Nidec Power

Protection Systems

Alternators
10 kVA - 35,000 kVA

LEROY-SOMER™


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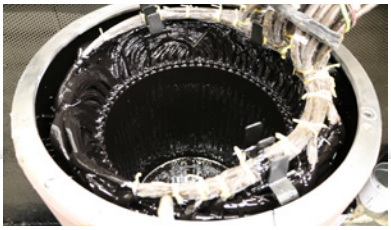
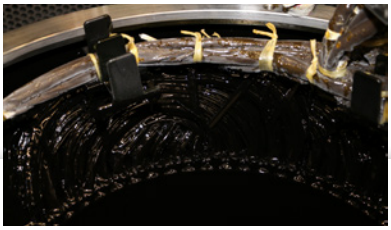
INTRODUCTION

Nidec Power has designed and tested a set of protection systems capable of withstanding the harm caused by the various different types of attack encountered. In severe environmental conditions, the traditional polyester varnish applied to the windings can be subject to ageing or premature corrosion. In such cases, the machine protection should be reinforced. For the majority of applications in a controlled environment, the class H insulation fitted on our alternators should be sufficient to guarantee the machine life. Protection systems are added where there are specific constraints.

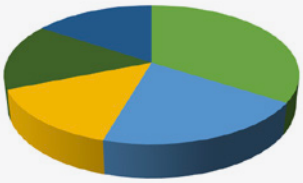
The primary purpose of generator sets is to provide electric current quickly and autonomously, in situations and places where the main supply has failed.
As a result, they are often faced with conditions of use that do not provide an optimum environment.

Extreme temperatures, humidity, dust, etc. All these aggressors are likely to speed up ageing of the genset and its different components. Resistance to the weather and demanding conditions of use is therefore essential to ensure the longevity of a generator set.

“ WINDING PROTECTION IS A KEY ISSUE WHEN USING GENERATOR SETS. ”

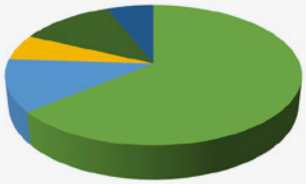
Alternators are of course affected by this issue, essentially due to their electromechanical nature, since they contain numerous components that can fail prematurely. In addition to the mechanical risk there is the risk of electrical malfunction.

In practice, we can see that for low-voltage machines excluding AVRs, the main sources of breakdown are divided evenly between the different alternator components.



34% Stator
20% Rotor
14% Excitation system
16% Bearing/coupling
16% Miscellaneous

For high-voltage machines, nearly 80% of alternator faults are of electrical origin and mainly concern stator windings.



64% Stator
12% Rotor
14% Excitation system
12% Bearing/coupling
6% Miscellaneous

* Source: Allianz Insurance, Germany (1996-1999), VDE Colloquium, June 28, 2001, SAV Leroy-Somer™ ASS statistics

DEMANDING ENVIRONMENTS

Environmental stress is usually classified according to four criteria:

- **Humidity** is a problem because it is an electrical conductor. It is therefore likely to encourage the development of potential short-circuits. Moreover, moisture tends to accumulate in the bottom of the machine, where it mixes with dust and does even more damage to the windings.

- **Dust and other particles** constitute another hazard, as they cause mechanical abrasion of the varnish, which will gradually lead to a deterioration in its performance. Since air circulation is used for cooling inside the alternator, the presence of particles in the environment is particularly harmful.

- **Corrosion**, especially rust due to a saline environment, is usually a factor in the premature ageing of mechanical parts and windings. Alternators used in coastal areas or in an unprotected marine environment are particularly exposed to this risk. Corrosion can also cause the build-up of deposits that may interfere with machine operation.

Typical deposits on an alternator used in a tropical industrial environment (palm oil refinery)

- In certain cases or for certain applications, generator sets can be used in environments saturated in **chemicals** which pose a particularly high level of attack (acids, bases, alkali). Although this rarely happens, these situations must also be taken into account.

