Airworthiness Bulletin

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Aircraft Alternators and Generators

An Airworthiness Bulletin is an advisory document that alerts, educates and makes recommendations about airworthiness matters. Recommendations in this bulletin are not mandatory.

1.1 Effectivity

Aircraft alternators and starter/generators as installed on small helicopters and aeroplanes.

1.2 Purpose

The purpose of this bulletin is to highlight to aircraft owners and maintainers, common issues encountered with alternators and starter/generators.

1.3 Background

From glass cockpits, integrated avionic systems, electrical, radio and navigation systems through to personal electronic devices used within a cockpit require alternators and generators to effectively operate to supply crucial electrical loads throughout all phases of flight. Power generation failures can lead to dependence on very limited battery power.

Poorly maintained, serviced and operated power generation systems can lead to multiple aircraft system failures. Failures that may increase a pilot or crew's workload and ability to operate an aircraft safely. Several single engine aircraft manufacturers appreciate the importance of alternator/generator systems and as a result, produce dual generation systems.

This AWB seeks to illustrate commonly reported alternator/generator related issues that may contribute to power generation system failures in typical small aircraft.

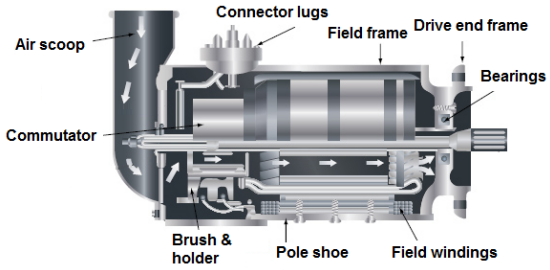
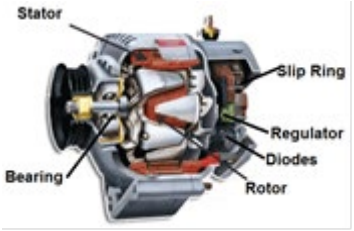
Starter/generators	Alternators
	
	

Figure 1 – Aircraft DC alternators and starter/generators

1.3.1 Bearing failure

Many starter generator and alternator failures reported begin with faulty bearings. These failures can be attributed to corrosion, misalignment, contamination, undetected shock loads and poor lubrication. In one case, see

Figure 2, the starter/generator rear bearing race collapsed in flight causing failure of the generator system. Many manufacturers produce simple generic inspection and maintenance instructions to troubleshoot bearing issues.

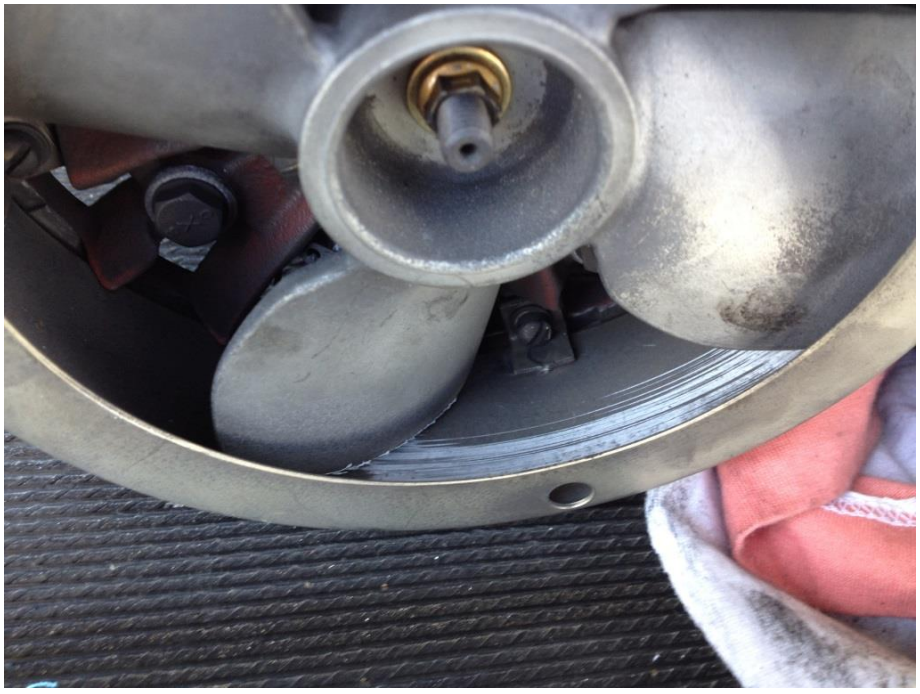


Figure 2 – Starter/Generator fan damage due to bearing failure

Bearing failure can lead to catastrophic damage. If a device is coupled to an engine via drive gear and a failure occurs, the engine or gearbox may be severely damaged through ingress of foreign objects. Figure 3 shows ball bearing spalling (fatigue failure formed with rolling components). This occurred within an engine alternator that led to an in-flight shutdown of an Airbus A340 engine.

