

**TEARDOWN REPORT
OF ONE MODEL TPE331-10-511M
TURBOPROP ENGINE
SERIAL NUMBER P36075C**

August 29, 2019

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Product Integrity

REPORT NO.:

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ATTACHMENTS: None

Revision	By	Approved	Date	Pages and/or Paragraphs Affected
New	JA	See Title Page	08/29/2019	All (Initial Issue)

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**TEARDOWN REPORT
OF ONE MODEL TPE331-10-511M
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SERIAL NUMBER P36075C**

1. INTRODUCTION AND SUMMARY

1.1 PURPOSE

This report, prepared by Honeywell Aerospace, presents the findings of a teardown and inspection conducted on one Honeywell Model TPE331-10-511M engine, Serial Number P36075C. The inspection took place at the Honeywell Investigation Laboratory in Phoenix, Arizona, on October 16 – 18, 2018.

The inspection was conducted at the request of, and under the cognizance of the National Transportation Safety Board (NTSB).

1.2 BACKGROUND

On April 29, 2018, at 15:30 pm local time, a Grumman / Schweizer G-164C/C, single engine agricultural airplane, N6674K, was substantially damaged following a forced landing due to a loss of engine power near Maxwell, CA. The commercial pilot was not injured. The pilot reported, while flying at 200 feet altitude, that the engine surged three times, followed by what he believed was a total engine failure. The aircraft was recovered to a secure facility where the engine was removed and shipped to Honeywell for teardown.

Engine S/N P36075 was returned to Honeywell and placed in bond until the date of the teardown. An engine teardown in support of the National Transportation Safety Board was conducted at the Honeywell Product Integrity Teardown Laboratory on October 16 - 18, 2018.

1.3 SUMMARY

The teardown and examination of the engine disclosed that the type and degree of damage was indicative of an engine that was not operating at time of impact but rotating at a very low speed. Functional tests of the fuel control unit identified fuel schedules that were out of specification limits. Operation of the engine at low power conditions with the out of specification fuel control setting most likely resulting in unstable engine operation below 100% engine speed. No cause for the engine shutdown was identified however, the fuel shutoff valve was found in the electrically commanded closed position.

2. FINDINGS OF TPE331-10-511M, TURBOPROP ENGINE, SERIAL NUMBER P36075C

NOTE

All references to position are aft looking forward.

All observations reported herein are based on visual examinations with the unaided eye, unless otherwise noted.

2.1 GENERAL

- (a) The engine was received in a standard wooden shipping container, in an open vacuum bag (Figure 1 and Figure 2).
- (b) The engine logbook was returned separate from the engine.
- (c) The nameplate identified the engine as (Figure 3):
 - Model: TPE331-10-511M
 - Serial Number: P36075C
 - Part Number: 3102180-2
- (d) There was no sign of fire damage (Figure 4 - Figure 7).
- (e) Various aircraft hardware remained attached to the engine.
 - Aircraft mounts on accessory gearbox (Figure 8).
 - Inlet guard (Figure 5).
 - Starter generator (Figure 9).
 - Exhaust duct (Figure 10).
 - Common drain plumbing (Figure 11).
- (f) The following engine damage was noted:
 - There was impact damage to the inlet (Figure 12)
 - The oil tank was crushed (Figure 13).
 - The oil bypass indicator was not popped (Figure 14).
 - There was a small amount of earthen debris in the inlet area (Figure 15).
 - One lead on the exciter box was damaged (Figure 16).
 - There was damage to the right side aft exhaust duct (Figure 17).
 - The oil supply tube was crushed.
 - A thermocouple was pulled out and bent.
 - The beta tube was not returned with the engine.
 - The fuel line in place of P/N 3102219-1 appeared to be non-Honeywell design.
 - The inlet mount flange of the accessory gearbox housing was separated and remained attached to the aircraft inlet (Figure 18).

- The exhaust flange was distorted ([Figure 19](#)).
- The fuel shutoff valve was in the AUTO position ([Figure 20](#)).
- (g) The engine propeller shaft would rotate, but the turbine did not rotate with the prop.
- (h) The engine's rotating group would rotate, but the prop did not rotate.
- (i) The FCU / PPC / Prop Governor rigging was verified to be correct.
- (j) The starter/generator was:
 - The starter shaft was intact and appeared undamaged ([Figure 21](#)).
 - The starter pad flange was intact and appeared undamaged ([Figure 22](#)).

2.2 OUTPUT GEARCASE (NOSE CONE) ASSEMBLY

- (a) Nose Cone Housing
 - The nose cone housing was intact and appeared undamaged ([Figure 23](#)).
 - There was a crack on the forward side at the bottom of the nose cone housing that appears to have originated from bearing bore at 6 o'clock ([Figure 24](#)).
- (b) Propeller Shaft Mount Flange
 - The propeller shaft mount flange was intact and appeared undamaged ([Figure 25](#)).
- (c) Propeller Shaft:
 - The propeller shaft was intact and appeared undamaged ([Figure 26](#)).
 - There was light rotational scoring over a 90-degree arc aft of the bearing retaining nut on the propeller shaft ([Figure 27](#)).
 - There was very light rotational scoring at the aft end of the propeller shaft over 180 degrees ([Figure 28](#)).
- (d) Forward Propeller Shaft Bearing Mount Bolts
 - Three forward propeller shaft bearing mount bolts were broken and found in the sump area of nose cone ([Figure 29](#) and [Figure 30](#)).
- (e) Propeller Shaft Lock Nut.
 - The propeller shaft lock nut was intact and appeared undamaged ([Figure 31](#)).
- (f) Propeller Shaft Output Seal Retainer.
 - The propeller shaft output seal retainer was intact and appeared undamaged ([Figure 32](#)).

- (g) Propeller Shaft Bearing Oil Jet
 - The propeller shaft bearing oil jet was intact and appeared undamaged ([Figure 33](#)).
- (h) Propeller Shaft Air/Oil Seal:
 - The propeller shaft air / oil seal was intact and appeared undamaged but was not removed for detailed inspection.
- (i) Propeller Shaft Bearing:
 - The propeller shaft bearing was intact and appeared undamaged but was not removed for detailed inspection ([Figure 34](#)).
 - The propeller shaft bearing rotated freely.
- (j) Propeller Shaft Coupler
 - The propeller shaft coupler was intact and appeared undamaged ([Figure 35](#)).

2.3 INTERMEDIATE HOUSING AND GEAR (DIAPHRAGM) ASSEMBLY

- (a) Planetary Gear Assembly:
 - The planetary gear assembly was intact and appeared undamaged ([Figure 36](#) and [Figure 37](#)).
- (b) Ring Gear
 - The ring gear was intact and appeared undamaged ([Figure 38](#) and [Figure 39](#)).
 - The ring gear was not removed from the ring gear support.
 - There were light impact marks on top of three gear teeth of the ring gear ([Figure 40](#)).
 - Debris was present between the gear teeth of the ring gear ([Figure 40](#)).
- (c) Ring Gear Support:
 - The ring gear support was intact and appeared undamaged ([Figure 38](#) and [Figure 39](#)).
 - The ring gear support was not removed from the ring gear.
 - There was a light impact mark on the bumper of the ring gear support at the 7 o'clock position ([Figure 41](#)).
- (d) Ring Gear Retainers
 - The ring gear retainers were intact and appeared undamaged ([Figure 42](#) and [Figure 43](#)).
 - The ring gear retainers were not removed from the ring gear and ring gear support.

- (e) Diaphragm Housing:
 - The diaphragm housing was intact and appeared undamaged (Figure 44 and Figure 45).
 - The diaphragm housing was not disassembled for detailed inspection.
 - The gears and bearings in the diaphragm housing rotated freely.
- (f) Forward and Aft Diaphragm Housings
 - The forward and aft diaphragm housing were intact and undamaged.
- (g) Bull Gear
 - The bull gear was intact and appeared undamaged (Figure 46 and Figure 47).
- (h) Forward Bull-Gear Bearing
 - The forward bull gear bearing was intact and appeared undamaged (Figure 48).
 - The forward bull gear bearing was not removed for detailed inspection.
- (i) Aft Bull-Gear Bearing:
 - The aft bull gear bearing was intact and appeared undamaged (Figure 49).
 - The aft bull gear bearing was not removed for detailed inspection.
- (j) Sun Gear
 - The sun gear was intact and appeared undamaged (Figure 50).
 - The oil jets for the sun gear were intact and appeared undamaged.
 - There was evidence of wear on the gear teeth with debris present between the gear teeth (Figure 51).
- (k) High-Speed Pinion HSP:
 - The high-speed pinion was intact and appeared undamaged (Figure 52).
 - The high-speed pinion was not removed for detailed inspection.
- (l) Forward High-Speed Pinion Bearing:
 - The forward high-speed pinion bearing was intact and appeared undamaged (Figure 53).
 - The forward high-speed bearing was not removed for detailed inspection.
- (m) Aft High-Speed Pinion Bearing:
 - The aft high-speed pinion bearing was intact and appeared undamaged (Figure 54).
 - The aft high-speed bearing was not removed for detailed inspection.

- (n) HSP-to-Power Section Coupling Shaft
 - The HSP-to-power section coupling shaft broke at the aft end ([Figure 55 - Figure 58](#)).
 - The HSP-to-power section coupling shaft was submitted for material analysis. The results are presented in [APPENDIX A](#).
- (o) Shouldered Ball-Lock Shaft
 - The shouldered ball-lock shaft was intact and appeared undamaged ([Figure 59](#)).
- (p) Negative Torque Sensor (NTS) Quill Shaft
 - The NTS quill shaft was intact and appeared undamaged ([Figure 60](#)).
- (q) Hydraulic Pump Drive Gearshaft.
 - The hydraulic pump drive gearshaft was intact and appeared undamaged ([Figure 61](#)).
- (r) Propeller Governor Drive Gear Assembly:
 - The propeller governor drive gear assembly was intact and appeared undamaged ([Figure 62](#)).
- (s) Starter/Generator Drive Gearshaft Assembly:
 - The starter/generator drive gearshaft assembly was intact and appeared undamaged ([Figure 63](#)).
- (t) Starter/Generator Idler Gears Assembly:
 - The starter/generator idler gears assembly was intact and appeared undamaged ([Figure 64](#)).
- (u) Gearcase Oil-Scavenge Pump Drive Idler Gear
 - The gearcase oil-scavenge pump drive idler gear was intact and appeared undamaged ([Figure 65](#)).
- (v) Gearcase Oil-Scavenge Pump Drive Shaft
 - The gearcase oil-scavenge pump drive shaft was intact and appeared undamaged ([Figure 65 - Figure 66](#)).
 - The gearcase oil-scavenge pump drive shaft remained installed in the gearcase oil-scavenge drive idler gear.

2.4 ACCESSORY DRIVE HOUSING (GEARCASE) ASSEMBLY

- (a) Exterior (Non Oil-Wetted) of the Gearcase Housing
 - The gearcase housing was intact ([Figure 67](#) - [Figure 70](#)).
 - A portion of the gearcase housing at the bottom of the inlet was damaged with the inlet flange and a portion of the inlet duct on the right side missing, but remained attached to the oil tank ([Figure 71](#)).
- (b) Interior (Oil-Wetted) of the Gearcase Housing
 - The interior (oil-wetted) of the gearcase housing was intact and appeared undamaged ([Figure 72](#) - [Figure 75](#)).
- (c) Anti-Ice Shield
 - The anti-ice shield was not installed on the engine.
- (d) Propeller Shaft Aft Ball Bearing
 - The propeller shaft aft ball bearing was intact and appeared undamaged ([Figure 76](#)).
 - The propeller shaft aft ball bearing rotated freely.
 - The retainer on aft side of the propeller shaft aft ball bearing was partially out of the groove ([Figure 77](#)).
- (e) Propeller Shaft Roller Bearing
 - The propeller shaft roller bearing was intact and appeared undamaged ([Figure 78](#)).
 - The propeller shaft roller bearing rotated freely.
 - The propeller shaft roller bearing was misaligned in the housing ([Figure 79](#)).
- (f) Forward (Compressor) Main-Shaft Nut
 - The forward compressor main-shaft nut was intact and appeared undamaged ([Figure 80](#)).
- (g) Compressor Bearing
 - The compressor bearing was intact ([Figure 81](#) and [Figure 82](#)).
 - The compressor bearing rotated freely.
 - The compressor bearing was not disassembled for visual inspection.
 - There were scratches on the compressor bearing inner race with corresponding scratches on the balls.
- (h) Compressor Air/Oil Carbon Seal
 - The compressor air/oil carbon seal was intact and appeared undamaged ([Figure 83](#)).
- (i) Compressor Carbon Seal Rotor

- The carbon seal rotor was intact and appeared undamaged ([Figure 84](#) and [Figure 85](#)).
- (j) Fuel Pump Drive Shaft
 - The fuel pump drive shaft was intact and appeared undamaged ([Figure 86](#)).
- (k) Magnetic Chip Detector
 - The magnetic chip detector was free of debris ([Figure 87](#)).
- (l) Gearcase Oil-Scavenge Pump
 - The gearcase oil-scavenge pump was intact and appeared undamaged ([Figure 88](#)).
- (m) NTS Regulator
 - The NTS regulator was intact and remained undamaged ([Figure 89](#)).
- (n) NTS Transfer Tube / Orifice
 - The NTS transfer tube was intact and appeared undamaged ([Figure 90](#)).
 - The orifice in the NTS transfer tube was free of debris.
 - Installation direction of the NTS transfer tube was verified to be correct.
- (o) Feather Valve Oil Transfer Tube
 - The feather valve oil transfer tube was intact and appeared undamaged.
- (p) Feather Valve Oil Transfer Tube Mount Boss
 - There were no impact or score marks on the feather valve oil transfer tube mount boss ([Figure 91](#)).
- (q) Propeller Governor “Spider” gasket
 - The propeller governor “spider” gasket was intact and appeared undamaged ([Figure 92](#)).
- (r) “Lee” Check Valve & Orifice Assembly
 - The “Lee” check valve orifice appeared free of debris ([Figure 92](#)).

2.5 TORQUE SENSOR AND DDFC GEAR TRAIN

- (a) General
 - The Direct Drive Fuel Control Drive (DDFC) gear train provides mechanical drive to the components listed below.

- The DDFC gear train was intact, undamaged and free to rotate ([Figure 93](#)).
- (b) Torque sensor:
 - The torque sensor was intact and appeared undamaged ([Figure 94](#)).
 - There was an impact mark on the aft side ID bore of the torque sensor from contact with the main shaft gear ([Figure 95](#)).
- (c) First Direct Drive Fuel-Control (DDFC) Gear Assembly
 - The first DDFC gear assembly was intact and appeared undamaged ([Figure 96](#)).
- (d) Second DDFC Gear
 - The second DDFC gear was intact and appeared undamaged ([Figure 97](#) and [Figure 98](#)).
- (e) Third DDFC Gear
 - The third DDFC gear was intact and appeared undamaged ([Figure 99](#)).
- (f) Fourth DDFC, Tach/Generator Drive Gear and Shaft Assembly
 - The fourth DDFC, tach/generator drive gear and shaft assembly was intact and appeared undamaged ([Figure 100](#)).
- (g) Hydraulic Oil Torque Sensor Output
 - The hydraulic oil torque sensor output was intact and appeared undamaged ([Figure 101](#) and [Figure 102](#)).

2.6 COMPRESSOR SECTION

- (a) Main Shaft
 - The main shaft was intact and appeared undamaged ([Figure 103](#)).
 - Debris was present in the knife seals at the compressor end of the main shaft ([Figure 104](#)).
- (b) Main Shaft Gear
 - The main shaft gear was intact and appeared undamaged ([Figure 105](#)).
 - Light contact marks were present on several gear teeth of the main shaft gear ([Figure 106](#)).
 - Debris remained between the gear teeth of the main shaft gear ([Figure 107](#)).

- The main shaft gear was submitted for material analysis. The results are presented in [APPENDIX A](#).
- (c) Torsion Shaft
- The torsion shaft was intact and appeared undamaged (Figure 108).
 - The torsion shaft was free of coking.
- (d) First-Stage Compressor Impeller Shroud
- The first-stage compressor impeller shroud was intact and appeared undamaged ([Figure 109](#) and [Figure 110](#)).
 - There was a rub on the first-stage compressor impeller shroud from 11 to 3 o'clock at the inducer ([Figure 111](#)).
 - There was very light score mark at the exducer from 10 o'clock to 3 o'clock of the first-stage compressor impeller shroud ([Figure 111](#)).
 - There was discoloration on the first-stage compressor impeller shroud at 11 static blade positions from 1 to 9 o'clock ([Figure 112](#)).
 - Debris was present forward of the inducer on the first-stage compressor impeller shroud ([Figure 112](#)).
 - Debris was present at the bottom of the first-stage compressor impeller shroud.
- (e) First-Stage Compressor Impeller
- The first-stage compressor impeller was intact and appeared undamaged ([Figure 113](#) - [Figure 115](#)).
 - There was light rotational scoring on the blades of the first-stage compressor impeller from the inducer to knee ([Figure 116](#)). The scoring was heavier at the inducer.
 - There was debris adhering to blades at the tip near the inducer of the first-stage compressor impeller ([Figure 117](#)).
 - Debris was present on the hub of the first-stage compressor impeller ([Figure 117](#)).
- (f) First-Stage Compressor Diffuser (Crossover Duct)
- The first-stage compressor diffuser was intact and appeared undamaged ([Figure 118](#) and [Figure 119](#)).
 - There was debris present in the flowpath of the first-stage compressor diffuser ([Figure 120](#)).
- (g) Second-Stage Compressor Housing
- The second-stage compressor housing was intact and appeared undamaged ([Figure 121](#) and [Figure 122](#)).
 - There was discoloration at 15 locations on the shroud of the second-stage compressor housing corresponding to impeller blade locations.

- There was a light rub in the knee of the shroud of the second-stage compressor housing from 9 to 3 o'clock with discoloration over the rubbed area ([Figure 123](#)).
- There was a rub at the inducer of the shroud of the second-stage compressor housing from 10 to 1 o'clock with no discoloration in rubbed area ([Figure 123](#)).

(h) Second-Stage Compressor Impeller

- The second-stage compressor impeller was intact and appeared undamaged ([Figure 124](#) - [Figure 126](#)).
- There was rotational scoring on the blade tip at the knee and inducer of the second-stage compressor impeller ([Figure 127](#)).
- Debris was adhering to the blades of the second-stage compressor impeller at the tip near the inducer ([Figure 127](#)).
- Debris was found on the hub between the blades of the second-stage compressor impeller ([Figure 128](#)).

(i) Second-Stage Compressor Diffuser Vane Assembly

- The second-stage compressor diffuser vane assembly was intact and appeared undamaged ([Figure 129](#)).

2.7 COMBUSTION SECTION

(a) Combustor Plenum Case

- The combustor plenum case was intact and appeared undamaged ([Figure 130](#)).
- There were slight dents at the 8 and 9 o'clock positions ALF on the combustor plenum case.

