

**INCIDENT**

<b>Aircraft Type and Registration:</b>	Jetstream 4100, G-MAJI	
<b>No &amp; Type of Engines:</b>	2 Garrett Airesearch TPE 331-14HR-804H turboprop engines	
<b>Year of Manufacture:</b>	1993	
<b>Date &amp; Time (UTC):</b>	1 May 1998 at 1550 hrs	
<b>Location:</b>	Southampton Airport	
<b>Type of Flight:</b>	Public Transport	
<b>Persons on Board:</b>	Crew - 3	Passengers - 24
<b>Injuries:</b>	Crew - None	Passengers - None
<b>Nature of Damage:</b>	Damage to the right-hand starter/generator electrical terminal block and electrical supply cables. A small fire in lower engine cowling	
<b>Commander's Licence:</b>	Airline Transport Pilot's Licence	
<b>Commander's Age:</b>	37 years	
<b>Commander's Flying Experience:</b>	2,769 hours (of which approximately 750 were on type) Last 90 days - approximately 160 hours Last 28 days - 75 hours	
<b>Information Source:</b>	AAIB Field Investigation	

During the start cycle for the right engine it was noticed that the engine was very slow to accelerate and, following a loud bang and sparks from the engine cowling, the commander instructed the First Officer to abort the engine start. Smoke was then seen issuing from the cowling vent holes and the ground engineer advised the flight deck crew to shut the aircraft down. All the electrical systems were then switched off. Whilst the passengers were disembarking the engineering staff advised the crew that smoke was still evident from the right engine cowling, however all the passengers were safely and expeditiously disembarked and the smoke ceased.

Subsequent inspection of the right engine found that the starter/generator's main electrical terminal block had suffered severe heat damage and that the positive electrical supply cable was no longer connected to the 'B' terminal (see diagram at Figure 1), although the self-locking terminal nut was still

located on the terminal threads. The 'eye' end of the positive supply cable tag had been partially burnt away to the extent that only half of the circumference of the eye end of the tag remained attached to the cable. The smoke had been caused by a rag, which had been inadvertently left in the lower engine cowling, that had been ignited by pieces of molten metal which had fallen from the terminal block.

The starter/generator unit was removed from the aircraft and taken to a manufacturer's approved overhaul organisation for detailed examination. This examination revealed that the B (positive) terminal of the starter generator had been incorrectly assembled (Figure 1) in that the large spacer washer had been fitted between the stator lug and the supply cable eye end. This incorrect assembly had resulted in the spacer washer being part of the electrical current path between the supply cable eye end and the stator lug, a purpose for which it was not designed; the spacer washer was manufactured from mild steel and effectively reduced the contact area between the supply cable eye end and the stator lug. Overheating, arcing and melting had consequently occurred due to the resultant high resistance at this supply connection. There was also no evidence of the lock washer which should have been fitted below the lock nut. In addition, it was noted during this examination that both the positive ('B') and negative ('E') terminals were identical, with no identifying marks.

Examination of the operator's maintenance records showed that the last time that any work had been carried out in the area of the starter/generator was towards the end of March 1998, when the starter/generator had been removed from the engine and fitted to a replacement engine which was installed in this aircraft. There was no mechanic's signature on the relevant worksheet against the task: 'Electrically connect starter/generator and enter the torque load achieved', but a torque figure of 230 lb ins and an inspector's stamp and signature had been entered. The inspector whose signature and stamp appeared on the worksheet could not, however, recall any detail of this particular task.

The manufacturer had issued Service Information Leaflet (SIL) 24-005, dated 17 October 1996, which described the correct Starter/Generator terminal build-up. This SIL was only valid for 12 months after the date of issue. In April 1997 the operator issued an in-house Technical Instruction No 14 on the correct build-up of the terminals in accordance with the manufacturer's SIL. The manufacturer's Illustrated Parts Catalogue (IPC) illustration of the terminal block and the components that formed the terminal build-up showed an incorrect assembly order which was similar to that found in this incident. Included in the introduction section of the IPC was a statement to the effect that the IPC must not be used as an aid to any maintenance work on the aircraft or its components. However, the illustration of the terminal build-up shown in the IPC was much clearer than that shown in the Aircraft Maintenance Manual (AMM).

