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TEST RECORD OF FLIGHT TESTS USING ALCOHOL-TO-JET/JP-8 BLENDED FUEL

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and Engineering Center

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This report documents the results of flying the U.S. Army's UH-60 and CH-47 helicopters on an alternative fuel blend. Test activities were performed by the Army to determine the results of flying the UH-60 and CH-47 aircraft on a 50:50 blend of Alcohol-to-Jet (ATJ) with JP-8. The flight tests and post test hardware inspections determined that there was no discernable difference between the use of petroleum based JP-8 and the ATJ/JP-8 blend. The reported flight tests culminate the activities required to validate that an alternative fuel may be certified for use in these air vehicles.

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I. INTRODUCTION

This report documents the results of flying the U.S. Army's UH-60 and CH-47 helicopters using a 50:50 blend of JP-8 with alcohol-to-jet (ATJ) alternative fuel. In order to reduce its dependency on foreign oil, the U.S. Department of Defense (DoD) is in the process of developing alternative sources of fuel including Fischer-Tropsch Synthetic Paraffinic Kerosene, hydro-treated renewable jet, and ATJ; all of which are blended 1:1 with traditional petroleum-derived fuels. Since the initial directive from the DoD, the U.S. Air Force, U.S. Navy, and U.S. Army have all taken part in certification of alternative fuel sources for use in air platforms. The following is a record of test activities performed by the Army to document the results of flying the UH-60 and CH-47 aircraft on a 50:50 blend of ATJ with JP-8. The reported flight tests culminate the activities required to validate that an alternative fuel may be certified for use in these air vehicles. The material presented is extracted from the Test Record provided by the U.S. Army Redstone Test Center (RTC) to document the test, (ref 1).

On 11 April 2013, the U.S. Army Aviation Engineering Directorate (AED) requested that the U.S. Army Redstone Test Center (RTC) collect flight-test data on UH-60 and CH-47 series helicopters to support ATJ certification effort. From November 2013 to November 2014, RTC collected flight test data for the UH-60L and CH-47D aircraft as outlined in the test plan (ref 2). The primary objective of this test was to determine whether ATJ, in a 1:1 blend with traditional petroleum-derived jet fuel (JP-8), served as a functional equivalent to JP-8 in the UH-60 and CH-47 series helicopters.

II. DESCRIPTION:

A. Alcohol-to-Jet

Isobutanol, the alcohol component of ATJ fuel, can be created by a number of chemical processes. With additional chemical processing, this alcohol can be converted into a jet fuel and blended to a 1:1 volumetric ratio with JP-8 to produce a fuel known as JP-8/ATJ or ATJ8. The resulting fuel is designed to be a drop-in substitute or replacement for petroleum-derived fuels and must meet the requirements of current JP-8 specifications, with the exception of its specified feedstock limitations. The JP-8/ATJ used for this test contained normal military fuel additives (fuel system icing inhibitor, static dissipater, and corrosion inhibiter/lubricity improver) and was mixed to the ratios specified in MIL-DTL-83133H (ref 3). JP-8/ATJ is certified to be flightworthy through the building block processes detailed in MIL-HDBK-510A (ref 4).

B. UH-60L Blackhawk

The UH-60L Black Hawk helicopter is a dual-piloted, twin-engine, turbine-powered, single main rotor helicopter manufactured by the Sikorsky Aircraft Corporation of United Technologies Corporation. The UH-60L is powered by two General Electric T700-GE-701C (-701C) front-drive, turboshaft engines, each rated at 1,890 shp sea level, standard day, maximum rated power. Fuel is stored in two interchangeable, crashworthy, ballistic-resistant tanks, each with a maximum capacity of 180 gal. The fuel system consists of lines from the main fuel tanks, firewall-mounted selector valves, prime/boost pump and fuel tanks, and engine-driven suction pumps. The prime/boost pump primes all fuel lines if prime is lost and acts as an auxiliary power unit (APU) boost for APU starts and operation. A selector valve, driven by a cable from the engine fuel system selector lever on the engine control quadrant, permits operation of either engine from either fuel tank. The engines and APU are suction fed; the APU is fed from the left main fuel tank by a separate fuel line. Control of fuel to the combustion system is accomplished by the hydromechanical unit (HMU) which is mounted to, and driven by, the accessory gear box. The HMU contains a high-pressure pump that responds to three different primary inputs: collective pitch through the load demand spindle, power control lever through the power available spindle, and the electronic control unit or digital electronic control unit inputs for governing. In addition to fuel flow metering, the HMU positions the VG actuator link through a hydraulic piston extending from the left side of the HMU. The VG actuator link varies the angle of attack of the inlet guide vanes and the stage-1 and -2 compressor stator vanes, and opens or closes the anti-ice/start bleed valve. Dual conventional irreversible controls are provided for the pilot and copilot and consist of cyclic, collective, and directional controls. The four-bladed, fully articulated main rotor has a diameter of 53 ft 8 in. and rotates counterclockwise when viewed from above. The tail rotor is a four-bladed, rigid system inclined 20 degrees left from vertical and rotates counterclockwise when viewed from the right side of the aircraft. A more complete description of the aircraft can be found in the operator's manual (ref 5). The test aircraft was considered representative of production UH-60L helicopters. The test aircraft No. 1 engine was a T700-GE-701C engine with approximately 2,670 hours, and the No. 2 engine was a T700-GE-701D/CC (T700-GE-701D with C Control laws) engine with approximately 7,364 hours.

C. CH-47D Chinook

The CH-47D Chinook helicopter is a twin turbine-engine, tandem-rotor helicopter designed for transportation of cargo, troops, and weapons during day and night, visual and instrument meteorological conditions. The helicopter is equipped with two production Honeywell T55-GA-714A (-714A) engines rated at a maximum of 4,777 shp per engine (transmission limited at 7,500 horsepower at 15,066 engine rpm when combined). Fuel is stored in two separate systems which are connected by crossfeed and pressure refueling lines. Each of two fuel system consists of three crashworthy, self-sealing fuel tanks contained in a pod on each side of the fuselage. The left fuel system has a total capacity of 518 gal, and the right fuel system has a total capacity of 510 gal. Each main tank contains two fuel boost pumps, three fuel quantity probes, a jet pump for evacuating the pressure refueling system, a dual pressure refueling shutoff valve, a dual fuel level control valve, and a gravity filler port. Each auxiliary tank contains a fuel pump with an automatic shutoff feature, a quantity probe, a dual pressure refueling shutoff valve, and a fuel level control valve. During normal operation, with all boost pumps operating, fuel is pumped from the auxiliary tanks into the main tanks, then from the main tanks to the engine. Fuel is delivered to the APU from the left main tank and to the heater from the right main tank. Each engine is controlled by a full authority digital electronic control manufactured by Triumph Engine Control Systems. The two engines simultaneously drive tandem, three-bladed, counterrotating rotors through engine transmissions, a combining transmission, driveshafting, and the forward and aft transmissions. When the rotors are stationary, a gas turbine APU drives a generator and hydraulic pump to furnish hydraulic and electrical power. The helicopter is equipped with four, fixed landing gear; an entrance door at the forward right side of the cargo compartment; and a hydraulically powered loading ramp at the rear of the cargo compartment. The pilot and copilot are seated side-by-side with dual, irreversible flight controls. A more detailed description of the CH-47D is contained in the CH-47D operator's manual (ref 6). The test aircraft was considered production representative. The test aircraft No. 1 engine had approximately 1,065 hours, and the No. 2 engine had approximately 1,868 hours.

D. Scope

Flight tests were conducted on a UH-60L and CH-47D at Redstone Arsenal, AL, and within the local flying area from November 2013 to November 2014 as outlined in table 1 through table 4. All flights conducted during Phase I and Phase II were conducted under day visual meteorological conditions (VMC). Flights conducted during Phase III were flown during day or night and VMC or instrument meteorological conditions. Test execution for the UH-60L included 180.0 total flight-hours and 3.2 hours of ground testing. Approximately 12,000 gal of JP-8/ATJ fuel was used during UH-60L flight testing. Test execution for the CH-47D included 27.1 total flight-hours and 0.5 hours of ground testing. Approximately 7,000 gal of JP-8/ATJ fuel was used during CH-47D flight testing. Flight restrictions and operating limitations were in accordance with (IAW) the limits of the applicable helicopter operator's manual (ref 5 or ref 6) and the applicable AED-issued airworthiness releases. Additional flight restrictions and operating limitations for the UH-60L were outlined in the RTC-issued flight release.

Table 1. UH-60L Test Configurations

Configuration	No. 1 Fuel System	No. 2 Fuel System
A	JP-8	JP-8
B	JP-8	JP-8/ATJ[1]
C[2]	JP-8	JP-8/ATJ

NOTES:
[1]JP-8/ATJ – 1:1 volumetric blend of JP-8 and alcohol-to-jet (ATJ) fuel
[2]Aircraft was only flown in configuration C during Phase III longevity flight testing.

