

Product Support Bulletin



Service

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Title: Guidance on Inspection of Main Stator Winding Slot Wedges

Model(s): DIG 120 / 130 / 140 / 142

Disclaimer

This document is intended to provide a high-level summary of the subject matter and is for information purposes only. Its use is limited to providing you, the intended recipient, with a base-level understanding of the subject matter as it affects alternators manufactured by Cummins Generator Technologies (CGT), and not by other alternator manufacturers. We accept no liability for any reliance placed on the information in this document and strongly advise that the recipient seek specialist advice prior to taking any action in response to the information provided. The techniques and processes described herein require a high degree of specialist engineering knowledge and experience to be performed successfully. CGT always recommends referral to our network of Authorised Service Dealers to assist with field and in service operational maintenance requirements. The information within this document is proprietary and confidential and must not be disseminated to, or used by, third parties without our consent.

Background / Description:

This document provides guidance on inspection of the condition of wedges that retain the stator windings within the slots of the main stator core of DIG 120/130/140/142 AC alternators. The purpose is to guide Authorised Service Agents on the assessment and need for rework from the number of missing or loose wedges.

The main stator is manufactured as follows: Bundles of varnished copper bars of rectangular cross-section are formed into coils, and each coil covered with various insulating and conducting tapes. The coils are fitted into the slots of the stator laminated core and a filling material is added, so that every slot is full. Isosceles trapezoid cross-section wedges manufactured from Magnoval 2067, are driven into a longitudinal groove in both faces of every slot to secure the coils. The coils are joined at the non-drive end (NDE) to adjacent coils and flexible cable leads to form the stator windings, according to the

machine specification. The stator core assembly is then impregnated to provide a fully amalgamated winding construction.

In challenging operational environments, occasional inspection of DIG120/130/140/142 alternators has demonstrated credible benefit to main stator slot wedging systems, where those slot closure pieces (wedges), may be loosened to some extent, and in extreme cases, may suffer sufficient wear to allow ejection from the slot locations. If more than 50 % of slot wedges are missing from any one slot, or if there are loose or missing slot wedges in 20 % or more of the stator slots, the condition must be referred to CGT for guidance to assess whether the slot wedges need to be reworked. If fewer slot wedges are loose or missing, the alternator can be continued in operation, with a recommended increase in frequency of periodic inspection to track the condition, or if desired, corrective field action may be conducted with rework being completed at a suitable scheduled service.

Section 5 provides guidance on the inspection activity. Observations may be recorded on a copy of the service record template in **Section 6**.

Corrective Actions:

1. Safety

Danger, Warning and Caution panels are used in this manual to describe the sources of hazards, associated consequences and how to avoid injury. Service and maintenance procedures must only be carried out by experienced and qualified engineers, who are familiar with the product and the equipment.

DANGER

The following procedure involves removing safety covers to expose potentially live electrical conductors and moving parts. Risk of serious injury or death by electrocution or limb entrapment. To prevent injury, electrically isolate the generator and prevent mechanical movement.

Use lock and tag safety procedures and prove that the generating set is isolated from all energy sources before starting work.

WARNING

Risk of flying debris. In the event of catastrophic failure, debris may be ejected from the generator air inlet/outlet and may cause severe injury or death. Avoid access to these areas while the generator is operating.

WARNING

Danger of chemical burn and poisonous vapours will chemically burn or burn or cause suffocation. Flammable and hazardous substances like solvents, resins and lacquers must be handled and used by authorized specialist personnel only while following the related safety regulations and instructions. These substances must not be inhaled or swallowed or come into contact with the skin or other organs. Seek medical attention immediately in case of an accident. Take the necessary precautions if you are working in pits or poorly accessible / poorly ventilated areas. Do not smoke or eat in the workplace. Wear PPE. For spray lacquering, ensure that the lacquering equipment, the alternator frame and the windings are earthed. Solvents, lacquers and resins are required to clean and re-lacquer the windings.

CAUTION

Place warnings and prevent access by unauthorised persons. Before starting work, assess risks and take precautions for safe working.

CAUTION

All persons must wear appropriate Personal Protective Equipment (PPE) and be fully aware of the emergency procedures in case of accidents. Recommended PPE includes eye, ear, head and face protection, safety footwear and overalls that protect the arms and legs. Access for working is severely restricted. Do not over-reach or strain your arm muscles. Wear knee and elbow pads and bump cap as needed to avoid injuries.

CAUTION

Dust. Inhaling dust can cause minor or moderate injury by irritating the lungs. Dust can cause minor or moderate injury by irritating the eyes. To prevent injury, wear appropriate personal protection equipment (PPE). Ventilate the area to disperse dust.