APPLICATIONS CONCERNED

Although it's difficult to generalise, we can nonetheless draw up guidelines relating to the correlation between the application for which an alternator is used, its environment and hence the required protection level.
The table below summarises these considerations.

	HUMIDITY	DUST	CORROSION	CHEMICAL HAZARDS	Recommended system
Rental/construction	*	*			SYSTEM 2
Marine engine room	*				SYSTEM 1
Industrial environment	*	**		*	SYSTEM 2
Telecoms	*	*			SYSTEM 2
Mining, traction, rail applications	*	***		*	SYSTEM 4
Offshore oil exploitation	**	*	***	**	SYSTEM 6

Nature of Air	Humidity RH %	Low Voltage Alternators types 40 to 50	Low Voltage Alternators types 52 and above	Medium and High Voltage Alternators
Clean air	≤ 95%	SYSTEM 1	STANDARD	STANDARD +
All applications, marine engine room		High performance dielectric impregnation varnish		High performance dielectric impregnation varnish + insulation coating on all windings
Clean air	> 95%	SYSTEM 2 (*)	STANDARD +	
All applications, tropical ambiance, rental		SYSTEM 1 / STANDARD + insulation coating on all windings		
Saline air Chemical air Abrasive air Aggressive air	> 95%	SYSTEM 4 (*)	REINFORCED	REINFORCED
All applications, including coastal location		SYSTEM 2 + protection of mechanical parts and connections of electronic components	STANDARD + insulation coating or fibreglass enamelled stator wire (**) + coating (***) + special protections according to environment, such as paint and filters	STANDARD + exciter with fibreglass enamelled wire + special protections according to environment, such as paint and filters
Saline air Chemical air Abrasive air Aggressive air Corrosive air	> 95%	SYSTEM 6 (*)		
All applications, including coastal location		SYSTEM 4 + additional protection of mechanical parts + stainless steel screws and grills		

(*) Possible derating according to voltage and alternator models for TAL range (refer to catalogue).
(**) Depending on the production site, the fibreglass enamelled wire solution may be replaced by another process, for example, double application of insulation coating, by spraying and dipping.
(***) For low voltage machines > 500 V, the reinforced system is applied by default as standard.
For low voltage machines < 500 V, using a reinforced protection system leads to a power derating of about 6%.

