

R-44 Servo Exam Field Notes (CEN22LA333 / N442JE)

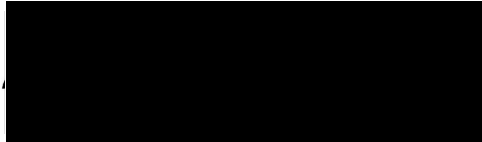
Friday, October 28, 2022

9:27 AM



Attendees:

NTSB AS40	Van McKenny Aerospace Engineer (Helicopters) Washington, DC
RHC	Thom Webster Air Safety Investigator Torrance, CA



Concurrence via email
11.2.2022

Examination Location:

Robinson Helicopter Company
Torrance, CA

Components Examined:

Aft servo	PN: D212-1 Rev F	Lot: 298	SN: 2906
Fwd Left servo	PN: D212-1 Rev F	Lot 298	SN: 2909
Fwd Right Servo	PN: D212-1 Rev F	Lot: 298	SN: 2908
Hyd pump	PN: D500-1 Rev F	Lot: 109	SN: 1077
Hyd reservoir	PN: D211-2 Rev H	Lot: 51	SN: 0975

Visual Inspection:

Aft Servo

- No apparent impact damage.
- Piston shaft is straight. No visible scoring.
- No indication of leaks on the cylinder or manifold.
- Hardware at upper & lower clevis secure. Torque strip on nut present. No indication of tool marks on hardware.
- Smooth movement of lower rod end in clevis.
- Hydraulic connections and lines attached to the manifold. The crossover line to the forward left was disconnect. Both fittings were capped.

Fwd Left Servo

- No apparent impact damage.
- Piston shaft is straight. No visible scoring.
- No indication of leaks on the cylinder or manifold.
- Hardware at upper clevis loose

- Hardware at lower clevis secure. Torque stripe on nut present. No indication of tool marks on hardware.
- Slight binding in movement of lower rod end in clevis. Movement required abnormal force. Dirt present in the area.
- Hydraulic connections and lines attached to the manifold.

Fwd Right Servo

- No apparent impact damage.
- Piston shaft is slightly bent. No visible scoring.
- No indication of leaks on the cylinder or manifold.
- Hardware at upper clevis loose
- Hardware at lower clevis secure. Torque stripe on nut present. No indication of tool marks on hardware.
- Smooth movement of lower rod end in clevis. Dirt present in the area.
- Hydraulic connections and lines attached to the manifold.

Hyd Pump

- No external damage observed.
- Hydraulic lines connected at both ends with the service caps in place. Both lines were connected to the hydraulic reservoir.
- All blocks on the teletemp are silver.
- Input drive shaft rotates when turned by hand.

Hyd Reservoir

- All 4 lines were connected. Torque strips on the return and pressure ports were broken, the other two connections torque stripes were unbroken/\..
- No external damage observed.
- Light hyd oil film on top of the reservoir. Likely leaked from breather hole.
- Red hyd fluid is visible in the sight glass.
- Hyd ON/OFF solenoid in place and undamaged.
- Hyd filter cap secure and safety wired

Manual Movement of servos and removal of hydraulic hoses:

- Manual movement of aft and fwd left servo cylinders back and forth on the piston shaft required moderate hand force (lines connected).
- Manual movement of the fwd right servo back and forth on the piston shaft required excessive hand force (Lines connected).
- Fittings were removed from all the servos, hyd pump, and hyd reservoir. Fluid collected and passed through a 190 micron filter.
 - Black particles observed from the hyd res return line and passed through a 190 micron filter. Particles did not respond to a magnet. Particles appeared to be very fine/dust like. Fluid had clear red properties.
 - Hyd reservoir pressure line was drained and the fluid passed through a 190 micron filter. Black particles were observed to come from the pressure line. Consistent with those found in the return line.
 - The reservoir fluid was drained. 2 cups of fluid collected and passed through a 190 micron filter. No particles collected.

