RAAF C-130J-30 Wing Trailing Edge Corrosion Management
Presentation Summary

- What is a C-130J-30 and how is it different to legacy C-130’s
- What is the corrosion problem
- Work to date. What worked and what didn’t
- STI-C130J-212 – Fleet sample inspection
- Fleet wide rectification plan
  - Scope of work
  - Design changes
  - Maintenance requirements
What is a C-130J-30?

The “Wikipedia” definition: “The Lockheed Martin C-130J "Super" Hercules is a four-engine turboprop military transport aircraft. The C-130J is a comprehensive update of the Lockheed C-130 Hercules, with new engines, flight deck, and other systems”

The operator’s definition: The C130J is a utility aircraft that can haul anything, anywhere, anytime.
How is the J different to legacy aircraft

The big differences are

• New more powerful engines with composite 6 blade scimitar propellers.
• Completely revised glass cockpit and digital avionics suite that facilitates a reduction to a 2 man flight crew.
• The -30 variant has a 180in longer fuselage providing a 30% increase in cargo hold volume over legacy C130 models.
• These and other changes provide a 40% greater range, 21% higher maximum speed, and 41% shorter take off distance over legacy C130 models.

The not so obvious difference

• Wing flaps and wing trailing edge structure have been completely redesigned and are now predominantly manufactured from carbon epoxy composite materials.
The structure

- **Carbon Epoxy Trailing Edge Panels**
- **2024-T3 / T4 / T42 Clad alloy formed intermediate ribs**
- **7075-T6 extruded alloy built up ribs**
- **4340 Steel Flap Track Rib Caps**
- **2024-T4 Aluminium Extruded Trailing Edge Arrow Head**
- **7075-T7351 Aluminium Extruded Spar Cap**
- **Carbon Epoxy Trailing Edge Lower Pans**
The Problem

Corrosion....... 

Apparently on a quiet night you can actually hear the aircraft sizzle

Steel Flap Track Rib Upper Caps
Severe surface corrosion

Trailing Edge Arrow Heads
Pitting and intergranular / exfoliation corrosion

Spar Cap Pitting Corrosion
(Shown after blending)
Prior maintenance activities

- Initial finding of exfoliation corrosion on Trailing Edge Arrowheads.
- Maintenance requirements revised
- Modification issued to install drainage holes in TE Pans
- P1 inspect and apply CIC’s

Acquisition
Causes for Corrosion

- Poor drainage – Water entrapment
- Insufficient maintenance
  - Inspections
  - CPC/CIC application
- High Galvanic potential
- Barriers Compromised
  - Poor coatings adhesion
  - Fay surfaces not adequately sealed
  - Swarf entrapment in fay surfaces

The Galvanic Series

Anodic (more easily corroded)
- Magnesium
- Aluminium
- Cadmium
- Aluminium Alloys
  - Mild Steel

Low Alloy Steels
- 304/316 Stainless
  - Lead
  - Tin
  - Nickel
  - Copper
  - Bronze
  - Silver
  - Titanium
- graphite
- gold
- platinum

Cathodic (less easily corroded)

Spar Cap and Intermediate Ribs
Flap Track Ribs
Carbon Trailing Edge Panels
Prior maintenance activities

Initial finding of exfoliation corrosion on Trailing Edge Arrowheads. Maintenance requirements revised

Fleet wide program to remove OW TE panels

Modification issued to install drainage holes in TE Pans
P1 inspect and apply CIC’s
Prior maintenance activities

Rectification Activities:

Where possible, corrosion was blended out either within SRM negligible damage limits or under concession by engineering.

Many Trailing Edge Arrow Heads were replaced and mechanical repairs were required on most of the aluminium trailing edge ribs.

Surface protection restored IAW the C130J CPCM.

- Steel Flap Track Ribs – Epoxy Prime X2 +aluminized epoxy enamel
- Spar Caps – Alodine + Epoxy Prime x2 + fay surface, wet install and fillet seal with polysulfide sealant. Fay surface rib cap to TE panel
- Trailing Edge Arrowheads – Alodine + Epoxy Prime x2 + fay surface, wet install and fillet seal with polysulfide sealant.

Since then reoccurrence of the corrosion has been found.