(b) Combustion Chamber:

- The combustion chamber was intact and appeared undamaged ([Figure 131](#)).

(c) Outer Transition Liner

- The outer transition liner was intact and appeared undamaged ([Figure 132](#) and [Figure 133](#)).

(d) Inner Transition Liner:

- The inner transition liner was intact and appeared undamaged ([Figure 134](#) and [Figure 135](#)).

2.8 TURBINE SECTION

(e) Center Curvic Coupling

- The center curvic coupling was intact and appeared undamaged ([Figure 136](#) and [Figure 137](#)).
- (b) Turbine Stator Housing
- The turbine stator housing was intact and appeared undamaged ([Figure 138](#) and [Figure 139](#)).
 - There were no shims found between the turbine stator housing and the combustor plenum.
- (c) First-Stage Turbine Stator Assembly
- The first-stage turbine stator assembly was intact and appeared undamaged ([Figure 140](#) and [Figure 141](#)).
- (d) First Stage Turbine Shroud
- The first-stage turbine shroud was intact and appeared undamaged ([Figure 142](#)).
 - There was localized rubbing at the end of four shroud segments of the first-stage turbine shroud ([Figure 143](#)).
- (e) First-Stage Turbine Rotor Assembly
- The first-stage turbine rotor assembly was intact and appeared undamaged ([Figure 144](#) and [Figure 145](#)).
 - The blades of the first-stage turbine rotor assembly were brownish in color.
 - There was rotational scoring on the aft blade platform of the first-stage turbine rotor assembly ([Figure 146](#)).
 - There was light rotational scoring on the blade tips of the first-stage turbine rotor assembly with additional rub at the aft end of the blade tip ([Figure 147](#)).
- (f) Second-Stage Turbine Stator
- The second-stage turbine stator was intact and appeared undamaged ([Figure 148](#) and [Figure 149](#)).
 - There was rotational scoring over a 45-degree arc on the shroud of the second -stage turbine stator ([Figure 150](#)).
 - There was rotational scoring on the forward side ID platform of the second-stage turbine stator over 360 degrees ([Figure 151](#)).
 - There were small earthen deposits on two adjacent vanes of the second-stage turbine stator.
 - There was discoloration at the outer vane leading edge of 20 vanes of the second-stage turbine stator ([Figure 152](#)).
- (g) Second-Stage Turbine Rotor

- The second-stage turbine rotor was intact and appeared undamaged (Figure 153 and Figure 154).
 - There was light rotational scoring on the blade tips of the second-stage turbine rotor (Figure 155).
 - There was light erosion on the blade leading edge of the second -stage turbine rotor at tips (Figure 156).
 - There were contact marks on the aft side of the disk of the second-stage turbine rotor (Figure 157).
- (h) Third-Stage Turbine Stator
- The third-stage turbine stator was intact and appeared undamaged (Figure 158 and Figure 159).
 - There were contact marks on the forward inner diameter outboard of seal on the third-stage turbine stator (Figure 160).
- (i) Third-Stage Turbine Rotor
- The third-stage turbine rotor was intact and appeared undamaged (Figure 161 and Figure 162).
- (j) Rear Curvic Coupling
- The rear curvic coupling was intact and appeared undamaged (Figure 163 and Figure 164).
- (k) Engine Exhaust Duct
- The engine exhaust duct was intact (Figure 165 and Figure 166).
 - The rear flange of the engine exhaust duct was bent and distorted (Figure 167).
 - The fitting for the oil supply tube pulled out of the engine exhaust duct (Figure 168).
 - The fitting for the P5 pressure was pulled out of the engine exhaust duct (Figure 168).
- (l) Thermocouple Harness Assembly
- Three probes on the thermocouple harness assembly were damaged.
- (m) Turbine Bearing Support
- The turbine bearing support was intact and appeared undamaged (Figure 169 and Figure 170).
- (n) Turbine Bearing Housing
- The turbine bearing housing was intact and appeared undamaged (Figure 171 and Figure 172).
- (o) Turbine Bearing Retainer:

- The turbine bearing retainer was intact and appeared undamaged ([Figure 173](#)).
- (p) Turbine Sump Cover
 - The turbine sump cover was intact and appeared undamaged ([Figure 174](#)).
- (q) Turbine Oil-Scavenge Pump and Drive Shaft:
 - The turbine oil-scavenge pump and drive shaft were intact and appeared undamaged ([Figure 175](#)).
- (r) Turbine Air/Oil Carbon Seal
 - The turbine air/oil carbon seal was intact and appeared undamaged ([Figure 176](#)).
- (s) Aft Carbon Seal Rotor
 - The aft carbon seal rotor was intact and appeared undamaged ([Figure 177](#)).
- (t) Turbine Bearing:
 - The turbine bearing was intact and appeared undamaged ([Figure 178](#)).
- (u) Aft (Turbine) Main-Shaft Nut
 - The aft main-shaft nut was intact and appeared undamaged ([Figure 179](#)).

2.9 Controls & Accessories

- (a) Fuel Shutoff Valve
 - The fuel shutoff valve was intact and appeared undamaged ([Figure 180](#) and [Figure 181](#)).
 - There was an impact mark on the lower housing (square portion of the body) along the external surface ([Figure 182](#)).
 - The fuel shutoff valve was functionally tested and CT scanning. The results are presented in [APPENDIX B](#).
- (b) Fuel Pump Assembly
 - The fuel pump assembly was intact and appeared undamaged ([Figure 183](#)).
 - There was a small amount of debris inside the filter bowl of the fuel pump assembly ([Figure 184](#)).
 - The fuel pump was submitted for functional tests. The results are presented in [APPENDIX C](#).
- (c) Fuel Control Unit

- The fuel control unit was intact and appeared undamaged ([Figure 185](#)).
- Debris was present near the input shaft of the fuel control unit ([Figure 186](#)). The debris was collected and submitted for material analysis. The results are presented in [APPENDIX A](#).
- The fuel control unit was returned to the vendor for functional testing. The results are presented in [APPENDIX D](#).

(d) Fuel Filter

- The fuel filter was intact and appeared undamaged ([Figure 187](#)).
- A fuel sample obtained from the fuel filter housing.
- Soft, white material was found in the fuel filter ([Figure 188](#)).
- White debris was noted in the fuel filter cap.

(e) Shaft – Fuel Pump to Accessory Gearbox

- The shaft between the fuel pump and accessory gearbox was intact and appeared undamaged ([Figure 189](#)).

(f) Fuel Flow Divider Valve

- The fuel flow divider valve was intact and appeared undamaged ([Figure 190](#)).
- The fuel flow divider valve was functionally tested. The results are presented in [APPENDIX E](#).

(g) Propeller Governor

- The propeller governor was intact and appeared undamaged ([Figure 191](#)).
- The propeller governor was returned to the vendor for functional tests. The results are presented in [APPENDIX F](#).

(h) Propeller Pitch Control

- The propeller pitch control was intact and appeared undamaged ([Figure 192](#)).
- The pin in the propeller pitch control was intact and appeared undamaged ([Figure 193](#)).

(i) Oil Filter

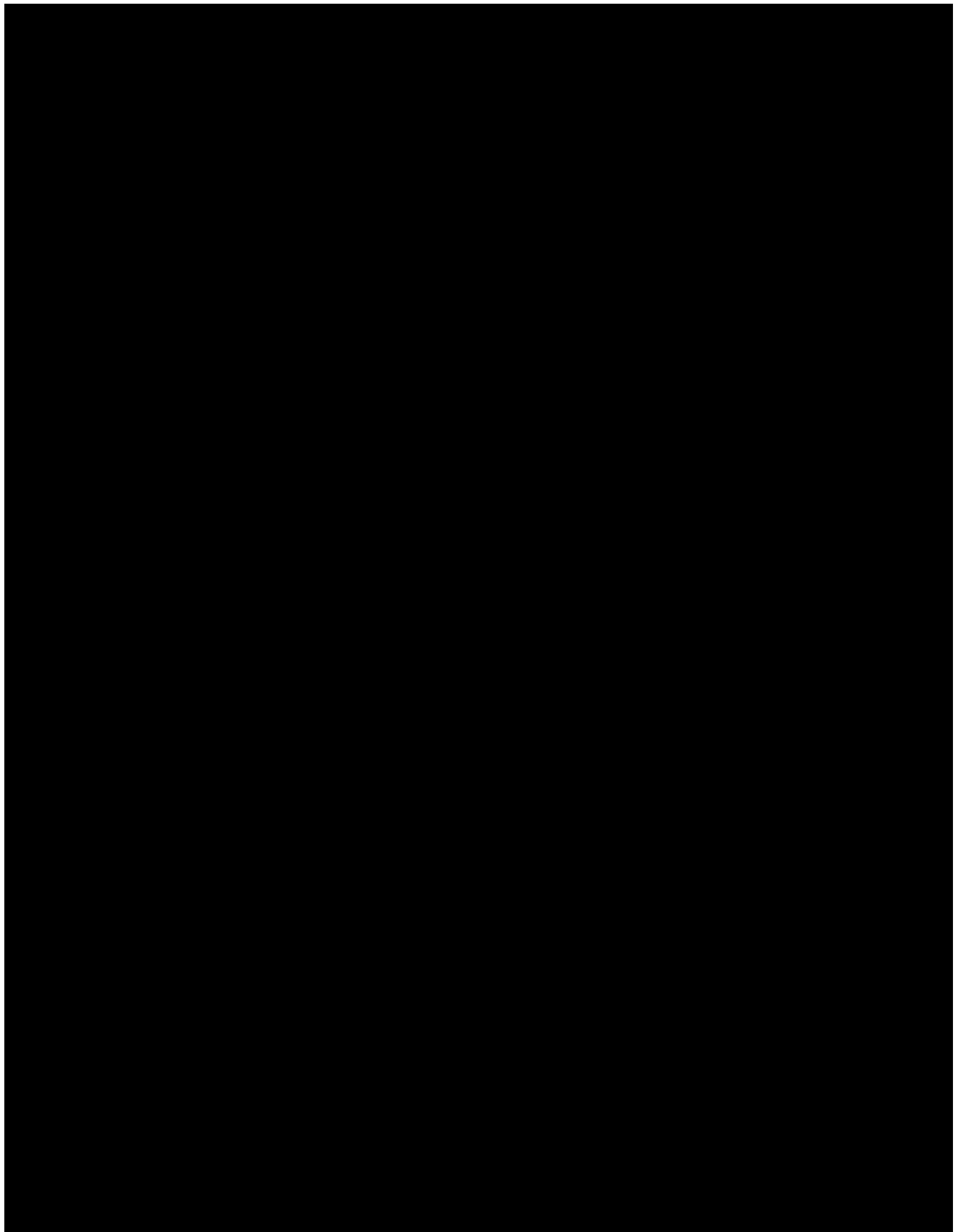
- The oil filter was intact and appeared undamaged ([Figure 194](#)).
- The oil filter appeared free of debris.

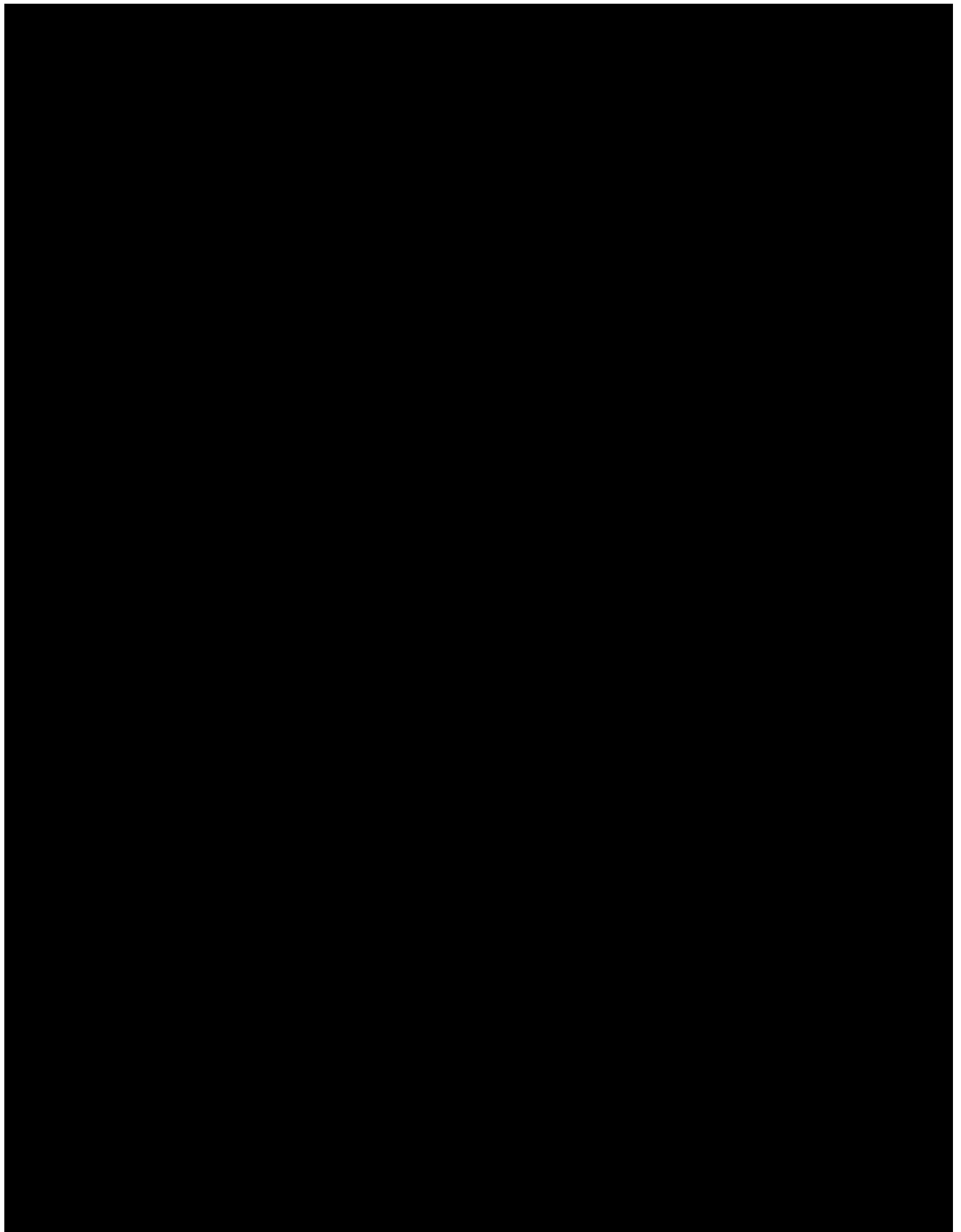
(j) Oil Tank

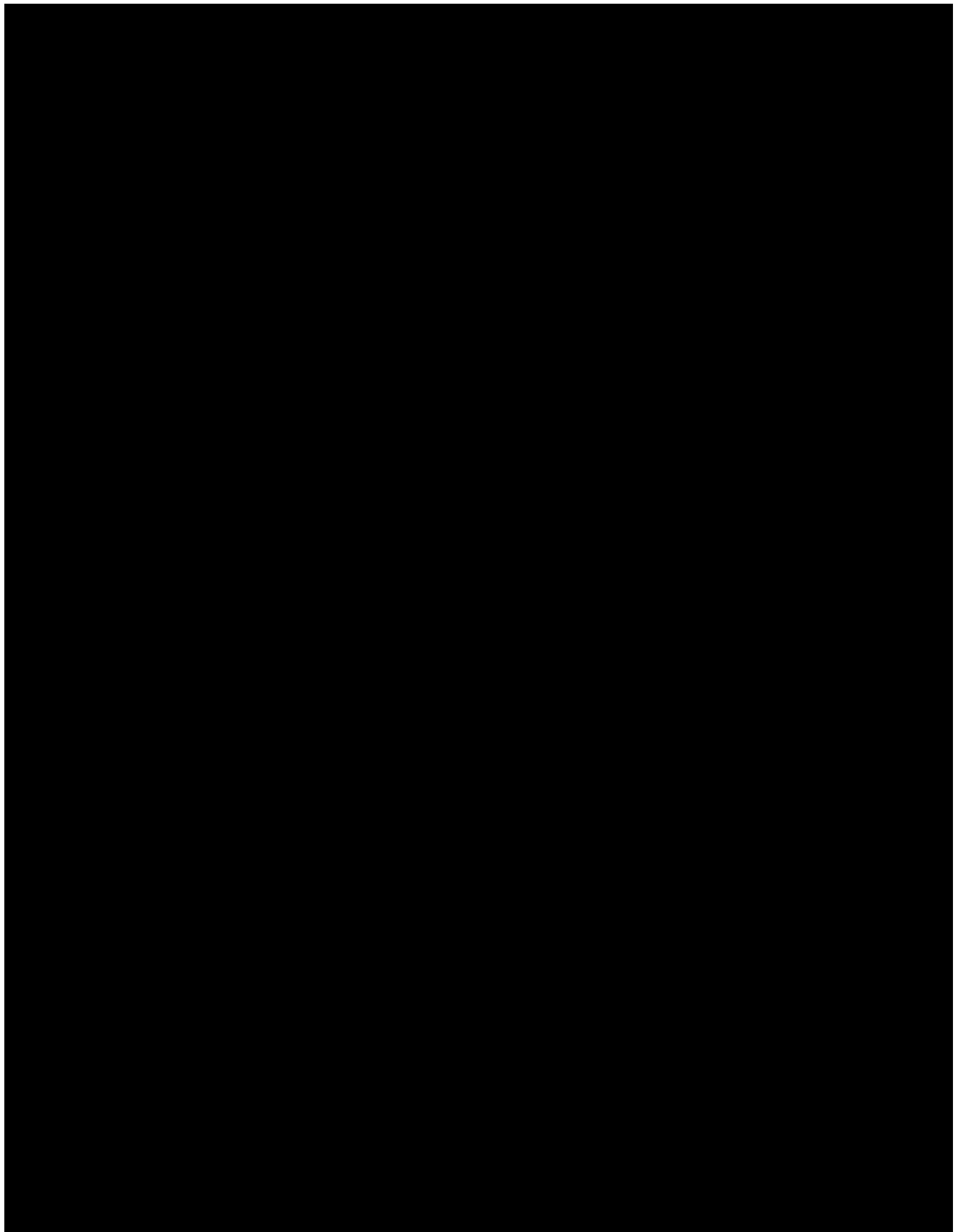
- The oil tank was crushed and torn on bottom ([Figure 195](#)).

