# Hydraulic Actuator - Chrome Replacement

**Title/Subtitle**: Hydraulic Actuator - Chrome Replacement

**Performing Organization**: 423 SCMS/GUEA, Tinker AFB, OK, 73145

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**19a. NAME OF RESPONSIBLE PERSON**

*Standard Form 298 (Rev. 8-98) Prescribed by ANSI Std Z39-18*
History

- 423 SCMS Hydraulic Components = Wear & Corrosion Coating
- Wear & Corrosion Coating = Hexavalent Chromium
- Hexavalent Chromium = Health Hazard
- Health Hazard = Government Regulation
- Government Regulation = Increase Operating Costs
- Increased Operating Costs = Hexavalent Chromium Alternatives
- Hexavalent Chromium Alternatives = HCAHC
History cont’d

- Hard Chrome Alternatives for Hydraulic Components (HCAHC)
- 2000 through present
- Phase 1: TO and Drawing Review, Database Development, Test Requirement Development
- Phase 2: Delta-Qualification and Service Testing
- Phase 3: Data Evaluation
- Phase 4: Implementation
Current Status

- Phase 1: TO and Drawing Review, Database Development, Test Requirement Development (COMPLETE)
  - 100% Complete

- 124 Air Force technical orders reviewed
- 729 engineering drawings reviewed
- 276 chrome plated parts identified with an additional 195 potentially chrome plated parts also identified.
- All data collected was input into a Microsoft ACCESS database for collection and search purposes. Hard copy binders of this data were also retained for record.
Current Status

- Phase 2a: Delta-Qualification
  - Flight Control Actuators
    - 87 distinct part numbers
    - 10-12 estimated to require delta-qualification
  - Utility Actuators
    - 73 distinct part numbers
    - 10-12 estimated to require delta-qualification
  - Snubbers/Other
    - 12 distinct part numbers
    - 3-4 estimated to require delta-qualification
Current Status

Phase 2a: Delta-Qualification
- Flight Control Candidates
  - B-1 Horizontal Stabilizer (Complete)
  - B-1 Pitch/Roll SCAS (Complete)
  - B-1 Spoiler – L5872400 (Complete)
  - B-1 Spoiler – L5872600 (Complete)
  - B-1 Lower Rudder (Complete)
  - B-1 Aft Structural Mode Servocylinder (SMCS) (Complete)
  - B-1 Forward SMCS (Complete)
  - C-130 Rudder Booster Actuator (Complete)
  - A-10 Aileron (Complete)
  - F-15 Pitch/Roll Channel Assembly (PRCA) (Complete)
  - T-38 Aileron Actuator (Complete)
  - F-15 Aileron Rudder Interconnect (On-Going)
  - A-10 Aileron – Reconfiguration (On-Going)
  - T-38 Rudder Actuator (On-Going)
- Utility Candidates
  - C-130 Ramp Actuator (Complete)
  - C/KC-135 Main Landing Gear Actuator (Complete)
  - C/KC-135 Main Landing Gear Door Actuator (Complete)
- Snubber/Other Candidates
  - C-135 Aileron Control Surface Snubber (Complete)
  - KC-135 Ruddevator (Complete)
Current Status

- Phase 2b: Service Testing
  - C-130 and C/KC-135 aircraft stationed in varying climate conditions were chosen for service testing
  - Little Rock AFB (C-130)
    - Ramp Door Actuator
    - Aft Cargo Door Actuator
    - Rudder Booster Actuator
    - Aileron Booster Actuator
  - Delaware ANG (C-130)
    - Ramp Door Actuator
    - Aft Cargo Door Actuator
    - Rudder Booster Actuator
    - Elevator Booster Actuator
- Service Test Time ~ 12 months
Current Status

- Phase 2b: Service Testing
  - Grand Forks AFB and MacDill AFB (C/KC-135)
    - Aileron Snubber Actuator
    - Ruddevator Actuator
    - Main Landing Gear Actuator
    - Main Landing Gear Door Actuator
- Service Test Time ~ 18 months
Current Status

- **Phase 2b: Service Testing**
  - **Success Criteria**
    - Some failures occurred due to reasons unrelated to the new coating, and thus those tests were considered incomplete because they did not meet the minimum flight time requirement of the service test plan.
    - All actuators that remained on aircraft throughout the service test successfully passed.
    - The upgraded seals selected for the C130 rudder delta qualification testing failed the friction requirements of the test, but the elastomeric contact T-seals, currently used on the chrome plated configuration of the actuator were successful in all delta-qualification tests, thus the seals used for all of the C130 flight control actuators during service testing were the elastomeric T-seals. The early seal degradation noted on these seals from the service testing indicates that additional testing on upgraded sealing configurations will be required.
## Current Status

