UNITED STATES ARMY AVIATION TEST BOARD
Fort Rucker, Alabama 36362

STEBG-TD

31 MAR 65

SUBJECT: 1200-Hour Progress Report, USATECOM Project No. 4-3-1110-06, "Logistical Evaluation of the T53-L-7 Engine"

TO: Commanding General
US Army Test and Evaluation Command
ATTN: AMSTE-BG
Aberdeen Proving Ground, Maryland 21005

1. REFERENCES.

a. 1000-Hour End-of-Test Report, "US Army Logistical Evaluation, AO-1 Mohawk," US Army Transportation Aircraft Test and Support Activity, July 1961.

b. Message, UNCLAS SMOSM-EOV-1 12-1436, US Army Transportation Materiel Command, 27 December 1962.

c. Message, TT 20448, Commanding General, US Army Test and Evaluation Command, 28 December 1962.

d. Letter, SMOSM-EUOV-1, US Army Aviation and Surface Materiel Command, 4 January 1963, subject: "T53-L-7 Test and Support Planning Data."

e. 300-Hour Progress Report, USATECOM Project No. 4-3-1110-06-R, "Logistical Evaluation of T53-L-7 Engine in an OV-1C Airplane," US Army Aviation Test Board, 26 June 1963. AD [illegible]

f. Letter, SMOSM-EW, US Army Aviation and Surface Materiel Command, 18 September 1963, subject: "1200-Hour Logistical Evaluation on OV-1 T53-L-7 Engine," with two indorsements.

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g. Letter, AMSTE-BG, Headquarters, USATECOM, 25 November 1964, subject: "Letter Report, USATECOM Project No. 4-3-1110-06, Logistical Evaluation of T53-L-7 Engines, OV-1C Aircraft."

h. Revised Plan of Test, USATECOM Project No. 4-3-1110-06, "Logistical Evaluation of T53-L-7 Engine Installed in OV-1C Airplane," US Army Aviation Test Board, 15 March 1965.

2. AUTHORITY.

a. Directive. Message TT 20448, Commanding General, US Army Test and Evaluation Command, 28 December 1962.

b. Purpose.

(1) To determine the logistical support requirements and extended service life capability of the T53-L-7 engines as installed in the OV-1C Airplane.

(2) To provide samples to justify an increase in time between overhaul (TBO) of dynamic components.

3. DESCRIPTION OF MATERIEL.

a. The T53-L-7 engine is a turboshaft aircraft engine rated at 1100 shaft horsepower (s.hp.). → next page

b. Other dynamic components under test are the standard OV-1C propeller, propeller controls, and hydraulic pump.

c. A detailed description of materiel is contained in reference e.

4. BACKGROUND.

a. The T53-L-3 engine was the original power plant for the OV-1 airplane. Problems were encountered with the L-3 during the logistical evaluation, product improvement program, and desert

tests of the OV-1. In an attempt to correct these problems, the manufacturer modified the engine to the T53-L-7 configuration. The T53-L-7 provides increased s.hp. (1100 s.hp. compared to 960 s.hp. for the T53-L-3) and improved propeller reduction gears.

b. The US Army Aviation Test Board (USAAVNTBD) was directed to perform a logistical evaluation of the T53-L-7 engine to determine changes in logistical support requirement resulting from installation of the T53-L-7 engines in the OV-1C Airplane. Testing began on 4 February 1963 (reference e). A 1200-hour engine hot-end sample was completed on 25 August 1964.

5. FINDINGS.

a. The following extended service life engine and component TBO samples were obtained (see inclosure 1 for Engine History):

(1) Engine hot-end inspection intervals:

S/N LE-02026 - 299:30 hours

*LE-02026 - 591:10 hours

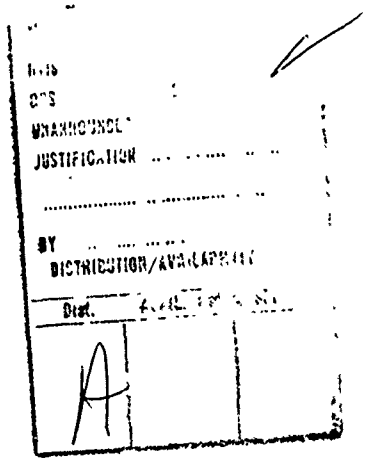
*LE-02026 -1185:00 hours

LE-02030 - 299:30 hours

LE-02030 - 279:05 hours

*LE-02030 - 633:15 hours

*LE-02030 - 943:00 hours



*These engines which operated at extended inspection intervals had improved vaporizer tubes, P/N 1-130-590-01, and asbestos seal materiel, P/N CAP887-B, installed.

NOTE: In order to operate the engines at a 600-hour hot-section inspection interval, certain presently-authorized inspection

criteria must be exceeded. These include crack limits of turbine nozzles and distortion and burning of fuel vaporizer tubes. Recommended changes in serviceability limits for hot-end inspection will be reported in detail in the final report.

(2) Three propellers and two propeller controls reached 1200 hours TBO. (See inclosure 2 for propeller and propeller control history.)

(3) Due to problems encountered with test hydraulic filters, reliable hydraulic pump data were not available.

b. The maintenance-man-hour-to-flight-hour ratio for engine and airframe was 6.6 to 1.

c. No additional special maintenance skills were required. MOS skill levels previously reported (reference a) were adequate with the T53-L-7/OV-1C combination.

d. Average consumption rates per flight hour of engine fuel and oil were as follows:

(1) JP-4 fuel (both engines) - 123 gallons per hour

(2) MIL-L-7808E engine oil (both engines) - 0.083 quart per hour

e. A total of 754 parts (164 line items) was consumed for engine maintenance.

f. Forty-four engine components required improvement. Equipment Improvement Recommendations (EIR's) were submitted (see inclosure 3).

g. Special tools, maintenance manuals, and the maintenance allocation chart were adequate. Fourteen minor changes to the maintenance manuals were reported by EIR (see inclosure 3).

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h. Engineering analysis (attached as inclosure 4) of problems encountered during the test revealed that the T53-L-7 engines would be suitable for operation with a 600-hour hot-end inspection interval.

6. CONCLUSIONS.

a. The T53-L-7 engine with the improved parts tested is suitable for operation with hot-section inspection interval of 600 hours.

b. Propellers and propeller controls are suitable for operation at time between overhaul of 1200 hours.

7. RECOMMENDATIONS.

Recommendations will be included in end-of-test report.

Raymond E. Johnson

4 Incl
as

RAYMOND E. JOHNSON
Colonel, Artillery
President

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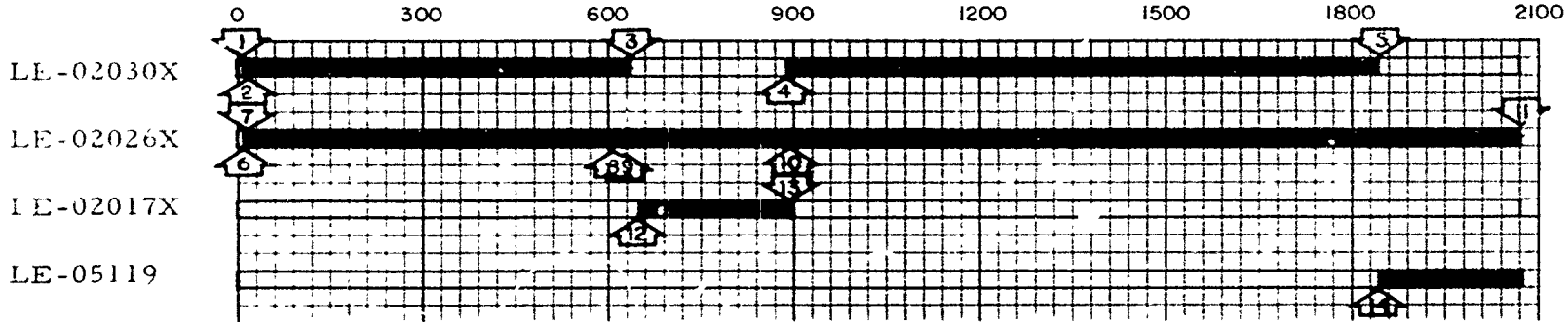
ENCLOSURE 1

ENGINE HISTORY



LEGEND:

___ Engine in test.

___ Engine not installed.

Extended service life (ESL) engine serial numbers are followed by an X.

