

Application Guidance Notes: Technical Information from Cummins Generator Technologies

AGN 033 – Shaft Bearing Currents

It is possible for the shaft within a rotating electrical machine - motor or alternator – to come under the influence of magnetic fields which result in a voltage (electrical pressure) generated along the axial length of the shaft.

This 'shaft voltage' will then force current to flow from one end of the shaft, along a path which is radially out of the shaft through an end bracket continue along the alternators stator frame, and then radially inward into the opposite end of the shaft and so complete the electrical circuit loop.

The described electrical circuit includes the electrical machines shaft supporting bearings, consequently any resulting current flow will pass across the rolling element of the bearings, and will initiate electrical erosion of the bearing materials, eventually reducing the low friction expectation of the bearing.

It is possible for a single bearing alternator to suffer from shaft bearing currents, but here the current flow path at the drive end of the alternator's shaft must include the engine main bearing consequently with adverse effects on bearing surfaces. Some crankshaft oil seals contain carbon, and so offer a conductive path.

Situations that can promote and support shaft bearing currents are:

- Unbalanced magnetic fields within the rotating electrical machine caused by gross eccentricity of stator and rotor assemblies, and this includes asymmetrical magnetic properties of the rotors magnetic steel.

- Imposed asymmetrical magnetic properties in the rotor assembly resulting from the alternator being connected to Non Linear Loads.
- Imposed shaft bearing current resulting from an external voltage source such as poorly installed sacrificial cathodic protection equipment.

STAMFORD Alternators.

As a process included in the manufacture of these alternators, the electrical steel lamination rotor core packs are built from multiples of four equal sections each rotated by 90° relative to each other.

This ensures the lamination steels natural magnetic orientation becomes self-cancelling with regard to residual, and mechanically any pole face eccentricity is offset. This manufacturing process mitigates the risk of inducing a shaft voltage, consequently Cummins Generator Technologies consider insulated bearings to be unnecessary for STAMFORD alternators, including P80 machines.

Testing to measure the shaft voltage on a HVSI804S single bearing alternator has been carried out. This alternator, shown in Figure 1, with a continuous rating of 2401kVA at 10.5kV 50Hz 1500rpm, was fitted to a Cummins QSK60-G8 engine.



Figure 1: HVSI804S1 Alternator with Shaft Voltage testing apparatus

Measurements taken during testing have concluded that the shaft voltage measured end to end, along the axial length of the alternator’s shaft was in the region of 60mV.

The international standards for shaft voltage measurement differs in their determination of acceptable levels for non-insulated bearings, as shown in Table 1.

Standard	Description	Range
NEMA MG 1-2014	If the shaft voltage is larger than 300 millivolts peak, bearing insulation should be utilized	induction motors (rated 3600 kW or less 7200V or less)
IEC60034-25 AC electrical machines used in power drive systems - Application guide	a shaft voltage limit of 500mV peak	low-voltage motors
	manufacturers generally define a bearing voltage threshold of 2V	medium-voltage motors

Table 1: Standards for Shaft Voltage limits

Conclusion: The rotor design for all STAMFORD alternator is the same. By testing the high voltage HVSI804S single bearing alternator, Cummins Generator Technologies are assured of the low levels of voltage present through the rotor shaft across the range. As the measured voltage is considerably lower than the levels of 300mV and 500mV given in the standards, non-insulated bearings will provide satisfactory service life.

AvK Alternators.

To overcome potential issues caused by induced shaft currents, AvK alternators utilise a combination of a rotor earthing brush and insulated bearings. The selection of these options are application and customer specific and will be determined during alternator specification negotiations.

All AvK alternators for marine applications that are fitted with sleeve bearings have the earthing brush option included.

An earthing brush is always used in conjunction with a None Drive End (NDE) insulated bearing. The earthing brush can also be utilised for rotor earth fault current detection.

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