

National Transportation Safety Board

Office of Aviation Safety

Washington, DC 20594



CEN21LA329

POWERPLANT TEARDOWN EXAM

Specialist's Factual Report

August 2, 2022

Table of Contents

A. INCIDENT	3
B. POWERPLANT EXAM INVESTIGATORS	3
C. SUMMARY	3
D. DETAILS OF THE EXAMINATION.....	4
1.0 ENGINE INFORMATION	4
1.1 Engine Description	4
1.2 Engine History	6
2.0 ENGINE EXAMINATION	6
2.1 General Condition	6
2.2 Nosecone, Propellor Gearbox, and Accessory Gearbox.....	9
2.3 Compressor Section	10
2.4 Combustor Section	11
2.5 Turbine Section	12
2.6 Exhaust Section	13
2.7 Aft Scavenge Pump	14

A. INCIDENT

Location: Amana, Iowa
Date: July 19, 2021
Time: 1410 central daylight time
2110 UTC
Airplane: Grumman G-164B, Registration N8422K

B. POWERPLANT TEARDOWN EXAM INVESTIGATORS

Group Chair	Harald Reichel National Transportation Safety Board Washington DC
Group Member	Matthew Walker National Transportation Safety Board Washington DC
Subject Matter Expert	Dana Metz Honeywell Aerospace Phoenix, Arizona
Subject Matter Expert	Joseph Costa Federal Aviation Administration Lakewood, CA

C. SUMMARY

On July 19, 2021, about 1410 central daylight time, a Grumman G-164B airplane, registration number N8422K, was substantially damaged when it was involved in an incident near Amana, Iowa. The pilot was not injured. The airplane was operated as a Title 14 *Code of Federal Regulations* Part 137 aerial-application flight.

The initial report indicated the airplane's engine lost power shortly after departure from runway 22. The airplane was loaded with 420 gallons of fungicide and climbed to about 30 feet above ground level before the engine reportedly lost power. The airplane settled back onto the runway before departing off the end of the runway and into a cornfield. The airplane nosed over and came to rest inverted. The airplane sustained substantial damage to the fuselage and wings.

The accident engine was examined and disassembled at the Honeywell facility in Phoenix, Arizona with persons from Honeywell, the Federal Aviation Administration (FAA), and the National Transportation Safety Board (NTSB) in attendance. The

engine tear down examination commenced on August 1, 2022, and completed on August 2, 2022.

No pre-impact damage was found in the engine that may have precluded normal operation.

D. DETAILS OF THE EXAMINATION

1.0 Engine Information

1.1 Engine Description

The accident engine was a Honeywell (formerly AlliedSignal, Garrett, and AiResearch) model number TPE331-6-252M turbopropeller engine, (Figure 1). The TPE331-6 is a single-shaft engine with a two-stage centrifugal compressor, an annular combustion chamber, and three-stage axial turbine that drives the compressor (gas generator section) and the reduction/accessory gearbox (Figure 2). The model number identification is broken down as follows:

TPE means turbopropeller engine.

331 is the series number assigned by Honeywell.

-6 identifies the type certificate model.

-252 is the rating code.