1. LE-02030X installed at 14:40 aircraft hours.
2. LE-02030X entered test at 35:45 aircraft hours.
3. LE-02030X removed at 633:15 engine hours due to 5th stage compressor disc failure.
4. LE-02030X installed at 890:40 aircraft hours, after overhaul (0 engine hours).
5. LE-02030X removed at 953:35 engine hours due to #3 and #4 bearing failure.
6. LE-02026X installed at 14:40 aircraft hours.
7. LE-02026X entered test at 35:45 aircraft hours.
8. LE-02026X propeller shaft replaced at 596:05 engine hours.
9. LE-02026X planetary gear bearing replaced at 607:20 engine hours.
10. LE-02026X hot-end rebuilt at 890:40 aircraft hours.
11. LE-02026X removed at 2061:40 engine hours due to suspected vibration.
12. LE-02017X installed at 647:55 aircraft hours due to failure of LE-02030X.
13. LE-02017X removed at 890:40 aircraft hours due to condemned 5th stage compressor disc.
14. LE-05119 installed at 1844:15 aircraft hours due to failure of LE-02030X.

PROPELLER AND PROPELLER CONTROL HISTORY

Propeller Assembly, Left
(FSN 1610-617-9735) (MPN 53C51-23)

Serial Number	POT*	Hours Attained	Reason for Removal
N220323	00:00	603:15	Attained 600-hour service tour.
N218777	00:00	7:30	To reinstall S/N N220323 for additional testing.
N220323	603:15	00:00	Would not go into high pitch.
N218777	7:30	11:15	Positions reversed to check for surging.
N220319	614:30	591:40	Attained 1200-hour service tour.
N219175	650:55	563:20	Attained 1200-hour service tour.
N222398	00:00	299:20	Presently installed.

*Previous Operating Time

Propeller Assembly, Right
(FSN 1610-617-9735) (MPN 53C51-23)

Serial Number	POT*	Hours Attained	Reason for Removal
N220319	00:00	603:15	Attained 600-hour service tour.
N218113	00:00	7:30	To reinstall S/N N220319 for additional testing.
N220319	603:15	11:15	Positions reversed to check for surging.
N218777	18:45	1155:00	Attained 1200-hour service tour.
N216990	00:00	299:20	Presently installed.

*Previous Operating Time

INCLOSURE 2

Propeller Controls, Left
(FSN 1610-671-1092) (MPN 557996P4)
(MPN 557996P2**)

Serial Number	POT*	Hours Attained	Reason for Removal
SE5709**	00:00	603:15	Attained 600-hour service tour.
SE5252	00:00	7:30	To reinstall S/N SE5709 for additional testing.
SE5709**	603:15	00:00	Would not go into high pitch.
SE6670	00:00	11:15	Positions reversed to check for surging.
SE6380	18:45	591:40	To install on propeller S/N N219175.
SE6380	610:25	563:20	Attained 1200-hour service tour.
SE6955	192:00	299:20	Presently installed

*Previous Operating Time

Propeller Controls, Right
(FSN 1610-671-1092) (MPN 557996P4)
(MPN 557996P2**)

Serial Number	POT*	Hours Attained	Reason for Removal
SE6168**	3:20	606:35	Attained 600-hour service tour.
SE6380	00:00	18:45	To install in propeller S/N N20319.
SE6670	11:15	1155:00	Attained 1200-hour service tour.
SE5884	00:00	299:20	Presently installed.

*Previous Operating Time

EQUIPMENT IMPROVEMENT RECOMMENDATIONS

1. EIR NO. 63-139: Control Assembly, Fuel

DESCRIPTION: Following flight No. 3, the pilot reported that the No. 1 engine torquemeter was sticking at 82 p.s.i. during takeoff and increase to military power settings. Subsequent check of engine during ground run-up revealed that during increases to takeoff power, the torque was sticking at 82 p.s.i.; however, on occasion would increase to normal p.s.i.

RECOMMENDATION: Recommend that manufacturer investigate this failure to determine exact cause(s) and initiate corrective action to preclude failures of this nature.

2. EIR NO. 63-185: Thermocouple, Exhaust

DESCRIPTION: Following flight No. 3, the pilot reported that the No. 1 engine exhaust gas temperature indicator was inoperative. Subsequent investigation by a continuity check revealed an open lead within the exhaust thermocouple harness.

RECOMMENDATION: Recommend that manufacturer be apprised of this failure to determine exact cause(s) and to initiate corrective action to preclude recurring failures of this nature.

3. EIR NO. 63-206: Vaporizer Assembly, Fuel

DESCRIPTION: During scheduled inspection of the hot section of No. 1 engine, it was found that the No. 2 fuel vaporizer assembly was burned beyond serviceable limits. The vaporizer, P/N 1-130-370-01, had a burned out area on the left exit leg approximately .500 inch deep and .500 inch around the circumference of exit hole. A review of engine records did not indicate any hot start or over-temperature conditions.

RECOMMENDATION: Recommend that manufacturer be apprised of this failure to determine exact cause(s) and initiate corrective action to preclude recurring failures of this nature.

INCLOSURE

4. EIR NO. 63-212: Liner, Combustion Chamber

DESCRIPTION: During scheduled inspection of the hot section of No. 1 engine, extensive damage was evident on the N_1 turbine wheel, P/N 1-100-490-04, S/N P-56-A4, and the first stage nozzle, P/N 1-110 030-28. Seventeen blades of the N_1 turbine wheel were damaged on the leading edges and fourteen blades were damaged on the trailing edges. Damage consisted of various portions broken out of blades and numerous indentions. Damage to the first stage nozzle consisted of two vanes being damaged, one with a .500 inch wide and .375 inch deep portion broken out and one with a .250 inch wide and .180 inch deep portion broken out. Further investigation revealed that a stud retainer bracket of the combustion chamber liner was partially broken off. It is suspected that the bracket breaking off and passing through the first stage nozzle and N_1 turbine wheel inflicted the damages stated above.

RECOMMENDATION: Recommend that manufacturer be apprised of this failure to determine exact cause(s) and initiate corrective action to preclude failures of this nature.

5. EIR NO. 63-251: Nozzle, Second Stage

DESCRIPTION: During No. 2 engine disassembly and inspection to replace the turbine nozzle seal retainer with the latest configuration item, the second stage nozzle was found cracked. The inner shroud of the nozzle was cracked on the leading side in the proximity of inner leading edges of vanes No. 8, 11, 12, 17, 20, and 21 with cracks ranging from 1/8 inch to 2 inches long. The inner shroud was cracked on the trailing side in the area of the inner trailing edges of vanes No. 1, 7, 12, 19, and 21 ranging in length from 3/8 inch to 1 1/4 inches. All cracks were separate and the majority of them were perpendicular to the circumference of the inner shroud.

RECOMMENDATION: Recommend that manufacturer determine exact cause(s) of this failure and initiate corrective action to preclude failures of this nature.

