

# PROTECTION, COOLING, INSULATION

Satisfactory brush operation is closely linked with the temperature of the commutators and rings - and in consequence to the method of thermal loss dissipation. It is always useful, therefore, when selecting a brush grade, to have the following information regarding the machine:

- Degree of protection
- Method of cooling
- Class of insulation

The definitions and values in the tables, below, are taken from the French Standard U.T.E. C51 - 100 of July, 1965, applicable on rotating electrical machines of output ratings greater than 600 VA (600 W).

## PROTECTION

**Open machine:** A machine without special protection of live or rotating parts which are accessible to touch. Moisture and foreign bodies can freely penetrate the machine.

**Semi protected machine:** A machine whose windings are partially protected by the disposition of the frame and bearings or by winding covers. Some live and rotating parts are accessible to touch. Moisture and foreign bodies can freely penetrate the machine.

**Sheltered machine:** A machine with devices to impede the entry of vertically falling water droplets or solid particles, when stationary. Some live and rotating parts accessible to touch.

**Protected machine:** A machine in which access to live and rotating parts is made difficult; the openings are situated in such a way that when the machine is stationary entry of solid particles and water splashes is restricted from a vertical downwards direction through any angle to 60° from the vertical.

**Screen-protected machine:** A machine whose ventilation openings are screened by wire or lattice framework, opposing accidental contact and entry of solid particles above a certain dimension whatever direction they come from.

The qualification "Screened" is often used in complement with the terms, sheltered, semi-protected and protected.

**Machine protected against rain:** A machine protected against water splashes when it is in operation.

**Enclosed machine:** A machine whose openings are covered by dust plates, the joints of which are not hermetically sealed, permitting an exchange of internal air with that of the surrounding environment.

The live and rotating parts are shielded against accidental or deliberate contact. Solid particles and coarse dust cannot penetrate into the machine in operation, whatever direction they come from.

Similarly water splashes cannot enter in sufficient amount to impede satisfactory operation or damage insulation.

**Dust-proof machine:** Enclosed machine constructed so as to impede penetration of fine dust, harmful to operation and insulation, when running.

**Hose-proof machine:** Enclosed machine constructed so as to prevent entry of water, projected at any angle from a hose, within specified conditions, in sufficient quantity to impede satisfactory operation when machine is running.

**Submersible machine:** Enclosed machine constructed for permanent operation when submerged in water at a specified depth.

**Hermetically sealed machine impervious to gas or vapour:** Enclosed machine constructed so as to prevent penetration of gas or vapour to the interior, within specified conditions of temperature and pressure.

**Anti-deflagrant machine:** Enclosed machine provided with a casing such that if the ambient atmosphere becomes explosive, an explosion within the machine will neither force, break nor dangerously damage the casing, or spread to the outside.

**Extra safe machine:** Enclosed machine destined for use in an inflammable atmosphere, whose normal operation does not entail sparking and in the construction of which measures are taken for (reduction of heating, increase of airgap), with a view to avoid combustion of the inflammable surrounding.

**Pressurised machine:** Enclosed machine destined for service in an inflammable atmosphere and in which units or circuits like to give rise to an explosion of the explosive mixtures, are enclosed in a casing whose internal atmosphere is a gas maintained at a greater pressure than exists outside of the casing.

## COOLING

**Naturally cooled machine:** A machine without devices for air movement other than those due to rotation and change in temperature.

**Self-cooled machine:** A machine which is cooled by its own means without the intervention of any motive force other than that created by shaft rotation nor any flow other than the air originating from outside of the machine.

**Separately cooled machine:** A machine which is cooled by means of a motive force unassociated with the machine shaft or by means other than the external air flow.

**Open circuit ventilated machine:** A machine in which the heat is transferred directly to a cooling fluid which is continuously renewed.

**Closed circuit ventilated machine:** A machine in which the heat is transferred to a cooling fluid, by an intermediate fluid closed ventilation circuit between the interior of the machine and a cooling unit (radiator or refrigerator).

**Enclosed machine with external ventilation:** An enclosed machine whose casing is cooled by external air driven by some means, in such a manner as to increase the transmission of heat between fluid and internal machine parts to the outside.

**Liquid cooled machine:** A machine cooled by water or other liquid circulating in the working parts or by the immersion of the active parts in a liquid.

**Internal gas-cooled machine:** A machine where one or all of the windings are cooled by a gas (generally hydrogen) circulating inside the coils or conductors.

**Internal liquid-cooled machine:** A machine where one or all of the windings are cooled by a liquid (mostly water) circulating inside the coils or conductors.

The classes and corresponding temperature limits of insulation are as follows:

Classes	Temperatures
Y	90°C
A	105°C
E	120°C
B	130°C
F	155°C
H	180°C
C	above 180°C

Maximum permissible heating for rotating machines (in degrees Celsius).

Machine part	Method of measurement	Insulation class			
		A	E	B	F H C
Commutators and rings according to the class of winding insulation to which one they are joined .....	T(a)	60	70	80	90(b) 100(b)

**Note:** a) These temperatures are measured with a thermometer.

b) The values for F, H and C above, are only applied after agreement between constructor and user.





The specifications or data here in contained are only given for indication, without any undertakings whatsoever. Their publication does not suggest that the matter is free of any rights whatsoever. Furthermore, due to constant evolution of techniques and norms, we reserve the right to modify, at any time, the characteristics and specifications contained in this document. LE CARBONE-LORRAINE refuses all and any responsibility concerning their use whatever the purpose or the application. Any copy, reproduction or information herein contained, in whole or in part, made without LE CARBONE-LORRAINE written consent, is forbidden according to the laws of France and particularly the law nr. 92-597 of July 1st 1992, relating to the copyright.

**LE CARBONE-LORRAINE**  
Applications Electriques  
10, RUE ROGER DUMOULIN  
F-80084 AMIENS Cedex 2  
FRANCE

R.C.S. Nanterre B 572 060 333

*SIEGE SOCIAL* : Immeuble La Fayette - LA DÉFENSE 5  
TSA 38001  
F-92919 PARIS LA DÉFENSE CEDEX  
FRANCE

Tél. : + 33 (0)3 22 54 45 00  
Fax : + 33 (0)3 22 54 46 08

<http://www.CARBONELORRAINE.com>