- Reservoir to aft servo input line was removed and fluid passed through a 190 micron filter. Fluid had black particle consistent with the others.
 - Reservoir to aft return line was removed, drained, and the fluid passed through a 190 micron filter. No particles collected.
 - Transfer pressure line from aft servo to fwd right servo was drained and the fluid passed through a 190 micron filter. Black particles collected.
 - Pressure line from left servo to right servo was removed, drained, and the fluid passed through a 190 micron filter. Black particles collected.
 - Crossover return line from right to left servo drained and the fluid passed through a 190 micron filter. Black particles collected.
- Aft servo - servo manipulated by hand and internal fluid drained and fluid pass through a 190 micron filter. Black particles collected from the fluid.
 - Left servo - servo manipulated by hand and internal fluid drained and the fluid pass through a 190 micron filter . No black particles collected from the fluid. Input clevis observed to have slight binding when manipulated.
 - Right servo - servo cylinder manipulated by hand back and forth up to the bend. Piston shaft is slightly bent starting at 2 inches from the upper end. Small amount Internal fluid drained and fluid pass through a 190 micron filter. A few black particles collected from the fluid.

Hyd. Reservoir:

- Hyd reservoir filter removed. Filter cut open. No particles or debris identified visually in the filter element.
- Hyd reservoir pressure line fitting, torque stripe was broken, and fitting was finger tight.

Hyd Pump

- Connected to hydraulic test bench. Ran pump up to 2100 rpm. Output pressure was 503 psi, 1.25 gpm. (min acceptable 1.10 gpm)

Hyd Reservoir - See ATP sheet

Aft Servo functional test- See ATP sheet

- Removed servo spool for examination. Spool drive rod was not chrome hardened. Wear mark identified on drive rod guide and lever. No groove identified on drive rod guide.

Fwd Left Servo functional test - See ATP sheet

- Removed servo spool for examination. Spool drive rod was not chrome hardened. Wear mark identified on drive rod guide and lever. No groove identified on drive rod guide.
- After ATP was completed it was noted that the input rod binding that was first observed had been resolved after cleaning with solvent and cycling the input rod in and out.

Fwd Right Servo functional test - See ATP sheet.

- Removed servo spool for examination. Spool drive rod was not chrome hardened. Wear mark identified on drive rod guide and lever. No groove identified on drive rod guide.

R44 SB-109 was applicable to all 3 servos examined. The servos were disassembled to inspect the spool drive that was the main wear issued that the service bulletin addresses. Wear on all 3 servo spool drives was within normal limits and unremarkable.

REPAIR STATION

D212-1, -5, -6 SERVO ACCEPTANCE TESTS (REF. RPS-82 Rev. I)

D212- 1 Rev F S/N 2909 Lot No. 298

Servo Valve S/N _____ Test Bench # _____ Left or Right (circle one)

Perform all tests (except steps 1 and 12) with servo installed in TD212-1-1 (-1 & -6 servo) or TD212-1-2 (-5 servo) test fixture. Unless otherwise noted, pressure port connected to pressure source, return port connected to return (0 psig). "Extend" is cylinder away from valve body.

1. INPUT ARM CLEARANCE

- a. Gap between D529-1 arm and D534-1 clevis (for D212-1 & -6) or D528-1 fitting and D543-3 spacer (for D212-5) (.008 in. min., .012 in. max.) .015 inch
- b. For D212-1 & -6, verify .005 inch minimum gap 3 places between clevis and D543-1 spacers/MS20002-4 washer. P

2. PILOT INPUT

500 psi at pressure port.

- a. Input total travel (.036 in. min., .044 in. max.) RET 0.004 .040 inch
EXT 0.004
- b. Input total dead band (.005 in. min., .011 in. max.) .008 inch
- c. Input active travel in each direction (.013 in. min.)
ext. .006 inch
retr. .016 inch

3. PROOF PRESSURE, PRESSURE CIRCUIT

Pilot input centered, 2000 psi for 3-4 minutes.

Verify no leakage or damage. N/A

4. PROOF PRESSURE, RETURN CIRCUIT

600 psi at pressure port, close return port.