2. Tools

- Digital camera – video with sound (recommended) or still images.
- Flashlight – magnetic LED strip light type (recommended)
- Borescope with 1.5m long flexible probe, a round nosed tip and maximum 8mm diameter. Image storage facility (recommended)

3. Consumables

- Non-conductive white paint marker pen – fine point (1-2mm)

4. Inspection Preparation

Alternators may require inspection during their service life, depending on operational and impacting environmental stress conditions. It is recognised that the most appropriate time to conduct full stator winding condition assessment is during major service intervals, where during overhaul, full

disassembly of the alternator, removing the rotor assembly from the main stator & frame assembly will allow free and clear access to the whole area.

In circumstances where a major overhaul period is not appropriate, it is possible, through partial disassembly, to access the stator/rotor airgap, utilising such devices as Borescopes, to conduct slot wedge condition surveys. In these cases, appropriate disassembly and support of the rotor assembly, especially at the NDE of the alternator is required. Care must be taken to manage the safe support of the rotor assembly and must be conducted by trained, competent persons only. For guidance and processes to complete this activity, CGT is receptive to provide details of our network of Authorised Service Dealers.

5. Inspect the Stator Slot Wedges

Record observations on a copy of the Service Record template (see **Section 6**).

- a. Record the alternator type and serial number (as shown on rating plate), commissioning date and installation site.
- b. Record the accumulated running time and duty cycle (continuous, cyclic, standby), and attach a copy of the load vs. time history (if available).
- c. Refer to **Figure 1**. Access the Main Stator winding assembly through full or partial disassembly of the Alternator as described in **Section 4**.



Figure 1: Alternator NDE

- d. Position the flashlight onto the frame to illuminate the near face of the stator coil slots.
- e. Refer to **Figure 2**. Identify the bottom dead centre slot. Using the paint marker pen, write “1” on the stator pole face (arrow A) immediately to the left of the identified slot. Continue to number poles in a clockwise direction until all are identified.

Note: Do NOT mark any coil surfaces

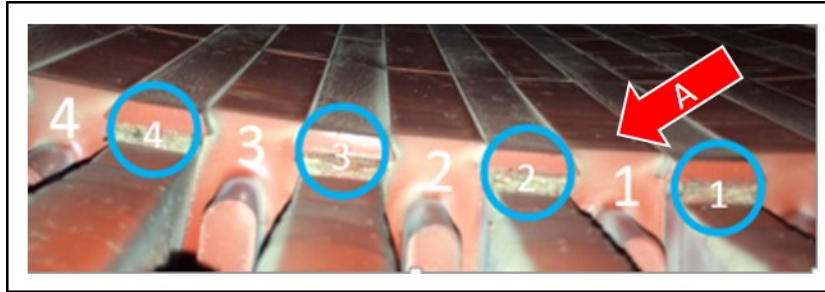


Figure 2: Slot identification and marking

- f. Record the total number of slots.
- g. Use the borescope to view along the full length of each slot. The rotor may be rotated to improve borescope access, if rotor removal is not required for this particular inspection.
- h. Record the total number of wedges for each slot.
- i. Using the camera capture the full length of each slot (make sure image frame is correctly illuminated, in focus and free of potential reflection. Record all observations.
- j. Inspect each slot for potential gap between each wedge and slot wall, (consequence of loose wedge fretting, see **Figure 3**). Record loose wedges.
- k. Inspect for missing wedges (see **Figure 4**). Record missing wedges. Document number of missing wedges, highlighting where slot has >50% wedges missing.

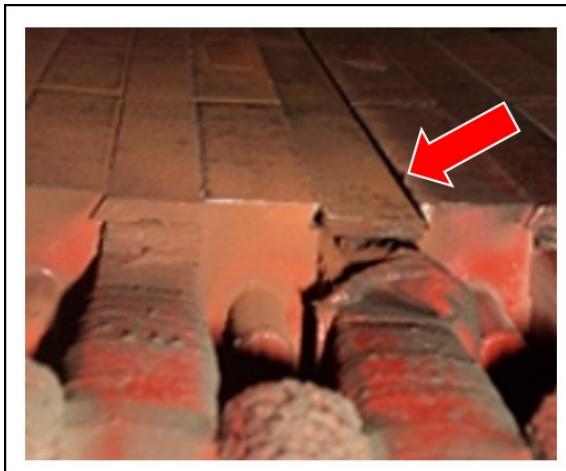


Figure 3: Loose wedge



Figure 4: Missing wedge

- l. Complete and record observations for all slots.
- m. **If any slot has >50% wedges missing**, contact CGT Customer Service and forward a copy of Service Record and all digital images. CGT will determine rework necessity and associated authorisation.
- n. On completion of inspection calculate the total number of intact slots (no missing **OR** loose wedges).
- o. **If <80 % of the total number of slots are intact**, contact CGT Customer Service and forward the completed Service Record and digital images. CGT Service will determine rework necessity and nominate an appropriate Authorised Service Provider.
- p. **If >80 % of the total number of slots are intact** the alternator can be operated, but an increase of inspection frequency must be adopted, and if desired, rework can be completed at the next service schedule.
- q. Remove the borescope and flashlight.