Table 2. UH-60L Tests and Test Conditions

Test Phase	Configuration[1]	Test[2]	Pressure Altitude (ft)	Indicated Airspeed (kt)	Remarks
I	NA[3]	Baseline Aircraft Inspection	Field	NA	Before fueling the aircraft with JP-8/ATJ[4], the following inspections were completed to establish baseline information for comparison with later test results. Fuel Cell: Aircraft fuel cells were fully drained. Using a borescope capable of recording images, the internal surface of the No. 2 fuel cell were visually inspected and the condition (to include any damage) documented. Engines: Engines were removed and disassembled IAW[5] technical manual 1-2840-248-23&P (ref 7) to allow detailed inspection and photographic documentation of the combustor, injector, gas generator turbine, and power turbine assemblies. New engine fuel filters were installed. Aircraft: The aircraft fuel system was inspected for visible seeps or leaks.

Table 2. UH-60L Tests and Test Conditions (cont.)

Test Phase	Configuration[1]	Test[2]	Pressure Altitude (ft)	Indicated Airspeed (kt)	Remarks
II[6]	A, B	Fuel Leak Checks/Fuel Quantity Indications	Field	NA	Static: The aircraft was gravity fueled to the bottom of the gravity fuel ports. After being allowed to sit overnight, the fuel system was inspected for leaks. Dynamic: Engine fuel system selector levers were placed in the DIR position. The fuel system was then pressurized by turning the prime fuel pump and the No. 1 and No. 2 fuel boost pumps on. The fuel system was inspected for leaks and the aircraft fuel quantity indicator readings were recorded.
	B	Engine Starts	Field	NA	Engine starts were conducted IAW the UH-60L operator's manual (ref 5). Bleed air for starting the No. 2 engine was provided by APU[7]. Bleed air for starting the No. 1 engine was provided by the No. 2 engine (cross bleed engine start). The maneuver was repeated by conducting an APU start on the No. 1 engine and a cross bleed start on the No. 2 engine.
			5,000	80	
			10,000		
	A, B	Engine Ground Operation	Field	NA	With collective in the full-down position and 100% N_R[8], torque, TGT[9], N_G[10], N_P[11], oil temperature, and oil pressure were recorded for both engines. Pressure altitude, ambient air temperature, and tower-reported wind speed and direction were also recorded.
		HIT[12] Check	Field	NA	Baseline HIT checks were conducted IAW the UH-60L MTF[13] checklist (ref 8). Daily HIT checks were conducted IAW the UH-60L operator's manual (ref 5). Torque, TGT, N_G, N_P, oil temperature, and oil pressure were recorded for both engines. Pressure altitude, ambient air temperature, and tower-reported wind speed and direction were also recorded.
	B	Single-Engine Acceleration/ Deceleration	Field	NA	With both EPCLs[14] at IDLE, the pilot advanced one EPCL to FLY and allowed the engine to stabilize. The pilot then retarded the EPCL to IDLE and allowed the engine to stabilize. Length of time for EPCL movements was decreased from 8 sec to 2 sec in 2-sec increments, or until an operator's manual limit was reached, or would have been reached by proceeding to the next increment. The maneuver was repeated with opposite engine.
			10,000	80	With both EPCLs at FLY, the pilot retarded one EPCL to IDLE and allowed the engine to stabilize. The pilot then advanced the EPCL to FLY and allowed the engine to stabilize. Length of time for EPCL movements was decreased from 8 sec to 2 sec in 2-sec increments, or until an operator's manual limit was reached, or would have been reached by proceeding to the next increment. The maneuver was repeated with the opposite engine.

Table 2. UH-60L Tests and Test Conditions (cont.)

Test Phase	Configuration[1]	Test[2]	Pressure Altitude (ft)	Indicated Airspeed (kt)	Remarks
II	B	Dual-Engine Acceleration/ Deceleration	Field	NA	The pilot simultaneously advanced both EPCLs from IDLE to FLY and allowed the engines to stabilize. The pilot then simultaneously retarded both EPCLs from FLY to IDLE and allowed the engines to stabilize. Length of time for EPCL movements was decreased from 8 sec to 2 sec in 2-sec increments, or until an operator's manual limit was reached, or would have been reached by proceeding to the next increment.
			10,000	80	From a steady-state autorotation with N_P/N_R just joined, the pilot simultaneously retarded both EPCLs from FLY to IDLE and allowed the engines to stabilize. The pilot then simultaneously advanced both EPCLs from IDLE to FLY and allowed the engines to stabilize. Length of time for EPCL movements was decreased from 8 sec to 2 sec in 2-sec increments, or until an operator's manual limit was reached, or would have been reached by proceeding to the next increment.
	A, B	Engine Performance at a Hover	IGE[15]	Hover	Dual Engine: From a stabilized hover, performance planning calculations for each engine were verified. Aircraft was oriented facing into the wind. Single Engine: From a stabilized hover, the pilot retarded one EPCL to IDLE. Performance planning calculations were verified. Aircraft was oriented facing into the wind. The maneuver was repeated with opposite engine.
	B	Hovering Turns	IGE	Hover	From a stabilized hover, the pilot performed a 180-deg pedal turn, stopped for 1-sec, and then reversed direction to return to the original heading. The yaw rate was increased in 10-deg/sec increments up to 30-deg/sec. The maneuver was conducted with winds of 5 kt or less.
			OGE[16]	Hover	
	A, B	Engine Performance in Forward Flight	3,000	80 to V_H[17]	The pilot stabilized in level flight at the target altitude. Torque, TGT, N_G, N_P, oil temperature, and oil pressure were recorded for both engines. Pressure altitude and ambient air temperature were also recorded. Airspeed was increased from 80 kt to V_H in 20-kt increments.
			10,000		
		Maximum Power Check	As Required	120	Maximum power checks were conducted IAW the MTF checklist (ref 8).
	B	Transient Droop	5,000	80	From a steady-state autorotation with N_P/N_R just joined, collective was input at a constant rate until reaching a maximum of 95% torque. Length of time for collective movement was decreased from 5 sec to 1 sec in 2-sec increments. The maneuver was repeated with N_P/N_R split of 5%.
			10,000		
	A, B	Fuel Consumption Check	3,000	120	Start time and fuel quantity were recorded. The pilot maintained level flight at the target altitude and airspeed for 30 min. End time and fuel quantity were recorded.
III[18]	B, C	Longevity Flights	As Required	As Required	The pilot conducted routine flight events (continuation training, chase, etc.). Basic flight data were recorded to identify system anomalies and assist in trend analysis.
		Non-Limiting Maximum Power Checks	2,000	As Required	Non-limiting maximum power checks were conducted using the procedure outlined in the airworthiness release. Data were collected for both engines.
			4,000		
			6,000		
			8,000		
			9,000		
			10,000		

Table 2. UH-60L Tests and Test Conditions (cont.)

Test Phase	Configuration[1]	Test[2]	Pressure Altitude (ft)	Indicated Airspeed (kt)	Remarks
III	B, C	Fuel Consumption Check	2,000 to 10,000	80	Start time and fuel quantity were recorded. The pilot maintained level flight at the target altitude and airspeed for 30 min. End time and fuel quantity were recorded. The maneuver was conducted at altitudes from 2,000 ft to 10,000 ft in 2,000-ft increments.
				V_H	
		Hot Restarts	Field	NA	Hot restarts were conducted on the No. 1 engine.

NOTES:

[1]UH-60L test configurations are defined in table 1.
[2]Unless otherwise specified, tests were conducted at a main rotor speed of 100% (258 rpm), ball-centered trim, with automatic flight control system ON (stability augmentation system [SAS], flight path stabilization, SAS/Boost, and Trim-ON; Stabilator-AUTO).
[3]NA – not applicable
[4]JP-8/ATJ – 1:1 volumetric blend of JP-8 and alcohol-to-jet fuel (ATJ)
[5]IAW – in accordance with
[6]During Phase II testing, aircraft was operated with fuel boost pumps ON and ENG FUEL SYS selector levers in the DIR position.
[7]APU – auxiliary power unit
[8]N_R – main rotor speed
[9]TGT – turbine gas temperature
[10]N_G – gas generator turbine speed
[11]N_P – power turbine speed
[12]HIT – health indicator test
[13]MTF – maintenance test flight
[14]EPCLs – engine power control levers
[15]IGE – in-ground effect
[16]OGE – out-of-ground effect
[17]V_H – level flight airspeed with maximum continuous power applied
[18]During Phase III testing, aircraft was operated with ENG FUEL SYS selector levers in the DIR position.

Table 3. CH-47D Test Configurations

Configuration	Fuel System[1]	
	No. 1	No. 2
A	JP-8	JP-8
B	JP-8	JP-8/ATJ[2]
C[3]	JP-8/ATJ	JP-8/ATJ

NOTES:

[1]Includes the forward auxiliary, main, and aft auxiliary fuel tanks
[2]JP-8/ATJ – 1:1 volumetric blend of JP-8 and alcohol-to-jet (ATJ) fuel
[3]Aircraft was only flown in configuration C during Phase III longevity flight testing.