Move pilot input once back and forth. Hold pressure 3-4 minutes. Verify no leakage or damage. N/A

5. CYLINDER FRICTION

Close pressure port, return port open.

- a. With input and cylinder centered within one inch, gradually increase force to cylinder until cylinder moves (30 pounds max.).
ext. 17 lb.
retr. 20 lb.
- b. Verify cylinder moves full stroke both directions with 30 pounds maximum force. P

6. IRREVERSIBLE CHECK VALVE

With full pilot input, apply 50-55 pounds force to cylinder in direction opposite normal movement.
Verify cylinder does not move.

ext. P
retr. P

7. VALVE AND PISTON LEAKAGE

Drip spout at return port, 500 psi at pressure port.

- Pilot input centered, measure leakage for one minute (10 cc max.).
- At full pilot input, measure leakage for one minute (10 cc max.).

3 cc

ext. 1 cc
retr. 1 cc

8. INLET CHECK VALVE AND DIFFERENTIAL RELIEF VALVE

Pressure source to return port, pressure port open.

- 150 psi at return port, measure pressure port leakage for three minutes (10 drops max.).
- 500 psi at return port (300 psi with D774-15 spring), full pilot input. Measure force to move cylinder in direction opposite normal movement (35 pounds max.).
- Same as step (b.) except 400 psi (200 psi with D774-15 spring). Measure force to move cylinder.
- Verify force in step (c.) is 5 to 40 pounds greater than force in step (b.).

0 drops

20 lb.

23 lb.

F

9. NO LOAD PISTON SPEED

500 psi at pressure port.

Time to travel full stroke (2.80 inches) at 500 psi
(1.0 sec. max. for D212-1 & -5, .85 sec. max. for D212-6)

ext. .71 sec.
retr. .83 sec.

10. INPUT FORCE

500 psi at pressure port.

- Measure force at input rod end bolt (10 oz. max.).
- Measure force to rotate rod end (D212-1 & -6) (8 oz. max at end of rod end).

ext. 3.3 oz.
retr. 4.2 oz.

0 oz.

11. PISTON ROD SEAL LEAKAGE

500 psi at pressure port.

25 full strokes each direction with no leakage.

P

12. INPUT ARM CLEARANCE

Verify gaps measured in step 1 are still correct.

Tested By: _____ Date: _____

Inspection Stamp and Date: _____

REPAIR STATION

D212-1, -5, -6 SERVO ACCEPTANCE TESTS (REF. RPS-82 Rev. I)

D212- 1 Rev F S/N 2906 Lot No. 298

Servo Valve S/N _____ Test Bench # _____ Left or Right (circle one)

Perform all tests (except steps 1 and 12) with servo installed in TD212-1-1 (-1 & -6 servo) or TD212-1-2 (-5 servo) test fixture. Unless otherwise noted, pressure port connected to pressure source, return port connected to return (0 psig). "Extend" is cylinder away from valve body.

1. INPUT ARM CLEARANCE

- a. Gap between D529-1 arm and D534-1 clevis (for D212-1 & -6) or D528-1 fitting and D543-3 spacer (for D212-5) (.008 in. min., .012 in. max.) .08 inch
- b. For D212-1 & -6, verify .005 inch minimum gap 3 places between clevis and D543-1 spacers/MS20002-4 washer. P

2. PILOT INPUT

500 psi at pressure port.

- a. Input total travel (.036 in. min., .044 in. max.) RETRACT 0.004 .040 inch
EXT 0.005
- b. Input total dead band (.005 in. min., .011 in. max.) ~~0.009~~ inch
- c. Input active travel in each direction (.013 in. min.)
ext. .015 inch
retr. ~~0.016~~ inch
0.016

3. PROOF PRESSURE, PRESSURE CIRCUIT

Pilot input centered, 2000 psi for 3-4 minutes.

Verify no leakage or damage. N/A

4. PROOF PRESSURE, RETURN CIRCUIT

600 psi at pressure port, close return port.

