Australian Government
Department of Defence

Wedgetail Engine Corrosion

CFM56-7B27A

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Introduction

- E-7A Background
- Engine Corrosion Issues
  - Main Fuel Pump
  - Fan Frame Handling Boss
  - Outlet Guide Vanes
  - Splitter Fairing
- Conclusion
- Questions

Background

- Wedgetail has been in RAAF service since mid 2010, with the final aircraft being delivered in May 2012.
- Fleet size is six aircraft (12 engines).
- All E-7A aircraft were built as commercial 737NG aircraft (Green) and then modified.
- The E-7A aircraft are based at RAAF Williamtown approximately 7 km from the open ocean. An environment with high humidity and salt laden air.
- E-7A aircraft are low utilisation. They typically fly 20% of the hours and 10% of the cycles completed by commercial operators.

Background

- Due to the E-7A home base location the following preventative measures have been introduced since entry into service:
  - Aircraft & engine preservation for periods of inactivity seven days and greater.
  - Engine press fit bungs.
  - Scheduled engine compressor washes.
  - Routine fuel tank sumping with requirement to report all findings.

- Priority has been to prevent degradation of the engine core over external cowling.

Background

- Even with these practices in place, E-7A engines are still not immune to environmental degradation as a result of low utilisation in a corrosive environment.
- Recently the CFM56-7B engine fitted to the E-7A has experienced corrosion in the following areas:
  - Engine Main Fuel Pump (MFP)
  - Fan frame handling boss
  - Outlet guide vanes
  - Booster splitter fairing

- This presentation discusses these issues, the investigation completed and the solutions implemented.

Engine Main Fuel Pump

- During a shop visit for an unrelated issue, internal corrosion was discovered in a MFP in June 2015.
- The internal corrosion exhibited a “tide line” in the High Pressure section of the pump.
- The tide line indicated the presence of water in the MFP for an extended period of time of inactivity.
- Long term exposure to corrosion products have the ability to ware away the dry film lubricant present on the bearings and could result in bearing failure and subsequent loss of thrust control.

Engine Main Fuel Pump

- Prior to the shop findings there no indications of a performance loss with the MFP.
- The MFP was installed on the same engine since manufacture.
- The MFP fitted to sister engine was removed to allow investigation.