- The oil tank remained attached to the inlet housing of the accessory gear case ([Figure 196](#)).
 - The fuel oil heater remained installed in the oil tank ([Figure 197](#)).
- (k) Ignition Exciter
- The connector for the lead to ignitor at the 5 o'clock position on the ignition exciter was missing ([Figure 198](#)).
 - There was a dent on the outer case of the ignition exciter ([Figure 199](#)).
- (l) Exciter to Ignitor Lead Assembly
- The exciter lead to the 7 o'clock ignitor was intact and appeared undamaged ([Figure 200](#)).
 - The connector on the exciter lead to the 5 o'clock ignitor remained attached to the lead ([Figure 201](#)).
- (m) Ignitor (1, 5:30 o'clock)
- The ignitor at the 5 o'clock position was intact and appeared undamaged ([Figure 202](#)).
- (n) Ignitor (2)
- The ignitor at the 7 o'clock position was intact and appeared undamaged ([Figure 202](#)).
- (o) Oil to Fuel Heater
- The inlet and outlet fittings on the oil to fuel heater were capped off and associated plumbing was not installed ([Figure 197](#)).
 - The oil to fuel heater remained in oil tank.
- (p) Anti-Ice Valve
- The anti-ice valve and associated plumbing was not installed on the engine.
- (q) Feather Valve
- The feather valve was intact and appeared undamaged ([Figure 203](#)).
- (r) P₂T₂ Inlet Sensor
- The P₂T₂ inlet sensor was intact and appeared undamaged ([Figure 204](#)).
 - The P₂T₂ inlet sensor remained attached to the fuel control.
 - There was earthen debris adhering to the P₂T₂ inlet sensor.
 - The P₂T₂ inlet sensor was returned with the fuel control unit for functional testing. The results are presented in [APPENDIX D](#).

- (s) Beta Block
 - The beta block was intact and appeared undamaged ([Figure 205](#)).
- (t) Beta and NTS Switch Manifold
 - The NTS valve was damaged ([Figure 206](#)).
- (u) Lockout and Fuel Enrichment Solenoids
 - The lockout and fuel enrichment solenoids were intact and appeared undamaged ([Figure 207](#)).
 - The fuel enrichment solenoid was functionally tested. The results are presented in [APPENDIX G](#).
- (v) BETA Tube
 - The beta tube was not returned with the engine.
- (w) Starter Mount Pad
 - The starter mount pad was intact and appeared undamaged ([Figure 208](#)).
- (x) Tact Generator
 - The tach generator was intact and appeared undamaged ([Figure 209](#)).
- (y) Fuel Manifold and Nozzle Assembly
 - The fuel manifold and nozzle assembly was intact and appeared undamaged ([Figure 210](#)).
 - The fuel manifold and nozzle assembly was functionally tested. The results are presented in [APPENDIX H](#).
- (z) Fuel System Plumbing
 - The line from the fuel shutoff valve to the primary only solenoid appeared to be an unapproved part and not P/N 3102219-1 as called out in the engine assembly drawing ([Figure 211](#)).
- (aa) Pneumatic Plumbing
 - The pneumatic system plumbing was intact and appeared undamaged ([Figure 212](#)).
- (bb) Lubrication System
 - The lubrication system plumbing was intact and appeared undamaged ([Figure 213](#)).







