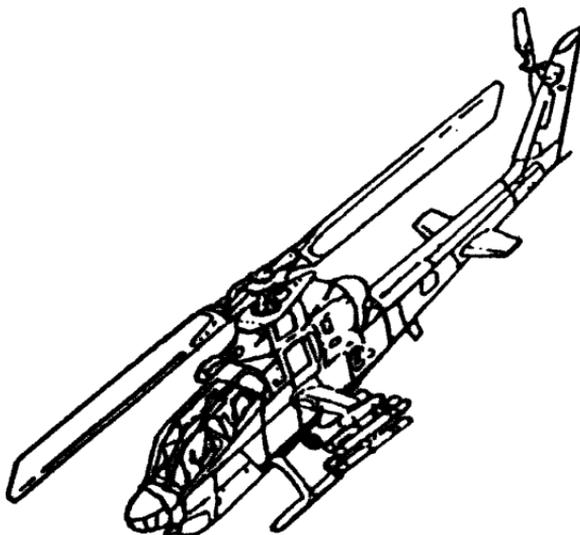


TM 1-1520-244-MTF

**MAINTENANCE TEST
FLIGHT MANUAL**

**ARMY MODEL
AH-1S HELICOPTER**



DISTRIBUTION STATEMENT A: Approved for public release; distribution is unlimited.

This manual supersedes TM 55-1520-244-MTF, 4 November 1988, including all changes

**HEADQUARTERS
DEPARTMENT OF THE ARMY
30 SEPTEMBER 1992**

WARNING

A maintenance test flight is an exceptionally demanding flight and requires a thorough flight readiness inspection (preflight). Procedures for the flight readiness inspection are prescribed in TM 55-1520-234-10 Operator's Manual and must be completed prior to the maintenance test flight. Emergency procedures are found in the-10 and/or-CL and are not duplicated in this publication. Prior to each maintenance test flight, the pilot will contact maintenance/quality control personnel to determine the maintenance that has been performed. This manual should be used only by qualified maintenance test flight pilots as required in AR 95-1.

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REPORTING ERRORS AND RECOMMENDING
IMPROVEMENTS

You can help improve this manual. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letter, DA Form 2028 (Recommended Changes to Publications and Blank Forms), or DA Form 2028-2 located in the back of the applicable Aircraft Operator's manual, (when using the 2028-2 from the Operator's manual, ensure the publication number and title reflect this MTF) directly to Commander, US Army Aviation Systems Command, ATTN: AMSAV-MC, 4300 Goodfellow Blvd., St. Louis, MO 63120-1798. A reply will be furnished to you.

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SECTION I. INTRODUCTION

1. Purpose. The purpose of this manual is to provide complete instructions for performing a maintenance test flight of the AH-1S aircraft. For the specific conditions which require a general or limited maintenance test flight, refer to TM 55-1520-234-23 and TM 55-1500-328-23.

2. Definitions.

a. Maintenance Test Flight. A functional test flight for which the primary purpose is to determine whether the airframe, powerplant, accessories and other equipment are functioning in accordance with predetermined requirements while subjected to the intended environment.

b. Warnings, Cautions, and Notes. Warnings, Cautions, and Notes are used to emphasize important critical instructions and are used for the following conditions:

WARNING

An operating procedure, practice, etc., which if not correctly followed, could result in personnel injury or loss of life.

CAUTION

An operating procedure, practice, etc., which if not strictly observed could result in damage to or destruction of equipment.

NOTE

An operating procedure, condition, etc., which it is essential to highlight.

3. General Information.

a. This manual covers maintenance test flight of the AH-1 S aircraft. For the purpose of maintenance test flights only, this manual satisfies all the requirements of the -CL from Interior Check through Engine Shutdown.

b. Crew requirements will be as specified in TM 1-1500-328-23, TM 55-1520-234-10, and AR 95-1.

c. The duration of the general or limited test flight will be in accordance with the requirements of TM 1-1520-328-23.

4. Special Instructions.

a. **Cargo and Passengers.** Cargo and passengers are prohibited on maintenance test flight.

b. **Forms and Records.** Forms and records will be checked prior to the maintenance test flight to determine what maintenance has been performed and the type of maintenance test flight required (i.e., General or Limited).

c. **Configuration.** The configuration of the aircraft should be verified prior to each maintenance test flight in order to determine performance parameters.

d. **Post Test Flight Inspection.** A thorough visual inspection will be performed to the extent necessary to assure that deficiencies or shortcomings that may have developed as a result of the test flight are detected.

e. References. When a maintenance test flight is required to assure proper operation of a specific system(s), refer to TM 55-1520-234-23 for the limits of that system.

f. Asterisked Checks. An asterisk (*) prior to a check requires that the Test Flight Check Sheet be annotated with a specific reading. Also, a check mark (√) for satisfactory performance or an (X) for problem detected, will be recorded and a short statement entered in the "remarks" block of the check sheet.

g. Maintenance Test Flight Check Sheet. The Check Sheet contained in Section V will be used for all test flights. When a test flight is performed to determine if specific equipment or systems are operating properly, completion of only that portion of the maintenance test flight Check Sheet applicable to the specific equipment or systems being tested is required. The aircraft test flight Check Sheet may be locally reproduced. Continuation sheets may be used when necessary. Items that prove to be unsatisfactory during the test flight and require corrective action, shall be listed in the remarks block during flight and transferred to DA Form 2408-13 immediately after termination of the flight. The sheet will be attached to the DA Form 2408-13 upon completion. After accumulation of two or more sheets, the data should be reviewed to determine if trends are developing.

CODE SYSTEM

B540

Bell Main Rotor Blade

O

If installed

K747

Kaman K747 Main Rotor Blades.

**SECTION II. MAINTENANCE TEST
FLIGHT CHECKLIST**

General. This section contains the requirements peculiar to the AH-1 S aircraft. Conditions requiring accomplishment of test flights shall be in accordance with TM 1-1500-328-23. The requirements contained herein are established to assure a thorough inspection of the aircraft before flight, during flight, and upon completion of the maintenance test flight. A dash between references means "through," a comma means "and." The references list the possible abnormal conditions, indications or malfunctions which could be encountered while performing the procedure.

PROCEDURE	TROUBLESHOOTING REFERENCE
PRIOR TO MAINTENANCE TEST FLIGHT	

1. Forms and records - Check for completion and accuracy.
2. Weight and balance - Compute for actual aircraft configuration.
3. Flight readiness inspection - Complete in accordance with TM 55-1520-234-10 or -CL.
4. Special pre-test flight requirements - Complete as applicable.
 - a. Armament systems - Check and safe.

PROCEDURE

**TROUBLESHOOTING
REFERENCE**

PRIOR TO MAINTENANCE TEST FLIGHT (CONT)

- b. Engine flush - Complete.
- c. FOD inspection - Complete.
- d. Engine vibration meter - Install pickups as required.
- e. Variable inlet guide vane system - Attach monitoring switches as required in TM 55-2840-229-23.
- f. Vibration analysis equipment- Install if needed.

LIGHTING SYSTEM CHECKS

NOTE

These checks should be performed prior to removing aircraft from hanger, while using external power source to preclude unnecessary drain of battery power.

- 1. Pilot light checks:
 - a. INSTR and CONSOLE LTS - Check operation of all lights and functioning of rheostats C17,C18
 - b. POSITION LTS - Check DIM and STEADY/FLASH operation. C19,C20

NOTE

Use night vision goggles to perform steps c and d.

PROCEDURE**TROUBLESHOOTING
REFERENCE**

- c. NVG POS LTS - Check ON, 5 brightness levels.

WARNING

Do not view searchlight with the naked eye. Eye damage may result.

- | | |
|---|-------|
| d. SEARCHLIGHT - Check operation of light,
SEARCH CONT and STOW. | C21 |
| e. SKID LIGHT - Check operation of light. | C21.1 |
2. Gunners light system checks:
- INSTR LTS - Check operation of all lights and functioning of rheostats.

INTERIOR CHECK (GUNNER)**CAUTION**

An open canopy is susceptible to possible damage from helicopters operating nearby.

1. Canopy hatch - Check condition, security, and operation; leave as desired for sunup.
2. Loose equipment - Check stowed and secure.
3. Fire extinguisher - Check security and presence of seal.

PROCEDURE

INTERIOR CHECK (GUNNER) (CONT)

4. Pedals - Check adjuster operation, set as required.
5. Seat belts and shoulder harness - Check condition, security, fasten and tighten.
6. Shoulder harness lock - Check proper operation.
7. Electric power switch - ELEC PWR.
8. ENG DE-ICE switch - OFF.
9. FORCED TRIM switch - TRIM.
10. INST LT rheostat - Check security; OFF.
11. Governor switch - AUTO.
12. NVG switch - OFF.
13. FIRE, MASTER CAUTION warning light NVG covers - OPEN.
14. IDLE STOP release switch - Check spring loaded OFF.
15. MISCELLANEOUS CONTROL PANEL cover - Check condition, leave as desired.
16. VENTS - Check unobstructed.

**TROUBLESHOOTING
REFERENCE**

PROCEDURE

17. STANDBY COMPASS - Check security, fluid level, current calibration.
18. EMER COLL HYD switch - OFF.
19. Wing stores jettison switch - Check off, cover down, and safetied.
20. ICS panel - Set as required.
21. VHF radio - OFF.
22. INSTRUMENTS - Check condition range - slippage marks, security, and static indications.
 - a. Torquemeter.
 - b. Dual tachometer.
 - c. Radio magnetic indicator.
 - d. Gas producer tachometer.
 - e. TGT indicator.
 - f. Airspeed indicator.
 - g. Attitude indicator.
 - h. Altimeter - Set to field elevation.
23. Mirror - Check security, cleanliness, adjust as required.

PROCEDURE

INTERIOR CHECK (GUNNER) (CONT)

24. Cockpit light - check condition, security, OFF.
25. Gunners Armament Systems - Check as follows:
 - a. HSS LINKAGE assembly - Check condition and security.
 - b. TSU left hand grip trigger cover - Closed.
 - c. Stow/Track/Acquisition switch - STOW.
 - d. TCP Mode select switch - OFF.
 - e. Ammo reserve percent counters - Set.
 - f. Turret select switch - As desired.
 - g. Compensation switch - ON.
 - h. Range switch - As desired.
 - i. HSS BIT switch - Spring-loaded off.

**TROUBLESHOOTING
REFERENCE**

PROCEDURE

- j. HSS reticle control - As desired.
- k. HSS RETICLE TEST switch - Spring loaded
- OFF.
- l. PLT OVRD switch - OFF.
- m. Wing stores select switch - OFF.
- n. TURRET DEPR LIMIT SWITCH - ON.
- o. Cyclic firing trigger-guard - Closed and does
not contact trigger.

INTERIOR CHECK (PILOT)

CAUTION

An open canopy is susceptible to possible damage from helicopters operating nearby.

1. Canopy hatch - Check condition, security, and operation; leave as desired for runup.
2. Loose equipment - Check stowed and secure.
3. Seat - Check freedom of travel, positive locking; set as required.
4. Pedals - Check adjuster operation, freedom of travel through full range; set as required. Check correlation of gunner and pilot pedals.

PROCEDURE

INTERIOR CHECK (PILOT) (CONT)

5. Seat belt and shoulder harness - Check condition, security; fasten and tighten.
6. Shoulder harness lock - Check operation; release.
7. Cyclic - Note position, firing trigger guard closed and guard does not contact trigger.

NOTE

Check all switches for condition, security, proper installation and operations.

8. Searchlight switch - OFF.
9. SKID LIGHT switch - OFF.
10. Throttle friction - OFF.
11. Collective friction - OFF: downlock removed.

NOTE

The collective may be in a position other than full down.

12. Ignition switch - ON.
13. AC/armament circuit breakers - Check condition; IN and ON (as required).
14. Smoke Grenade Arming switches - OFF.

TROUBLESHOOTING
REFERENCE

PROCEDURE

15. Battery switch - OFF.
16. Generator switch - OFF.
17. Inverter switch - OFF.
18. Non-essential buss switch - manual.
19. Engine device switch - OFF.
20. Force trim switch - TRIM.
21. Hydraulic test switch - Check
springloaded to BOTH.
22. RPM warning system switch Springloaded
On.
23. Fuel switch - OFF.
24. Engine oil bypass switch - AUTO.
25. Governor switch - AUTO.
26. Free air temperature gauge - Check
condition and security.
27. SCAS power switch - OFF.
28. ICS panel switches - As desired.
29. Instruments - Check condition, security,
range - slippage marks, and static indications.

PROCEDURE

INTERIOR CHECK (PILOT) (CONT)

- a. Dual tachometer.
- b. TGT indicator.
- c. Gas producer.
- d. Fuel pressure gauge.
- e. Engine oil temperature gauge.
- f. Transmission oil temperature gauge.
- g. Fuel quantity gauge.
- h. Transmission oil pressure gauge.
- i. Engine oil pressure gauge.
- j. Airspeed indicator.
- k. Attitude indicator.
- l. Altimeter - Set to field elevation.
- m. Pilot steering indicator - Check condition.
- n. Torque meter.

TROUBLESHOOTING
REFERENCE

PROCEDURE

- o. Turn and slip indicator - Check needle centered, fluid level.
 - p. RMI - Set to ADF position.
 - q. Vertical speed indicator - Check indication.
- 30. EMER COLL HYD switch - OFF.
 - 31. WING STORES JETTISON switch - OFF, cover down, and properly saftied.
 - 32. COMPASS SLAVING switch - MAG.
 - 33. Clock - Check wound and operational.
 - 34. Volt-ammeter - Check.
 - 35. Radar Warning Display.
 - 36. Pilot armament system check.
 - a. MASTER ARM switch - OFF.
 - b. TURRET SELECT switch - As desired.
 - c. WPN CONT switch - GUNNER.
 - d. HSS RET CONT - OFF.
 - e. HSS TEST switch - OFF (springloaded).
 - f. JETTISON SELECT switch - BOTH.

PROCEDURE

INTERIOR CHECK (PILOT) (CONT)

- g. ROCKET PAIR SELECTOR - Set to 1.
- h. WING STORE ARM switch - OFF.
- 37. FM radio - OFF.
- 38. PILOT HEAT switch - OFF.
- 39. FIRE DETECT switch - Springloaded OFF.
- 40. ECU switch - OFF.
- 41. Heat or vent knob - Check smooth operation; set as required.
- 42. Vents - Operation and freedom of travel.
- 43. IFF CODE/HOLD switch - OFF.
- 44. Defog controls - Check operation; set as required.
- 45. Reflex sight - Check condition and security; set as required.
- 46. ADF radio - OFF.
- 47. UHF radio - OFF.

TROUBLESHOOTING
REFERENCE

PROCEDURE

48. Transponder- OFF.
49. Voice security - OFF.
50. Radar warning power switch- OFF.
51. Radar warning discriminator switch -
OFF.
52. INSTR and CONSOLE LTS rheostats -
Check condition, security and OFF.
53. NVG switch - OFF.
54. Anti-collision light switch - ON.
55. Position light switches - As required.
56. DC circuit breakers - Check condition; IN
(except weapons and TOW blower).
57. Cockpit map lights - Check security - OFF.
58. Helmet sight system linkage - Check
security, cleanliness, freedom of travel; STOW.
59. FIRE, RPM LIMIT, and MASTER CAUTION
light covers - Open.

PROCEDURE

STARTING ENGINE

WARNING

Aircraft armed with rocket and/or missile ordnance must be started by battery only.

- | | |
|---|------------|
| 1. Battery switch - As required. (OFF for GPU start.) | A1,C34,C35 |
| 2. GPU - Connect as required. | A1,C36 |
| 3. Voltmeter - Check for minimum 22 volts for battery start; 28 volts for GPU start. | |
| 4. RPM warning system - Check RPM warning light illuminated, check for audible audio, audio switch OFF. | C36 |
| 5. Fire detector system - TEST. | C32,C33 |
| 6. Caution panel checks: | |

PROCEDURE	TROUBLESHOOTING REFERENCE
<p>a. Pilots caution panel - Note required caution segments illuminated; test, note all segments illuminated, MASTER CAUTION light illuminated; check proper lights illuminated on gunners panel, check gunners MASTER CAUTION light illuminated. Test dim function; reset MASTER CAUTION.</p>	<p>C16 D A11</p>
<p>b. Gunner caution panel - Note required caution segments illuminated; Test, note all caution segments illuminated; Test dim function.</p>	<p>C16 D A11</p>
<p>7. CHIP DET panel - Press to test, all light illuminate; release test, all lights extinguish; press the quadrant in, no lights illuminate; release quadrant, should return flush to panel.</p>	<p>D15</p>
<p>8. Inverter switch (GPU starts only) - MAIN, note INST INVERTER caution light extinguishes, and OFF flags disappear from gyro instruments after warm up period.</p>	<p>C3-C5</p>
<p>9. Fuel switch - ON; Note FWD FUEL BOOST and AFT FUEL BOOST caution segment lights extinguish. (Note FUEL PRESSURE if inverter is being used.)</p>	<p>B8-B12, C15</p>

PROCEDURE

STARTING ENGINE (CONT)

10. Increase/decrease switch - Decrease for 10 seconds.
11. Throttle system checks:

CAUTION

Use of excessive force may cause damage to throttle linkage or bellcranks.