### Phase 2b: Service Testing

<table>
<thead>
<tr>
<th>C-130</th>
<th>Part Number</th>
<th>Install Location/Tail Number</th>
<th>Date installed</th>
<th>Date removed</th>
<th>Findings</th>
<th>Pass/Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ramp ID # 1</td>
<td>370750-1</td>
<td>Little Rock AFB</td>
<td>6-Jun-06</td>
<td>N/A</td>
<td>Actuator installed on aircraft deployed &gt;May 08</td>
<td>Unknown</td>
</tr>
<tr>
<td>H503021677</td>
<td></td>
<td>31037</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ramp ID # 2</td>
<td>370750-1</td>
<td>Delaware ANG</td>
<td>20-Jun-06</td>
<td>?</td>
<td>Completed test</td>
<td>Pass</td>
</tr>
<tr>
<td>R4951</td>
<td></td>
<td></td>
<td>84000209</td>
<td></td>
<td>Passed posttest ATP, Inspection revealed no damage to coating</td>
<td></td>
</tr>
<tr>
<td>Aft Cargo Door ID # 3</td>
<td>370749-1</td>
<td>Little Rock AFB</td>
<td>6-Jun-06</td>
<td>N/A</td>
<td>Actuator installed on aircraft deployed &gt;May 08</td>
<td>Unknown</td>
</tr>
<tr>
<td>H503020719</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aft Cargo Door ID # 4</td>
<td>370749-1</td>
<td>Delaware ANG</td>
<td>20-Jun-06</td>
<td>?</td>
<td>Completed test</td>
<td>Pass</td>
</tr>
<tr>
<td>H503020583</td>
<td></td>
<td></td>
<td>84000209</td>
<td></td>
<td>Passed posttest ATP, Inspection revealed no damage to coating</td>
<td></td>
</tr>
<tr>
<td>Rudder Booster ID # 5</td>
<td>5C5792-1</td>
<td>Little Rock AFB</td>
<td>6-Jun-06</td>
<td>30-Aug-07</td>
<td>Removed due to chattering during operation</td>
<td>Unknown</td>
</tr>
<tr>
<td>H503020778</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rudder Booster ID # 6</td>
<td>5C5792-1</td>
<td>Delaware ANG</td>
<td>20-Jun-06</td>
<td>17-Nov-06</td>
<td>Failure unrelated to coating</td>
<td>Incomplete*</td>
</tr>
<tr>
<td>H503020781</td>
<td></td>
<td></td>
<td>84000209</td>
<td></td>
<td>Removed due to binding when coming off hard over, Inspection revealed piston head sticking in snubber IDs, metal debris, early seal wear</td>
<td></td>
</tr>
<tr>
<td>Aileron Booster ID # 7</td>
<td>5C5791</td>
<td>Little Rock AFB</td>
<td>6-Jun-06</td>
<td>5-Feb-07</td>
<td>Failure unrelated to coating</td>
<td>Incomplete*</td>
</tr>
<tr>
<td>PRJYF55999</td>
<td></td>
<td></td>
<td>31037</td>
<td></td>
<td>Removed due to leakage, Inspection revealed crown wear on T-seal</td>
<td></td>
</tr>
<tr>
<td>Elevator Booster ID # 10</td>
<td>5C5803</td>
<td>Delaware ANG</td>
<td>26-Jun-06</td>
<td>25-Sep-07</td>
<td>Failure unrelated to coating</td>
<td>Pass*</td>
</tr>
<tr>
<td>H503020616</td>
<td></td>
<td></td>
<td>84000209</td>
<td></td>
<td>Removed due to leakage, Inspection revealed very heavy crown wear on T-seal</td>
<td></td>
</tr>
</tbody>
</table>

* Indicates the actuator successfully passed the testing requirements, but did not meet the 1 year service test schedule requirement and/or additional seal testing is necessary.
# Current Status