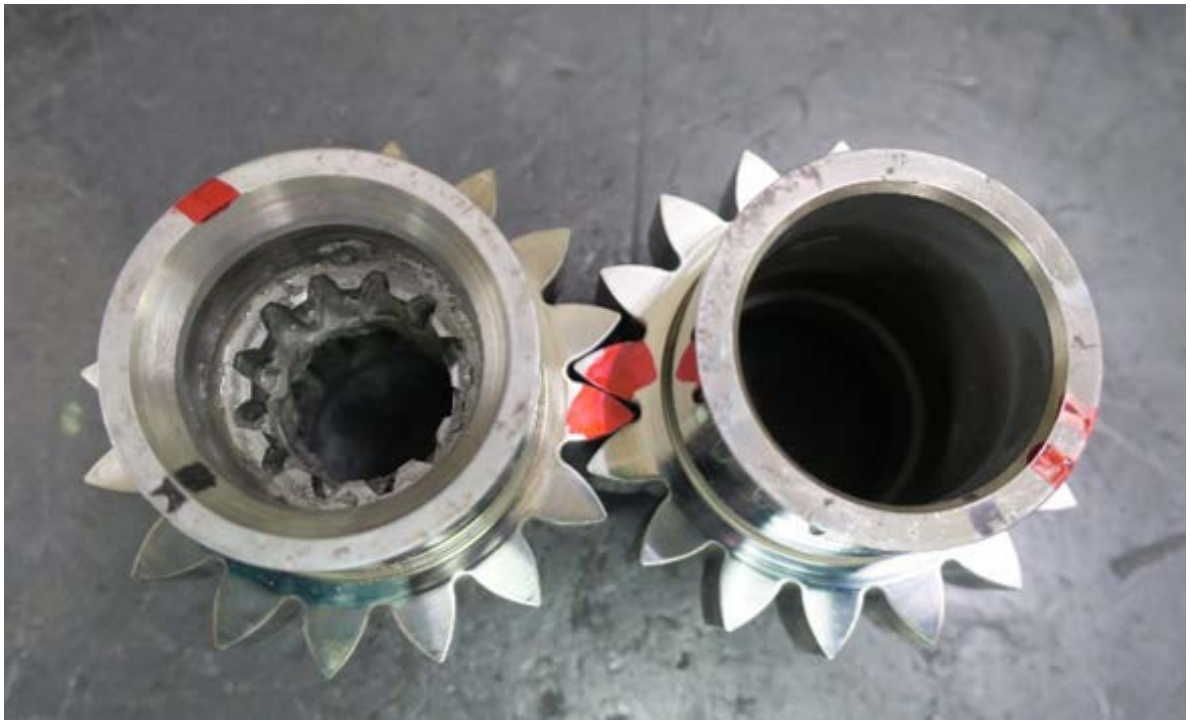
Engine Main Fuel Pump

Engine Main Fuel Pump

- Sister engine MFP findings were similar to first pump.

Engine Main Fuel Pump

- Fleet wide inspection conducted to confirm fleet condition. Total of four additional suspect MFPs identified.
- The four suspect MFPs were removed and inspected. No internal corrosion or abnormal defects were found.



Engine Main Fuel Pump – Root Cause

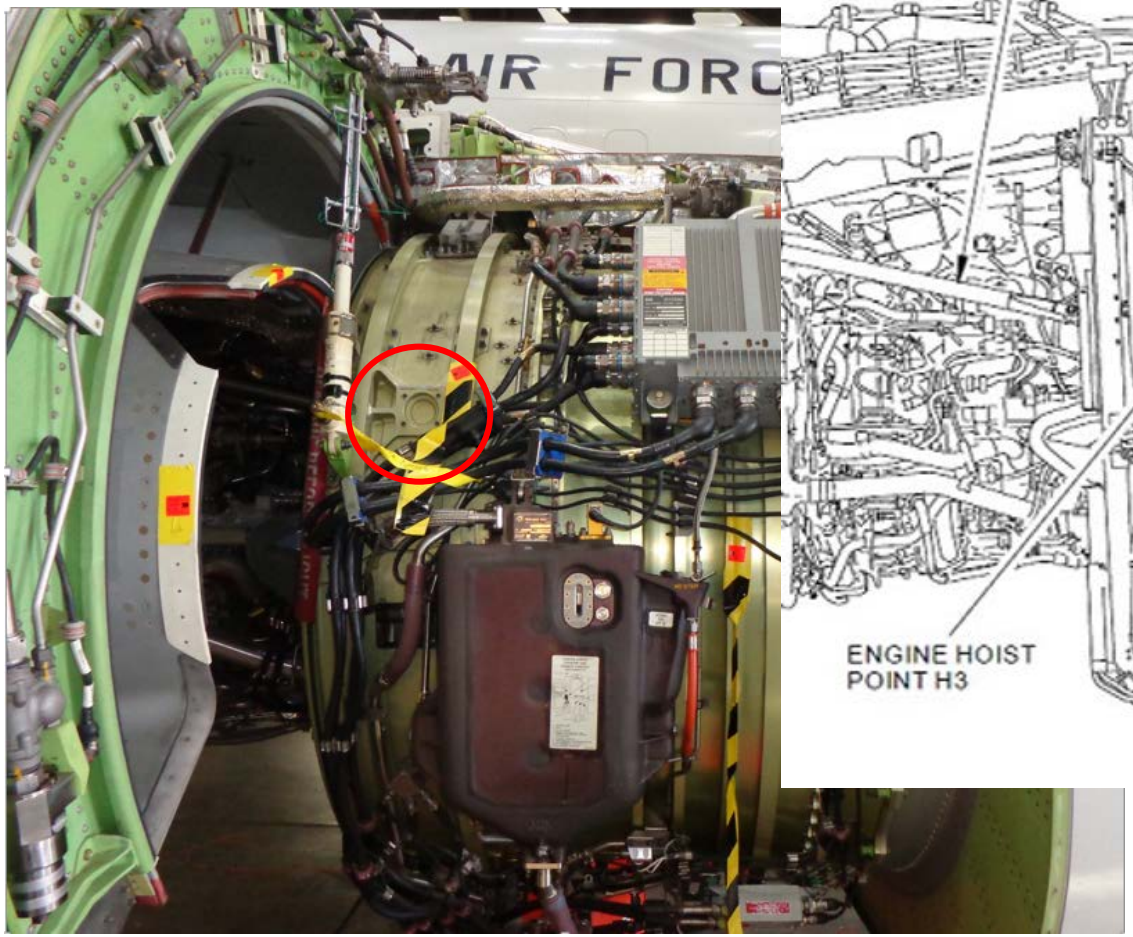
- Two possible causes:
  - Presence of water in the fuel tanks ingested during engine runs.
  - Contamination during engine removal as part of E-7A modification. Both engines were removed during this time.
- Cannot determine when corrosion initiated so unable to identify actual root cause. Instead address possible contributing factors:
  - A short engine run can scavenge water with the fuel. Shutting down the engine prior to removal of all the water will trap water in the MFP.
  - Condensation most probable cause for the water in the fuel tank.