⚠ WARNING

Risk of flying debris. In the event of catastrophic failure, debris may be ejected from the generator air inlet/outlet and may cause severe injury or death. Avoid access to these areas while the generator is operating.

⚠ CAUTION

Dust. Inhaling dust can cause minor or moderate injury by irritating the lungs. Dust can cause minor or moderate injury by irritating the eyes.
To prevent injury, wear appropriate personal protection equipment (PPE). Ventilate the area to disperse dust.

- r. Ensure that the windings and stator core pack and clean of any loose particles.
- s. Ensure that windings are clean and dry. Refer to relevant sections within the Installation, Service and Maintenance Manual.
- t. Ensure that all tools and equipment are removed from within the alternator.
- u. Re-assemble the alternator completely.

6. Record Observations and Measurement Results

Service Record: Inspect Main Stator Winding Slot Wedges (DIG 120/130)												
Generator Type:					Serial Number:			Location:				
Total number of slots =					Running Time: <i>Hours</i>			Use: Continuous/Cyclic/Standby <i>Please circle</i>				
Number of wedges/slot =					Commission Date: ____ / ____ / ____							
Slot number	Auxiliary winding? (Y/N)	Loose wedge(s)? (Y/N)	Missing wedge(s)? (Y/N)	Number of missing wedges	> 50 % missing? (Y/N)	Slot number	Auxiliary winding? (Y/N)	Loose wedge(s)? (Y/N)	Missing wedge(s)? (Y/N)	Number of missing wedges	> 50 % missing? (Y/N)	
30						60						
29						59						
28						58						
27						57						
26						56						
25						55						
24						54						
23						53						
22						52						
21						51						
20						50						
19						49						
18						48						
17						47						
16						46						
15						45						
14						44						
13						43						
12						42						
11						41						
10						40						
9						39						
8						38						
7						37						
6						36						
5						35						
4						34						
3						33						
2						32						
1						31						
Number of intact slots (no loose wedges and no missing wedges) ...												
... in slots 1 - 15			... in slots 16 - 30			... in slots 31 - 45			... in slots 46 - 60			
TOTAL number of intact slots =						Greater than 80 % of total no. of slots: Y / N <i>Circle</i>						
Inspection Engineer (Name & Company):												
Signature:						Inspection Date: ____ / ____ / ____						
Comments:												

Service Record: Inspect Main Stator Winding Slot Wedges (DIG 140/142)												
Generator Type:					Serial Number:			Location:				
Total number of slots =					Running Time: <i>Hours</i>			Use: Continuous/Cyclic/Standby <i>Please circle</i>				
Number of wedges/slot =					Commission Date: ____ / ____ / ____							
Slot number	Auxiliary winding? (Y/N)	Loose wedge(s)? (Y/N)	Missing wedge(s)? (Y/N)	Number of missing wedges	> 50 % missing? (Y/N)	Slot number	Auxiliary winding? (Y/N)	Loose wedge(s)? (Y/N)	Missing wedge(s)? (Y/N)	Number of missing wedges	> 50 % missing? (Y/N)	
36						72						
35						71						
34						70						
33						69						
32						68						
31						67						
30						66						
29						65						
28						64						
27						63						
26						62						
25						61						
24						60						
23						59						
22						58						
21						57						
20						56						
19						55						
18						54						
17						53						
16						52						
15						51						
14						50						
13						49						
12						48						
11						47						
10						46						
9						45						
8						44						
7						43						
6						42						
5						41						
4						40						
3						39						
2						38						
1						37						
Number of intact slots (no loose wedges and no missing wedges) ...												
... in slots 1 - 18			... in slots 19 - 36			... in slots 37 - 54			... in slots 55 - 72			
TOTAL number of intact slots =						Greater than 80 % of total no. of slots: Y / N <i>Circle</i>						
Inspection Engineer (Name & Company):												
Signature:						Inspection Date: ____ / ____ / ____						
Comments:												

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