

**ENGINE TEST REPORT
OF ONE MODEL LTS101-700D-2
TURBOSHAFT ENGINE
SERIAL NUMBER LE-46018C**

August 30, 2023

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Approved **Dana Metz** 

Dana Metz
Product Integrity

REPORT NO.:

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ATTACHMENTS: None

Revision	By	Approved	Date	Pages and/or Paragraphs Affected
New	DSM	See Title Page	08/30/2023	All (Initial Issue)

ENGINE TEST REPORT
Ninilchik, Alaska
Eurocopter AS350B2, Registration N160SH
August 25, 2020
NTSB Investigation ANC20LA082

On August 25, 2020, about 0709 Alaska Daylight Time, a Eurocopter (Airbus) AS350B2 helicopter, N160SH, was substantially damage when it was involved in an accident near Ninilchik, Alaska. The commercial pilot sustained minor injuries. The airplane was operated as a Title 14 *Code of Federal Regulations* Part 135 air taxi flight.

On the day of the accident, the aircraft was approaching a mountainside helipad at a slow forward airspeed, when the pilot reported the engine flamed out and yawed right. The pilot attempted an autorotation to a level area approximately 600 feet below the helipad. The aircraft landed on it skids, facing downhill, and started to slide down the mountain. The left skid impacted a rock causing the aircraft to roll on its side. The aircraft came to rest on its left side approximately 200 feet below the helipad.

The aircraft was recovered to the operator's facility where it was inspected by the National Transportation Safety Board (NTSB) Investigator-In-Charge (IIC). The engine was then removed from the aircraft and shipped to Honeywell's Product Integrity Lab where it was placed in bonded storage. At the direction of the NTSB IIC, along with guidelines provided by the NTSB, Honeywell was instructed to conduct an incoming inspection of the engine and a test cell run without oversight by the NTSB or Federal Aviation Administration (FAA), and without party members present.

Incoming Inspection

On February 15, 2021, the engine in its shipping container was moved from the Product Integrity Lab to the Honeywell Engine Development Assembly area for the incoming inspection. The following observations were noted:

- The engine was received in a standard wooden LTS101 shipping container, wrapped in a plastic bag ([Figure 1](#) and [Figure 2](#)).
- The logbook and engine overspeed controller were stored in the bottom of the shipping container ([Figure 3](#)).
- The name plated identified the engine as: ([Figure 4](#))
 - o Model: LTS101-700D-2
 - o MFR Serial No.: LE-46018C
- There was no evidence of fire damage ([Figure 5](#) -[Figure 11](#)).
- There was no evidence of impact damage with the exception of a clamp / bracket on the top of the rear bearing support housing (RBSH) which was bent toward the RBSH ([Figure 12](#)).
- One of the thermocouple leads was damaged ([Figure 13](#)).
- An insert on the top of the plenum was missing ([Figure 14](#)).
- The power turbine was free to rotate.

- The gas producer was free to rotate.
- The accessory gearbox (AGB) mag plug was free of debris (Figure 15 and Figure 16).
- A rear sump Delta Pressure check was conducted in accordance with HTS900-71-00 - 0004 (Figure 17 and Figure 18).
 - o Input P1 = 50 / 14.5 upper limit
 - o Output P2 = 6.5 (offset of 0.5 psi)
 - o 41.4% Acceptable
 - o Orifice 0.040 S/N A, Kit No. 79000171-1
- The cover on the power turbine governor (PTG) was removed to facilitate inspection of internal bearing (Figure 19). The cover broke at the hole for the cotter pin during removal.
- Visual inspection under the cover on the PTG showed no debris present, which was confirmed via borescope. The PTG flyweights were in place and rotated with the power turbine (Figure 20 - Figure 24).
- Safety wire was in place on the PTG in place of the broken cover.

The incoming inspection did not reveal any anomalies that would prevent an attempt to operate the engine. Therefore, the engine was then moved to Test Cell C903 for installation on February 16.

Test Cell Run, No. 1

Engine testing was initiated on February 18, 2021. The engine was installed and operated in accordance with Test Instruction TI-8361C (Figure 25 - Figure 28). After successful dry and wet motors to verify oil flow, vibration levels, start fuel flows, and the ability to terminate fuel flow on command, an engine start was conducted. The initial start was terminated by the cell safety system at the N2 speed limit of 60%. The cell N2 speed limit was raised 70% and a second attempt to start was initiated. The engine successfully reached and stabilized at idle conditions. Engine operating parameters were within acceptable limits. The engine was then accelerated to flight idle conditions, verifying flow fence operation and power turbine governor operation. The engine was then returned to idle and shutdown. The engine was started again and accelerated to maximum continuous power (MCP) setting to establish performance of the engine. Engine performance at MCP Measured Gas Temperature (MGT) appeared slightly low, however an engine performance calibration was not conducted (Figure 29). The power turbine high limit check was also successfully demonstrated. No additional testing was conducted. The engine demonstrated the ability to meter and control fuel flow, power turbine governor operation, and performance. No abnormal operation of the engine was observed. Total operating time was 1 hour 14 minutes and five starts. The engine was preserved and then removed from the test cell, placed back in its shipping container and returned the bonded storage in the Product Integrity Teardown Lab. The engine overspeed controller was not installed or tested during this run.

LTS101 Overspeed Control System

The LTS overspeed control system is an electronic system that consists of a controller that monitors power turbine speed for overspeed condition and a solenoid valve that vents

pneumatic control pressure during an overspeed event causing a reduction in fuel flow. A test circuit, which requires an input from the cockpit is also included in the system. A schematic of the overspeed system is shown in [Figure 30](#). The controller receives two power turbine speed inputs which are compared to reference values (limits) in both digital and analog detectors. Both the digital and analog detectors from either one of the two speed inputs must be true for the system to activate an output signal to the overspeed solenoid valve. A block diagram of the overspeed controller is shown in [Figure 31](#). For the LTS101-700D-2 model engine, the overspeed controller will trip at 108.8 – 109.3 percent power turbine speed and reset at 106.6 – 107.2 percent power turbine speed. The trip speed for the test circuit is 85%.