- *a. Full open cushion check - Note additional cushion at full open position with slight pressure, is 5 +2 degrees; record actual indications. E40

NOTE

Ridge to ridge travel on the knurled throttle friction knob represents 10 degrees for purposes of this check.

- b. Idle stop check - Note presence of mechanical stop. C31
- c. Gunners idle stop release switch - Check operation allows throttle to be rolled below idle.
- *d. Full closed cushion check - Note additional cushion at full closed position with slight additional pressure, is 5 +2 degrees; record actual indication. E40

PROCEDURE	TROUBLESHOOTING REFERENCE
e. Freedom of travel check - Note free travel of throttle through entire range; check proper operation of throttle friction, set as desired.	E9
f. Pilots idle stop release - Check proper operation; set throttle slightly below idle stop for start.	C31
12. Rotor blades - Note displaced, clear and untied.	
13. Fireguard - Briefed and posted.	
14. Helmets and gloves - On, visors down.	
15. Intercom check - As required.	K6
16. Instruments - Check for normal prestart indications.	E7, F7
a. Engine and transmission oil temp indicates and TGT gauge approximately ambient.	
b. Master caution light extinguished.	
c. Fire light extinguished.	
d. Check for proper caution panel lights illuminated.	

TROUBLESHOOTING
REFERENCE

PROCEDURE

STARTING ENGINE (CONT)

17. Volt/ammeter - Note indications; 22 volts is minimum allowable for battery start attempt. C10,C11
18. Engine start:

CAUTION

To preclude engine hot start, abort start if less than 15 volts is indicated at 12% gas producer speed. In the event any condition necessitating shutdown becomes evident during start, corrective action must be taken immediately in accordance with TM 55-1520-234-10, Chapter 9.

- a. Start trigger - Energize and hold. A1 - A3
- b. Clock - Start.
- c. Voltage - Note initial decrease; should increase as gas producer accelerates. C1,C2
- d. Gas producer - Note normal acceleration; 15 volt minimum indicated voltage at 12% gas producer speed. A2-A4
- e. TGT - Note normal increase. A5-A7
A11,A12
- f. Ignition circuit breaker - Out at 750 degrees TGT.

PROCEDURE**TROUBLESHOOTING
REFERENCE**

- | | | |
|----|--|--------------|
| g. | Rotor blades - Note turning normally. | |
| h. | Cyclic- Center. | |
| i. | Collective - Ensure full down. | |
| j. | Engine oil pressure - Note increasing normally; ENG OIL PRESS caution segment should extinguish as pressure passes 25 psi. | D2,
E1-E5 |

NOTE

During a battery start there will be no gauge indication for torque, engine oil, or transmission oil pressure until the inverter is turned on.

- | | | |
|----|--|-------|
| k. | Transmission oil pressure - Note increasing. | F1-F5 |
|----|--|-------|

NOTE

Transmission oil pressure may indicate below minimum until last portion of start.

- | | | |
|----|--|-----------------|
| l. | Start trigger - Release at 40% N1 speed or 35 seconds; note gas producer continues normal acceleration. | A10,A12,
A13 |
| m. | Transmission oil pressure - Note pressure increasing; TRANS OIL BYPASS/XMAS OIL PRESSURE caution segments should extinguish as pressure increases past 38 psi. | F1-F5 |

PROCEDURE

STARTING ENGINE (CONT)

- n. Ignition circuit breaker - IN.
19. Generator switch - ON; note generator voltage indicated, amperage should begin decreasing after a short period of time; note DC GEN caution light segment extinguished.
 20. GPU - Disconnect as appropriate.
 21. Battery switch - ON as appropriate.
 22. Inverter switch - (Battery start only) MAIN; note INST INVERTER caution segment extinguished, and torque engine and transmission oil pressure indicator.
 - 22.1 Check for normal rise on instruments. (Battery start only).
 23. Non-essential bus switch - NORMAL.
 24. Caution panels - Note all caution segments extinguished. D A11
 25. Fire detect light - Extinguished. C32
 - *26. Throttle - Slowly advance past idle stop; then manually check stop to prevent inadvertent shutdown; record indicated gas producer speed (68 to 72%) while maintaining slight pressure against idle stop. A10, A12

TROUBLESHOOTING
REFERENCE

PROCEDURE

27. Canopy doors - As required.

ENGINE RUNUP

1. Instruments - Check normal indications; note fuel quantity and pressure gauges indicating correctly. Torque gauge for some indication.
2. Deice system check:
 - a. Pilots engine deice switch - Deice position; note 5 to 40 degree rise in TGT. E23-E25
 - b. Gunners engine deice switch - Deice position; note no change in TGT.
 - c. Pilots engine deice switch - OFF; note no change in TGT.
 - d. Gunners engine deice switch - OFF; note TGT decreases to nearly original indication.

NOTE

Any difficulty noting proper operation, recheck at 6600 N2 RPM.

3. Environmental control system check: C28-C30

PROCEDURE

TROUBLESHOOTING
REFERENCE

ENGINE RUNUP (CONT)

- a. ECU/rain removal switch - HTR; C28-C30
note TGT increase 5 to 40 degrees.
Check rheostat operation (heat and cool
settings). Set as desired. ECU/rain
removal switch - OFF; verify 5 to 40
degree TGT decrease.

NOTE

Operation of rain removal for long periods of time over a dry canopy will cause melting or deformation of forward windshield.

- b. ECU/rain removal switch - To rain removal position; verify air delivery to front windscreen. ECU/rain removal switch - OFF.

CAUTION

Oil pressure may exceed maximum on low ambient temperature starts. Do not exceed engine idle until engine oil pressure is below 100 psi. Extreme caution should be used during throttle advance. Initial throttle rigging may be improper causing the possibility of overspeed at maximum throttle settings. A maximum steady state N2 rpm of 6900 is permissible provided the TGT is below 750 degrees C. N2 rpm limit is 6700 to 6900 rpm for 10 seconds with TGT above 750 degrees C or maximum of 6900 rpm.

TROUBLESHOOTING
REFERENCE

PROCEDURE

4. Bleed band operation check - Note closing speed falls within required range of bleed band chart (figure 5-2).
 - a. Bleed air (engine deice and ECS) switches - OFF.
 - b. Ensure bleed band is open.
 - *c. Closing speed check - Smoothly advance throttle while monitoring TGT for a sudden 5 to 40 degree decrease (indicating bleed band is closed); note gas producer speed at closure. Bleed band must remain closed at all higher N1 speeds. E26
 - *d. Opening speed check - Smoothly retard throttle while monitoring TGT for sudden 5 to 40 degrees increase (indicating bleed band-opening); note and record gas producer speed at opening.
 - *e. Free air temperature - Record actual indication, add 3 degrees for inlet temperature rise. Compare actual bleed band closing speed with required range from bleed band chart.

PROCEDURE

TROUBLESHOOTING
REFERENCE

ENGINE RUNUP (CONT)

CAUTION

If bleed band closing speed does not meet required range or if any evidence of deice or bleed air malfunction becomes evident during runup, repeat bleed band check after correcting the abnormal condition.

NOTE

Certain combinations of operating conditions and/or pilot techniques may preclude detection of TGT changes as bleed band operates. In these instances a visual and/or audible confirmation of actual operation is necessary.

5. Variable inlet guide vane check:

NOTE

The begin-to-open check is a recommended starting point for adjustment of VIGVs. If the begin-to-open point, as plotted on the VIGV chart, is not within the chart limits, perform a complete VIGV check in accordance with TM 55-2840-229-23 before continuing.

- a. Brief and post observer alongside engine right side.
- b. All bleed air- OFF.
- c. Slowly increase throttle until VIGV actuator rod begins to move; note N1 speed and FAT.

PROCEDURE

TROUBLESHOOTING
REFERENCE

- d. Free air temperature - Note actual indication. Add three degrees for inlet temperature rise. Compare data with VIGV chart (figure 5-3).
 - e. Adjust as appropriate.
6. Pitot heat check - Place pitot heat switch in HTR; note slight rise in amperage then OFF; note corresponding decrease in amperage.

CAUTION

Minimize movement of the cyclic during ground runup to preclude damage to input quill and/or main driveshaft.

- | | | |
|----|---|-------------------------------------|
| 7. | Force trim system checks - Note immediate and nearly equal resistance to cyclic and pedal inputs in all directions; note momentary interrupt buttons, pilot and gunner, release all magnetic brakes and hold controls in selected positions. Check gunners force trim switch. | H20, H21
H23, H24 |
| 8. | Flight control check - Force trim switch - OFF; note all controls free; main rotor tip path plane corresponds to cyclic input; aircraft tends to move in correlation to pedal pressure; note any tendency of flight controls to creep or motor. | H1-H5,
H8-H10,
H22
H6, H11 |

PROCEDURE

TROUBLESHOOTING
REFERENCE

ENGINE RUNUP (CONT)

- *9. Cyclic friction check - Using a suitable spring scale, note cyclic begins to move at 2 +1/4 pounds breakaway force in all quadrants. H22, H23
H4

NOTE

All quadrant breakaways should be initiated from neutral cyclic position.

10. Collective friction check:
- a. Move OFF bottom (slightly).
 - *b. Minimum friction breakaway force required is 9 to 11 pounds in both directions of movement; break-away force must be equal to within 1 pound. H12-H17
G3
 - *c. Maximum friction breakaway force required is 14 to 16 pounds. With maximum friction applied, ensure gunner can move the collective.
 - d. Collective friction - Set as required.
11. Hydraulic systems check:

NOTE

The following warning applies to all operational checks that require a hydraulics system to be failed when main rotor is turning.

PROCEDURE

TROUBLESHOOTING
REFERENCEWARNING

The aircraft may become airborne following a hydraulic malfunction if immediate corrective action is not taken. Should any uncommanded control inputs be noted, the gunner must immediately reduce throttle to idle and the pilot must immediately place the hydraulic test switch to the opposite system test position, then back to both in order to regain control of the aircraft. Collective movement should be kept to a minimum to prevent inadvertant flight or yaw condition.

- a. Hydraulic test switch - Place hydraulic test switch to SYS #1 G1-G3, TEST position, note illumination of MASTER CAUTION and No. 2 HYD PRESS caution segment lights; all controls should move freely; return hydraulic test should switch to BOTH position; all caution segments be extinguised. C12, H6,H7, H15-H17, H27
- b. Hydraulic test switch - Place hydraulic test switch to SYS #2 TEST position, note illumination of MASTER CAUTION and No. 1 HYD PRESS caution segment lights; cyclic and collective should move freely, pedals should be stiff but moveable; return hydraulic test switch to BOTH position; all caution segments should be extinguised. Check pedal boost restored.

PROCEDURE

TROUBLESHOOTING
REFERENCE

ENGINE RUNUP (CONT)

12. Force trim switch - Force trim.
- *13. Minimum beep check - Smoothly increase throttle to full open. Note N2 stabilizes at 6000 ± 50 RPM; record actual indication. E18,E19

CAUTION

Do not exceed N2 operating limitations.

- *14. Maximum beep check - Slowly increase N2 to maximum noting the following: D18-D22, E16,E17, E20-E22
- a. RPM warning system - RPM light extinguishes and audio switch snaps off at 6200 ± 100 N2. Decrease slightly to assure light and audio operate at 6200 ± 100 N2 continue to increase. E36,E37
- b. Stop at 6600 - Check TGT below 75 degrees.
- c. N2 at full beep - 6700 ± 50 ; record actual indication.
- d. High RPM warning light - Note if illuminated.

PROCEDURE**TROUBLESHOOTING
REFERENCE**

*15. Linear actuator travel time check - Note D20,D18 actual time required for N2 to decrease from maximum beep, with RPM increase/decrease switch in the full decrease position. Travel time should be from 5 to 10 seconds. Record actual travel time.

NOTE

RPM light should illuminate and audio should be heard as N2 decreases below 6200 ± 100 RPM.

16. Gunner linear actuator switch - Check proper operation.

17. High RPM warning system - Check as required.

D24

NOTE

This check is required only if the high RPM light setting was not verified during the maximum beep check.

CAUTION

Throttle must be at flight idle prior to switching governor to emergency position. A maximum steady state N2 RPM of 6900 is permissible provided the TGT is below 750 degrees C. N2 RPM limit is 6700 to 6900 for 10 seconds with the TGT above 750 degrees C or a maximum of 6900.

PROCEDURE

TROUBLESHOOTING
REFERENCE

ENGINE RUNUP (CONT)

CAUTION

Because automatic acceleration, deceleration, and overspeed control are not provided with the governor switch in EMER position, throttle control movements must be smooth to prevent overspeed, overtemp, or engine failure.

- a. Throttle - Reduce to idle and note N1 speed.
- b. Pilots governor switch - Place in the EMER position; stabilize prior to N1 decreasing below 60%. Reset MASTER CAUTION.

NOTE

Normal to rapid throttle applications with N1 below 60% RPM can contribute to an engine overtemp.

- c. Throttle - Smoothly increase throttle; do not exceed N2 limits.
- d. High RPM warning light - Light should illuminate at 6800 ± 100 N2; audio should remain inactive.
- e. Throttle - Smoothly reduce to idle stop, placing pilots governor switch to AUTO after mechanical contact with idle stop and prior to excessive N1 decrease. Ensure N1 speed is stable at engine idle (68 to 72%).
- f. Throttle - Increase to 6000.

PROCEDURE**TROUBLESHOOTING
REFERENCE**

18. Increase/decrease switch - Increase to 6600 N2 RPM.
19. Tail rotor rigging check:

CAUTION

Ensure gunner is aware of hydraulic malfunction procedure since he will have control of the collective during this check. The aircraft may become airborne due to the high operating RPM.

- a. Force trim - OFF.
- b. Place hydraulic test switch to SYS #2 TEST position; note illumination of MASTER CAUTION and No. 1 HYD PRESS caution segment light. H37
- c. Relax pressure on pedals noting any tendency to creep or motor in either direction.
- d. Place hydraulic test switch to BOTH position; note all caution segments extinguished.
- e. Force trim switch - ON.

PROCEDURE

TROUBLESHOOTING
REFERENCE

ENGINE RUNUP (CONT)

20. SCAS system check:
- a. SCAS power switch - ON; note pitch, roll, and yaw NO-GO lights illuminate and remain on for approximately 10 seconds, then extinguish prior to 30 seconds. C22-C24
 - b. Engage/disengage check - Engage each channel individually while noting tip path plane for unusual deflections. Disengage SCAS using pilots SCAS release button; reengage and disengage using gunners SCAS release button. C25-C27
H38
 - c. Deflection check - Inverter Switch - OFF; Cyclic centered. H38
 - (1) Pitch channel check - Engage and hold pitch switch only; note tip path deflection; Release pitch switch; Note that tip path returns to original position.
 - (2) Roll channel check - Engage and hold roll switch only; Note tip path deflection at the 3 or 9 o'clock; release roll switch; note tip path returns to original position.
 - (3) Inverter switch - Main.

PROCEDURE	TROUBLESHOOTING REFERENCE
d. SCAS - Engage all channel switches.	H38
e. Cyclic - Center.	
f. SCAS - Engage pitch and yaw channel switches.	
21. Fuel system check:	

WARNING

Should the fuel quantity gauge not indicate the approximate amount of fuel noted during preflight (allowing for fuel burned during runup) investigate before flight.

NOTE

It is advisable to repeat this check at the completion of the test flight with minimum fuel remaining.

- | | |
|---|--------|
| *a. Forward fuel boost circuit breaker - Pulled; note illumination of MASTER CAUTION and FWD FUEL BOOST caution segment lights; reset master caution. Record fuel pressure. | |
| b. Aft fuel boost circuit breaker - Pulled; note illumination of MASTER CAUTION and AFT FUEL BOOST caution segment lights; reset master caution. | B8-B12 |
| c. Engine should continue to run for a minimum of one minute without boost pump pressure. No change in indicated N1 or N2 speed should be noticed. | E12 |

PROCEDURE

TROUBLESHOOTING
REFERENCE

ENGINE RUNUP (CONT)

- d. Fuel quantity indicator test - Press test button; note smooth operation to zero indication; release test button; fuel gauge should smoothly return to original quantity indication. B1-B7
 - *e. Forward fuel boost circuit breaker - IN; note FWD FUEL BOOST caution segment extinguishes.
 - f. Aft fuel boost circuit breaker - IN; note AFT FUEL BOOST caution segment extinguishes.
22. DC electrical systems check:
- *a. Volt/ammeter - Note generator voltage set for 27.5 ± 0.5 volts; some amperage should be indicated; record actual indications. C6-C11
 - b. Generator switch - OFF; note illumination of MASTER CAUTION, DC GEN, and AFT FUEL BOOST caution segments; volt/ammeter should indicate battery voltage and zero amperage. C14

PROCEDURE	TROUBLESHOOTING REFERENCE
c. Non-essential bus switch - MANUAL; note AFT FUEL BOOST caution segment light extinguishes; non-essential bus switch as required for flight.	C14, C15
d. Generator switch - ON; note all caution lights extinguished; volt/ammeter indicates recorded generator voltage and some amperage.	C10, C11

23. AC electrical system check:

NOTE

Any difference in indicated oil pressure is cause to check both inverters for output voltage and frequencies as at least one is incorrect.

