

**NATIONAL TRANSPORTATION SAFETY BOARD
OFFICE OF AVIATION SAFETY
WASHINGTON, D.C. 20594**

June 16, 2020

POWERPLANTS GROUP CHAIRMAN'S FACTUAL REPORT

NTSB ID No.: CEN19LA231

A. ACCIDENT

Location: Breckenridge, Michigan
Date: July 21, 2019
Time: 0705 Eastern Daylight Time
Aircraft: Ayres S2R-G10, Registration: N766BF

B. POWERPLANTS GROUP

Group Chairman: Harald Reichel
Aerospace Powerplant Engineer
National Transportation Safety Board
Washington, DC

Member: Dana Metz
Air Safety Investigator
Honeywell Aerospace
Phoenix, Arizona

Member: Wayne Thomas
Pacific Oil Coolers
La Verne, California

C. SUMMARY

On July 21, 2019, about 0705 eastern daylight time, an Ayres S2R-G10 airplane, N766BF, impacted terrain during a forced landing after a loss of engine power shortly after takeoff from a private airstrip near Breckenridge, Michigan. The commercial pilot was not injured, and the airplane was substantially damaged. The airplane was registered to and operated by Earl's Spray Service, Inc. as a Title 14 Code of Federal Regulations (CFR) Part 137 agricultural flight. Day visual meteorological conditions prevailed, and no flight plan was filed for the local agricultural application flight.

The pilot stated that the accident occurred on his second agricultural application flight of the day. The first flight was completed without any issues. The pilot reported that the airplane was loaded with 325 gallons of fungicide and water, and that the fuel tank contained about 60 gallons of Jet-A fuel, before he departed on the accident flight. The pilot stated that shortly after takeoff on runway 27, about 100 feet above the ground, he observed a sudden increase in exhaust gas temperature (EGT) above the redline limit. He immediately reduced throttle, but the engine had a total loss of engine power. The pilot turned on the igniters to restart the engine, but the low altitude of the airplane required an immediate forced landing in a cornfield. The pilot lowered the flaps and leveled the wings for landing, but the main landing gear collapsed when it contacted the corn. After the accident, the pilot pulled the emergency fuel cutoff, and turned off the igniters, generator, and battery.

The airplane was equipped with an Electronics International MVP-50T-TI-G10 flight data recording system, which was removed from the airplane and shipped to the National Transportation Safety Board (NTSB) Investigator-In-Charge to be downloaded. The recovered data indicated that there was a sudden loss of engine oil pressure that resulted in a loss of control of propeller blade angle with a corresponding drop in engine speed (N1) and an increase of exhaust gas temperature (EGT).

The engine was shipped to the Honeywell facility in Phoenix, Arizona where it was examined on December 4-5, 2019. The engine exam revealed no anomalies or pre-existing conditions that would have precluded normal operation. No possible source of the oil loss was found.

The rest of the airframe oil system, consisting of the oil cooler and transfer flex-hoses, was therefore examined for the source of the oil leak. The oil cooler as well as the inlet and outlet oil transfer flex-hoses were shipped to the Pacific Oil Cooler facility in La Verne, California, where they were examined on February 20, 2020. No source of the oil loss was found in any of the oil cooling components.

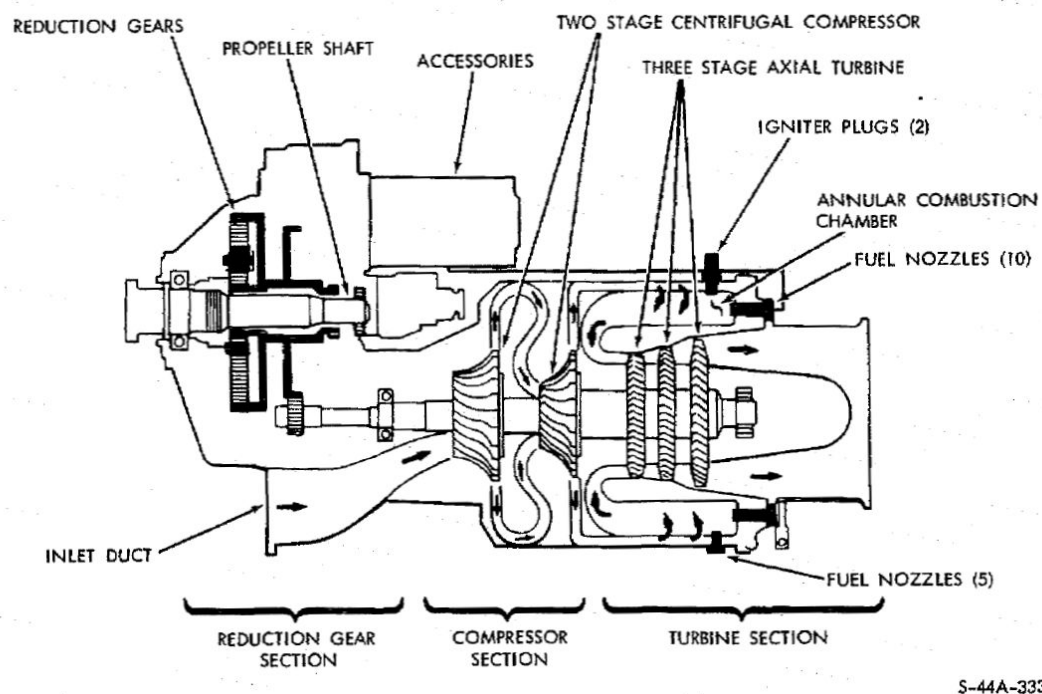
D. DETAILS OF THE ENGINE EXAMINATION

D.1 Scene Visit and Engine Recovery Notes

A Honeywell flight safety engineer travelled to the scene at Earl's Flying Service in Breckenridge, Michigan on August 14, 2019, 21 days after the event, and under the direction of the Grand Rapids, Michigan Federal Aviation Administration Flight Standards District Office (FSDO) principal maintenance inspector, examined the engine while still installed in the airplane, removed the engine from the airframe, boxed and shipped it to the Honeywell facility in Phoenix, Arizona, where it was stored until the teardown. The Honeywell investigator took field notes. While at Earl's Flying Service, the investigative team met the pilot, who had arrived coincidentally, at the facility. An informal discussion ensued, and notes were taken.

D.2 Engine Description

The Honeywell TPE331-10 turbo-propeller engine ([Figure 1](#)) features an integral gearbox, two-stage centrifugal compressor, reverse flow annular combustor¹, and a three-stage axial flow turbine. There are ten fuel nozzles. The engine has a maximum takeoff power rating of 940 shaft horsepower (SHP) which is limited to 5 minutes and the maximum rated continuous power is 900 SHP.



[Figure 1](#) – Honeywell TPE331 Cross Section

¹ A reverse flow annular combustor has the airflow change direction so that the airflow and combustion flows from back to front.

D.3 History of the Engine

The accident engine was a Honeywell TPE331-10-511M, Part Number (P/N) 3102180-2, Serial Number (S/N) P42076C. The engine was built in November 1983 as model number TPE331-10UF-512H, P/N 3102600-5, S/N P-42076 for Scottish Aviation's Jetstream 31. The last known entry in the engine logbook indicated that the engine had accumulated 11,773.6 hours, time since new (TSN) as of December 23, 1998.

A review of the stamped engine dataplate ([Photo 2](#)) revealed that it contained erroneous information. The dataplate indicated a 5-minute takeoff rating of 900 shaft horsepower (SHP) and the Maximum Continuous rating of 940 SHP. According to the Type Certificate Data Sheet, E4WE, the engine has a 5-minute takeoff rating of 940 SHP and Maximum Continuous rating of 900 SHP. The dataplate did not appear to be original.

Although no recent engine time and cycle records were found in the engine logbook, the last spectrographic oil analysis program (SOAP) records dated July 22, 2019 showed that the engine had accumulated 604 hours, time since overhaul (TSO) of, and 16,998.0 hours TSN. The oil time in service was 97 hours and the oil filter time in service was 66 hours.

The airframe records stated that the airplane oil cooler was replaced on July 19, 2019, 2 days before the accident and 1.7 hours prior to the accident.

D.4 Propeller Operational Notes

The airplane was equipped with Hartzell type B4TN-5, 4-bladed propeller. When not in operation, the normal position of the propeller blades in a single acting propeller, such as the event propeller, is feather (See [Figure 2](#)). The Hartzell propeller features an internal feather spring and counterweighted blades that constantly push the blades toward coarse pitch / feather. To make it fully controllable, the propeller features an external piston, upon which oil pressure is directed via the propeller governor to counteract the feathering effects of the counterweights and spring. As the oil pressure is increased, the external piston moves forward, pulling the link arms which are connected to a crank on the blade sleeves, moving them toward low or fine pitch (See [Figure 3](#)). When the piston pressure is decreased, the counterweights and springs drive the propeller toward high pitch. The external blade angle control components are depicted in [Photo 1](#).