The overspeed solenoid valve is a normally closed valve mounted in line with the pneumatic control pressure lines. When the solenoid valve is powered open, pneumatic control pressure is vented to ambient condition which causes the fuel control to command minimum fuel flow to the engine, resulting in the engine decelerating to a sub-idle condition. Once the power turbine speed decreases below the reset value, the output signal from the controller to the solenoid will be terminated, de-energizing the solenoid. The valve will close allowing the pneumatic pressure to return to normal values. The fuel control and power turbine governor will then return to normal operation.

The overspeed system also includes the ability to detect movement of the power turbine shaft in the event of a failure of the thrust bearing. A rotating cutter on the power turbine speed pickup will contain the Py elbow mounted in the front of the engine. The loss of axial position of the power turbine shaft due to a failure of the thrust bearing will allow the power turbine shaft to move forward. As the power turbine shaft moves forward, the rotating cutter will cut through the elbow allowing pneumatic control pressure to vent to ambient. As with the reaction of the activation of the overspeed controller, cutting the Py elbow results in the fuel flow being commanded to minimum pressure. Unlike the overspeed solenoid valve, the Py elbow cannot close resulting in the engine continuing to operate at the minimum flow condition. Engine operation above the minimum fuel flow is confirmation of the integrity of the power turbine shaft and thrust bearing, and the rotating cutter did not contact the Py elbow.

Test Cell Run No. 2

On February 23, 2022, Engine S/N LE-46018C was moved back to and installed in Test Cell C903 to conduct testing on the engine overspeed system. The engine overspeed controller was connected to the overspeed solenoid mounted on the engine and powered by the facility 28Vdc power supply. In order to test the overspeed system without operating the power turbine in an overspeed condition, two frequency generators were used to provide input signals to the overspeed controller. The engine was started and accelerated to a flight idle condition, where the power turbine speed was at 100% with minimal torque on the engine. One of the two frequency generators was then increased to a frequency corresponding to approximately 109% power turbine speed. At that input frequency, the overspeed control detected the overspeed condition and the engine decelerated and stabilized at a sub-idle condition and remained operating. The input frequency was then reduced below the reset value, resulting in the engine accelerating back to the flight idle condition. The process was repeated utilizing the second input frequency, and a third time with both frequencies increasing simultaneously. All three

tests successfully demonstrated the ability of the overspeed system to detect the overspeed, command the overspeed solenoid to activate, vent pneumatic control pressure, command the fuel control minimum fuel flow, and the engine to remain operating at the minimum flow condition. The tests also demonstrated the ability of the system to deactivate once the input speed dropped below the reset value, and the engine recovered to normal operation. Operating time for this test was 1 hour 9 minutes and four starts. Total operating time for this investigation was 2 hours 23 minutes and 9 starts. After preservation of the engine, the engine was removed from the test cell, placed back in its shipping container and returned the bonded storage in the Product Integrity Teardown Lab.

Engine test log sheets are presented in [APPENDIX A](#).

Conclusion

Engine S/N LE-46018C successfully demonstrated normal operation during engine testing. The engine operation was free of vibration with no fuel or oil leaks noted. Power turbine governor operation was demonstrated as well as normal operation of the engine overspeed operations. No abnormal engine operation, uncommanded shutdown, or loss of power control was observed during engine operation.