Move pilot input once back and forth. Hold pressure 3-4 minutes. Verify no leakage or damage. N/A

5. CYLINDER FRICTION

Close pressure port, return port open.

- a. With input and cylinder centered within one inch, gradually increase force to cylinder until cylinder moves (30 pounds max.).
ext. 19 lb.
retr. 20 lb.
- b. Verify cylinder moves full stroke both directions with 30 pounds maximum force. P

6. IRREVERSIBLE CHECK VALVE

With full pilot input, apply 50-55 pounds force to cylinder in direction opposite normal movement.
Verify cylinder does not move.

ext. P
retr. P

7. VALVE AND PISTON LEAKAGE

Drip spout at return port, 500 psi at pressure port.

- Pilot input centered, measure leakage for one minute (10 cc max.).
- At full pilot input, measure leakage for one minute (10 cc max.).

4 cc

ext. 1 cc
retr. 1 cc

8. INLET CHECK VALVE AND DIFFERENTIAL RELIEF VALVE

Pressure source to return port, pressure port open.

- 150 psi at return port, measure pressure port leakage for three minutes (10 drops max.).
- 500 psi at return port (300 psi with D774-15 spring), full pilot input. Measure force to move cylinder in direction opposite normal movement (35 pounds max.).
- Same as step (b.) except 400 psi (200 psi with D774-15 spring). Measure force to move cylinder.
- Verify force in step (c.) is 5 to 40 pounds greater than force in step (b.).

0 drops

~~12~~ 12 lb.

~~14~~ 14 lb.

F

9. NO LOAD PISTON SPEED

500 psi at pressure port.

Time to travel full stroke (2.80 inches) at 500 psi
(1.0 sec. max. for D212-1 & -5, .85 sec. max. for D212-6)

ext. .81 sec.
retr. .77 sec.

10. INPUT FORCE

500 psi at pressure port.

- Measure force at input rod end bolt (10 oz. max.).
- Measure force to rotate rod end (D212-1 & -6) (8 oz. max at end of rod end).

ext. 4.7 oz.
retr. 50 oz.
0 oz.

11. PISTON ROD SEAL LEAKAGE

500 psi at pressure port.

25 full strokes each direction with no leakage.

0 P

12. INPUT ARM CLEARANCE

Verify gaps measured in step 1 are still correct.

Tested By: _____ Date: _____

Inspection Stamp and Date: _____

REPAIR STATION

D212-1, -5, -6 SERVO ACCEPTANCE TESTS (REF. RPS-82 Rev. I)

D212- 1 Rev F S/N 2908 Lot No. 298

Servo Valve S/N _____ Test Bench # _____ Left or Right (circle one)

Perform all tests (except steps 1 and 12) with servo installed in TD212-1-1 (-1 & -6 servo) or TD212-1-2 (-5 servo) test fixture. Unless otherwise noted, pressure port connected to pressure source, return port connected to return (0 psig). "Extend" is cylinder away from valve body.

1. INPUT ARM CLEARANCE

- a. Gap between D529-1 arm and D534-1 clevis (for D212-1 & -6) or D528-1 fitting and D543-3 spacer (for D212-5) (.008 in. min., .012 in. max.) .008 inch
- b. For D212-1 & -6, verify .005 inch minimum gap 3 places between clevis and D543-1 spacers/MS20002-4 washer. P

2. PILOT INPUT

500 psi at pressure port.

- a. Input total travel (.036 in. min., .044 in. max.) .040 inch
- b. Input total dead band (.005 in. min., .011 in. max.) .013 inch
- c. Input active travel in each direction (.013 in. min.)
- ext. .0 inch
- retr. .0 inch

3. PROOF PRESSURE, PRESSURE CIRCUIT

Pilot input centered, 2000 psi for 3-4 minutes.

Verify no leakage or damage. N/A

4. PROOF PRESSURE, RETURN CIRCUIT

600 psi at pressure port, close return port.