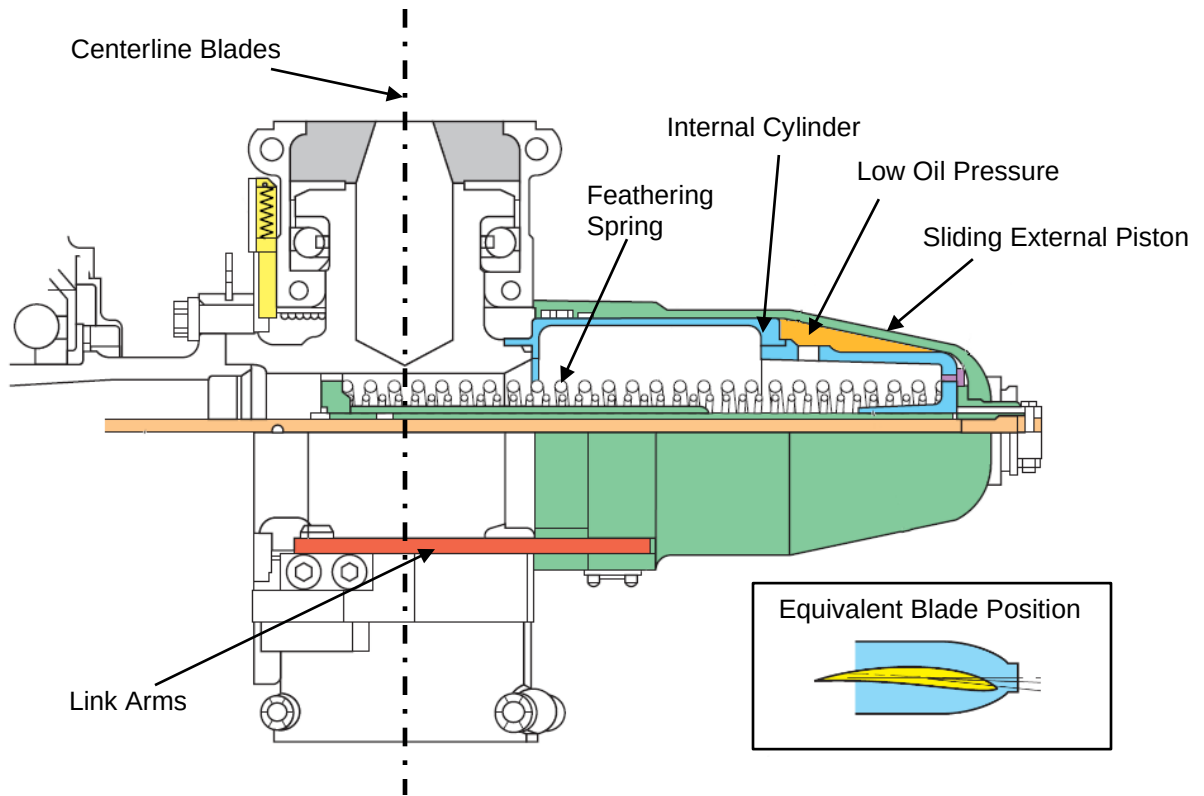


Figure 2 – Hartzell Propeller at Feather Condition

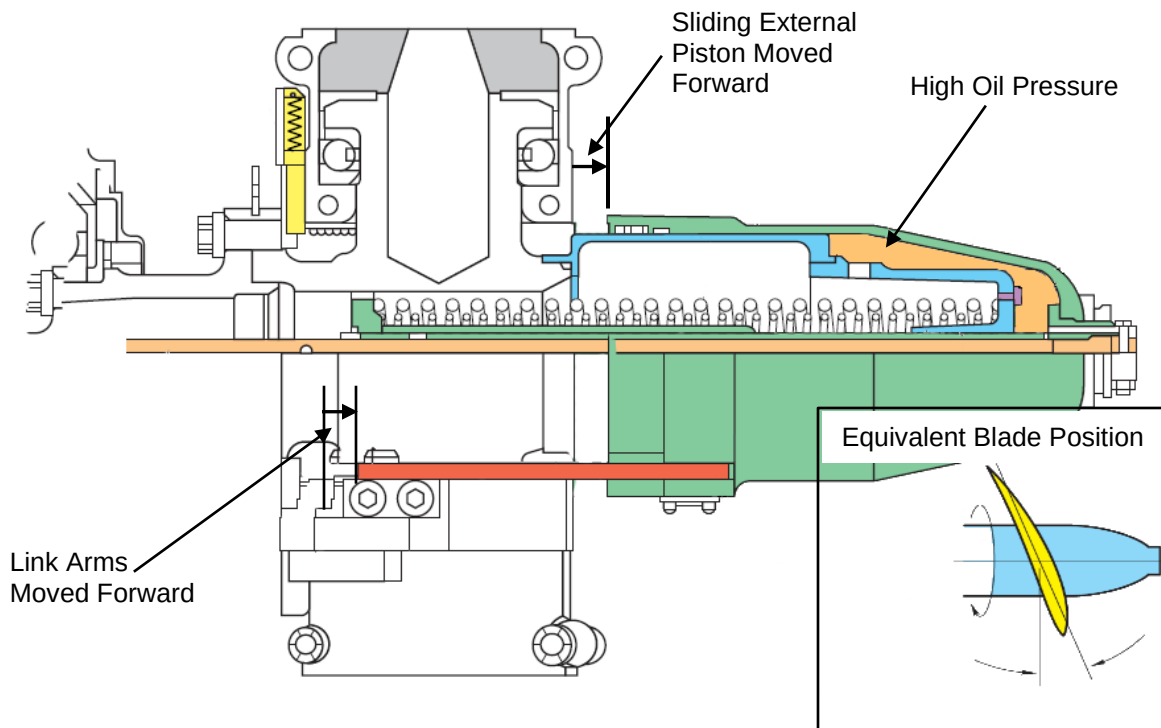


Figure 3 – Hartzell Propeller at a Power Condition

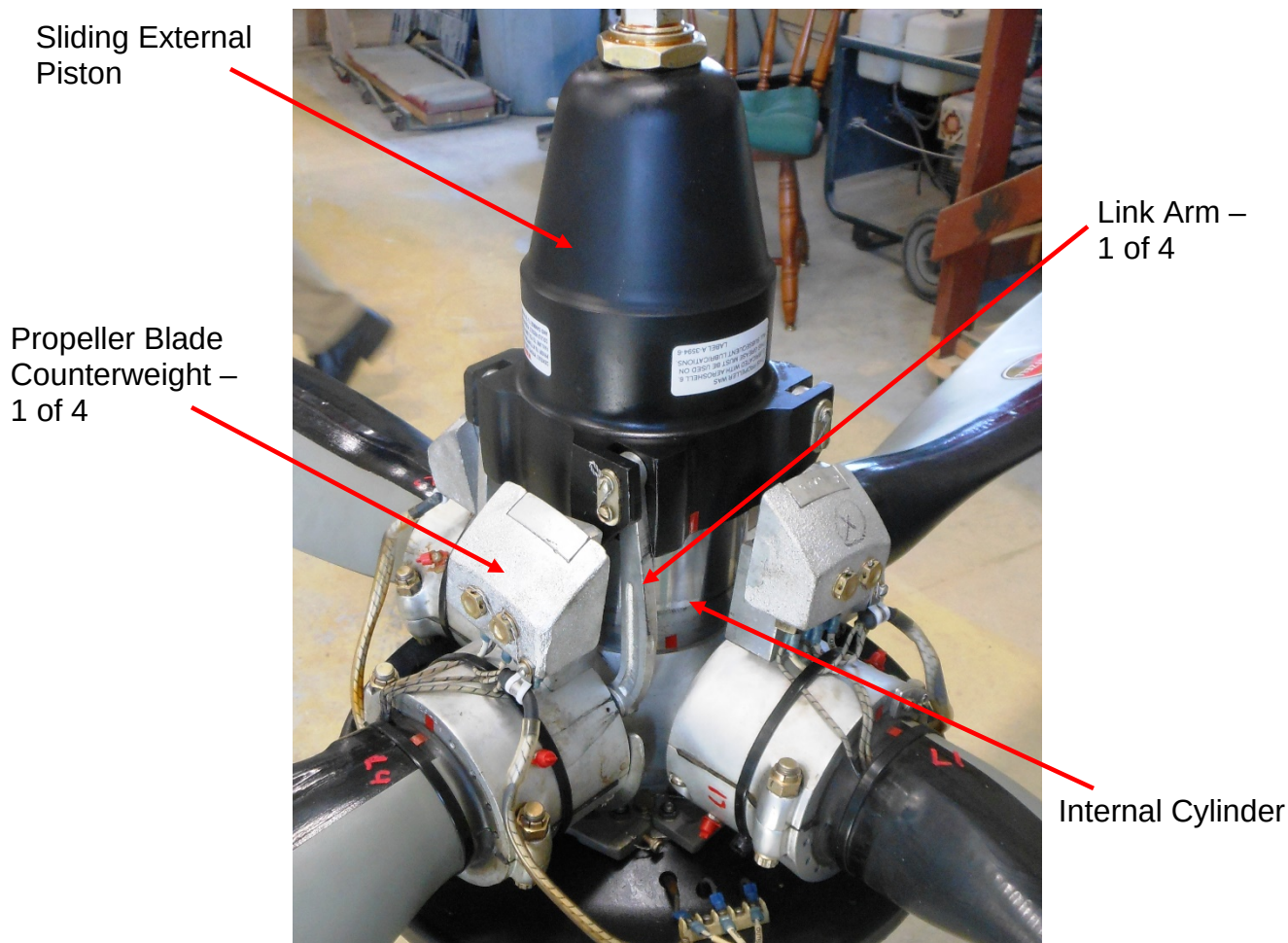


Photo 1 – Hartzell B4TN Type Propeller Exemplar Depicting Blade Angle Control Components.