M identifies this engine was originally installed in a Mitsubishi

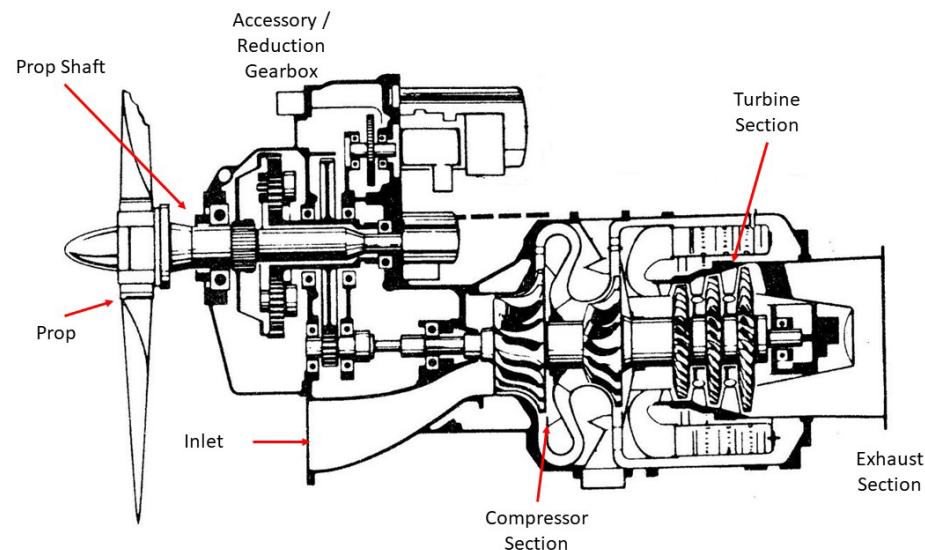


Figure 1: Generic TPE331 Engine Cros-Section; Figure Courtesy of Honeywell

According to the Federal Aviation Administration (FAA) Type Certificate Data Sheet (TCDS) E3WE, revision 34, dated May 22, 2014, the TPE331-6 turbopropeller engine, the engine has maximum continuous shaft horsepower power (SHP) of 715; 776 Equivalent Shaft Horsepower (ESHP); and output shaft rotation speed of 2,000 revolutions per minute (RPM). The takeoff (5 minute) limit is as follows: 750 SHP, 808 ESHP, and output shaft rotation speed of 2,000 RPM. The maximum exhaust gas temperature is 1,002°F (539°C) for maximum continuous and takeoff.¹ Maximum allowable propeller shaft torque as sensed by the torque sensor, in pound-feet (lb.-ft.), is 2,040 for 5-minute torque limit and 1,878 lb.-ft. for maximum continuous.

The TPE 331-6-252M is a clockwise rotating propeller installation². The gearbox incorporates a fixed planetary gear carrier assembly. The bull gear/sun gear assembly drives the planet gears, which drive the rotating ring gear. The ring gear is

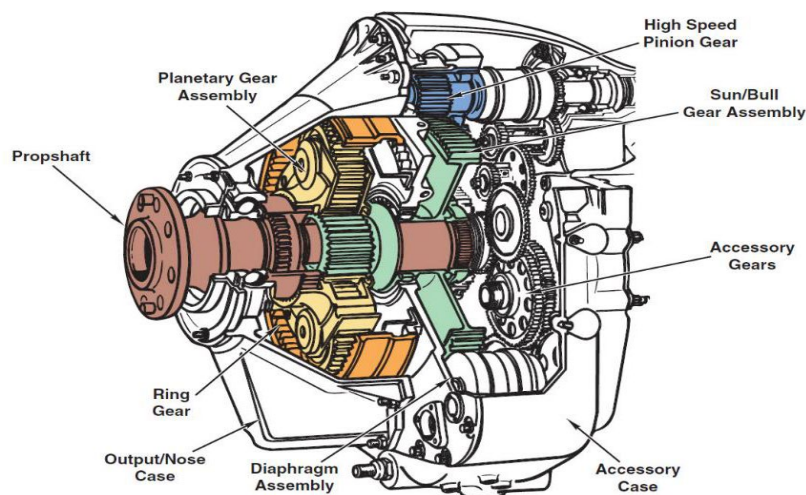


Figure 2: Accessory/Reduction Gearbox; FIGURE COURTESY OF HONEYWELL

¹ Engine power rating is based on the following: 1) International Standard Atmosphere (ISA), Sea Level Static Conditions; 2) fuel with lower heating value of 18,400 British Thermal Unit (BTU) per pound; 3) No bleed-air extraction; 4) No anti-icing airflow; 5) No external accessory loads; 6) Zero inlet loss; 7) Exhaust gas discharging to ambient-static pressure through the furnished turbine exhaust diffuser; and 8) Turbine gas temperature limits not exceeded. ESHP is for a static condition and is based on the following equation: $ESHP = (Net Thrust (pounds) / 2.5) + SHP$