OVERVIEW OF PROTECTION SYSTEMS

for Low Voltage Alternators

SYSTEM 1

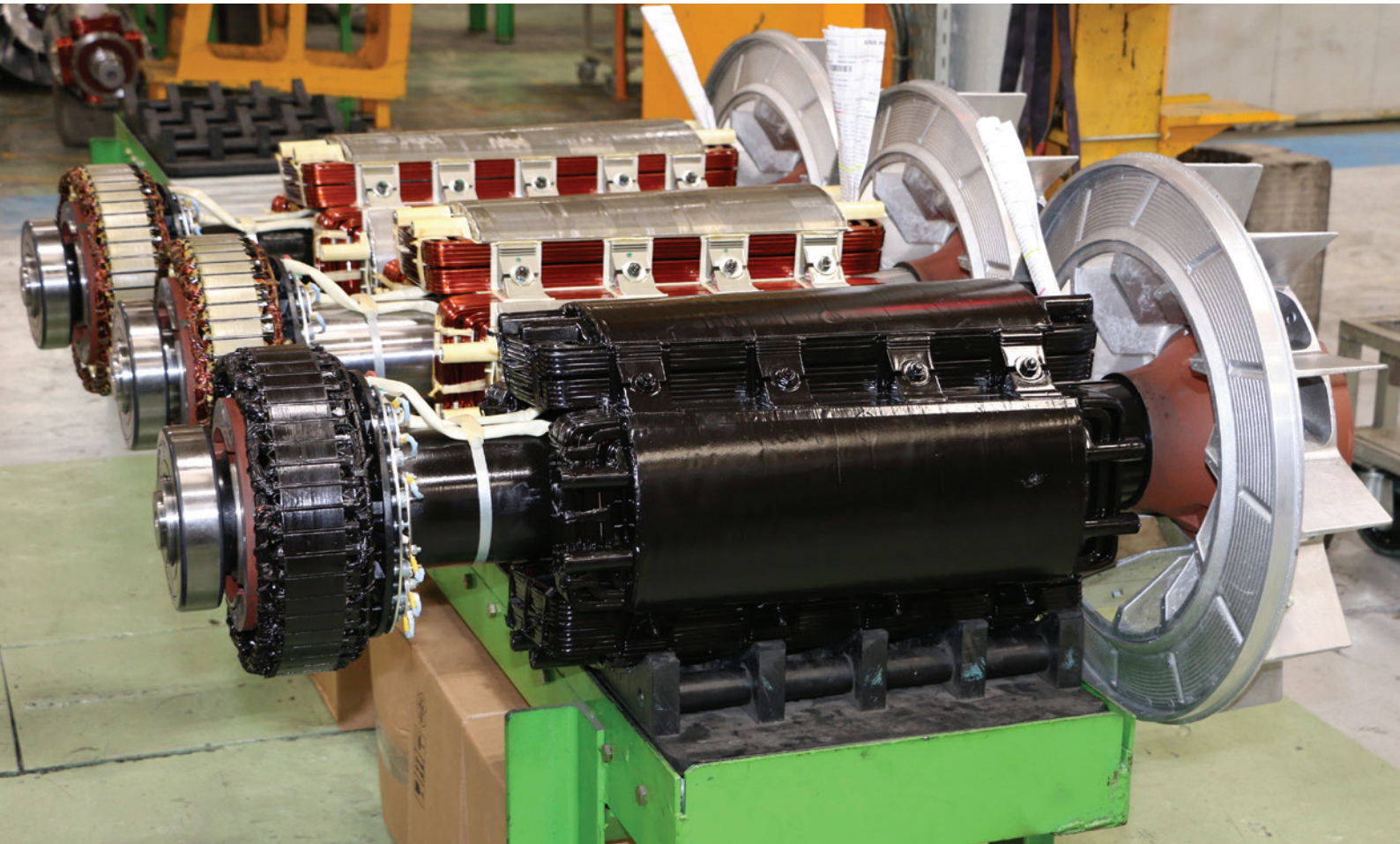
This protection level is standard across the whole low-voltage range. To give our alternators the best possible protection, we have chosen a high-performance polyester varnish which is applied by impregnating all the windings and the rotor and stator lamination stacks, and also the exciter.

In addition, in order to provide superior electrical insulation, we use exclusively enamelled copper wire with performance and durability levels that can satisfy a particularly demanding specification.

On the largest machines which will be used intensively (LSA 49/50), the exciter stator (field) is also covered in CW1081 two-part flexible epoxy resin.

All the sheet metal components are covered with epoxy paint to protect them against corrosion.

We also asked our supplier to develop a special coating LS EB43 with improved viscosity and longevity. This coating is used as standard on machine stators from LSA 44 upwards, offering an unrivalled level of protection.



SYSTEM 2

System 2 is used when the alternator environment is very likely to be damp. This system primarily concerns the windings, which are given a special treatment. It should be noted that this treatment protects the windings effectively against all potential aggressors. This same winding protection system will therefore also be used for Systems 4 and 6.

We are the only manufacturer to offer such a high-performance winding protection system at entry level.

From protection system 2 upwards, all windings are protected by an additional coat of enhanced insulation coating LS EB43, applied by spraying or dipping according to the level of protection required.

For medium and high-voltage products, this additional coating is applied as standard in order to protect the windings against short-circuits that can occur when high voltage is present.