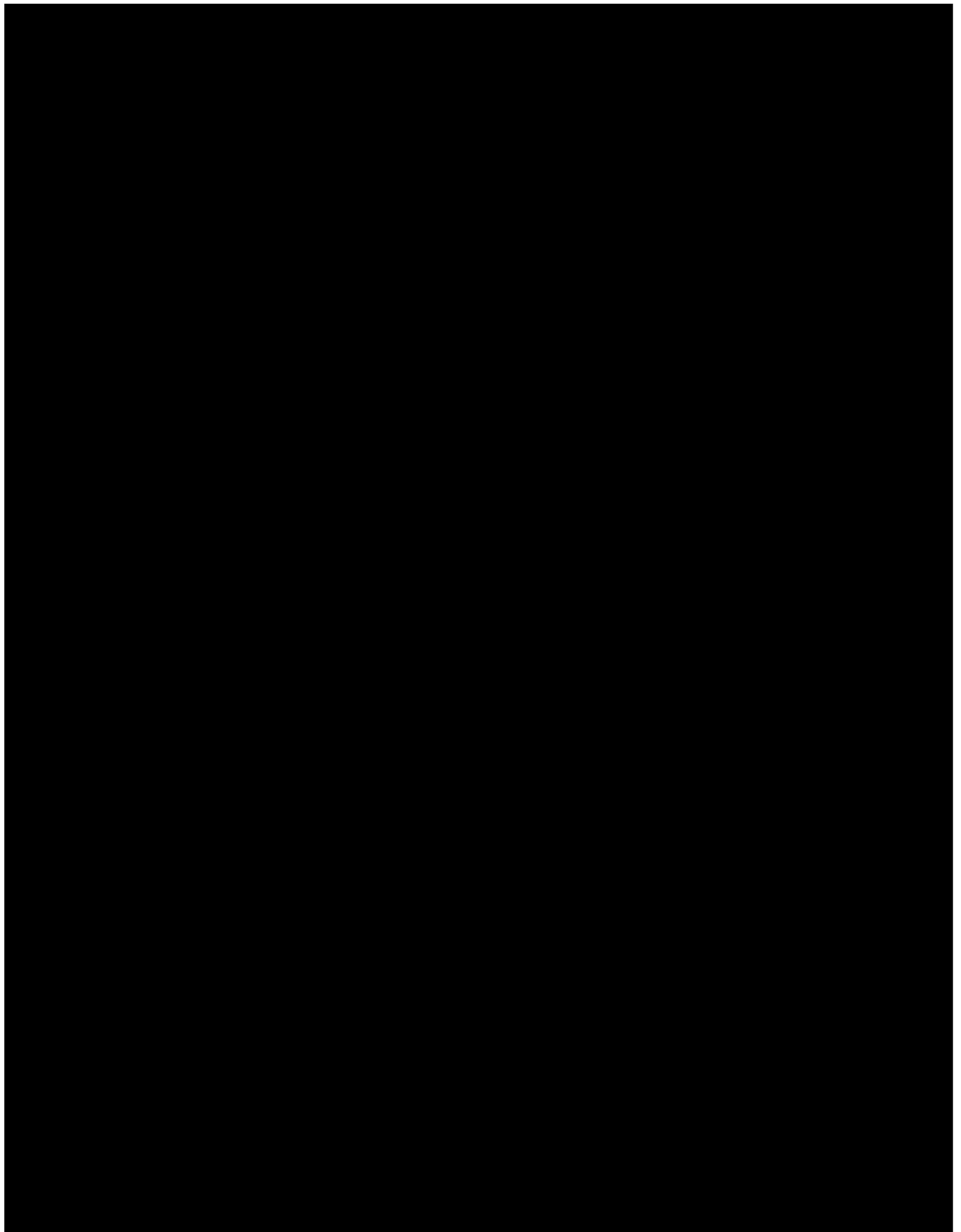




Figure 1. Engine S/N P36075C, As Received



Figure 2. Engine S/N P36075C, As Received



Figure 3. Engine S/N P36075C, As Received

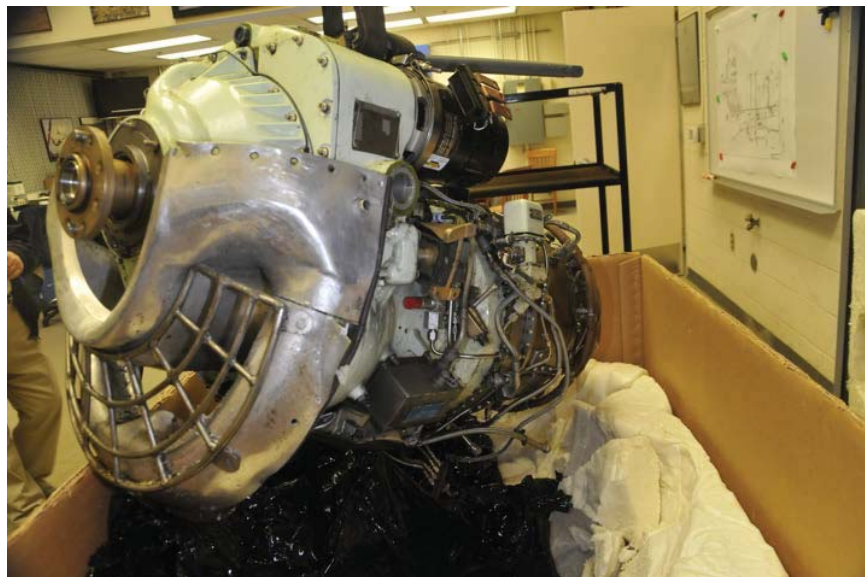


Figure 4. Engine S/N P36075C, As Received



Figure 5. Engine S/N P36075C, As Received



Figure 6. Engine S/N P36075C, As Received



Figure 7. Engine S/N P36075C, As Received



Figure 8. Engine S/N P36075C, As Received



Figure 9. Engine S/N P36075C, As Received



Figure 10. Engine S/N P36075C, As Received

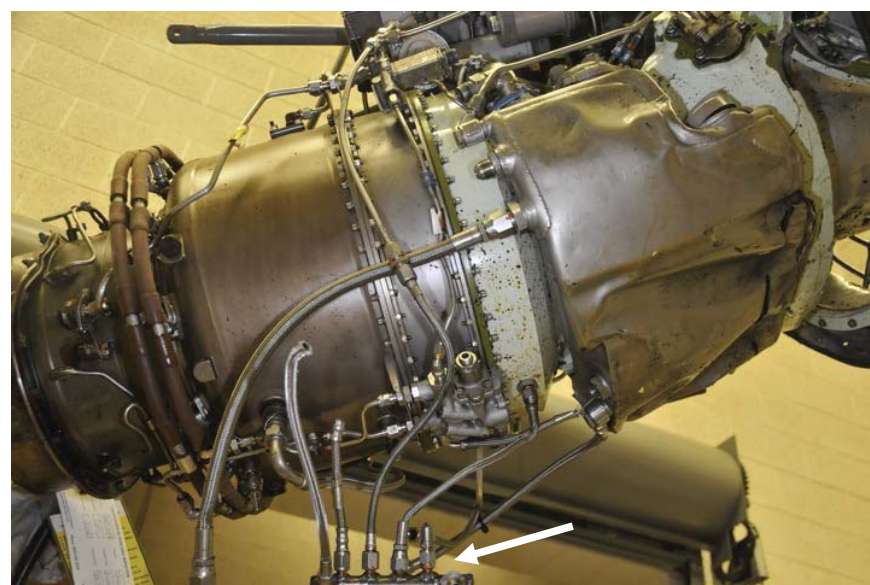


Figure 11. Engine S/N P36075C, As Received



Figure 12. Engine S/N P36075C, As Received

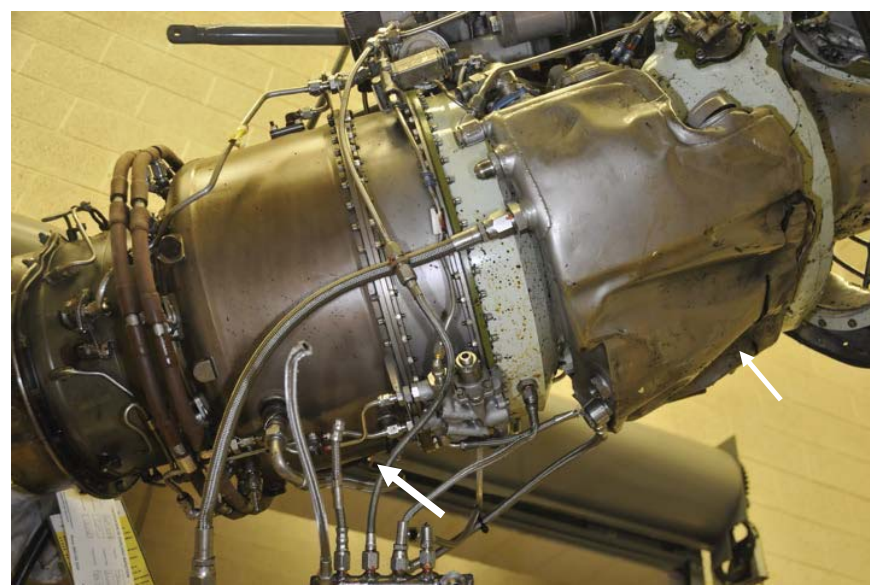


Figure 13. Engine S/N P36075C, As Received

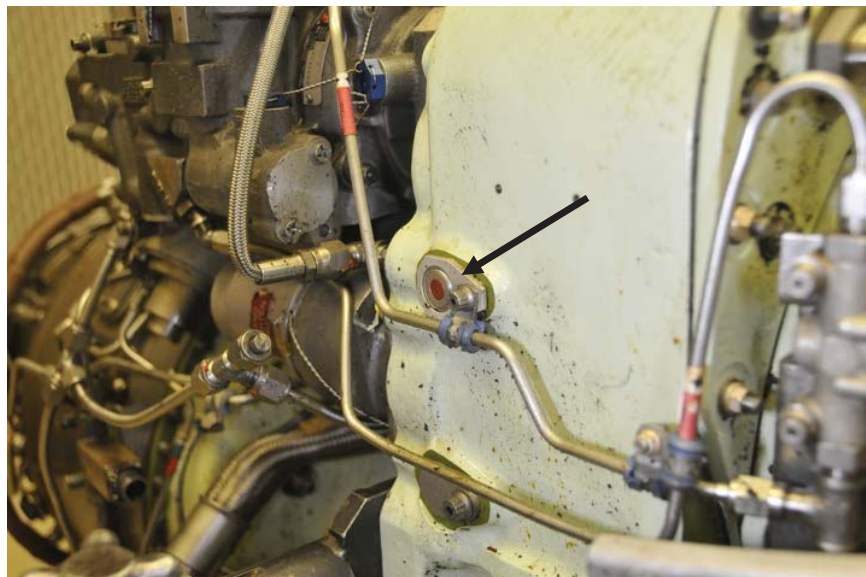


Figure 14. Engine S/N P36075C, As Received



Figure 15. Engine S/N P36075C, As Received

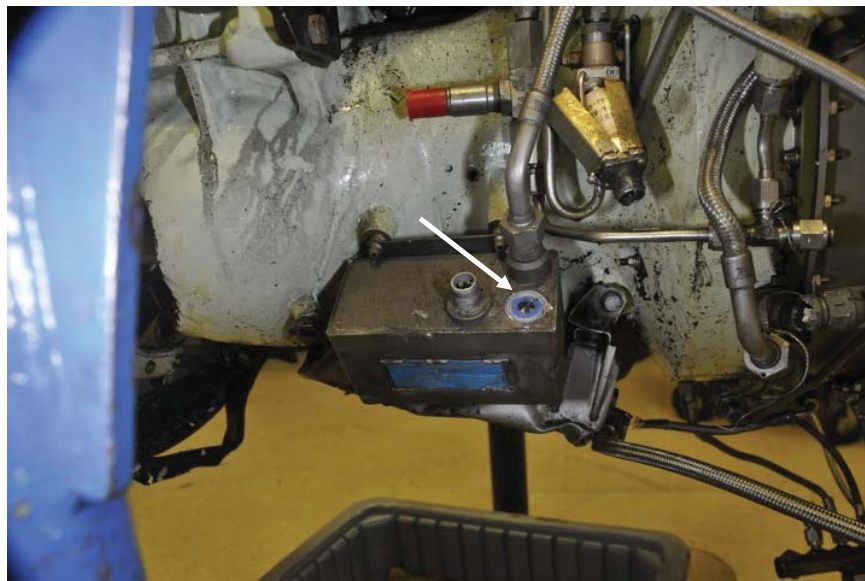


Figure 16. Engine S/N P36075C, As Received



Figure 17. Engine S/N P36075C, As Received



Figure 18. Engine S/N P36075C, As Received

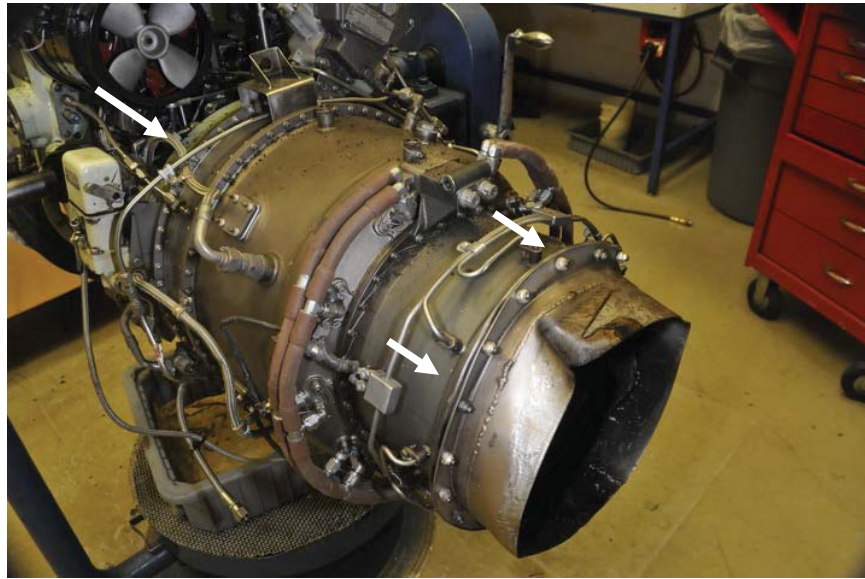


Figure 19. Engine S/N P36075C, As Received



Figure 20. Engine S/N P36075C, As Received

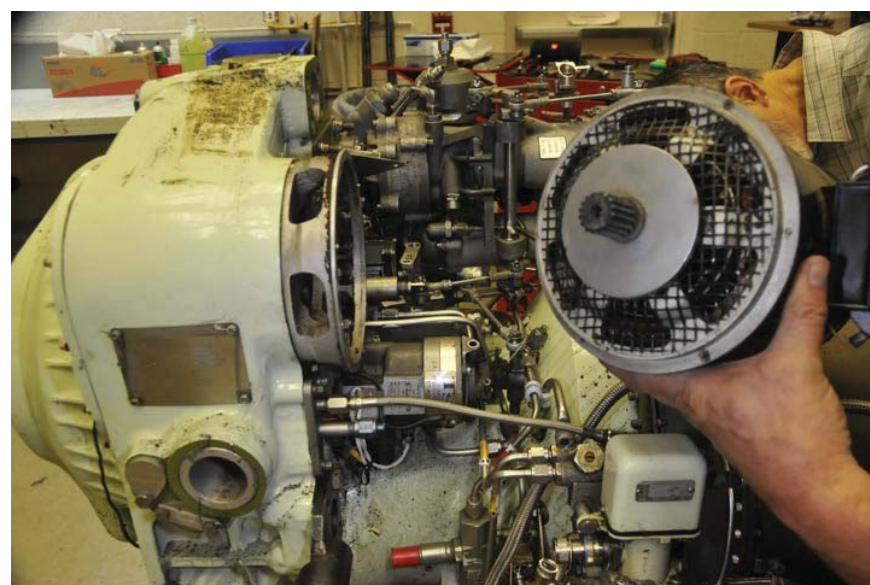


Figure 21. Engine S/N P36075C, As Received

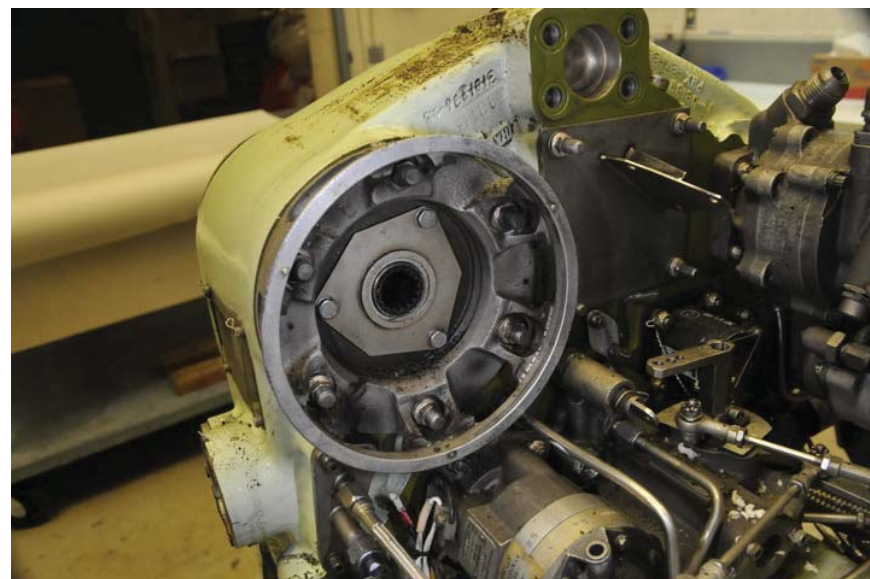


Figure 22. Engine S/N P36075C, As Received



Figure 23. Nose Cone Housing



Figure 24. Nose Cone Housing



Figure 25. Propeller Shaft Mount Flange



Figure 26. Propeller Shaft



Figure 27. Propeller Shaft



Figure 28. Propeller Shaft



Figure 29. Forward Propeller Shaft Bearing Mount Bolts



Figure 30. Forward Propeller Shaft Bearing Mount Bolts



Figure 31. Propeller Shaft Lock Nut

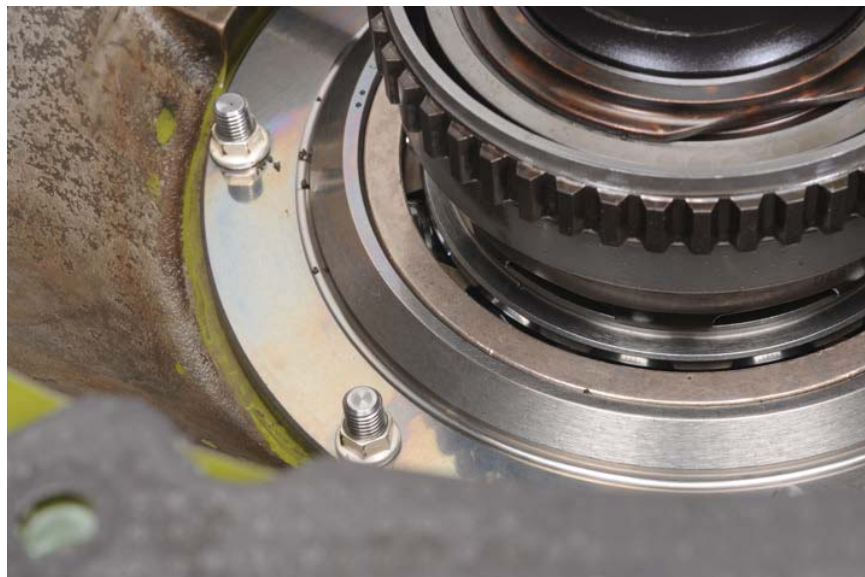


Figure 32. Propeller Shaft Output Seal Retainer



Figure 33. Propeller Shaft Bearing Oil Jet

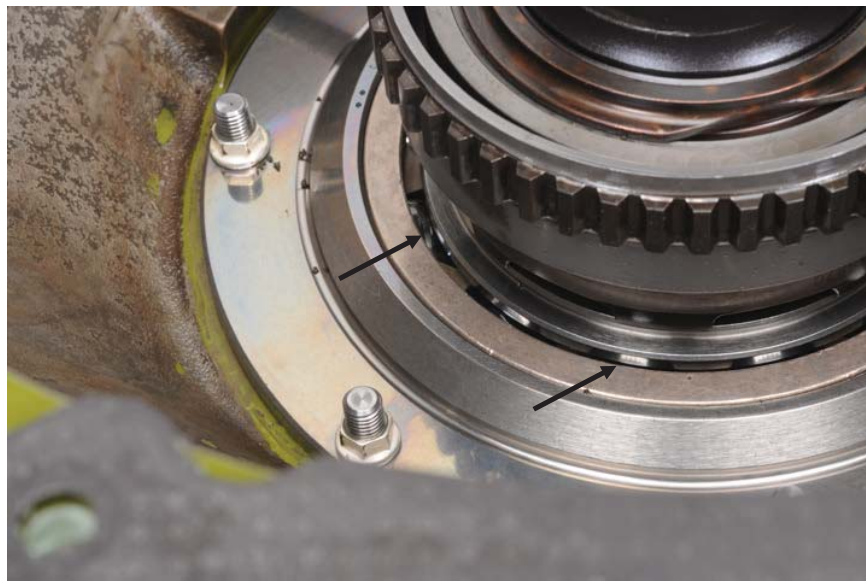


Figure 34. Propeller Shaft Bearing



Figure 35. Propeller Shaft Coupler

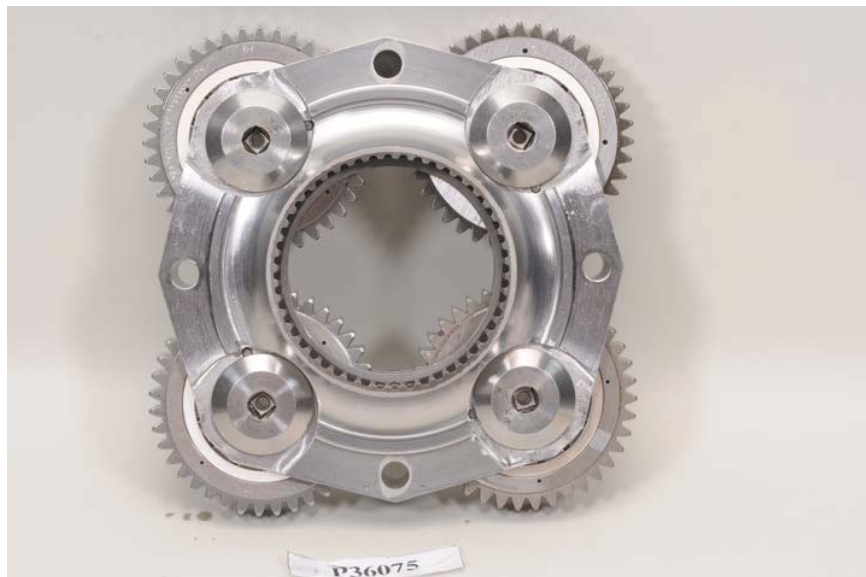


Figure 36. Planetary Gear Assembly



Figure 37. Planetary Gear Assembly

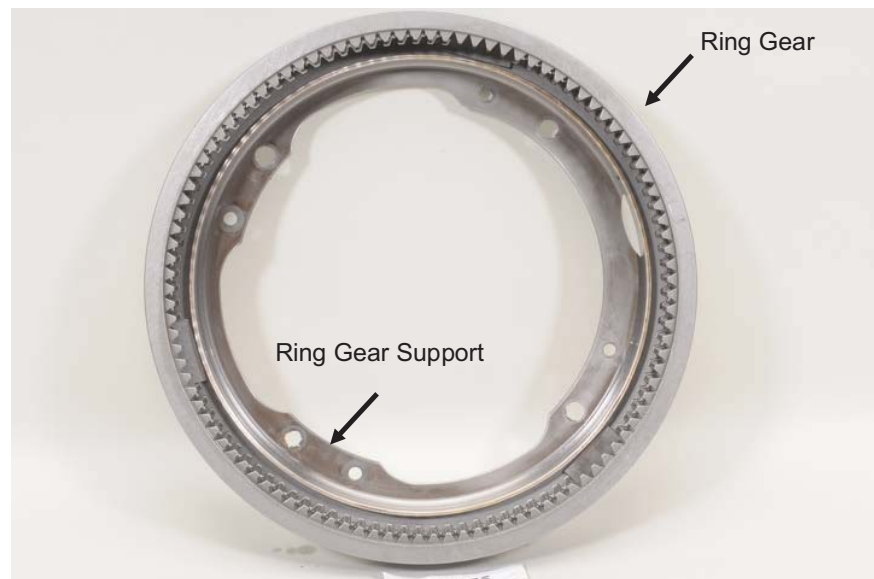


Figure 38. Ring Gear / Ring Gear Support



Figure 39. Ring Gear / Ring Gear Support

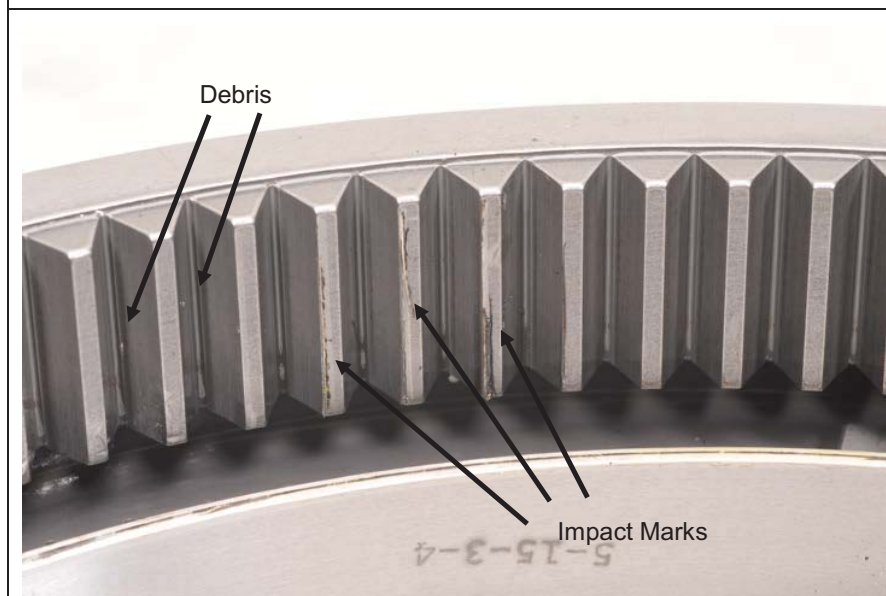


Figure 40. Ring Gear



Figure 41. Ring Gear Support



Figure 42. Ring Gear Retainers



Figure 43. Ring Gear Retainers



Figure 44. Diaphragm Housing



Figure 45. Diaphragm Housing



Figure 46. Bull Gear



Figure 47. Bull Gear

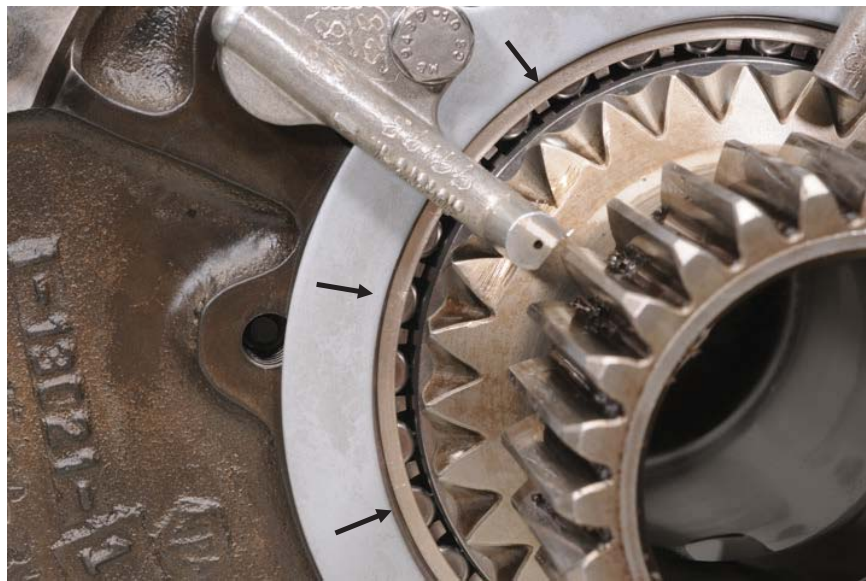


Figure 48. Forward Bull Gear Bearing

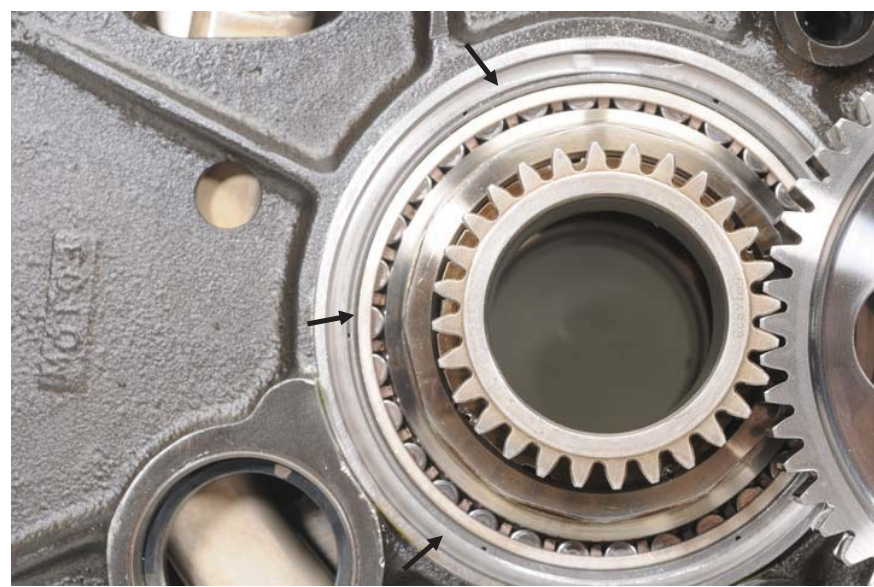


Figure 49. Aft Bull Gear Bearing



Figure 50. Sun Gear



Figure 51. Sun Gear



Figure 52. High-Speed Pinion (HSP)

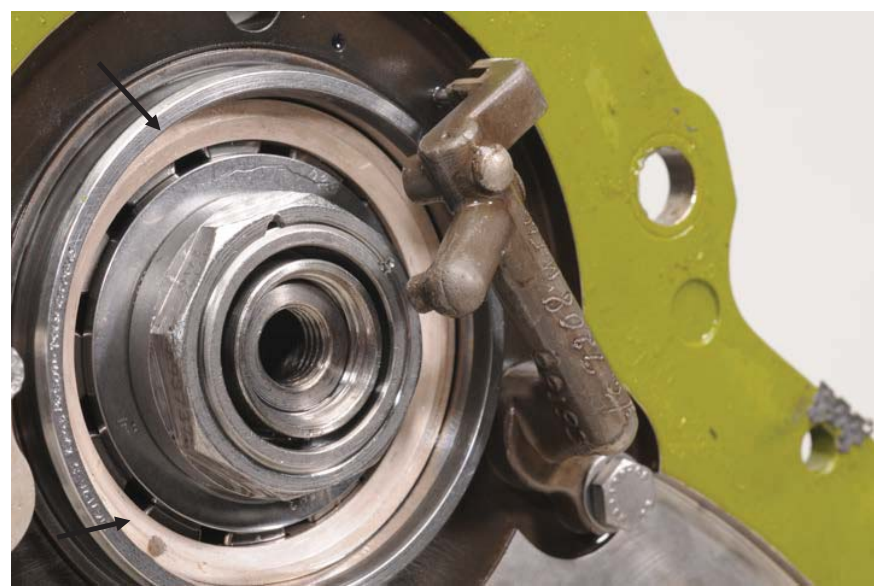


Figure 53. Forward High-Speed Pinion Bearing



Figure 54. Aft High-Speed Pinion Bearing



Figure 55. HSP-to-Power Section Coupling Shaft



Figure 56. HSP-to-Power Section Coupling Shaft



Figure 57. HSP-to-Power Section Coupling Shaft



Figure 58. HSP-to-Power Section Coupling Shaft



Figure 59. Shouldered Ball-Lock Shaft

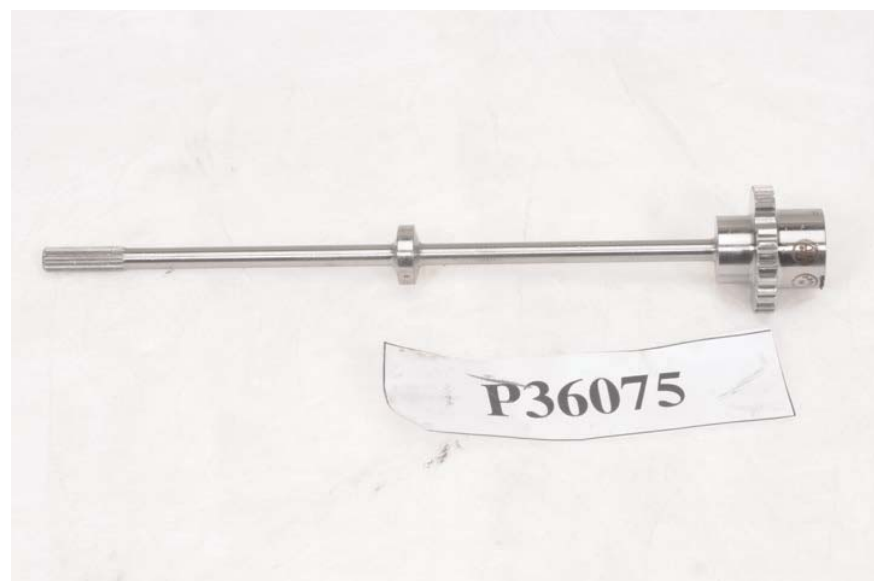


Figure 60. NTS Quill Shaft



Figure 61. Hydraulic Pump Drive Gearshaft

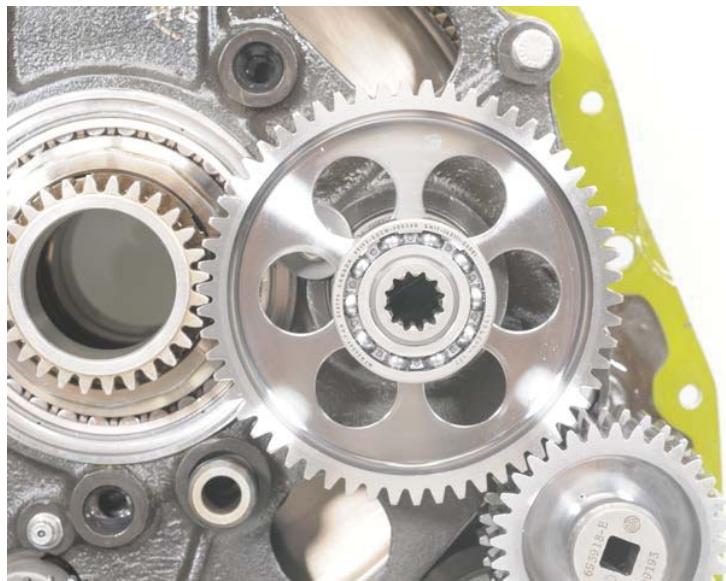


Figure 62. Propeller Governor Drive Gear Assembly



Figure 63. Starter/Generator Drive Gearshaft Assembly

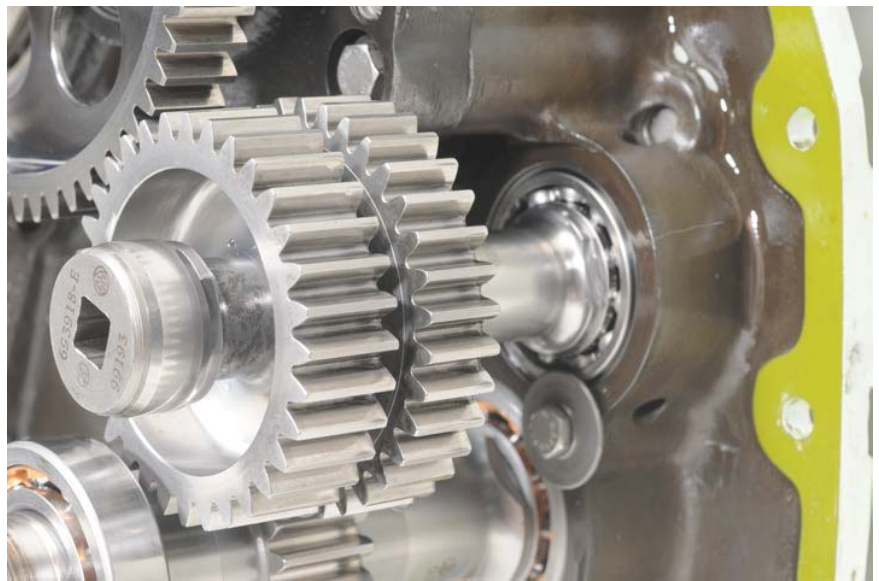


Figure 64. Starter/Generator Idler Gears Assembly



Figure 65. Gearcase Oil-Scavenge Pump Drive Idler Gear and Drive Shaft



Figure 66. Gearcase Oil-Scavenge Pump Drive Shaft



Figure 67. Gearcase Housing (Exterior)