Table 4. CH-47D Tests and Test Conditions

Test Phase	Configuration[1]	Test[2]	Pressure Altitude (ft)	Indicated Airspeed (kt)	Remarks
I	NA[3]	Baseline Aircraft Inspection	Field	NA	Before fueling the aircraft with JP-8/ATJ[4] the following inspections were completed to establish baseline information for comparison with later test results. Fuel Cells: Aircraft fuel cells were fully drained. Using a borescope capable of recording images, the internal surfaces of all six fuel cells were visually inspected and the condition (to include any damage) documented. Engines: The engines were inspected using SE-876-TM-1005 (ref 9) as a guide. Photographic documentation of the combustor, injector, gas generator turbine, and power turbine assemblies was collected. New engine fuel filters were installed. Aircraft: The aircraft fuel system was inspected for visible seeps or leaks.
II[5]	A, B	Fuel Leak Checks/ Fuel Quantity Indications	Field	NA	Static: The aircraft was gravity fueled to the bottom of the gravity fuel ports. After being allowed to sit overnight, the fuel system was inspected for leaks. Dynamic: XFEED fuel valve switch was placed in the CLOSE position. The fuel system was then pressurized by turning all main tank and auxiliary tank fuel boost pumps on. The fuel system was inspected for leaks and the aircraft fuel quantity indicator readings were recorded.
		Engine Starts	Field	NA	APU[6]: APU engine starts were conducted IAW[7] the CH-47D operator's manual (ref 6). Engine: Engine starts were conducted IAW the CH-47D operator's manual (ref 6). Testing included mixed mode (PRI[8]/PRI, REV[9]/PRI, PRI/REV, REV/REV) starts/shutdowns on both engines.
		Cabin Heater Operation	Field	NA	The pilot operated the cabin heater IAW the CH-47 operator's manual (ref 6). The pilot rotated the CABIN TEMP SEL knob to COOL position and allowed the heater to stabilize for 5 min. The CABIN TEMP SEL knob was adjusted incrementally through the full range to verify proper heater operation. The pilot moved the heater function switch to OFF and allowed the heater to completely cool.
		Engine Ground Operation	Field	NA	With thrust control lever in the ground detent and 100% N_R[10], torque, PTIT[11], N_1[12], oil temperature, and oil pressure for both engines were recorded. Pressure altitude, ambient air temperature, and tower-reported wind speed and direction were also recorded.
		PAC[13]/PAT[14] Check	Field	NA	Baseline PAC checks were conducted IAW the CH-47D MTF[15] checklist (ref 10). Daily PAT checks were conducted IAW the CH-47D operator's manual (ref 6). All four, two-digit hexadecimal series (i.e., XX-XX-XX-88) displayed on the DECU[16]/electronic control unit bit display were recorded.

Table 4. CH-47D Tests and Test Conditions (cont.)

Test Phase	Configuration[1]	Test[2]	Pressure Altitude (ft)	Indicated Airspeed (kt)	Remarks
II	B	Single-Engine Acceleration/ Deceleration	Field	NA	With both ECLs[17] at GND, the pilot advanced one ECL to FLT and allowed the engine to stabilize. The pilot then retarded the ECL to GND and allowed the engine to stabilize. Length of time for ECL movements was decreased from 12 sec to 6 sec in 2-sec increments, or until an operator's manual limit was reached, or would have been reached by proceeding to the next increment. The maneuver was repeated with the opposite engine.
			10,000	80	With both ECLs at FLT, the pilot retarded one ECL to GND and allowed the engine to stabilize. The pilot then advanced the ECL to FLT and allowed the engine to stabilize. Length of time for ECL movements was decreased from 12 sec to 6 sec in 2-sec increments, or until an operator's manual limit was reached, or would have been reached by proceeding to the next increment. The maneuver was repeated with opposite engine.
		Dual-Engine Acceleration/ Deceleration	Field	NA	The pilot simultaneously advanced both ECLs from GND to FLT and allowed the engines to stabilize. The pilot then simultaneously retarded both ECLs from FLT to GND and allowed the engines to stabilize. Length of time for ECL movements was decreased from 12 sec to 6 sec in 2-sec increments, or until an operator's manual limit was reached, or would have been reached by proceeding to the next increment.
			10,000	80	From trimmed level flight, main rotor speed was reduced by selecting 97% N_R on the full authority digital electronic control panel. The pilot then lowered the thrust control lever and stabilized in an autorotation. The pilot simultaneously retarded both ECLs from FLT to GND and allowed the engines to stabilize. The pilot then simultaneously advanced both ECLs from GND to FLT and allowed the engines to stabilize. Length of time for ECL movements was decreased from 12 sec to 6 sec in 2-sec increments, or until an operator's manual limit was reached, or would have been reached by proceeding to the next increment.
	A, B	Engine Performance at a Hover	IGE[18]	Hover	Dual Engine: From a stabilized hover, performance planning calculations for each engine were verified. Aircraft was oriented facing into the wind. Single Engine: From a stabilized hover, the pilot retarded one ECL to GND. Performance planning calculations were verified. Aircraft was oriented facing into the wind. The maneuver was repeated with opposite engine.
	B	Hovering Turns	IGE	Hover	From a stabilized hover, the pilot performed a 180-deg pedal turn, stopped for 1-sec, and then reversed direction to return to the original heading. Yaw rate was increased in 10-deg/sec increments up to 30-deg/sec. The maneuver was conducted with winds of 5 kt or less.
			OGE[19]		
	A, B	Engine Performance in Forward Flight	3,000	80 to V_H[20]	The pilot stabilized in level flight at the target altitude. Torque, PTIT, N_1, N_P, oil temperature, and oil pressure were recorded for both engines. Pressure altitude and ambient air temperature were also recorded. Airspeed was increased from 80 kt to V_H in 20-kt increments.
			10,000		
		Maximum Power Check	As Required	120	Maximum power checks were conducted as outlined in the MTF checklist (ref 10).

Table 4. CH-47D Tests and Test Conditions (cont.)

Test Phase	Configuration[1]	Test[2]	Pressure Altitude (ft)	Indicated Airspeed (kt)	Remarks
II	B	Transient Droop	5,000	80	From a steady-state autorotation, collective was input at a constant rate until reaching a maximum of 80% torque. Length of time for collective movement was decreased from 8 sec to 2 sec in 2-sec increments.
			10,000		
	A, B	Fuel Consumption Check	3,000	120	Start time and fuel quantity were recorded. The pilot maintained level flight at the target altitude and airspeed for 30 min. End time and fuel quantity were recorded.
III	C	Longevity Flights[21]	As Required	As Required	The pilot conducted routine flight events (continuation training, chase, etc.). Basic flight data were recorded to identify system anomalies and assist in trend analysis.

NOTES:

[1]CH-47D test configurations are defined in table 3.
[2]Unless otherwise specified, tests were conducted at a main rotor speed of 100% (225 rpm), ball-centered trim, with advanced flight control system ON.
[3]NA – not applicable
[4]JP-8/ATJ – 1:1 volumetric blend of JP-8 and alcohol-to-jet fuel (ATJ)
[5]During Phase II testing, aircraft was operated with fuel boost pumps ON and XFEED switch in the CLOSE position.
[6]APU – auxiliary power unit
[7]IAW – in accordance with
[8]PRI – primary
[9]REV– reversionary
[10]N_R – main rotor speed
[11]PTIT – power turbine inlet temperature
[12]N_1 – gas generator turbine speed
[13]PAC – power assurance check
[14]PAT – power assurance test
[15]MTF – maintenance test flight
[16]DECU – digital electronic control unit
[17]ECLs – engine condition levers
[18]IGE – in-ground effect
[19]OGE – out-of-ground effect
[20]V_H – maximum level flight airspeed as limited by 100% dual-engine torque, 10-min limit power turbine inlet temperature, cruise guide indicator, or the velocity to never exceed speed, whichever occurs first
[21]Longevity flights were only conducted in configuration C.

E. Methodology

Tests were conducted IAW the RTC test plan (ref 2). Data for all testing were recorded using handheld data cards and cockpit voice recorders. No comprehensive digital data collection system was installed. No additional test-specific engine instrumentation was installed. Two RTC experimental test pilots, qualified in the applicable aircraft, comprised the test aircrew for all ground tests with rotors turning and all flight tests during Phase I and Phase II testing. Two RTC pilots, qualified in the applicable aircraft, comprised the test aircrew for all flight tests during Phase III testing.

III. DISCUSSION

A. UH-60L Black Hawk Tests:

Testing on the UH-60L was conducted from November 2013 to April 2014. Test execution included 180.0 total flight-hours, 3.2 hours of ground testing, and used approximately 12,000 gal of JP-8/ATJ. Throughout the conduct of the UH-60L testing, the -701D/CC engine using JP-8/ATJ operated similarly to the -701C engine burning JP-8. No qualitative performance deltas or objectionable engine operating characteristics were observed. Additional details regarding each phase of testing are outlined below.

1. Phase I (Pre-Test): Pre-test baseline aircraft inspections were conducted as outlined in table 2. The aircraft fuel cells were visually inspected and no abnormalities were observed. Both engines were removed from the aircraft and disassembled for visual inspection of the combustor, injectors, gas generator turbine, and power turbine assemblies. Representatives from AED Propulsion Division inspected the engine, documented the physical condition of the components of interest, and were provided with a complete set of the photographs that were taken during the inspections. The aircraft fuel system was visually inspected by representatives from AED, and no abnormalities were observed. Enclosure 1 contains a partial set of pre-test photographs of engine components to illustrate the condition of the engine components before flight testing (fig 1-1 through fig 1-8). Upon completion of Phase I inspections, the aircraft was cleared to begin flight testing.

2. Phase II. Phase II flight test maneuvers were first conducted with both engines operating with JP-8, and were then repeated with the No. 1 engine operating with JP-8 and the No. 2 engine operating with JP-8/ATJ. When operating with JP-8/ATJ, tests were conducted with the ENG FUEL SYS selector levers in the DIR position to ensure that only JP-8 was used in the No. 1 engine and only JP-8/ATJ was used in the No. 2 engine. All manuevers were conducted as outlined in table 2, and with the exception of the items noted below, no performance deltas or objectionable engine operating characteristics were observed.