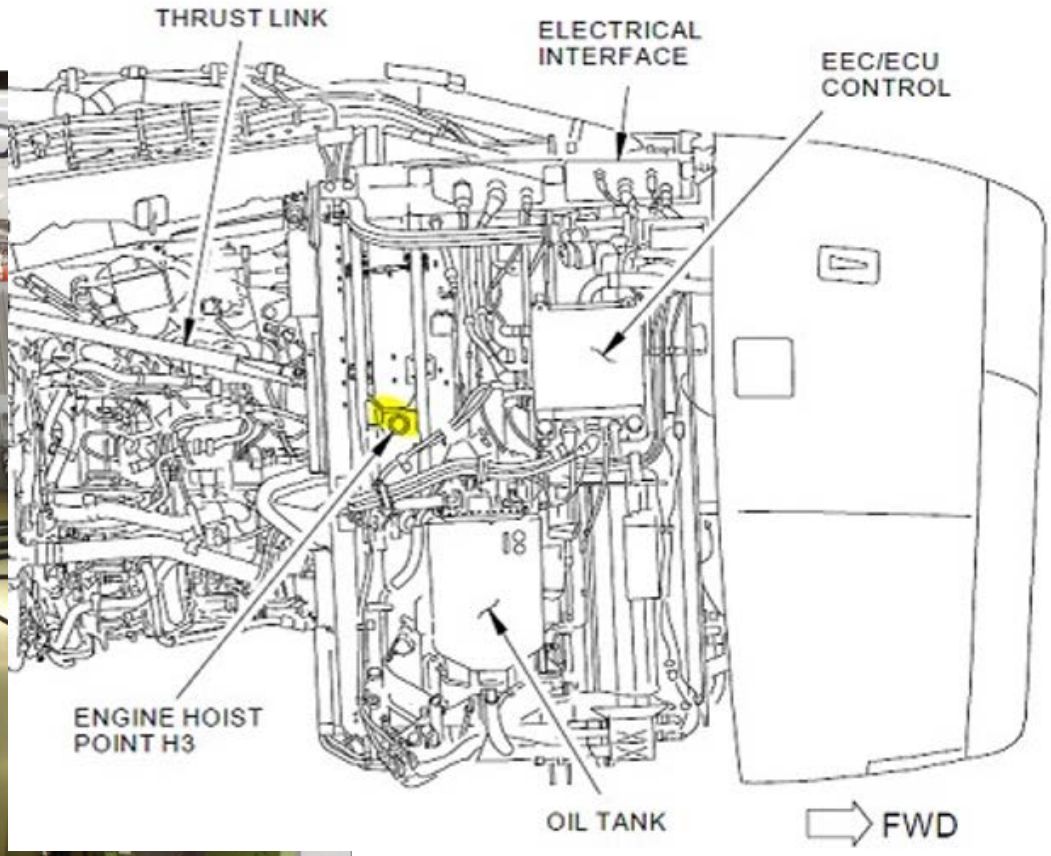
Engine Main Fuel Pump – Mitigation Actions