Figure 1. Engine S/N LE-46018C, As Received



Figure 2. Engine S/N LE-46018C, As Received



Figure 3. Engine S/N LE-46018C, As Received

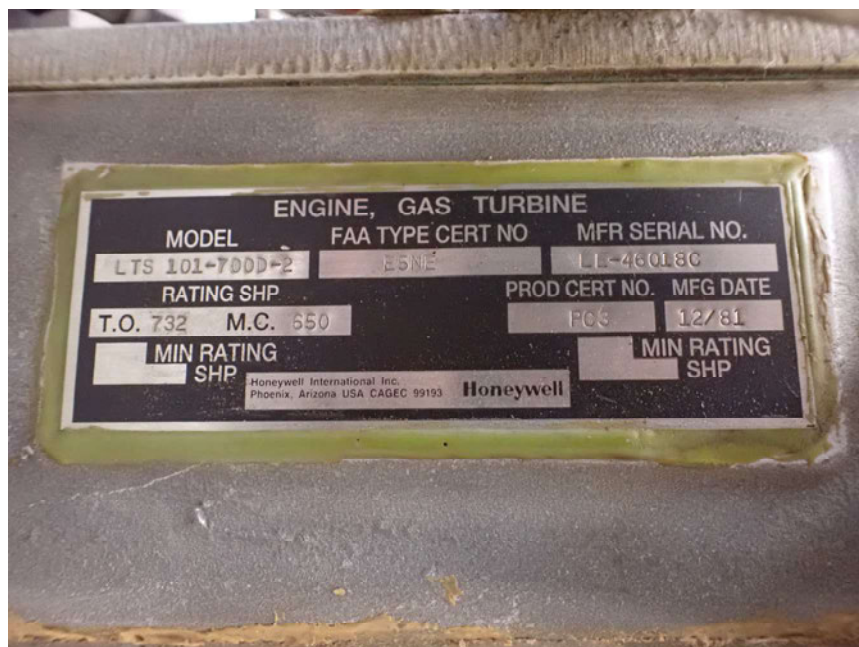


Figure 4. Engine S/N LE-46018C, As Received

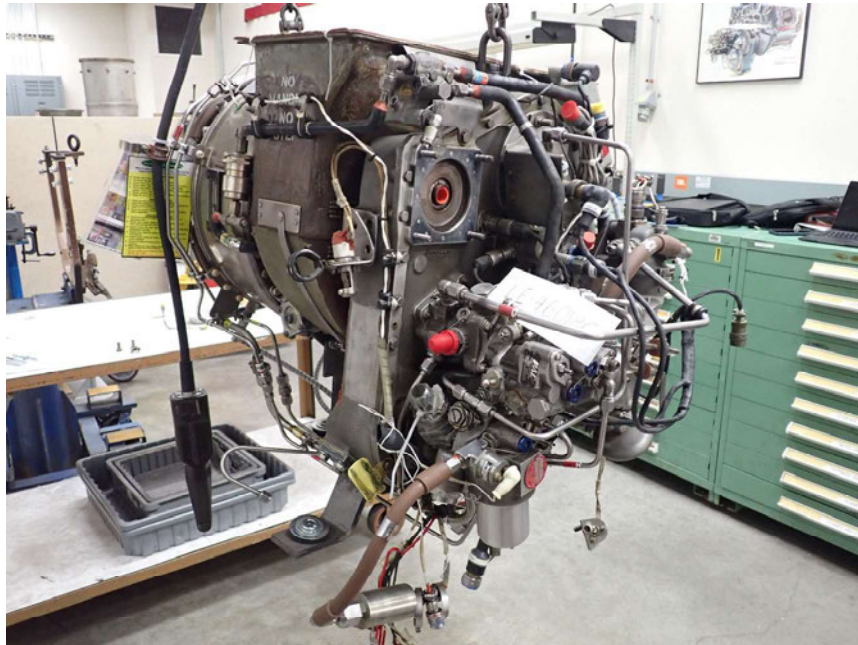


Figure 5. Engine S/N LE-46018C, As Received

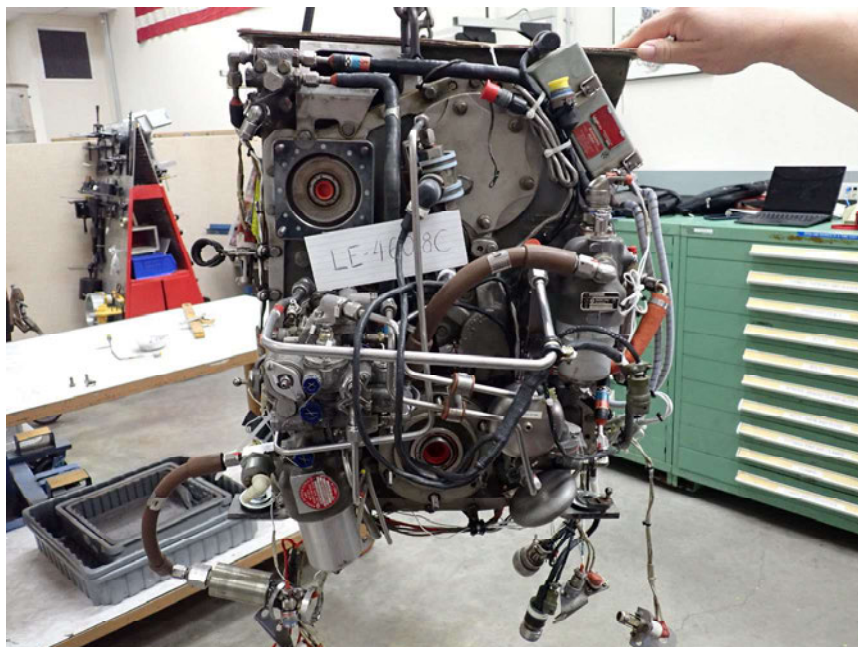


Figure 6. Engine S/N LE-46018C, As Received



Figure 7. Engine S/N LE-46018C, As Received



Figure 8. Engine S/N LE-46018C, As Received



Figure 9. Engine S/N LE-46018C, As Received



Figure 10. Engine S/N LE-46018C, As Received

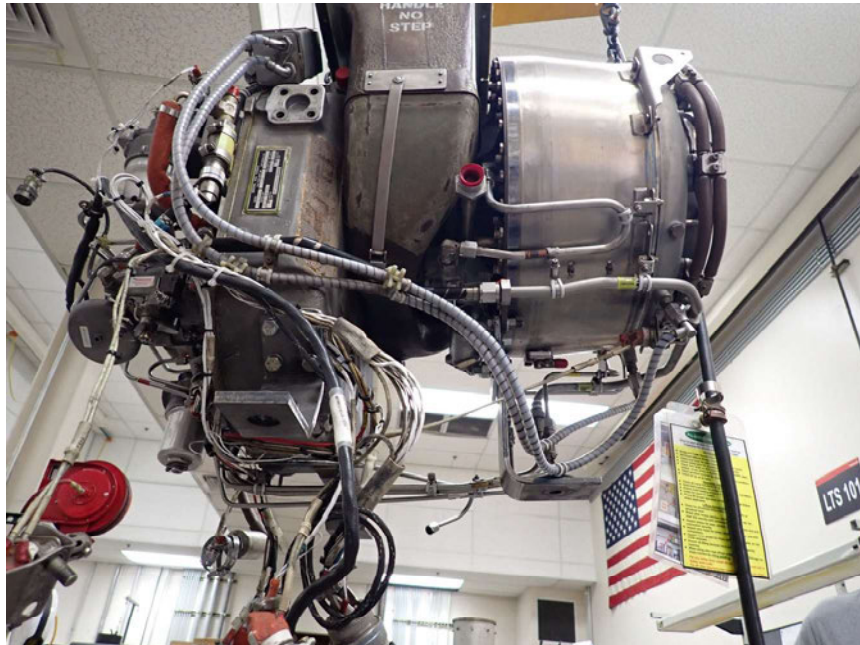


Figure 11. Engine S/N LE-46018C, As Received



Figure 12. Engine S/N LE-46018C, As Received



Figure 13. Engine S/N LE-46018C, As Received



Figure 14. Engine S/N LE-46018C, As Received

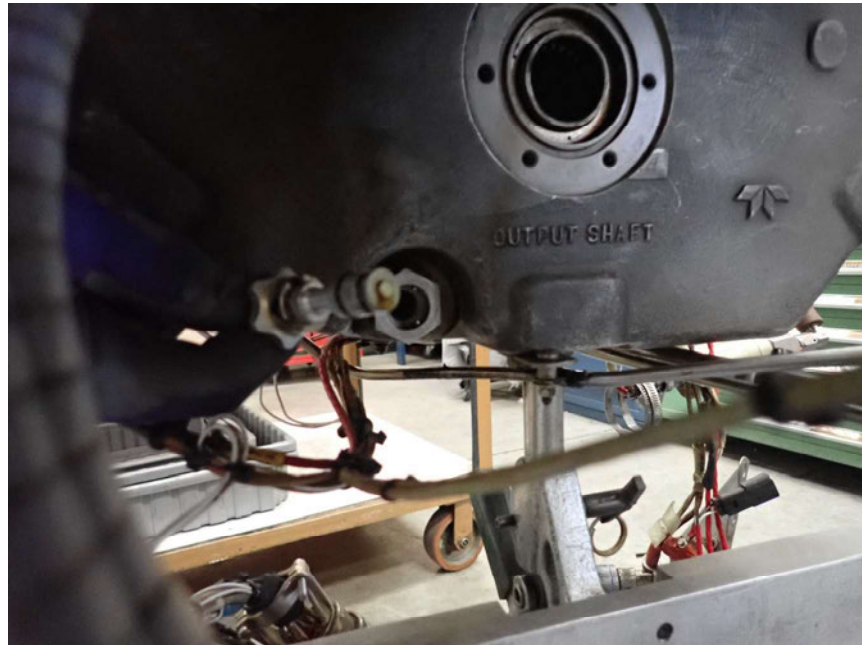