D.5 Evaluation of the Data from MVT-50T Digital engine monitor

The airplane was equipped with an Electronics International MVP-50T-TI-G10 digital engine monitor, serial number 173643, which was removed from the airplane, shipped to the NTSB Investigator-In-Charge, and successfully downloaded.

Figure 4 is a graphical representation of select parameters from the last 75 seconds of recorded data which includes the event flight. This data represents engine operation at idle, an increase to 100% engine speed associated with takeoff and flight, and engine shutdown. Lines A, B, C, and D have been added for reference in the following paragraphs.

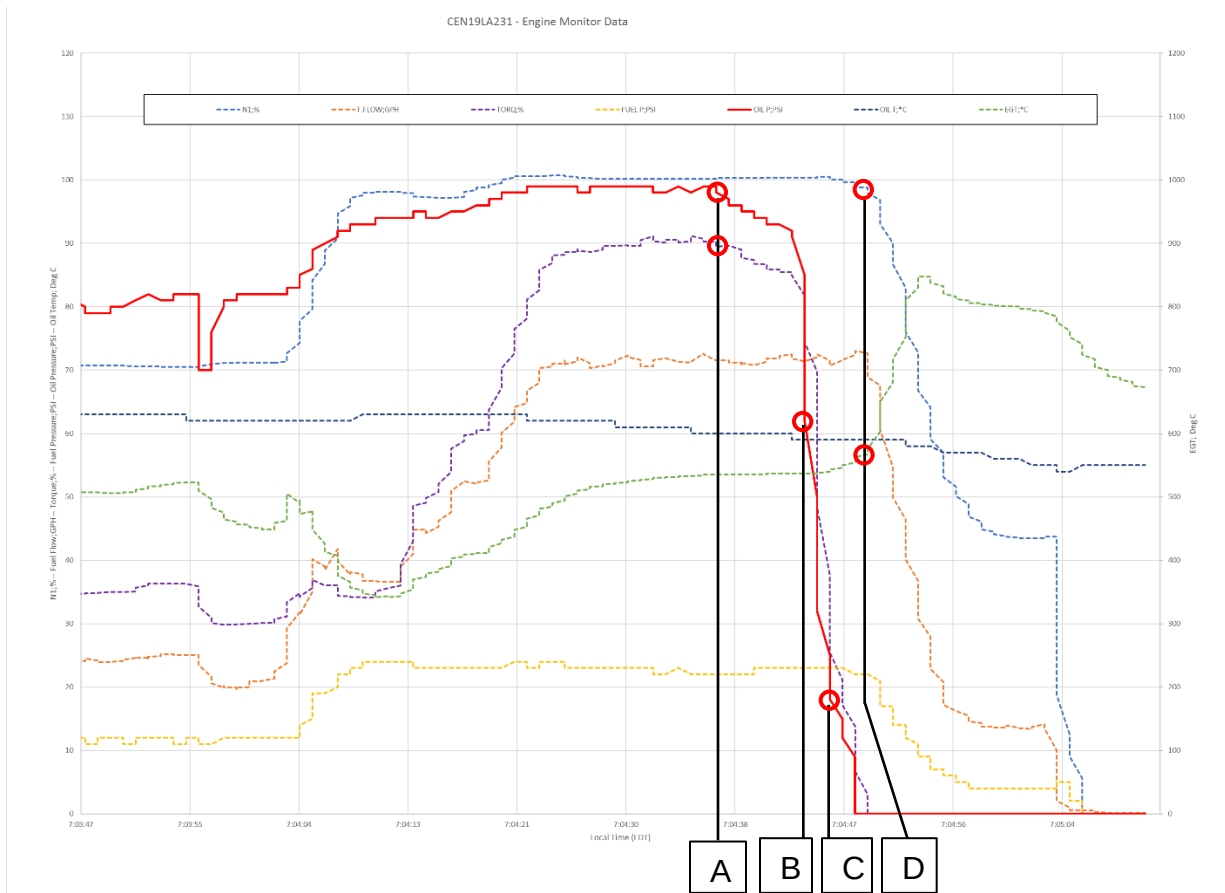


Figure 4 – Event Flight Plotted from Digital Engine Monitor Data.

Engine operation prior to reference line A (at approximately 7:04:37 local time) appears normal, after which engine oil pressure and torque begin to decrease. The decrease in oil pressure is consistent with a low oil supply to the oil pump when the main engine oil pump begins to ingest some air and the regulator can no longer maintain regulated oil pressure. The TPE331 engine features a hydraulic torque sensor, which requires engine oil pressure as a reference. With a decrease in oil pressure, the resultant indicated torque would also decrease despite the actual engine torque remaining unchanged.

Between the reference lines A to B (approximately 6 seconds), the oil pressure and indicated torque continue to decrease. During this time, the engine maintains 100% speed, constant fuel flow, and EGT. This condition is consistent with a constant power demand i.e. the power lever angle (PLA) set by the pilot, and the propeller governor controlling propeller blade angle to maintain 100% engine speed. The propeller governor controls propeller blade angle by metering high-pressure oil to and from the propeller to counteract the propeller spring and counterweight forces (See [D.4 Propeller Operational Notes](#) for more details). Oil from the main engine oil pump is supplied to the propeller governor, which contains its own internal oil pump to increase the oil pressure required

by the propeller. With the relatively small decrease in engine main oil pressure during this time frame, the propeller governor oil pump was still able to produce the oil pressure needed to control the propeller blade angle.

At reference line B (approximately 7:04:43 local time), there is dramatic reduction in oil pressure and indicated torque. This sudden drop is consistent with the loss of oil quantity and the engine oil pump ingesting more air and no longer being able to provide pressurized oil. For the next three seconds, engine speed, fuel flow, and EGT remain constant due to the constant PLA and the propeller governor continuing to provide high-pressure oil to the propeller.

At reference line C (approximately 7:04:45 local time), the engine oil pressure drops to approximately 20 pounds per square inch (psi). At this pressure and flow, the propeller governor internal oil pump begins to cavitate and is no longer able to provide the oil flow and pressure needed by the propeller to maintain the blade angle required to maintain the engine speed at 100 %. The resultant inability to counteract the spring and counterweight force in the propeller will allow the propeller blade angle to increase toward the feather position, increasing load from the propeller. For the next three seconds, the increasing propeller blade angle and corresponding load increases, results in a proportional drop in engine speed. The data also shows a very slight increase in fuel flow as the under-speed governor in the fuel control gains authority and reacts to the drop in engine speed. During this time, the EGT starts to increase as the engine speed decreases along with a corresponding drop in engine airflow.

As the engine speed continues to drop, the fuel control switches authority from the under-speed governor to the accel schedule (Reference Line D). The accel schedule controls fuel flow as a function of compressor discharge pressure which is determined by engine speed. However, due to the lack of oil pressure available to the propeller, the propeller blades continue to move toward a feathered blade angle and the accel schedule is unable to accelerate the engine back to 100% speed, resulting in the engine roll-down. Following the accel schedule, the fuel flow continues to decrease as the engine speed decreases due to the increased load from the propeller as it moves closer to the feathered blade angle. EGT increases rapidly as the engine airflow decreases with engine speed.

Engine speed and fuel flow eventually begin to stabilize at approximately 45% speed. The pilot reported that he exited the aircraft while the engine was still running but reached back inside the cockpit and activated the emergency shutdown. The fuel flow terminated at approximately 7:05:06 local time.

D.6 The Engine Examination

D.6.1 General Observations

The engine was received in a standard TPE331 shipping container ([Photo 3](#)). A Pacific Oil Cooler P/N 10717B, S/N E1714382-1, an airframe mounted part and the two flexible hoses that carry the oil from and to the engine, were also received in the box. An engine lifting tool was also in the box. The starter generator was not received. The bottom of the engine box contained approximately an ounce of oil.

The engine was generally intact and clean. There were no signs of un-containment or external fire. The propeller flange was intact. Areas around the left top and side near the FCU, fuel pump and propeller governor, were coated with dirt and were mildly oil-wetted ([Photo 4](#)) as well as a yellow colored fluffy material, consistent with fine shavings from the protective foam cover, released due to vibration during transit.

The nose cone, gearbox housing and the compressor housing were intact and undamaged ([Photo 5](#)). The nose cone chip detector ([Photo 6](#)) and the oil filter ([Photo 7](#)) were removed, and both were clean and oil wetted. The oil tank was intact; however, it was dented and scratched in several locations, consistent with impact damage ([Photo 8 & Photo 9](#)). The oil tank appeared to be empty; however, as the engine was tilted aft-wards while it moved to the engine stand via overhead crane, approximately 0.5 liter of clean oil was captured as it drained from the oil tank and lines. The tank normally contains 6 liters.