6. EIR NO. 63-252: Vaporizer Assembly, Fuel

DESCRIPTION: During No. 2 engine disassembly and inspection to replace the turbine nozzle seal retainer with the latest configuration item, the No. 4 fuel vaporizer assembly, P/N 1-130-370-01, was found to be cracked. The crack was located at the base leg weld approximately 7/16 inch around the leg circumference.

RECOMMENDATION: Inasmuch as three similar failures were found by this activity (reference EIR NO. 63-253), recommend that manufacturer be apprised of these failures, to determine exact cause(s) and initiate corrective action to preclude failures of this nature.

7. EIR NO. 63-253: Vaporizer Assembly, Fuel

DESCRIPTION: During No. 1 engine disassembly and inspection to replace the turbine nozzle seal retainer with the latest configuration item, the No. 1 and No. 3 fuel vaporizer assemblies, P/N 1-310-370-01, were found cracked. The No. 1 vaporizer, S/N 210, was cracked at the base leg weld approximately 1/2 inch around the leg circumference. The No. 3 vaporizer, S/N 188, was cracked approximately 3/8 inch above the base leg weld and approximately 3/4 inch in length around the base leg.

RECOMMENDATION: Inasmuch as three similar failures were found by this activity (reference EIR NO. 63-252), recommend that manufacturer be apprised of these failures to determine exact cause(s) and initiate corrective action to preclude recurring failures of this nature.

8. EIR NO. 63-427: Gear Assembly, Reduction

DESCRIPTION: The No. 2 engine nose section and accessory drive gear box were removed and inspected for possible defects and/or damages in relation to metal contamination. Inspection of the gears in the reduction gear assembly revealed no defects; therefore, the drive gear assembly was disassembled for inspection. During this inspection a crack was found in the web of the propeller shaft assembly, P/N 1-020-180-01, S/N 112, starting at the outer bearing race retainer of the primary planetary gear and extending into the propeller shaft.

RECOMMENDATION: Recommend that manufacturer expedite investigation to determine exact cause(s) and initiate corrective action to preclude recurring failures of this nature.

9. EIR NO. 63-441: Plug, Igniter

DESCRIPTION: During a scheduled inspection of No. 1 engine hot section, the No. 2 igniter plug was found defective inasmuch as the ceramic insulator between the igniter and the plug housing was chipped and metal had begun to burn away.

RECOMMENDATION: Inasmuch as this is the first failure of this nature reported by this activity, there are no recommendations and subject EIR is submitted for statistical purposes.

10. EIR NO. 63-455: Bearing, Roller

DESCRIPTION: During flight No. 1, 45 minutes after takeoff on 4 June 1963, the chip detector light of No. 2 engine came on. The engine nose section was removed and inspected and the No. 9 bearing of the accessory gear box assembly was found defective. The roller bearings and the outer case of the bearing were found to have metal "pick out"; however, the amount of "pick out" was not sufficient to cause the chip detector light to come on.

RECOMMENDATION: Recommend that manufacturer expedite investigations currently underway, to determine exact cause(s) and initiate corrective action to preclude failures of this nature.

11. EIR NO. 63-456: Bearing, Primary Planetary Gear

DESCRIPTION: During flight No. 1, 45 minutes after takeoff on 4 June 1963, the chip detector light on No. 2 engine came on. The engine nose section was removed and inspected and the primary planetary gear bearing of the reduction gear assembly was found defective. Excessive wear was evident on the roller bearings and inner and outer races, ridges were found on the rollers in excess of .040 inch and noticeable grooves were visible on the races.

RECOMMENDATION: Recommend that manufacturer expedite current investigations to determine exact cause(s) and initiate corrective action to preclude failures of this nature.

12. EIR NO. 63-467: Indicator, Temperature

DESCRIPTION: Following flight No. 2, the pilot reported that the No. 1 EGT indicator reached 640°C. on takeoff. Subsequent check of No. 1 EGT system with a Jet-Cal Tester revealed the indicator to be defective, in that calibration could not be accomplished. The indicator read 10 degrees high at the low temperatures range and 30 degrees high around the 600°C. mark, with varying high readings between.

RECOMMENDATION: Recommend that manufacturer be apprised of this failure, to determine exact cause(s) and initiate corrective action to preclude failures of this nature.

13. EIR NO. 63-470: Motor, Direct Current

DESCRIPTION: Following the initial flight after installation of the propeller and control, the pilot reported that the No. 1 propeller control auxiliary motor would not terminate. Subsequent ground check revealed that the auxiliary motor would activate the propeller, very slowly, but would not generate sufficient pump pressure to activate the pressure switch and would run continuously.

RECOMMENDATION: Recommend that manufacturer be advised of this failure, to determine exact cause(s) and initiate corrective action to preclude failures of this nature.

14. EIR NO. 63-483: TM 55-1510-204-34

DESCRIPTION: Paragraph 2-172d, of TM 55-1510-204-34, dated 12 April 1962, states that the limits for the firing pin protrusion should be 0.109 ± 0.15 inch. This is not possible since the variance is greater than the primary dimension.

RECOMMENDATION: Recommend that this area be reviewed and that correct information be furnished using activities at the earliest possible date.

15. EIR NO. 63-501: Propeller Control

DESCRIPTION: Following flight No. 1, the pilot reported that the No. 1 propeller was reversing faster than No. 2 and both were uncontrollable in reverse. The pilot reported that both engines seemed to accelerate forward immediately after reversing of propellers. Subsequent investigation revealed that No. 2 propeller was slow going into reverse, approximately one second slower than the No. 1 propeller, and the No. 2 propeller control, S/N SE6168, was determined to be defective. Although the TBO of subject propeller control was 600 hours, the item was proposed for a 1200 hours test program; therefore, this EIR is submitted for statistical purposes.

RECOMMENDATION: Inasmuch as the control reached scheduled operating time, there are no recommendations and subject EIR is submitted for statistical purposes only.

16. EIR NO. 63-502: Propeller and Propeller Control

DESCRIPTION: During operational check after installation, it was found that the No. 1 propeller would not turn above 1375 r.p.m. and would not go into high pitch. After replacement of No. 1 propeller control, S/N SE5709, an operational check revealed the same condition. The No. 1 propeller was then replaced, leaving the new propeller control installed and the operational check revealed satisfactory performance.

RECOMMENDATION: Inasmuch as above items reached scheduled operating time, there are no recommendations and subject EIR is submitted for statistical purposes only.

17. EIR NO. 64-14: Engine Assembly

DESCRIPTION: Following a normal takeoff and during a climb out at military power, the No. 1 engine, S/N LE-02030X, failed at an altitude of 500 feet. The pilot reported a loud bang and an immediate torqueing effect from loss of No. 1 engine. The auto-feather switch was on; therefore, the engine propeller feathered immediately. Controls were adjusted to single-engine performance and aircraft returned to field and landed without incident. Subsequent investigation after removal of engine from the aircraft revealed the N_1 turbine wheel blades were all burned off. The second stage nozzle had a build-up of metal on the vanes, but otherwise damage was negligible. The 1st stage turbine nozzle had approximately 25 percent of the vanes showing pieces missing from the trailing edges varying from 1/8 inch square to 1/2 x 1 inch in size. A metal build-up and a peened effect were noted on the leading edges of all the 2nd stage turbine rotor blades. Inasmuch as metal particles were noted in the tail pipe and metal had been forced out the interstage bleed ports, snapping the upper compressor bleed band at the attaching loop, the top compressor half was removed for compressor section inspection. This inspection disclosed that all the 5th stage compressor rotor blades were broken off at the root and two blades were missing including the portion of the compressor rotor disc which separates the blades. The blade particles moved forward causing extensive damage to the 4th stage compressor vanes and the trailing edges of the 4th stage rotor blades. The trailing edges of several 3rd stage blades were also nicked, and

heavy nicks and chafes were evident on the 4th stage shroud area of the compressor housing. The exit guide vane assembly was heavily damaged with the trailing edge of the outer shroud being distorted enough to allow metal to be forced out of the interstage bleed ports thus snapping the upper bleed band. The leading edges of all the vanes on the centrifugal compressor impeller were damaged as was the impeller housing.