- | | |
|--|--------|
| a. Engine oil pressure - Note indication. | |
| b. INVTR switch - OFF; note illumination of MASTER CAUTION and INSTRUMENT INVERTER caution segment, pressure instruments inoperative and gyroscopic instrument OFF FLAGS appear. | C3, C5 |
| c. Inverter SW to STBY, note all caution segments extinguished, all instruments operational. | |
| d. Engine oil pressure - Note indication same as previous. | |

PROCEDURE

TROUBLESHOOTING
REFERENCE

ENGINE RUNUP (CONT)

- | | | |
|------|---|----------------|
| e. | INVERTER switch - MAIN. | C3, C5 |
| f. | Reengage SCAS. | |
| 24. | Radio and navigation equipment - ON. | K1, K6,
B37 |
| 25. | Transponder - Standby. | |
| *26. | Instrument checks: | |
| a. | Dual tachometer - N2 set at 6600, both needles steady and joined. | B18-B24 |
| b. | Gas producer tachometer - Indicating between 84 and 88%; pilot and gunner indicators agree with $\pm 1\%$. | |

NOTE

The range of 84 to 88% applies to operations during normal temperature and pressure altitude conditions. During extreme temperature and pressure altitude conditions, the N1 may not fall within this range.

PROCEDURE	TROUBLESHOOTING REFERENCE
c. TGT gauge - Pilot and gunner indicators should agree within 20 degrees.	B25
d. Torquemeter - Pilot and gunner indicators should be nearly identical.	B16, B17, B29

NOTE

Flat pitch torque indications relate to main rotor blade angle settings and auto rotational rpm. Aircraft normally flown in high gross weight configurations may indicate as high as 18 psi. Light gross weight configurations may indicate as low as 14 psi.

e. Fuel pressure - Record.	
f. Transmission oil temperature - Record.	F6, F7
g. Engine oil temperature - Record.	E6, E7
h. Transmission oil pressure - Record.	F3-F5
i. Engine oil pressure - Record.	E3-E5
27. Radios - Check as appropriate.	B37, B33 K6, K7
28. Instrument/nav aids - Check as follows:	
a. Gyrocompass - Null annunciator in conjunction with magnetic compass indication; note RMI indicates properly.	B35, K2-K5

PROCEDURE

TROUBLESHOOTING
REFERENCE

ENGINE RUNUP (CONT)

- | | | |
|----|---|-----|
| b. | Attitude direction indicator - Check as required. | B36 |
| c. | Gunners attitude indicator - Set as required. | B36 |
| d. | Altimeters - Check; note altimeter settings within 70 feet of actual elevation. | B33 |

NOTE

Kollsman setting $\pm .07$, once the rotor is turning, compare the altimeter readings ± 70 feet is not an accurate check due to local high pressure at static port.

- | | |
|----|--|
| e. | Transponder - Check as required; set. |
| f. | Radar Warning Display (AN/APR-39) - Check as required. |
29. Clock - Set as required.
30. Armament - Set and check as required IAW TM 55-1520-234-CL.

BEFORE TAKEOFF CHECKS

1. Canopy removal arming/firing mechanism safety pins - Remove and stow.
2. RPM - 6600 RPM N2.
3. Caution and warning lights - Extinguished.
4. Instruments - Normal indications.

TROUBLESHOOTING
REFERENCE

PROCEDURE

5. Fuel quantity - Note.
6. Armament switches - As required in accordance with TM 55-1520-234-CL.
7. ECS switch - as required.
8. Deice switch - As required.
9. Force trim switch - As required.
10. HIT check- Completed.

E31, E32

NOTE

HIT check may be deferred until arrival in test flight hover area if conditions in runup area preclude accurate and/or safe completion of check. HIT check must be completed prior to takeoff.

HOVER CHECKS**WARNING**

Any binding or lack of proper control/aircraft response is cause to terminate flight immediately. Excessive control displacement requires a control rigging check or weight and balance verification.

PROCEDURE

TROUBLESHOOTING
REFERENCE

HOVER CHECKS (CONT)

- | | | |
|----|---|--|
| 1. | Takeoff to hover check - As collective is increased, note smooth power response; torque within limits; normal control response and position; normal aircraft vibrations; normal instrument response; N2 stabilizes within ± 40 RPM of flat pitch RPM. | H15, H18,
H19,H30,
H36,
G1-G2 |
| 2. | Instruments - Check normal response and indications. | |

NOTE

Observe runup area for any condition that would indicate abnormal leakage or functioning of aircraft.

- | | | |
|----|--|---------------------|
| 3. | Hover to test area - HIT check should be completed if deferred. | |
| 4. | Torque meter check - Stabilize aircraft at a five foot hover into the wind and note that torque indication is correct as predetermined from performance charts in the -10. | B12,B15,
B16,B17 |
| 5. | Pedal authority check: | |

WARNING

Improper pedal rigging may result in momentary loss of heading control.

PROCEDURE

TROUBLESHOOTING
REFERENCE

- | | | |
|----|---|---------------------------|
| a. | Place aircraft into the prevailing wind. | |
| b. | Make pedal turns 90 degrees to prevailing wind (each direction); note any lack of response or control authority; note any change in vibration levels. | H8,H9,
H11,H25,
H26 |
| c. | Compass, RMI, and turn and slip indicator should respond normally. | |
| 6. | Yaw channel response check: | H38 |

NOTE

A comparison of SCAS functioning may be made as necessary by disengaging the yaw channel switch and repeating check.

- | | | |
|----|--|------------------------------|
| a. | Face aircraft into the wind. | |
| b. | Without moving pedals, increase collective slightly; note SCAS tends to maintain nearly original heading. | |
| 7. | Sideward hover flight check - Perform sideward hovering flight in each direction noting proper response, control rigging, and remaining control authority. Hover speed should be consistent with autorotation requirements, yet be sufficient to determine aircraft response and control reaction. | H1-H3,
H6,H22,
H28,H29 |

PROCEDURE**TROUBLESHOOTING
REFERENCE**

8. Forward hovering flight check - Accelerate into translational lift; note proper aircraft response, vibration levels, and instrument response. Return to normal hovering flight.
9. Pylon mount check:

CAUTION

Should pylon rock intensify or fail to dampen out, disengage all SCAS channels.

NOTE

Generally, 4 to 5 cycles is normal; however, new mounts may result in more oscillations. Pylon rocking should not become evident in forward flight.

- a. SCAS ON - Move cyclic fore and aft as required to induce pylon rocking, stabilize cyclic, then note the number of oscillations required for rocking to subside. Note any abnormal engine responses. H40,J1

PROCEDURE	TROUBLESHOOTING REFERENCE
b. SCAS OFF - Disengage all SCAS channel switches and repeat pylon mount check. No significant variation between SCAS ON and SCAS OFF check should be evident. Land aircraft and reengage SCAS.	J1,J7
10. Engine response check - Increase collective as required to obtain a noticeable decrease in N2 RPM; without further collective movement, note the overspeed governor tends to increase N2; then abort the maneuver by a smooth reduction of collective before excessive altitude is gained.	E27,E30, E31,E37
11. Low RPM hover (Low RPM hover check is not required if vibration analysis equipment is being used.):	E17,E22, H26, H29,J2

NOTE

Be aware of reduced tail rotor efficiency and effectiveness at low RPM. Should control problems be encountered, increase N2 RPM.

- a. Slowly decrease N2 RPM using increase/decrease switch until a stable hover is achieved at 6000 N2 RPM.

PROCEDURE

TROUBLESHOOTING
REFERENCE

HOVER CHECKS (CONT)

- b. Perform 45 degree turns out of prevailing wind, noting any lack of response attributable to tail rotor pitch settings or rigging. Note any one per revolution lateral type vibrations.
 - c. Increase RPM to 6600% RPM N2. Land aircraft.
12. Emergency governor system check:

CAUTION

Because automatic acceleration, deceleration, and overspeed control are not provided with the governor switch in the emergency position, control movements must be smooth and precise to prevent overspeed, overtemp, or engine failure.

NOTE

Ambient temperatures in excess of 29 degrees C may prevent maintaining 6400 RPM during hover due to reduced fuel flow in emergency mode.

- a. Bleed air switches - OFF.
- b. Reduce throttle to engine idle; note N1 speed.

PROCEDURE	TROUBLESHOOTING REFERENCE
c. Place pilots governor switch to emergency governor position. Apply throttle as necessary to minimize N1 change. Note illumination of GOVERNOR EMERGENCY segment light and master caution. Reset master caution.	E14
d. Smoothly increase throttle to 6400 N2.	
e. Hover aircraft in emergency governor mode maintaining 6400 N2. Aircraft should be capable of 6400 N2 while maintaining a 3 foot stabilized hover. Land aircraft.	E28, E29
f. Smoothly reduce throttle to idle, placing pilots governor switch to automatic as soon as the idle stop is contacted. Note N1 stabilizes at or near previously noted N1 speed.	E15
g. With throttle at idle, have gunner place his governor switch momentarily to emergency governor position noting a decrease in N1, immediately place switch back to automatic. N1 should return to previously noted indication; all caution lights extinguished.	

PROCEDURE

TROUBLESHOOTING
REFERENCE

HOVER CHECKS (CONT)

- h. Confirm all cockpit indications are normal.
Smoothly increase throttle to 6600 N2.
13. Power cylinder check:

WARNING

Should the flight controls become abnormally stiff or jam during this check, immediately recycle hydraulic test switch to opposite system, then to both. Land aircraft and do not continue until correcting cause of abnormal condition.

This check requires a qualified pilot in the front seat, since the gunner must maintain hovering altitude of the aircraft and be prepared to cope with any possible emergency that may arise.

Cyclic inputs must be timed with aircraft responses to minimize aircraft movement.

- a. Increase hovering altitude to 10 to 15 feet;
transfer control of collective to gunner.

PROCEDURE

TROUBLESHOOTING
REFERENCE

- b. Dual system check: G1, G2
- (1) Fore and aft check - Smoothly move cyclic fore and aft through 6 to 8 inches of cyclic travel. Note smooth operation of controls and aircraft response. Stabilize aircraft.
 - (2) Lateral check - Smoothly move cyclic laterally through 6 to 8 inches of cyclic travel. Note smooth operation of controls and aircraft response. Stabilize aircraft.
- c. Hydraulic system #1 check: G1, G2
- (1) Place hydraulic test switch to System #1 Test position; note illumination of MASTER CAUTION and No. 2 HYDRAULIC PRESSURE caution segment lights. Stabilize aircraft.

PROCEDURE

TROUBLESHOOTING
REFERENCE

HOVER CHECKS (CONT)

- (2) Fore and aft check - Smoothly move cyclic fore and aft through 6 to 8 inches of cyclic travel. Note smooth operation of controls and aircraft response. Stabilize aircraft.
 - (3) Lateral check - Smoothly move cyclic laterally through 6 to 8 inches of cyclic travel. Note smooth operation of controls and aircraft response. Stabilize aircraft.
- d. Hydraulic system #2 check: G1, G2
- (1) Place hydraulic test switch to System #2 Test position; note illumination of MASTER CAUTION and No. 1 HYDRAULIC PRESSURE caution segment lights. Stabilize aircraft.
 - (2) Fore and aft check - Smoothly move cyclic fore and aft through 6 to 8 inches of cyclic travel. Note smooth operation of controls and aircraft response. Stabilize aircraft.

PROCEDURE

TROUBLESHOOTING
REFERENCE

- (3) Lateral check - Smoothly move cyclic laterally through 6 to 8 inches of cyclic travel. Note smooth operation of controls and aircraft response. Stabilize aircraft.
- e. Hyd test switch - BOTH.
14. Collective servo authority check: H42

CAUTION

Due to requirement for gunner to control aircraft during the most critical parts of this maneuver, a qualified MTFE or IP/SP is required in the gunners seat to conduct this maneuver.

Conduct this maneuver in an area that permits a run-on landing at 50 KIAS. If a collective lock-up, jam, or control limitation occurs, note indicated torque value, and return hydraulic test switch to the center (both) position and land aircraft.

NOTE

This check is required only if **K747** blades are installed. During accomplishment of this check do not exceed 50 feet AGL. The intercom system (ICS) should be in the PVT position. The rate of collective movement should not exceed a rate necessary to produce a smooth controlled ascent. The force required to increase the collective, single system, should not be greater than the force required to increase the collective during the dual system check. If up collective cannot be applied above that required to hover, land aircraft and begin the check on the ground at flat pitch, collective full down.

PROCEDURE

TROUBLESHOOTING
REFERENCE

HOVER CHECKS (CONT)

- a. Transfer controls to gunner and have him bring the aircraft to a 5- foot hover.
- b. Dual system check - Have gunner smoothly increase the collective until reaching a torque of 85%. Gunner returns aircraft to a stable 5- foot hover.
- c. Hydraulic system No. 1 check - Place hydraulic test switch to system #1 test position; note illumination of master caution and #2 hydraulic pressure caution light.
- d. Gunner smoothly raises collective control until reaching a torque of 48 psi or until a restriction is felt. Note torque value; relax pressure on controls; pilot returns hydraulic test switch to BOTH position.
- e. Gunner returns aircraft to a 5-foot hover.

PROCEDURE**TROUBLESHOOTING
REFERENCE**

- f. Hydraulic system No. 2 check - Place hydraulic test switch to system #2 test position; note illumination of master caution and #1 hydraulic pressure light.
- g. Gunner smoothly raises collective until reaching a torque of 48 psi or until a restriction is felt. Note torque value; relax pressure on controls; pilot returns hydraulic test switch to BOTH position. Return control of aircraft to pilot.

NOTE

Aircraft may be released for normal flight operations with 48 psi torque or above. Aircraft with less than 48 psi torque but more than 40 psi torque may be operated with restrictions IAW Operator's Manual. Aircraft with less than 40 psi torque may not be released for normal flight operations.

PROCEDURE

BEFORE TAKEOFF CHECK

Immediately prior to takeoff, the following checks shall be accomplished.

1. RPM - 6600.
2. Systems - Normal.
3. Armament panels - Switches set as required.
4. ECS switch - As required.
5. Transponder- As required.
- *6. Fuel quantity and time - Record.
7. Hover power check in direction of takeoff - Completed.

PROCEDURE

TROUBLESHOOTING
REFERENCE

FLIGHT CHECKS

NOTE

A normal takeoff is recommended because it provides the most desirable flight profile in the event of an actual emergency.

- | | | |
|----|---|--------------------------|
| 1. | Takeoff/climbout checks - Perform normal takeoff and climbout to initial test altitude; note proper aircraft response, vibration levels, vibration entry airspeeds, and instrument operation. | H1-H3,
H6,
H26-H29 |
| 2. | Instrument operation/correlation checks - Fly in different attitudes as necessary to check instrument operation. | |
| a. | Attitude indicators - Note nearly correct indication; indicators should agree ± 1 degree roll attitude; pitch attitude will vary with adjustment. | B36 |
| b. | Airspeed indicators - Note nearly correct indicated airspeed; indicators should agree within ± 5 knots. | B26 |
| c. | Altimeters - Note nearly correct indication; indicators should agree within ± 50 feet. | B33 |

PROCEDURE	TROUBLESHOOTING REFERENCE
d. Compasses - Note nearly correct heading; RMIs should agree within ± 1 degree and indicate nearly the same as the standby compass.	B34,B35
e. VSI/IVSI - Note nearly correct response.	B30,B27
f. Torquemeters - Indicators should be nearly identical.	
g. Dual tachometers - Indicators should be nearly identical.	B18,B19,B20, B21,B23,B24
h. TGT gauges - Should indicate nearly identical.	B25
*i. Engine oil pressure and temperature - Record.	
*j. Transmission oil pressure and temperature - Record.	
k. Fuel quantity - Note indication.	
3. Flight control rigging check - At selected test altitudes, establish 100 knots IAS at 25 psi torque.	H26,H28, H33

NOTE

A slight climb or descent may be required to maintain 100 knots IAS at 25 psi torque.

PROCEDURE

TROUBLESHOOTING
REFERENCE

FLIGHT CHECKS (CONT)

- | | | |
|----|--|---------|
| a. | Control positions - Note cyclic nearly centered; pedals neutral within $\pm 1/2$ inch. | |
| b. | Force trim check - Place force trim switch to FORCE TRIM; note force trim tends to hold aircraft attitude; force trim switch OFF. | H20-H22 |
| c. | SCAS check - Disengage all SCAS channel switches, note any abnormal aircraft attitude changes or control displacement; reengage SCAS channels. | H28 |
4. Autorotation check:

WARNING

Autorotational RPM will vary significantly with gross weight and ambient conditions. Ensure rotor RPM does not increase or decrease drastically as collective is decreased to full down; if so, abort maneuver and take corrective action prior to continuing.

