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DEBRIEFING

Flight Safety is Everybody's Business

Compressor Surges and Stalls

Transport Canada (TC) recently released a "SERVICE DIFFICULTY ADVISORY" - AV 2004-05 dated 2004-12-01. It focuses on an engine that we do not use in any of our fleets but the greater message of the dangers of compressor surges and stalls applies to all jet engines.

With the permission of TC the advisory is printed below in its entirety. This advisory serves as a caution to all those in the flying and maintenance communities of our jet aircraft. **Heed it well!**

Pratt & Whitney Canada JT8D-17 Series Engine Compressor Failures

Shortly after departure and climbing through 3,300 feet AGL, the crew of a commercial air carrier reported a loud bang that sounded much like an engine compressor stall. Cockpit indications revealed rapidly declining N1 (low-pressure compressor) and N2 (high-pressure compressor) readings on the number 1 engine gauges. The exhaust gas temperature (EGT) had exceeded the highest temperature on the gauge, and the cockpit crew immediately shut down the faulty engine. The crew declared an emergency, landed uneventfully, then taxied back to the departure gate.

Investigation carried out by the Transportation Safety Board of Canada (TSB) revealed that all engine indications were normal at start-up, taxi, take-off, and climb phases until the sudden loud bang occurred. Company maintenance personnel found evidence of extremely high temperatures in the turbine sections. Turbine nozzle guide vanes were intact but revealed heat distress on the trailing edge. The high-pressure turbine (HPT) blades had melted from about 30 degrees of the span and outboard. All three stages of the low-pressure turbine (LPT) had melted at various lengths, and solidified pools of metal had formed on the inside of the exhaust nozzle outlet. Noticeable damage to the 3rd stage compressor disk was also discovered, however, there was no evidence of foreign object ingestion.

High pressure turbine (HPT)

Prior to departure on the previous day, a review of company maintenance documents revealed that the #1 engine compressor surging had occurred during start-up and acceleration from idle. During taxi back to the ramp for maintenance attention, at least five more surging events occurred. Maintenance

personnel then followed the engine manual instructions and replaced the pressure ratio bleed control valve and the start bleed control valve. Inspection of the compressor section was not carried out, nor was it required according to the engine maintenance trouble-shooting instructions. A subsequent low power engine run-up led maintenance personnel to believe that the "compressor surging" problem was solved.

The aircraft then returned to service and operated for three hours before the subject in-flight failure occurred. Prior to flight on the day of the failure, engine performance data was reviewed and it was noted that EGT had increased by 20° C and N2 had increased by 2.5%. This type of deterioration in engine performance parameters is a dependable indicator of progressive gas-flow inefficiencies, compressor turbine damage, and incipient engine failure.

TSB engineering analysis of the damaged engine components revealed that the majority of the compressor blade roots exhibited fatigue fractures consistent with reverse bending. Reverse bending of the compressor blades is a reliable indication of compressor "stall". Compressor stalls can cause reverse bending of the compressor blades, causing fatigue fractures, resulting in engine failures such as seen in this particular event.

Although not required by the engine manufacturer's troubleshooting guidelines, it is most likely that a maintenance high-powered engine ground run-up and engine performance analysis, followed by a compressor borescope inspection, would have discovered the previously damaged blades.

Transport Canada Civil Aviation (TCCA) **strongly advises maintainers, operators and other responsible persons that compressor surging should be given the same attention as compressor stalls. Surges should be considered minor stalls and should not be underestimated in the damage that can occur. It is evident that compressor surges and stalls can induce latent fatigue fractures culminating in engine failures.**

In the absence of the manufacturer's maintenance instructions directed specifically towards monitoring the effects of compressor surges, operators are advised to apply these instructions provided for monitoring the effects of compressor stalls.

Any defects or further occurrences should be reported by sending a Service Difficulty Report to Transport Canada, Continuing Airworthiness, Ottawa.

For further information, contact a Transport Canada Centre, or Mr. Barry Caldwell, Continuing Airworthiness, Ottawa, telephone (613) 952-4358, facsimile (613) 996-9178 or e-mail caldweb@tc.gc.ca.

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