The FCU, fuel pump, propeller governor and feather valve were intact and undamaged. They were not removed or tested. All the control shafts and inputs to the accessories rotated normally ([Photo 10](#)). The fuel filter cap was in place; however, the fuel pressure sense tube fitting was not present, exposing the opening to the fuel filter cavity. The fuel filter was removed and found to be clean.

The control (synchronization) rods to the FCU, propeller pitch control and feather valve were all intact as were the spherical end fittings. During rigging, the propeller governor is synchronized to the FCU via an adjustable control rod and the protractors of both units matching at 0° and 40°. A rigging check revealed that when the FCU protractor was placed in the 0° position, the propeller pitch control was observed to be at 3°. When the FCU protractor was placed into the 40° position, the propeller pitch control protractor indicated 42°. This mis-rigging would have no effect on the oil system but would manifest itself as a propeller power discrepancy during ground operation.

The 1st stage impeller, as observed through the inlet duct was intact and undamaged ([Photo 11](#)). The impeller and directly adjacent area were oil free. The 3rd stage turbine blades and 3rd stage vane ring were undamaged and dry ([Photo 12](#)). No rub could be seen on the 3rd stage shroud.

The 3rd stage turbine could be turned with normal effort and the propeller shaft, starter generator splined shaft turned in unison, confirming internal mechanical integrity.

With the diaphragm assembly removed, mechanical continuity from the power section to the fuel pump and oil / scavenge pump drives was verified.

The tach generator was removed from the gearbox and the input spline was found fractured at the anti-rotation pin hole (Photo 13). A visual examination revealed the fracture surface to be consistent with fatigue and subsequent overload.

D.6.2 Nose Cone and Gearbox

The Nose Cone (Photo 14 & Photo 15) and Gearbox Housing (Photo 16) were removed, and the internal mechanism examined. All the parts were oil wetted. All the gears, shafts and bearings were undamaged. The torque sensor was intact (Photo 17) and the direct drive fuel control (DDFC) gears turned freely. The scavenge oil screen was free of debris. There was an impact mark on the forward face of the torque sensor, consistent with contact against the sun gear nut during impact. The spur gear and cam assembly (Figure 5) could not be separated from the helical gearshaft, consistent with the spur gear and cam assembly moving aft and over-traveling the engagement with the helical gearshaft (circled in red), causing the helical gearshaft to become stuck in the cavity of the spur gear and preventing the spur gear from returning to the forward position (Photo 18), consistent with a propeller sudden stoppage. No further disassembly was done.

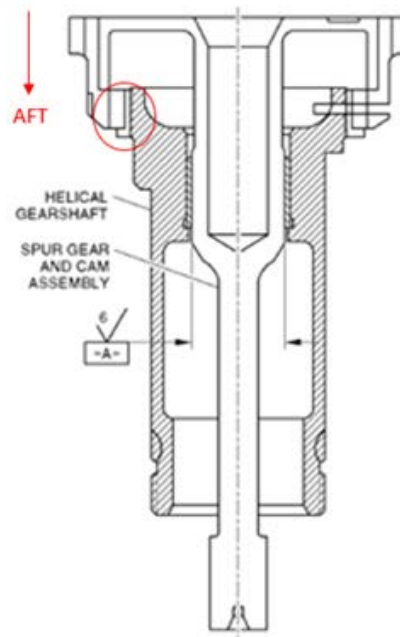


Figure 5 – Spur Gear and Cam Assembly & Helical Gearshaft

D.6.3 Compressor Section

If the compressor bearing carbon seal is damaged, then oil could leak into the engine flow path, so therefore the compressor bearing, and carbon seal were removed and both parts were found undamaged ([Photo 19](#) & [Photo 20](#)). The compressor section contains no oil system related components and was therefore not further disassembled.

D.6.4 Combustor Plenum

The combustor section contains no oil system related components and was therefore not disassembled or examined.

D.6.5 Turbine Section

If the turbine bearing carbon seal is damaged, then oil could leak into the engine flow path, so therefore the turbine bearing, and carbon seal were removed and examined. Both were found to be undamaged. It was observed that the 3rd stage vane ring and turbine were undamaged and oil free ([Photo 12](#)). The turbine was not further disassembled.

D.6.6 Fuel System

The fuel control, flow divider, fuel manifold and fuel nozzles were not further disassembled or examined, since they are not part of the oil system.

D.6.7 Oil System

Because there was a report of loss of oil, all the components in the engine lubrication system were examined. The TPE331 oil schematic is shown in ([Figure 6](#)).

Lubrication System Schematic

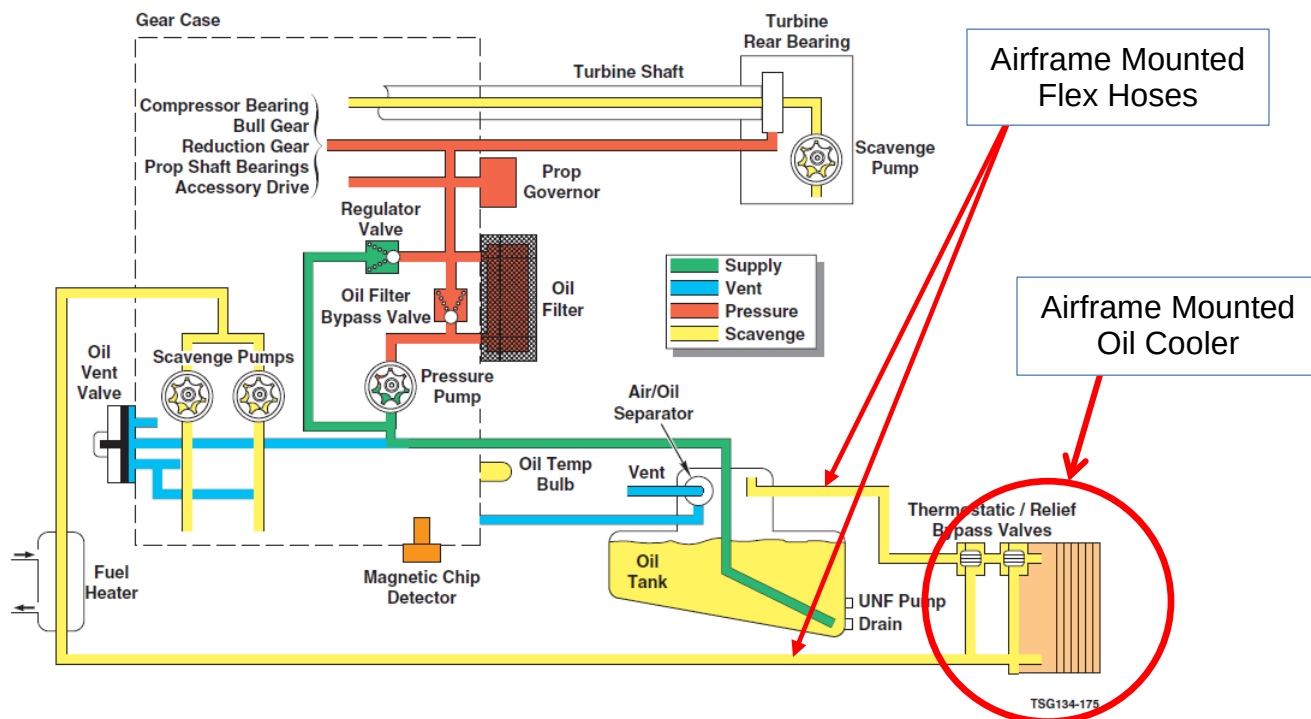


Figure 6 – Ayres S2R-G10 and TPE331 Lubrication System Schematic

The oil tank was dented and scratched in several locations, consistent with impact damage; however, it was intact and not breached (Photo 9). The oil tank was removed from the engine and the air/oil separator and the fuel heater were withdrawn from the oil tank. The air/oil separator was intact and undamaged (Photo 21); however, an airframe supplied B-nut and short section of tubing was attached to the fitting. Routing of the vent line in the Ayres installation is unknown. The internal surface of the short section of tubing was coated with a thick layer of black debris. The external face of the Teflon ribbon cylinder was coated with black debris; however, the cylinder and aft face of the Teflon ribbon cylinder were clean. Additionally, the Teflon ribbon cylinder was observed to slide in the metallic sleeve when tapped on a hard surface. The air oil separator cavity in the oil tank contained loose black debris. In this Ayres airframe installation, the fuel heater function is not used; however, the fuel heater is still mounted in the oil tank and the fuel fittings are blanked off. The fuel heater (Photo 22) was undamaged, and all O-rings were in location and undamaged.

The oil filter bypass valve poppet was not triggered, indicating that there was no obstruction in the oil filter. The oil pressure regulating valve (Photo 23) was removed and found to be undamaged.

The scavenge (Photo 24) and oil pressure (Photo 25) pumps were removed from the engine and the housings as well as the gerotors were found to be oil wetted and

undamaged. The shafts could be rotated with normal effort. They were not further examined.

The turbine bearing scavenge pump was removed, examined, and found to be oil wetted and undamaged ([Photo 26](#)).