Figure 68. Gearcase Housing (Exterior)



Figure 69. Gearcase Housing (Exterior)



Figure 70. Gearcase Housing (Exterior)



Figure 71. Gearcase Housing (Exterior)



Figure 72. Gear Case Housing (Interior)



Figure 73. Gear Case Housing (Interior)



Figure 74. Gear Case Housing (Interior)



Figure 75. Gear Case Housing (Interior)



Figure 76. Propeller Shaft Aft Ball Bearing



Figure 77. Propeller Shaft Aft Ball Bearing



Figure 78. Propeller Shaft Roller Bearing



Figure 79. Propeller Shaft Roller Bearing



Figure 80. Forward Main-Shaft Compressor Nut



Figure 81. Compressor Bearing



Figure 82. Compressor Bearing



Figure 83. Compressor Air/Oil Carbon Seal



Figure 84. Compressor Carbon Seal Rotor



Figure 85. Compressor Carbon Seal Rotor



Figure 86. Fuel Pump Drive Shaft



Figure 87. Magnetic Chip Detector

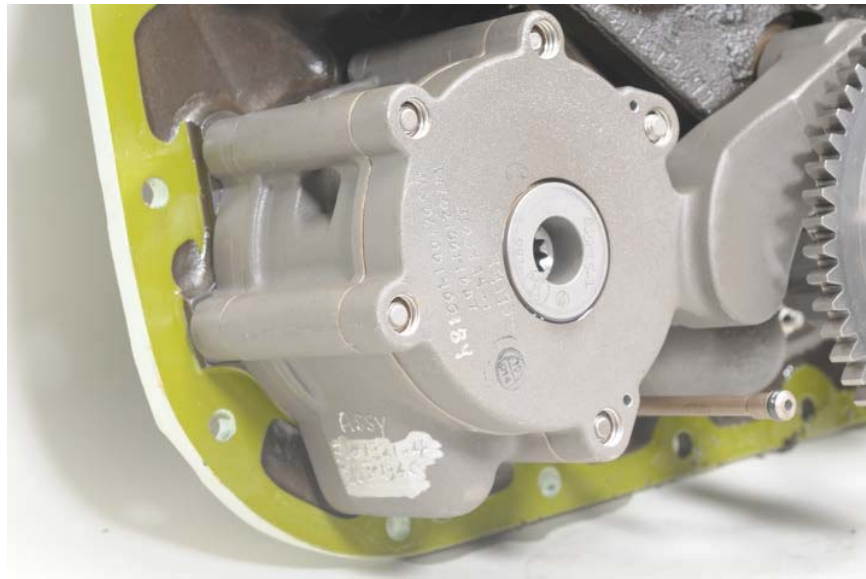


Figure 88. Gearcase Oil-Scavenge Pump



Figure 89. NTS Regulator



Figure 90. NTS Transfer Tube



Figure 91. Feather Valve Oil Transfer Tube Mount Boss



Figure 92. Propeller Governor "Spider" Gasket and "Lee" Check Valve and Orifice Assembly

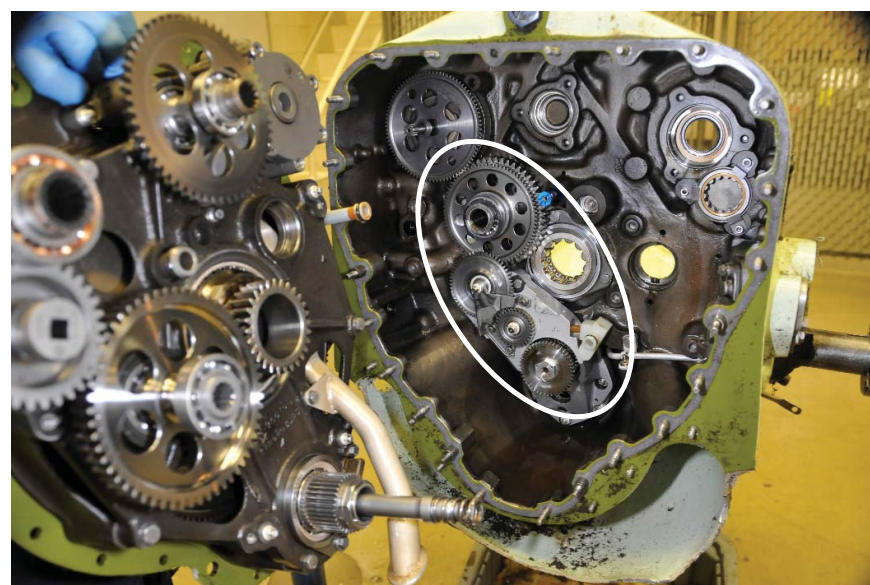


Figure 93. Torque Sensor and DDFC Gear Train

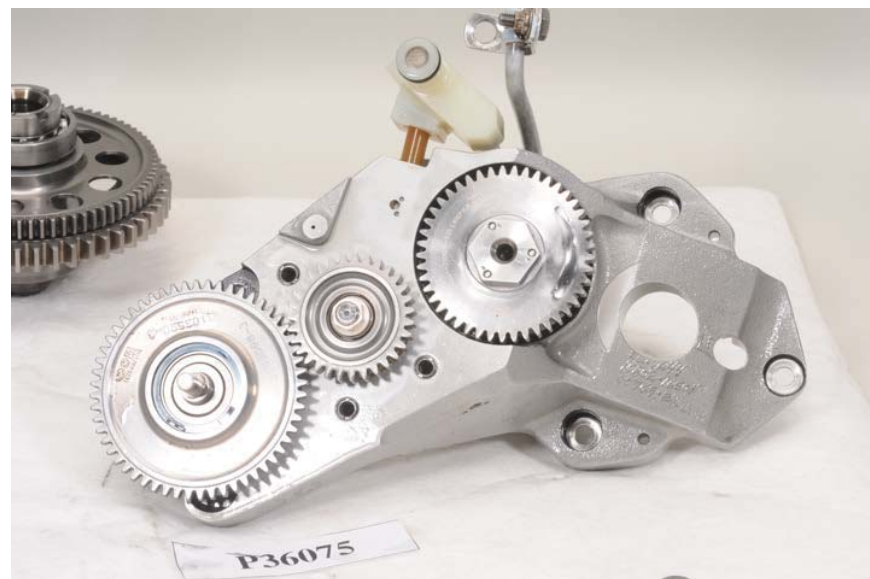


Figure 94. Torque Sensor



Figure 95. Torque Sensor



Figure 96. First DDFC Gear Assembly



Figure 97. Second DDFC Gear



Figure 98. Second DDFC Gear

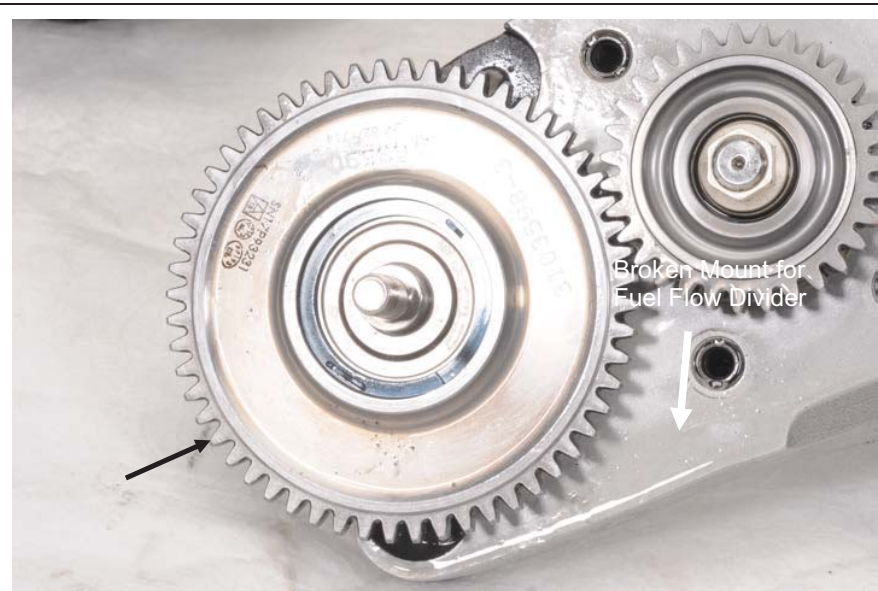


Figure 99. Third DDFC Gear



Figure 100. Fourth DDFC Tach/Generator Drive Gear and Shaft Assembly



Figure 101. Hydraulic Oil Torque Sensor Output



Figure 102. Hydraulic Oil Torque Sensor Output



Figure 103. Main Shaft



Figure 104. Main Shaft



Figure 105. Main Shaft Gear



Figure 106. Main Shaft Gear

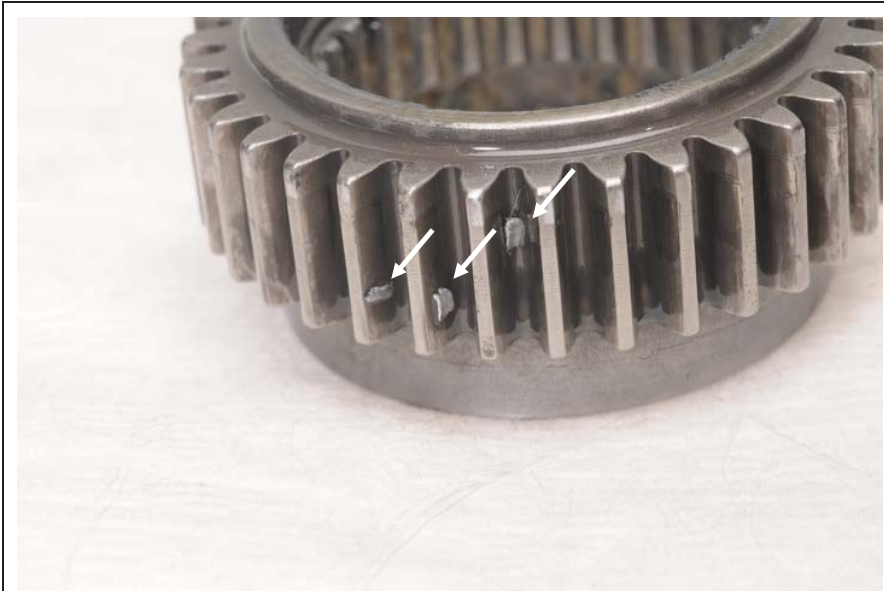


Figure 107. Main Shaft Gear



Figure 108. Torsion Shaft



Figure 109. First-Stage Compressor Impeller Shroud



Figure 110. First-Stage Compressor Impeller Shroud



Figure 111. First-Stage Compressor Impeller Shroud



Figure 112. First-Stage Compressor Impeller Shroud



Figure 113. First-Stage Compressor Impeller



Figure 114. First-Stage Compressor Impeller



Figure 115. First-Stage Compressor Impeller



Figure 116. First-Stage Compressor Impeller



Figure 117. First-Stage Compressor Impeller



Figure 118. First-Stage Compressor Diffuser (Crossover Duct)



Figure 119. First-Stage Compressor Diffuser (Crossover Duct)



Figure 120. First-Stage Compressor Diffuser (Crossover Duct)