RECOMMENDATION: Recommend that manufacturer determine exact cause(s) and initiate corrective action to preclude failures of this nature.

18. EIR NO. 64-52: Control Assembly, Fuel

DESCRIPTION: During an operational run-up of the No. 2 engine, it was found that the engine was unstable with the propeller in reverse. The N_1 speed fluctuated between 93.5 and 96 percent, the N_2 (propeller r.p.m.) fluctuated from 1600-1650 and the EGT fluctuated from 590 to 630°C., at about a two-cycle-per-second rate. This fluctuation was accompanied by a noticeable surging of the engine. During subsequent troubleshooting, the engine performance, with the propeller in reverse, remained in an unstable condition until a serviceable fuel control and overspeed governor were received and installed, at which time the engine operation returned to normal.

RECOMMENDATION: Recommend that manufacturer be advised of this failure, to determine exact cause(s) and initiate corrective action to preclude failures of this nature.

19. EIR NO. 64-76: Pump, Engine Drive Hydraulic

DESCRIPTION: Following flight No. 3, the same day, the pilot reported that the No. 1 hydraulic system read 2000 p.s.i. with an occasional drop to zero and that an excessive amount of noise was evident during pump operation. Subsequent ground operational check revealed that with the hydraulic pump operating the pressure fluctuated from 0 to 2000 p.s.i. and excessive noise was produced during operation.

RECOMMENDATION: Inasmuch as this is the first recorded failure of this nature at this activity on this configuration pump, there are no recommendations and subject EIR is submitted for statistical purposes only.

20. EIR NO. 64-85: Valve, Thermo

DESCRIPTION: Following flight No. 2, 23 July 1963, the pilot reported that the No. 1 engine EGT read up to 630°C. at military power (1600 r.p.m. and 80 p.s.i. torque), transient EGT readings went as high as 680°C. in reverse propeller operation, and as high as 650°C. from ground to flight idle. He further stated that in one descent (dive) from 3500 feet to 1000 feet, the EGT rose to 640°C. at military power. During subsequent investigation to determine cause of the high EGT readings, a complete check of both engine bleed air systems revealed normal operation with no restrictions or loss of bleed air. The EGT system of No. 1 engine was also checked with satisfactory results. For further checking, the customer air bleed on No. 1 engine was blocked off and the thermo valves of the two engines were exchanged for the purposes of a test flight. During the test flight the EGT of No. 1 engine remained within the normal operating range and the No. 2 engine EGT increased slightly, but also remained within limits. Following this flight, the No. 1 engine customer air bleed was unblocked, the same blocked on the No. 2 engine, and subsequent flights revealed normal EGT readings. A new thermo valve was ordered and upon receipt on 3 August 1963 was installed on No. 2 engine to return the aircraft to normal service.

RECOMMENDATION: Recommend that manufacturer be advised of this failure; however, inasmuch as this is the first reported failure of this nature at this activity, there are no further recommendations.

21. EIR NO. 64-90: Band Assembly, Taped, Interstage Bleed

DESCRIPTION: Following flight No. 5, the pilot reported the No. 2 engine developed 14 p.s.i. torque less than No. 1 engine on run-up and takeoff. Investigation of this difficulty revealed that the lower bleed band, P/N 1-160-800-01, of the taped interstage bleed band assembly was broken. The break was found to be located where the bushing attachment connects to the air bleed actuator.

RECOMMENDATION: Recommend that manufacturer be advised of this failure to determine exact cause(s) and initiate corrective action to prevent failures of this nature.

22. EIR NO. 64-97: TM 55-1510-204-20, 25 May 1962, Change 2

DESCRIPTION: TM 55-1510-204-20, dated 25 May 1962, and Change 2, dated 13 May 1963, chapter 3, section IV, Periodic Inspection Requirements, requires replacement of hydraulic and pneumatic system

filters in Areas 1.15, 4.25, and 11.25. Areas 1.15 and 11.25 are due every 3rd PE, whereas 4.25 is due every 2nd PE. Area 4 is Engine and Nacelle Right Hand and Area 11 is Engine and Nacelle Left Hand.

RECOMMENDATION: Recommend that the hydraulic filters be changed every 3rd PE throughout the aircraft, thus making Area 4.25 due every 3rd PE in lieu of every 2nd PE.

23. EIR NO. 64-139: TM 55-1510-204-34, dated 7 June 1963

DESCRIPTION: Paragraph 3-28(s), page 3-12, TM 55-1510-204-34, gives reference to TM 55-1510-204-20, chapter 2, section IV, paragraph 4-58, in installation of nose and lower cowling assemblies on engine. Installation of the cowling is given in paragraph 4-337 of TM 55-1510-204-20, chapter 2, section IV.

RECOMMENDATION: Recommend that paragraph 3-28(s), page 3-12, TM 55-1510-204-34, be changed to read: Install nose and lower cowling assemblies as outlined in TM 55-1510-204-20, chapter 2, section IV, paragraph 4-337.

24. EIR NO. 64-151: MWO 55-1510-204-34/50, dated 12 October 1962

DESCRIPTION: Reference paragraph 2f, which reads "Position cap (134P10235-3) on duct assembly (134P10117-1). Drill #30 (.1285) 4 holes approximately as shown. Secure cap with 4 bolts (AN3-3A), 8 washers (AN960C10L) and 4 nuts (MS21042L3) (fig. 1)." Step 2f tells you to use a #30 drill for drilling holes in cap but calls for #10 bolts, nuts, and washers.

RECOMMENDATION: Recommend that step 2f be changed to read, "Drill #10" instead of "Drill #30."

25. EIR NO. 64-164: TM 55-1510-204-20, dated May 1962, w/changes

DESCRIPTION: TM 55-1510-204-20, dated May 1962, w/changes No. 1 and No. 2, does not contain any requirement to inspect the drop tank release mechanism for proper operation, both manually and electrically.

RECOMMENDATION: Recommend that approval be given to add Areas 5.14 and 12.15, "Perform operational check, both manual and electrical, of the drop tank release mechanism. Insertion of ground safety pins should require one-hand pressure only. If difficulty is experienced while inserting safety pins, check rigging of tank installation in accordance

with TM 55-1510-204-20, chapter 2, section IV, paragraph 4-153," to the Periodic Inspection, chapter 3, section IV, pages 4-6 and 4-11, of TM 55-1510-204-20.

26. EIR NO. 64-175: Thermocouple, Exhaust

DESCRIPTION: During an engine inspection as a result of loss of engine oil caused by a broken oil manifold (reference this activity's EIR No. 64-177), the exhaust thermocouple was found to be shorted internally. The exhaust thermocouple was tested by continuity method and by moving or bending the flexible lead and the thermocouple was found defective.

RECOMMENDATION: Recommend that manufacturer be advised of this failure to determine exact cause(s) and to initiate corrective action to prevent failures of this nature.

