TRANSPORTATION

Railways: Indian Railways (India), Southern Rail (UK), ACTS (Netherlands), Goviathameslink (UK)

Transit transport: London Underground, Rotterdam metro, Athens metro, Transpole, Paris metro, SNCF (France)

Ports & Marine: Jan de Nul (Belgium), Dredging (Belgium), ECT (Netherlands), Igma Bulk Terminal (Netherlands) etc.

Training made for Metro of Istanbul (Turkey), Metro of Cairo (Egypt), RATP (France), Metro of Singapore, Indian Railways, SNCF (France), ONCF (Morocco) etc.

PROCESS INDUSTRIES

Metallurgy: Arcelor Mittal (Belgium, France, Germany, Spain), Usiminas (Brazil), Tata Steel (Netherlands, France), Marcegaglia (Italy) etc.

Pulp & Paper: Shotton Paper (UK), SCA Hygiene (UK), Kappa (Netherlands), Sappi (Netherlands, Belgium) etc.

Cement: Orcem (Netherlands), Holcim (Belgium), CBR (Belgium), Italcementi, Colacem (Italy)

Plastic & Rubber: Azko Nobel (Netherlands), Bayer (Belgium, Germany), AKG Polymers (Netherlands) etc.

Others: Eiffel Tower, Disneyland Paris (France)

Training made for Arcelor Mittal, Thales (France), ACOME (France), Georgia Pacific (France), Vicat (France), Steel Authority of India, Jindal Steel (India) etc.



Diagnostics Form (1/2): In Situ Machining of Motors or Generators

Customer:

Name:
Email:
Telephone:
Address:
GPS coordinates:

Mersen representative:

Name:
Email:
Telephone:

Information required before the intervention:

● **Subject of the intervention:** ☐ Motor ☐ Generator

● **Machine:**

Machine manufacturer:
Machine type:
Generator: ☐ DC ☐ AC
Motor: ☐ DC ☐ AC

Nominal Speed (rpm)

Power (kW)

● ☐ Horizontal ☐ Vertical

● **Slip Ring Assemblies:**

Number of rings:
Material: ☐ Steel (Alloys) ☐ Bronze
Diameter (mm):
Ring width (mm):
Helical groove: ☐ with ☐ without
Depth of the helical groove (mm):

● **Access to the machine:**

Access door dimensions: Width (cm) _____ x Height (cm) _____
Distance between rotor and door (cm):
Comments:



Please send us pictures of the Commutator or Slip Ring assemblies, their nameplate, environment, conditions etc.

DC Machine	
Armature Voltage (V)	
Armature Current (A)	
Field Voltage (V)	
Field Current (A)	

AC Machine	
Stator Voltage (V)	
Stator Current (A)	
Rotor Voltage (V)	
Rotor Current (A)	

● **Commutator:**

Diameter (mm):
Width (mm):
Nr of bars:
Mica width (mm):



Diagnostics Form (2/2): In Situ Machining of Motors or Generators

● Brush-holder bolt:

Type: ☐ Square ☐ Circle

Number:

Diameter of the brush-holder bolt (mm):

Or section (mm):

Length of the brush-holder bolt (mm):

Distance between the centre of the brush-holder bolt and the commutator (mm):

Distance between two brush-holder bolts (mm):

Distance between the centre of the brush-holder bolt and the centre of the carbon brushes (mm):

● Brush-holders:

Adjustment to be made: ☐ Yes ☐ No

Replacement to be made: ☐ Yes ☐ No

● Carbon brushes:

Grade:

Dimensions (mm) t _____ x a _____ x r _____

Drawing reference:

Replacement to be made: ☐ Yes ☐ No

● Motor power supply during the intervention:

☐ By the customer ☐ By Mersen

If "by the customer", please precise the method:

☐ Auxiliary motor

☐ Hydraulic, please precise the rotation speed (rpm):

☐ Other (please precise):

● Specific electrical motor inspection to be done:

☐ Insulation measurement and control

☐ Other (please precise):

● Machine's availability (provisional dates):

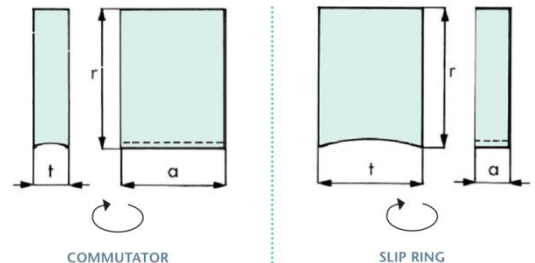
● Machine's condition:

☐ Dust

☐ Oil

☐ Other (please precise):

● Comments





Diagnostics Form (1/2): Wind turbine: In Situ Machining of Slip Ring Assemblies

Customer:

Name:

Email:

Telephone:

Address:

GPS coordinates:

Mersen representative:

Name:

Email:

Telephone:

Type and model of the wind turbine:☐ Onshore☐ Offshore**Generator type:****Information required before the intervention:**

● Rings to be machined:

☐ Power☐ Grounding

● Method to take our tools to the nacelle:

☐ Lifting device☐ Elevator☐ Other (please precise):

