



Power Puzzle

GE Probes mystery of 777 engine transfer-gearbox failures after third inflight shut down

COULD THERE BE any connection between the end of the summer vacation period in Italy last year and the unexpected diversion of a Korean Air Boeing 777-300ER on July 2 to a remote airport in Russia?

This might sound like the unlikely plot line of a modern-day detective story, but it is one line of inquiry General Electric is pursuing as it investigates a puzzling string of transfer-gearbox failures this year on its otherwise reliable GE90-115B engine. The latest incident, which occurred as the Korean Air aircraft was flying from Chicago to Incheon, followed virtually identical failures on other 777s earlier this year.

Made by GE's Italian-based supplier Avio, the affected part is the transfer gearbox, which transmits energy from the engine core to drive the accessory gearbox. When the problems first occurred, GE and Avio originally suspected a material "anomaly" as the source of the issue, which was manifested in cracking and separation in the radial gear. Detailed examination of the gears involved led the manufacturers to believe the issue was isolated to a specific batch of gearboxes made between September 2012 and March 2013. However, the engine in the Korean Air incident involved a brand-new 777 and GE90s that incorporated gears assembled as recently as June, catching GE offguard and forcing it to reconsider other causes.

When the material anomaly was originally suspected earlier this year, GE employed an enhanced Eddy Current Inspection (ECI) process to check for possible gear separation within the transfer gearbox. However, although the ECI did reveal two more cases of cracking, it did not pinpoint material issues as the cause. The manufacturers therefore switched the investigation to the heat transfer process used in the making of the gearbox housing as the possible cause of surface stress on the gear that, in turn, led to radial cracking and the separation.

The puzzle remains, though, as to what changed in the process that until last September had produced problem-free gearbox assemblies. "It's been mysterious," says GE, which adds that it has looked into any changes that may have been

made in the Avio equipment. The timing of the first faulty gear assembly also coincides with the period when Italian industry traditionally ramps up after the summer break.

To counter the separation issue, since mid-June Avio has been treating all transfer-gearbox housings with a cold working process called **shot peening**, which entails impacting the surface with a high-velocity shot that plastically deforms the metal, producing a surface more resistant to fatigue. The Korean Air aircraft involved in the July 2 diversion is the only one of the airline's fleet of 15 777-300ERs that was fitted with transfer gearboxes from the suspect population of 132 engines. Both gearboxes were replaced and the aircraft has returned to service, GE notes.

The Korean Air inflight shutdown triggered the FAA to issue an emergency airworthiness directive (AD) on July 12 mandating "de-twinning" of 20 more 777-300ERs by replacing the transfer-gearbox assembly with an earlier model or with a modified version. The action was essentially a repeat of the AD issued in May in the wake of an inflight shutdown in February on an Aeroflot 777-300ER en route to Moscow from Bangkok, and a similar event on May 9, when an Air China flight from Beijing to Paris diverted to Stockholm after the left engine had to be shut down in flight.

GE says that as of July 18, the suspect fleet of engines still flying had been reduced to 29. "With the ones completed, either the entire gearbox was replaced or a couple of the suspect gears in the transfer gearbox were replaced with ones that were **shot-peened**," says the engine maker. The extent of the refurbishment task remains large, as there are now many other engines to replenish on the production line and in maintenance and repair shops. GE is also expected to issue a service bulletin shortly, requiring all suspect transfer gearboxes to be removed from service by late September.

The Korea Aviation and Railway Accident Investigation Board delegated the investigation of the July 2 inflight shutdown to the U.S. NTSB, which is working with GE and the FAA to determine the root cause. GE says the "final probable cause" for the July 2 event will be determined by the NTSB. ●

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