Figure 15. Engine S/N LE-46018C, As Received

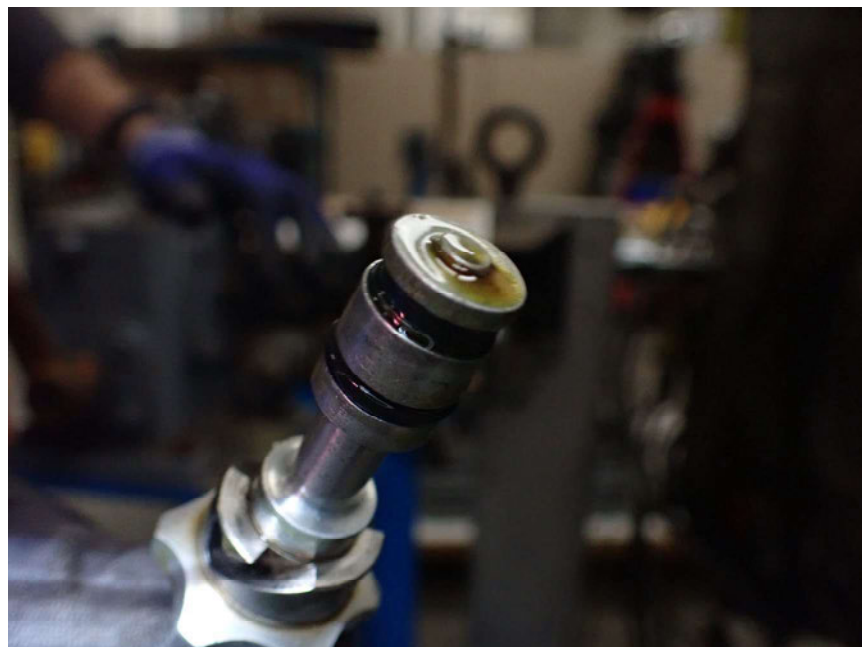


Figure 16. Engine S/N LE-46018C, As Received



Figure 17. Engine S/N LE-46018C, As Received



Figure 18. Engine S/N LE-46018C, As Received

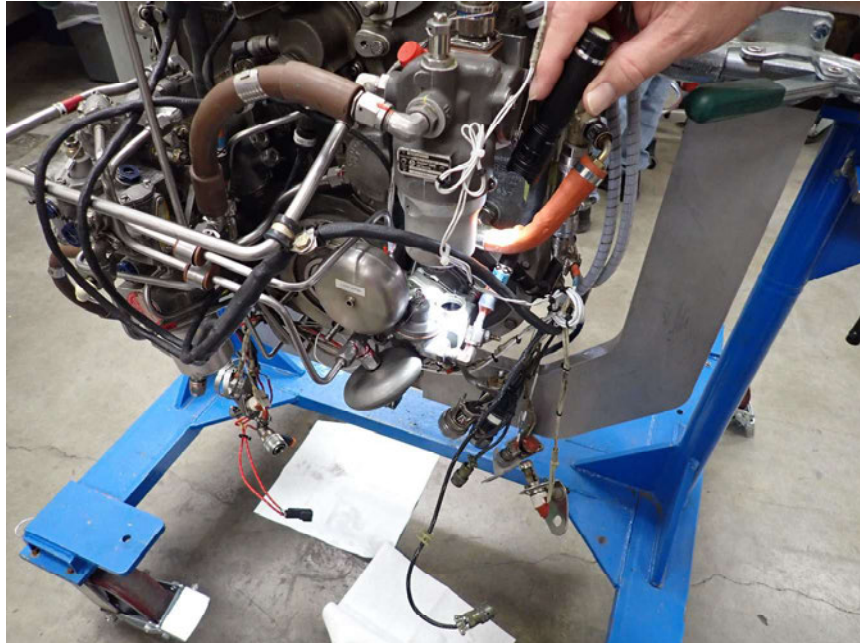


Figure 19. Engine S/N LE-46018C, As Received



Figure 20. Engine S/N LE-46018C, As Received



Figure 21. Engine S/N LE-46018C, As Received



Figure 22. Engine S/N LE-46018C, As Received



Figure 23. Engine S/N LE-46018C, As Received



Figure 24. Engine S/N LE-46018C, As Received



Figure 25. Engine S/N LE-46018, Installed in Test Cell



Figure 26. Engine S/N LE-46018C, Installed in Test Cell

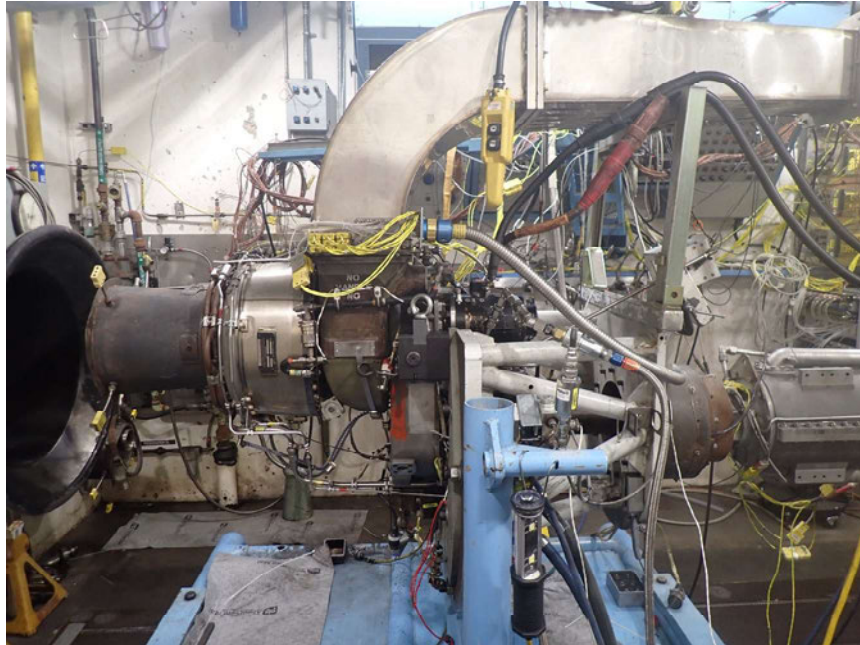


Figure 27. Engine S/N LE-46018C, Installed in Test Cell

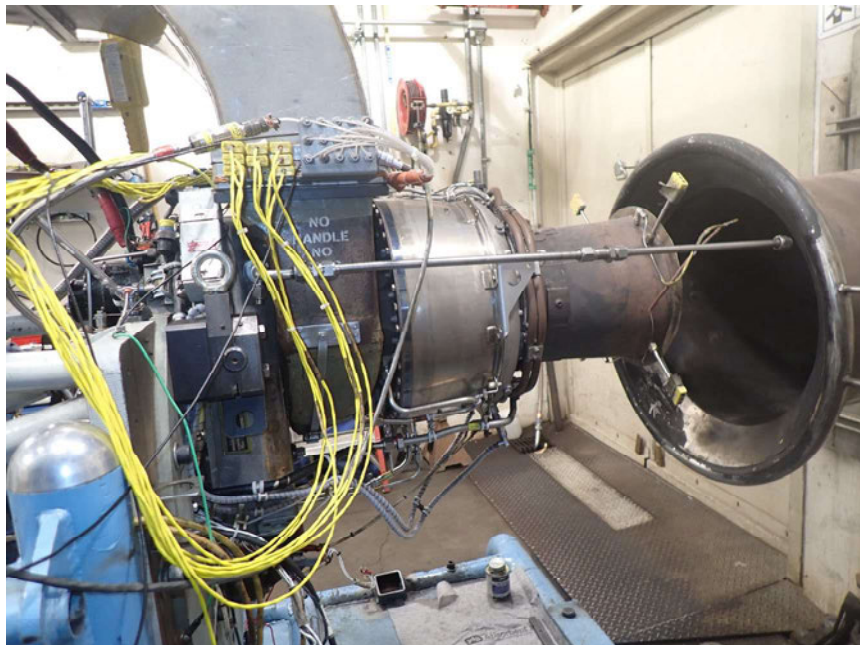
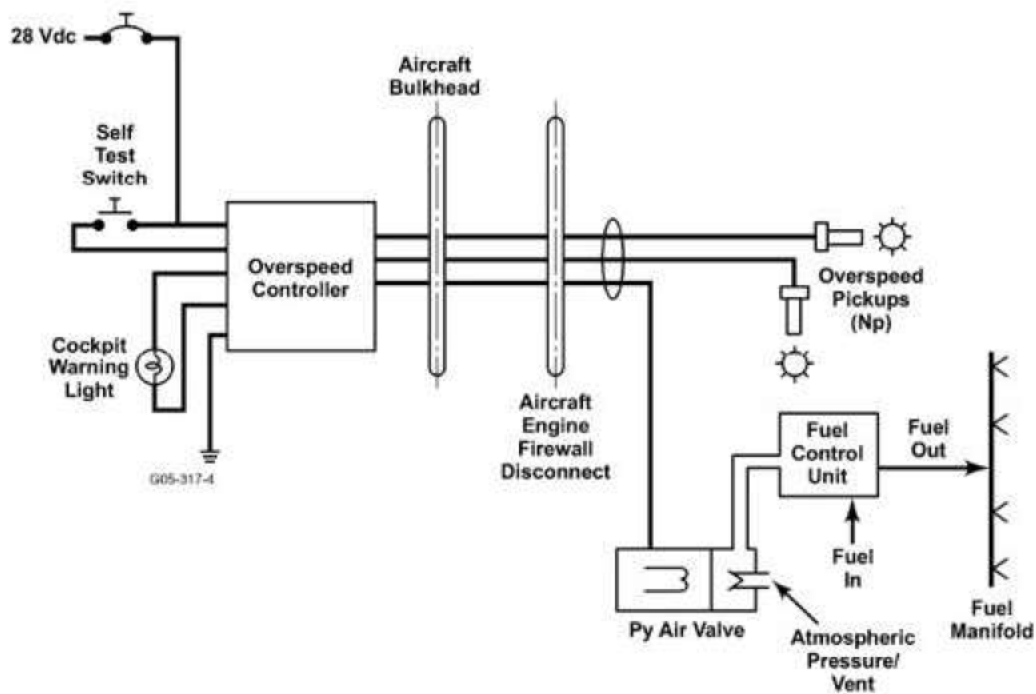