The oil vent valve ([Photo 27](#)) operates during the cold engine start sequence and temporarily allows air to enter the pressure and scavenge pumps, so that they do not offer resistance during a cold start sequence. If the valve fails, then it could allow air to enter the oil system and cause aeration and foaming.

Oil wetting was observed in all the cavities during disassembly and therefore the internal oil transfer tubes were not examined.

E. DETAILS OF THE OIL COOLER AND FLEX HOSES EXAMINATION

E.1 General

No anomalies or pre-existing conditions were found in the engine that would have precluded normal operation. No evidence of an oil leak, was observed on the engine; however mild oil-wetting was observed on the accessories. The airframe oil system, which consists of the oil cooler and two transfer flex-hoses, was therefore examined to determine if they were the source of the oil leak. The oil cooler and the two associated tubes were shipped in the engine box; however, they are not Honeywell parts. The oil cooler, P/N 10717B, S/N E1714382-1, is manufactured by Pacific Oil Cooler, La Verne, California.

The oil cooler and two transfer flex-hoses were stored at the Pacific Oil Cooler facilities and were still sealed in the shipping cardboard box, which was opened in the presence of the NTSB investigator ([Photo 28](#)).

E.2 Oil Cooler Description

In the Ayres S2R airplane, the oil cooler is remotely mounted below and aft of the engine in the nacelle (See [Figure 6](#)), so that it has a good source of ambient air flow in which to transfer the heat. Flex-hoses carry hot engine oil from the engine scavenge pump to the oil cooler and then back to the engine oil tank. The oil cooler is a one-piece all-aluminum brazed assembly of a 'bar & plate' design. The heat transfer occurs between the oil on one side of the plates and ambient air, which is directed through the finned side of the plates.

E.3 History of the Oil Cooler

A review of the logbook revealed that the oil cooler had been installed on July 19, 2019, only 2 days before the event flight. The airplane had flown only 1.7 hours since the service.

E.4 Oil Cooler & Flex Hose Examination

The oil cooler was visually examined and a fracture along the weld and the parent material on the edge of the cooler housing by a deformed mounting flange ([Photo 29](#)) was observed. The sharp edges and visible fracture surface were consistent with a fracture that occurred after impact. According to the Pacific Oil Cooler technical staff, this type of fracture is typical when a mounting flange is deformed during an impact.

The fracture was cleaned, welded closed ([Photo 30](#)) and then tested in the water tank. The test consists of blocking the oil connections and then pressurizing the oil cavity with 100 psi air. Any leak can be observed as a stream of bubbles exiting any opening. None were seen ([Photo 31](#)), confirming the integrity of the oil cooler.

Similarly, the two flex-hoses were blocked at one connector end and 100 psi air pressure was introduced into the other ([Photo 32](#) & [Photo 33](#)). No leaks were seen on either flex-tube.

E.5 Oil Cooler Components Summary

The location and character of the fracture surface was inconsistent with a pre impact damage and oil leak. No preexisting damage was found in the oil cooler or the two flex-lines that would have precluded normal operation.

F. DETAILS OF ENGINE NACELLE PHOTO FINDINGS

F.1 Review of Photos of Inside the Nacelle

No NTSB investigator was sent to the accident scene or to the wreckage review which occurred at the operator's facility approximately three weeks after the event.

Some photos were taken at the accident scene and more were taken by the Honeywell investigators during the wreckage review.

An examination of the on-scene images, taken by the FAA, revealed that escaped engine oil was present inside the nacelle. [Photo 34](#) & [Photo 35](#) depict the rear frame of the engine, the exhaust duct, the firewall/battery box, the oil cooler just below the exhaust duct and the oil cooler hoses. The photos reveal (1) engine oil pooled on the ledge of the

battery box frame, which is consistent with escaped oil being distributed around the inside surfaces of the nacelle. (2) engine oil wetting as far as the top of the exhaust duct and the engine rear frame, which is consistent with eductor² operation and an engine still in high-speed operation, drawing oil particles that have escaped into the nacelle to be drawn through 360 degrees of the annulus. It is observed that there was more oil wetting on the center of the engine exhaust pipe, at the same plane as the oil cooler, gradually becoming less until it stops at the mid-point of the engine rear frame. This observation is consistent with a leak in the plane of the oil cooler area. An engine oil leak would manifest itself as significant oil wetting of the engine body, which was not observed.

[Photo 36](#) was taken during the wreckage review and its examination reveals that the eductor mixing duct is oil wetted on the inside, consistent with the engine in operation, drawing escaped oil particles through the annulus into the mixer duct.

[Photo 37](#) was taken during the wreckage review and depicts an oil wetted FCU and fuel pump assembly and is consistent with escaped oil being distributed around the inside of the nacelle.

G. MAINTENANCE

The FAA FSDO Principal Maintenance Inspector for the operator, interviewed the principal mechanic (See App. I). The mechanic statements could not help explain the reason for the engine behavior, loss of oil evidence.

² A nacelle eductor aims the high-speed engine exhaust airflow into a slightly larger diameter mixing duct causing a suction of air inside the nacelle through the annulus made between the two ducts. The entrained cooling flow drawn from the nacelle compartment is used to cool the engine as well as draw air through the oil cooler, especially during low speed operation.

AlliedSignal
AEROSPACE
 AlliedSignal Inc.
 AlliedSignal Engine
 Phoenix, AZ, USA
 CAGE
 98199

TURBOPROP ENGINE

PART NO.	3401140	SERIES	
MODEL	10-511 M	SERIAL	P42076 C
CONTRACT		EQUIP CODE	m
STOCK		TYPE CERT	6401
WARRANTY		PROD CERT	913
REPAIRING		ROTAT	

ALL SHIP-LEVEL REPAIRS
 ALL CONT-LEVEL REPAIRS
 ALL MAINTENANCE MANUAL

RECORD

A photograph of a complex mechanical assembly, likely a turbine engine, packed in a cardboard box. The engine is surrounded by white foam padding and secured with orange straps. A white plastic bag containing additional parts is visible in the foreground.