   During baseline testing with both engines operating with JP-8, it was noted that the No. 2 engine oil pressure was consistently 15 to 20 psi lower than the No. 1 engine oil pressure. This condition was observed throughout the remainder of the ATJ test program on the UH-60L and was not attributable to the use of JP-8/ATJ.

   During the 30-min fuel consumption checks at 3,000 ft pressure altitude and 120 knots indicated airspeed (KIAS), the No. 1 engine burned 250 lb of JP-8 and the No. 2 engine burned 200 lb of JP-8/ATJ. This resulted in a fuel flow (calculated from main tank fuel quantity indications) for the No. 1 and No. 2 engines of 500 lb/hr and 400 lb/hr, respectively. The UH-60L fuel quantity indication system displays individual fuel tank quantities in 50-lb increments and is not suitable for determining small changes in average fuel flow over short durations. Fuel consumption rates for the No. 1 and No. 2 engines, based on engine start and shutdown fuel quantities, were comparable and no significant differences in fuel consumption were observed.

   During postflight debrief, the pilots stated they noticed a strong fuel odor during flight. Preflight and postflight fuel system inspections were satisfactorily completed, and no signs of fuel leakage were observed. Before flight, the sound-proofing panels covering the fuel cells had been removed to conduct the fuel system inspection and were not replaced before takeoff. With the sound-proofing panels removed during flight, the fuel odor may have been more noticeable to the crew. No further comments regarding fuel odor were received for the remainder of the UH-60L flight test program.

3. Phase III. Phase III flight test maneuvers were conducted with the No. 1 engine operating with JP-8 and the No. 2 engine operating with JP-8/ATJ. Tests were conducted with the ENG FUEL SYS selector levers in the DIR position to ensure that only JP-8 was used in the No. 1 engine and only JP-8/ATJ was used in the No. 2 engine. All manuevers were conducted as outlined in table 2, and no performance deltas or operating objectionable engine operating characteristics were observed.

   Fuel Consumption Checks. The UH-60L fuel quantity indication system displays individual fuel tank quantities in 50-lb increments and is not suitable for determining small changes in average fuel flow over short durations. Fuel consumption rates for the No. 1 and No. 2 engines differed by up to 100 lb/hr, but the difference in fuel consumption could not be correlated to either engine and any observable differences were largely attributable to the fidelity of the UH-60L fuel quantity indication system. The utilization of JP-8/ATJ did not appear create any noticeable change in fuel consumption. Within the limitations of the UH-60L fuel quantity indication system, no significant differences in fuel consumption were observed. Data collected during fuel consumption checks were provided to AED and are summarized in tables 5 and 6.

Table 5. UH-60L Fuel Consumption Checks (Configuration B[1])

Pressure Altitude (ft)	Airspeed (KIAS[2])	OAT[3] (°C)	Torque		TGT[4]		N_G[5]		Engine Oil Temperature		Engine Oil Pressure		Average Fuel Flow[6]	
			No. 1 (%)	No. 2 (%)	No. 1 (°C)	No. 2 (°C)	No. 1 (%)	No. 2 (%)	No. 1 (°C)	No. 2 (°C)	No. 1 (psi)	No. 2 (psi)	No. 1 (lb/hr)	No. 2 (lb/hr)
2,000	80	12	36	34	566	555	87.0	88.0	85	80	65	50	300	300
4,000	80	7	39	38	560	548	87.2	87.4	80	80	70	50	300	300
6,000	80	4	39	38	564	555	87.2	87.9	75	75	70	55	300	400
8,000	80	8	37	37	574	574	87.2	88.4	80	80	70	55	300	300
10,000	80	8	38	38	591	588	88.3	88.8	80	80	70	55	300	200
10,000	145	6	93	93	789	786	96.0	96.6	80	75	80	60	600	600
8,000	145	8	94	95	810	803	96.5	96.8	75	75	80	60	600	600
2,000	151	4	95	95	709	708	93.6	93.5	70	70	80	55	600	600
4,000	155	4	100	100	746	740	94.4	95.0	70	70	80	60	700	700
6,000	155	7	100	100	783	781	95.6	95.9	75	70	80	60	700	700
6,000	80	10	38	38	598	570	88.1	88.5	80	80	70	58	400	400
8,000	80	10	37	36	593	581	88.7	88.9	80	85	70	55	300	300
10,000	80	4	36	35	600	586	88.8	89.0	80	80	70	55	300	300
4,000	80	13	40	39	565	561	87.7	88.1	85	85	70	50	350	350
9,900	DNR[7]	5	86	86	811	795	96.6	96.4	80	75	80	60	600	600
7,850	145	9	95	93	808	792	96.5	96.6	75	75	80	60	650	600
2,400	156	3	98	100	723	718	93.8	94.0	71	62	80	60	620	620

Table 5. UH-60L Fuel Consumption Checks (Configuration B[1]) (cont.)

Pressure Altitude (ft)	Airspeed (KIAS[2])	OAT[3] (°C)	Torque		TGT[4]		N_G[5]		Engine Oil Temperature		Engine Oil Pressure		Average Fuel Flow[6]	
			No. 1 (%)	No. 2 (%)	No. 1 (°C)	No. 2 (°C)	No. 1 (%)	No. 2 (%)	No. 1 (°C)	No. 2 (°C)	No. 1 (psi)	No. 2 (psi)	No. 1 (lb/hr)	No. 2 (lb/hr)
4,450	154	4	99	100	754	739	94.6	94.7	70	61	80	60	650	650
7,600	145	4	87	87	804	784	96.1	97.1	85	80	80	60	600	600
9,600	140	0	82	82	810	785	96.0	96.7	85	80	80	75	500	600
3,700	80	10	39	39	581	571	88.0	89.0	80	80	70	55	300	300
5,700	80	9	38	38	574	560	87.5	87.8	75	75	70	55	400	300
7,700	80	6	37	36	575	572	88.2	88.6	80	75	70	55	300	300
6,000	151	11	100	100	802	793	96.5	96.6	75	75	80	60	680	680
10,000	80	2	39	38	593	582	88.6	88.7	80	75	70	55	340	320
2,000	80	0	37	38	536	525	85.9	86.4	70	70	70	55	300	400
4,000	80	4	36	37	546	547	86.4	87.0	75	75	70	55	400	300
6,000	80	4	36	35	562	558	87.1	87.5	75	75	70	55	300	300
8,000	80	-2	35	36	556	559	86.6	87.4	75	75	70	55	300	400
2,000	152	6	97	97	720	707	93.8	94.1	70	70	80	55	700	600
4,000	150	6	100	99	758	741	95.0	95.2	70	70	80	60	700	600
6,000	151	6	98	98	779	769	95.5	95.7	70	70	75	65	600	600
8,000	151	6	98	98	819	779	96.1	96.3	70	70	65	50	740	600
10,000	140	-1	91	91	809	806	95.6	95.9	75	70	85	65	600	600
10,000	80	-3	34	35	560	561	87.3	88.0	75	70	70	55	300	300
2,000	80	4	27	27	538	531	86.5	86.6	75	70	70	55	300	400
4,000	80	0	32	32	540	527	85.7	87.2	75	70	70	55	300	300
6,000	80	0	36	36	570	563	87.0	87.1	70	70	70	55	300	400
8,000	80	-2	38	37	566	556	87.4	87.6	70	70	70	55	300	300
7,950	152	-8	99	99	793	793	94.5	95.5	60	60	85	65	700	600
10,000	148	-8	100	100	862	853	97.2	99.2	70	60	85	70	700	700
10,000	80	-12	34	35	529	530	85.2	85.8	70	70	70	55	300	300
2,000	150	0	100	100	710	704	93.5	93.5	70	70	80	60	680	680

NOTES:

[1]UH-60L test configurations are defined in table 1.
[2]KIAS – knots indicated airspeed
[3]OAT – outside air temperature
[4]TGT – turbine gas temperature
[5]N_G – gas generator turbine speed
[6]Average fuel flow was determined by doubling the weight of the fuel used to fly at a constant altitude and indicated airspeed over a 30-min period. Beginning and ending fuel quantities were recorded from the main tank fuel quantity indicators.
[7]DNR – data not recorded

Table 6. UH-60L Fuel Consumption Checks (Configuration C[1])

Pressure Altitude (ft)	Airspeed (KIAS[2])	OAT[3] (°C)	Torque		TGT[4]		N_G[5]		Engine Oil Temperature		Engine Oil Pressure		Average Fuel Flow[6]	
			No. 1 (%)	No .2 (%)	No. 1 (°C)	No. 2 (°C)	No. 1 (%)	No. 2 (%)	No. 1 (°C)	No. 2 (°C)	No. 1 (psi)	No. 2 (psi)	No. 1 (lb/hr)	No. 2 (lb/hr)
3,700	80	0	38	39	533	535	85.8	86.3	70	70	70	55	300	350
6,400	80	-2	37	38	544	548	86.3	86.8	70	70	70	55	300	300
8,450	80	-3	38	39	556	555	86.6	86.9	70	70	70	55	400	300
10,400	83	-5	35	36	562	560	86.9	87.2	70	70	70	55	300	300
2,400	80	-3	39	39	525	522	85.5	85.7	70	70	70	55	350	350
6,000	152	0	100	100	771	764	95.1	95.0	70	70	85	60	660	640
4,000	155	2	100	100	745	735	94.5	94.5	70	60	80	60	680	640
10,000	150	-1	91	91	794	802	95.3	95.6	70	70	85	65	600	600

Table 6. UH-60L Fuel Consumption Checks (Configuration C[1]) (cont.)

