Ferrium S53
T-38 MLG Piston Inspection

July 10, 2012
Approved for Public Release
Background

- Prior mechanical, corrosion, and stress corrosion cracking laboratory studies have indicated that Ferrium S53 is a suitable replacement for 300M that offers performance enhancements in manufacturing and service along with elimination of the Cadmium coating protection scheme.
- OO-ALC is interested in field service evaluation of Ferrium S53, a corrosion-resistant ultrahigh strength steel, in a prime and paint only protection scheme.
- ES3 was contracted by OO-ALC to redesign the T-38 MLG piston that had some fatigue cracking related issues. While completing this redesign, ES3 produced several Ferrium S53 pistons along with the redesigned baseline (4340) pistons for qualification and flight testing.
- While OO-ALC moved forward with the purchase of the redesigned pistons using 4340, there was still high interest in determining the field performance of the Ferrium S53 pistons to gain knowledge that would assist in determining if the prime and paint only protection scheme could be implemented on future components (i.e. KC-135 truck beam assembly).
Production / Pre-flight

- Material – Carpenter
- Forging – Ladish
- Manufacturer – Heroux
- Installed December 8, 2010
Inspection

• 307 sorties (Operational in Gulf of Mexico area)
  – 390.2 flight hours
  – 541 landings
  – 44 total tire changes (# of left vs. right unknown)
    • No defects or rust found

• Main pistons pulled from outer cylinder on July 10, 2012
  – Visual inspection indicated a few small paint chips with no visible rust or pitting; and some pitting located on brake flange
  – Use of a small optical scope indicated that there were small rust pits formed within the small paint chips (no bleeding present) and that the pit size in the brake flange area was less than 0.02” in width, with clusters on order of 1” in length (depth could not be measured, but is estimated to be on the order of 0.001 to 0.003”)

Approved for Public Release
Inspection (cont’d – during tire changes)

- Standard visual inspection locations that were observed during tire changes.
- No visual observations that showed damage or corrosion were noted in any of the inspection reports throughout the FSE.
Inspection (cont’d – visual prior to strip)

• Brake flange area has brake dust and shows some small areas of pitting
Inspection (cont’d – visual prior to strip)

• Cr-plated cylinder appears normal, transition region from cylinder to axle portion in good shape, and small rust spots noted around dip-gage hole.

• Paint chips near transition to brake flange and near dip-gage hole that do not show visual signs of rust (later optical scope indicates small pits present where paint is damaged.)
Inspection (cont’d – visual prior to strip)

- Some pitting is present in chipped areas; scale is 0.01” per hash mark
Inspection (cont’d – visual prior to strip)

• Threads and axle bore look good, no signs of rust present

• Threads on upper part of cylinder look same as installed; spacers shows typical wear near wheel interface, similar to old configuration.
Inspection (cont’d – visual after strip)

- Stripped part indicates some rust pits in brake flange area and around machining center point area. Threads look good and show no signs of rust or pitting.
Inspection (cont’d – visual after strip)

• Some pitting is within brake flange area; not present across full part; scale is 0.01” per hash mark
Inspection (cont’d – mag. particle and UT)

- No defects present in magnetic particle (images below) or ultrasonic testing.
Inspection (cont’d – comparison of 4340 vs. S53)

- 4340 condition ready to be reinstalled into flight service compared to S53

*4340 piston has been in service for much longer time (time frame unknown)
Inspection (cont’d – Ferrium S53 new and overhaul)

- A few pits located in flange and near dip-gage are only distinguishable differences between as-installed and 1st Article Field Service Evaluation test piece.

As-machined, prior to original application of prime and paint.

1st article FSE inspection after strip of prime and paint.
Additional information
Additional images