Photo 4 - FCU, Fuel Pump and Propeller Governor Coated with Dirt

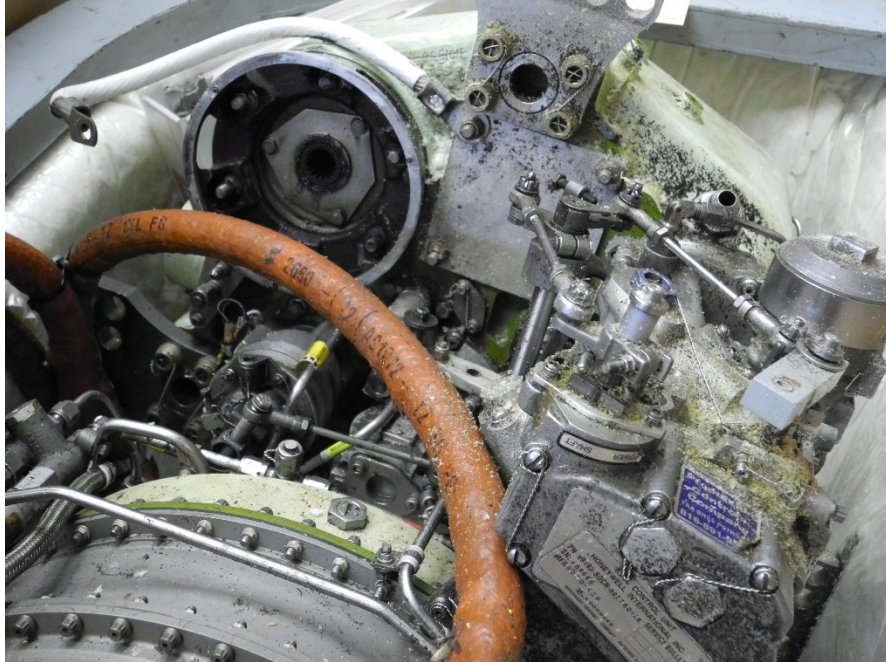


Photo 5 - Nose Cone, Gearbox Housing and Compressor Housing - Undamaged



Photo 6 - Nose Cone Chip Detector - Clean



Photo 7 – Oil Filter - Clean

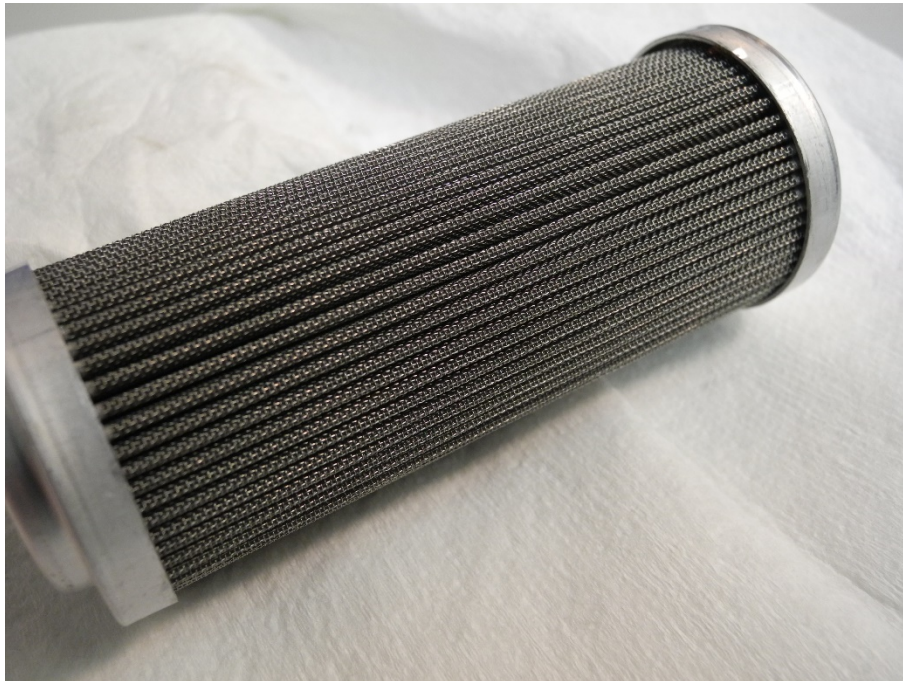


Photo 8 – Oil Tank – Still Installed on Engine



Photo 9 – Oil Tank – Removed from Engine – Dented & Unbreached



Photo 10 – Accessories - Undamaged

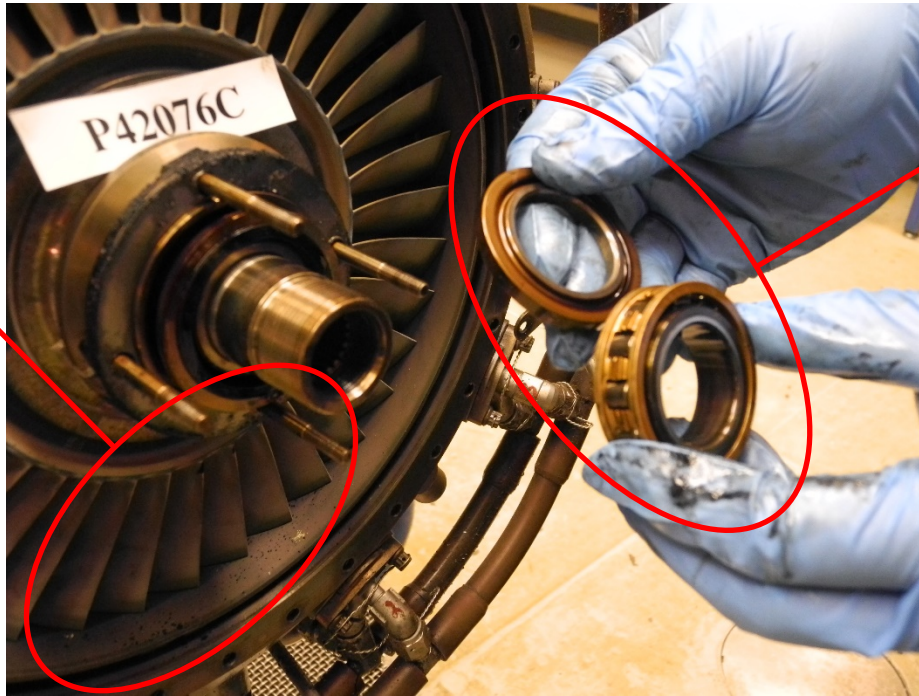


Photo 11 – 1st Stage Impeller – Undamaged and Oil Free



Photo 12 – 3rd Stage Turbine – Dry and No Rub on Shrouds

Turbine Blades
& Shroud –
Undamaged &
Oil Free



Turbine Bearing
and Carbon Seal -
Undamaged

Photo 13 – Tach-Generator Drive Shaft - Fractured



Photo 14 – Nose Cone & Propeller Shaft – Undamaged, Oil Wetted

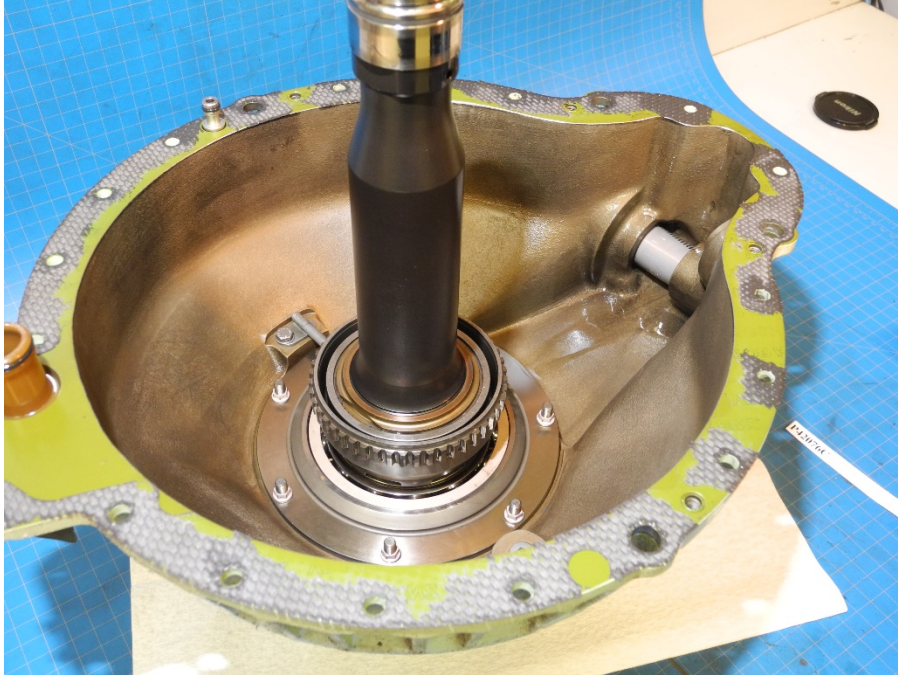


Photo 15 – Nose Cone Gearing – Undamaged & Oil Wetted

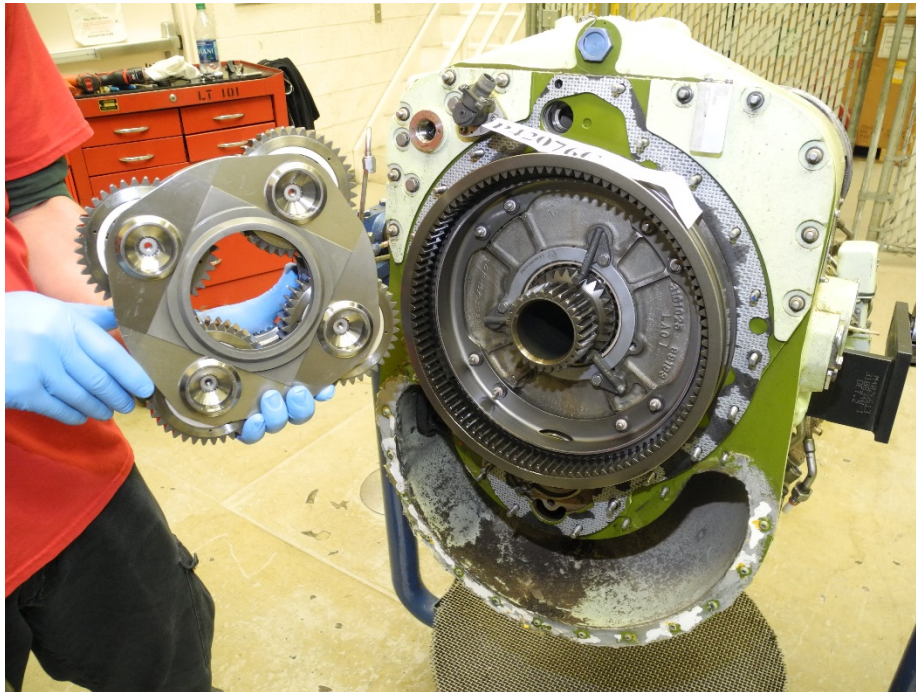


Photo 16 – Gearbox Housing – Undamaged & Oil Wetted



Photo 17 – Torque Meter Assembly – Intact

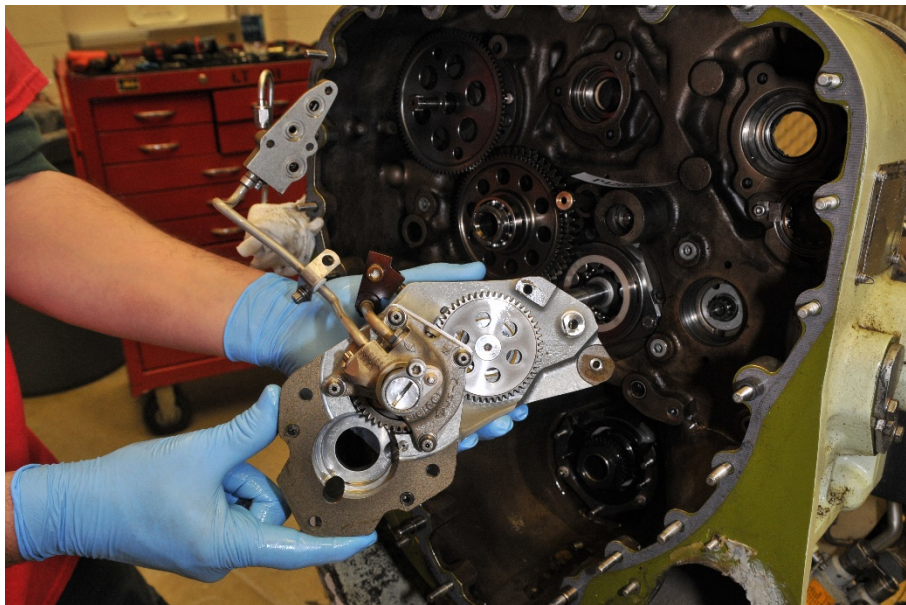


Photo 18 – Torque Sensor Helical Gearshaft & Spur Gear and Cam Assembly – Seized



Photo 19 – Compressor Bearing - Undamaged



Photo 20 – Compressor Bearing Carbon Seal - Undamaged



Photo 21 - Air/Oil Separator - Intact and Undamaged



Photo 22 – Fuel/oil Heater - Undamaged



Photo 23 – Oil Pressure Regulating Valve - Undamaged



Photo 24 – Oil Scavenge Pump - Undamaged



Photo 25 – Oil Pressure Pump - Undamaged

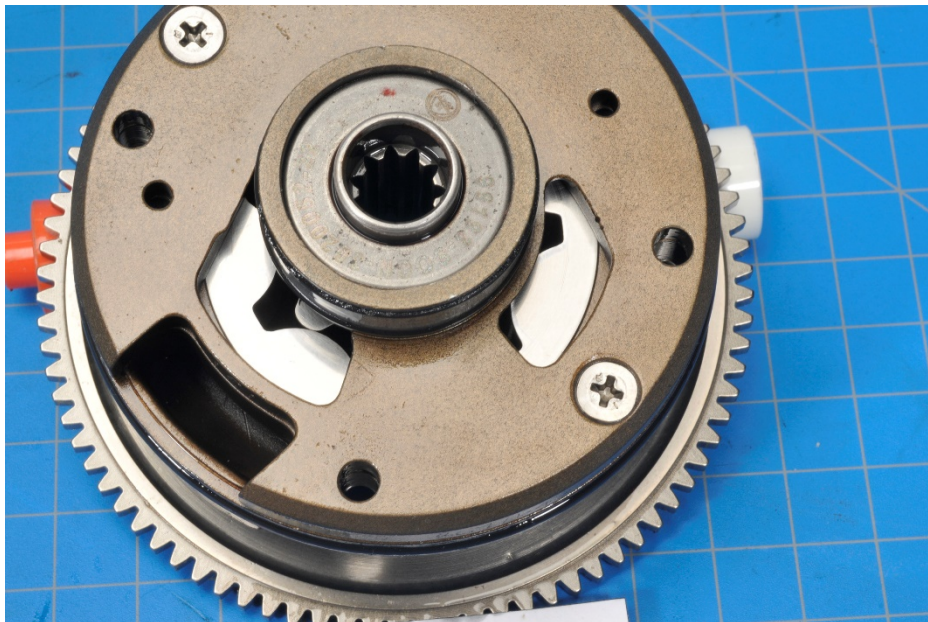