- One aircraft had 21/22 trailing edge arrow heads replaced at DM.
- Corrosion products seen at edge of faying surfaces.
Initial finding of exfoliation corrosion on Trailing Edge Arrowheads. Maintenance requirements revised.

Fleet wide program to remove OW TE panels.

Modification issued to install drainage holes in TE Pans P1 inspect and apply CIC’s.
STI-C130J-212 - Findings

Corrosion on all metallic trailing edge components including spar caps, aluminium ribs, steel flap track ribs, trailing edge arrow heads and spar cap end fittings. In some cases corrosion growth since previous inspection/repair (6 years ago) was quite aggressive.
NOTES

LH Outer Wing = Wing Station -550 to -220
LH Centre Wing = Wing Station -220 to 0
RH Centre Wing = Wing Station 0 to 220
RH Outer Wing = Wing Station 220 to 550

Damage to the centre wing corresponds to the use of composite panels (     ) and aluminium panels (     ) .
Where to now?

STI-C130J-212 identified that the corrosion issue was not solved by the prior teardown program and that the centre wing is also susceptible.

The current find it and grind it maintenance philosophy is considered unsupportable as significant unscheduled maintenance time and costs would be required on an ad-hoc basis to maintain the airframe through to its structural Life of Type.

Further, it was assessed that if allowed to progress without intervention, the rate of corrosion growth would impact both primary and secondary structure to a point where it would be unable to support flight loads.
Where to now?

- Initial finding of exfoliation corrosion on Trailing Edge Arrowheads. Maintenance requirements revised.
- Acquisition


- Fleet wide rectification commences
- Fleet wide program to remove OW TE panels
- Peening of Arrowheads
- Modification issued to install drainage holes in TE Pans
- P1 inspect and apply CIC's

STI-C130J-212
Notes for fleetwide rectification.

This scope of work can only be performed during Depot Level Maintenance ("D" check) which has a 6 year interval.

A risk analysis is therefore required to support the 6 year implementation period.

STI-C130J-212 provided corrosion growth rates, enabling us to make conservative assumptions as to structural impact on the fleet due to corrosion growth over the incorporation period.

The Risk Analysis must demonstrate that the fleet will remain within the structural certification basis during the implementation period.

Improved maintenance requirements will be implemented immediately which will hopefully arrest corrosion growth during the implementation period and minimise the damage. This however cannot be relied upon to mitigate the risk.
Hurdles under STI-C130J-212

Maintenance planning
- Removal of trailing edge structure requires the wings to be in a no load configuration.
- Centre and outer wings require different jacking configurations to achieve a no load configuration.
- Significant risk for Deeper Maintenance (DM) Time to Make Serviceable (TMS).

Logistics Management.
- Long lead times for some fasteners.
- Turnaround times for component rework and CAD plating.
- Spares acquisitions driven by maintenance demands which often resulted in an impact on maintenance schedule.
Solutions for Fleetwide Rectification

Maintenance Planning

• Development of an outer wing removal procedure to decouple the no load requirements of centre and outer wings and allow concurrent maintenance. Cost Benefit Analysis currently in work

Logistics Management

• Fleetwide acquisition strategy for fasteners to take advantage of bulk pricing on high cost/long lead time items.
• Early identification and removal of parts requiring plating repairs to minimise impact on TMS.
Design Improvements

Improved surface finish

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<th>Existing Surface Finish requirements for repairs at Fay Surface</th>
<th>Revised Surface Finish Requirements</th>
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<td>Surface treatment</td>
<td>Aluminium parts - Alodine</td>
<td>Aluminium parts - Anodise/Alodine</td>
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<td>Steel Parts – No repair for Cad plating</td>
<td>Steel Parts - Cad plate</td>
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<tr>
<td>Prime</td>
<td>Epoxy Prime</td>
<td>2x Epoxy Prime</td>
</tr>
<tr>
<td>Paint</td>
<td>Nil</td>
<td>2x White Polyurethane</td>
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<tr>
<td>Sealant</td>
<td>Fay Surface Seal and Wet Assemble</td>
<td>Fay Surface Seal and Wet Assemble</td>
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<tr>
<td>CPC/CIC</td>
<td>Nil</td>
<td>Overcoat assembly with CorBan-35</td>
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Improved Maintenance Requirements

- Routine cleaning followed by application of CorBan-35 at R30 (3 year interval)
QUESTIONS?

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