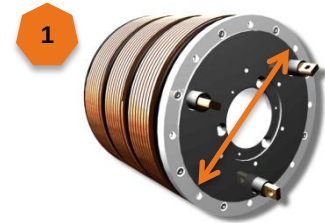
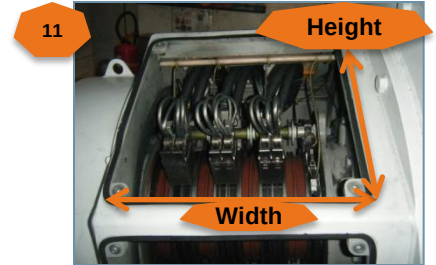
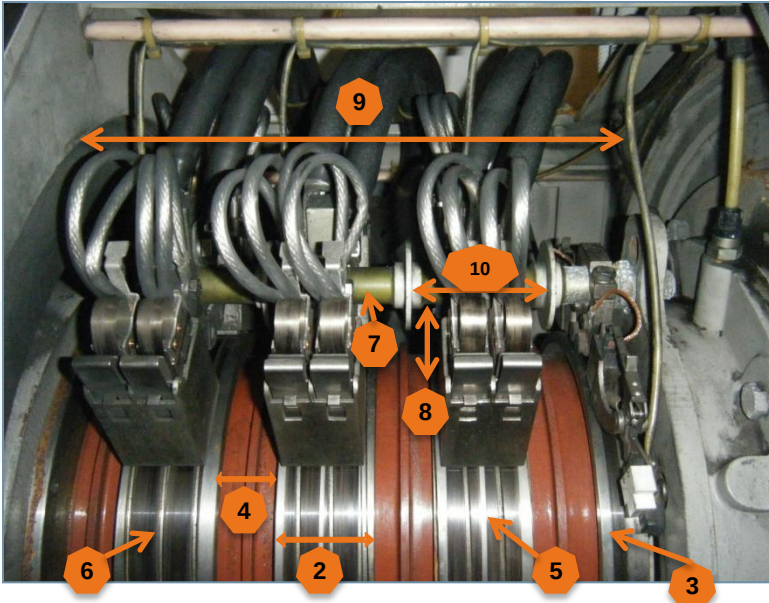
● Comments



Please send us pictures of Slip Ring assemblies, their environment, conditions etc.



Diagnostics Form (2/2): Wind turbine: In Situ Machining of Slip Ring Assemblies



Dimensions to be checked before the intervention:

1. Ring Diameter (mm):
2. Power Ring width (mm):
3. Grounding ring width (mm):
4. Distance between rings (mm):
5. Helical groove: ☐ with ☐ without
Depth of the helical groove (mm):
6. Ring material:
☐ Stainless steel
☐ Bronze
☐ Other (please precise)
7. Diameter of insulated rod (mm):
8. Distance between insulated rod and slip ring (mm):
9. Length of insulated rod (mm):
Please precise if the measurement includes ☐ Power rings and/or ☐ Grounding ring
10. Distance between white insulated plates (mm):
11. Slip ring access dimensions: : Width (mm) _____ x Height (mm) _____



Survey (1/2): Testing capabilities

Customer:

Name:

Email:

Telephone:

Address:

Mersen representative:

Name:

Email:

Telephone:

● Application:Renewable Energy: ☐ Wind power ☐ Hydro powerConventional Energy: ☐ Thermal & Nuclear power ☐ Mining ☐ Oil & GasTransportation: ☐ Railways ☐ Transit ☐ Aerospace ☐ MarineProcess Industries: ☐ Metallurgy ☐ Wire & Cable ☐ Paper ☐ Cement ☐ Other _____ (please precise)**● Test bench:**☐ Slip ring assemblies ☐ Turbo generator ☐ Environmental chamber:**● Testing objectives:****● Test bench description:****Motor**

Range of speed (rpm)

Electrical parameters

AC or DC current

Rated current (A)

Maximum current (A)

Slip ring assemblies

Quantity of slip rings

Material

Diameter (mm)

Width (mm)

Grooving pitch/groove (mm)

Slip ring assembly drawing number
(please include the drawing to the questionnaire)**Support slip rings**

Quantity

Material



Survey (2/2): Testing capabilities

● Test bench description:

Carbon brushes

Quantity	
Grade	
Tangential dimension (t), (mm)	
Axial dimension (a), (mm)	
Radial dimension (r), (mm)	
Specific carbon brush pressure (kPa)	

Brush-holders

Quantity	
Brush-holder drawing number (please include the drawing to the questionnaire)	

Environmental parameters

Temperature (C)	
Humidity (RH)	
Altitude (mbar)	

Ventilation system (if necessary)

Necessary airflow (m3/s)	
--------------------------	--

● Measurement parameters

- Please precise the measurements to be done:

- Method of recording :
 - ☐ Continuous recording
 - ☐ Item by item recording

Mersen's Services



- **On-site service calls** throughout the world
- **Commutation expertise**
- **Measurements and diagnostics**
- **Support services** on a daily basis
- Phone **technical assistance**
- Technical literature on line of our site www.mersen.com or on request (infos.amiens@mersen.com)



Mersen provides **training courses for maintenance of electric motors**. For over 25 years, more than 3,000 technicians have been undergone training, either at our facility or theirs.



- **Diagnostics**
- **In situ commutator, slip ring and brush-holder refurbishment**
- **Support services** on a daily basis

A GLOBAL PLAYER

Mersen is a Global Expert in electrical specialties and graphite-based materials.

Contact: infos.amiens@mersen.com
www.mersen.com/en