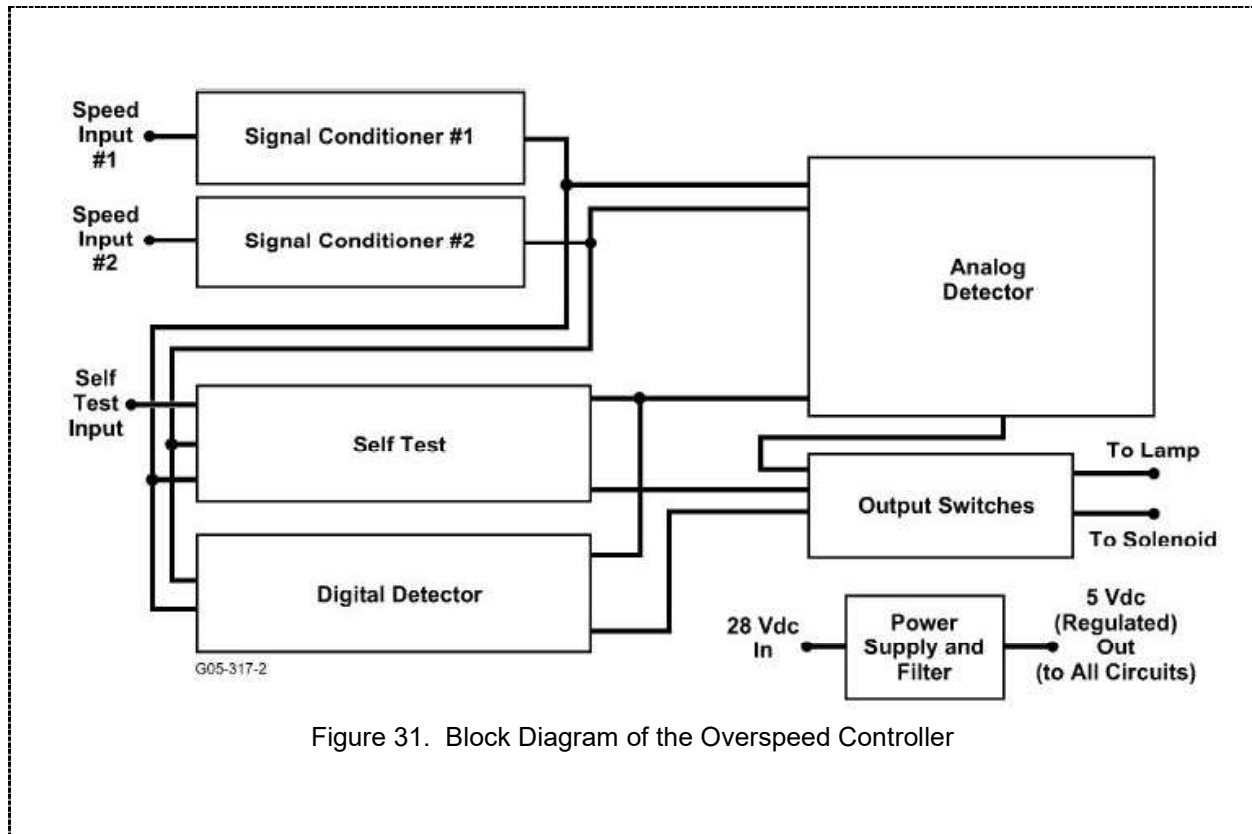


Figure 28. Engine S/N LE-46018C, Installed in Test Cell





APPENDIX A

Test Log Sheets

7 pages

Honeywell

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Engines & Systems

LAB TRAVELER

PRE LAB ACCEPTANCE



DATE 16-Feb-21

OUTLINE NUMBER		SERIAL NUMBER		SERIES	CUSTOMER NAME		MODEL		
4-001-000-33		LE-46018C			NTSB INVEST ANC20LA083		LTS101-700D-2		
PRODUCTION		PRODUCTION RETURN		MILITARY	COMMERCIAL		OTHER	SPECIFY	
☐		☐		☐	☐		☒	CHECK RUN/EVAL	
G / R	Final Run	DISCREPANCY REPORT			BUILD NUMBER		SAP CHARGE NUMBER		
NO	YES	YES ☐ NO ☐ IDR ☐			UNK		7027507971-0010		
PRODUCTION ASSEMBLY				VERIFIER		LABORATORY		VERIFIER	
INSPECT SPINNER ASSY PRIOR TO REMOVING ENGINE FROM PRODUCTION ASSEMBLY				N/A		CLEAN & INSPECT SPINNER ASSY. PRIOR TO REMOVAL OF ENGINE FROM TEST CELL		N/A	
ENGINEERING INSTRUCTIONS: <u>Test ITW Product Integrity</u>									