27. EIR NO. 64-177: Manifold, Lubrication Pressure

DESCRIPTION: During flight No. 2, pilot reported that the No. 2 engine oil pressure gauge fluctuated excessively (15 lb. to 75 lb), and a visual check of the engine disclosed engine oil being emitted from the No. 2 engine drain line. The engine was immediately shut down with 40 p.s.i. oil pressure indicated. A visual inspection of the engine after returning to home base revealed that the oil pressure manifold was broken approximately 1/2 inch from the weld at lower end of the manifold that connects to the flexible tube assembly, P/N 666304-23 (reference T53-L-7 Field Maintenance Repair Parts Manual, 15 December 1963, page 2-16, figure 9, index 14).

RECOMMENDATION: Recommend that manufacturer be notified of this discrepancy to determine exact cause(s) and to initiate corrective action to prevent failures of this nature.

28. EIR NO. 64-208: TM 55-1510-204-34, dated June 1963

DESCRIPTION: TM 55-1510-204-34, dated June 1963, chapter 2, section III, page 3-33, paragraph 3-79c, states, "Inspect....by the post emulsion florescent penetrant method, Specification MIL-I-6866." TB 55-2800-200-30/1, dated 12 June 1963, page 19, paragraph 21, does not require an inspection by the post emulsion florescent penetrant method, Specification MIL-I-6866.

RECOMMENDATION: Recommend that TM 55-1510-204-34 be changed or revised to read the same as TB 55-2800-200-30/1, excluding inspection, "by the post emulsion florescent penetrant method, Specification MIL-I-6866."

29. EIR NO. 64-231: TM 55-1510-204-34, June 1963

DESCRIPTION: TM 55-1510-204-34, dated June 1963, chapter 2, section III, page 3-36, paragraph 3-80c(7), states that, "Original (factory) tip clearance and permissible minimum clearance for use in the field after engine operation are shown in figure 3-29." A review of figure 3-29 disclosed that no clearances are shown as stated in paragraph 3-80c(7). Also paragraph 3-80c(4) states that the clearance must be within 0.040 to 0.046 inch. However, the "NOTE" in the right hand column on page 3-36 states that "It is anticipated that, at overhaul, engines with blade tip clearance of 0.040 to 0.046 inch will be fitted with second stage turbine nozzle and cylinder assembly that provide a 0.030 to 0.036 inch clearance."

RECOMMENDATION: Recommend that -34 be changed and/or revised to read 0.040 to 0.046 if a new second stage turbine wheel and cylinder are installed and 0.030 to 0.036 on second stage turbine wheels and cylinder having previous operating time. Also, a note should be added describing what to do in case the tip clearance is above maximum or below minimum.

30. EIR NO. 64-235: MWO 55-1610-201-30/2, dated 17 May 1963

DESCRIPTION: MWO 55-1610-201-30/2, dated 17 May 1963, paragraph 3a, page 2, states, "Parts required per aircraft." It then lists the quantity of parts required for one propeller. There are two propellers per aircraft involved.

RECOMMENDATION Recommend that paragraph 3a, page 2 of MWO 55-1610-201-30/2 be changed to read, "Parts required per propeller assembly," and an official manual change be issued to the field.

31. EIR NO. 64-256: TM 55-1510-204-10, dated May 1963

DESCRIPTION: TM 55-1510-204-10, dated May 1963, chapter 3, section II, paragraph 2-15f(3) does not include a check of the electrical or manual release mechanism prior to the removal of the ground safety pin.

RECOMMENDATION: Recommend that a "CAUTION" note be added following paragraph 2-15f(3) as follows: "Prior to removal of ground safety pin from drop tank pylon, visually inspect to insure that: (1) the sear lever is seated fully aft and in position to support the lock lever; and (2) the electrical drop tank release solenoid has not been actuated. If actuated, it is necessary that the solenoid be reset prior to removal of ground safety pin." These measures are necessary to prevent inadvertent release of the drop tank when the pin is removed.

32. EIR NO. 64-261: TM 55-1510-204-20, dated May 1962

DESCRIPTION: TM 55-1510-204-20, dated May 1962, chapter 2, section IV, page 4-47, paragraph 4-150c, "CAUTION" note, covers a safety measure for the electrical release mechanism prior to the removal of the ground safety pin but does not include a check of the manual release mechanism.

RECOMMENDATION: Recommend that a change or revision be made to subject paragraph listed above in item 14 as follows: "Prior to removal of ground safety pin from drop tank pylon, visually inspect the pylon to insure that: (1) the manual release sear lever is seated fully aft and in position to support the lock lever roller, and (2) that the electrical drop tank release solenoid has not been actuated. If actuated it is necessary that the solenoid be reset prior to removal of the ground safety pin." These measures are necessary to prevent inadvertent release of drop tanks when the pin is pulled. Further recommend that an additional subparagraph be added to paragraph 4-153 as follows: "(i) With the ground safety pin installed in the pylon, actuate the electrical release to verify solenoid serviceability, and the manual release similarly to verify operation. Following actuation, visually inspect the position of sear lever as seated fully aft and in position to support the lock lever roller when the safety pin is removed."

33. EIR NO. 64-262: Pump Assembly, Engine Driven, Hydraulic

DESCRIPTION: During a roll-out on flight No. 2, the pilot reported that the No. 1 and No. 2 hydraulic system pressure dropped to zero. Shortly thereafter, No. 1 hydraulic pressure came up to and fluctuated between 800 and 3800 p.s.i. while No. 2 remained on zero. Subsequent investigation by replacement with a like serviceable item revealed the subject hydraulic pumps to be defective internally. Defective pumps are 1200-hour replacement items IAW T53-L-7 Plan for Test and Evaluation.

RECOMMENDAT'ON: Inasmuch as the failed pumps are the latest configuration, recommend that manufacturer investigate to determine exact cause(s) and take necessary action to prevent recurring failures of this nature.

34. EIR NO. 64-272: Valve, Hot Air

DESCRIPTION: During flight No. 2, pilot reported that with heater line blocked, No. 1 engine temperature was normal. Subsequent investigation revealed the hot air valve, P/N 26230027, to be defective internally inasmuch as subject valve would not operate properly.

RECOMMENDATION: Recommend that manufacturer be advised of failure to determine exact cause(s) and to initiate corrective action to prevent failures of this nature.

35. EIR NO. 64-297: Valve, Hot Air

DESCRIPTION: During flight No. 3 on 6 November 1963, the pilot reported that the No. 1 engine EGT rose to 640°C. at military power on takeoff. Subsequent investigation by replacement with a like serviceable item revealed that the hot air valve was inoperative.

RECOMMENDATION: Recommend that manufacturer be advised of failure to determine exact cause(s) and to initiate corrective action to prevent failures of this nature.

36. EIR NO. 64-367: TM 55-1510-204-20, dated 25 May 1962

DESCRIPTION: Message DA 941898, dated 23 October 1963, paragraph 2A, requires that each aircraft be equipped with an up-to-date Pilot's Check List. TM 55-1510-204-20, chapter 3, section II, Daily Inspection, Area 13, does not contain any requirement to check for availability of Pilot's Check List.

RECOMMENDATION: Recommend that TM 55-1510-204-20, chapter 3, sections II, III, and IV, be revised to include, in Area 13 of the Daily, Intermediate, and Periodic Inspections, a requirement to check for availability of Pilot's Check List.

37. EIR NO. 64-376: Heater Assembly, Fuel

DESCRIPTION: During a scheduled periodic inspection, it was noted that the fuel heater assembly, P/N 5A470, was cracked.

The crack, approximately 1/8 inch, was located on the top side of the T53-L-7 engine fuel heater, at the oil outlet part of the fuel heater, and allowed oil to leak from the fuel heater manifold.

RECOMMENDATION: Inasmuch as this is the first failure of this nature reported by this activity, there are no recommendations and subject EIR is submitted for statistical purposes only.

