Hard Chrome Alternatives for Hydraulic Components

- Program established to assist Oklahoma City Air Logistics Center Airborne Accessories Directorate Avionics and Accessories Division (OC-ALC/LGERC) in development and implementation of replacement repair and overhaul procedures for hydraulic actuators across multiple weapon systems.
# Hard Chrome Alternatives for Hydraulic Components

**Abstract:**

23rd Replacement of Hard Chrome Plating Program Review Meeting, November 18-19, 2003, Cape Canaveral, FL. Sponsored by SERDP/ESTCP.

**Security Classification:**

- **a. Report:** unclassified
- **b. Abstract:** unclassified
- **c. This Page:** unclassified

**Limitation of Abstract:** Same as Report (SAR)

**Number of Pages:** 35

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Approved for public release; distribution unlimited
Hard Chrome Alternatives for Hydraulic Components

- Phase 1 - TO and Drawing Review, Database Development, Test Requirement Development.
    - 100% complete.
  - 729 Engineering Drawings Reviewed.
    - 60.4% reviewed. Remaining drawings are not available
  - 276 Chrome plated parts and 195 potentially chrome plated parts have been identified.
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• Phase 2 - Material, Rig, Service Testing.
  – Flight Control Actuators.
    • 87 distinct part numbers.
    • Revised estimate: 10 will require delta-qualification.
    • Candidate items selected.
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• Phase 2 - Material, Rig, Service Testing.
  – Utility Actuators.
    • 73 distinct part numbers.
    • Revised estimate: approximately 10 will require delta-qualification.
    • 5 candidate items selected to date.
  – Snubbers.
    • 12 distinct part numbers.
    • Estimate: approximately 3 will require delta-qualification.
    • 1 candidate item selected.
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- Phase 2 - Material, Rig, Service Testing.
  - Units undergoing delta-qualification
    - Flight Control: B-1 Horizontal Stabilizer
    - Flight Control: B-1 Pitch/Roll SCAS
    - Flight Control: C-130 Rudder Booster Actuator
    - Flight Control: A-10 Aileron
    - Flight Control: F-15 Pitch/Roll Channel Assembly (PRCA)
    - Utility: C-130 Ramp Actuator
    - Utility: C-135 Aileron Control Surface Snubber
    - Utility: C/KC-135 Main Landing Gear Actuator
    - Utility: C/KC-135 Main Landing Gear Door Actuator
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• Phase 2 - Material, Rig, Service Testing.
  – Planned
    • Special: KC-135 Ruddevator
    • T-38 Aileron Actuator
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- Phase 2 - Material, Rig, Service Testing.
  - Forward piston required redesign to eliminate fatigue failures (not related to chrome)
  - Design qualification required fatigue and endurance tests
  - Opportunity to include chrome alternatives in test
  - HVOF coatings replace chrome on forward and aft pistons
  - Endurance test included - approximately 750,000 cycles
  - Results will form basis for similarity arguments for other B-1 flight control actuators
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- Phase 2 - Material, Rig, Service Testing.
- Piston redesign completed
- Fatigue testing completed
- Endurance testing completed
- Actuator awaiting disassembly and documentation
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• Phase 2 - Material, Rig, Service Testing.
• Numerous product improvements to be investigated
• Will include incorporation of HVOF applied coating on primary piston and new seals
• Implementation to include design layout, coating prototype, fit check, simplified endurance schedule, and similarity argument
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- Phase 2 - Material, Rig, Service Testing.
  - C-130 Rudder Booster Assembly.
    - Rudder booster actuator delta-qualification was contracted to Kaiser Fluid Technologies (OEM).
    - In ~March 2002, Kaiser Fluid Technologies was acquired by Tactair Fluid Control.
    - Qualified by Lockheed Martin.
    - Delta-Qualification being performed by Tactair Fluid Control.
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- Phase 2 - Material, Rig, Service Testing.
  - C-130 Rudder Booster Assembly.
- 4 chrome plated surfaces.
  - Piston rod.
    » 3 sections, with piston heads separating them.
    » Significant straightness issues.
  - Piston head (2 piston heads on the unit).
    » Not part of the piston rod.
  - Trunnion OD.
    » Mates with an aluminum-bronze bushing.
  - Trunnion ID.
    » Not wearing part.
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• Phase 2 - Material, Rig, Service Testing.
  – Rod coating surface finish and seal selection.
  – 4 Configurations being tested:
    • Electroplated Chrome with AGT seals (baseline).
    • HVOF WC-CoCr with AGT seals (new coating, baseline seals).
    • HVOF WC-CoCr with new Greene Tweed seals (new coating, cap seals).
    • HVOF WC-CoCr with new Shamban seals (new coating, cap seals).
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• Phase 2 - Material, Rig, Service Testing.
  – A-10 Aileron Actuator (Parker)
    • Seals being selected.
    • Vibration testing cancelled.
    • Test fixture under design.
    • Redesign of piston may be required.
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• Phase 2 - Material, Rig, Service Testing.
  – F-15 Pitch/Roll Channel Assembly (PRCA)
• ARINC is working to award work to Moog as a Government directed source.
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• Phase 2 - Material, Rig, Service Testing.
  – Utility actuators.
• C-130 ramp actuator.
  – Part number 370750-1.
  – Stroke: 64.998” (maximum).
  – Extended/Retracted Length: 139.6” /74.6”.
  – Piston rod OD: 1.8”.
  – Piston rod Material: 4340.
  – Other coatings: None.
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• Phase 2 - Material, Rig, Service Testing.
  – Utility actuators.
• C-130 ramp actuator.
  – Two actuators planned for delta-qualification
  – Both actuators passed ATP and are ready for testing. First actuator should be completed by end of year.
  – Replacement scraper are being tested, but with limited success. Works fine with scraper oriented up. But when oriented horizontally, scrapers are not functioning as desired.
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Phase 2 - Material, Rig, Service Testing.