PROCEDURE

TROUBLESHOOTING
REFERENCE**CAUTION**

This check should be performed at an altitude that will allow a power recovery to be completed prior to descending below 500 feet AG L. A slow, gradual throttle reduction should be used to prevent inadvertent reduction below engine idle, should the idle stop mechanism malfunction. Perform power recovery by smoothly increasing throttle to full open, (needles joined) then increase collective sufficiently to effect a positive climb.

NOTE

Maneuver is entered at 80 knots from straight and level flight. Eighty knots IAS is maintained throughout entire maneuver.

- a. Collective - Full down.
- b. Rotor RPM - Note that rotor RPM does not tend to overspeed.
- c. Throttle - Reduce to idle.
- d. Check gas producer speed - 68-72% N1.
- *e. Rotor RPM - Note: Rotor RPM in the green - record steady state RPM.
- f. Torque - Zero.
- g. Vibrations - Note any abnormal vibrations.
- h. Pedal authority - Note sufficient right pedal remains.

PROCEDURE

TROUBLESHOOTING
REFERENCE

FLIGHT CHECKS (CONT)

- i. Throttle - Smoothly increase to full open.
- j. Power recovery - Complete.

NOTE

Autorotational RPM will vary significantly with gross weight and ambient conditions. In no event should rotor RPM be set to exceed 339 RPM at max gross weight or go lower than 305 RPM at minimum gross weight.

- 5. Vibration analysis checks:

NOTE

Lateral vibrations must be corrected by balance of the rotor and hub assembly prior to further smoothing operations.

Any abnormal change in vibrations noted in the following check is attributable to trim tab effect on the rotor system. Cruise/descent and acceleration checks are not required when using vibration detection and analysis equipment.

- a. **B540** Cruise/descent check - Establish an 80 knot IAS straight and level cruise noting vibration levels. Smoothly reduce collective to 5-10 psi torque. Note any change in vibrations as collective is reduced or during descent. J3-J8
- b. Acceleration check: J3-J8

PROCEDURE

TROUBLESHOOTING
REFERENCE

NOTE

Vertical vibrations that remain nearly constant through entire speed range are due to pitch change link positioning. Vibrations that change with airspeed are normally caused by **B540** trim tab positioning or possibly weak blade condition (blade climb). **B540** In some cases, combination adjustments will be required for smoothing.

- (1) Smoothly increase airspeed, in level flight if possible, to 150 KIAS (unless vibration intensity becomes excessive).
 - (2) Note any one per revolution vibrations and their entry air speed. Two per revolution vibrations will normally increase but should not become excessive.
- c. G loading check - Perform normal dive and moderate G pullout noting any abnormal pylon rocking or excessive two per revolution type vibrations. C25, H40, J4, J6
 - d. Airframe vibrations - Note any abnormal vibrations which may be present, throughout aircraft, during the course of the previous maneuvers. J6J8, J7
6. Radio and nav aids - Check. K6, K1

PROCEDURE

TROUBLESHOOTING
REFERENCE

FLIGHT CHECKS (CONT)

7. Perform topping check:

E31,E34

NOTE

Prior to performing topping check ensure that all required maintenance checks are completed IAW TM 55-2840-229-23-1, Chapter 1.

- a. ECS/Deice switches - OFF.
- b. Pilot's altimeter - set to 29.92.
- c. Airspeed adjust to 80 ± 10 KIAS.
- d. Climb at a normal rate until approximately 1500 feet below expected topping altitude.
- e. Monitor torque, N1 and TGT throughout the maneuver to ensure no limits are exceeded.
- f. Without exceeding any engine limits ie. Max Calibrated Torque, N1, or TGT, increase collective until N2 decreases to 6400 RPM.
- g. Maintain 6400 RPM N2 with collective.
- h. At the next whole thousand foot altitude record torque, N1, TGT, and PA.

PROCEDURE

**TROUBLESHOOTING
REFERENCE**

- i. Without exceeding any engine limits further increase collective in order to decrease N2 to 6200 RPM noting N1 does not increase.

NOTE

If N1 increases as N2 decreases from 6400 to 6200 RPM the droop cam is probably worn out or out of adjustment.

- j. Reduce collective and descend to the topping altitude as recorded in step h. Fly at topping altitude for one minute and then read FAT.
- k. Reset pilot's altimeter and resume normal flight.

NOTE

The T53-L-703 engine must meet required torque derived from the power adjustment chart within the limits of minus zero to plus five per- cent. For engines not within limits refer to proper troubleshooting/adjustment procedures IAW TM 55-2840-229-229-23, Chapter 1.

This procedure may be repeated several times to ensure readings are correct.

BEFORE LANDING CHECK

1. RPM-6600.
2. Systems - Note all indications normal.

**PROCEDURE
FUGHT CHECKS (CONT)**

3. Armament systems - As required.
4. ECU/rain removal switch - As required.
5. Searchlight - As required.
6. Skid light - As required.

AFTER LANDING CHECK

1. Searchlight - As required.
2. Skid light - As required.
3. Transponder - Standby.

ENGINE SHUTDOWN CHECKS

1. Collective - Full down.
2. Cyclic - Centered.
3. Pedals - Neutral.
4. Force trim switch - FORCE TRIM.
5. ECS/deice switches - OFF.
6. Armament systems - Set in accordance with TM 55-1520-234-CL.
- *7. Engine oil pressure and temperature - Record. E3-E6
- *8. Transmission oil pressure and temperature - Record. F3-F6
- *9. Fuel quantity - Note quantity indicated and time. B1-B6

PROCEDURE

- | | |
|--|-----------------------|
| 10. Throttle - Retard to engine idle; note gas producer speed. | E9-E11 |
| 11. SCAS power switch - OFF. | |
| 12. Non-essential bus switch - Manual. | |
| 13. Avionics - OFF. | |
| 14. Battery condition check Place battery switch to OFF noting change in indicated amperage; return battery switch to ON. Less than 5 amps change indicates a fully charged battery. | |
| 15. Throttle - Close (after two minute cool down time has expired). | E39, E40,
E-38, J9 |
| 16. Fuel switch - OFF. | |
| 17. Generator switch - OFF. | |
| 18. Inverter switch - OFF. | |
| 19. Collective accumulator - Check as follows: | |
| a. Collective Note no movement with battery switch on, both emergency collective hydraulic switches off. | |
| b. Pilot emergency collective hydraulic switch ON, move collective up one full stroke; then turn switch off, note no movement possible. | |

PROCEDURE

ENGINE SHUTDOWN CHECKS (CONT)

- c. Gunner emergency collective hydraulic switch ON, move collective down one full stroke; then turn switch off, note no movement possible.
- d. Battery switch off, note two full strokes (minimum) of collective movement remain.

NOTE

After completion of four full collective strokes make only small movements of the collective to complete bleed down.

- 20. Electrical switches - OFF.
- 21. Ignition switch - OFF.
- 22. Canopy removal arming/firing mechanism safety pins - Install.
- 23. Main rotor blades - Tie down.

BEFORE LEAVING HELICOPTER

- 1. Post test flight inspection - Perform. E-8
- 2. Armament systems - Safe.
- 3. Forms and records - Complete.
- 4. Secure helicopter.
- 5. Required computations - Complete.
- 6. Maintenance personnel - Debrief.

SECTION III. TROUBLESHOOTING GUIDE.

General. This section contains troubleshooting information that has been referenced in Section II checklists. This section lists possible conditions, abnormal conditions and indications and probable causes. The information is to be used only as a quick reference and may not be all encompassing.

TROUBLESHOOTING GUIDE A - STARTING

CONDITION PROBABLE CAUSE

A1. No starter action.

- a. Circuit breaker out.
- b. Battery dead.
- c. Battery cable connector not connected.
- d. GPU polarity reversed (if used).
- e. Starter switch inoperative.
- f. Faulty starter relay.
- g. Starter failure.
- h. Wiring to starter open or shorted.
- i. Internal seizing of N1 System.

A2. No N1 indication, but starter turns.

- a. Faulty N 1 tachometer transmitter or instrument.
- b. Wiring open or shorted.
- c. Starter drive failed.
- d. N1 gearbox internal failure.

A3. Failure to start.

- a. Key off or open circuit in key system.
- b. Low input voltage to ignition unit.
- c. Faulty ignite plugs.
- d. Faulty ignition unit.
- e. Faulty coil and lead assembly.
- f. No electric power to starting fuel solenoid valve.
- g. Starting fuel nozzles clogged or damaged.
- h. Faulty starting fuel solenoid valve.
- i. Starting fuel filter or hoses clogged.
- j. Faulty fuel control.
- k. Low fuel pressure.

A4. Unable to get sufficient rpm for start.

- a. Weak battery.
- b. GPU underrated (if used).
- c. Throttle not open.
- d. Too much electrical drain on battery.
- e. Engine scavenge oil line quick disconnect loose or line clogged.
- f. Internal failure in the engine

A5. N1 hangs at about 15%, TGT holds at about 100° C.

- a. Main fuel hose clogged.
- b. Flow divider assembly inoperative.
- c. Main fuel control inlet screen installed back-wards.
- d. Faulty fuel control.
- e. Fuel supply system malfunction.
- f. Wiring to starter/generator improperly connected.

A6. Normal start except TGT rises too rapidly or exceeds limits.

- a. Wind blowing up tailpipe.

- b. TGT high when start initiated.
- c. Extremely high ambient temperature.
- d. Wrong starting procedure.
- e. Battery weak.
- f. Wrong type fuel.
- g. Air intake obstructed.
- h. Faulty fuel control scheduling.
- i. GPU - underrated (if used).
- f. Fuel control malfunction.

A7. Torching start (flames shoot from exhaust).

- a. Improper starting procedure.
- b. Accumulation of fuel inside tail pipe or combustion chamber.
- c. Start fuel purge check valve malfunction.

A8. Normal start, rotor turns but no N2 indication.

- a. Faulty tachometer instrument, transmitter or wiring.
- b. N2 gearbox internal failure.

A9. N1, TGT indication, but main rotor doesn't turn as soon as normal. No N2 indication.

- a. Main or tail rotor still tied down.
- b. Extremely cold ambient conditions.
- c. Foreign object(s) binding tail rotor drive.
- d. Transmission or gearbox failure.

A10. Start quits.

- a. Starter switch released too soon.
- b. Fuel valve shut off.
- c. Main fuel quick disconnect not connected tightly.
- d. Air in fuel control.
- e. Circuit breaker pops (starter or ignition).
- f. Starter failure (electrical or mechanical).

- g. Ignition system failure (exciter or ignite).
- h. Fuel control malfunction.
- i. Flow divider malfunction.

A11. N1, TGT indication but main rotor doesn't turn. No N2 tachometer engine indication.

- a. Engine drive shaft failed.
- b. Sprig clutch failure.
- c. Transmission failure.

A12. N1 continues to accelerate over 72%.

- a. Throttle positioned above idle.
- b. Idle stop misruled.
- c. Power level controls misruled.
- d. Fuel control malfunction.

A13. N1 speed low in idle position.

- a. Power control improperly rigged.
- b. Selector switch in EMER position.
- c. Fuel control in EMER (caution light out).
- d. Fuel flow restricted.

TROUBLESHOOTING GUIDE B-INSTRUMENTS**CONDITION****PROBABLE CAUSE**

- B1. Fuel quantity gauge won't decrease when PRESS-TO-TEST button pressed.**
- Inverter not on.
 - Press-to-test button faulty.
 - AC power failure.
 - Fuel gauge stuck.
 - Break or short in wiring.
 - Connections loose.
- B2. Fuel quantity gauge reads low.**
- Out of adjustment.
 - Tank unit capacitance high.
 - Defective indicator.
 - Compensator capacitance too high.
 - Incorrect AC voltage or frequency.
- B3. Fuel quantity gauge reads high.**
- System out of adjustment.
 - Tank unit has low capacitance.
 - Open lead on compensator circuit.
 - Compensator section of tank unit open.
 - Incorrect AC voltage or frequency.
- B4. Fuel quantity gauge remains at one point on scale.**
- No power.
 - Defective indicator.
 - Coaxial lead grounded.
 - 400 cycle lead grounded.
- B5. Fuel quantity gauge remains at zero or below.**
Open wiring.

B6. Fuel quantity gauge operation sluggish.

Low insulation resistance of the circuit.

B7. Fuel quantity gauge indicates one half to two thirds actual fuel level.

One tank capacitance unit inoperative.

B8. Low or no fuel pressure.

- a. Electric pump circuit breakers out.
- b. Pump electric circuit malfunction.
- c. Indicating system malfunction.
- d. Kinked or obstructed transmitter pressure line.

B9. Fuel pressure too high.

- a. Indicating system malfunction.
- b. Wrong pump installed.

B10. Fuel pressure erratic.

- a. Air in system.
- b. Electric pump malfunction.
- c. Serious fuel leak.
- d. Indicating system malfunction.
- e. Pump inlet restricted.
- f. Kinked or obstructed transmitter pressure line.

B11. Fuel pressure indicator sticks or does not return to zero.

- a. Defective indicator.
- b. Indicator clamped too tight in panel.

B12. No fuel pressure indication, constant or intermittent.

- a. Defective indicator.
- b. Break or grounded circuit or leads.
- c. Poor connection at indicator.
- d. Defective transmitter.

B13. No torquemeter indication after start.

- a. Faulty indicator circuit or no AC power.
- b. Restricted pressure line.
- c. Disconnected or broken pressure line.
- d. No oil in system.
- e. Faulty indicator or transmitter.
- f. Torquemeter internal system malfunction.
- g. Faulty torquemeter boost pump.
- h. N2 gearbox internal failure.
- i. No engine oil pressure.

B14. Torquemeter indication rises rapidly after start, or pegged.

- a. Open torquemeter POPPET valve.
- b. Faulty indicator or transmitter.
- c. Main drive shaft binding.
- d. Instrument clamped too tight in panel.
- e. Plugged meter and bleed valve.

B15. Torquemeter response slow.

- a. Restricted torquemeter strainer.
- b. Faulty indicator or transmitter.
- c. Too many in-line RESTRICTOR.
- d. Stuck rings in nose case.
- e. Low AC power.

B16. Low torquemeter indication.

- a. Faulty indicator or transmitter.
- b. Low torquemeter boost pressure (adjustment or malfunction).
- c. Restricted boost pump screen.
- d. Damaged torquemeter sealing ring.
- e. Abnormal density altitude.

B17. High torquemeter indication.

- a. Abnormal density altitude.

- b. Torquemeter internal system malfunction.
- c. Engine scavenger pump malfunction.
- d. Minimum rotor blade angle set too high.
- e. Aircraft weight incorrectly calculated.
- f. Torquemeter valve stuck open.

B18. N2 needles not joined.

- a. May be normal unless not jointed at operating rpm.
- b. Instrument tachometer or tachometer generator malfunction.
- c. Wrong instrument installed.

B19. N2 tachometer fluctuates, all other instruments steady.

- a. Some fluctuation (25 RPM) normal with some instruments.
- b. Instrument or tachometer generator malfunction.
- c. Wiring malfunction.

B20. Excessive tachometer error.

- a. Faulty instrument or tachometer generator.
- b. Wrong instrument or tachometer generator installed.

B21. Tachometer no indication.

- a. Leads reversed at tachometer generator.
- b. Tachometer generator shaft sheared.

B22. Tachometer indicates only half actual speed.

- a. Leads have excessive resistance.
- b. Faulty instrument or generator.

B23. Low N2 tachometer reading, either constant or intermittent.

- a. Poor connections.
- b. Indicator resistance out of adjustment.
- c. Faulty wiring.
- d. Wrong instrument installed.

- B24. High N2 tachometer reading, either constant or intermittent.**
- Indicator resistance out of adjustment.
 - Wrong instrument installed.
- B25. TGT fluctuating, all other engine instruments steady.**
- Faulty indicating system.
 - Loose connection.
 - Resistance box wiring damage.
- B26. Airspeed indicator reads incorrectly or fluctuates excessively.**
- Pitot tube restricted.
 - Line not completely connected.
 - Static port or line clogged by water or dirt.
 - Leak in line.
 - Defective indicator.
- B27. Vertical velocity indicator not zeroed (on ground).**
Mechanism shifted (adjustment off).
- B28. Vertical velocity indicator inaccurate.**
- Loose connections in static line.
 - Static port or line clogged.
- B29. Torquemeter fluctuates, all other instruments steady.**
- No in-line RESTRICTOR.
 - Indicator transmitter malfunction.
 - Instrument clamped too tightly in panels.
 - Indicator case leaks.
 - Defective indicator.
- B30. Vertical velocity indicator fluctuates excessively.**
- Loose connections in static line

- b. Leak in static line.
- c. Defective indicator.

B31. Turn and slip indicator needle erratic or inoperative.

