Infinitum

# Interpreting Insulation Class for Aircore EC Motors

**Class B or F insulation class is a common requirement for conventional electric motors. This document explains common misconceptions of applying standard insulation class requirements for Aircore EC motor.**

Motors can be designed for high insulation temperature rating and a relatively lower operating temperature. This provides for thermal margins in the event of motor overload, severe starting duty, safety margin for adjustable speed drive applications, and for many other reasons.

Some motors are designed with a Class F insulation class having a temperature rise corresponding to Class B (see table below). This can extend the stator life following the general rule that every 10°C that the motor temperature is hotter, the insulation life is halved.

The main benefit of choosing a higher temperature insulation class is that the motor can be designed to operate at a higher temperature reducing the amount of active material (iron and copper).

The insulation class does not determine the life of the stator in an electric motor. The life of the stator is dictated by the operating temperature, by thermal induced stress on the motor insulation, and by partial discharge activity. Thermal induced stress happens when the stator is subjected to variable loads. The stator heats up under heavy load and cools off under light load. The difference in the thermal expansion of the different materials in the stator (iron, copper and insulation) causes the insulation to be continuously stressed under variable operating temperatures. Partial discharge activity can happen when the motor operates connected to an adjustable speed drive. Voltage spikes due to the drive operation can cause electrical arcing in insulation voids.

## Aircore EC Stator Insulation and Life

> Aircore EC printed circuit board (PCB) stators are made with materials rated (UL rating) for 150°C maximum continuous operating temperature, which is near NEMA Class F (155°C)

Aircore EC printed circuit board (PCB) stators are made with materials rated (UL rating) for 150°C. Material operating Temperature (MoT), which is near NEMA Class F (155°C), However, Aircore PCB stators last much longer than conventional stators because they are free of thermal induced stress and of partial discharge activity. The materials in the Aircore PCB stators (copper and glass-epoxy laminate) have matching thermal expansion coefficients, so under variable load, the entire PC stator expands and contracts at the same rate without thermally induced stresses. The manufacturing process of the Aircore PCB stator guarantees a void-free structure, so the stator is virtually immune to partial discharge activity. The absence of thermal induced stresses and partial discharge activity contribute to substantially extending the life of Aircore PCB stator to up to 10x the life of a conventional copper-wound stator under the same operating conditions.

## Stator Temperature Class v. Life

So, any discussion on insulation class begs the question; should the goal be meeting an insulation class for the stator or improving the stator life as a whole? Furthermore, some practitioners also equate insulation class to general robustness of the motor. It's important to separate the insulation class – Myth from Truth.

| NEMA Motor Insulation Temperature Class | | Temperature Rise @ 1.0 SF | | |
|---|---|---|---|---|
| **Insulation Class** | **Temperature Class** | **Ambient Temp** | **Hotspot Temp** | **Temp Rise** |
| A | 105C | +40C | +5C | 60C |
| B | 130C | +40C | +10C | 80C |
| F | 155C | +40C | +10C | 105C |

| Myth | Truth |
|---|---|
| Higher insulation class means longer stator life | Stator life is dependent on a variety of factors including ambient temperature, temperature rise, thermal stresses and partial discharge activity. The Aircore stator is designed taking all these factors into consideration, hence its 10x longer life when compared to conventional copper-wound stators. |
| Higher insulation class means higher thermal margin for extreme conditions | A higher insulation class does not guarantee higher thermal margin. Higher thermal margin depends on the difference between insulation class temperature and the operating temperature of the motor. |
| Higher insulation class means longer MTBF | MTBF is a function of the motor's electrical, mechanical and operational characteristics. In fact, the biggest influencing factors for MTBF are the bearing loads and ambient temperatures. Therefore, increasing the insulation class may not result in increased MTBF.<br>A motor with Class F insulation can have shorter MTBF then a motor with Class B insulation. |
| Insulation temperature class is same as operating temperature | Insulation temperature class is defined as the temperature the insulation can operate continuously without failing for 20,000 hours.<br>Operating temperature is the temperature of the equipment operating continuously at full load and speed. |