38. EIR NO. 64-413: TM 55-1510-204-20, May 1962, w/Changes 1 and 2

DESCRIPTION: TM 55-1510-204-20, dated May 1962, w/ changes 1 and 2, chapter 3, section III, Intermediate Inspection, Areas 3.4 and 10.4, requires servicing of the propeller control atmospheric sump and, as a note, states, "2 to 2.5 inches of fluid in atmospheric sump." Chapter 2, section II, paragraphs 2-27h and k(5), require a minimum level of 1.5 to 2 inches of fluid in the atmospheric sump after the system has been thoroughly scavenged.

RECOMMENDATION: Recommend that TM 55-1510-204-20, chapter 3, section III, Intermediate Inspection, NOTE following Areas 3.4 and 10.4 be changed to read, "1.5 to 2 inches of fluid in atmospheric sump," to correspond with chapter 2, section II, Propeller Servicing Instructions.

39. EIR NO. 64-427: Exciter, Ignition, Type TGLN-1112

DESCRIPTION: During flight No. 4, the pilot reported that the No. 2 engine was difficult to start using normal methods. Subsequent investigation by installing a test ignition exciter revealed that the ignition exciter was defective.

RECOMMENDATION: Recommend that manufacturer be advised of failure to determine exact cause(s) and to initiate corrective action to prevent failures of this nature.

40. EIR NO. 64-499: Pump Assembly, Engine Driven Hydraulic

DESCRIPTION: Before flight No. 1, it was necessary to bleed the No. 1 hydraulic pump before sufficient pressure could be attained. Subsequent trouble shooting disclosed the subject pump defective by replacement with a like serviceable item.

RECOMMENDATION: Recommend that manufacturer be advised of failure to determine exact cause(s) and to initiate corrective action to prevent failures of this nature.

41. EIR NO. 64-504: TM 55-1510-204-20, dated 10 September 1963

DESCRIPTION: TM 55-1510-204-20, dated 10 September 1963, chapter 2, section III, paragraph 3-381e, page 3-108, and paragraphs 3-435a(5) and b(4) on pages 3-119 and 3-120 specify required tire inflation for main wheels (90 p.s.i.g) and nose wheels (65 p.s.i.g), respectively. No reference is made throughout the subject paragraphs to Table 1-III of chapter 2, section I, on page 1-11 of TM 55-1510-204-20. This table provides the required tire inflation versus aircraft gross weight.

RECOMMENDATION: Recommend that TM 55-1510-204-20, dated 10 September 1963, chapter 2, section III, paragraph 3-381e, on page 3-108, and paragraphs 3-435a(5) and b(4), on pages 3-119 and 3-120, respectively, be changed to read, "Inflate tire to the required pressure in accordance with chapter 2, section I, Table 1-III."

42. EIR NO. 64-533: Heater Assembly, Fuel

DESCRIPTION: During post-flight inspection, an excessive oil leak was noted under No. 2 engine. Subsequent investigation revealed that the No. 2 engine fuel heater was cracked. The crack was located in the housing at the point where the mount is welded to the housing.

RECOMMENDATION: Inasmuch as this is the first failure of this nature reported at this activity, there are no recommendations and subject EIR is submitted for statistical purposes only. EIR No. 64-376, on the same item and nomenclature, is for heater assembly manufactured by another company and bears a different part number.

43. EIR NO. 64-588: Heater Assembly, Fuel

DESCRIPTION: Upon landing after last flight of the day, it was noted that oil was leaking under the No. 2 engine. Subsequent

investigation revealed that the No. 2 fuel heater assembly was cracked and leaking. The crack was located along the weld of the aft inboard attaching bracket.

RECOMMENDATION: Recommend that manufacturer be advised of failure to determine exact cause(s) and to initiate corrective action to prevent failures of this nature.

44. EIR NO. 64-589: Heater Assembly, Fuel

DESCRIPTION: After receiving a new fuel heater assembly from supply, properly sealed in appropriate container, it was noted by visual means that the new fuel heater assembly contained foreign matter. This foreign matter was found in the fuel outlet port and appeared to be an accumulation of grit or dirt. Also, the heater assembly had the appearance of being used prior to this incident.

RECOMMENDATION: Recommend that manufacturer be advised of discrepancy to determine exact cause(s) and to initiate corrective action to prevent failures of this nature.

45. EIR NO. 64-606: TM 55-1510-204-20, dated 10 September 1963

DESCRIPTION: TM 55-1510-204-20, dated 10 September 1963, chapter 2, section IX, paragraph 9-7b, page 9-1, requires inspection of flight control bearings for excessive looseness or binding; however, no radial or axial limits are provided for outboard rudder hinge bearings. Chapter 2, section IV, Periodic Inspection, Area 7.6, on page 4-6, requires inspection of the rudder bearings for excessive wear, and again no limits are provided.

RECOMMENDATION: Recommend that wear tolerance for the outboard rudder bearing be established and that these criteria be furnished using field activities at the earliest possible date.

46. EIR NO. 64-648: Gear Box Assembly, Engine

DESCRIPTION: During a routine daily inspection, the No. 2 engine gear box assembly was found to be cracked. The crack, approximately 2 inches in length, was located at the upper mounting flange.

RECOMMENDATION: Inasmuch as this is the first failure of this nature reported within the last 12 months at this activity, there are no recommendations and subject EIR is submitted for statistical purposes only.

47. EIR NO. 64-672: Control Assembly, Fuel

DESCRIPTION: During flight No. 1, the pilot reported that No. 2 engine developed compressor stalls on takeoffs, static run-ups, and landings. Subsequent investigation by replacement of the No. 2 fuel control assembly with a like serviceable item revealed that the subject fuel control was defective.

RECOMMENDATION: Inasmuch as this is the first failure of this nature reported at this activity, there are no recommendations and subject EIR is submitted for statistical purposes only.

48. EIR NO. 64-732: Thermocouple, Exhaust

DESCRIPTION: During flight No. 3, the pilot reported that the No. 1 engine EGT indicator was inoperative. Subsequent investigation by a continuity check revealed an open circuit between pins "A" and "B" of the thermocouple electrical connector.

RECOMMENDATION: Inasmuch as this is the first failure of this nature by this part number reported at this activity, there are no recommendations and this EIR is submitted for statistical purposes only.

49. EIR NO. 64-749: Pump Assembly, Engine Driven Hydraulic

DESCRIPTION: During flight No. 2, 15 May 1964, all hydraulic pressure was again lost on both systems. In troubleshooting the system to determine the cause of the malfunction, excessive hydraulic fluid leakage was noted at the pump drive shaft drain lines, which indicated internal failure of pump seals.

RECOMMENDATION: Recommend that the manufacturer investigate this failure to determine what action is necessary to eliminate recurring failures of this nature.

50. EIR NO. 64-750: Pump Assembly, Engine Driven Hydraulic

DESCRIPTION: During flight No. 1, the pilot reported that the No. 1 engine hydraulic pressure fluctuated between 0-1500 p.s.i. Investigation disclosed that the hydraulic reservoir was low, and further inspection revealed evidence of hydraulic oil leakage at the pump drive shaft drain line.

RECOMMENDATION: Recommend that manufacturer investigate this failure to determine what action is necessary to eliminate recurring failures of this nature.

51. EIR NO. 64-808: Pump Assembly, Engine Driven Hydraulic

DESCRIPTION: Upon returning to home base, an inspection of the hydraulic pumps was initiated resulting from the need to refill the reservoir 2 times within a period of 02:55 hours. The inspection of the hydraulic pumps revealed that hydraulic fluid was leaking from the pump cavity drains. Further investigation revealed that the No. 1 hydraulic pump case drain line was completely clogged with metal particles. NOTE: Each of the above mentioned hydraulic pumps had 2 each check valves, P/N 134SCH174-4, installed in the case drain lines.