- a. Sticking gyro.
- b. No electrical power to indicator.
- c. Loose connections.

B32. Turn and slip indicator ball too sensitive.

Dampening fluid leaked out.

B33. Altimeter reads incorrectly or fluctuates excessively.

- a. Out of adjustment.
- b. Leak in static line.
- c. Static port or line clogged by dirt or water.
- d. Defective instrument.

B34. Standby compass inaccurate, sluggish or erratic.

- a. Improper compensation (compass swing).
- b. Mounting brackets loose.
- c. External magnetic interference.
- d. Insufficient liquid.
- e. Defective instrument.

B35. Gyro compass inaccurate or erratic.

- a. Compass slaving switch in DG position.
- b. Improper adjustment of transmitter unit.
- c. External magnetic interference.
- d. Indicating system malfunction.
- e. Gyro compass control malfunction.

B36. Attitude indicator inoperative.

- a. 115V AC circuit breaker out.
- b. Faulty capacitors.

- c. 115V AC power failure.
- d. Defective indicator.
- e. Faulty wiring.
- f. Faulty aircraft attitude gyro.

B37. Radios inoperative.

- a. Circuit breaker out.
- b. Headset not plugged in completely.
- c. Improper radio switch position.
- d. ICS panel malfunction.

**TROUBLESHOOTING GUIDE C - ELECTRICAL
CONDITION****PROBABLE CAUSE**

- C1. Battery will not hold charge.**
- Demand too great.
 - Charging rate too low.
 - Electrolyte level too low.
 - Impurities in electrolyte.
 - Broken cell partitions.
 - Dirty cell tops.
- C2. Excessive loss of electrolyte.**
- Poor servicing.
 - Charging rate too high.
 - Cracked case.
 - Faulty cells or cell.
 - Essential bus voltage over 28VDC.
- C3. Main or spare inverter fails to operate.**
- Open circuit breaker.
 - Faulty switch.
 - Faulty wiring or connections.
 - Poor bonding to ground.
 - Defective inverter.
- C4. Inverter voltage output not correct.**
- Voltage set improper.
 - Low input voltage.
 - Inverter defective.
 - Power factor correction circuit breakers out.
 - Faulty voltage regulator.
- C5. AC voltage varies from time to time.**
- Faulty system component.

- b. Adjustment loose.
- c. Connection loose.
- d. Bad bearings in inverter (motorized).

C6. No generator output.

- a. Open circuit, switch, relay or generator field.
- b. No residual magnetism in field.
- c. Generator armature burned out.
- d. Generator shaft sheared.
- e. Brushes worn.
- f. Faulty field control relay.
- g. Faulty connections to voltage regulator.
- h. Faulty voltage regulator.
- i. Shorted wiring.
- j. Commutator dirty or pitted.

C7. Generator produces voltage but ammeter reads zero.

- a. Circuit breaker(s) out aft battery area.
- b. Faulty reverse current relay.
- c. Faulty ammeter or circuit.
- d. Faulty generator control relay.

C8. Generator voltage low.

- a. Regulator adjusted improperly or faulty.
- b. Generator field circuit connections faulty.
- c. Defective voltmeter.

C9. Generator voltage high.

- a. Regulator adjusted improperly.
- b. Faulty regulator.
- c. Faulty voltmeter.
- d. Faulty wiring between generator and voltmeter.

C10. Ammeter or voltmeter fluctuates rapidly under steady loads.

Faulty voltage regulator.

C11. Voltage varies excessively with changes in engine speed or electrical load.

Voltage regulator out of adjustment or defective.

C12. Hydraulic control switch ineffective.

- a. Hydraulic control circuit breaker out or faulty.
- b. Faulty switch.
- c. Faulty connections or wiring.
- d. Faulty solenoid valve.
- e. Electrical failure.

C13. No ammeter indication when pitot heat turned on.

- a. Heater inoperative.
- b. Circuit breaker out (pitot heat).
- c. Faulty switch or wiring.
- d. Ammeter malfunction.

C14. Non-essential bus remains energized with generator switch off.

Faulty non-essential bus relay.

C15. Non-essential bus not energized with switch in manual position.

- a. Faulty switch or wiring.
- b. Faulty non-essential bus relay.
- c. Faulty circuit breaker.

C16. Caution panel lights dim when they should stay bright, fail to dim or brighten.

- a. Faulty bright/dim switch.
- b. Faulty pilot's instrument light rheostat.
- c. Faulty wiring.

- C17. Interior lights fail to illuminate or brighten.**
- Faulty switch or rheostat.
 - Faulty or broken wiring.
- C18. One or several lights operate dim or intermittent.**
Faulty ground.
- C19. Navigation lights fail to operate.**
- On or more bulbs burned out.
 - Faulty switch.
 - Loose connections.
 - Poor ground.
- C20. Navigation lights fail to dim or flash.**
- Faulty dimmer resistor.
 - Faulty flasher.
 - Faulty switch.
- C21. Searchlight fails to illuminate, extend, retract.**

WARNING

Do not view searchlight with the naked eye. Eye damage may result.

- Circuit breaker open.
- Faulty switch.
- Faulty light relay.
- Broken or shorted wiring.
- Poor ground connection.
- Bulb burned out or socket corroded.
- Faulty motor, gears.

C21.1. Skid light fails to illuminate.

- a. Circuit breaker open.
- b. Faulty switch.
- c. Broken or shorted wiring.
- d. Poor ground connection.
- e. Bulb burned out or socket corroded.

C22. SCAS NO-GO lights do not illuminate.

- a. Faulty bulbs.
- b. SCAS control 28V DC circuit breaker out or faulty.
- c. SCAS power 115 VAC circuit breaker out or faulty.
- d. Power switch faulty.
- e. Faulty AC fuse in S.A.M.
- f. Faulty wiring or connections in power circuits.

C23. One or two NO-GO lights do not illuminate.

- a. Faulty bulbs.
- b. Faulty control channel assembly.
- c. Faulty sensor amplifier unit.
- d. Faulty wiring or connections.

C24. One or more NO-GO lights remain illuminated after approximately 30-second warm-up period (controls not moved).

- a. Faulty control motion transducer.
- b. Faulty servo actuator.
- c. Faulty rate gyro.
- d. Faulty pylon compensation system.
- e. Faulty or out of balance control channel assembly.
- f. Faulty sensor amplifier unit.
- g. Faulty wiring.

C25. SCAS will not engage or remain engaged.

- a. Faulty wiring or connections.
- b. Pilot or gunner emergency disengage switch faulty.
- c. Faulty control panel.

C26. Rotor tip path plane moves excessively when SCAS engaged (cyclic centered, held steady).

- a. Control channel ASSY out of balance.
- b. Faulty servo actuator.
- c. Faulty amplifier unit.
- d. Faulty transducers.

C27. SCAS will not disengage.

- a. Faulty disengage switch.
- b. Faulty or shorted wiring.

C28. No heated air from registers or insufficient amount of warm air.

- a. Rain removal switch in wrong position.
- b. Cabin heater switch inoperative.
- c. Mixing valve malfunctioning.
- d. Ducting obstructed.

C29. Insufficient air from registers.

- a. Manually operated flapper valve closed.
- b. Leaking or obstructed ducts.
- c. Malfunctioning mixing valve.

C30. ECU gives cold air only.

- a. Open wiring to temperature sensor.
- b. Open wiring to torque motor of the temperature control valve.

C31. ECU inoperative.

- a. Faulty pressure regulating and shutoff valve.
- b. Blocked or broken bleed air regulated supply line.
- c. Faulty or block one way check valve/filter.

C32. Excessive hot air from registers.

- a. Manually operated flapping valve malfunctioning.
- b. Mixing valve malfunctioning.
- c. Probe thermal switch malfunctioning in addition to above causes.

C33. Unable to go to idle cutoff.

- a. Idle stop solenoid stuck.
- b. Solenoid electrical failure.

C34. Fire warning light on, no actual fire.

- a. Moisture or foreign matter in electrical plug.
- b. Wiring frayed, chaffed, shorted, or grounded out.
- c. Fire detect relay faulty.
- d. Fire sensing wire damaged or has bend or is kinked.
- e. Faulty test button.

C35. Fire warning light inoperative.

- a. Bulbs burned out or missing.
- b. Break in circuit wiring or electrical plug disconnected.
- c. Fire detector relay faulty, not installed, or incorrectly wired.
- d. Faulty test button.

C36. Battery does not come on.

- a. Switch or switch wiring faulty.
- b. Battery relay faulty or incorrectly wired.
- c. Battery voltage low.
- d. Internal failure of battery or faulty connection.

C37. GPU does not provide current to aircraft.

- a. External power relay or wiring faulty.
- b. Polarity of GPU reversed.
- c. GPU voltage low.
- d. Diode incorrectly installed or faulty.
- e. External power plug faulty or faulty wiring.

C38. RPM warning light and/or audio inoperative.

- a. Bulbs burned out or missing.
- b. Break in circuit wiring or electrical plugs disconnected.
- c. RPM warning box faulty, disconnected, or not installed.
- d. RPM warning box not adjusted properly (did not follow published procedures).
- e. Tachometer generator faulty.

TROUBLESHOOTING GUIDE D - CAUTION PANEL**CONDITION****PROBABLE CAUSE****D1. All or many caution lights illuminated.**

- a. Moisture in electrical plug.
- b. Caution panel malfunction.

D2. ENG OIL PRESS light on.

- a. Check gauge. If pressure is up and changes with power change, trouble is faulty caution panel or pressure switch.
- b. If pressure is not correct, see E2.

D3. DC Generator caution light not on prior to engine start.

- a. Defective bus control relay.
- b. Faulty caution panel circuit.
- c. Lamp faulty.

D4. DC Generator caution light on after engine start.

- a. Faulty bus control relay (voltmeter and ammeter will have indications).
- b. Faulty reverse current relay.
- c. Faulty generator switch or circuit breaker.
- d. Faulty or maladjusted regulator.
- e. Defective generator.
- f. Faulty field control relay.
- g. Faulty caution panel.

D5. Hydraulic Pressure caution light on.

- a. Solenoid malfunction.
- b. Leakage in system.
- c. Faulty system pressure relief valve.

- d. Relief pressure set too low.
- e. Hydraulic fluid level low.
- f. Faulty pump.
- g. Faulty pressure switch or wiring.
- h. Faulty caution panel.

D6. Fuel boost caution light on.

- a. Circuit breaker out.
- b. Boost pump malfunction.
- c. Pump inlet restricted.
- d. Faulty pressure switch.
- e. Faulty fuel switch.
- f. Faulty caution panel or wiring.
- g. Fuel line clogged.

D7. Engine fuel pump caution light on.

- a. One or both sides of pump producing low pressure.
- b. One or both sides of pump failed.
- c. Faulty caution panel or wiring.
- d. Faulty pressure switch.

D8. Fuel filter caution light on.

- a. Fuel filter restricted.
- b. Faulty fuel filter pressure switch.
- c. Faulty caution panel or wiring.

D9. GOV EMER caution light on.

- a. GOV switch in EMER.
- b. Faulty caution panel.
- c. Faulty switch or wiring.

D10. XMSN OIL BYPASS light on.

- a. Oil cooler leak.
- b. Oil leak in cooler lines.
- c. Faulty caution panel or wiring.
- d. Bypass valve malfunction.

D11. XMSN OIL PRESS caution light on.

Check gauge, if pressure is up and pressure changes slightly with RPM changes, trouble is faulty caution panel, pressure switch or wiring. If pressure is not correct, see F2.

D12. XMSN OIL HOT caution light on.

- a. Check gauge. If temperature is normal, trouble is faulty caution panel or thermos switch.
- b. If gauge indicates hot, see F6.

D13. INST INVERTER caution light on.

- a. Inverter malfunction (see C4).
- b. Faulty caution panel.

D14. External Power power caution light on.

- a. GPU connected.
- b. External power door open.
- c. Micro switch out of adjustment.
- d. Faulty caution panel.

D15. Chip detector caution light on.

- a. Determine which system is showing warning.
- b. Metal chips on detector.
- c. Shorted wiring or plug.
- d. Faulty caution panel.

D16. ENG OIL BYPASS caution light on.

- a. Low oil level.
- b. Faulty float switch.
- c. Faulty bypass valve.
- d. Faulty caution panel or wiring.

- D17. Master caution panel press-to-test inoperative.**
- Faulty circuit or switch.
 - Bulbs burned out.
- D18. Low rpm warning light not on at 300 ± 5 rpm or below.**
- Circuit breaker out.
 - Bulbs burned out.
 - Light not making electrical connection.
 - Warning system malfunction.
 - Loose connections.
 - Improper adjustment of warning system.
 - Tachometer generator malfunction.
- D19. Low rpm warning light on when it should be off.**
- Improper adjustment of the warning system.
 - Internal malfunction of warning box.
- D20. Low rpm audio inoperative, warning light on.**
- Headset not plugged in completely.
 - Audio switch off.
 - Faulty audio switch.
 - Malfunction in warning system.
 - Wiring open or shorted.
- D21. Low rpm audio too weak.**
- Malfunction in warning box.
 - High resistance in wiring.
- D22. Rpm warning indications at different rpm's on different flights.**
- Adjustment potentiometer vibrating to different settings.
 - Faulty wiring.

D23. Caution panel lights dim when they should be bright, fail to dim or brighten.

- a. Faulty bright/dim switch.
- b. Faulty dimming circuit.
- c. Faulty dim resistor.
- d. Faulty pilot instrument light rheostats.

D24. Rpm warning light off when it should be on.

- a. Circuit breaker out.
- b. Improperly adjusted.
- c. Lamps burned out.
- d. Light not making electrical contact.
- e. Loose connection.
- f. Tachometer generator malfunction.
- g. Internal malfunction of warning box.

D25. Master caution light on only.

- a. Small resistance in a chip detector plug.
- b. Caution panel malfunction.

D26. Fuel 10% caution light on.

- a. Low fuel.
- b. Faulty float switch.
- c. Faulty caution panel or wiring.
- d. Faulty K-26 relay.
- e. Faulty Diode CR1 on TB17.

**TROUBLESHOOTING GUIDE E - ENGINE
CONDITION
PROBABLE CAUSE**

- E1. No engine oil pressure, caution panel light out.**
- Circuit breaker out.
 - Instrument or transmitter failure.
 - No AC power either 115V or 28V.
 - Instrument wiring shorted or open.
 - Faulty caution panel combined with actual engine oil system problem.
- E2. No engine oil pressure indication, caution panel light on.**
- Loose hose connection(s).
 - No oil in system.
 - Restriction in lines.
 - Faulty transmitting system.
 - Oil pump failure.
 - Oil pump shaft sheared.
 - Pressure relief valve not closing.
- E3. Low engine oil pressure.**
- Low oil level.
 - Faulty indicating system.
 - Oil pump inlet restricted.
 - Clogged oil filter.
 - Oil pump improperly adjusted.
 - Oil leak.
- E4. Fluctuating engine oil pressure.**
- Low oil supply.
 - Sticking pump relief valve.
 - Pump inlet restricted.

- d. Faulty indicating system.
- e. Gauge clamped too tight in panel.
- f. Air in oil system.

E5. High engine oil pressure.

- a. Faulty indicating system.
- b. Oil pump relief valve setting wrong.

E6. High engine oil temperature.

- a. Low oil supply.
- b. Oil cooler blower inoperative or bleed air restriction.
- c. Faulty or obstructed cooler.
- d. Faulty thermal relief valve.
- e. Restriction in oil system; clogged jets.
- f. Scavenge pump inoperative.
- g. Clogged oil filter.
- h. Faulty indicating system.

E7. No engine oil temperature indication.

- a. Faulty temperature bulb or connection.
- b. Faulty indicating system.
- c. Gauge to bulb wire shorted to ground.

E8. Excessive engine oil consumption.

- a. Leakage at fittings and hose assemblies.
- b. Output shaft seal damaged.
- c. No. 3 main bearing seal leaking (check for smoke from tailpipe and oil stains on rear face of power turbine disc).
- d. No. 2 main bearing forward seal leaking (check for smoke from tailpipe and oil stains on forward face of gas producer rotor and curl).
- e. No. 1 main bearing seal leaking (check for indications of oil leakage on variable inlet guide vanes, compressor bleed band holes, or mating surfaces of compressor housings).

- f. Cracked pressure or scavenge oil tubes in air diffuser (same indications as No. 2 bearing forward seal leaking).

E9. Throttle stiff or binding.

- a. Idle stop misaligned or rough.
- b. Wrong bolts installed at idle stop.
- c. Deck firewall boot rubbing control tube.
- d. Bearings dirty or worn.
- e. Fuel control arm stiff.
- f. Misalignment at base of gunner collective stick.
- g. Throttle friction on or bound up.
- h. Rod end at fuel control binding.
- i. Sector gears (base of collective) worn, broken or dirty.

E10. N1 below 68% with throttle at idle.