Figure 3 – Spalling damage

In the starter/generator below (see Figure 4) the bearings failed causing interference between the stator and armature.

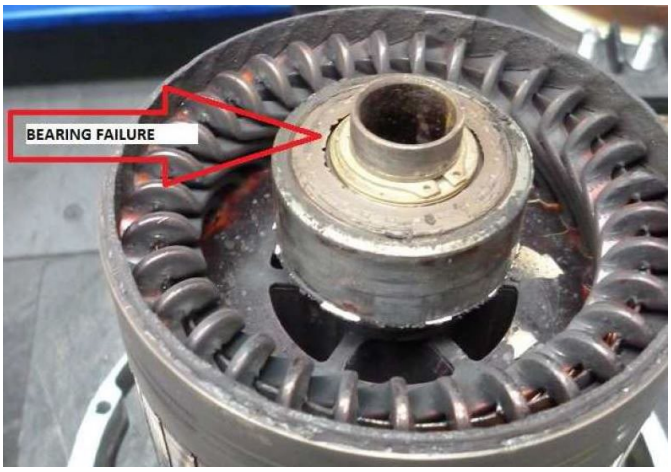


Figure 4 - Bearing failure

In some instances, the rotor shaft can slip in the rear bearing. If the fault is not detected it can progress to where the alternator starts shedding components, such as the bearings, with consequential damage to the alternator drive train and potential engine damage.

1.3.2 Mechanical induced failures

Vibration induced failures can be attributed to external sources such as the engine, propeller, alternator mounts or bushings. Out of balance propellers or harmonic engine vibrations due to detuned counterweights can also result in possible vibration related failures. Examples of CASA reported defects involving vibration are,

- shaft and rotor failures
- alternator mounting bracket failures and damage
- broken or damaged electrical terminals, contacts or wiring
- hardware/components failed or missing
- loose rotor or housing/casing components leading to failure.

Commutator out of round can be caused by vibration or other mechanical deficiencies. Possible signs are carbon films with dark areas as opposed to uniform colouring see Figure 5.

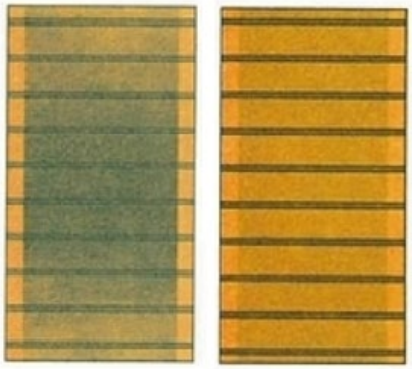


Figure 5 - Out of round compared to good condition commutator

1.3.3 Security of alternator body screws

If the alternator body screws become loose, the end housing moves thus resulting in bearing failure or the rotor rubbing on the stator winding. In either case, the result may be an alternator failure. It should be noted that many alternators received from overhaul facilities carry a warning to tension the through bolts every 100 hours.

1.3.4 Drive systems

Typically, generators or alternators are either gear or belt driven. Belt driven systems rely on correct belt tension and alignment to efficiently operate. Over tensioned or mis-aligned belts can result in bearing and/or belt failure. Slipping belts may lead to undercharging batteries or damage to electrical components.

Gear driven equipment can suffer from misalignment during installation causing shafts to shear. Shaft failures can lead to engine or gearbox contamination potentially leading to engine failure.

Specified torque settings on gear drive couplings are crucial. If not correctly torqued coupling slip, damage and failure may occur. The FAA have released a special airworthiness information bulletin for Continental Motors with direct drive alternator systems.

1.3.5 Electrical induced failures

Diodes, windings, wiring and connection components can be adversely affected by temperature, vibration, contamination, and wear.

Insulation breakdown in external leads or internal windings may develop through chaffing, poor manufacture, poor overhaul practices or heat damage. See Figure 6.

Figure 6 - Diode block wiring short circuit

There have been cases of alternator internal wiring failures producing no output, with field windings re-wound too loose and rotating at high RPM chaffing against each other.

1.3.6 Brush failures

Damaged brushes, springs, contacts, inconsistent maintenance practices or contamination can lead to faster wear rates and more required maintenance. Brushes require a smooth clean surface to effectively transfer electricity. Poor contact with sliprings can not only cause electrical supply issues but produce radio interference. Brushes should be replaced in pairs. See Figure 7 for an example of uneven wear.