Pressure Altitude (ft)	Airspeed (KIAS[2])	OAT[3] (°C)	Torque		TGT[4]		N_G[5]		Engine Oil Temperature		Engine Oil Pressure		Average Fuel Flow[6]	
			No. 1 (%)	No .2 (%)	No. 1 (°C)	No. 2 (°C)	No. 1 (%)	No. 2 (%)	No. 1 (°C)	No. 2 (°C)	No. 1 (psi)	No. 2 (psi)	No. 1 (lb/hr)	No. 2 (lb/hr)
8,000	150	0	96	98	790	783	95.5	95.7	70	70	85	65	600	600
2,000	155	2	97	97	713	706	93.6	93.7	54	54	80	60	640	640
2,000	155	6	100	100	738	725	94.7	94.5	70	70	80	60	700	700
4,000	152	8	99	99	765	745	95.3	95.2	70	70	80	60	600	600
2,000	80	8	42	42	554	550	87.1	87.4	75	75	70	55	400	400
4,000	80	6	35	36	556	553	87.3	87.6	80	70	70	55	400	400
6,000	80	4	37	36	DNR[7]	DNR	87.0	87.0	75	75	70	55	290	300
8,000	80	0	34	34	567	561	87.1	87.3	70	50	70	55	300	290
10,000	80	-4	35	34	586	574	87.9	88.2	75	70	70	55	300	300
6,000	152	6	98	97	780	764	95.8	95.5	70	70	80	60	600	700
8,000	150	1	97	98	799	800	95.8	95.8	70	70	85	60	700	700
10,000	142	0	88	88	800	790	95.7	95.6	75	70	85	65	600	600
5,750	80	4	34	35	638	632	90.3	90.6	90	85	70	55	300	300
7,700	80	2	DNR	DNR	635	635	90.5	90.5	90	89	70	55	300	320
9,800	80	-1	34	33	656	643	91.4	92.3	90	85	70	55	300	400
10,080	140	0	86	86	785	801	95.2	96.0	70	70	85	65	600	600
4,000	80	7	35	36	554	548	87.3	87.5	75	75	70	55	400	400
6,000	153	6	99	100	788	785	96.0	96.2	70	70	85	65	700	700
8,000	145	3	93	92	803	787	95.5	95.8	70	70	85	65	700	700
2,000	80	DNR	35	36	545	533	86.6	86.7	75	75	70	55	400	300
2,000	157	10	99	99	732	718	94.7	94.6	70	70	80	60	700	700
4,000	156	6	99	99	761	743	95.4	95.4	70	70	80	60	700	600
4,000	80	10	37	35	570	553	87.7	87.5	80	80	70	55	300	300
6,000	80	8	38	37	568	555	87.6	87.4	80	75	70	55	400	300
8,000	80	7	33	35	571	566	87.8	88.1	80	80	70	55	300	300
6,000	152	12	98	98	790	773	96.6	96.4	75	75	80	60	600	600
8,000	149	10	98	98	834	807	97.4	97.1	80	75	80	60	700	700
10,000	80	5	35	35	586	573	88.4	88.4	80	80	70	55	300	300
2,050	160	17	100	99	756	732	96.2	95.8	75	75	80	60	700	600
10,050	139	5	91	90	815	798	95.9	96.0	75	75	80	60	600	600
2,000	80	15	36	36	569	557	88.0	88.0	75	75	70	50	400	300
4,050	154	14	97	98	770	748	96.2	96.1	75	75	80	60	700	600

NOTES:

[1]UH-60L test configurations are defined in table 1.
[2]KIAS – knots indicated airspeed
[3]OAT – outside air temperature
[4]TGT – turbine gas temperature
[5]N_G – gas generator turbine speed
[6]Average fuel flow was determined by doubling the weight of the fuel used to fly at a constant altitude and indicated airspeed over a 30-min period. Beginning and ending fuel quantities were recorded from the main tank fuel quantity indicators.
[7]DNR – data not recorded

Hot Restarts. Data collected during 21 hot restarts on the No. 1 engine are summarized in table 7. The utilization of JP-8/ATJ did not appear to affect the engine start or hot restart capability.

Table 7. UH-60L Hot Restart Summary

Configuration[1]	Hot Restart Attempts	Pressure Altitude (ft)	OAT[2] (deg)	Maximum Motoring N_G[3] (%)	Peak TGT[4] (deg)	Engine Oil Temperature (deg)	Engine Oil Pressure (psi)
B	10	100 to 650	3 to 24	29.0 to 29.7	611 to 678	70 to 85	40 to 50
C	11	50 to 750	1 to 23	28.9 to 30.2	615 to 684	70 to 85	40 to 50

NOTES:

[1]UH-60L test configurations are defined in table 1.
[2]OAT – outside air temperature
[3]N_G – gas generator turbine speed
[4]TGT – turbine gas temperature

4. Phase I (Post-Test). Upon completion of flight testing, the post-test aircraft inspections were conducted as outlined in table 2.

   The aircraft fuel cells were visually inspected while still installed on the aircraft, and no abnormalities were observed. During a subsequent phase inspection conducted immediately following completion of the UH-60L flight testing, the fuel cells were removed from the aircraft and the internal components of the fuel cells were removed. Maintenance personnel noted corrosion on several fuel cell components and immediately notified the test team. Representatives from AED inspected the components, and photos of the affected items were provided to AED. The corrosion was observed on components from the No. 1 and No. 2 fuel cells, and as a result, it was determined that the corrosion was not attributable to the use of JP-8/ATJ. Corrosion on the UH-60L fuel pump can be seen in figure 1.

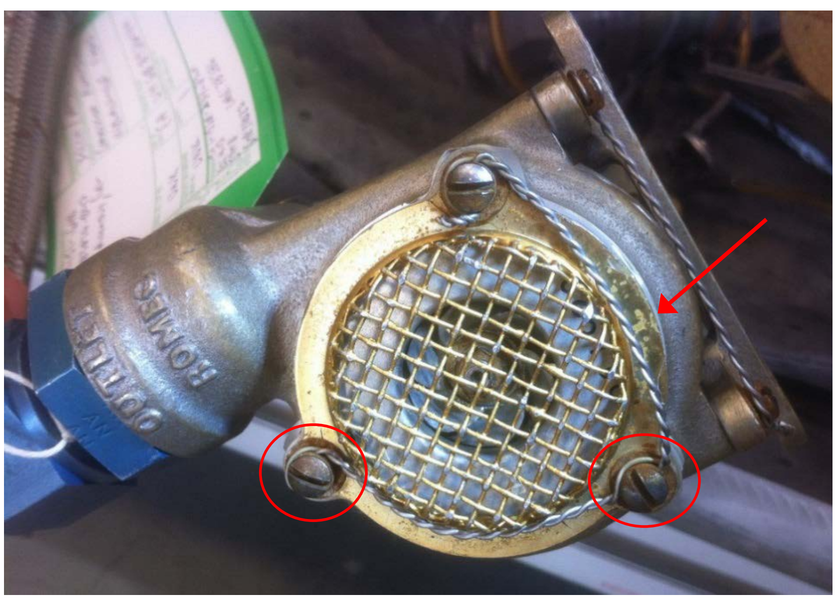

Figure 1. UH-60L Fuel Pump Corrosion

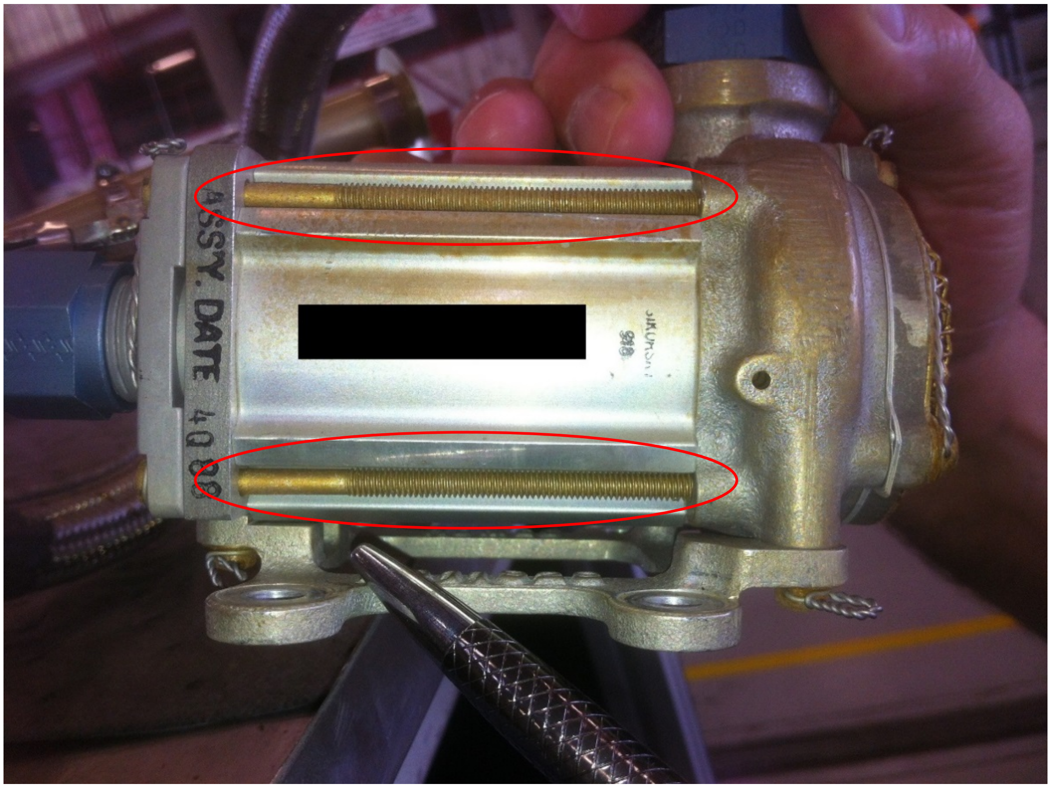

Figure 1. UH-60L Fuel Pump Corrosion (concluded)