The aircraft manufacturer has been aware of the problem of starter/generator terminal arcing/burning for a number of years and has introduced modifications, issued an SIL and revised the AMM. The starter/generator manufacturer provided training for operators with the highest number of occurrences and distributed diagrams showing the correct build-up for the terminal block connections. Following these actions the number of occurrences of terminal block overheating/burning reduced considerably. As a result of the findings from this investigation the aircraft manufacturer has taken the following additional action:

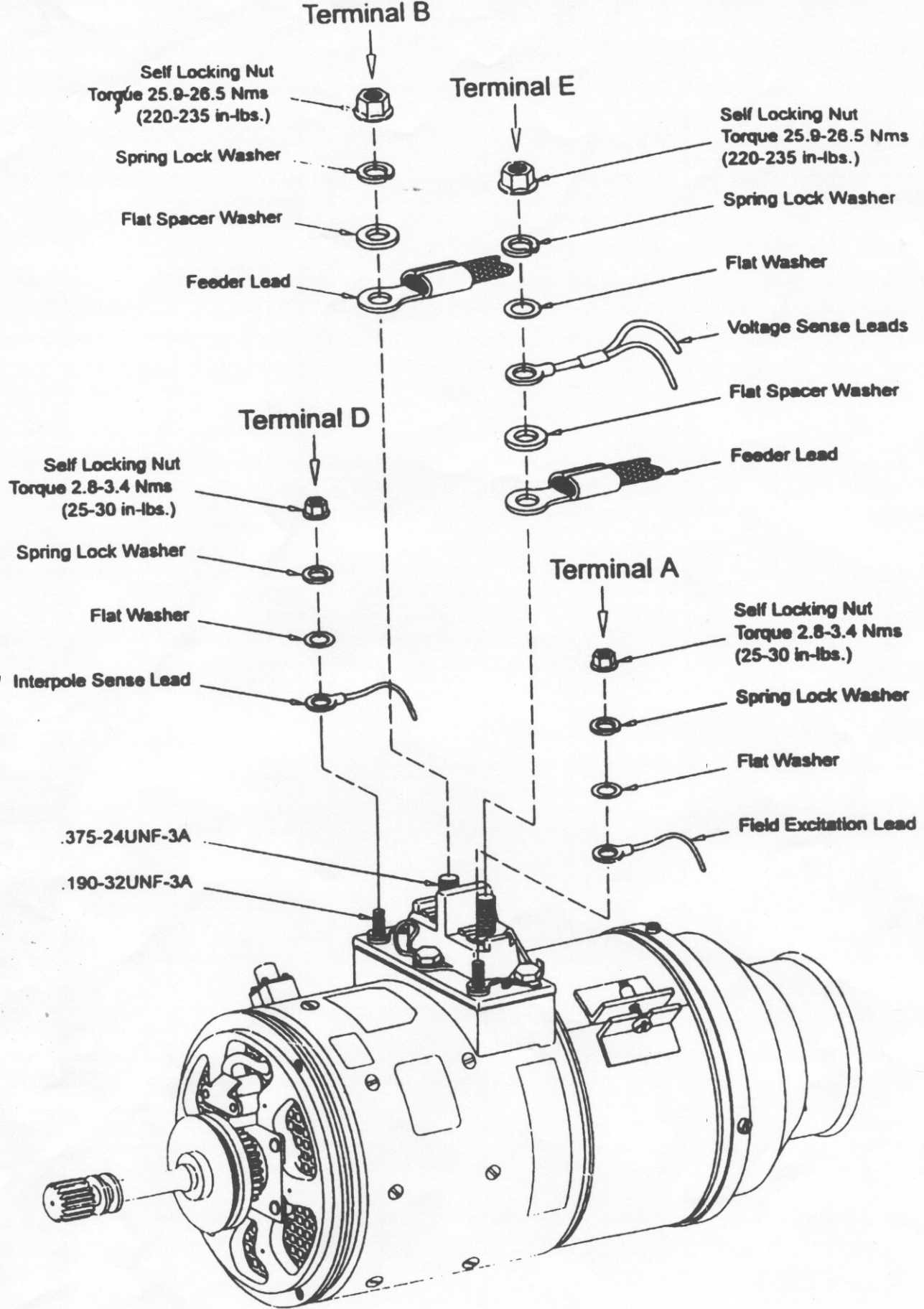
Re-issued SIL 24-005 with two diagrams for the terminal build-up configurations.

Issued SIL 20-002 to remind Operators that the IPC must not be used for aircraft or component maintenance purposes.

Revised the AMM to improve the clarity of the starter/generator terminal build-up description.

Revised the IPC to correct the error in the terminal build-up illustration.

Introduced labels on starter/generator units to show the terminal build-up and to state the torque value for the studs.



**Figure 1** Correct starter/generator terminal build-up