HVOF as a Hard Chrome Replacement

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AIR - 4.3.4.1
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Materials Engineer
**Report Documentation Page**

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**12. DISTRIBUTION/AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited

**13. SUPPLEMENTARY NOTES**


**14. ABSTRACT**

**15. SUBJECT TERMS**

**16. SECURITY CLASSIFICATION OF:**

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**17. LIMITATION OF ABSTRACT**

Same as Report (SAR)

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HVOF as a Hard Chrome Replacement

Chrome Plated
Metcut Large
Fatigue Bars
with 4.5” Radius
per ASTM E-606

Chrome plated at
NADEP JAX
HVOF as a Hard Chrome Replacement

Chrome Plated PAX LAB 4.3.4.2 Large Fatigue Bars with 0.625” Radius

Chrome plated at NADEP JAX
HVOF as a Hard Chrome Replacement
HVOF as a Hard Chrome Replacement
HVOF as a Hard Chrome Replacement
Alternate-to-Chrome ID Test Specimen Holder

Baseline for alternate ID thermal spray coatings

Cylinder required modification for Cr plating

Requires plating solution to be pumped through ID

Cylinder ID approx. 3” dia

Anode dia approx. 1.420”
Alternate-to-Chrome ID Test Specimen Holder

Cr used as baseline for alternate ID thermal spray coatings

Four total runs completed; 22 samples coated

First test coupon run completed 26 Aug 02; 11 samples coated

Second test coupon run completed 09 Sept 02; 11 samples coated
F/A-18 Horizontal Stabilator Piston Rod

P/N 3003130 (Vendor Code 93835)

HVOF Coat short external end with WC/Co/Cr  86/10/4
HVOF Coat longer internal end with WC/Co  83/17

Grind to 8 - 16 µin Ra finish
Superfinish to ≤ 2 µin Ra finish

Ship to PAX Lab for additional Hydraulic Actuator seal compatibility testing
AMEC Specifications

AMEC Meeting No. 172 @ Goodrich Landing Gear - Cleveland, OH    1-2 August 2002

Grinding Spec went out on 28-day ballot
14 Approvals, 5 Disapprovals, 1 Waive
0 out of 52 addressees on ballot

AMEC direction: Add statement to Grinding Spec;
Cutting fluids containing amines shall not be used when grinding coatings which contain cobalt.

Reason: Cutting fluids containing amines may leach cobalt from coatings during grinding.

Send comments to: Scott.Maitland@goodrich.com
AMEC Specifications

AMEC Meeting No. 172 @ Goodrich Landing Gear - Cleveland, OH 1-2 August 2002

HVOF Coating Specs went out on 28-day ballot

AMEC 99B: WC/Co powder spec; 16 Approvals, 0 Disapprovals, 7 Waive

AMEC 99C: WC/Co/Cr powder spec; 15 Approvals, 0 Disapprovals, 8 Waive

AMEC 00AB: Application Spec; 13 Approvals, 1 Disapproval, 8 Waive

HVOF as a Hard Chrome Replacement
Current Status of P-3 Main Landing Gear

HVOF MLG Piston installed 26 April 99 on VP-30 Aircraft BuNo 156522

Aircraft completed PDM at NADEP JAX on 5 Dec 99

PDM extended due to multiple spar cap insertions

850 Landings on HVOF coated MLG Piston (Aug 00)

HVOF Coated Piston removed from service Aug 00 due to internal oil leak on ID-2 (NOT HVOF COATED)

HVOF Coated Strut repaired, sent back to VP-30 Installed on Aircraft 160284 STBD April 25, 2001

1,078 Total Landings on HVOF coated strut (8/23/01)
Current Status of P-3 Main Landing Gear

HVOF Coated Strut installed on VP-30 Aircraft 160284 STBD side on April 25, 2001

655 Landings on HVOF coated strut since 4-25-01 (2/1/02)

1,505 Total Landings on HVOF coated strut as of 01 Feb 02

44 Landings on HVOF coated strut since 2-1-01 (9/5/02)

1,549 Total Landings on HVOF coated strut as of 5 Sept 02
HVOF as a Hard Chrome Replacement

Buno-156522
VP-30 Aircraft
Installed 4/26/99
HVOF as a Hard Chrome Replacement

Buno-156522
VP-30 Aircraft-Installed – 4/26/99
Second P-3 MLG Piston coated with HVOF WC/Co 83/17

- To be used in $70M P-3 aircraft SLAP/SLEP - Full Scale Fatigue Test
- R/H MLG chrome plated
- L/H MLG HVOF coated
- HVOF coating, grinding & processing of gear funded by Naval Research Lab (NRL)
- Testing started 30 August 2001 (24 month test)
- 16,000 Cyclic Test Hrs. accumulated as of 30 Aug. 02
- Test down since April ‘02 for repairs; hope to be up Sept. 02
- 26,000 CTH planned; ECD December 02 if all goes well
- Landing gear shows no sign of coating problems
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• P-3 Bomb Bay Door Actuator Pistons coated, ground, & superfinished

• Four HVOF coated P-3 Bomb Bay Door Actuator Assemblies RFI and installed on VP-30 Aircraft BuNo 156510 July 2001

• Aircraft undergoing PDM at JAX July 2001

• A/C delivered back to VP-30 on 7 Sept 01

• 91 Flight Hours on HVOF coated actuators (01 Feb 02)

• 232 Flight Hours on HVOF coated actuators (05 Sept 02)
Aft view
Current Status of HVOF Coated EA-6B Main Landing Gear Flight Clearance

MLG Collar and Piston coated Oct. 99
Components completed depot processing Dec. 99
Flight clearance requested Jan 00
Meeting at NAVAIR/Pax River 13 April 00
Obtained NAVAIR approval of data May 00
Flight clearance at AIR 4.3.3 waiting final approval
“NAVAIR ONLY” HVOF L.G. meeting 16 Nov 00
Flight clearance on-hold
NAVAIR presented 240KSI requirement for all landing gear fatigue tests at Dec 00 HCAT mtg.
NAVAIR & NRL meeting 29 Jan 01
Large sample (2”-3” dia) testing discussed
NAVAIR (Eui Lee) to conduct testing
Flight clearance at AIR 4.3.3 waiting final approval
Meeting at BWI Sheraton 23 OCT 01

Large sample (2 1/4” OD dia) testing discussed

NAVAIR (Eui Lee) to test additional 30 large samples

Must test one NAVAIR large sample with 0.010” coating thickness at max. stress of 200 KSI, actual R-ratio of EA-6B MLG axle to be used during testing

Request to AIR 4.3.3 (Alysha Roerden) for R-ratio & max stress of EA-6B MLG inboard axle journal 23 Oct 01

R-ratio & max. stress from AIR-4.3.3 Feb 02

(200 KSI @ R = -1)

Flight clearance at AIR 4.3.3 waiting final approval
HVOF as a Hard Chrome Replacement
Current Status of E-6A Main Landing Gear

Two HVOF coated E-6A MLG Uplock Hook Shafts installed 10 March 99 on A/C 164388

- 2,838 Flight Hours (7/31/02) A/C completed
- 2,480 Landings (7/31/02) Mod in Waco, TX

One HVOF coated E-6A MLG Uplock Hook Shaft installed on Aircraft 162784 in Feb. 2000

- 3,241 Flight Hours (7/31/02)
- 2,413 Landings (7/31/02)
HVOF as a Hard Chrome Replacement

E-6A MLG Lock Hook Shaft  P/N 9-45196