- As a result of the MFP corrosion, a number of changes have been incorporated to remove contributing factors and prevent recurrence:
  - Increase the minimum engine run time to 15 minutes. This provides sufficient time to clear any water from the fuel tanks that may not be identified by sumping.
  - Failure reporting requirement introduced on fuel tank sumping servicing. No water identified in fuel samples since.
  - Boeing SB to be incorporated that improves effectiveness of the fuel scavenge system.

- The importance of the regular fuel tank sumping has also been highlighted as a result of this investigation.

Fan Frame Handling Boss





Fan Frame Handling Boss

- The Fan Frame Handling Boss is an attachment point for GSE to allow engine removal/installation.
- The Fan Frame is manufactured from an aluminium alloy with an anodised coating.
- Corrosion was first identified during deeper maintenance. Minor corrosion removed (up to 0.014”) which did result in the wider removal of the original anodising coating.
- Standard OEM repair for the surface protection was to apply Alodine in lieu of restoring the anodising.
- OEM reported no previous experience of corrosion in this location in world fleet.

Fan Frame Handling Boss

- Extent of original repair as of October 2015:

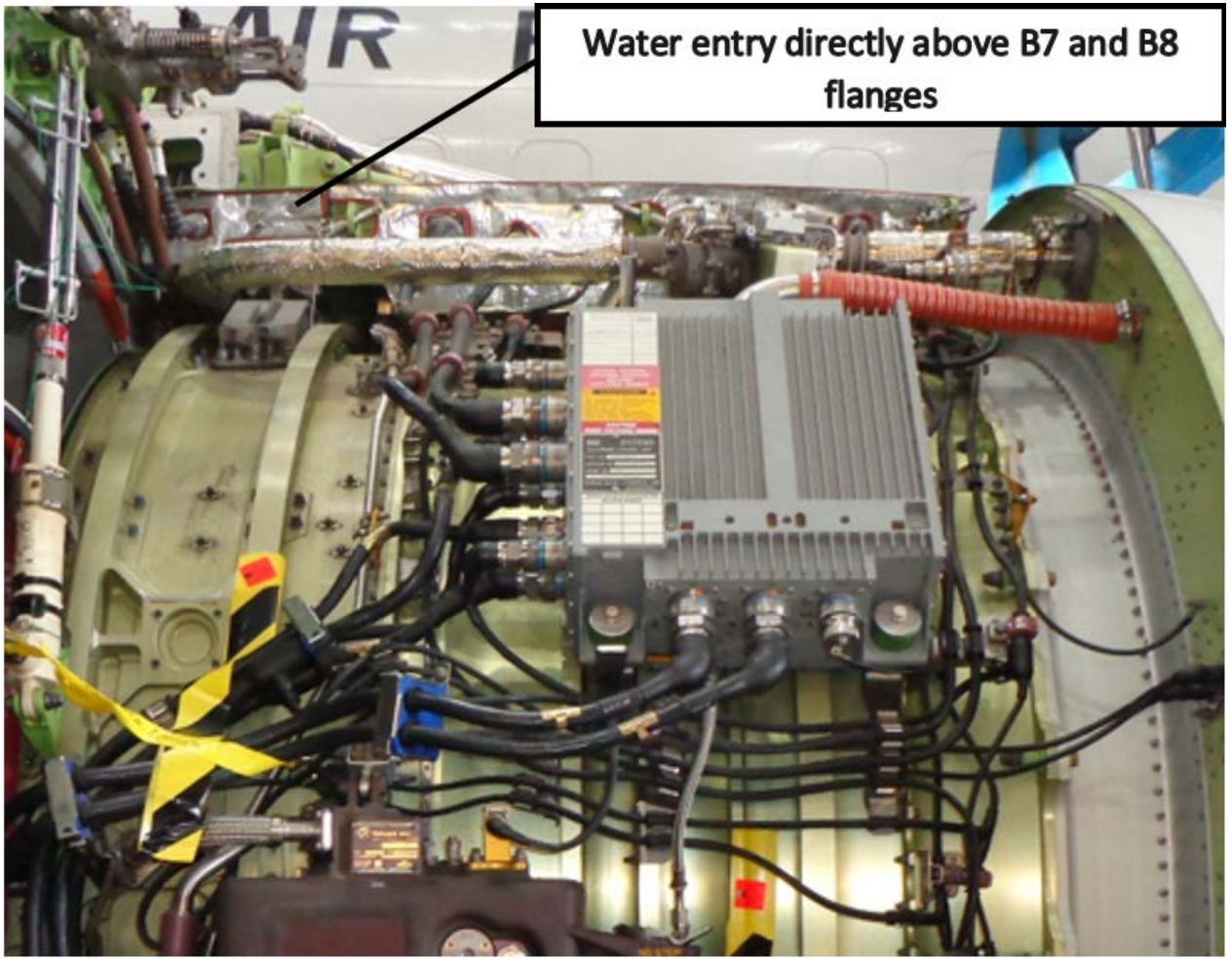
Fan Frame Handling Boss

- Surface protection did not display suitable durability considering the E-7A location or operating environment.

Fan Frame Handling Boss

- Corrosion found to be still localised yet far more severe than original occurrence. Material removed up to 0.055” compared to 0.014” at original finding.
- The corrosion foot print of the secondary corrosion indicated pooling of water on the handling boss.
  - Leak path identified at the top of engine fan cowl. Insulation blanket and aerodynamic seal ends between B7 and B8 flanges, so water could drip from seal on to fan frame.
- A total of six engines have experienced this condition, requiring a more robust repair method.
  - Worked with engine OEM to identify and incorporate a more durable surface protection scheme (paint).