<u>Instructions Per TI-8361C.</u>									
DATE	ACCEPT	REJECT	T. I. NO. & REV.		LAB ACCEPTANCE		UNIT PRESERVED	FUEL	OIL
2-22-21	☐	☒	8361 C				2-22-21	☒	
HOURS THIS RUN	STARTS THIS RUN	TOTAL HOURS		TOTAL STARTS		ENGINE WEIGHT	TEMPERATURE COMPENSATION		
1:14	5			5					
LAB FINDINGS (REF. DATA SHEETS FOR DETAILS) <u>UNIT TESTED Per Product</u>									
<u>INTEGRITY INSTRUCTIONS</u>									
FADEC P/N			FADEC P/N			HMU P/N			
N/A			N/A			N/A			
FADEC S/N			FADEC S/N			HMU S/N			
N/A			N/A			N/A			
NOZZLE AE.			NOZZLE AE.			NOZZLE AE.			
N/R			N/R			N/R			
A4 AE.			A5 AE.						
NR			NR						
FUEL CONTROL P/N			S/N			FAN P/N			
N/R			N/R			N/A			
TORQUE RING P/N			S/N			FAN S/N			
N/R			N/R			N/A			
PARTS INSTALLED					PARTS REMOVED				
PART NUMBER	LOT NUMBER	SERIAL NUMBER			PART NUMBER	LOT NUMBER	SERIAL NUMBER		
LOOSE ITEMS									