Both engines were removed from the aircraft and disassembled for visual inspection of the combustor, injectors, gas generator turbine, and power turbine assemblies. Representatives from AED propulsion conducted the engine inspections, documented the physical condition of the components of interest, and were provided with a complete set of the photographs that were taken during the inspections. Enclosure 1 contains a partial set of pre-test and post-test photographs of engine components to illustrate the condition of the engine components before, and after, completion of 180.0 hours of flight testing (fig 1-1 through fig 1-8).

The aircraft fuel system (fuel lines, engine nacelle, etc.) was visually inspected by representatives from AED, and no abnormalities were observed.

B. CH-47D Chinook Tests: Testing on the CH-47D was conducted from September 2014 to November 2014. Test execution included 27.1 total flight-hours and 0.5 hours of ground testing. When using JP-8/ATJ, the -714A engines, APU, and cabin heater performed similarly to when operated using JP-8. No qualitative performance deltas or objectionable engine operating characteristics were observed. Additional details regarding each phase of testing are outlined below.

1. Phase I (Pre-Test). Pre-test baseline aircraft inspections were conducted as outlined in table 4.

The aircraft fuel cells, fuel system, APU, and cabin heater were visually inspected, and no abnormalities were observed.

Both engines were removed from the aircraft and a visual inspection of the combustor, injectors, gas generator turbine, and power turbine assemblies were conducted IAW the borescope inspection procedures (ref 9). During the borescope inspection of the No. 1 and No. 2 engines, significant coke (carbon) buildup on the fuel nozzles and swirl cups was observed. The combustor section inspection criteria stipulates that any amount of coke buildup is unacceptable. As a result, both engines were shipped to Fort Rucker, AL, for tear-down and hot-end inspection. An AED liaison engineer was present during the engine inspections and documented the physical condition of the components of interest before and after completion of the hot-end inspection and repairs. The condition of both engines was deemed consistent with normal wear and tear and was comparable to that of other -714A engines with a similar number of hours. Figure 2 shows the coke buildup observed during the tear-down inspections. Table 8 contains a list of parts that were replaced during the pre-test tear-down inspections. During tear-down inspections, the engines were cleaned and reassembled IAW the applicable maintenance manuals.

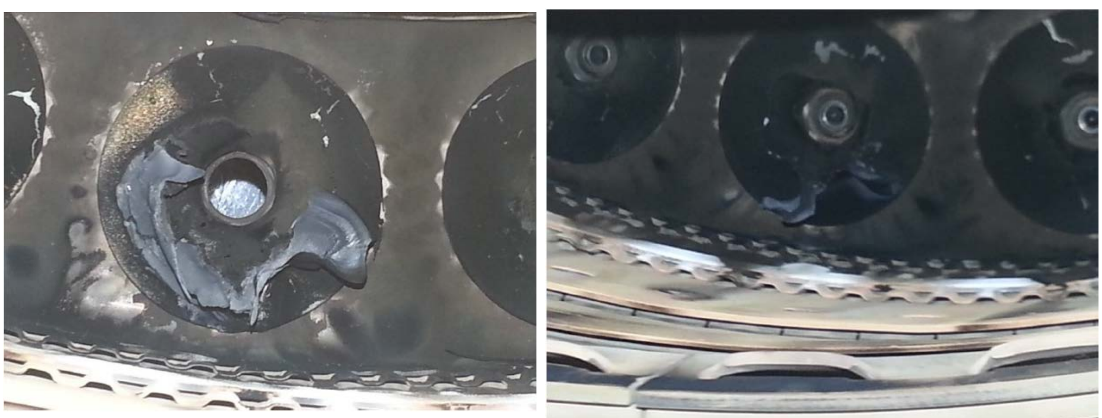

Figure 2. Pre-Test Coke (carbon) Buildup on Swirl Cups in T55-GA-714A Engines

Table 8. Parts Replaced on T55-GA-714A Engines

Engine Number	Part Name (Part Number)
No 1	Thermocouple Harness (01-451-2602)
	Thermocouple Harness (01-451-2596)
	Nozzle, Turbine (01-453-7890)
	Nozzle, Turbine (01-461-4685)
	Baffle, Air (01-200-0299)
No 2	Nozzle, Turbine (01-453-7890)
	Baffle, Air (01-200-0299)
	Coil and Cable Assembly (00-779-3410)
	Liner, Combustion (01-458-9984)
	Seal Assembly (01-169-5088)

2. Phase II: Phase II flight test maneuvers were first conducted with both engines operating with JP-8 and were then repeated with the No. 1 engine operating with JP-8 and the No. 2

engine operating with JP-8/ATJ. When operating with JP-8/ATJ, tests were conducted with the XFEED switch placed in the CLOSE position to ensure that only JP-8 was used in the No.1 engine and only JP-8/ATJ was used in the No. 2 engine. All manuevers were conducted as outlined in table 4. With the exception of the items noted below, no performance deltas or objectionable engine operating characteristics were observed.

During baseline ground testing, the cabin heater did not function properly when using JP-8. A set of contacts on the temperature controller relay closes to complete a circuit to the heater windings in the cabin thermostat. The heater windings heat a column of mercury in the thermostat, and when the temperature reaches 34°C, a contact within the temperature control relay opens and interrupts the circuit to the fuel control solenoid valve. This stops heater operation by shutting off the fuel supply to the heater. Due to the ambient outside air temperature (OAT) of approximately 24°C, it is believed that the switch within the fuel control relay was activated when the air temperature reached 34°C, and caused the cabin heater to shut down within a short time after being started. The crew attempted to check cabin heater operation at 10,000 ft pressure altitude (H_p) with an OAT of approximately 10°C, and obtained a similar result. On additional attempts during the same flight, the cabin heater could not be started. Maintenance inspected the cabin heater and recommended that the cabin heater igniter assembly be cleaned and/or replaced. Based upon the satisfactory results of the cabin heater testing with JP-8/ATJ at the Redstone Aviation Propulsion Test and Research Facility (ref 11), AED authorized RTC to proceed with flight test with JP-8/ATJ. On subsequent flights, the cabin heater was successfully started and functioned properly throughout the selectable temperature range while operating on JP-8/ATJ.

Engine Acceleration/Deceleration. During single-engine acceleration/deceleration testing with the No. 1 engine using JP-8 and the No. 2 engine using JP-8/ATJ, the No. 1 engine reached a peak torque of 120% during the 6-sec movement of the engine control lever (ECL). To prevent exceedance of the 123% single-engine torque limit, ECL movements less than 6 sec were not attempted during the remaining single-engine or dual-engine acceleration/deceleration testing.

Transient Droop. During transient droop testing with No. 1 engine using JP-8 and the No. 2 engine using JP-8/ATJ, the 4-sec thrust control lever (TCL) inputs resulted in the main rotor speed decreasing to approximately 93%. To prevent excessive rotor droop, TCL inputs less than 4-sec were not attempted.

3. Phase III. Phase III flight test maneuvers were conducted with the No. 1 and No. 2 engines, the APU, and cabin heater (when used) operating with JP-8/ATJ. A total of 19.9 flight-hours were flown during Phase III testing. All manuevers were conducted as outlined in table 4. No performance deltas or objectionable engine operating characteristics were observed. Upon completion of Phase III testing, the No. 1 and No. 2 engines had accumulated 19.9 and 25.2 hours of JP-8/ATJ operating time, respectively.

4. Phase I (Post-Test) The aircraft fuel cells were visually inspected while still installed on the aircraft, and no abnormalities were observed.

The No. 2 engine was removed from the aircraft and a visual inspection of the combustor, injectors, gas generator turbine, and power turbine assemblies was conducted IAW the borescope inspection procedures (ref 9). Approval to conduct the post-test borescope inspection on only one engine was provided by AED. As shown in figure 3, the swirl cups were coated with a thin layer of coke. Representatives from AED Propulsion Division conducted the engine inspections, documented the physical condition of the components of interest, and were provided with photographs of the engine components that were taken during the inspection. The post-test condition of the engine was compared to the condition observed during pre-test inspections and deemed, by AED, as consistent with normal wear and tear. The engine was reassembled and reinstalled on the aircraft without any further inspections.

Figure 3. Post-Test Coke (carbon) Buildup on Swirl Cups in T55-GA-714A Engines

C. **Post-Test Actions:** Upon completion of flight test requirements, the following actions were completed as outlined in table 4.

