

Alternative Means of Compliance with FAA AD 2005-24-08

Introduction

The Jetstream 41 aircraft is fitted with propellers manufactured by McCauley Propeller Systems. McCauley have recently issued service information which significantly reduces the published lives of the propeller hubs on the Jetstream 41 aircraft operated in South Africa by Airlink. These reduced lives have been mandated by FAA Airworthiness Directive 2005-24-08. BAE believe these new lives are unnecessarily restrictive, and are based on flawed reasoning. The grounds for an alternative means of compliance with the FAA AD are presented below.

Background

Over the last three years, significant cracks have been found on three McCauley propeller hubs on aircraft operated by Airlink. Investigations into these cracks were conducted by both McCauley and BAE Systems, and these have led to a difference of views as to the cause.

McCauley contend that the sole cause of the Airlink hub cracks are damaging stresses encountered during brakes-locked, high power, tailwind (take-off) operations. Whilst BAE agree that this operating condition has the potential for causing damage, BAE also found that all the cracks originated from pitting in the base of blind dowel holes and that these pits acted as stress concentration points. McCauley and BAE both agree that the pits were caused by poor control of overhaul processes by a contracted overhaul shop, and that the resulting cracks were actually present but went undetected during subsequent overhauls of the failed hubs.

To safeguard the fleet, and to deal with the immediate airworthiness issue, McCauley issued service bulletins 242A (11 March 2003), 244 (7 April 2003), 245A (13 Aug 2003) and 247A (13 Sept 2004).

As a closing action, McCauley have now issued Alert Service Bulletin ASB250 on 26th October 2005. This requires propeller hubs which have been fitted to water-methanol powered engines to be life limited to 6,000 hours (TSN), and those hubs already beyond 6,000 hours TSN are required to be retired from service within the next 50 operating hours. For hubs which have never been fitted to water-methanol powered engines, the life limit has been set at 18,000 hours. A 50 hour compliance period also applies to those hubs already beyond 18,000 hours.

Damaging hub stresses

Ever since the original certification testing of the propeller, it has been recognised that damaging hub stress levels occur during brakes-locked, high power operation in rear quartering/tailwind conditions. Currently, water methanol powered aircraft are compelled by the Flight Manual to conduct brakes-locked take-offs. For operational reasons, a small proportion of these take-offs may be performed in tailwind conditions. Note that until very recently, Airlink have been the only operator using water methanol. The rest of the Jetstream 41 fleet typically use a rolling take-off technique, where the hub stresses are much lower.

At a joint FAA/BAE/McCauley meeting in Chicago in July 2005, a 6,000 hour life for hubs on water methanol powered aircraft was proposed by McCauley. This was based on an assumption that these aircraft routinely operated in the damaging brakes-locked condition for hubs, at a frequency much greater than that occurring in the rest of the Jetstream 41 fleet.

This was a flawed assumption. A subsequent statistical analysis was performed by Airlink using their route structure and aircraft utilisation data. It indicated that less than 2 percent of their annual flight operations were potentially exposed to damaging stresses due to brakes-locked take-offs in tailwinds. This exposure level at Airlink is probably comparable to that which has existed in the rest of the Jetstream 41 fleet (where there have been no rear hub cracks).

To provide further evidence that Airlink hubs have not actually been subjected to a more damaging stress environment than the rest of the fleet, Airlink have recently completed a full eddy current survey of the condition of all of their active hubs. All the hubs passed the eddy current crack detection criteria set by McCauley. None of the hubs showed any signs of cracking in the sensitive regions in the base of the dowel holes. None of the hubs had pitting in the base of the dowel holes. In fact, only one hub was found with damage which was considered cause for rejection, and this was due to rough machining marks seen in both dowel holes. Note also that, of the thirty hubs surveyed for damage, many have lives far exceeding the notional 6000 hour "limit" proposed by McCauley, and four of these hubs exceed 18,000 hours TSN.

The above would appear to contradict McCauley's assertion regarding the cause of the hub cracks.

To further minimise the possibility of hubs being subjected to damaging stresses in the future, BAE are removing the Limitation in the Flight Manual Supplement which prohibits rolling take-offs during water methanol operations. This has been accomplished after a thorough re-examination of the original take-off performance data. Confirmatory flight testing of rolling take-off techniques using water methanol was also performed by Airlink flight crews, under BAE's direction. This means Airlink aircraft will no longer be compelled to carry out brakes-locked take-offs.

A further re-wording of the general propeller Limitations in the AFM (applicable to all J41 aircraft) prohibits the use of a brakes-locked take-off technique in rear quartering/tailwind conditions. Taken together, these two Flight Manual changes now greatly reduce the possibility of encountering the damaging condition for the hubs.

Overhaul processes

The three cracked hubs were subjected to rigorous metallurgical examinations by BAE and McCauley (Cessna) laboratories following their removal from the aircraft. In each case, the crack initiated in the bottom of a blind dowel hole on the rear hub face, and propagated in fatigue. The cracks ran inwards to the central pilot bore, and outwards towards one of the blade sockets. Microscopic examination revealed the presence of pitting and corrosion in the bottom of these blind holes (and elsewhere). It also revealed evidence that the cracks had been present during the last overhaul of each hub (anodic coating and/or staining was seen on part of the fracture surfaces). Since all of these hubs had been returned to service, it must be assumed that these cracks were not detected during those overhauls.

This evidence raised questions about the origin of the surface pitting and the possibility that it might be due to improper surface treatment during overhaul. It also called into question the efficacy of the inspection techniques specified by McCauley in their overhaul manuals.

Accordingly, an audit of the plating shop contracted by Airlink to carry out the etching and re-anodising elements of the overhaul was conducted by McCauley, with BAE in attendance. This revealed some lax process controls, not in conformance with McCauley's published overhaul procedures. These discrepancies were such that the overhaul processes in this facility were judged to be capable of causing surface pitting on the hubs. On receiving this information, Airlink immediately stopped using this facility and engaged another plating shop which has full McCauley approval.

In addition, it was recognised by McCauley that their recommended inspection technique using dye penetrant was inappropriate for identifying small cracks in the base of blind holes. It is understood that they have subsequently amended their overhaul manuals to require the use of eddy current inspections in these areas.

Summary

Airlink's route analysis shows that exposure to the brakes-locked, tailwind damaging condition was much less frequent than had been assumed by McCauley when they drafted their service bulletin. A subsequent eddy current inspection of their entire fleet has confirmed the lack of historical damage in Airlink's hubs, several of which have achieved crack-free lives of between 15,000 and 20,000 hours.

The possibility of encountering this damaging condition in the future has been minimised by amendments to the aircraft Flight Manual by BAE.

Since May 2004, Airlink have used a reputable overhaul agent, audited and approved by McCauley. The potential exposure of their hubs to damaging surface treatments has been removed. McCauley have improved their recommended crack detection techniques during overhaul which further minimises the risk of cracked propellers being released to service.

Conclusion

There are no grounds for imposing a low retirement life on the hubs fitted to water methanol powered aircraft. They do not need to be treated differently from the hubs in the rest of the Jetstream 41 fleet. A retirement life of 18,000 hours for all hubs provides an acceptable level of safety.