

## Electric Motor Ambient Temperature & Insulation Systems

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**The relationship between temperature and electric motors is often misunderstood. The ambient temperature of a motor can affect both a motor's performance and its life.**

Let's take a look at some basic information about the ambient temperature of a motor and how this relates to a motor's insulation system.

### Ambient Temperature

The ambient temperature of a motor is defined as the temperature of the surroundings of the motor. This is the temperature of the motor when it's not in operation (and hasn't recently been operating). Because motors are not 100% efficient, the power applied to a motor will cause it to generate heat and raise the temperature of the motor. The temperature rise of a motor is the change in motor temperature when power is applied to the motor. Generally it is defined as the difference between the ambient temperature of the motor and the temperature of the motor when powered at full load. Temperature rise is measured at the motor's windings, which is generally the hottest part (or hot spot) of a motor.

### Insulation Systems

An insulation system is a combination of various insulating materials used in electrical systems. In a motor, this would include ground insulation, magnet wire, varnish, lead wire insulation, tapes, strings, and sleeves. Each insulation system is given an insulation class. An insulation class is a standardized way to indicate the maximum hot spot temperature for an insulation system. These insulation classes are usually referred to by their UL/NEMA letter designation. The most common letter designations and their maximum allowable hot spot temperatures are shown in this chart.

The temperature rating of these insulation classes indicates at what temperature the insulation system can operate at in order to average 20,000 hours of life. Each insulation class also has a temperature rise associated with it.

Letter Designation	Max Hot Spot Temp (°C)
<b>A</b>	<b>105</b>
<b>B</b>	<b>130</b>
<b>F</b>	<b>155</b>
<b>H</b>	<b>180</b>

Ambient temperature and allowable temperature rise are used to determine the rating for a motor. The electric motor industry standard for ambient temperature is 40°C. The motor rating is determined by gradually increasing the load of a motor until its steady state temperature rise reaches the allowable temperature rise for the insulation class. So, if your motor application has a high ambient temperature (above 40 °C) or needs extended life (greater than 20,000 hours), you should work with your motor supplier to make sure the motor you are using is designed with the correct insulation system.

