

## COMMENT RESPONSE DOCUMENT

EASA PAD No. 19-150

[Published on 30 July 2019 and officially closed for comments on 27 August 2019]

### Commenter 1: Collins Aerospace – Marco Perrella – 27/08/2019

#### Comment # 1

##### References:

- A. Goodrich RSE 097, Investigation of Cracked MLG Piston/Axle, P/N 41141-5, SIN SS0239
- B. GKN Report VOLS:10245711, Fokker F100 Piston Failure Investigation
- C. EASA Notification of a Proposal to issue an Airworthiness Directive, PAD No.: 19-150

On being notified of the cracking of a Main Landing Gear (MLG) Piston/Axle P/N 41141-5 on a Fokker F28 aircraft operated by Network Aviation in Australia, Goodrich Aerospace Canada Ltd, a part of Collins Aerospace, acting by and through its Landing Systems (Landing Gear) business ("Collins"), was initially informed that an analysis would be performed by a commercial materials lab in Australia. Being concerned about the lab's general lack of familiarity with the low alloy steels used in aircraft landing gear, Collins offered to assist in the investigation. This was supported by both Fokker Services and Network Aviation, and the cracked Piston/Axle was dispatched to our facility in Oakville, Canada. Unfortunately, prior to shipment, the Piston/Axle was stripped of all organic coatings and subject to NDT. Regrettably, these procedures and a lack of corrosion protection during shipping introduced a number of uncertainties and partly compromised the subsequent metallurgical investigation.

In any event, investigations performed on sections of the Piston/Axle by both Collins and GKN in Sweden found that the subject material exhibited significant levels of hydrogen and attributed initiation of the issue to hydrogen-assisted cracking. This led to the cracking occurring in two phases: (1) initial intergranular cracking, followed by (2) ductile fracture at the wire port. While the Collins report (Ref. A) is cautious about defining the source of the hydrogen (SCC or hydrogen embrittlement), the GKN report (Ref. B) offers a more definite opinion that the cause was hydrogen introduced by plating during overhaul, leading to hydrogen embrittlement.

Having reviewed Ref. C, Collins is concerned that the "Reason" statement on Page 2 provides an emphasis that could lead to a belief that the root cause of the failure was an undetectable crack in the highly stressed area of the wire port. While the Ref. A and Ref. B reports agree that the final phase of



the failure was a ductile failure, Ref. C fails to emphasize that initiation of the extensive intergranular cracking was hydrogen-assisted, most likely caused by missed hydrogen relief baking after plating operations during overhaul.

Throughout the investigation, Goodrich fully cooperated with Fokker Services, the Type Certificate Holder, and this cooperation included providing some unusual (for safe-life landing gear structure) crack-growth analysis. This analysis was performed in support of a Fokker Services theory that the crack may have initiated and rapidly propagated from an undetectable crack in the wire port. As a follow-up to the analysis, Collins continued to support Fokker Services by revising the CMM to include additional preventative measures and issued SB 41-32-036. However, throughout the investigation and the follow-up analysis, Collins continued to emphasize that the evidence reported in Ref. A and Ref. B does not support an undetectable crack theory.

Collins acknowledges the action taken by Fokker Services to remove from service the five Piston/Axles that could not be verified as having been correctly processed through overhaul. This was an appropriate action in the interest of caution. However, we believe that the "Reason" statement would be more accurately represented by embodying the change proposal [copied below]. We encourage you to adopt the proposed change.

#### Reason, 3rd Paragraph:

More recently, during a normal walk-around check, a large crack was found in the lower portion of the left-hand (LH) MLG piston, P/N 41141-5, installed on an F28 Mk0100. Because this case was initially assumed to be similar to the 2009 event, Fokker Services issued SBF100-32-169 to provide instructions for a detailed inspection of the MLG pistons P/N 41141-5. EASA issued AD 2017-0163 to require that action. Goodrich and Fokker Services investigated that occurrence, but no firm conclusion could be established as to the root cause of the event. However, the wire harness port of the MLG piston was identified as a highly stressed area, prone to high-rate crack growth if small surface imperfections would be present.

This condition, if not detected and corrected, could lead to MLG failure during rollout after landing, possibly resulting in damage to the aeroplane and injury to occupants.

#### Change to:

More recently, during a normal walk-around check, a large crack was found in the lower portion of the left-hand (LH) MLG piston, P/N 41141-5, installed on an F28 Mk0100. Because this case was initially assumed to be similar to the 2009 event, Fokker Services issued SBF100-32-169 to provide instructions for a detailed inspection of the MLG pistons P/N 41141-5. EASA issued AD 2017-0163 to require that action. Goodrich and Fokker Services investigated the occurrence and, although no firm conclusion could be established as to the root cause of the event, Goodrich did report that initiation of the event was caused by hydrogen-assisted cracking. The investigation also identified the failed piston as one of five MLG pistons P/N 41141-5 for which it could not be shown that the required heat treatments had been accomplished correctly during overhaul. The SB identifies those pistons and requires that they be removed from service. It was also determined that the wire harness port of the MLG piston is a highly stressed area, prone to high-rate crack growth if small surface imperfections would be present.

This condition, if not detected and corrected, could lead to MLG failure during rollout after landing, possibly resulting in damage to the aeroplane and injury to occupants.



To address this unsafe condition, Goodrich amended the Component Maintenance Manual (CMM) overhaul instructions to introduce an additional detailed inspection step and subsequent diameter increase of the wire harness port, prior to the application of the nickel plating. This modification will (re)identify MLG pistons as P/N 41141-7. Goodrich issued SB 41000-32-036 (which is the subject of the SB, as defined in this AD) for modification of non-nickel-plated P/N 41141-3 pistons and P/N 41141-5 pistons. In the frame of the investigation of the latest event, the SB also identifies certain MLG pistons P/N 41141-5 for which it could not be shown that the required heat treatments had been accomplished correctly.

To address this **potentially** unsafe condition, Goodrich amended the Component Maintenance Manual (CMM) overhaul instructions to introduce an additional detailed inspection step and a subsequent safety cut of the wire harness port, prior to application of the nickel plating. This modification will (re)identify MLG pistons as P/N 41141-7. Goodrich issued SB 41000-32-036 (which is the subject of the SB, as defined in this AD) for modification of non-nickel-plated P/N 41141-3 pistons and P/N 41141-5 pistons.

***EASA response:***

***Comments partially agreed. The Final AD has been amended accordingly.***