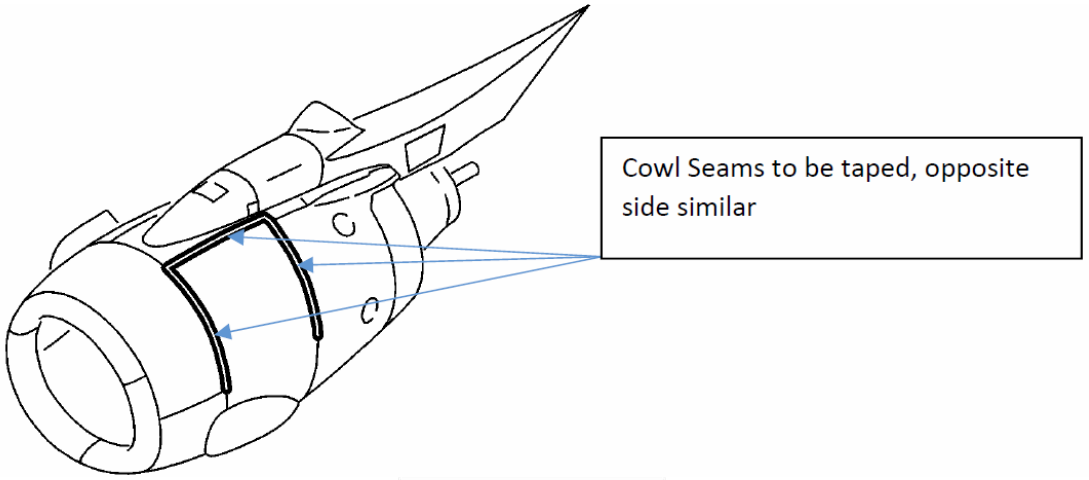
Fan Frame Handling Boss



Fan Frame Handling Boss

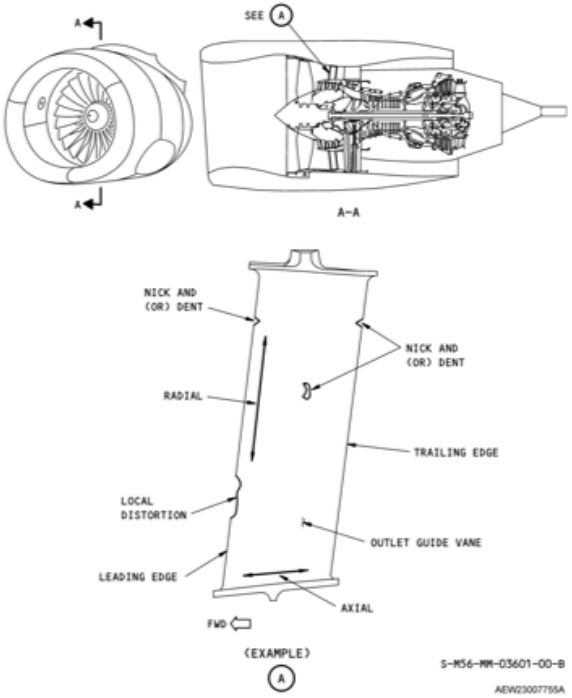
Fan Frame Handling Boss

- OEM identified a paint as an acceptable surface protection post repair. A more durable paint is still in work.
- AMM changes to prevent water ingress:
  - The engine cowl taped before washes or during periods of extended ground time.
  - Post wash, aircraft clear water rinse (bird bath) and depreservation the cowls are opened and moisture removed.



Outlet Guide Vanes

- Initial report of pitting corrosion on surface and leading edge of three OGVs, December 2015.
- Investigation identified seven OGVs replaced on aircraft to date, and up to 20 on aircraft A30-002 currently undergoing R8.



Outlet Guide Vanes

- Most occurrences of pitting corrosion have been on the concave surfaces with some instances on the convex side and leading edges.

