Nidec Power

TECHNICAL NOTE

TN11

INSULATION CLASS / TEMPERATURE RISE CLASS

PREAMBLE

This technical note aims at:

- Clarifying Insulation Class and Temperature Rise Class notions
- Comparing possible systems available (Insulation Class H / Temperature rise F vs. Insulation Class F / Temperature rise B)
- Showing evidences on generator lifetime extension, by sizing the generator on a lower Temperature Rise Class

INSULATION CLASS

The IEC 60085 specifies that an Insulation system permanently submitted to its Insulation Class temperature has a life expectancy of 20 000h.
It defines the Insulation Class temperatures as follows:

Insulation class	H	F	B
Temperature	180 °C	155 °C	130 °C

(Reference Document: IEC 60085)

All LEROY-SOMER™ generators windings are manufactured with Class H insulation system.

TEMPERATURE RISE CLASS

The temperature rise class is the maximum allowed difference between the measured temperature, after temperature stabilisation, of one of the active generator components (stator or rotor copper) and the cooling fluid temperature (e.g. ambient air temperature for instance, at 40°C).
In other words, this is the maximum allowed temperature increase, from cold to warm condition, when the alternator is running at rated values.

The IEC 60034-1 defines the temperature rise class as follows:

Temperature rise Class	H	F	B
Temperature limits	125 K	105 K	80 K

(Reference Document: IEC 60034-1 - Table 7, Resistance method of measurement)

Note: Temperature rise data are stated in Kelvin (K).

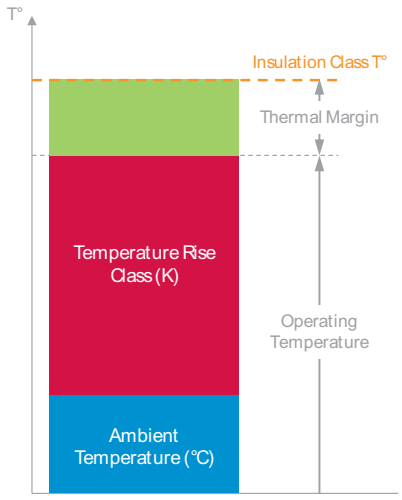
INSULATION CLASS AND TEMPERATURE RISE CLASS

We define the following:

Thermal Margin = **Insulation Class Temperature**
— Operating Temperature

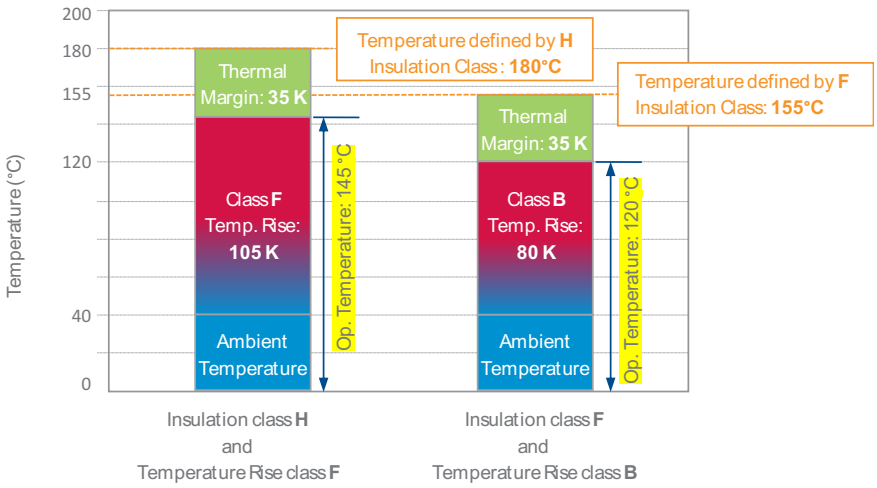
Where :
Operating Temperature = Temperature Rise Class
+ Ambient Temperature

Note :
When a generator system is designated as **"H / F"**
The 1st letter defines the Insulation Class
The 2nd letter defines the Temperature Rise Class



H / F VERSUS F / B

Thermal margin = Insulation Class Temperature - Total Temperature



In other words:

LEROY-SOMER™	Usual requirement
Insulation class **H** / Temperature Rise class **F**	Insulation class **F** / Temperature Rise class **B**
Thermal margin: 180-(105+40) = 35 K	**Thermal margin:** 155-(80 +40) = 35 K