1. JP-8/ATL Blended Fuel: All JP-8/ATJ fuel was used on the UH-60L or CH-47D test aircraft.

2. Fuel Storage Tank: The fuel storage tanker was completely drained and returned to BakerCorp IAW the lease agreement.

3. Aircraft: The following procedures were conducted to ensure the test aircraft were JP-8/ATJ blend free upon completion of testing.

a. UH-60L. The UH-60L entered into phase inspections immediately following completion of flight testing. The fuel cells were drained/sumped such that no JP-8/ATJ fuel remained. Upon completion of phase inspections, the aircraft was refueled with JP-8 fuel and resumed normal flight operations.

b. CH-47D. Upon completion of the post-test inspections, and with AED approval, the remaining 900 gal of JP-8/ATJ fuel were used on the CH-47D test aircraft in support of a separate test effort. Once all remaining JP-8/ATJ fuel was used, the aircraft was refueled with JP-8 and resumed normal flight operations. Per AED guidance, no further inspections were required after the remaining 900 gal of JP-8/ATJ were used.

IV. SUMMARY:

Throughout the testing and in all post test inspections and examinations of hardware, no anomolies were found that are attributable to the ATJ/JP-8 fuel blend being used on these aircraft. The pilots noted no discernable performance or operability impacts due to the use of the alternative fuel. For the duration of these tests, use of the JP-8/ATJ blend was transparent to all fuel wetted systems including the engines.

REFERENCES.

1. Test Record, Alcohol-to-Jet/JP-8 Blended Fuel Certification, ATEC, 5 January 2015

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ENCLOSURE 1. T700-GE-701D/CC INSPECTION PHOTOGRAPHS
Test Record, Alcohol-to-Jet/JP-8 Blended Fuel Certification

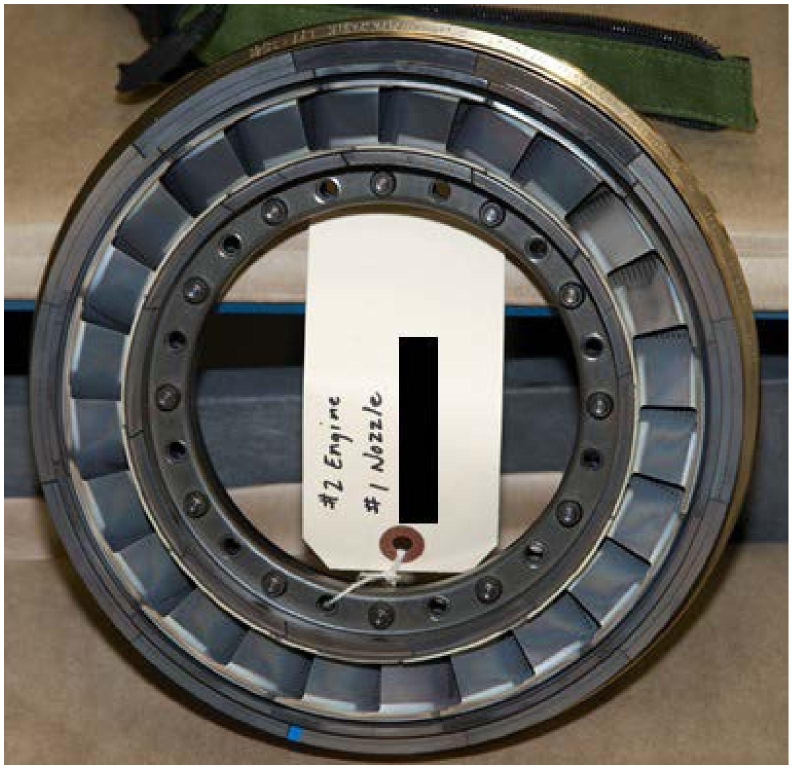

Figure 1-1. T700-GE-701D/CC Stage-1 Nozzle Assembly (Pre-Test)

Figure 1-2. T700-GE-701D/CC Stage-1 Nozzle Assembly (Post-Test)

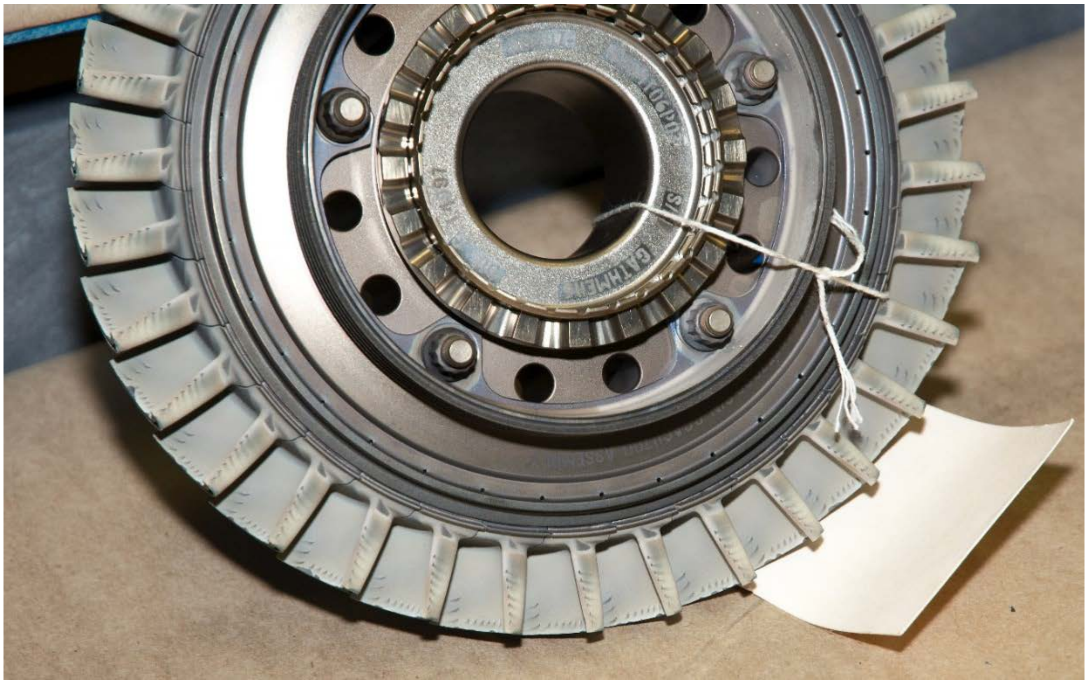

Figure 1-3. T700-GE-701D/CC Stage-1 Gas Generator Turbine Rotor (Pre-Test)

Figure 1-4. T700-GE-701D/CC Stage-1 Gas Generator Turbine Rotor (Post-Test)

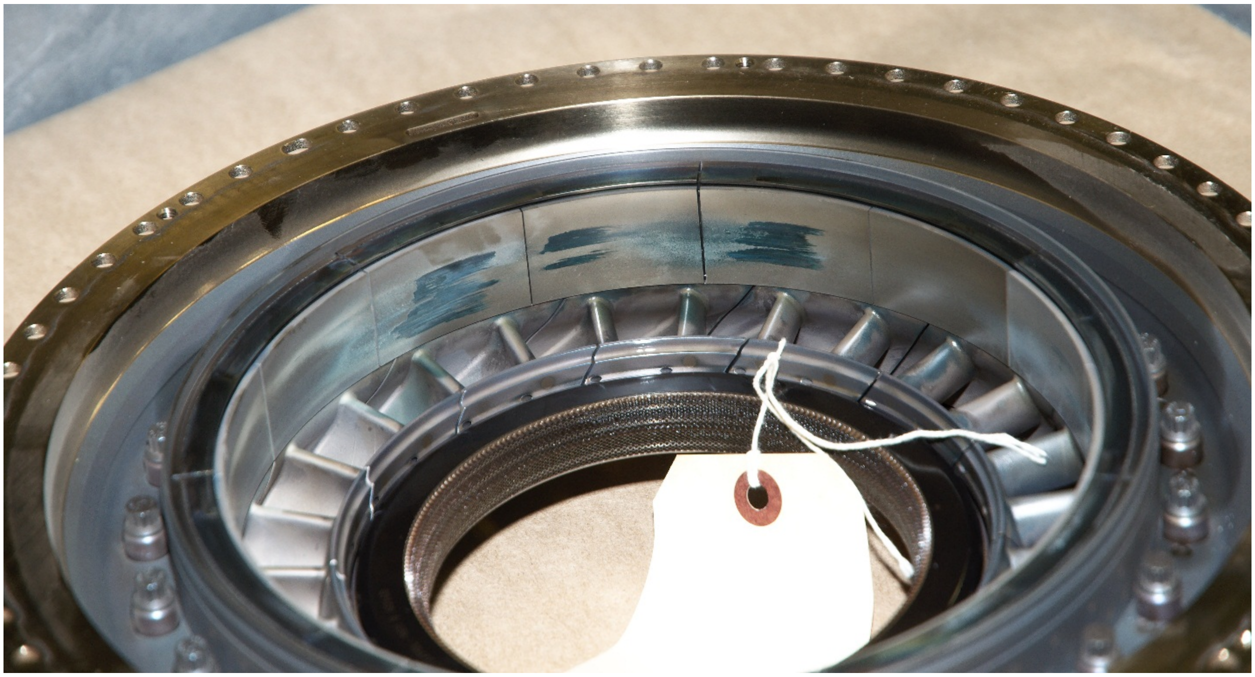

Figure 1-5. T700-GE-701D/CC Stage-1 Gas Generator Stator (Pre-Test)

