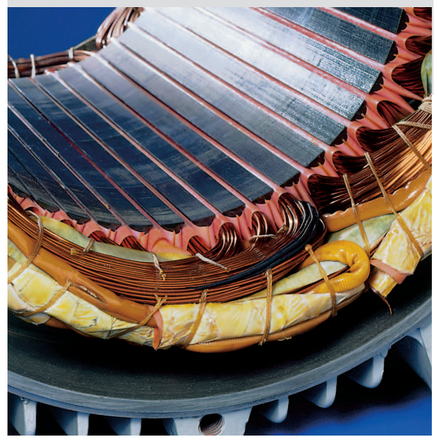
# Windings

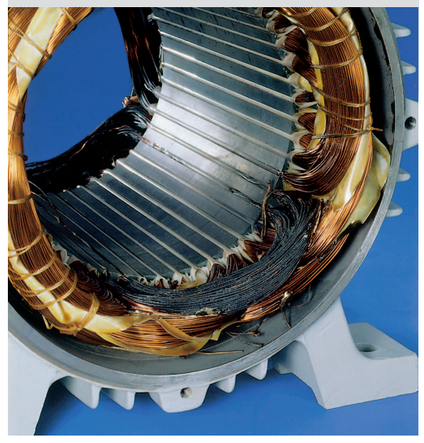
## Three-Phase Motors

The correct specification of the motor (voltage, frequency, polarity, degree of protection, among others) for its application is the first basic requirement for a long useful life of the motor. However, this is not all that will ensure proper operation.
The correct installation, maintenance and operation are essential. In the event of the burnout of an electric motor, the first measure to be taken is to identify the cause (or possible causes) for the burnout by analyzing the damaged winding. It is essential that the cause of the burnout be identified and eliminated so as to prevent any new damages to the motor.
In order to help in the analysis, the pictures and the table below present the characteristics of some types of winding burnouts and their possible causes.

