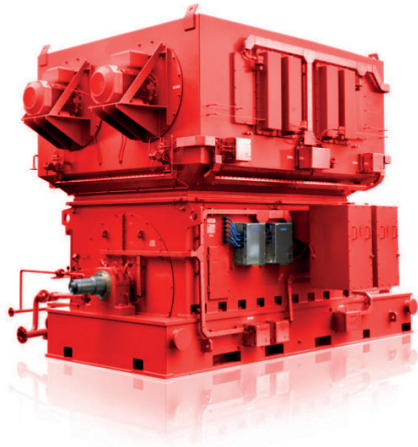


# Maintenance of WMT+ Machines



Your Birr Machines motor is serving your process during many years of operation.

In order to maximise reliability, availability and maintainability of the machine, Birr Machines offers a four level maintenance program.

The program produced based on operational data, inspections and maintenance and can include the Birr Machines Winding diagnosis.

## Four Level Maintenance Program

### Level 1 (L1)

L1 maintenance consists of visual inspections and light maintenance. The purpose of the maintenance is to identify operational issues and inspect high wear items. An L1 also provides recommendations regarding the general installation and site preparations for higher level inspections.

### Level 2 (L2)

L2 maintenance consists of inspections and tests and small maintenance tasks.

The purpose of the maintenance is to find out whether there are emerging issues that may affect the reliability of the machine.

### Level 3 (L3)

L3 maintenance consists of performing extensive inspections, tests and larger maintenance tasks, based on the information and recommendations from the L1 and L2 inspections. The purpose of the maintenance is to rectify problems and replace parts subjected to wear.

### Level 4 (L4)

L4 maintenance consists of extensive inspections and maintenance. The purpose of the L4 is to restore the machine to a reliable operating condition.

L4 maintenance for large machines is generally performed in situ, while smaller machines may be sent to a capable service workshop.

## Winding diagnosis

Winding diagnosis is a Birr Machines service tool used to assess the high voltage stator windings.

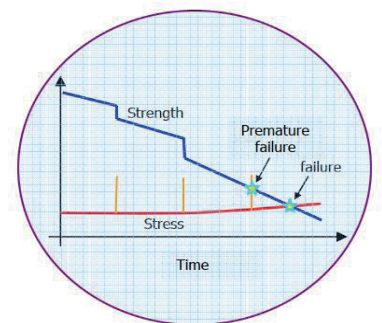
### The Blue Curve

The materials and components of electrical machines are subject to thermal, electrical, ambient and mechanical stresses.

This leads to a process of degradation as materials lose strength over time.

### The Red Curve

Operating stresses, both steady state and transient are also present. At the point where the two curves intersect, failure becomes imminent.



Winding diagnosis provides the information needed for timely action to reposition the red and blue curves and enables us to recommend a maintenance plan to prolong the intervals between maintenance inspections. i.e. movement from time based to condition based maintenance.

WMT+

## Recommended maintenance program

Maintenance Level	Level 1 (L1)	Level 2 (L2)	Level 3 (L3)	Level 4 (L4)
<b>Time based</b>	Up to 1 year (or equivalent hours <sup>1</sup> of operation)	1-2 years (or equivalent hours <sup>1</sup> of operation)	3-5 years (or equivalent hours <sup>1</sup> of operation)	8-12 years (or equivalent hours <sup>1</sup> of operation)
<b>Preparations</b>	Open inspection covers	Open inspection covers, terminal box cover	Open inspection covers, bearings, heat exchanger	Dismantle machine, remove rotor
<b>Inspections and tests</b>	Basic Inspection  Visual inspection  Check on vibration  Record and analyse operational data	Same as L1 plus  <b>Stator</b> -Visual inspection (limited) - Winding resistance - Exciter stator  <b>Rotor</b> Insulation Resistance (IR), Polarisation Index (PI) - Insulation resistance -Surge testing (field winding) -Rotating exciter  <b>Winding diagnosis</b> - Charging/ Discharging current, Insulation Resistance (IR), Polarisation Index (PI) -Loss factor tan delta, Capacity -Partial discharges	Same as L2 plus  -Visual inspection of end winding and end part of core -Bearing insulation - Visual Inspection of rotor caps with borescope - Check Diodes	Same as L3 plus  - Boroscopic inspection of stator core: condition of stator winding (corona protection, looseness...) -Stator wedge tightness mapping
<b>Operational and spare parts</b>	Operational spares can include bearing shells, gaskets	Same as L1	Same as L1 plus, bearing insulation, seals, gaskets (as applicable)	Same as L3 plus, exciter diodes (as applicable)
<b>Expected downtime</b>	Approx. 0.5-1 day	Approx. 1-2 days	Approx. 2-5 days <sup>3</sup>	Approx. 10 days <sup>3</sup>

1) Equivalent hours = Total hours of operation + number of starts x 20

2) Winding diagnosis is a Birr Machines product service tool used to assess the high voltage stator windings.

3) Depends on the accessibility of the machine and lifting facilities.

### Example of a time based maintenance schedule

Interval hours x 1000	10	20	30	40	50	60	70	80
Program	L1	L2	L1	L3	L1	L2	L3	L4

Each maintenance schedule is determined from actual site conditions, number of operating hours, the mode of operation, the number of starts and information received from Winding diagnosis.