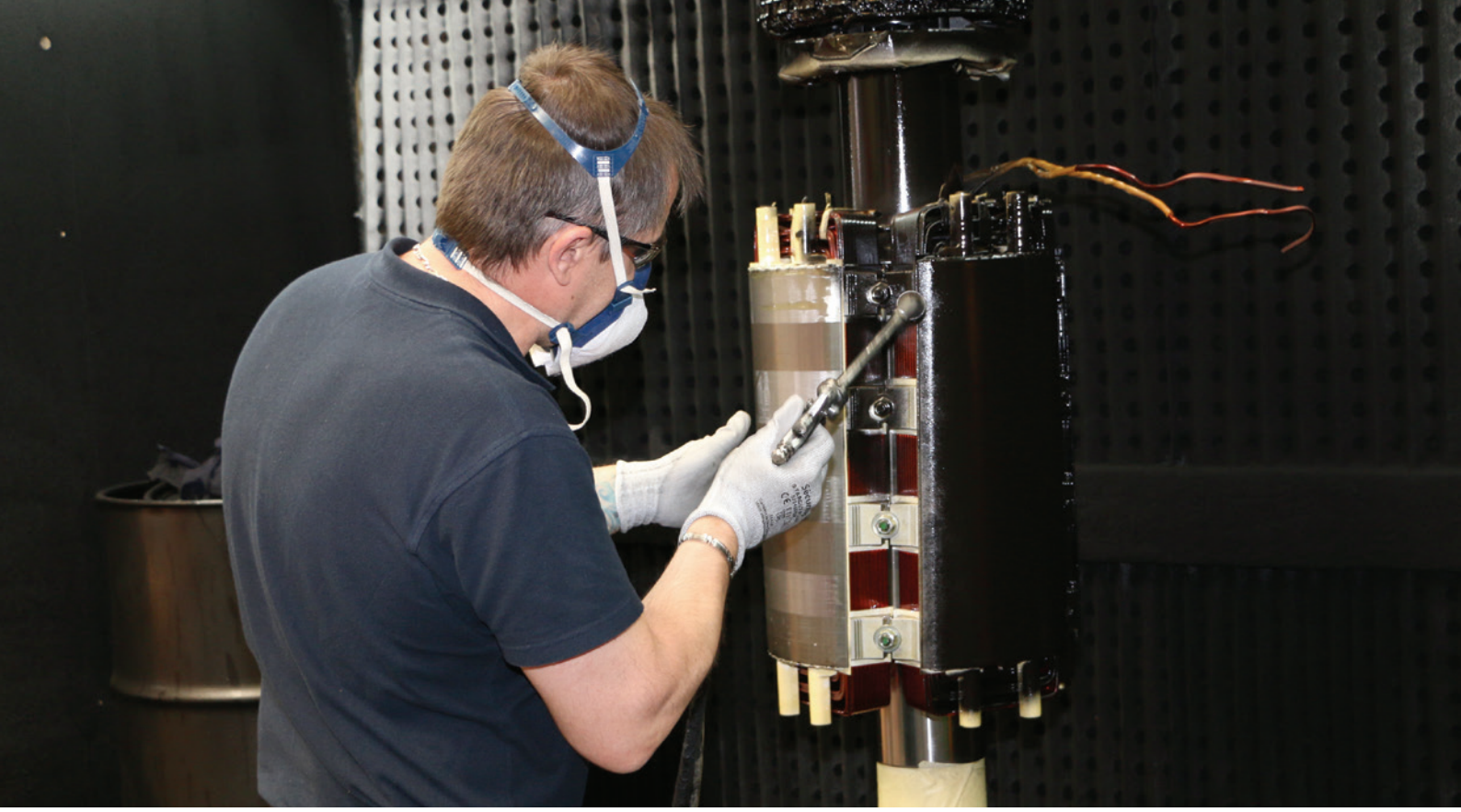
The main stator protection is reinforced still further by brushing a coating of CB 1128 (Polybutadiene) on the non-drive end (NDE) shield, in order to protect this particularly exposed area.