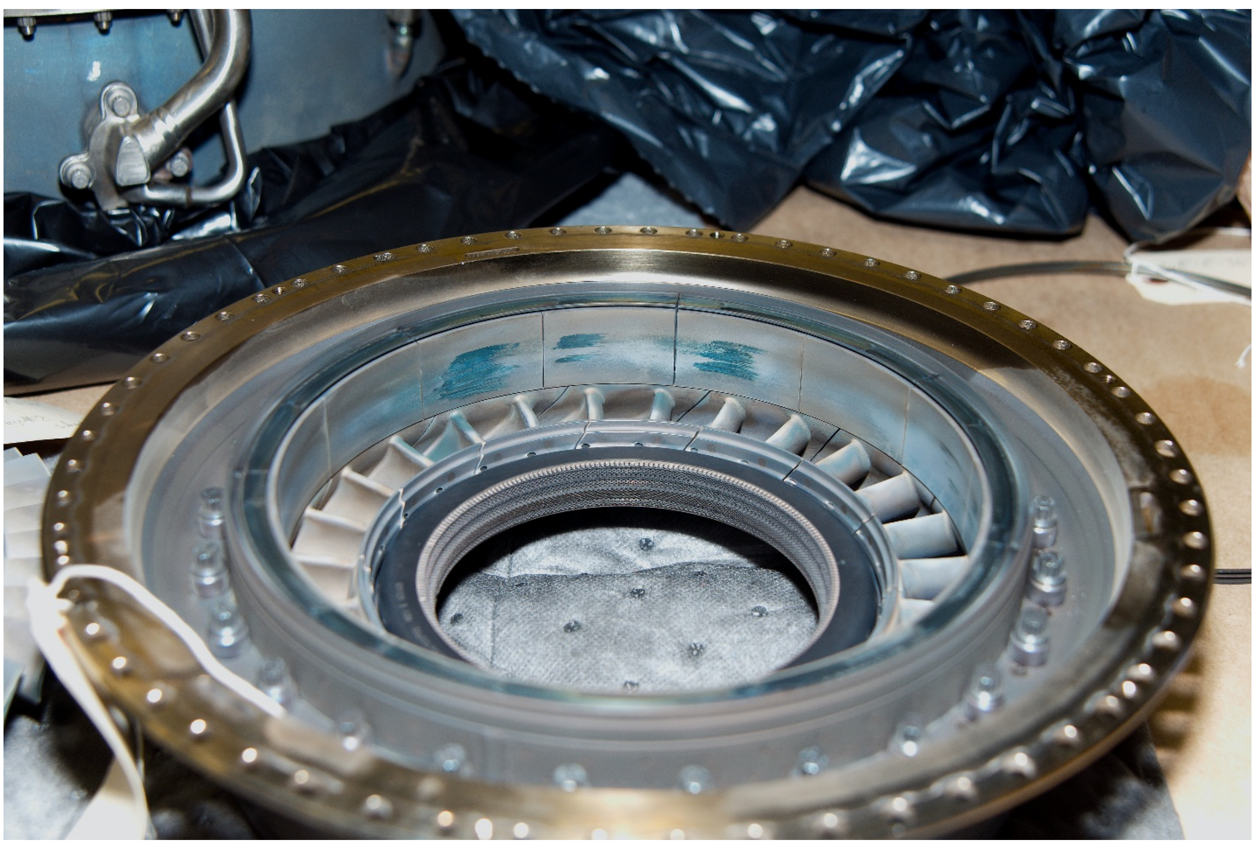

Figure 1-6. T700-GE-701D/CC Stage-1 Gas Generator Stator (Post-Test)

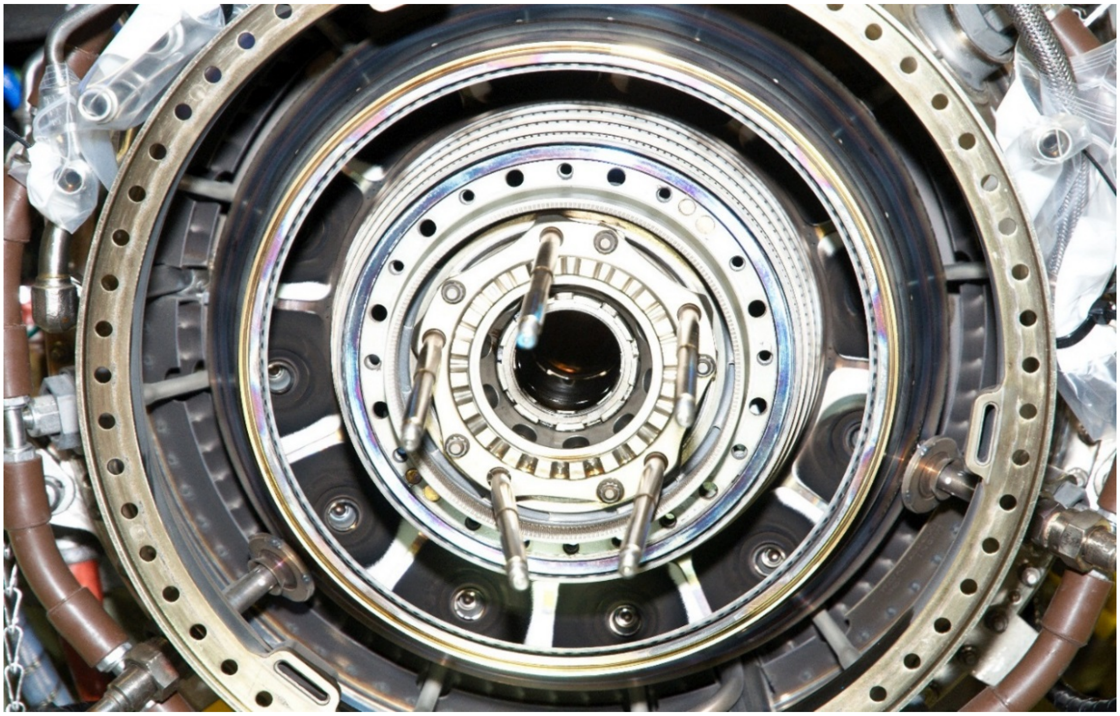

Figure 1-7. T700-GE-701D/CC Combustion Liner (Pre-Test)

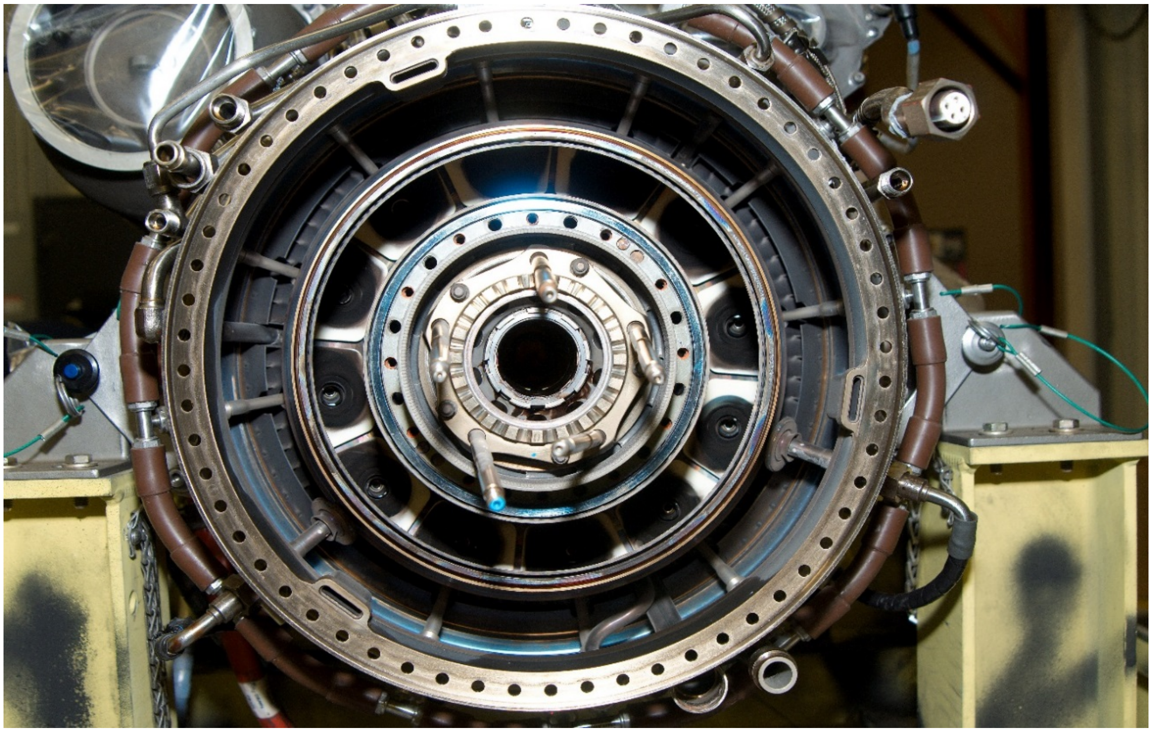

Figure 1-8. T700-GE-701D/CC Combustion Liner (Post-Test)

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