PX2310-5P

QUALIFICATION TEST LOG

E.W.O. No. 7027507971	Date 2-17-2021	Test Cell 903
Assembly No. 4-001-000-33	Model No. LTS-101-101-700D-2	Unit Serial No. LE-46018C
Development Engineer MPT2	Technician Cowie	Supervisor Lockwood
Test Type CRASH INVESTIGATION	Lab Engineer PRATT	Build No. UNKNOWN

Start Time	Stop Time	Hrs.	Starts	REMARKS
				T.I 8361 C.
		---		ENG INSTALLED IN 903. CUST. BLUED PORT
		---		REMOVED AND PLATE INSTALLED -
		---		Set up for wet motor - set NG AND
		---		TO 100% OVERSPEED S/D PROTECTION -
		---		MOTOR ENG W/ CRANK - oil press rise
		---		AND NO OBSERVED LEAKS. DISCONNECTED
		---		FUEL LINE AT EXIT OF HMU. DIRECTED LINE
		---		INTO BUCKET START ATTEMPT W/ PLA @ IDLE
		---		TO DEMONSTRATE WF THRU HMU CAN BE
		---		SHUT OFF VIA PLA, TEST CELL STOP BUTTON.
		---		RECONNECTED FUEL LINE TO RUN CONFIG.
		---		RECONNECTED IGNITION SYSTEM.
1257		---	1	1/2 ENG, AND FUEL SHUT DOWN VIA %S
		---		CUTTING AS PLA SET HIGH FOR START
		---		Verify RIG ON PLA - DECIDED TO REMOVE
		---		FUEL INLET AND VERIFY 20° PLA POSITION
		---		FOR NEXT START. RECONNECTED FUEL LINE
		---		MOTOR ENG TO CLEAR FUEL

SUMMARY: Total Operating Time _____ hrs. _____ min. Ref. Data Page _____
 Total Manual Starts _____
 Total Automatic Starts _____ Project Engineering _____

QUALIFICATION TEST LOG

E.W.O. No. 7027507971	Date 2-17-2021	Test Cell 903
Assembly No. 4-001-000-33	Model No. LTS-101-700D2	Unit Serial No. LE-4(2)18C
Development Engineer MATZ	Technician COWIE	Supervisor LOCKWOOD
Test Type CRASH INVESTIGATION	Lab Engineer PRATT	Build No. UNKNOWN

Start Time	Stop Time	Hrs.	Starts	REMARKS
1524		---	2	LIGHT OFF ENG ENG START LESS AGGRESSIVE
		---		THAN LAST START - ENG ACCELERATED ABOVE
		---		9/5 TRIP POINT - MOTOR ENG TO COOL.
		---		BELIEVE PLA WAS POSSIBLY NEAR 28° -
		---		NEXT START @ 20° PLA - START ATTEMPT
		---		W/ NO FUEL FLOW. - ADS TO JUST
		---		ABOVE 20° FOR START ATTEMPT # 3
1548		---	3	4/0 TOWARDS IDLE - HIT EVENT DATA -
		---		2-18-21
		---		ADJUSTED OVERSPEED PROTECTION IN TEST CELL
		---		TO 70% - NEW OFFCM1 @ 09:30:17
		---		REC ALL @ 09:38 @ 10 hz
0939		---	4	4/0 TO 60% NG - START MGT = 918°F
0940	1:01	---		STOP REC ALL @ 09:39 AND CHANGE REC RATE
		---		TO SLOW SCAN. REC DATA POINT - 5/1 ENG
		---		ROLL DOWN SOUNDS AS EXPECTED AND NORMAL.
		---		SET CELL OVERSPEED PROTECTION @ 105%
		---		ON NP AND NG

SUMMARY: Total Operating Time _____ hrs. _____ min. Ref. Data Page _____
 Total Manual Starts _____
 Total Automatic Starts _____ Project Engineering _____

QUALIFICATION TEST LOG

E.W.O. No. 7027507971	Date 2-18-21	Test Cell 903
Assembly No. 4-001-000-33	Model No. LTS-101-70002	Unit Serial No. LE-46018C
Development Engineer Metz	Technician Cowie	Supervisor Lockwood
Test Type CRASH INVESTIGATION	Lab Engineer PRATT	Build No. UNKNOWN

Start Time	Stop Time	Hrs.	Starts	REMARKS
		101	1	FROM LAST PAGE -
1023		---	2	1/2 TO 63% NG - START MGT=923°F
	1034	11 12	3	ADJ PLA TO 68% NG - NO ability to ADVANCE ABOVE 68% - LOWER PLA TO bring ENG TO 60% NG - S/D ENGINE
1211		---	4	1/2 TO FLIGHT IDLE - START MGT = 911° ADV TO 70% NG DATA POINT @ 12 21 w/ PLA set @ 61.2 PLA @ 824 NP @ 87 NG @ 92 - Rec DATA @ 12:34 - DATA REC @ 12:36 Demonstrate NP Gov @ MIN STOP Gov eng and verify FUEL reduction @ 88% NPT. - Adj PT Gov TO MAX STOP - MOTOR ENG -
1204		31 43	5	1/2 TO F.I - MAX START TEMP = 968°F DATA @ MCP @ 13:16 - 99 NPT 98 NG DATA @ 13:19 MGT @ 1477°F WF = 357

