



When a wire carries electrical current, its temperature will increase due to the resistance of the wire. The factor that mostly influences/ limits the acceptable level of temperature rise is the insulation system employed in an alternator. The hotter the wire, the shorter the life expectancy of the insulation, and of course the machine itself. This information sheet will explain some standards and considerations regarding **alternator winding temperature rise**.

The standard for designing generators relied on by the electrical generation industry is National Electrical Manufacturers Association (**NEMA**) Standard **MG1**, which encompasses the entire machine, and includes requirements for alternator temperature rise.

The MG1 standard defines two duty cycles: continuous (base), and standby (peak).

Base Continuous Duty – for operation 24-hours a day, 7- days a week, under full load conditions. Base Continuous Ratings, also known as BASIC CONTINUOUS - BR (ISO 8528 - 3) or Continuous Running Duty - Duty type S1(EN 60034-1, IEC34-1 AND BS4999 part 101) or Continuous Duty (NEMA MG1-22). As the title suggests the generator is capable of supporting the specified kVA rating at the specified ambient and power factor for continuous use without over stressing the insulation system.

Standby Duty – for an emergency power source (EPS) - or standby generator set. This is designed to operate as back-up power should the principal power source (utility) be lost or fall outside the nominal frequency or voltage requirements.

Peak Standby Rating (40°C ambient temperature), is defined in ISO 8528-3 as PEAK CONTINUOUS PR it equates to S10 (rating with discrete constant loads) in EN60034-1 and STANDBY RATING in NEMA MG1-22. Here the class H temperature rise is allowed to increase above the BASE continuous rating. The result is an increased rating at the expense of reducing the lifetime of the generator by between 2 to 6 times. Peak standby continuous rating offers an economical sizing for emergency backup power supplies.

Peak Standby Rating (27°C ambient temperature), EN 60034-1 states that with the customer's prior agreement an increase in rating may be made to account for a decrease in ambient temperature. The ratings quoted at 27°C ambient allow an increased temperature rise to bring the operating temperature of generator to the same level as seen at 40°C ambient as above.

As the standby category (NEMA MG1 – 22.40) has no defined hour limits, the EPS is considered to typically run for about 200 hours or less a year – considerably fewer than that for a continuous duty application. This higher temperature rise allows more kW to be utilized and is justified by the higher standby output ratings commonly found on most emergency generator sets. However, the insulation of a standby unit will age thermally at about four to eight times that of a continuously rated alternator.



NEMA MG1 recognizes four classes of electrical insulation of the alternator:

- A
- B
- F
- H

Each of these categories has different characteristics, but the accepted common feature is an anticipated minimum life expectancy of 30,000 hours. The letter signifies the maximum allowable windings temperature allowable while the alternator is operating, if exceeded the insulation will breakdown resulting in winding burn out.

The primary difference is the maximum allowable temperature at which the alternator windings can operate with these types of insulation, as shown in Table 1.

Since standby duty requires less operating hours than continuous use, MG1 allows the standby windings to operate at a temperature up to 25 °C warmer, as shown in Table 2. If used for continuous duty or prime power, the standby alternator's useful working life will be considerably shortened and reliability may well become an issue.

Table 1 - Maximum Temperature Rise (40°C Ambient)				
Continuous				
Temperature Rise	Class A	Class B	Class F	Class H
Temp. Rise °C	60	80	105	125
Temp. Rise °F	108	144	189	225

Table 2 - Maximum Temperature Rise (40°C Ambient)				
Standby				
Temperature Rise	Class A	Class B	Class F	Class H
Temp. Rise °C	85	105	130	150
Temp. Rise °F	153	189	234	270

Typical Windings Within a Generator Set's Alternator