² All directional references to front and rear, left and right, top and bottom, and clockwise and counterclockwise are made aft looking forward (ALF), as is the convention. All numbering is in the circumferential direction, starting with the No. 1 position at the 12:00 o'clock position or immediately clockwise from the 12:00 o'clock position and progressing sequentially clockwise ALF. The direction of rotation of the engine compressor and turbine is clockwise, and the propeller shaft is clockwise ALF. Since the TPE331 may be installed either with the inlet up or down based on the type of airplane installation, references to top and bottom are as the engine is installed in the airplane, not in reference to whether the inlet is up or down.

attached to the propeller shaft with a splined hub. With the ring and propeller shaft rotating as one assembly this produces clockwise rotation. The gearbox ratio is 20.865 to 1, with a 2,000 RPM propeller speed at 100% engine speed (Figure 2).

1.2 Engine History

According to the data plate, which is affixed to the accessory gear box case, the engine serial number (ESN) was P20381C (Photo 1). According to the engine logbook, as of April 12, 2019, the accident the engine had accumulated 14,715.6 hours, time since new (TSN).

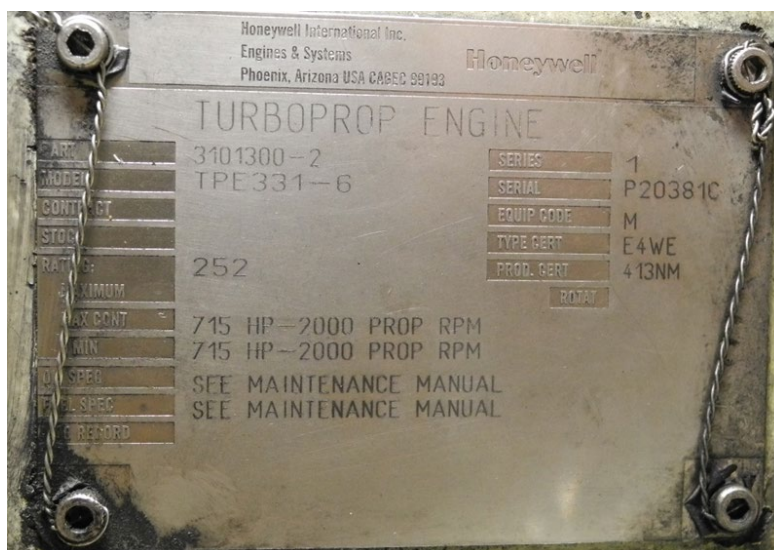


Photo 1: Engine Data Plate

2.0 Engine Examination

2.1 General Condition

It was reported that the engine was boxed at the salvage yard St. Pete's, Wright City, Missouri and sent to the Honeywell facilities for an engine test cell run. Honeywell conducted the testing at their Phoenix, Arizona facility. Prior to testing, the fuel control unit was confirmed to be in the Auto position and the valves open. During the test cell start attempt, low torque was observed by the technicians, consistent with a disconnection between the propeller shaft and the turbines. At the request of the NTSB, the engine was boxed again and stored for an exam.

The engine was removed from its shipping container (Photo 2, Photo 3, and Photo 4) on August 1, 2022, with persons from the FAA, NTSB, and Honeywell in attendance. All sections were intact and boxed with an oil sample. Some minor leakage was noted in the exhaust section. A small dripping leak was seen at the elbow in the fuel drain return to the fuel control unit.