- a. Flight idle stop improperly positioned.
- b. Power control improperly rigged.
- c. Fuel control on emergency (switch position or wiring wrong).
- d. Wrong military trim setting on fuel control.
- e. Fuel control malfunction.
- f. Throttle linkage bellcrank or support loose or broken.
- g. Fuel flow restricted.
- h. Tachometer system malfunction.
- i. Wrong fuel.

E11. N1 speed above 72% with throttle at flight idle.

- a. Idle stop improperly positioned.
- b. Power lever controls improperly rigged.
- c. Wrong military trim setting on fuel control.
- d. Tachometer system malfunction.
- e. Wrong fuel

- E12. TGT, N1, N2, torque fluctuating.**
- Faulty overspeed governor.
 - Faulty fuel control.
 - Engine deterioration.
 - Inlet obstructed.
 - Contaminated fuel.
 - P3 airline to bleed band actuator loose or cracked.
 - Loose or leaking internal fuel cell fuel delivery line.
 - Internal lining to fuel lines breaking loose from fuel line walls.
- E13. TGT fluctuating, other instruments steady.**
- Faulty indicating system.
 - Loose connections.
 - Resistance box wiring open.
- E14. No decrease in N1 when switching to emergency.**
- Throttle position too high.
 - Solenoid malfunction.
 - Switch malfunction.
 - Fuel control misrigged.
 - Fuel control already in emergency.
 - Faulty governor control circuit breaker.
- E15. No increase in N1 when switching from emergency to automatic.**
- Solenoid stuck or faulty.
 - Switch malfunction.
 - Throttle inadvertently moved.
 - Faulty governor control circuit breaker.
- E16. Governor RPM increases when decreased, or vice versa.**
Faulty wiring (connected wrong).

E17. No change in governor rpm when INCR/DECR switch activated.

- a. Circuit breaker out.
- b. Actuator bound up.
- c. Faulty wiring.
- d. Switch failure.
- e. Actuator failure.
- f. Fuel control in emergency.
- g. N2 governor failure.

E18. Rpm too low at full open throttle and decreased linear actuator.

- a. Governor misrigged.
- b. Faulty overspeed governor.

E19. Rpm too high at full open throttle and decreased linear actuator.

- a. Governor misrigged.
- b. Faulty overspeed governor.
- c. Droop compensator misrigged.
- d. Bent control tubes.
- e. Actuator malfunction.
- f. Droop compensator shear pin sheared.

E20. Governor rpm too low at full open throttle and full rpm increase.

- a. Droop compensator shear pin sheared.
- b. Governor misrigged.
- c. Faulty overspeed governor.
- d. Engine not developing sufficient power (Inlet clogged).

E21. Governor rpm too high at full open throttle and full rpm increase.

- a. Governor misrigged.
- b. Faulty overspeed governor.
- c. Droop compensator misrigged.

E22. Excessive time for governor linear actuator to complete travel one way.

- a. Actuator binding.
- b. Actuator malfunction.
- c. N2 governor binding.
- d. Primary bus voltage low.
- e. Wiring malfunction.

E23. No increase in TGT when DE-ICE circuit breaker pulled.

- a. Power failure to valve solenoid.
- b. Faulty wiring.
- c. Engine de-ice switch in DE-ICE position.
- d. Malfunction in circuit breaker.
- e. Hot air valve stuck.
- f. Faulty temperature indicating system.

E24. No increase in TGT when engine de-ice switch in DE-ICE position.

- a. DE-ICE circuit breaker out or faulty.
- b. Faulty switch or wiring.
- c. Hot air valve stuck.
- d. Bleed air leakage.
- e. Power failure to valve solenoid.
- f. Faulty de-ice valve solenoid.
- g. Faulty temperature indicating system.

E25. No decrease in TGT when DE-ICE turned off.

- a. DE-ICE circuit breaker out.
- b. Hot air valve stuck.
- c. Switch malfunction.
- d. Power failure to valve solenoid.

E26. Bleed band opening/closing abnormal.

- a. Leaks or obstructions in hoses or fittings.
- b. Adjustment not correct.
- c. Clogged strainer in actuator valve.
- d. Actuator piston sticking.
- e. Fuel control airbleed valve dirty, sticking.
- f. Faulty fuel control.

E27. Engine surge (compressor stall) during acceleration, fluctuating instruments, high TGT.

- a. Air inlet dirty.
- b. Compressor dirty.
- c. Bleed band maladjusted or malfunctioning.
- d. Engine deterioration.
- e. Improper inlet guide vane operation.
- f. Fuel control in emergency mode.
- g. Damaged P3 fitting on air diffuser.
- h. Faulty de-ice valve.
- i. Faulty fuel control.

E28. Unable to attain hover power on emergency fuel control.

- a. Fuel control maladjusted.
- b. Throttle rigging.
- c. Faulty fuel control.
- d. FAT above 290C.

E29. Engine surges (compressor stall) during operation on emergency fuel.

- a. Throttle movements too rapid.
- b. Engine deterioration.
- c. Air inlet dirty.
- d. Faulty fuel control.
- e. (One or two "pop" stalls on switchover to emergency or back to automatic is normal on some engines. If more than two "pops" occur accompanied by TGT rise, see also E27).

E30. Excessive overshooting of rpm or hunting by engine during collective application.

- a. Droop compensator rigging.
- b. Governor malfunction.
- c. Collective/N2 shear pin sheared.

E31. TGT abnormally low for power indicated.

- a. Faulty indicating system.
- b. Not actually developing power indicated.

E32. TGT abnormally high during steady state operations.

- a. Engine inlet dirty.
- b. Air screen clogged.
- c. De-ice valve open.
- d. Combustion chamber drain open.
- e. Faulty bleed band.
- f. Inlet guide vanes malfunctioning.
- g. Engine deterioration.
- h. Dirty or damaged compressor.
- i. Bleed air leakage.
- j. Starting fuel valve fails to shut off.
- k. Faulty indicating system.
- l. Damaged gas producer nozzles.
- m. Damaged or broken sealing rings.
- n. Faulty fuel control.
- o. Fuel control military trim screw adjustment too high.

E33. N1 speed lower than computed at maximum throttle (more than 1.0%).

- a. Computation error.
- b. Engine de-ice on if engine is TGT limited.
- c. Fuel control in emergency.
- d. Droop compensator misrigged.
- e. Throttle misrigged.
- f. Fuel flow restricted.
- g. Air loss from engine if engine is TGT limited.
- h. Engine deterioration.
- i. Faulty tachometer system.
- j. Faulty fuel control.

E34. N1 speed higher than computed at maximum throttle (by more than 1.0%).

- a. Computation error.
- b. Fuel control adjustment.
- c. Faulty tachometer system.
- d. Faulty fuel control.

E35. Low N2 speed.

- a. Governor arm travel restricted.
- b. Faulty overspeed governor.

E36. Excessive droop of N2 speed.

- a. Droop compensator out of adjustment.
- b. Throttle not fully open.
- c. Low N1 speed.

E37. N2 overspeed.

- a. Selector switch in emergency.
- b. Faulty overspeed governor.

E38. Engine fails to shutdown.

- a. Faulty or out of rig N1 throttle linkage.
- b. Faulty fuel control.

E39. Engine coast down noisy or time too short.

Internal engine binding.

E40. Too much or too little throttle cushion.

- a. Incorrect throttle rigging.
- b. Throttle linkage bellcrank or support loose or broken.

**TROUBLESHOOTING GUIDE F -
TRANSMISSION
CONDITION
PROBABLE CAUSE**

- F1. No transmission oil pressure indication, caution light out.**
- Circuit breaker out.
 - Instrument or transmitter failure.
 - No AC power (either 115V or 28V). (Will also have no engine oil pressure indication.)
 - Instrument wiring open or shorted.
 - Faulty control panel combined with actual oil system problem.
- F2. No transmission oil pressure indication, caution light on.**
- Loose hose connections.
 - No oil in system or quick disconnect loose.
 - Pressure relief valve malfunction.
 - Pump inlet screen clogged.
 - Faulty oil pump.
 - Oil leak.
- F3. Low transmission oil pressure.**
- Pressure relief valve adjustment or malfunction.
 - Restricted pump inlet screen.
 - Faulty oil pump.
 - Leakage or restriction between pressure relief valve and transmitter.
 - Faulty indicating system.

- F4. Fluctuating transmission oil pressure.**
- Faulty indicating system, gauge or transmitter.
 - Instrument clamped too tightly in panel.
 - Sticking pressure relief valve.
 - Restricted pump inlet screen.
 - Low oil level.
- F5. High transmission oil pressure.**
- Faulty indicating system.
 - Pressure relief valve malfunction or set wrong.
 - Clogged jets.
- F6. High transmission oil temperature on gauge and caution panel.**
- Faulty oil jets.
 - Seized bearings or other internal transmission failure.
 - Oil cooler obstructed.
 - Oil cooler bypass valve malfunction.
 - Oil cooler bypass due to leak in cooler lines.
 - Oil cooler thermostatic valve malfunction.
 - Oil cooler blower malfunction.
 - Faulty indicating system.
 - Wrong orifice in oil cooler blower.
 - Open circuit in wiring.
- F7. No transmission oil temperature indication.**
- Faulty temperature bulb or connection.
 - Faulty indicating system.
 - Wire grounded.

TROUBLESHOOTING GUIDE G -HYDRAULICS**CONDITION****PROBABLE CAUSE****G1. Excessive feedback in controls.**

- a. Air in hydraulic system.
- b. Servo control head bolts too tight.
- c. Internal leakage in power cylinder.
- d. Power cylinder assembly faulty.
- e. Hydraulic pump faulty.

G2. Cyclic gets hard to move with feedback.

- a. Faulty servo pilot valve.
- b. Faulty hydraulic pump.
- c. Low hydraulic pressure.
- d. Faulty check valve.
- e. Restriction in pump inlet.
- f. Low fluid level.

G3. Collective comes up easier than it goes down or vice versa.

- a. Balance spring on servo pilot valve out of adjustment.
- b. Balance spring on servo pilot valve missing.

G4. Collective moves freely with emergency accumulator switches off and battery on.

- a. Faulty switch or switches.
- b. Faulty emergency solenoid.
- c. Check valve installed backwards.
- d. Friction collet loose.

TROUBLESHOOTING GUIDE H - FLIGHT CONTROLS**CONDITION****PROBABLE CAUSE****H1. Controls do not operate smoothly.**

- a. Servo valve sticking.
- b. Bearings dirty or worn.
- c. Bent or binding control tubes.
- d. Misaligned power cylinders.
- e. Relief valve malfunction.
- f. Servo control head bolts too tight.
- g. Worn servo valves.
- h. Hydraulic pump malfunction.
- i. Magnetic brake draggings.

H2. Cyclic chatters when being moved.

- a. Air in hydraulic cylinder.
- b. Power cylinder mount uniball adjustment loose.
- c. Misaligned power cylinders.
- d. Power cylinder mounting loose.
- e. System pressure low.

H3. Cyclic binding in certain areas with force trim off.

- a. Hydraulic lines restricting movement.
- b. Wiring harness binding in base of cyclic stick.
- c. Foreign matter in base of cyclic stick.
- d. Foreign matter under deck (ice).
- e. Bearings worn or dirty.
- f. Rough spots in friction device.
- g. Magnetic brake draggings.

H4. Cyclic binding in certain areas with force trim on.

- a. Force gradient draggings.
- b. Force gradient improperly rigged.

- c. Wrong force gradient installed.

H5. Cyclic built-in friction too low or too high.

- a. Improperly adjusted.
- b. Foreign matter in base of cyclic stick.
- c. Wiring harness binding in base of cyclic stick.
- d. Bearings worn or dirty.
- e. Magnetic brake unit stiff (dragging).
- f. Frictioning device wet.
- g. Cycle balance springs out of adjustment.

H6. With force trim off, cyclic continues to move after small force applied or moves without force application.

- a. Power cylinder control head bolts binding.
- b. Collective pilot valve spring installed on cyclic cylinder(s).
- c. Pilot valve centering spring missing or maladjusted.
- d. Improperly rigged force gradient.
- e. Rough bearings in linkage aft of SCAS actuator.
- f. Hydraulic cylinder malfunction.

H7. Feedback in controls.

- a. Low or no cyclic friction (SCAS on).
- b. Servo control head bolts too tight.
- c. Air in hydraulic system.
- d. Internal leakage in servo valve.
- e. Power cylinder assembly malfunction.

H8. Feedback in controls with either hydraulic system off.

- a. Control head bolts too tight.
- b. Pilot valve malfunction.
- c. Pump malfunction.
- d. Low hydraulic pressure.
- e. Tail rotor cylinder malfunction.
- f. Check valve malfunction.

H9. Pedals chatter when being moved.

- a. Air in hydraulic system.
- b. Power cylinder mounting bearings loose or binding.
- c. Cylinder Misaligned.
- d. Servo support assembly and/or mounting surface distorted.

H10. Pedals binding with force trim off.

- a. Binding controls.
- b. Worn or dirty pedal adjuster assembly.
- c. Magnetic brake dragging.

H11. With force trim off, one or the other pedal creeps forward.

- a. Hydraulic cylinder lines putting force on cylinder.
- b. Hydraulic cylinder malfunction.
- c. Power cylinder Misaligned.
- d. Servo support assembly and/or mounting surface distorted.

H12. Excessive play in pedals.

- a. Worn pitch change mechanism.
- b. Worn tube rod ends.

H13. Adjustable friction device will not increase friction on pilot collective.

- a. Friction knob jammed.
- b. Threads dirty.
- c. Malfunction in base of collective stick.

H14. Collective built-in friction too light or too heavy.

- a. Improper adjustment in base of collective.
- b. Droop compensator.
- c. Malfunction in base of collective.
- d. On abnormally damp days friction may be more than normal. Friction adjusted on damp days may be too heavy for dry days.
- e. Friction collet adjustment.
- f. Grease on friction collective.

- H15. Collective pitch maximum adjustable friction too high, friction full on.**
- Not adjusted properly at base of collective.
 - Malfunction at base of collective.
- H16. Unable to get collective up sufficiently.**
- Controls fouled.
 - Top side N2 governor stop misadjusted.
 - Control rigging.
 - Hydraulic cylinder malfunction.
- H17. Collective binds.**
- Friction device worn.
 - Droop compensator sticking or pin sheared.
 - Power cylinder malfunction.
- H18. Collective comes up easier than it goes down or vice versa.**
- Balance springs adjustment.
 - Balance springs missing.
- H19. N2 increases more than 40 rpm when collective raised.**
- Droop compensator adjustment.
 - Wrong droop cam installed.
- H20. N2 droops off more than 40 rpm when collective raised. (Not to be confused with transient droop.)**
- Droop compensator adjustment.
 - Wrong droop cam installed.
 - Droop compensator linkage sheared.
 - Fuel control on emergency.
 - Throttle not fully open.
 - Droop linkage out of rig.
 - Throttle out of rig.
 - Excessive play in linkage.
 - Engine not developing sufficient power. (Inlet clogged.)

H21. Force trim weak.

- a. Magnetic brake not holding.
- b. Wrong gradient spring assembly installed.
- c. Spring tension adjustment.
- d. Improperly rigged.

H22. Force trim stiff.

- a. Wrong gradient spring assembly installed.
- b. Spring tension adjustment.

H23. Excessive friction on cyclic with force trim off.

- a. Built-in friction too high.
- b. Foreign matter in base of cyclic.
- c. Wiring harness binding in base of cyclic.
- d. Magnetic brake unit stiff.
- e. Bearings dirty or worn.

H24. Force trim holds in some positions with switch off.

- a. Rough spots in magnetic brake travel.
- b. Improperly rigged.
- c. Magnetic brakes not completely releasing.
- d. Residual magnetism in magnetic brake.

H25. Force trim inoperative.

- a. Faulty switches.
- b. Open circuit breaker.
- c. Faulty magnetic breaker.
- d. Arm disconnected.
- e. Open or shorted wiring.

H26. Insufficient pedal travel or pedal position abnormal for flight condition.

- a. Tail rotor rigging.
- b. Fouled control tubes or control components.
- c. SCAS actuator fully extended in one direction(hardover).

H27. Unable to get normal cyclic travel.

- a. Rigging error.
- b. Force trim misrigged.
- c. Fouled controls.
- d. Control components improperly installed.

H28. Cyclic position abnormal for flight condition.

- a. Rigging error, swashplate or elevator.
- b. CG not as computed.
- c. Airspeed indicator malfunction.
- d. SCAS actuator fully extended in one direction(hardover).

H29. Rotor response to cyclic inputs slow or inconsistent.

- a. Power cylinder leaking.
- b. Rigging off.
- c. Faulty hydraulic pump.
- d. Faulty relief valve.

H30. Cyclic not centered in stable hover.

- a. Fore and aft CG off center.
- b. Lateral CG off center.
- c. Cyclic rigging.
- d. SCAS actuator fully extended in one direction(hardover).

H31. Autorotation rpm too high or too low.

- a. Gross weight different than computed.
- b. Minimum blade angle set incorrect.
- c. Airspeed not held steady.
- d. Abnormal density altitude.