This flexible coating is only applied to the lower parts of the stator. Feedback from the field has shown this area to be the most vulnerable to attack, as it is here that deposits and condensation tend to concentrate. Moreover, since the thickness of the coating causes the winding temperature to rise, it would be counter-productive from a longevity point of view to apply it all around the stator.

“ FROM SYSTEM 2 UPWARDS, WE OFFER A COMPLETE PROTECTION SYSTEM FOR ALL TYPES OF WINDING. ”

The exciter stator (field) is also covered in a two-part flexible epoxy resin.

System 2 is suitable for use in an atmosphere with humidity higher than 95%, however the ambient temperature should not exceed 40°C.



SYSTEM 4

Protection system 4 uses the same winding protection as system 2 and boosts the protection level of the mechanical parts so as to offer increased resistance to hostile environments.

Exposed parts of the alternator rotor shafts are protected against rust with a black coating that has been specially formulated to withstand saline mist.

System 4 is suitable for use in an atmosphere with humidity higher than 95% and an ambient temperature over 40°C.

SYSTEM 6

This system has been specially designed for using machines in an extreme environment: exposure to sea spray, abrasive dust or corrosive air.

In order to guarantee an optimal level of protection, the whole of the machine is specially treated with the application of a double layer of high-resistance epoxy paint.
This additional protection eliminates the risks associated with premature ageing of the most exposed parts of the machine.

The overall machine protection is completed by replacing all the screws and protection grilles with specially designed stainless steel hardware.

System 6 is only recommended in the most extreme scenarios, and we recommend consulting our experts in order to determine the best approach.