Photo 3: In the box



Photo 2: TPE331-6-252M Engine ESN P20381C - As Received

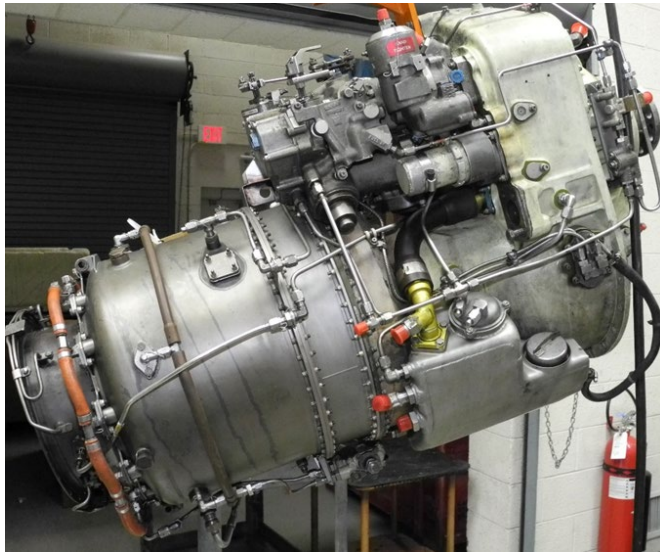


Photo 4: TPE331-6-252M Engine ESN P20381C - As Received

The propeller governor was in place and intact. Compressor intake was dirty (Photo 5). There was no visible damage to the 1st stage impeller (Photo 6).



Photo 5: Compressor inlet



Photo 6: Compressor inlet

A non-OEM banding clamp was present on the oil filter housing. The oil tank was intact and in place, with some oil still present.

The starter-generator was not returned with the engine.

There was no visible damage to the 3rd stage turbine wheel blades when viewed from aft.

In an effort to validate the previous report from the test cell of low torque, a turbine lock was installed at the aft end of the 3rd turbine wheel, and rotation of the starter-generator shaft attempted. As a single-shaft engine directly geared to the accessory gearbox, no rotation should be possible if the engine was intact; however, the accessory gearbox was able to rotate with the turbine locked in place, confirming a discontinuity in the drive system.

2.2 Nosecone, Propellor Gearbox, and Accessory Gearbox

The nosecone interior was clean and oil wetted. All dowels and retaining bolts were in place and not displaced. The ring gear was intact, and the propeller shaft was clean, with the snap ring seated and nominal, and with no visible signs of scoring or corrosion. The planetary gears were all intact and in place. The ball lock, quill shaft and coupler were intact and in place. Inside the diaphragm, the gear trains were intact, in place, and oil wetted. The tach generator was intact and in place. The gearing and shafts for the scavenge pump, torque sensor, fuel pump, and fuel control unit was intact. The helical gear in the torque sensor was intact and in place.

Honeywell sent the propeller governor and fuel control unit to Woodward to test for proper functionality. The units were tested on August 17, 2022, with the only discrepancies associated with authorized field adjustments.

2.3 Compressor Section

Significant earthen debris was present throughout the compressor consistent with continuous engine rotation during impact. The shroud lines of the vanes were predominantly coated with a thick, black earthen debris. The debris consisted of burnt fibrous and earthen material (Photo 7). Some rubbing/scuffing was present on exducer.



Photo 7: Debris along the compressor shroud lines.

2.4 Combustor Section

With the outer turbine case removed, significant buildup of dirt and burnt, earthen debris was present in all the air supply nozzles, or swirlers, consistent with engine operation during impact. (Photo 8 and Photo 9).