Figure 121. Second-Stage Compressor Housing



Figure 122. Second-Stage Compressor Housing

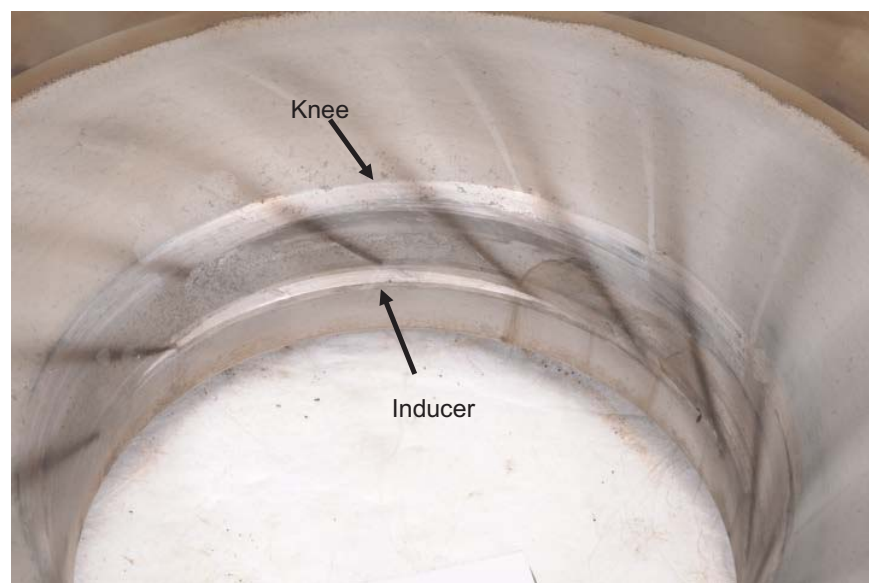


Figure 123. Second-Stage Compressor Housing



Figure 124. Second-Stage Compressor Impeller



Figure 125. Second-Stage Compressor Impeller



Figure 126. Second-Stage Compressor Impeller

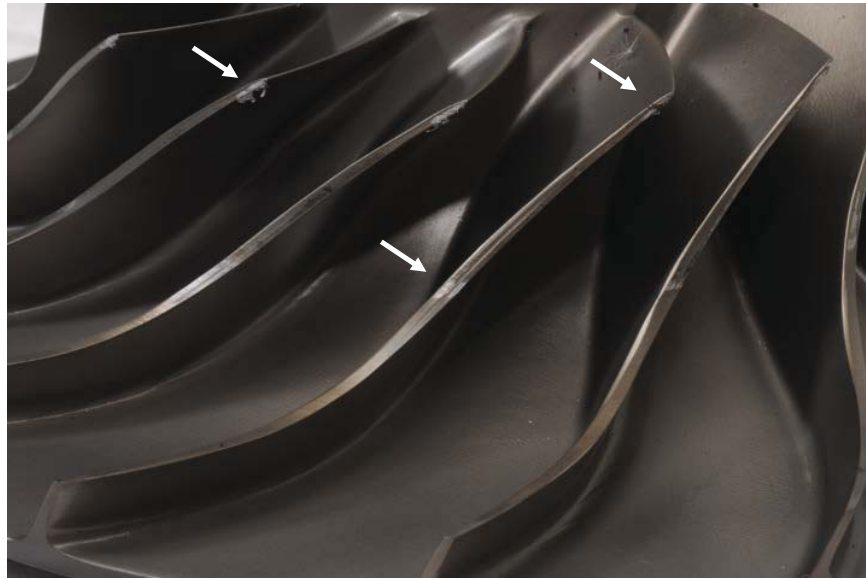


Figure 127. Second-Stage Compressor Impeller

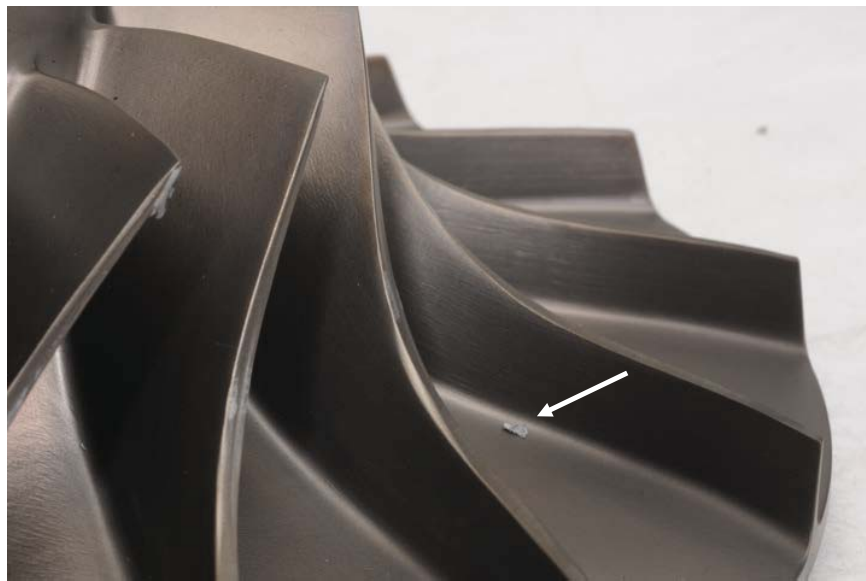


Figure 128. Second-Stage Compressor Impeller



Figure 129. Second-Stage Compressor Diffuser Vane Assembly



Figure 130. Combustor Plenum Case



Figure 131. Combustion Chamber



Figure 132. Outer Transition Liner



Figure 133. Outer Transition Liner



Figure 134. Inner Transition Liner



Figure 135. Inner Transition Liner



Figure 136. Center Curvic Coupling



Figure 137. Center Curvic Coupling



Figure 138. Turbine Stator Housing



Figure 139. Turbine Stator Housing



Figure 140. First-Stage Turbine Stator Assembly



Figure 141. First-Stage Turbine Stator Assembly



Figure 142. First Stage Turbine Shroud



Figure 143. First Stage Turbine Shroud



Figure 144. First-Stage Turbine Rotor Assembly



Figure 145. First-Stage Turbine Rotor Assembly



Figure 146. First-Stage Turbine Rotor Assembly



Figure 147. First-Stage Turbine Rotor Assembly

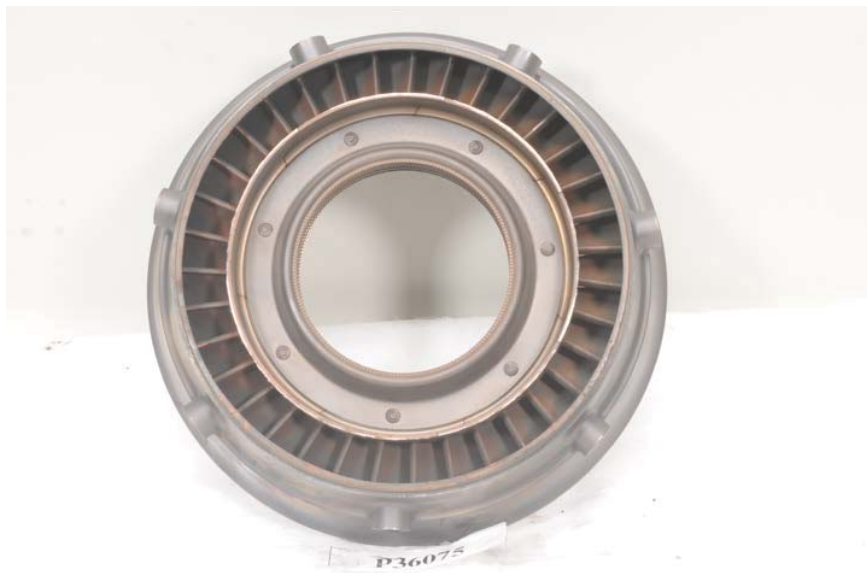


Figure 148. Second-Stage Turbine Stator



Figure 149. Second-Stage Turbine Stator



Figure 150. Second-Stage Turbine Stator

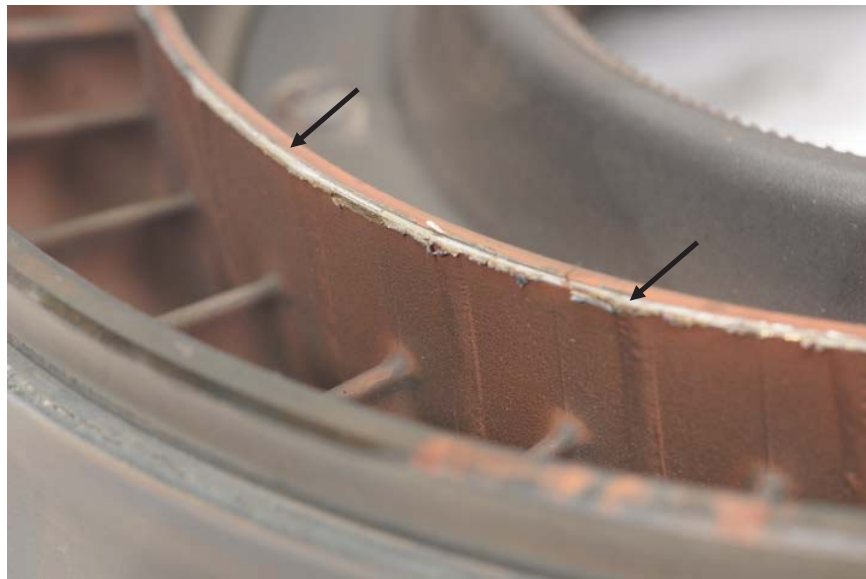


Figure 151. Second-Stage Turbine Stator



Figure 152. Second-Stage Turbine Stator



Figure 153. Second-Stage Turbine Rotor



Figure 154. Second-Stage Turbine Rotor

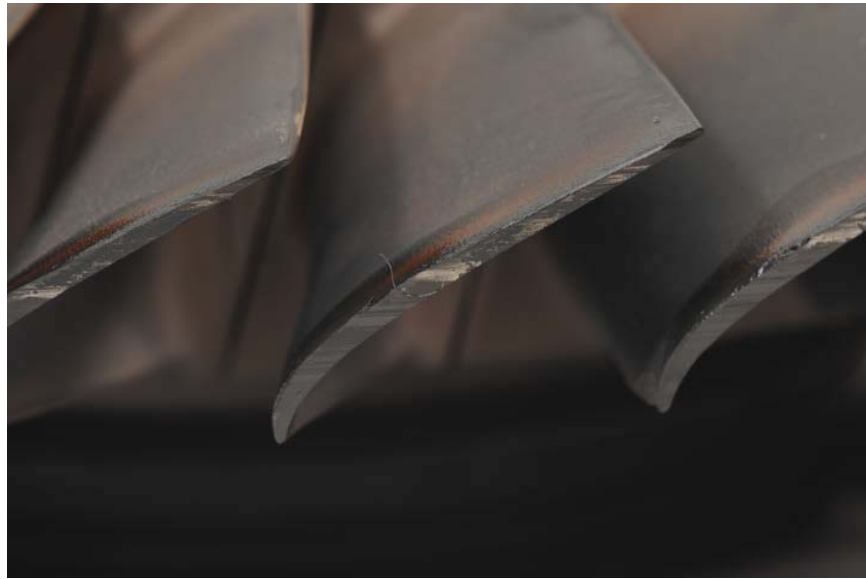


Figure 155. Second-Stage Turbine Rotor



Figure 156. Second-Stage Turbine Rotor



Figure 157. Second-Stage Turbine Rotor



Figure 158. Third-Stage Turbine Stator



Figure 159. Third-Stage Turbine Stator



Figure 160. Third-Stage Turbine Stator



Figure 161. Third-Stage Turbine Rotor



Figure 162. Third-Stage Turbine Rotor



Figure 163. Rear Curvic Coupling



Figure 164. Rear Curvic Coupling



Figure 165. Engine Exhaust Duct



Figure 166. Engine Exhaust Duct



Figure 167. Engine Exhaust Duct

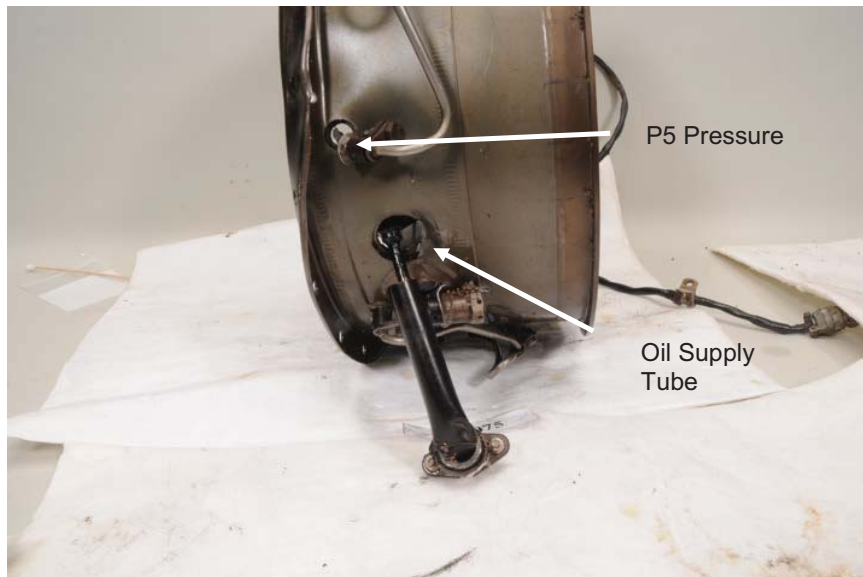


Figure 168. Engine Exhaust Duct



Figure 169. Turbine Bearing Support



Figure 170. Turbine Bearing Support



Figure 171. Turbine Bearing Housing



Figure 172. Turbine Bearing Housing



Figure 173. Turbine Bearing Retainer



Figure 174. Turbine Sump Cover



Figure 175. Turbine Oil-Scavenge Pump and Drive Shaft



Figure 176. Turbine Air/Oil Carbon Seal



Figure 177. Aft Carbon Seal Rotor



Figure 178. Turbine Bearing



Figure 179. Aft (Turbine) Main-Shaft Nut



Figure 180. Fuel Shutoff Valve



Figure 181. Fuel Shutoff Valve



Figure 182. Fuel Shutoff Valve



Figure 183. Fuel Pump Assembly



Figure 184. Fuel Pump Assembly

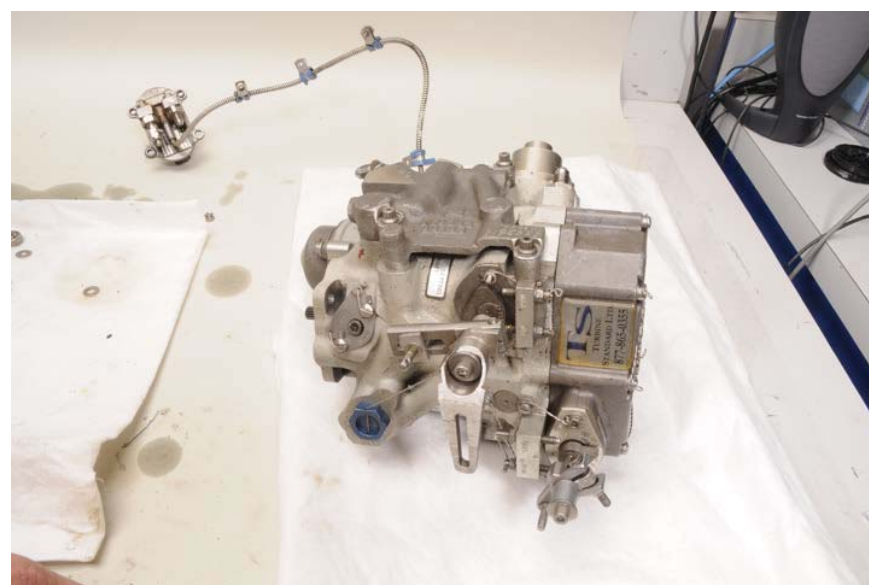


Figure 185. Fuel Control Unit



Figure 186. Fuel Control Unit



Figure 187. Fuel Filter

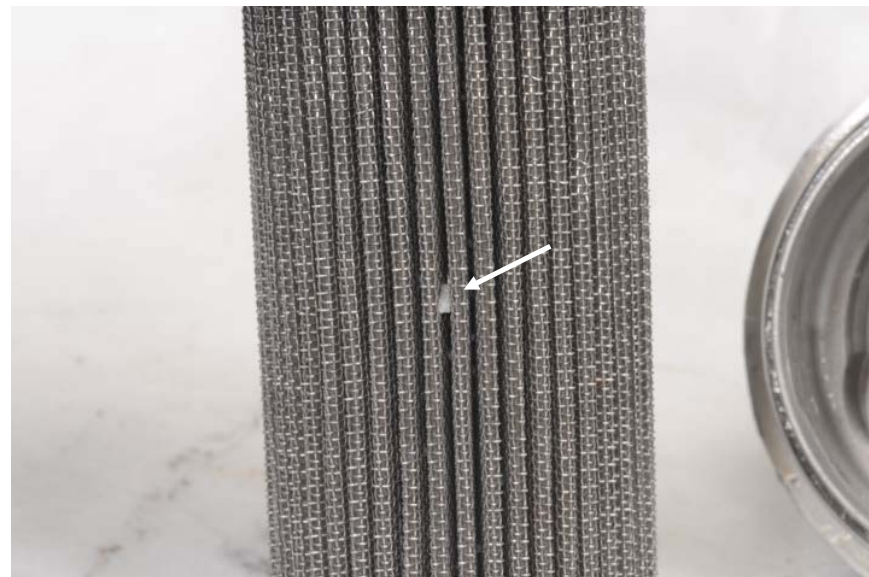


Figure 188. Fuel Filter



Figure 189. Shaft - Fuel Pump to Accessory Gearbox



Figure 190. Fuel Flow Divider



Figure 191. Propeller Governor



Figure 192. Propeller Pitch Control



Figure 193. Propeller Pitch Control



Figure 194. Oil Filter



Figure 195. Oil Tank



Figure 196. Oil Tank



Figure 197. Oil Tank



Figure 198. Ignition Exciter



Figure 199. Ignition Exciter



Figure 200. Exciter to Ignitor Lead Assemblies



Figure 201. Exciter to Ignitor Lead Assemblies



Figure 202. Ignitors



Figure 203. Feather Valve



Figure 204. P2T2 Inlet Sensor



Figure 205. Beta Block

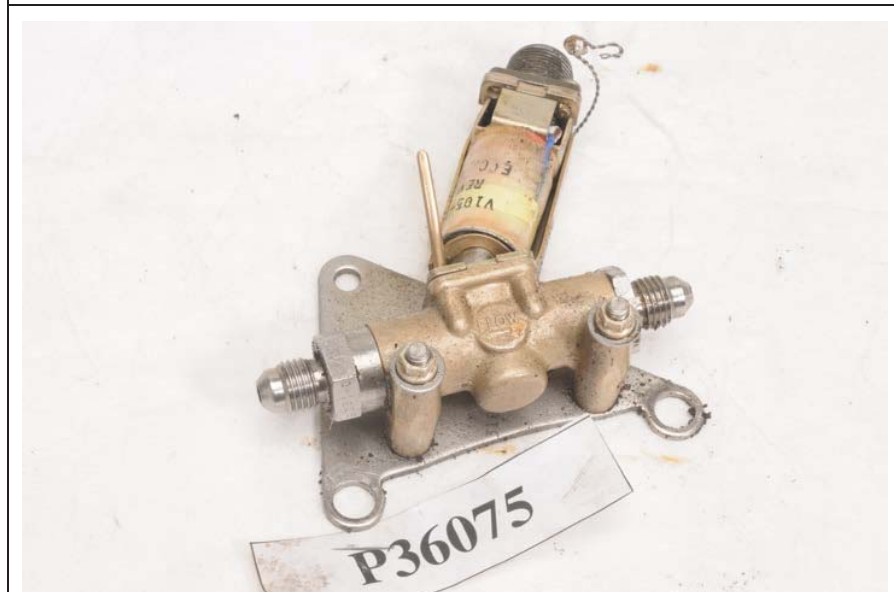


Figure 206. NTS Switch



Figure 207. Fuel Enrichment Solenoid



Figure 208. Starter Mount Pad



Figure 209. Tach Generator



Figure 210. Fuel Manifold and Nozzle Assembly

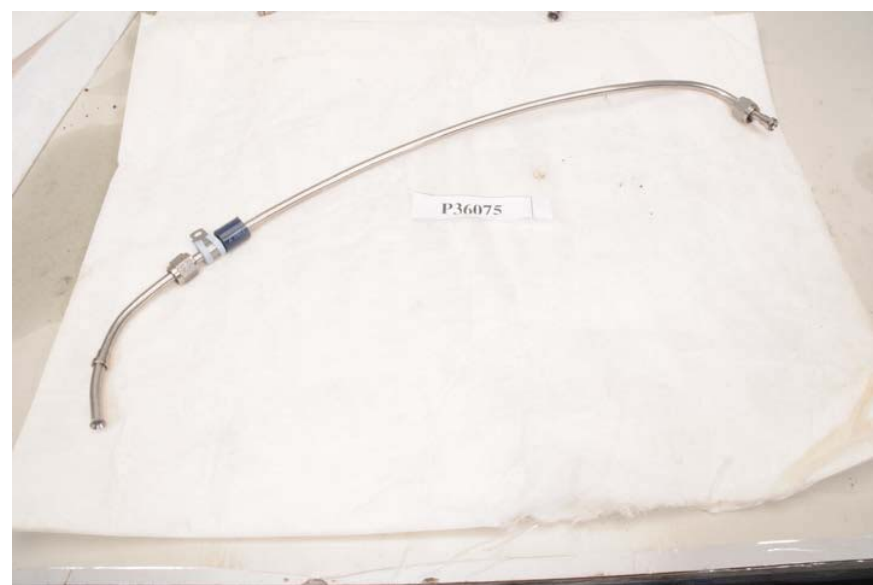


Figure 211. Installed Fuel Line In Place of P/N 3102219-1



Figure 212. Pneumatic Plumbing



Figure 213. Lubrication Plumbing



Figure 214. Functional Testing of Fuel Shutoff Valve



Figure 215. Fuel Shutoff Valve CT Scan