RECOMMENDATION: Recommend that manufacturer be advised of failure to determine exact cause(s) and to initiate corrective action to prevent failures of this nature.

52. EIR NO. 64-809: Pump Assembly, Engine Driven Hydraulic

DESCRIPTION: During the first flight after installation of the pump, the pilot reported that the hydraulic pressure on the No. 1 engine dropped to 2100 p.s.i. Also, upon landing all hydraulic pressure was lost on the No. 1 engine. Subsequent investigation by removal of the No. 1 hydraulic pump revealed that the pump head seal was blown, allowing hydraulic fluid leakage.

RECOMMENDATION: Recommend that manufacturer be advised of failure to determine exact cause(s) and to initiate corrective action to prevent failures of this nature.

53. EIR NO. 64-818: Engine Assembly, Aircraft Turbo-Prop

DESCRIPTION: During normal flight at 2500 feet, 130 knots with 61 p.s.i. torque pressure, 520° exhaust gas temperature, 88

percent N_1 r.p.m., and 1450 N_2 r.p.m., the No. 1 engine chip detector light came on. Approximately two seconds later No. 1 engine EGT rose to 640°C. and torque pressure fell to zero. The engine was immediately shut down and the aircraft was returned to home base and landed without incident. Upon removal and partial disassembly of the engine it was found that the No. 3 and No. 4 main bearings were burned excessively and the main power shaft is believed to be broken, inasmuch as the power turbine could be rotated without turning the propeller shaft. It is not known at the present time which failure occurred first.

RECOMMENDATION: Recommend that manufacturer investigate this failure to determine exact cause(s) and, if necessary, initiate corrective action to preclude recurring failures of this nature.

54. EIR NO. 64-847: Pump Assembly, Engine Driven Hydraulic

DESCRIPTION: During flight No. 1, the pilot reported that the No. 1 hydraulic system pressure dropped from normal operating pressure to 2400 p.s.i. The speed brakes were actuated and the pressure returned to normal, 3000 p.s.i., but would gradually drop to 2200-2400 p.s.i. This process was repeated several times, but the same discrepancy occurred. The pilot then started to return to home base with the No. 1 hydraulic pressure at 2400 p.s.i. On the return trip, the No. 1 hydraulic pressure dropped to 0 p.s.i. and shortly thereafter, the No. 2 hydraulic system pressure fell to zero. The landing gear was lowered pneumatically, and a landing was accomplished without incident. Subsequent investigation revealed a seal had blown in the No. 1 hydraulic pump, allowing fluid to escape between the mating surfaces at the head of the pump. Further investigation revealed that the quick disconnect in the No. 1 hydraulic pump bypass line was clogged with metal particles. After the No. 1 hydraulic pump and No. 1 quick disconnect were replaced, the aircraft was operationally checked. During the operational check, the No. 2 hydraulic system had no pressure. The system was bled and the pressure then came up. The engines were shut down and a second start again revealed no pressure indication on the No. 2 hydraulic system. The system was bled again and the pressure came up; however, the No. 2 hydraulic pump, S/N 54115, was excessively noisy.

RECOMMENDATION: Recommend that manufacturer be advised of failure to determine exact cause(s) and to initiate corrective action to prevent failures of this nature.

55. EIR NO. [illegible]-853: Pump Assembly, Engine Driven Hydraulic

DESCRIPTION: During operational check after the installation of a new engine, S/N LE-05119, in the No. 1 position with a new hydraulic pump, it was noted that the No. 1 hydraulic pressure would not stay in the normal operating range. Subsequent investigation revealed that No. 1 hydraulic pump was leaking between the mating surfaces at the head of the pump.

RECOMMENDATION: Recommend that manufacturer be advised of failure to determine the exact cause(s) and to initiate corrective action to prevent failures of this nature.

56. EIR NO. 64-854: Pump Assembly, Engine Driven Hydraulic

DESCRIPTION: During flight No. 1, the pilot reported that the No. 2 engine hydraulic pressure fluctuated during the last 15 minutes of the flight. During flight No. 4, it was reported that the No. 2 engine hydraulic pressure was reading 800 p.s.i. low at cruise power. Subsequent investigation revealed that the No. 2 hydraulic pump was defective.

RECOMMENDATION: Recommend that manufacturer be advised of failure to determine exact cause(s) and to initiate corrective action to prevent failure of this nature.

57. EIR NO. 64-85[illegible]: Pump Assembly, Engine Driven Hydraulic

DESCRIPTION: During flight No. 1, the pilot reported that the No. 2 hydraulic system pressure dropped to 2100 p.s.i. in approximately seven minutes. Activation of the speed brakes brought the pressure back to normal, but the same condition occurred in a matter of a few minutes.

RECOMMENDATION: Recommend that manufacturer be advised of failure to determine exact cause(s) and to initiate corrective action to prevent failure of this nature.

58. EIR NO. 65-80: Vaporizer Assembly, Fuel Combustion Chamber

DESCRIPTION: During an engine hot section inspection, pulled in an attempt to isolate the cause of an over-temperature condition

(680°), seven fuel vaporizer assemblies were found damaged. Three T-canes, No. 1, No. 3, and No. 10 were found to be broken completely in two pieces; the seal combustion chamber nozzle sleeve, P/N 1-130-083-01, and the fuel vaporizer combustion chamber divider, P/N 1-130-112-01. The other four damaged T-canes, No. 4, No. 5, No. 6, and No. 9, were cracked at the aft end of the sleeve.

RECOMMENDATION: Recommend that manufacturer be advised of failure to determine exact cause(s) and to initiate corrective action to prevent failures of this nature.

ENGINEERING ANALYSIS

USATECOM PROJECT NO. 4-3-1110-06

"LOGISTICAL EVALUATION OF THE T53-L-7 ENGINE"

1. This engineering analysis presents a summary of the engine and hydraulic problems encountered.

2. During the first 300 hours of this test, plots showed that both engines were performing in accordance with engine specifications. Following the 300-hour internal inspection, the performance data indicated that both engines were producing approximately 60 horsepower less than rated power at takeoff power gas-producer speed, and that the exhaust gas temperature was higher than normal on the left engine (LE-02030X). In an effort to determine the reason for the loss in power and the high exhaust gas temperature and to correct the condition, the left engine was disassembled twice and the right engine (LE-02026X) once.

a. During the first disassembly of the left engine, the power turbine segment seal, P/N 1-140-277-02, was replaced and the bumper clearance (clearance between the gas-producer turbine nozzle and the power turbine nozzle) was found to be 0.073 inch. The allowable bumper clearance is 0.030 to 0.070 inch. This discrepancy was corrected. A power check following reassembly of this engine indicated that the high exhaust gas temperature condition had been corrected but that the power output was still low. Based on the manufacturer's recommendation, both engines were then disassembled and the following components replaced in both engines:

(1) Power turbine nozzle seal retainer assembly, P/N 1-140-290-02.

(2) Power turbine seal spring, P/N 1-140-223-01.

(3) Power turbine segment seal, P/N 1-140-222-02.

(4) Power turbine cylinder sealing ring, P/N 1-140-224-02.

(5) Power turbine cylinder lockwires, P/N 1-140-225-01.

b. Following this maintenance and replacement of these components, performance data indicated that the engines were producing approximately 30 horsepower less than rated power at takeoff power gas-producer speed and the exhaust gas temperatures were normal. The indication of reduced power output was considered to be within the range of the data reproducibility and, therefore, the airplane was released for flight.

c. Subsequent performance data indicated that the performance of the left engine did not change significantly during the 300- to 600-hour test period; however, the right engine experienced a loss of power output of approximately 150 horsepower at the rated takeoff power gas-producer speed. Some of this power loss was regained at 750 hours when a new bleed band was installed. After the hot end was rebuilt, at 876 hours, the engine again produced normal rated power. The reason for the power loss is not known.