REINFORCED SYSTEM

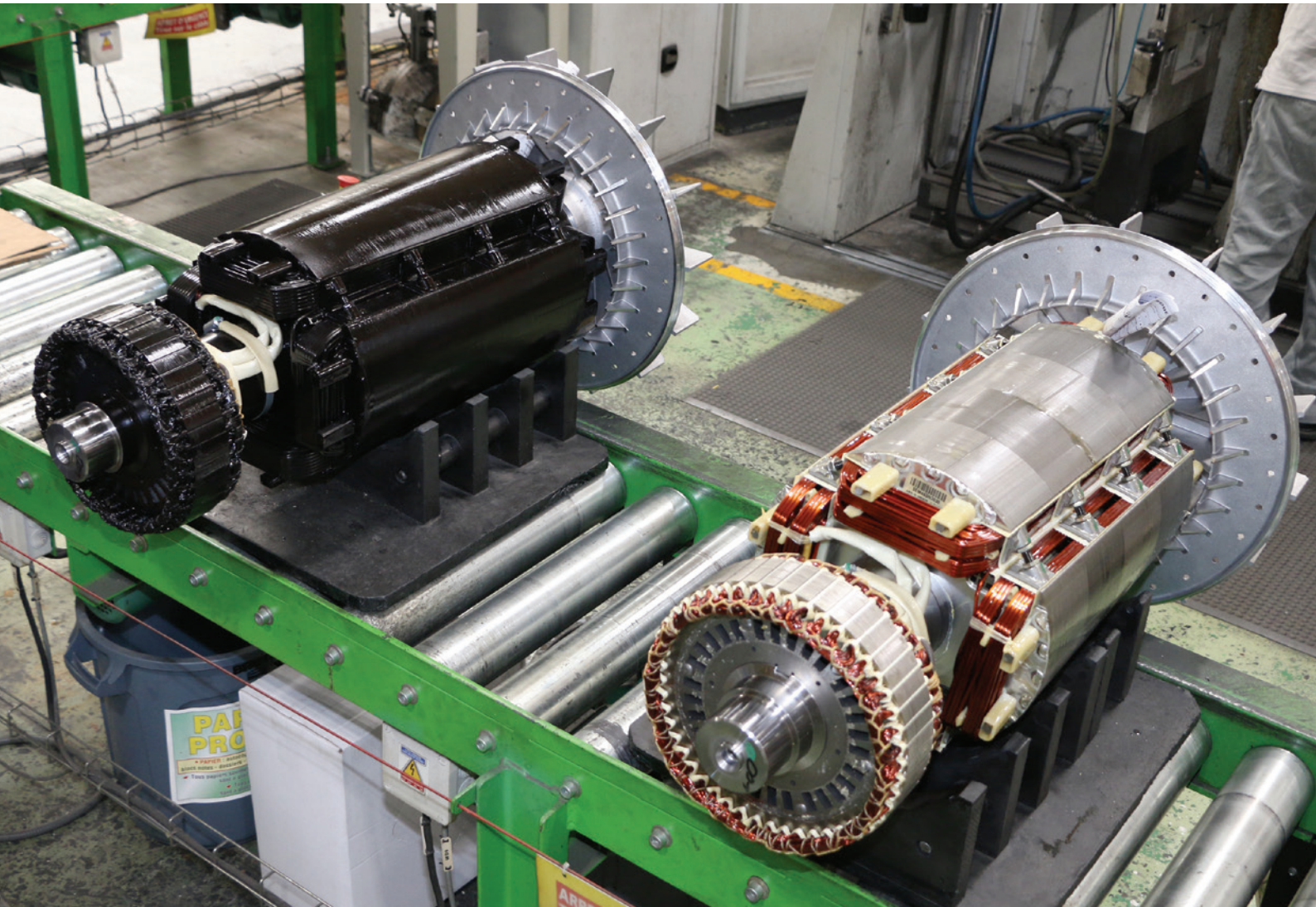
for High Voltage Alternators

This system is possible on the most powerful machines in our range (LSA 52 and above).
For the reinforced system, the exciter windings are replaced by enamel covered copper wire. The other windings are also reinforced with special insulation systems.

Other protections (filters, special paint) can also be applied according to the anticipated conditions of use for the alternator.

Standard protection of the high voltage insulation system is provided by a class H epoxy enhanced insulation varnish that reduces surface discharges onto the windings, dust penetration, corrosion and humidity.

For very harsh environments, a second VPI impregnation is performed to boost the winding protection against dust, corrosion, oils, fuels and humidity.
Then a class H epoxy enhanced insulation varnish is applied, just like the standard protection.



ADDITIONAL PROTECTION DEVICES

Protection systems are inextricably linked to other components that may be added to protect the alternator.

LSA 58 alternator destined for use in a power station equipped with filters

SPACE HEATERS

In conditions where the humidity is high or the machine is only used irregularly or occasionally, space heaters are a vital component to ensure correct alternator operation.

The differences in temperature range between day and night or moisture in the air can cause significant condensation on the inner surfaces of the coils and bearings.

In these conditions, even with reinforced insulation, it is almost impossible to guarantee adequate insulation, especially in the stator (> 1 MΩ). Space heaters are a good solution to this type of problem, as they keep the alternator internal temperature above the condensation point. However, they are only really effective if they are working continuously while the machine is stopped.

FILTERS

In cases where the environment has a high concentration of particles (dust, sand, pollution, etc), placing filters on the alternator air inlets constitutes effective additional protection.

They must however be regularly cleaned or changed, and do cause additional temperature build-up which should be dealt with by derating and by monitoring the machine via temperature sensors on the stator.

ENCLOSED MACHINES

For the most demanding environments or if you are trying to preserve the longevity of the alternator, a totally enclosed machine can be considered.
In this case, the cooling system flows through an air/air or air/water exchanger that is designed according to the application. With this approach, the air circulating inside the alternator is unaffected by external factors.

This type of dual-fluid cooling causes derating which should be applied during the design phase.

Pressurised Hydro-refrigerated machine for use in offshore oil exploitation in a hazardous environment

Nidec

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