» **Generators designed as F / B or H / F have the same thermal margin, and hence the same insulation system lifetime.**

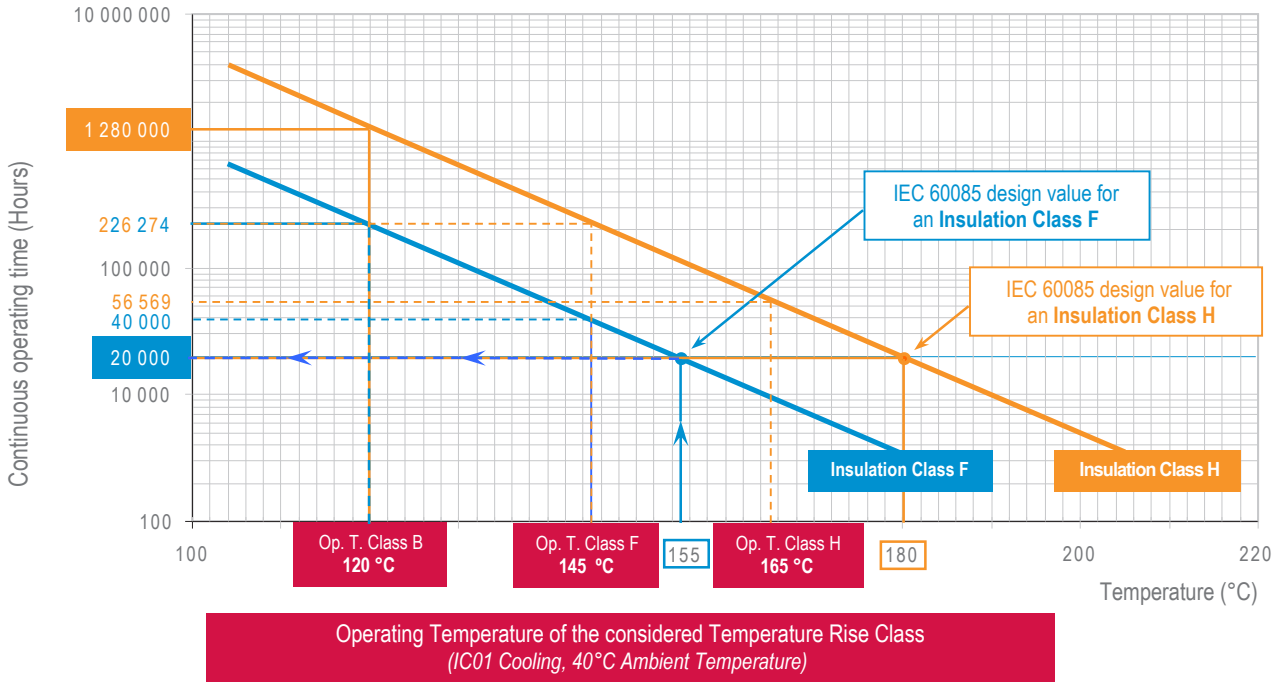
» **Using H / F designs enables the selection of more compact and economic generators with the same design life time.**

GENERATOR INSULATION LIFETIME EXTENSION POSSIBILITIES

The « Rule of 10 » (c.f. Arrhenius Equation) can be adapted to approximate the relationship between insulation lifetime and operating temperature. This rule states that if a generator's operating temperature is reduced by 10°C, the insulation system lifetime is doubled.

Using a higher Insulation Class, associated with a lower Temperature Rise Class, allows a drastic increase the insulation lifetime.

Insulation Class H & F vs. Operating Temperature (OT in °C)



H & F insulation lifetimes, depending on the selected Temperature Rise Class:

	Insulation Class H		Insulation Class F	
	System	Lifetime (Years)	System	Lifetime (Years)
Operated at **Class H** Temperature rise	H / H	6.5	N / A	N / A
Operated at **Class F** Temperature rise	H / F	26	F / F	4.6
Operated at **Class B** Temperature rise	H / B	146	F / B	26

» **H / B designed generators have oversized insulation lifetime. At least 5 times the expected lifetime of F/B design for the same active part size and mass.**

This design can be offered by Nidec Power.