Move pilot input once back and forth. Hold pressure 3-4 minutes. Verify no leakage or damage. N/A

5. CYLINDER FRICTION

Close pressure port, return port open. BENT SHAFT

- a. With input and cylinder centered within one inch, gradually increase force to cylinder until cylinder moves (30 pounds max.).
- ext. F lb.
- retr. F lb.
- b. Verify cylinder moves full stroke both directions with 30 pounds maximum force. F

6. IRREVERSIBLE CHECK VALVE

With full pilot input, apply 50-55 pounds force to cylinder in direction opposite normal movement. Verify cylinder does not move.

ext. P

retr. P

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7. VALVE AND PISTON LEAKAGE

Drip spout at return port, 500 psi at pressure port.

- Pilot input centered, measure leakage for one minute (10 cc max.).
- At full pilot input, measure leakage for one minute (10 cc max.).

P cc

ext. P cc
retr. P cc

8. INLET CHECK VALVE AND DIFFERENTIAL RELIEF VALVE

Pressure source to return port, pressure port open.

- 150 psi at return port, measure pressure port leakage for three minutes (10 drops max.).
- 500 psi at return port (300 psi with D774-15 spring), full pilot input. Measure force to move cylinder in direction opposite normal movement (35 pounds max.).
- Same as step (b.) except 400 psi (200 psi with D774-15 spring). Measure force to move cylinder.
- Verify force in step (c.) is 5 to 40 pounds greater than force in step (b.).

0 drops

F lb.

F lb.

F

9. NO LOAD PISTON SPEED

500 psi at pressure port.

Time to travel full stroke (2.80 inches) at 500 psi
(1.0 sec. max. for D212-1 & -5, .85 sec. max. for D212-6)

ext. .83 sec.
retr. .91 sec.

10. INPUT FORCE

500 psi at pressure port.

- Measure force at input rod end bolt (10 oz. max.).
- Measure force to rotate rod end (D212-1 & -6)
(8 oz. max at end of rod end).

ext. 1 oz.
retr. 5 oz.

0 oz.

11. PISTON ROD SEAL LEAKAGE

500 psi at pressure port.

25 full strokes each direction with no leakage.

N/A

12. INPUT ARM CLEARANCE

Verify gaps measured in step 1 are still correct.

Tested By: _____ Date: _____

Inspection Stamp and Date: _____

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FAA CRS YV3R012M
REPAIR STATION

D211-1, -2, & -3 RESERVOIR ACCEPTANCE TESTS

A.O.G.
O.H. / REPAIRCUSTOMER SERVICE
O.H. / REPAIRSHIP-IN-HOUSE
O.H. / REPAIR

RHC

D211- _____ Rev _____ S/N _____ Lot _____ Test Bench No. _____
Left/Right

1. PROOF PRESSURE, SET PRESSURE RELIEF VALVE, AND SOLENOID TEST
Supply line to pump pressure port, return line to pump supply port, and both servo return port and servo pressure port blocked.

- a. Adjust D500-1 pump to 2100 ± 50 rpm. P
- b. Adjust regulator in reservoir to 750 ± 20 psi for 3 minutes. Verify no leakage. P
- c. Adjust regulator in reservoir to 480 ± 10 psi. 480 psi
- d. With solenoid energized, verify fluid supply pressure equals 0-10 psi. P

2. RETURN SHUT OFF VALVE AND INTERNAL LEAKAGE
Remove D486-1 housing. Hand pump to pump pressure port, servo pressure port and pump supply port blocked, and servo return port open.

- a. From 200 psi, verify 50 psi min. after 30 seconds. P
- b. Record pressure required to open return shut off valve. (120-160 psi) Opens at 160 psi
- c. Record pressure at which return shut off valve closes. (80 psi min) Closes at 80 psi

3. THERMAL RELIEF VALVE
Hand pump to servo return port.

- a. Apply 50 ± 10 psi for one minute. Verify no leakage. P
- b. Record pressure required to open thermal relief valve. (100-160 psi) Opens at 120 psi

Tested By: _____ Date: 10-28-2022

Inspection Stamp and Date: _____