3. The following problem areas were encountered:

a. Fuel Control. This problem was characterized by failure of the bleed band to close on the left engine (LE-02030X) during takeoff. Signals from the fuel control (P/N 1-170-240-01) are designed to keep the bleed band closed during steady state engine operation above approximately 78 percent gas-producer speed. Pilots reported, and the photo panel confirmed, that during takeoff the left engine would be 10 to 15 p. s. i. lower in torque pressure than the right engine. However, when the power lever was retarded slightly, the torque pressure would jump up to a value corresponding to that of the other engine. The manufacturer recommended that the fuel control be replaced on the left engine. This was accomplished at 165:25 hours (engine time) and this action corrected the discrepancy. The defective fuel control was returned to the manufacturer and subsequent investigation revealed that the lock screw which holds the compressor outlet pressure signaling device to the extended fuel control shaft had loosened, allowing the shaft to rotate without transmitting the compressor outlet pressure closing signal to the bleed-band actuator. The bleed-band actuator not receiving the closing signal allowed compressor discharge pressure to bleed off resulting in low power output. Other problems associated with this mechanism have not been encountered.

b. Engine Failure of LE-02030X. No. 1 engine LE-02030X failed at 633:15 hours. Inspection showed the probable cause to be a structural failure of the rotor disc at the 5th axial compressor stage.

The centrifugal compressor stage and the No. 1 gas-producer turbine were heavily damaged. All blades had been sheared off the No. 1 turbine wheel. A new T53-L-7 engine, LE-02017X, was installed and engine LE-02030X was returned to the manufacturer for investigation. LE-02017X was removed at 242 flight hours because the manufacturer suspected that it also had a faulty 5th stage rotor disc. LE-02030X, which had been overhauled and zero timed, was reinstalled.

c. Engine Failure of LE-02030X. No. 1 engine LE-02030X failed at 943 hours. The engine chip detector warning light came on in flight. Seconds later, the torque pressure dropped to zero and the EGT went to 640°C. The engine was removed and sent to the manufacturer for analytical teardown. The primary cause of engine failure was No. 3 and No. 4 main bearing failure with subsequent power shaft failure. The reason for the bearing failure has not been determined; however, a full report will be forwarded by the manufacturer. Engine LE-05119 with no previous operating time was installed in the No. 1 position.

d. Cracking of Propeller Shaft on LE-02026X.

(1) The reduction gearing section was removed and disassembled at 596 engine hours after illumination of the magnetic chip detector warning light in flight, and appropriate maintenance troubleshooting procedures were accomplished. It was discovered that the propeller shaft, P/N 1-020-180-01, was cracked. The cracked shaft was sent back to the manufacturer for investigation and a new shaft and reduction gear assembly, P/N 1-020-200-01, were installed. Several of the components of the old reduction gear assembly were installed in the new assembly, among which were the planetary gear roller bearings. After reassembly and reinstallation of the engine, the aircraft was flown for 11 hours and the chip detector warning light came on again. The No. 2 forward planet bearing in the reduction gear assembly was found to be damaged and was replaced. This damage was apparently caused by the previous propeller shaft failure.

(2) Upon removal and inspection of LE-02026X at 2061 hours, the propeller shaft was again found to be cracked.

(3) The manufacturer's report on this problem indicated that the cracking was caused by the failure to eliminate certain stress-rising radii in the manufacturing process. The second propeller shaft which had not been modified to eliminate the stress risers was inadvertently installed. No cracking problems have been experienced with the modified shaft installed on other engines.

(4) Changing of the propeller shaft and No. 2 planetary bearing was accomplished under the supervision of the manufacturer's engineers and is depot-level maintenance.

e. Hot-End Failure of LE-02026X.

(1) During flight (at 876 engine hours), No. 2 engine, LE-02026X, lost oil pressure and was shut down. Subsequent investigation disclosed a broken oil scavenge manifold to the No. 3 and No. 4 bearings, which had failed. Two cracks, 2-3 inches in length, were found in the support cone. Since high-frequency vibrations would most likely cause these cracks, it was decided to conduct a special hot-end inspection. Failure of one of the main bearings was suspected. The inspection disclosed the following:

(a) Seven fuel vaporizer seals ("T" cane seals) had broken. Parts of the seals were found in various sections of the engine, from the combustion chamber to the power turbine nozzle. All "T" canes were burned or cracked, seven requiring replacement; however, none had broken off completely, as has been the case in the past.

(b) The gas-producer nozzle had sustained extensive damage to all the trailing edges of its vanes. The gas-producer turbine wheel had extensive damage to all blades, especially to the leading edges and tips. Seventy percent of one blade was missing.

(c) Similarly, severe damage was found on the power turbine wheel and nozzle.

(d) The mounting brackets of the combustor liner assembly were worn excessively.

(2) It is believed that a high-frequency vibration caused failure of the fuel vaporizer seals, P/N 1-130-097-02, P/N 1-130-094-02. Pieces of these seals, which are metal, passed through the engine and caused the extensive damage to the gas-producer and power turbine wheels and nozzles. The source of the vibration could have been either the failed No. 3 and No. 4 bearings or the loosening of the combustor liner due to wear of the combustor liner mounting brackets and studs. Upon disassembly of the engine, the liner was found to be very loose.

f. Suspected Engine Vibration of LE-02026X. At 2061 engine hours, the pilot reported excessive vibration in the aircraft. Normal

maintenance troubleshooting procedures, including engine vibration checks, and test flights could not reduce the vibrations, but it was determined that the cause of the vibration was in the area of the right engine. The engine has been sent to the manufacturer for analytical teardown. The manufacturer was unable to reproduce the vibrations in the test cell and could find no cause for them upon engine teardown.

g. Hydraulic Pump (P/N 56175). During the test, several complete hydraulic system failures were experienced and 24 hydraulic pumps were replaced. The cause of this problem was determined to be the installation of five test metallic filters. When the filters were removed, no further problems were experienced with the hydraulic pump. However, sufficient data were not obtained to substantiate a change in the TBO.

4. In considering the problem areas encountered during the test, the following facts were determined:

a. The fuel control malfunction on LE-02030X was an isolated case and had no relationship to engine operating time.

b. The failure of the compressor 5th stage rotor disc on LE-02030X was caused by a flaw in the forging process used by the manufacturer. This malfunction should not reoccur and should not be considered in determining engine operating time.

c. The failure of the No. 3 and No. 4 bearings on LE-02030X is not considered to be a function of engine operating time. Although the bearings were ground up too badly to determine conclusively, it appeared at the engine teardown inspection that the failure was due to oil starvation at these bearings and not faulty bearings. Since other engines with the same bearings have operated longer than 950 hours with no problems, this is considered a random failure.

d. The failure of various hot-end components on LE-02026X was the result of the broken oil line to the No. 3 and No. 4 bearings causing bearing oil starvation, bearing failure, and subsequent engine vibrations. All repairs were made at the direct support level. (Normally replacement of the No. 3 and No. 4 bearings is a depot maintenance function. This replacement entailed the replacement of the turbine rotor assembly, P/N 1-140-200-14, which includes these bearings and can be accomplished at direct support level.)

5. It is concluded that, based on the overall performance of the test engines and a total of over 6000 hours of T53 engine flight test experience and engine component development, the hot-end inspection interval should be increased to 600 hours.