SUMMARY: Total Operating Time _____ hrs. _____ min. Ref. Data Page _____
 Total Manual Starts _____
 Total Automatic Starts _____ Project Engineering _____

QUALIFICATION TEST LOG

E.W.O. No. 7027507971	Date 2-18-21	Test Cell 903
Assembly No. 4-001-000-33	Model No. LTS-101-700 D2	Unit Serial No. LE-46018C
Development Engineer Met2	Technician Cowie	Supervisor Lockwood
Test Type CRASH INST	Lab Engineer PRATT	Build No. UNKNOWN

Start Time	Stop Time	Hrs.	Starts	REMARKS
		---		CONTINUE TESTING FROM START # 5
		---		SET ENG TO 86% NPT 93.2% NG
		---		MGT = 1293°F WF = 280 - Set up for
		---		MAX GOU CHECK - Reduce ENG TO FI
		---		CHANGED Thumbwheel setting in TEST CELL
		---		FOR NP overspeed to 110% . Advance
		---		ENG TO 80% NPT 92% NGG
		---		WF 278 , MGT = 1283°F - Set up
		---		FOR NPT GOU CHECK - Eng Gou
		---		@ NPT OF 102.5% - Reduce to F.I
1335	1331	---		DATA COPIED OUT S/D ENG
		---		Fuel = 37 gal. SAP c/w.
		---		2-22-2021 oil Sample provided
		---		PRESERVED ENG per PARA 3.19
		---		NOTE: FOUND VADA ACCELEROMETER LOOSE
		---		FROM ENG - STILL CONNECTED ELECTRICALLY.
		---		ENGINE REMOVED AND SENT TO Dev. ASSY

SUMMARY: Total Operating Time _____ hrs. _____ min. Ref. Data Page _____
 Total Manual Starts _____
 Total Automatic Starts _____ Project Engineering _____

Honeywell

LAB TRAVELER

International Inc.
Engines & Systems

PRE LAB ACCEPTANCE



DATE 16-Feb-21

OUTLINE NUMBER		SERIAL NUMBER		SERIES		CUSTOMER NAME		MODEL	
4-001-000-33		LE-46018C				NTSB INVEST ANC20LA083		LTS101-700D-2	
PRODUCTION		PRODUCTION RETURN		MILITARY		COMMERCIAL		OTHER SPECIFY	
☐		☐		☐		☐		☒ CHECK RUN/EVAL	
G/R NO		Final Run YES		DISCREPANCY REPORT YES ☐ NO ☐ IDR		BUILD NUMBER UNK		SAP CHARGE NUMBER 7027507971-0010	
PRODUCTION ASSEMBLY				VERIFIER		LABORATORY			
INSPECT SPINNER ASSY PRIOR TO REMOVING ENGINE FROM PRODUCTION ASSEMBLY				N/A		CLEAN & INSPECT SPINNER ASSY. PRIOR TO REMOVAL OF ENGINE FROM TEST CELL			
ENGINEERING INSTRUCTIONS: Test IAW Product Integrity									
Instructions Per TI-8361C. [REDACTED]									
DATE		ACCEPT		REJECT		T. I. NO. & REV.		LAB TECH SIGNATURE	
2-22-21		☐		☒		8361 C		[REDACTED]	
HOURS THIS RUN		STARTS THIS RUN		TOTAL HOURS		TOTAL STARTS		ENGINE WEIGHT	
1:14		5				5			
LAB FINDINGS (REF. DATA SHEETS FOR DETAILS) UNIT TESTED Per Product									
INTEGRITY INSTRUCTIONS									
FADEC P/N		N/A		FADEC P/N		N/A		HMU P/N	
								N/A	
FADEC S/N		N/A		FADEC S/N		N/A		HMU S/N	
								N/A	
NOZZLE AE.		N/R		NOZZLE AE.		N/R		NOZZLE AE.	
								N/R	
A4 AE.		NR		A5 AE.		NR			
FUEL CONTROL P/N		N/R		S/N		N/R		FAN P/N	
								N/A	
TORQUE RING P/N		N/R		S/N		N/R		FAN S/N	
								N/A	
PARTS INSTALLED					PARTS REMOVED				
PART NUMBER		LOT NUMBER		SERIAL NUMBER		PART NUMBER		LOT NUMBER	
LOOSE ITEMS									

PX2310-5P

GAS TURBINE TEST LOG

START TIME	STOP TIME	RUN MIN.	STARTS	TIME	REMARKS
			P/T		INSTALLED ENG Per TI-B361 Rev C — 02-23-22
		1:41	5	1:41	FROM LAST INSTALL - CRANK ENG 3 TIMES TO CLEAR COMBUSTION OBSERVED OIL PRESS RISE
0903			6	1:00	1/0 TO IDLE . NO MGT RISE S/D - FOUND COLD JUNCTION IN MGT BREAK OUT - REPAIRED.
0928	0950	:32 2:13	7		1/0 TO IDLE , NO LEAKS - RAN ENG TO 70% NP 70% Ng AND ANALOG INPUT SIGNAL TO REDUCE WF - WORKED AS EXPECTED - S/D
0955			8		1/0 TO IDLE - ADV TO 70% NPT + NG - WF @ 125 - INDUCED %S SIGNAL - WF REDUCED AS EXPECTED. RADIAL ^{FC} CHANGED TO RADIAL SENSOR FOR TESTING - %S CHECK PERFORMED - WF REDUCED AS EXPECTED SWITCHED TO DUAL SENSOR. - TESTED - WORKS AS EXPECTED
	1029	:34 2:47			S/D ENG - SET UP TO PRESERVE SET ^{FC}
1200	1203	:03 2:50	9		1/0 - PRESERVED - SAP C/W FUEL = 16
		TOTAL			