Photo 26 - Turbine Bearing Scavenge Pump - Undamaged



Photo 27 – Oil Vent Valve



Photo 28 - Oil Cooler & Flex-Hoses - As Received

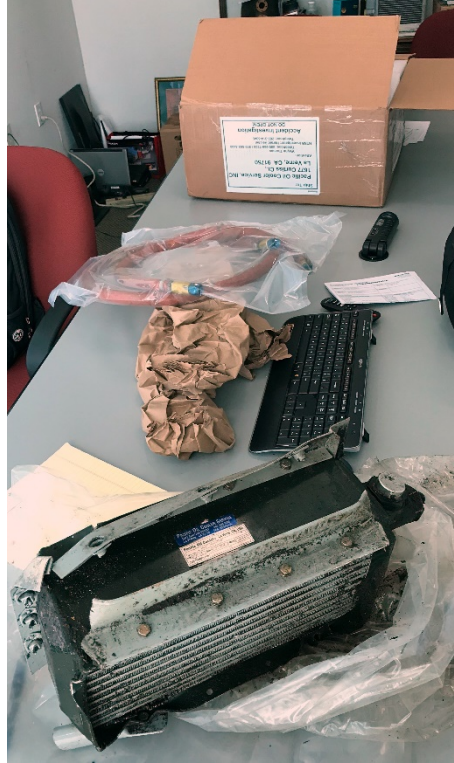


Photo 29 - Fracture on Edge Between the Weld and Parent Material

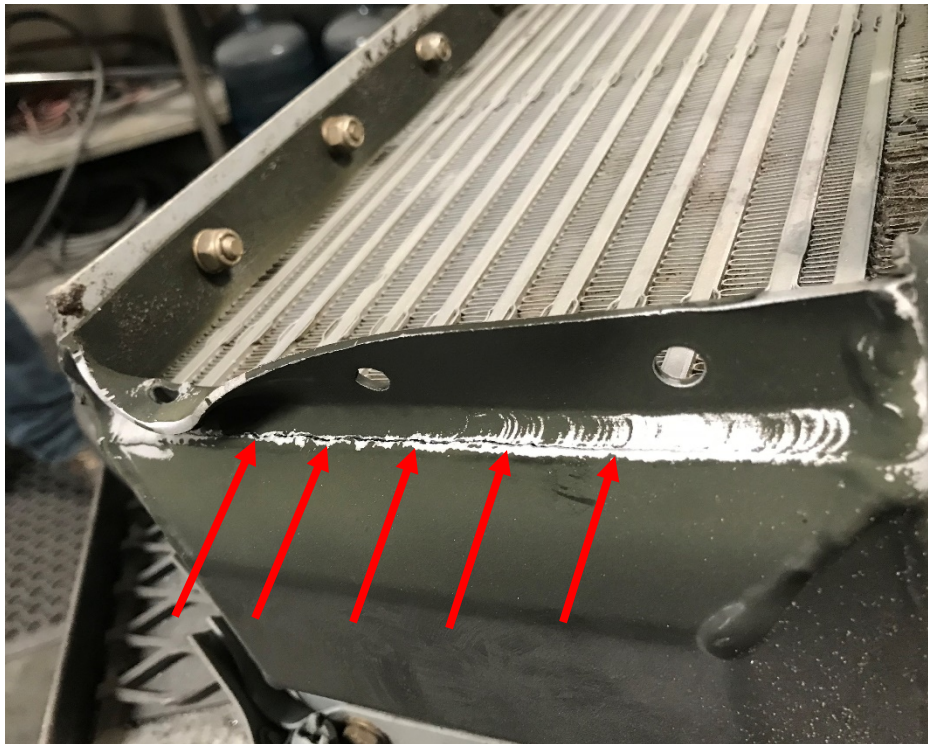


Photo 30 - Fracture Welded Closed

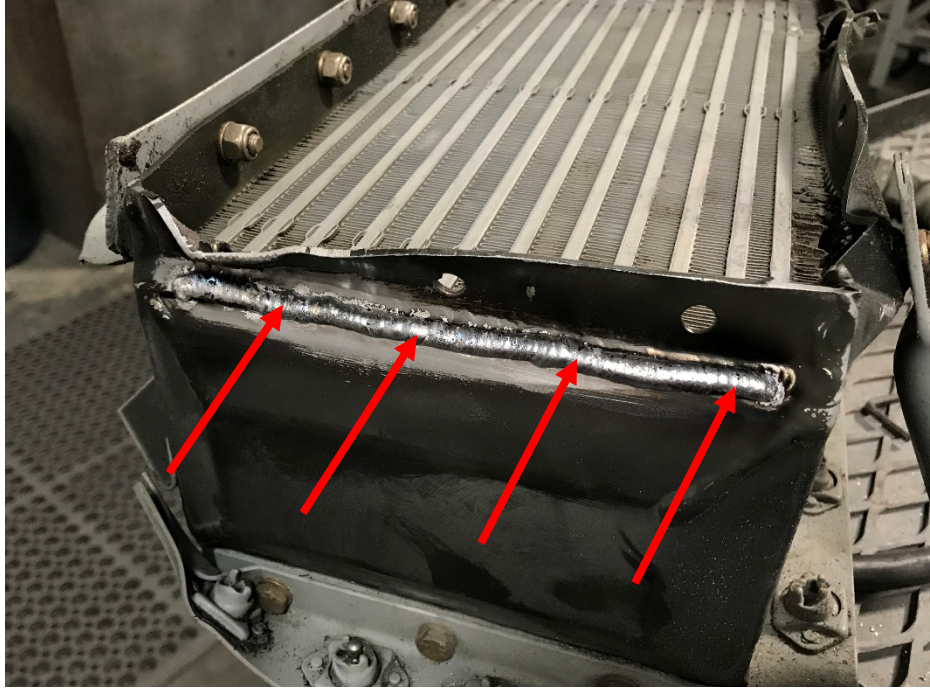


Photo 31 - Oil Cooler with 100 psi Air Pressure in Tank – No Leaks

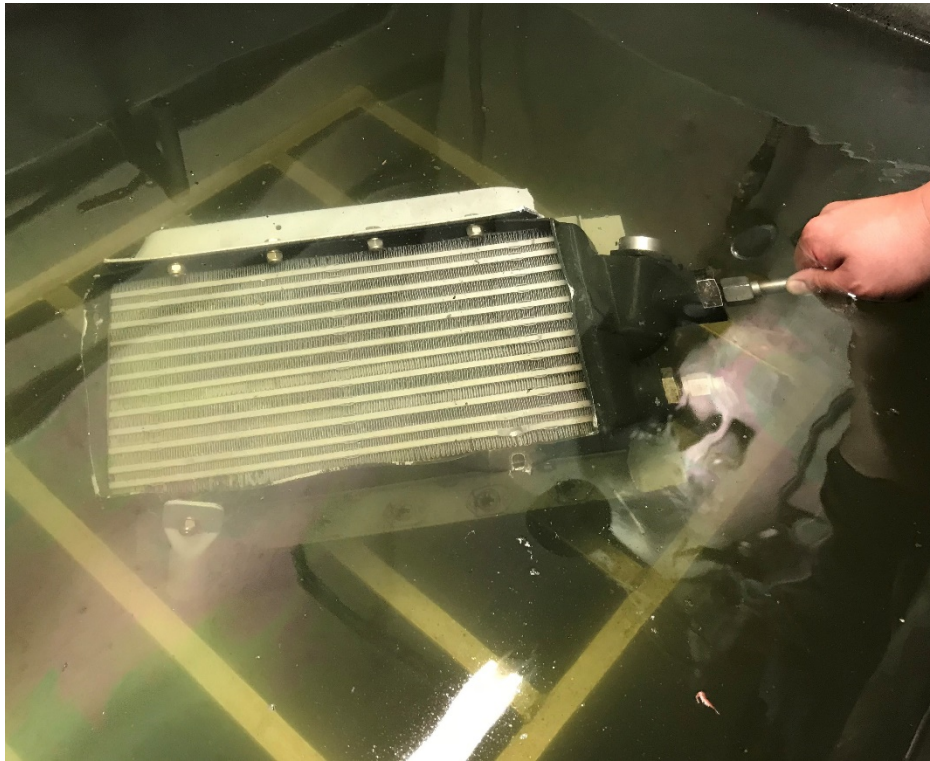


Photo 32 - Flex-Hose (1) with 100 psi Air Pressure in Tank – No Leaks



Photo 33 - Flex-Hose (2) with 100 psi Air Pressure in Tank – No Leaks

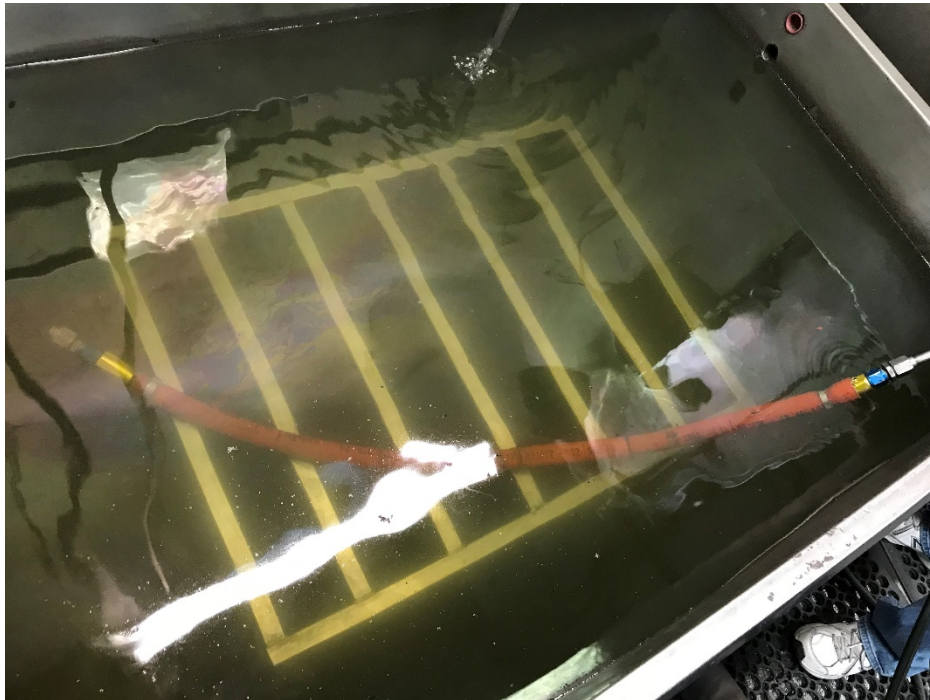
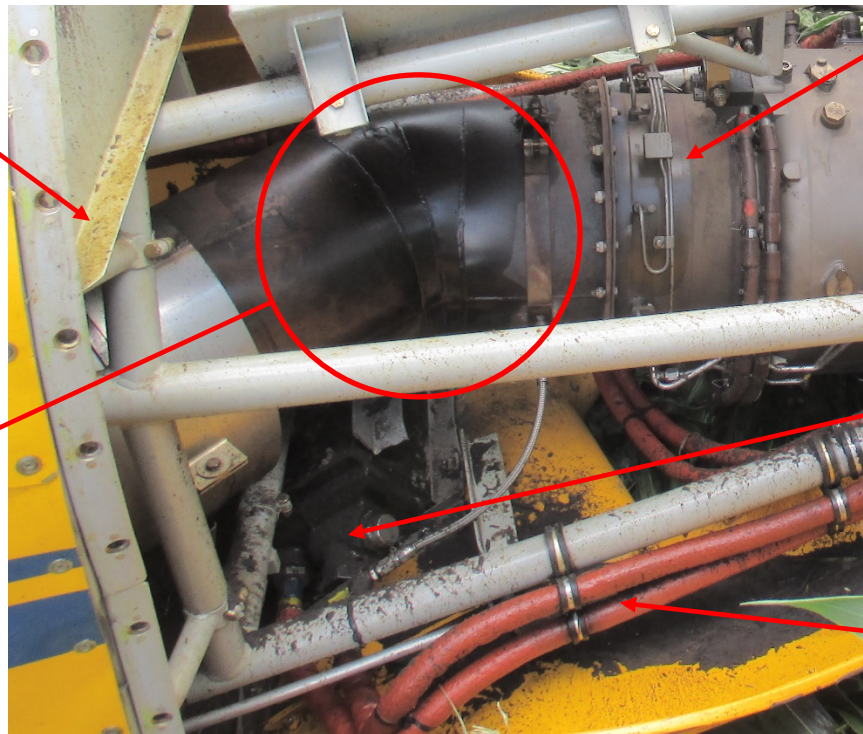


Photo 34 – Engine in airplane nacelle – On-scene



See Close-up
Photo 35

Photo 35 – Close up of Photo 34



Oil Pooling
on Ledge of
Battery Box
Frame

Engine Rear
Frame – Oil
Wetted until
Mid-point

Engine
Exhaust Duct
– Oil Wetted

Oil Cooler

Oil Cooler
Hoses

Photo 36 – Eductor Interior Surface – Oil Wetted near Exhaust Duct



Photo 37 – FCU & Fuel Pump Assembly – General Oil Wetting



Circlip is Oil
Soaked

Appendix I

RECORD OF CONVERSATION

05/21/2020

Telephone conversation with [REDACTED] in reference the aircraft accident involving N766BF, Thrush S2R-G10 on 07/21/2019 near Breckenridge, Michigan.

On this date I made telephone contact with [REDACTED], principal mechanic for Al's Air Service, and whose signature appears in the aircraft maintenance records for N766BF. I told [REDACTED] of the findings from Honeywell and NTSB, that no anomalies were detected during the formal teardown and run inspection of the engine. He stated he had received this information prior to our conversation and could not understand the cause of the oil pressure loss and high EGT temperature prior to the loss of power and subsequent accident. He believes if there was a loss of oil prior to engine shutdown the internal engine bearings and gears would show some form of damage.

[REDACTED] also reiterated what he had told me at the accident site, that there was oil still in the sump shortly after the accident. He feels the oil loss was caused by the impact crack in the oil cooler which allowed the oil to slowly drain from the sump during and following aircraft recovery from the field. Additionally, the aircraft had been test run and flown following the replacement of the oil cooler and no leaks were detected prior to the accident flight. [REDACTED] also stated (and I can confirm), there was no oil on the outside aircraft surfaces. However, with 300 gallons of fungicide spilled at the accident site, it would be almost impossible to detect engine oil on the underside of the aircraft or in the soil.

Finally, [REDACTED] believes the loss of oil pressure, high EGT, and subsequent loss of power was caused by a failure of the Thrust Sensor Bearing internal to the engine, but also stated it was only his belief and could not prove this statement.

[REDACTED] was friendly, cooperative, and forthright with all information given to questions asked. He also stated if I had additional questions to just give him a call.

END_____

[REDACTED]
Principal Maintenance Inspector

GRR FSDO GL-09