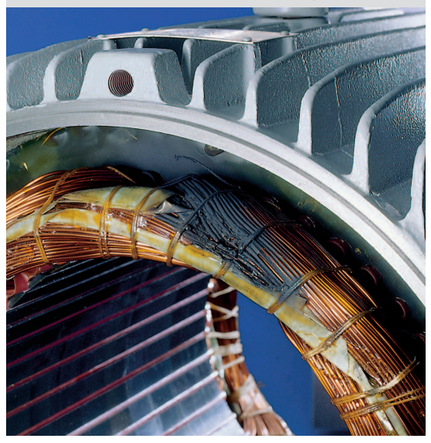
Short-circuit between turns



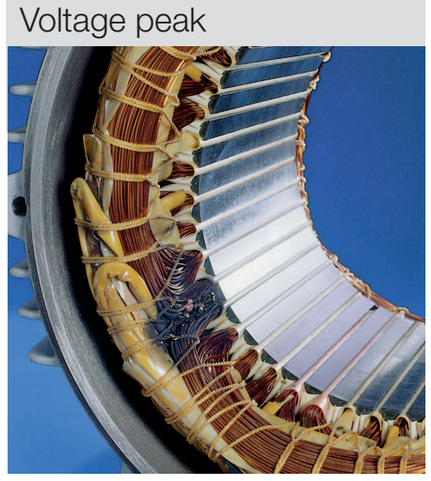
Short-circuited coil



Short-circuit between phases

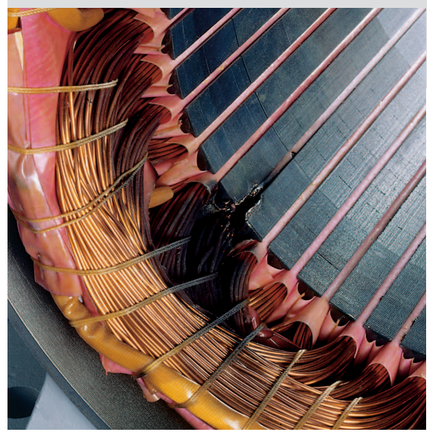


Voltage peak

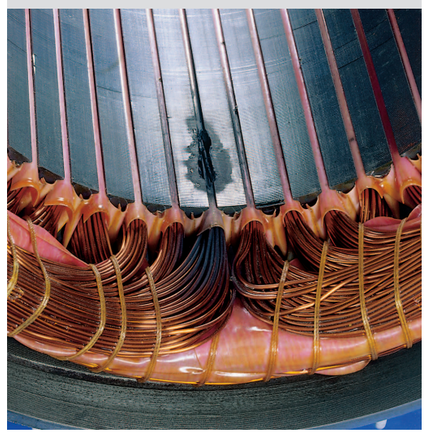


Short-circuit in the connection

Short-circuit at the slot end



Short-circuit within the slot

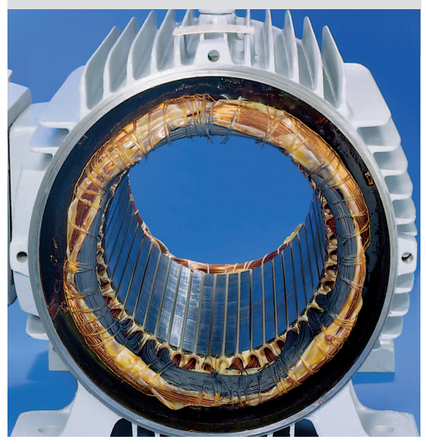


Unbalance and voltage

Overheating

Phase loss star connection

Phase loss delta connection



Stuck rotor

## Table of burnout characteristics and possible causes

| Burnout characteristics | Possible causes |
|---|---|
| Short circuit between turns or<br>Short circuited coil | ▪ Internal contamination of the motor;<br>▪ Fault on the wire insulating enamel;<br>▪ Fault in the impregnation varnish;<br>▪ Fast oscillations in the power supply. |
| Short circuit between phases | ▪ Internal contamination of the motor;<br>▪ Degradation of the insulating material by drying out caused by high temperatures;<br>▪ Fault in the insulating material. |
| Short circuit in the connection | ▪ Internal contamination of the motor;<br>▪ Fault in the insulating material;<br>▪ Overheating of the connection due to poor contact. |
| Short circuit at the slot end or<br>Short circuit within the slot | ▪ Internal contamination of the motor;<br>▪ Degradation of the insulating material by drying caused by high temperatures;<br>▪ Fault in the wire insulating enamel;<br>▪ Fault in the impregnation varnish;<br>▪ Fault in the insulating material;<br>▪ Fast oscillations in the power supply. |
| Voltage peak | ▪ Motor driven by frequency inverter with some incorrect parameters (amplitude of the voltage pulse, rise time, dv/dt , distance between pulses, switching frequency);<br>▪ Great oscillation in the power supply, for example, lightning discharges;<br>▪ Switching surges of capacitor bank. |
| Voltage unbalance | ▪ Voltage and/or current unbalance between phases;<br>▪ Fault in capacitor bank;<br>▪ Poor contact in connections, switches, contactors, circuit breakers, etc.;<br>▪ Voltage oscillations in the three phases. |
| Stuck rotor | ▪ Excessive difficulty to start the motor due to significant voltage drop, very high inertia and load torque;<br>▪ Load shaft is stuck. |
| Overheating | ▪ Too long and/or very thin supply cables;<br>▪ Incorrect wiring of the motor connecting cables;<br>▪ Excessive number of starts in a short time;<br>▪ Load excess on the shaft end (permanent or occasional/periodic);<br>▪ Overvoltage or undervoltage in the power supply (permanent or occasional/periodic);<br>▪ Poor ventilation (damaged or obstructed fan cover, dirt on the frame, high ambient temperature, etc.). |
| Phase loss:<br>▪ Star (Y): Burnout of two phases<br>▪ Delta (Δ): Burnout of one phasee | ▪ Poor contact in switch, contactor or circuit breaker;<br>▪ Poor contact in connections;<br>▪ Poor contact in the terminal of one phase of the transformer;<br>▪ Burnout of a phase of the supply transformer;<br>▪ Burnout of a fuse;<br>▪ Disruption of a feeder cable. |

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