• C/KC-135 main landing gear door actuator.
  – Stroke: 20.66” (nominal).
  – Extended/Retracted Length: 51.66”/31.00”.
  – Piston rod OD: 1.3”.
  – Piston rod Material: 4340 or 4140.
  – Other coatings: Cadmium.
  – Identical to E-3 main landing gear door actuator (P/N 50-6832-10).
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Phase 2 - Material, Rig, Service Testing.

• C/KC-135 main landing gear door actuator.
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• Phase 2 - Material, Rig, Service Testing.
  – Utility actuators.
  • C/KC-135 main landing gear actuator.
    – P/N: 5-84046-6.
    – Stroke: 13.78” (nominal).
    – Extended/Retracted Length: 44.62”/30.84”.
    – Piston rod OD: 2.995”.
    – Piston rod Material: AMS 6371C.
    – Other coatings: None.
    – Identical to E-3 main landing gear actuator (P/N 50-6833-9).
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• Phase 2 - Material, Rig, Service Testing.
  – Utility actuators.
  • C/KC-135 main landing gear actuator.
    – Units have been disassembled.
    – One unit found to be in very bad shape.
      » Required 1300 ft-lbs to open housing.
      » TO stated 350 ft-lbs maximum.
      » Local shop has capability to apply up to 5500 ft-lbs torque to open housings.
    – Cleaning and inspecting components.
    – Replacing “bad” unit.
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• Phase 2 - Material, Rig, Service Testing.
  – Utility actuators.
    • One C/KC-135 aileron snubber has been assembled and successfully passed delta-qualification testing.
    • Second C/KC-135 aileron snubber has passed cyclic testing.
    • Currently being leak tested.
    • Will be cold temperature tested after leak test.
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• Phase 2 - Material, Rig, Service Testing.
  – Special actuator.
  • KC-135 Ruddevator.
    – Stroke: 5.875” (maximum).
    – Extended/Retracted Length: 25.580”/19.705”.
    – Piston rod OD: 0.746 to 0.748”.
    – Piston rod Material: 4140.
    – Other coatings: Cadmium.
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• Phase 2 - Material, Rig, Service Testing.
  – Special actuator.
  • KC-135 Ruddevator.
    – Been placed on hold.
    – Cyclic testing will require 200,000 cycles. Most likely on hold until a facility capable of doing cyclic testing is located.
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• Phase 2 - Material, Rig, Service Testing.
  – Service testing.
    • A 2 year service test is planned for all actuators and their similar components.
    • Example: C-130 rudder booster will be service tested concurrently with C-130 aileron and elevator actuators (based upon qualification by similarity arguments). Estimated to last two years.
    • Similar service testing planned for all other actuators.
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• Phase 2 - Material, Rig, Service Testing.
  – Service testing.
    • Drafts of C-130 and C/KC-135 Service Test Plans will be ready for Government on December 1.
    • Coordination of STPs to commence as soon as STPs are released.
    • Implementation of test plans to begin as actuators complete cyclic testing.
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• Phase 3 - Data Evaluation
  – Results of Testing will be evaluated and a solution finalized.
  • This phase has not been reached yet.
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• Phase 4 - Implementation
  – The solution developed during evaluation will be implemented.
    • This phase has not been reached yet.