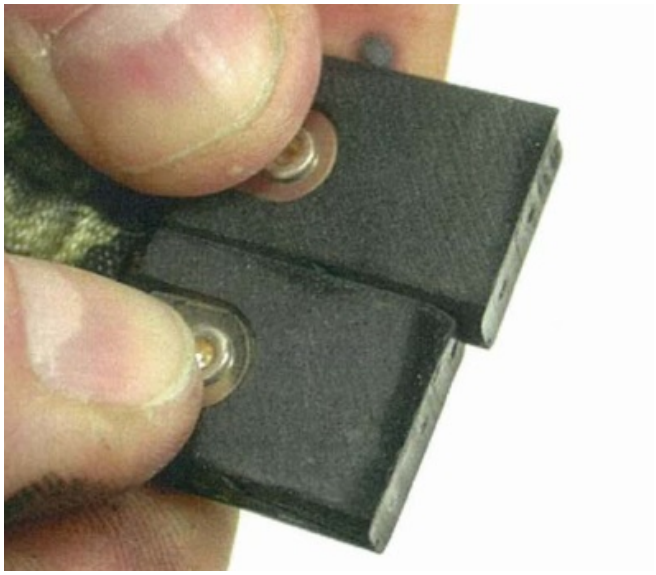


Figure 7 - Uneven Starter/generator brush wear rates

During brush system inspection ensure brush holders, pig tails and interconnection leads are all inspected. There have been cases reported of loose rivets on the pigtail leads. In the case below (Figure 8) rivet material that secured the pigtails fell out creating FOD. These brushes were worn to their halfway position.

Figure 8 - Loose starter/generator brush rivets

1.3.7 Diode failure

Typical aircraft alternators produce alternating current which are rectified by diodes, to produce DC power. Diode failure may cause supply issues from the alternator or damage to remaining diodes. Diode failures may be due to age, poor installation techniques at manufacture or overhaul, overheating and overloading of electrical buses.

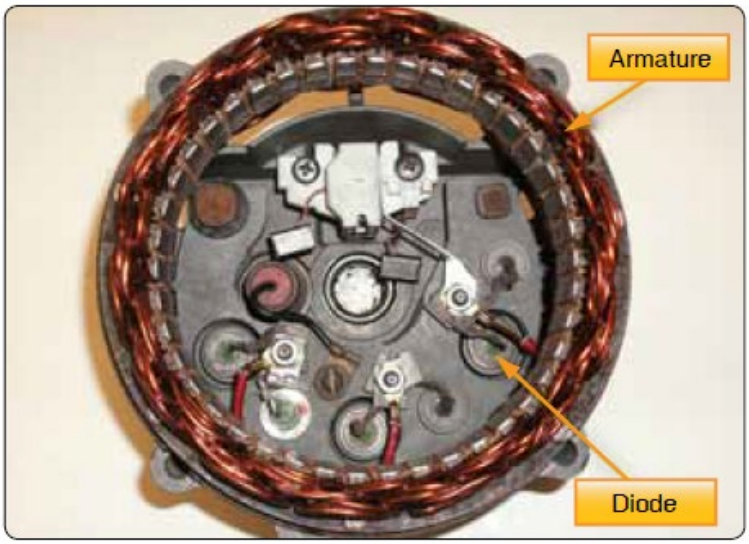


Figure 9 – Alternator diodes

CASA has numerous reports detailing squealing radios that have been rectified by the replacement of failed alternator diodes.

Further damage may be done by voltage spikes that can be attributed to loose connections.

1.4 Recommendations

Careful inspection and attention to correct procedures during maintenance and replacement may help reduce the incidents of premature alternator and starter / generator failures. Following correct procedures may also avoid costly major engine repairs due to contamination by metal fragments from the alternator drive gear.

In the absence of or potentially in addition to manufactures instructions, CASA suggests inspection of alternators/generators at 100 hour or annual inspections considering:

- bearing serviceability
- signs of shaft/bearing slippage in the rear housing, traces of wear on the rotor shaft or the rear bearing
- voltage regulation systems
- freedom of rotor movement
- signs of heat damage that could be indicative of future failures
- any build-up of material or FOD
- alternator/generator case security
- security of associated wiring and terminals
- balance of rotor
- required torque values
- serviceability of drive belts for condition and proper tension

All appropriate reports of damage and failure should be forwarded to CASA using the CASA Defect Reporting System (DRS) system.

1.5 Enquiries

Enquiries with regard to the content of this Airworthiness Bulletin should be made via the direct link email address:

AirworthinessBulletin@casa.gov.au

or in writing, to:

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Civil Aviation Safety Authority
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