H32. Tip path appears wider than normal.

Blades out of track (if more than 6 or 8 inches, do not fly helicopter.

H33. Tailboom intermittently kicks left or right in normal flight.

- a. Tail rotor pitch change rod bearings worn excessively.
- b. Tail rotor crosshead loose.

H34. Less than four full strokes available on emergency hydraulics after shutdown.

- a. High or low nitrogen charge.
- b. Collective lockout valve closing at lower than normal hydraulic pressure.
- c. Faulty collective lockout valve.
- d. Switch malfunction.
- e. Solenoid malfunction.
- f. Emergency solenoid valve not fully closing.
- g. Collective lockout valve check valve not fully closing.
- h. Internal leakage in collective power unit.
- i. Accumulator drain line left connected and valve leaking.
- j. Accumulator valve or fittings leaking.
- k. Accumulator leaking internally.
- l. Friction collet adjusted too tight.
- m. Feather bearings binding.

- H35. After shutdown, collective moves freely with battery switch on, emergency hydraulic switch off.**
- Circuit breaker out.
 - Switch malfunction.
 - Solenoid valve malfunction.
 - Friction collet loose.
- H36. Accumulator gauge not in green with system bled off.**
- Improper servicing.
 - Faulty gauge.
 - Accumulator valve or fittings leaking.
 - Accumulator leaking internally.
- H37. Tail rotor pedals creep or motor with NO. 1 SCAS HYD off line.**
Improper tail-rotor rigging.
- H38. No evidence of SCAS correction for small control inputs.**
- Faulty SCAS actuator.
 - Faulty control motion transducer.
 - Faulty amplifier unit.
 - Pitch and roll actuator electrical plug reversed.
 - SCAS solenoid valve not receiving power.
- H39. Aircraft unstable at hover (SCAS ON).**
- Cyclic friction too low.
 - Inverter voltage to SCAS rate gyros low.
 - Faulty pylon transducer.
 - Faulty rate gyros.
 - Faulty amplifier unit.
 - Amplifier unit base bolts loose.
 - Faulty control motion transducer.
 - Faulty actuator.
 - Faulty pylon compensator unit.

H40. Excessive pylon oscillation with SCAS engaged.

- a. Faulty pylon compensator unit.
- b. Faulty pylon transducers.
- c. Faulty wiring.

H41. SCAS induces hardovers.

- a. Faulty sensor amplifier unit.
- b. Broken wires.
- c. Faulty control motion transducer.
- d. Faulty pylon compensator.
- e. Faulty pylon transducer.

H42. Insufficient Collective Authority.

- a. Perform power cylinder check and troubleshoot accordingly.
- b. Verify rotor blade to hub alignment (scope blades).
- c. Check friction adjustment and friction collet.
- d. Verify droop cam and linkage are not binding.
- e. Trouble-shoot hydraulic system if this phenomenon is more pronounced in one system.
- f. Check hydraulic system operating pressure.
- g. Check main rotor feather bearings for sticking or binding.
- h. Change rotor blades.
- i. Test Fly to verify if the problem is corrected prior to release for normal flight operations.

TROUBLESHOOTING GUIDE I - NOT APPLICABLE

TROUBLESHOOTING GUIDE J - VIBRATIONS

CONDITION

PROBABLE CAUSE

J1. Pylon rocking continues abnormally or is present in forward flight.

- a. Faulty transmission mount dampers.
- b. Wrong dampers installed.
- c. Pylon mounts worn.
- d. Defective fifth mount.
- e. Mount bolts bottomed, loose or stripped.
- f. Lift link loose.

J2. 1/Rev vibration at hover.

- a. Blade balance.
- b. Severe out of track.
- c. Excessively worn dynamic components.

J3. 1/Rev vertical in forward flight.

- a. Blade out of track.
- b. Pitch change rod end bearings worn.
- c. Grip bearings sticking.
- d. Servo uniball torque incorrect.
- e. Scissors bearings or bushings.
- f. Trunnion bearings.
- g. Undertorqued trunnion cap bolts.
- h. Loose power cylinder mounting.

J4. 1/Rev vibration, intermittent.

- a. Collective friction collet assembly loose or broken.
- b. Collective sleeve bearings worn.
- c. Collective lever pivot bearings worn.
- d. Collective lever idler pivot bearings worn.
- e. Anti-drive link worn.
- f. Swashplate uniball preload incorrect.
- g. Internal wear or damage in main rotor hub assembly.
- h. Blade out of track.
- i. Excessive tab differential.

J5. 2/3 (0.666) per rev intermittent vibration (resembles a lateral but slower than 1/rev and faster than pylon rock).

- a. Trunnion bearings worn or dirty.
- b. Loose trunnion.

J6. Excessive 2/Rev vibration.

- a. Pylon mounts deteriorated.
- b. Loose, worn or improperly shimmed drag braces.
- c. Rod end bearings worn.
- d. Excessive play in swashplate assembly.
- e. Loose power cylinder mount.
- f. Lift link bushing worn.
- g. Undertorque trunnion cap bolts.
- h. Trunnion cap bearings binding.

J7. Medium frequency vibration felt in airframe.

- a. Cross tubes loose.
- b. Radio or electronic gear loose.
- c. Unstowed loose equipment.
- d. Excessive elevator play.
- e. Airframe component loose.
- f. Wing stores installation.

J8. Excessive high frequency vibration.

- a. Tail rotor out of track.
- b. Tail rotor out of balance.
- c. Tail rotor pitch change link bearings loose.
- d. Bent pitch change link.
- e. Loose tail rotor retaining nut.
- f. Worn or loose pitch change rod duplex bearings.
- g. Worn or loose pitch change slider.
- h. Oil cooler fan or mount loose.
- i. Oil cooler blower, bearing assembly loose or dry of lubricant.
- j. Engine alignment or mounts.
- k. Cockpit air blower or ducts.
- l. Motorized inverter loose in mounts.
- m. Generator bearing failure.
- n. Tail rotor drive shaft balance.
- o. Tail rotor drive shaft bent.
- p. Tail rotor drive shaft alignment.
- q. Hanger bearing failure.
- r. Worn or loose tail rotor pivot bearings.
- s. Hydraulic pumps.
- t. Hydraulic modules loose.
- u. Oil pump.
- v. Loose equipment in cabin or ammo compartment.
- w. Loose tail rotor pitch change bearings.
- x. Engine coupling shaft balance (short shaft).
- y. Drive shaft clamps not matched properly.
- z. Drive shaft clamps not installed at 90°.
- aa. 42° gearbox alignment, shimming, or looseness.
- ab. Lack of, or excessive lubrication of drive shaft couplings.
- ac. Bad bearings in any quill assembly.
- ad. Loose elevator linkage.

J9. Abnormal noises.

- a. Engine vibration.
- b. Oil cooler fan blades dragging.
- c. Heater ducts improperly fitted or leaking.
- d. Faulty cockpit air blower.
- e. Motorized inverter loose in mounts.
- f. Hydraulic pump failure.
- g. Faulty hydraulic module.
- h. Transmission drive quill(s) failing.
- i. Internal gearbox failure.
- j. Turret stow lock (no gun installed and master arm switch on).
- k. Blade tape.
- l. Canopy vibration.
- m. Inverter (motorized).
- n. Fuel boost pumps.
- o. Air ducts.

TROUBLESHOOTING GUIDE K - COMMUNICATIONS/NAVIGATION EQUIPMENT

CONDITION

PROBABLE CAUSE

K1. High load meter indication when turning radio on, or radio inoperative.

- a. Faulty wiring.
- b. Internal failure.
- c. Improperly tuned.
- d. Improper radio switch position.
- e. Faulty ICS panel.
- f. Headset not plugged in completely.

K2. Gyro compass won't null.

- a. Compass slaving switch in wrong position.
- b. Internal failure.
- c. Faulty wiring.

K3. Gyro operated instruments processing excessively.

- a. Inverter power frequency output incorrect.
- b. Faulty inverter.
- c. Faulty power correction network or circuit breaker out.

K4. Gunner RMI card inoperative, inverter on.

- a. Faulty 28V AC transformer.
- b. 28V AC transformer circuit breaker out.
- c. Inverter voltage excessively high or low.
- d. Faulty wiring.

K5. Gyro compass inaccurate or erratic.

- a. Improper position of compass slaving switch.
- b. Improper adjustment of transmitting unit.
- c. External magnetic interference.
- d. Faulty components.
- e. Faulty indicators.

K6. Communication and/or navigation equipment does not operate properly.

- a. Faulty wiring.
- b. Faulty impedance pad.
- c. Internal failure of radio.
- d. Faulty antenna or connection.

K7. Noise in both headsets.

- a. Faulty starter/generator noise suppressor/filter circuit.
- b. Faulty audio threshold unit.

SECTION IV. SPECIAL PROCEDURES

General. This section contains special procedures which were referenced in Section II.

A. Avionics/Navigation Checks:

Refer to TM 55-1520-234-10, Chapter 4.

NOTE

Refer to TM1 1-1520-234-23 for calibration and complete operation check procedures and troubleshooting conditions and probable causes.

B. Radar Warning Display Check.

NOTE

Refer to TM 11-1520-234-23 for calibration and complete operation check procedures and troubleshooting conditions and probable causes.

1. PWR SWITCH - ON. Allow one minute warm-up.
2. DSCRM SWITCH - OFF.
3. Self Test Switch - Press and Hold. The forward and aft strobes appear and a 2.5 KHz audio tone is present in the headset. In approximately six seconds, the MA light will start flashing and the audio becomes intermittent.
4. BRIL CONTROL - Rotate, check indicator illumination.
5. Audio Control - Adjust as required.
6. Day-Night Control - Adjust as required.
7. Self Test Switch - Release.
8. DSCM Switch - ON.
9. Self Test Switch - Press and hold. One of the strobes appear and a 1.2 KHz audio tone is present after approximately four seconds. Within approximately six seconds, the other strobe will appear and the audio tone will double.
10. Self Test Switch - Release.
11. DSCM Switch - As required.

C. Main Rotor Tracking.

Refer to TM 55-1520-234-23, Chapter 5.

D. Tail Rotor Tracking.

Refer to TM 55-1520-234-23, Chapter 5.

Track and Balance Chart # 4273

Date: _____

For BELL COBRA MODEL _____

Serial No: _____

MAIN ROTOR

067-207

INSTALL

MAGNETIC PICKUP
INTERRUPTERS
ACCELEROMETERS
REFLECTIVE TARGETS
and
INSTRUMENTS

as shown in manual and checklist for model being worked.

INSTRUCTIONS

- 1) Set tabs at trail (zero degrees). Hover ship and use Strobex to observe track. Adjust if required, for good hover track, USING PITCH LINK ONLY.
- 2) Hover ship, set Balancer to 324 RPM ("RPM TUNE to 324 and "RPM Range to "X 1"). Place "Function" Switch in "A" (Lateral Accelerometer). Push "Test" Button and check that 1 2:00 and 6:00 O'clock lights are lighted in Phazor. Release button.
- 3) Observe "Clock Angle" of lighted light, then press "Verify Tune" Button. Adjust "RPM Tune" Dial WHILE BUTTON IS PUSHED TO RETURN LIGHT TO ANGLE OBSERVED BEFORE BUTTON WAS PUSHED. Release button, observe angle, press and adjust again to match new "UNPUSHED ANGLE." Repeat until there is NO CHANGE WHETHER BUTTON IS PUSHED OR RELEASED. After tuning, record track, "Clock Angle" and "IPS" in "Balance Data" Section of Chart.
- 4) Set ship down, plot "Clock Angle" and "IPS" on "Balance Chart," labeling it point #1, record changes to be made in "Data" Section. Make the indicated changes to blade bolt weights and sweep.
- 5) Hover ship to check results, repeating all readings. Set ship down, plot point (label it #2) and repeat until "IPS" reading is reduced to .1 or less. Check track with Strobex after each balance move, especially if sweep was changed.

NOTE

As long as you can read a "Clock Angle," the balance can be improved. As balance gets better, "Clock Angle" will become more jittery and uncertain. Make the best possible estimate. BALANCE IS VERY IMPORTANT IN THE FINAL ROTOR SWEETENING RESULT.

- 6) If "Hove Line" (point #1 to #2) is not in correct direction, use "Clock Angle Corrector" #3597, and assign new numbers to clock. SEE MANUAL FOR DETAILS.
- 7) After balancing, track ship in-flight (see inside of this folder) Then after track is satisfactory, check hover balance and make final adjustments if needed.

NOTE

The indicated changes for balancing and tracking are approximate, and are based on averages of a number of experimental changes. Tab, especially, is difficult to predict, for blades of exactly the same type will respond differently. After the first one or two moves, you can judge the calibration of the Charts and use more or less "action" as needed.

BALANCE DATA

READINGS MUST BE MADE IN HOVER, READ CHANNEL "A" (LATERAL ACCELEROMETER)

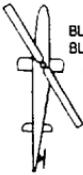
	1st Run	2nd Run	3rd Run	4th Run	5th Run	6th Run
Check TRACK after each balance move						
Clock Angle						
READINGS						
"IPS"						

NOTE	GRAMS in TARGET Blade Bolt					
	GRAMS in BLANK Blade Bolt					
	SWEEP TARGET Blade Alt					
	SWEEP BLADE Blade Alt					

Never sweep blade forward of stopped or stung position.

Target Blade is at about 11:00 O'Clock when double interrupter is over magnetic pickup.

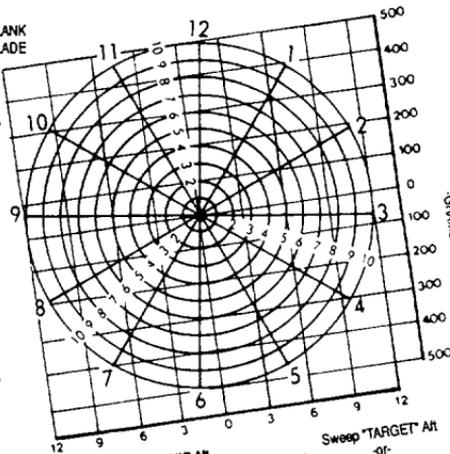
DO NOT ATTEMPT TO BALANCE UNLESS SHIP IS IN GOOD HOVER TRACK.



Viewed from top.

Set Balancer to 324 RPM.

The amount of weight or sweep required may be somewhat different for the various models of Cobra.



Sweep "BLANK" Alt or "TARGET" Forward

SWEEP Blade -FLATS-

Sweep "TARGET" Alt or "BLANK" Forward

← Sweep change should generate a "Move Line" in this direction. →

↑ Add to "BLANK" or Subtract from "TARGET" WEIGHT in Blade Bolt GRAMS. Weight change should generate a "Move Line" in this direction.

↓ Add to "TARGET" or Subtract from "BLANK"

Figure 4-1. Balance Data
4-8

INSTRUCTIONS
IN-FLIGHT TRACK

- 1) After balancing, switch Balancer "Function" Switch to "Track" and sketch the track observed with the Strobex at 90 and 140 knots STRAIGHT and LEVEL. Switch Balancer to "B" (vertical) and take "Clock Angle" and "IPS" readings at the same airspeeds. (DON'T EXCEED A COMFORTABLE AIRSPEED.) Tune balancer as described in 2) and 3) on previous page. Land ship, plot point on "Tracking Chart" (label it #1), and record changes to tab and pitch link in "Data" Section. Plot 140 knot, or fastest airspeed.

**NOTE
(IMPORTANT)**

	90	140
Use tab if blade "spread" increases greatly with airspeed	+	+
Use pitch link if "spread" is fairly uniform with airspeed.	+	+

CAUTION

Use the minimum possible tab to do the job. Excessive tab tends to "wash out" and may deteriorate the ride in some flight regimes.

- 2) Make the indicated changes and fly again to check result. Repeat as required to reduce vertical one-per-rev to .2 or less.

NOTE

With some rotors you will find that the plotted points, ("Move Line") as track is changed, will not go through the center, but rather will be tangent to some "IPS" circle. This point of tangency is the best track attainable, for tab and pitch link both generate a "Move Line" in generally the same direction. There is no known control to move perpendicular to this.

This may indicate a mismatch of blades and/or loose control linkages. You must be satisfied with this ride or change blades, and this can be determined in two or three flights.

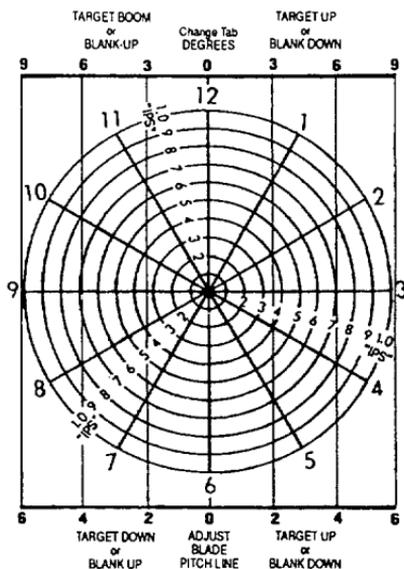


Figure 4-2. Instructions, IN-FLIGHT TRACK.