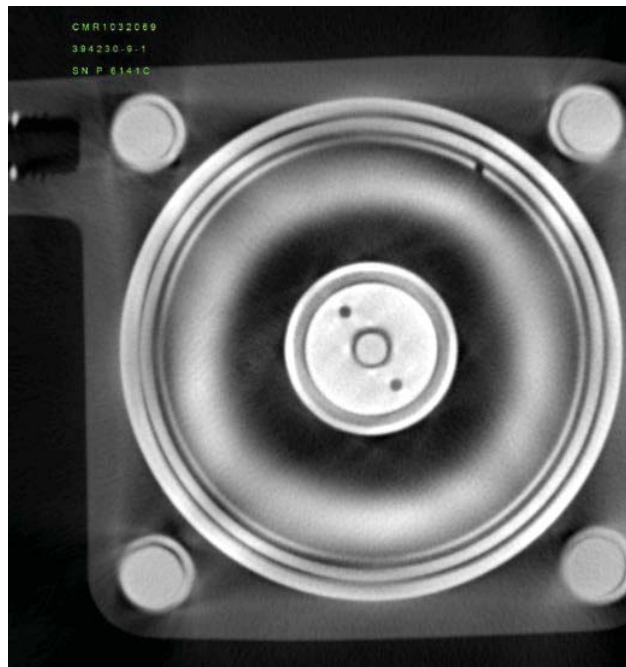


Figure 216. Fuel Shutoff Valve CT Scan



Figure 217. Functional Testing of Fuel Pump Assembly

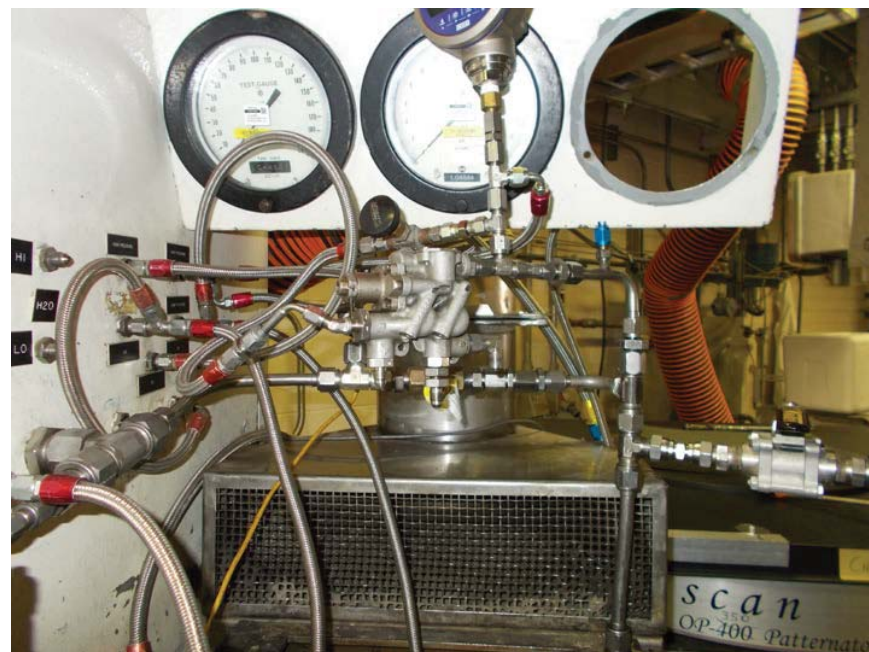


Figure 218. Functional Testing of Fuel Flow Divider Valve



Figure 219. Functional Testing of Fuel Flow Divider Valve

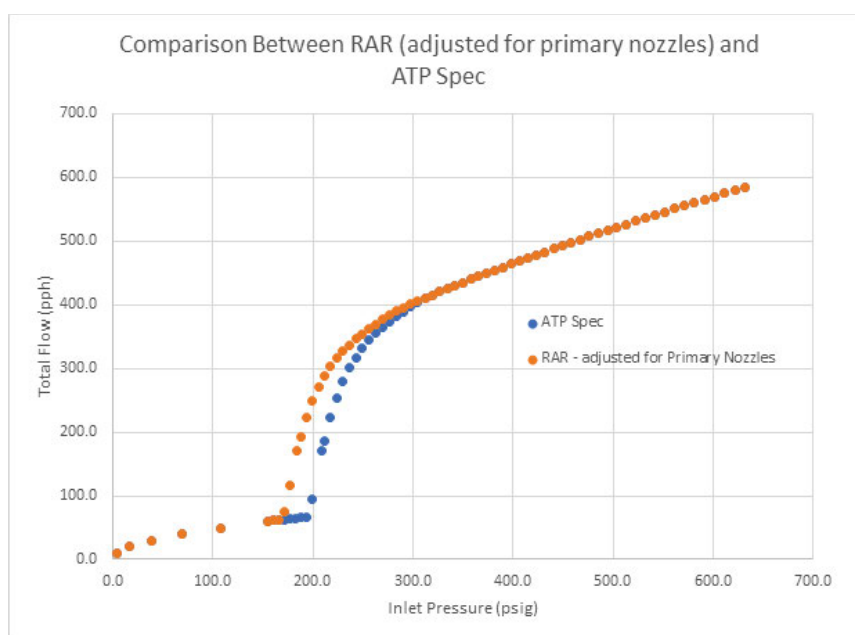


Figure 220. Fuel Flow Divider Test Data



Figure 221. Functional Testing of Fuel Enrichment Solenoid



Figure 222. Functional Testing of Fuel Manifold and Nozzle Assembly

APPENDIX A

Material Analysis

11 Pages

BACKGROUND

No background information was provided.

PROBLEM STATEMENT

Please use energy dispersive X-ray (EDX) analysis to determine composition of material observed on the spur gear. Please analyze the other submitted debris. Backflush the oil and fuel filters and analyze the collected debris. Please analyze the fracture surface on the coupling shaft.

SUMMARY/CONCLUSIONS

- White colored debris was observed in the fuel filter (Figure 1). Fourier transform infra-red (FTIR) analysis of the debris produced a spectrum suggestive of a fluorinated lubricant (Figure 2). Most of the debris flushed from the fuel filter had a similar composition.
- FTIR analysis of the clear debris collected from the ring gear support produced a spectrum suggestive of a silicone elastomer (Figure 3).
- FTIR analysis of the fibrous white debris collected from the fuel control door produced a spectrum suggestive of a polyurethane foam (Figure 4).
- The metallic debris collected from the ring support gear was silver, as determined by energy dispersive X-ray (EDX) analysis (Figure 5).
- Metallic debris was observed on the submitted spur gear. EDX analysis of the debris produced a spectrum indicative of a material similar to Al 356 (Figures 6-7).
- Most of the debris flushed from the oil filter was silver, as determined by EDX analysis. Evidence of cadmium rich, and silicon rich debris was observed in limited areas (spectra not shown).

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ECCN 9E991 - The enclosed unclassified technical data includes items that are controlled by the U.S. Department of Commerce Export Administration Regulations (EAR) and require export authorization from the U.S. Government prior to exporting outside of the United States or sharing with a foreign person, as defined by the U.S. Department of Commerce EAR. Diversion contrary to U.S. export laws and regulations is prohibited.

Honeywell Internal

PART NAME: Coupling shaft
PART NUMBER: 894119-1
PART S/N: Not Reported

MODEL/PROGRAM: PHX TPE331-10/11
MODEL/PROGRAM S/N: P-36075C
OPERATING TIME: Not Reported
OPERATING CYCLES: Not Reported

MATERIAL: Various
MATERIAL SPEC: Various

SUPPLIER: Not Reported
SUPPLIER P/N: Not Reported

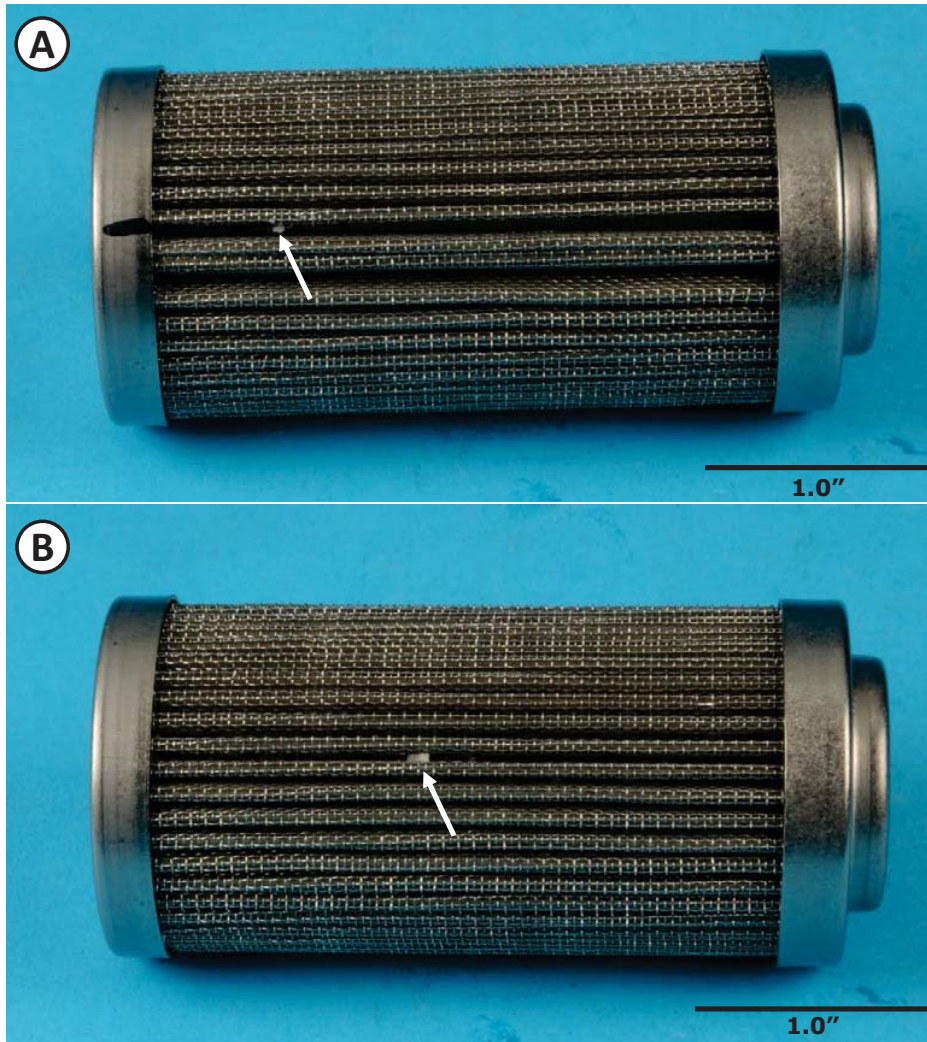
REQUESTOR:
INVESTIGATOR:
REVIEWER:

[REDACTED]

CHARGE #:
LIMS REQUEST: CMR 1007651
RECEIVED DATE: 10/17/2018

COMPLETION DATE: 02/08/2018

- Most of the debris flushed from the spur gear was rich in molybdenum and sulfur, with lesser amounts of calcium, silicon, and aluminum (Figure 8). The spectrum was suggestive of molybdenum disulfide.
- The fracture features on the separated coupling shaft were indicative of torsional overload (Figure 9-10).

**Figure 1.**

(A-B) Overall views showing the fuel filter in the as-received condition. White colored debris was observed in the filter (white arrows).

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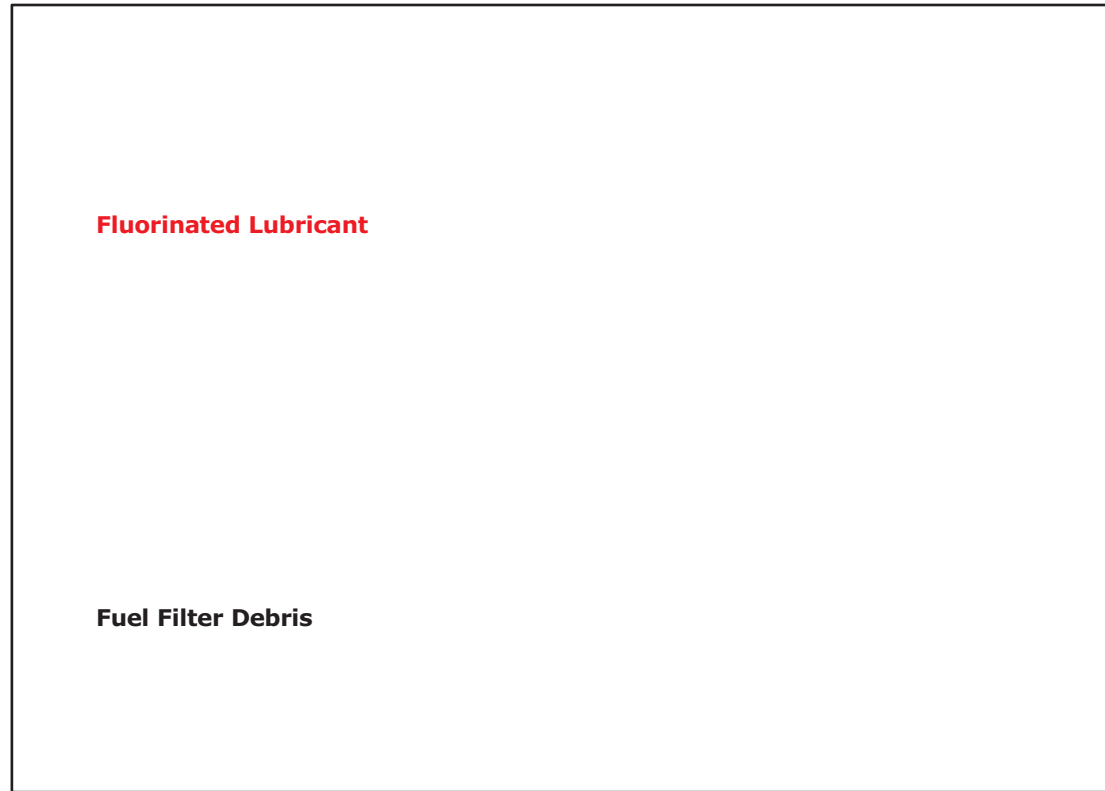
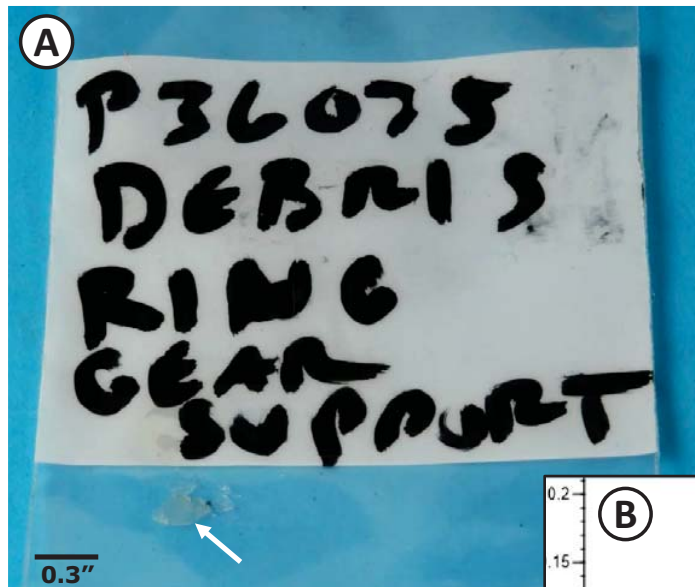
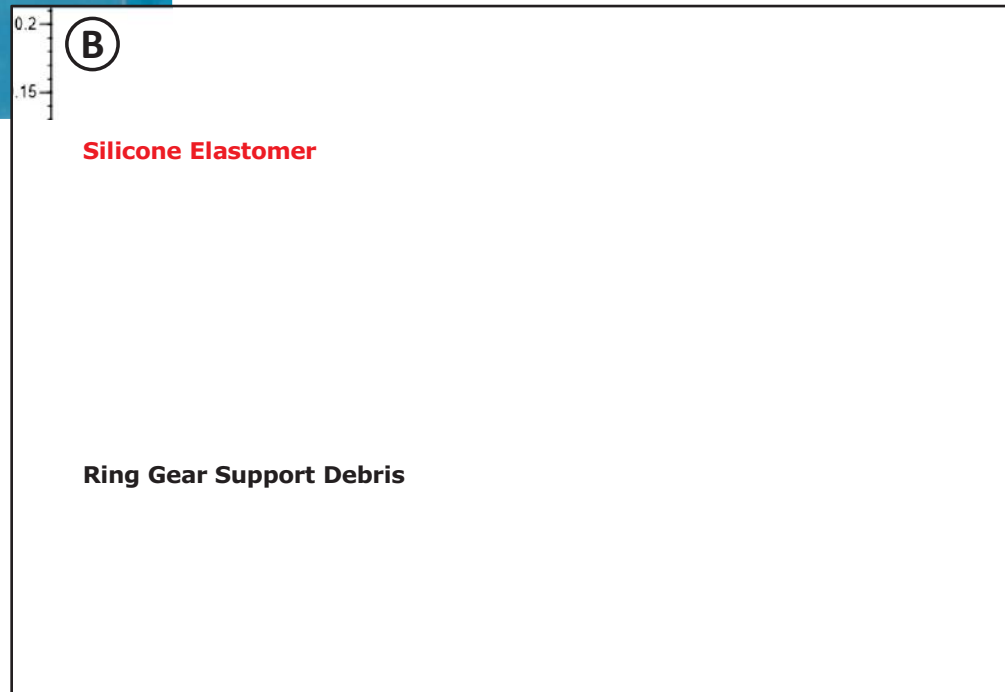


Figure 2.

Fourier transform infrared (FTIR) spectra generated from analysis of the fuel filter debris (black spectrum) and the lab database for comparison (red spectrum). Note the fuel filter debris was suggestive of a fluorinated lubricant.

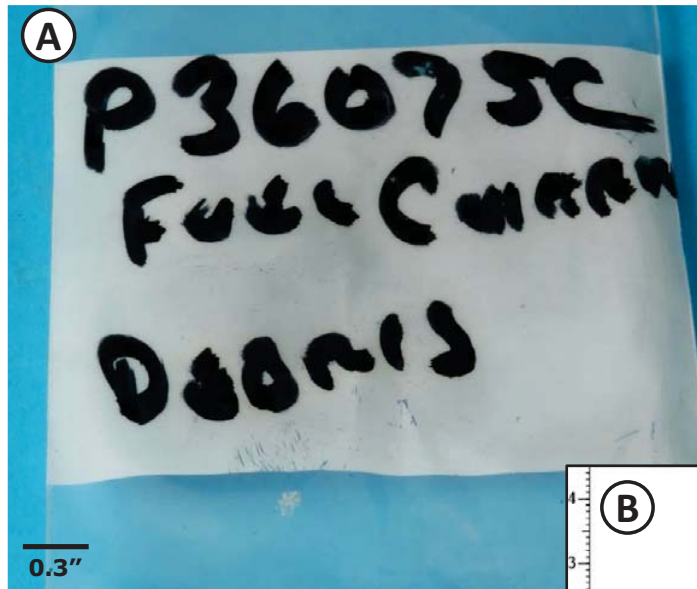
**Figure 3.**

(A) Overall photo showing the clear debris collected from the ring gear support (white arrow). (B) FTIR spectra generated from analysis of the ring gear support debris (black spectrum) and the lab database for comparison (red spectrum). Note the ring gear support debris was suggestive of a silicone elastomer.