## Phase 2b: Service Testing

<table>
<thead>
<tr>
<th>C-135</th>
<th>Part Number</th>
<th>Install Location/ Tail Number</th>
<th>Date installed</th>
<th>Date removed</th>
<th>Findings</th>
<th>Pass/Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Snubber ID # 11</td>
<td>5-88763-10</td>
<td>Grand Forks AFB</td>
<td>14-Feb-06</td>
<td>?</td>
<td>Completed test</td>
<td>Pass</td>
</tr>
<tr>
<td>DMI-138</td>
<td></td>
<td>91502</td>
<td></td>
<td></td>
<td>Passed posttest ATP, Inspection revealed no damage to coating</td>
<td></td>
</tr>
<tr>
<td>Snubber ID # 12</td>
<td>5-88763-10</td>
<td>MacDill AFB</td>
<td>20-Mar-06</td>
<td>?</td>
<td>Reason for failure/removal unknown</td>
<td>Unknown</td>
</tr>
<tr>
<td>DMI-043</td>
<td></td>
<td>62-3548</td>
<td></td>
<td></td>
<td>Inspected aircraft at PDM, 9-26-07, snubber not there, Current whereabouts are unknown</td>
<td></td>
</tr>
<tr>
<td>Ruddevator ID # 13</td>
<td>65-6750-501</td>
<td>Grand Forks AFB</td>
<td>14-Feb-06</td>
<td>?</td>
<td>Failure unrelated to coating</td>
<td>Pass**</td>
</tr>
<tr>
<td>345</td>
<td></td>
<td>91502</td>
<td></td>
<td></td>
<td>Showed up for repair at Hill, Mar. 12, 2007, Actuator failed posttest ATP deadband test, passed all other portions of ATP</td>
<td></td>
</tr>
<tr>
<td>Ruddevator ID # 14</td>
<td>65-6750-501</td>
<td>MacDill AFB</td>
<td>20-Mar-06</td>
<td>15-Jul-07</td>
<td>Failure unrelated to coating</td>
<td>Pass</td>
</tr>
<tr>
<td>454</td>
<td></td>
<td>62-3548</td>
<td></td>
<td></td>
<td>Failed ATP due to high input force required on slide and sleeve assembly</td>
<td></td>
</tr>
<tr>
<td>MLG ID # 15</td>
<td>5-84046-6</td>
<td>Grand Forks AFB</td>
<td>14-Feb-06</td>
<td>7-Oct-06</td>
<td>Failure unrelated to coating</td>
<td>Pass*</td>
</tr>
<tr>
<td>H503020400</td>
<td></td>
<td>91502</td>
<td></td>
<td></td>
<td>Removed from aircraft due to exterior rust and missing roller bearings, actuator passed posttest ATP, Inspection revealed no damage to coating</td>
<td></td>
</tr>
<tr>
<td>MLG ID # 16</td>
<td>5-84046-6</td>
<td>MacDill AFB</td>
<td>20-Mar-06</td>
<td>24-Mar-08</td>
<td>Completed test</td>
<td>Pass</td>
</tr>
<tr>
<td>H503001000</td>
<td></td>
<td>62-3548</td>
<td></td>
<td></td>
<td>Passed posttest ATP, Inspection revealed no damage to coating</td>
<td></td>
</tr>
<tr>
<td>MLG Door ID # 17</td>
<td>5-84045-9</td>
<td>Grand Forks AFB</td>
<td>14-Feb-06</td>
<td>?</td>
<td>Current whereabouts are unknown</td>
<td>Unknown</td>
</tr>
<tr>
<td>9760</td>
<td></td>
<td>91502</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MLG Door ID # 18</td>
<td>5-84045-9</td>
<td>MacDill AFB</td>
<td>20-Mar-06</td>
<td>24-Mar-08</td>
<td>Completed test</td>
<td>Pass</td>
</tr>
<tr>
<td>1669</td>
<td></td>
<td>62-3548</td>
<td></td>
<td></td>
<td>Passed posttest ATP, Inspection revealed no damage to coating</td>
<td></td>
</tr>
</tbody>
</table>

* Indicates the actuator successfully passed the testing requirements, but did not meet the 1 year service test schedule requirement

** The removal date from aircraft will determine if the actuator met the 1 year service test schedule requirement.
Current Status

- Phase 3: Data Evaluation
  - All delta-qualification and service test data has been reviewed, analyzed, and summarized in final reports for each individual actuator.
Current Status

- Phase 4: Implementation
  - This phase has been initiated through the development and submittal of repair figures and updated seal information for technical order (TO) applications for all identified actuators.
  - Implementation strategy under discussion with AF internal Technical Review Boards (TRBs), OEMs, SPOs (e.g., configuration issues, part numbers, etc.)
Current Status - Summary

- Phase 1: TO and Drawing Review, Database Development, Test Requirement Development – COMPLETE

- Phase 2a: Delta-Qualification and Service Testing
  - 11 Flight Control Candidates Complete / 3 On-Going
  - 3 Utility Candidates Complete
  - 2 Snubber/Other Candidates Complete

- Phase 2b: Service Testing
  - 3 Flight Control Candidates Complete
  - 4 Utility Candidates Complete
  - 2 Snubber/Other Candidates Complete

- Phase 3: Data Evaluation
  - Complete on all units that have completed phase 2

- Phase 4: Implementation
  - Initiated
Future

- Build & Prioritize a plan to include:
  - Implementation of those components that have been proven
    - Provisioning
    - TO integration
    - Approve sources of overhaul / repair
  - Complete Similarity Analysis
  - Continue with Delta-Qualification (as needed)
Points of Contact

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