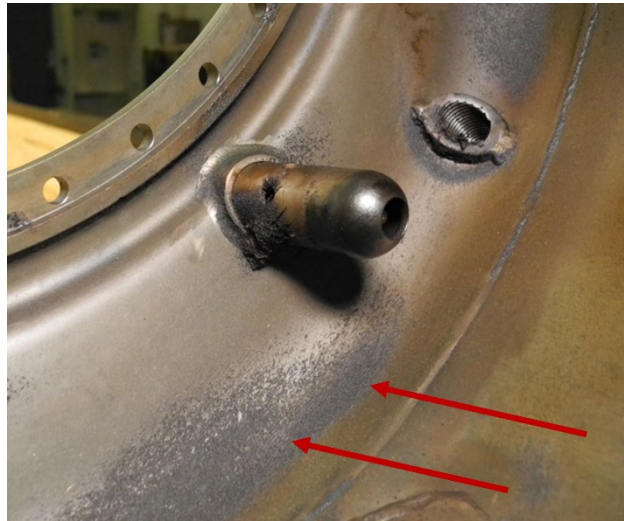


Photo 8: Debris inside the turbine casing

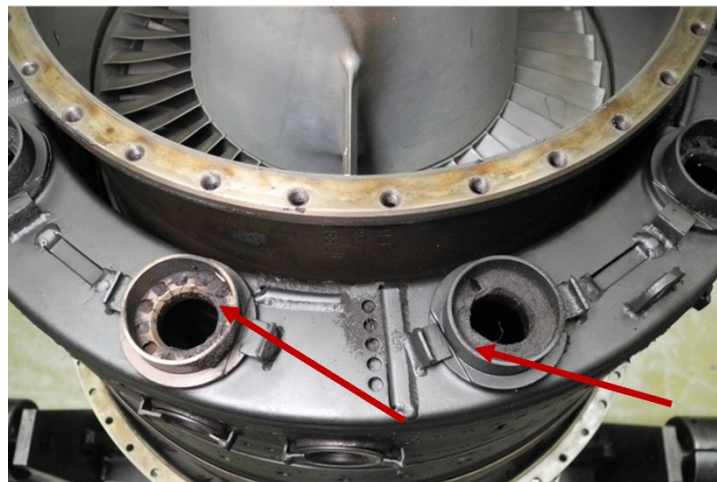


Photo 9: Debris in the air inlets

There was also deposits of burnt debris on the inner liner (Photo 10). Some of the debris shook loose during disassembly (Photo 11).



Photo 10: Burnt debris on the inner combustion liner.



Photo 11: Sample of burnt debris from the engine.

2.5 Turbine Section

Both the Interstage Turbine Temperature (ITT) and Exhaust Gas Temperature cables were present. A previous bulletin from Honeywell directed removal of the ITT and replacement with the EGT harness. Once opened, the ITT was observed to be cut and capped inside the turbine (Photo 12).



Photo 12: Capped ITT wiring

All nozzles were clean and undamaged. All three turbine wheels were intact and undamaged (Photo 13).



Photo 13: Turbine wheels

2.6 Exhaust Section

The exhaust section was intact with no signs of external thermal damage, uncontainment, or impact.

2.7 Aft Scavenge Pump

The aft turbine oil scavenge pump was sooted with light wetting, intact and turned smoothly. The aft bearing was intact, oil-wetted, with no signs of thermal damage.

When the scavenge pump was removed, the aft end of the torsion shaft was found free and resting at the 6-o'clock position against the splined end of main shaft (Photo 14). Honeywell retained the torsion shaft for metallurgical analysis, the results of which are available in the docket.

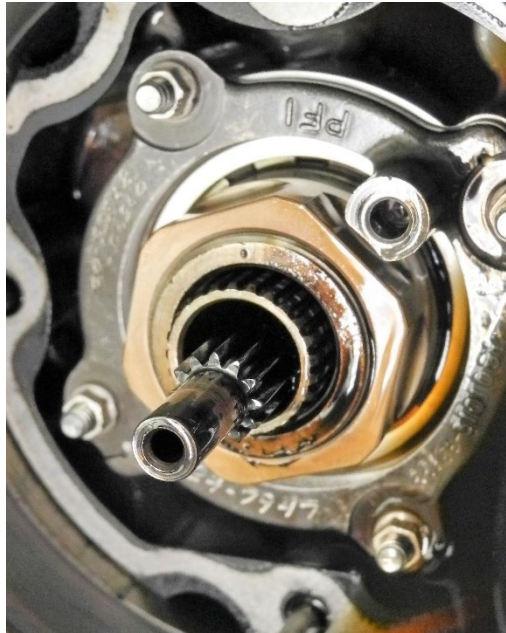


Photo 14: Torsion shaft resting at 6 o'clock position.

Submitted by:

Matthew Walker
Powerplants Engineer