Outlet Guide Vanes

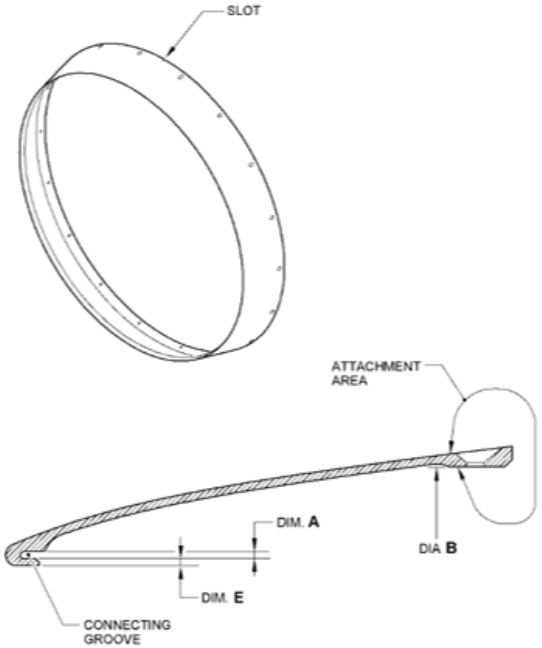
Outlet Guide Vanes

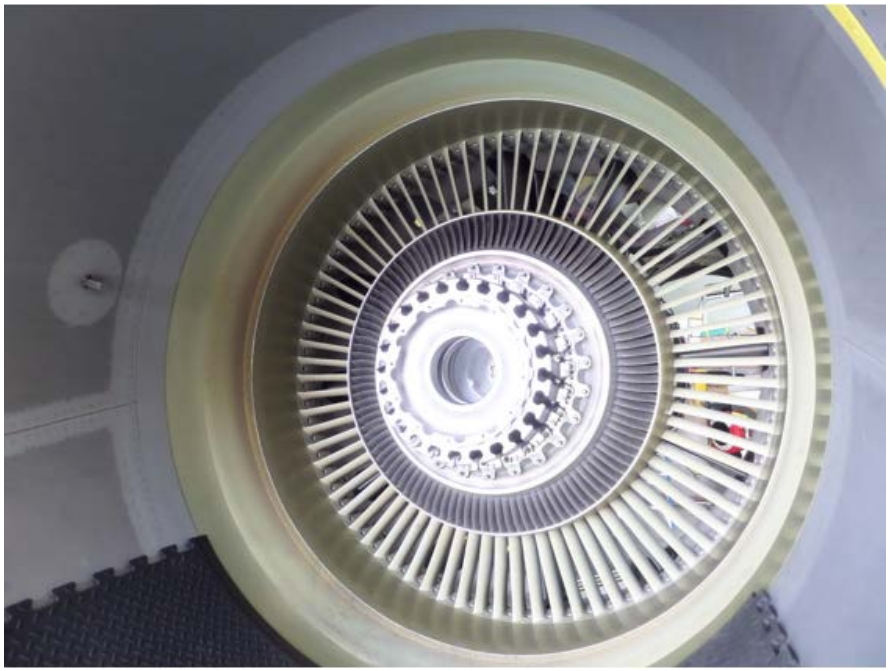
Prevention and Repair Strategies

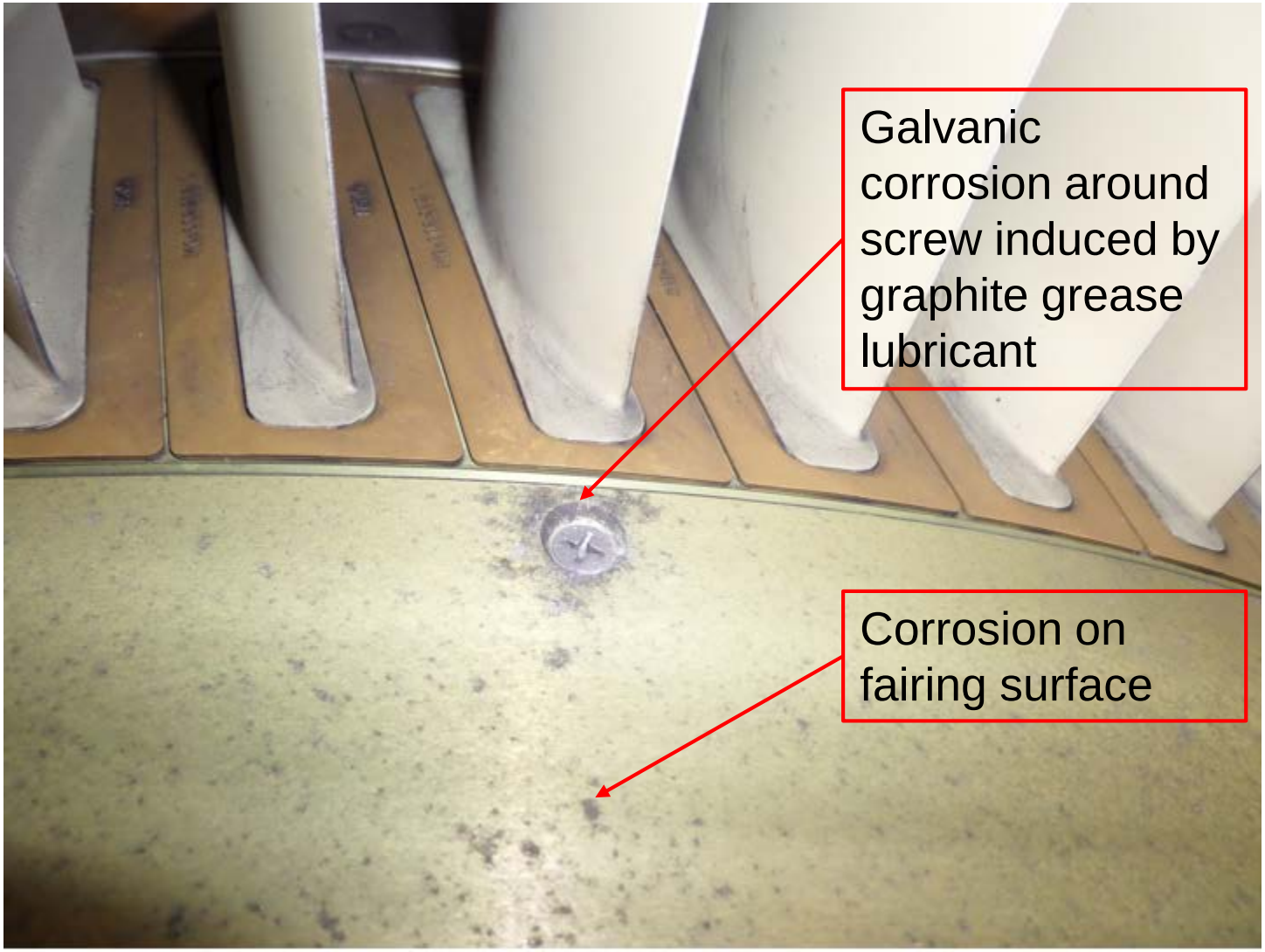
- Existing strategy is to remove and replace OGVs on identification of pitting corrosion.
- Alternative strategies under consideration:
  - Increase inspection intervals and repair OGVs.
  - Re-apply protective coating.
- Need to consider lifetime costs of repair vs replacement strategy when deciding which path to take.

Booster Splitter Fairing

- Corrosion of the Splitter Fairing identified on both engines of A30-002 during R8, March 2017.
  - This is the first occurrence.
  - Corrosion on surface and around attachment screws.






Galvanic corrosion around screw induced by graphite grease lubricant
Corrosion on fairing surface

Wedgetail Engine Corrosion

Splitter Fairing – Prevention & Repair

- A30-002 Splitter Fairings:
  - Replacement Splitter Fairings will be sourced and installed during R8.
  - Removed Splitter Fairings sent to repair shop to quote on repair.
  - Repaired Splitter Fairings will then be used as serviceable spares.
- Establish an alternative for graphite grease lubricant.

- Due to recently identified corrosion issues (Splitter Fairing & OGV) a more holistic corrosion prevention program is being considered.
  - Are existing actions still effective? Are new actions required?

Conclusion

- Main Fuel Pump
  - Only two MFPs affected.
  - All suspect pumps have been overhauled.
  - AMM updated to eliminate contributing factors & prevent recurrence.

- Fan Frame Handling Boss
  - Six engines experienced corrosion in this location.
  - Repair procedure with additional protective coating developed.
  - AMM updated to reduce likelihood of future corrosion.
  - Identification of alternate surface protection still in work.

Conclusion

- Outlet Guide Vanes
  - Pitting corrosion on concave surface
  - Parts are replaceable
  - Increased inspection interval and repair OGVs

- Splitter Fairing
  - Corrosion on surface and at screw attachments
  - Induced by graphite grease lubricant
  - Researching cost of repairs

- Use these issues to continually assess corrosion prevention strategies and revise ESIP as required.

Questions