IN-FLIGHT TRACKING DATA

FLIGHT NUMBER		BOYER BALANCE READING (CHANNEL A)	TRACK (CHANNEL "B") AT AIRSPEED		CHANGE BEFORE NEXT FLIGHT
			90	140	
1	TRACK				
	CLOCK ANGLE				
	"IPS"				
2	TRACK				
	CLOCK ANGLE				
	"IPS"				
3	TRACK				
	CLOCK ANGLE				
	"IPS"				
4	TRACK				
	CLOCK ANGLE				
	"IPS"				
5	TRACK				
	CLOCK ANGLE				
	"IPS"				
6	TRACK				
	CLOCK ANGLE				
	"IPS"				

Figure 4-3. Inflight Tracking Data

4-11/(4-12 blank)

SECTION V. CHARTS AND FORMS

1. General. This section contains the necessary charts and forms required to ascertain that the aircraft is performing to established standards and to record readings, pressures, RPM, etc., obtained during maintenance test flight.

2. Table of Charts.

Number	Title	Page
5-1	T53-L-703 Power Chart	5-3
5-2	T53-L-703 Bleed Band Chart	5-5
5-3	T53-L-703 Variable Inlet Guide Vane Chart	5-7
5-4	Test Flight Record Sheet	5-9
5-5	Temperature Conversion	5-11

5-1/(5-2 blank)

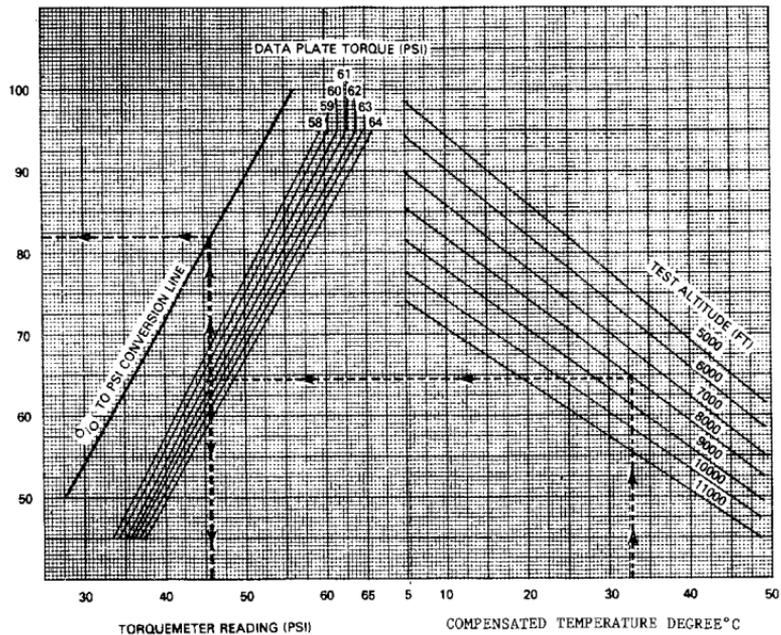


Figure 5-1. T53-L-703 Power Chart

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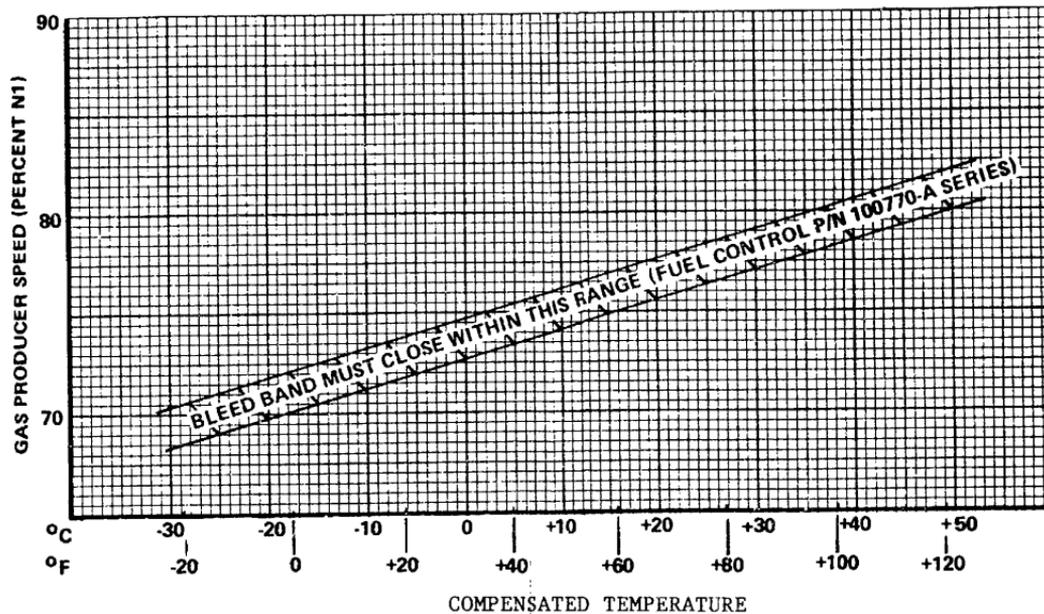
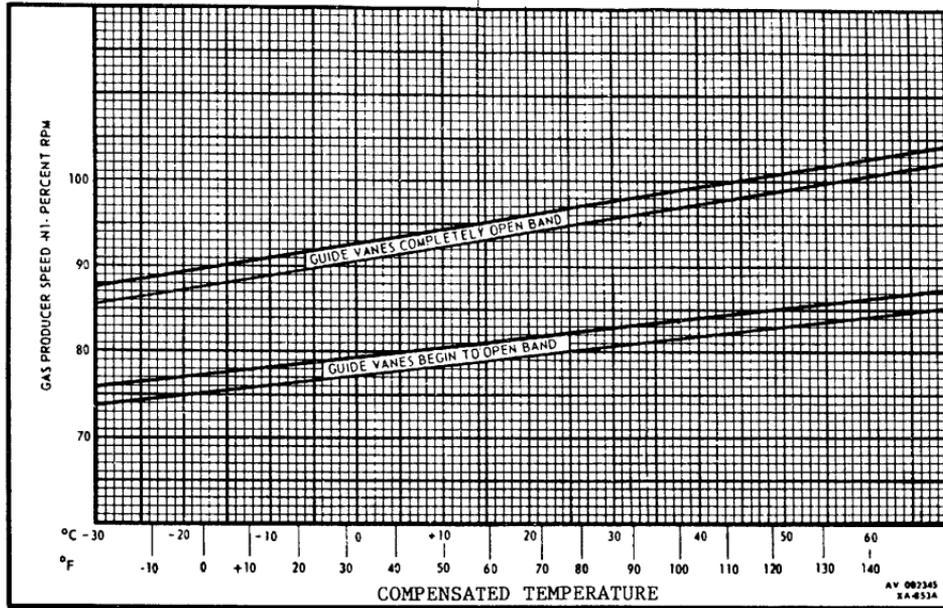


Figure 5-2. T53-L-703 Bleed Band Chart

5-5/(5-6 blank)



*U.S. G.P.O. 1991 554-122/21095

Figure 5-3. T53-L-703 Variable Inlet Guide Vane Chart

5-7/(5-8 blank)

AH-1S Maintenance Test Flight Record Sheet.

PURPOSE OF TEST FLIGHT:		ACFT S/N:	DATE:
PILOT:		UNIT:	
SYMBOLS:		√ = SATISFACTORY	X = DEFICIENCY
PRIOR TO MTF			
1. FORMS AND RECORDS CHECK		LOW RPM AUDIO	____ RPM
2. FLIGHT READINESS INSPECTION		HIGH RPM LIGHT	____ RPM
3. SPECIAL REQUIREMENTS		14. LINEAR ACTUATOR TRAVEL TIME	____ SECONDS
INTERIOR CHECKS			
1. GUNNER		15. HIGH RPM WARNING SYSTEM	
2. PILOT		16. TAIL ROTOR RIGGING CHECK	
STARTING ENGINE CHECKS			
1. CAUTION/WARNING LIGHTS		17. SCAS SYSTEM CHECK	
2. THROTTLE CUSHION CHECK		18. FUEL SYSTEM CHECK	
FULL OPEN ____ °		19. ELECTRICAL SYSTEMS CHECK	
FULL CLOSED ____ °		20. INSTRUMENT CORRELATION CHECK	
ENGINE RUNUP CHECKS			
		DUAL TACK ____ RPM	
1. FLIGHT IDLE SPEED ____ % N1		GAS PRODUCER ____ % N1	
2. DEICE SYSTEM CHECK		TGT ____ ° C	
3. ECS OPERATION CHECK		TORQUEMETER ____ PSI	
4. BLEED BAND CHECK ____ OAT		ENG OIL PRESS ____ PSI	
CLOSING SPEED ____ % N1		ENG OIL TEMP ____ ° C	
5. VIGV CHECK ____ OAT		TRANS OIL PRESS ____ PSI	
BEGIN TO OPEN ____ % N1		21. RADIOS CHECK	
FULLY OPEN ____ % N1		22. INSTRUMENT CHECKS	
6. PITOT HEATER CHECK		NAVIGATIONAL AIDS CHECKS	
7. FORCE TRIM SYSTEM CHECK		ASE CHECKS	
8. FLIGHT CONTROL CHECK		23. ARMAMENT SYSTEMS CHECK	
9. CYCLIC FRICTION ____ LBS		BEFORE TAKEOFF CHECKS	
10. COLLECTIVE FRICTION		1. HIT CHECK	
MINIMUM FRICTION UP ____ LBS		OAT ____ ° C	
MINIMUM FRICTION DN ____ LBS		N1 ____ % N1	
MAXIMUM FRICTION ____ LBS		TGT ____ ° C	
11. HYDRAULICS SYSTEM CHECK		DIFFERENCE ____ ° C	
SYSTEM #1 ____		HOVER CHECKS	
SYSTEM #2 ____		1. TAKEOFF TO HOVER CHECKS	
12. MINIMUM BEEP CHECK ____ RPM		2. INSTRUMENT CHECKS	
13. MAXIMUM BEEP CHECK ____ RPM		3. TORQUEMETER CHECK	
LOW RPM LIGHT ____ RPM		4. PEDAL AUTHORITY CHECK	

Figure 5-4. Test Flight Record Sheet (Sheet 1 of 2)

5. YAW CHANNEL RESPONSE CHECK	5. VIBRATION ANALYSIS CHECKS
6. SIDEWARD HOVER FLIGHT CHECK	6. RADIO AND NAV AIDS CHECKS
7. FORWARD HOVER FLIGHT CHECK	7. TOPPING
8. PYLON MOUNT CHECK	TORQUE ____ PSI
9. ENGINE RESPONSE CHECK	N1 SPEED ____ %
10. LOW RPM HOVER CHECK	TGT ____ ° C
11. EMER. GOVERNOR SYSTEM CHECK	OAT ____ ° C
12. POWER CYLINDER CHECK	PRESSURE ALTITUDE ____ FT
13. COLLECTIVE SERVO AUTHORITY CK	BEFORE LANDING CHECKS
SYSTEM #1 ____ PSI	AFTER LANDING CHECKS
SYSTEM #2 ____ PSI	1. ENG OIL PRESS ____ PSI
14. BEFORE TAKEOFF CHECKS	2. ENG OIL TEMP ____ ° C
15. FUEL ____ LBS ____ TIME	3. TRANS OIL PRESS ____ PSI
FLIGHT CHECKS	4. TRANS OIL TEMP ____ ° C
1. TAKEOFF/CLIMBOUT CHECKS	5. FUEL QUANTITY/TIME
2. INSTRUMENT CORRELATION CHECK	LBS ____ TIME ____
ENG OIL PRESS ____ PSI	6. BATTERY CONDITION CHECK
ENG OIL TEMP ____ ° C	7. COLLECTIVE ACCUMULATOR CHECK
TRANS OIL PRESS ____ PSI	8. POST FLIGHT INSPECTION
TRANS OIL TEMP ____ ° C	9. FORMS AND RECORDS COMPLETED
FUEL CONSUMPTION CHECK	10. PERSONNEL DEBRIEF
3. FLIGHT CONTROL RIGGING CHECK	11. AIRCRAFT RELEASED FOR FLIGHT
4. AUTOROTATION CHECK	
ROTOR ____ RPM	
REMARKS:	
_____ (SIGNATURE)	

Figure 5-4. Test Flight Record Sheet (Sheet 2 of 2)

TEMPERATURE CONVERSION CHART

Look up reading in middle column; if in degrees Centigrade, read Fahrenheit equivalent in right-hand column; if in degrees Fahrenheit, read Centigrade equivalent in left-hand column.

C	F	C	F	C	F	C	F
-54	- 65	- 85	28.9	84	183.2	266	510 950
-51	- 60	- 76	30.0	86	186.8	271	520 968
-46	- 50	- 58	31.1	88	190.4	277	530 986
-40	- 40	- 40	32.2	90	194.0	282	540 1004
-34	- 30	- 22	33.3	92	197.6	288	550 1022
-29	- 20	- 4	34.4	94	201.2	293	560 1040
-23	- 10	14	35.6	96	204.8	299	570 1058
-17.8	0	32	36.7	98	208.4	304	580 1076
-16.7	2	35.6	37.8	100	212.0	310	590 1094
-15.6	4	39.2	43	110	230	316	600 1112
-14.4	6	42.8	49	120	248	321	610 1130
-13.3	8	46.4	54	130	266	327	620 1148
-12.2	10	50.0	60	140	284	332	630 1166
-11.1	12	53.6	66	150	302	338	640 1184
-10.0	14	57.2	71	160	320	343	650 1202
- 8.9	16	60.8	77	170	338	349	660 1220
- 7.8	18	64.4	82	180	356	354	670 1238
- 6.7	20	68.0	88	190	374	360	680 1256
- 5.6	22	71.6	93	200	392	366	690 1274
- 4.4	24	75.2	99	210	410	371	700 1292
- 3.3	26	78.8	104	220	428	377	710 1310
- 2.3	28	82.4	110	230	446	382	720 1328
- 1.1	30	86.0	116	240	464	388	730 1346
0.0	32	89.6	121	250	482	393	740 1364
1.1	34	93.2	127	260	500	399	750 1382
2.2	36	96.8	132	270	518	404	760 1400
3.3	38	100.4	138	280	536	410	770 1418
4.4	40	104.0	143	290	554	416	780 1436
5.6	42	107.6	149	300	572	421	790 1454
6.7	44	111.2	154	310	590	427	800 1472
7.8	46	114.8	160	320	608	432	810 1490
8.9	48	118.4	166	330	626	438	820 1508
10.0	50	122.0	171	340	644	443	830 1526
11.1	52	125.6	177	350	662	449	840 1544
12.2	54	129.2	182	360	680	454	850 1562
13.3	56	132.8	188	370	698	460	860 1580
14.4	58	136.4	193	380	716	466	870 1598
15.6	60	140.0	199	390	734	471	880 1616
16.7	62	143.6	204	400	752	477	890 1634
17.8	64	147.2	210	410	770	482	900 1652
18.9	66	150.8	216	420	788	488	910 1670
20.0	68	154.4	221	430	806	493	920 1688
21.1	70	158.0	227	440	824	499	930 1706
22.2	72	161.6	232	450	842	504	940 1724
23.3	74	165.2	238	460	860	510	950 1742
24.4	76	168.8	243	470	878	516	960 1760
25.6	78	172.4	249	480	896	521	970 1778
26.7	80	176.0	254	490	914	527	980 1796
27.8	82	179.6	260	500	932	532	990 1814

Figure 5-5. Temperature Conversion

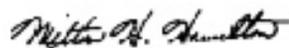
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The Metric System and Equivalents

Linear Measure

- 1 centimeter = 10 millimeters = .39 inch
- 1 decimeter = 10 centimeters = 3.94 inches
- 1 meter = 10 decimeters = 39.37 inches
- 1 dekameter = 10 meters = 32.8 feet
- 1 hectometer = 10 dekameters = 328.08 feet
- 1 kilometer = 10 hectometers = 3280.8 feet

Weights

- 1 centigram = 10 milligrams = .15 grain
- 1 decigram = 10 centigrams = 1.54 grains
- 1 gram = 10 decigrams = .035 ounce
- 1 dekagram = 10 grams = .35 ounce
- 1 hectogram = 10 dekagrams = 3.52 ounce
- 1 kilogram = 10 hectograms = 2.2 pounds
- 1 quintal = 100 kilograms = 220.46 pounds
- 1 metric ton = 10 quintals = 1.1 short tons

Liquid Measure

- 1 centiliter = 10 milliliters = .34 fl. ounce
- 1 deciliter = 10 centiliters = 3.38 fl. ounces
- 1 liter = 10 deciliters = 38.82 fl. ounces
- 1 dekaliter = 10 liters = 2.64 gallons
- 1 hectoliter = 10 dekaliters = 26.42 gallons
- 1 kiloliter = 10 hectoliters = 264.18 gallons

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