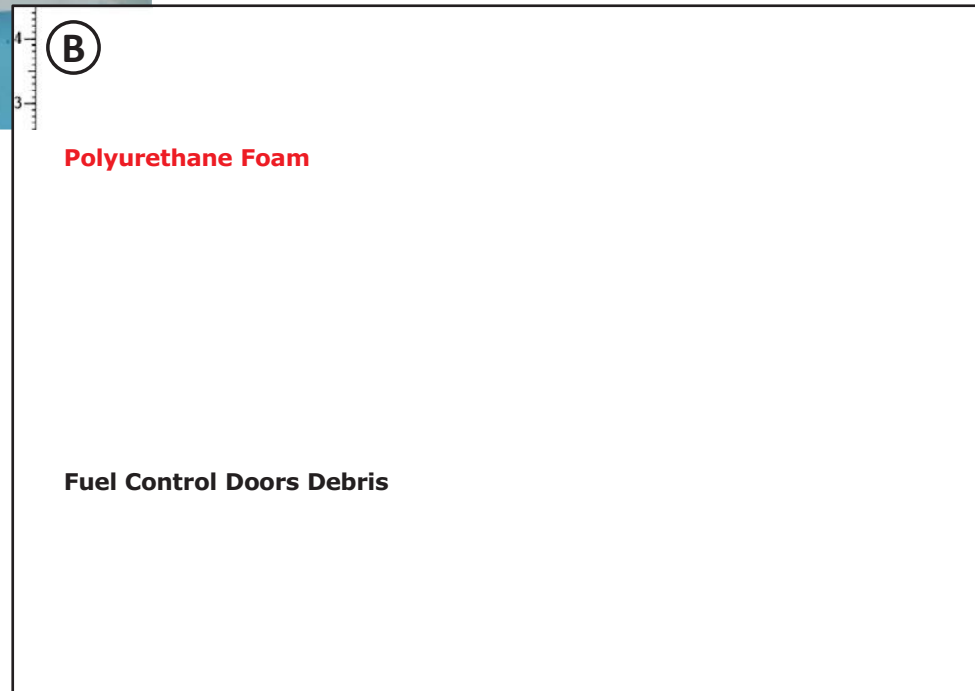


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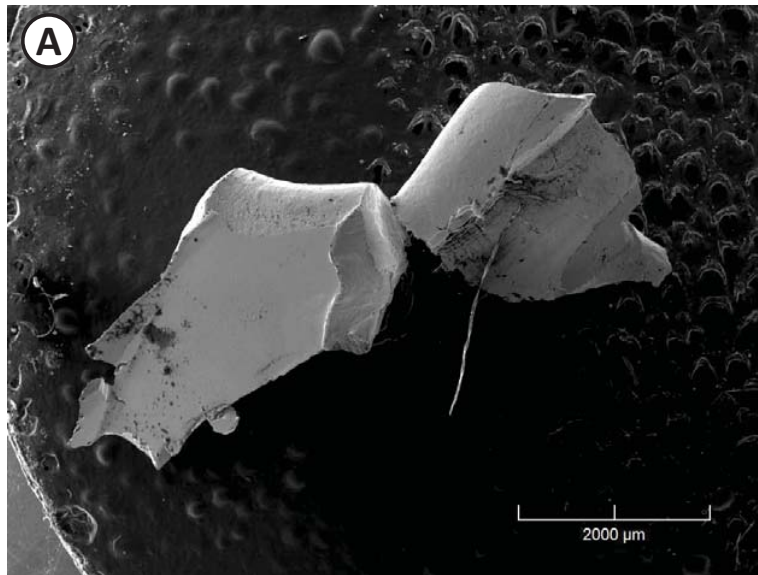
**Figure 4.**

(A) Overall photo showing the white, fibrous debris collected from the fuel control doors (white arrow). (B) FTIR spectra generated from analysis of the fuel control doors debris (black spectrum) and the lab database for comparison (red text). Note the fuel control doors debris was suggestive of a polyurethane foam.

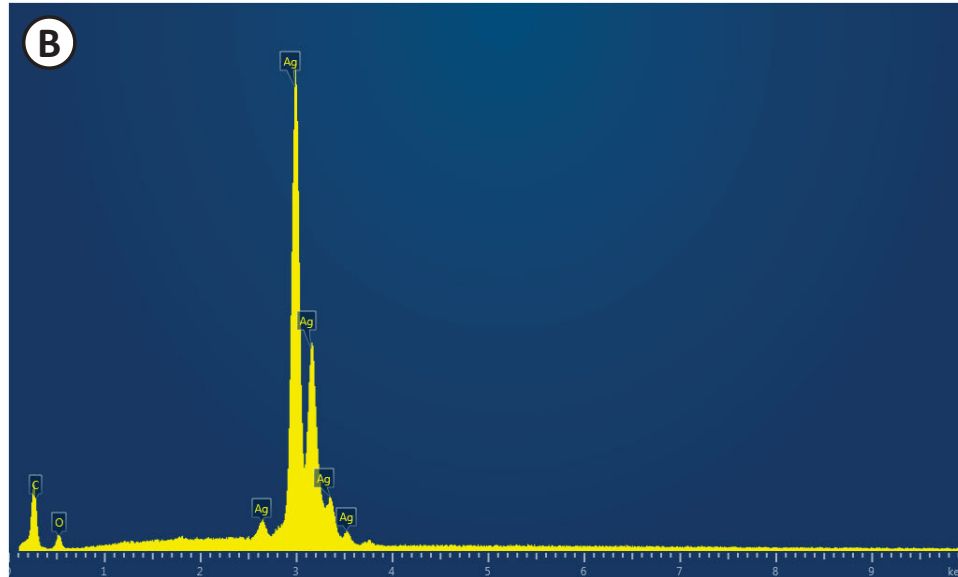


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**Figure 5.**

(A) Representative secondary electron (SE) scanning electron microscope (SEM) image showing the metallic debris collected from the ring gear support. (B) Energy dispersive X-ray (EDX) analysis of the particles produced a spectrum rich in silver.



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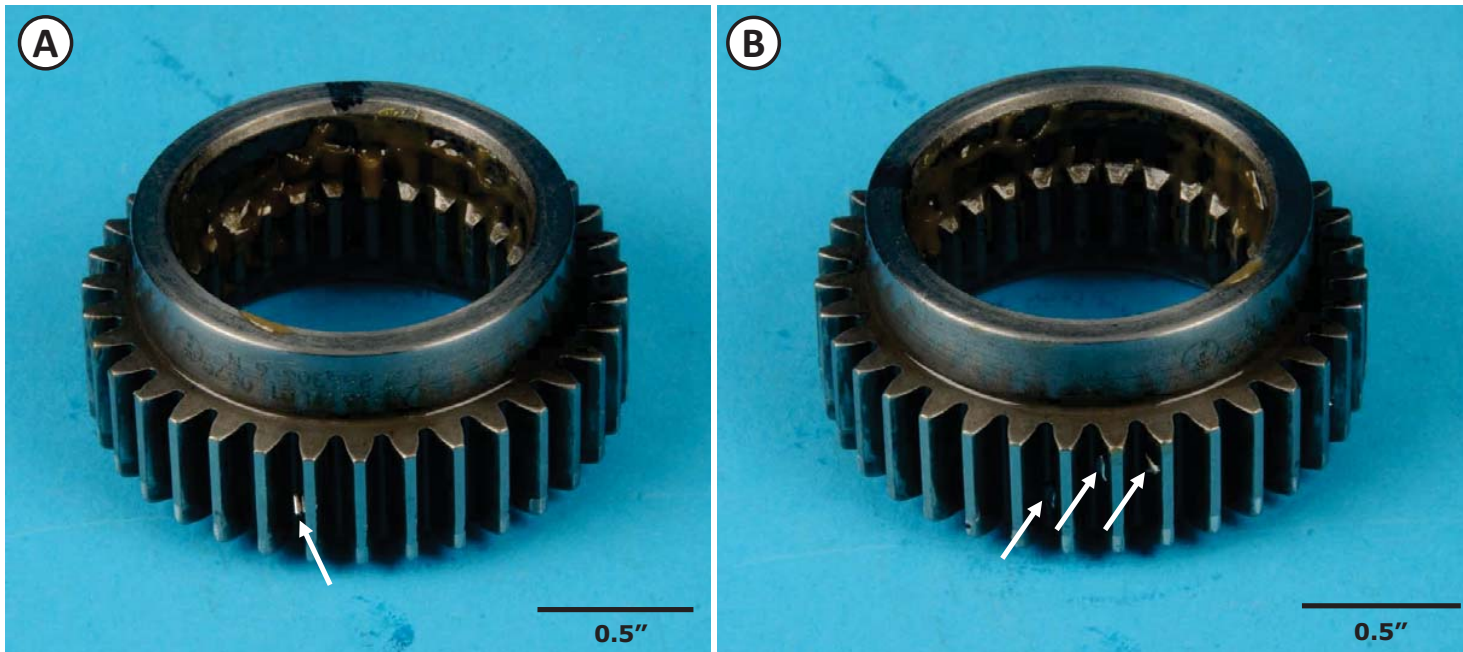


Figure 6.

(A-B) Overall photos showing the spur gear (P/N 866306-6) in the as-received condition. Metallic debris was observed on the teeth in some locations (white arrows). A representative EDX spectrum generated from analysis of the debris is shown in Figure 7.

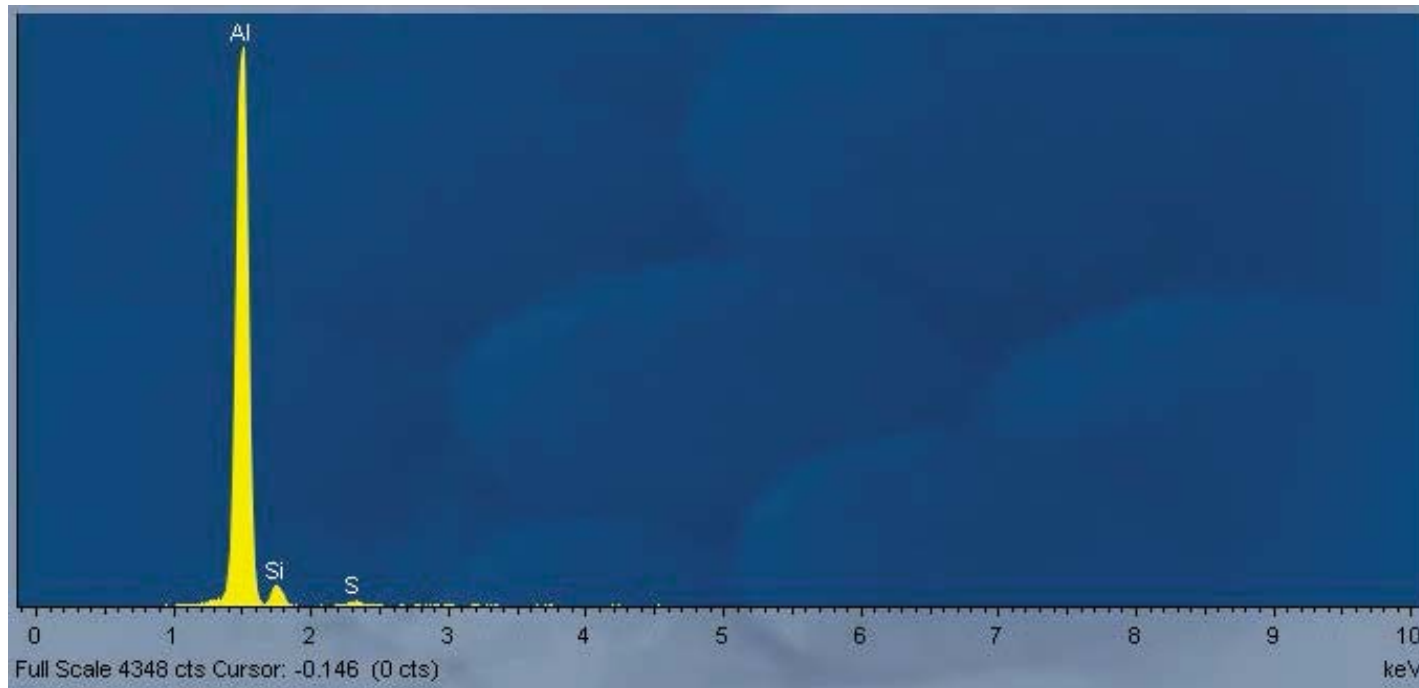


Figure 7.

Spectrum generated from EDX analysis of the metallic debris observed on the spur gear (reference Figure 6). The spectrum was indicative of a material similar to Al 356. Note that the torque sensor housing was specified to be made from Al 356.

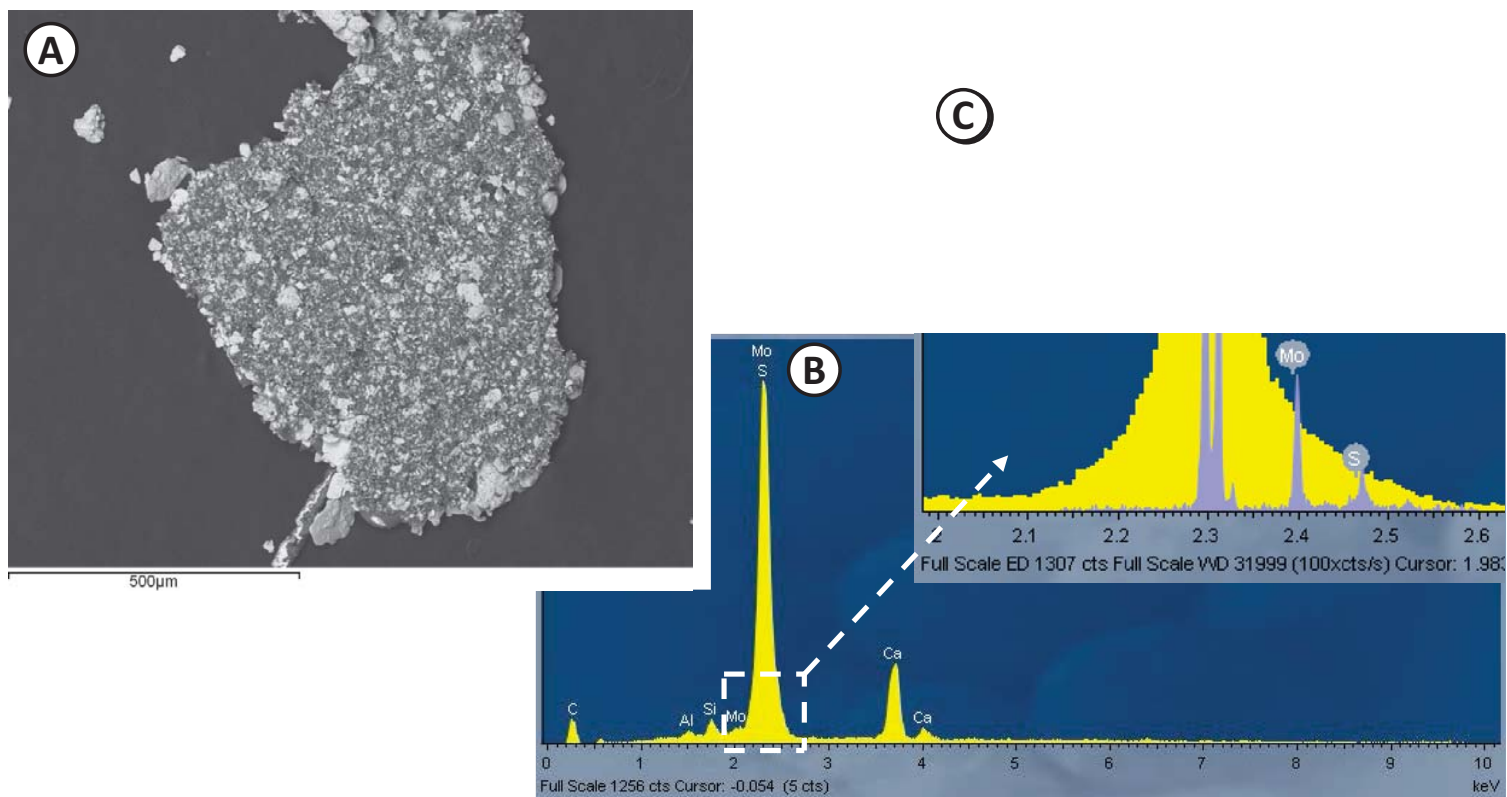
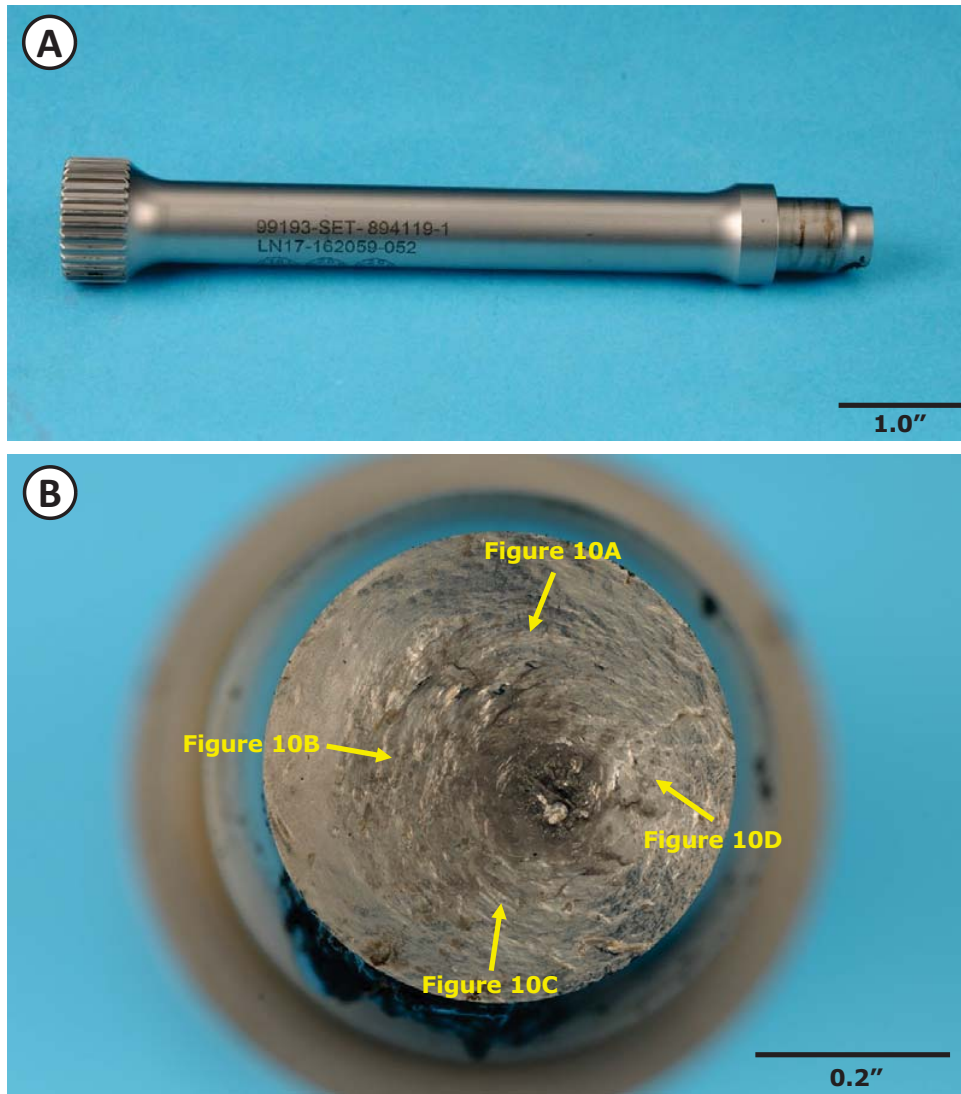


Figure 8.

(A) Representative backscattered electron (BSE) SEM image showing debris collected from the flushed spur gear. (B) EDX analysis of the debris produced a spectrum rich in molybdenum and sulfur, with lesser concentrations of calcium, silicon, and aluminum. (C) Enlarged portion of the spectrum shown in (B) with a wavelength dispersive X-ray (WDX) spectrum overlay (blue spectrum). The WDX spectrum confirmed the presence of both molybdenum and sulfur. The spectra were suggestive of molybdenum disulfide.

**Figure 9.**

(A) Overall view showing the separated coupling shaft in the as-received condition. (B) Close-up view showing the fracture surface of the coupling shaft. SEM images of the fracture surface are shown in Figure 10, as indicated.

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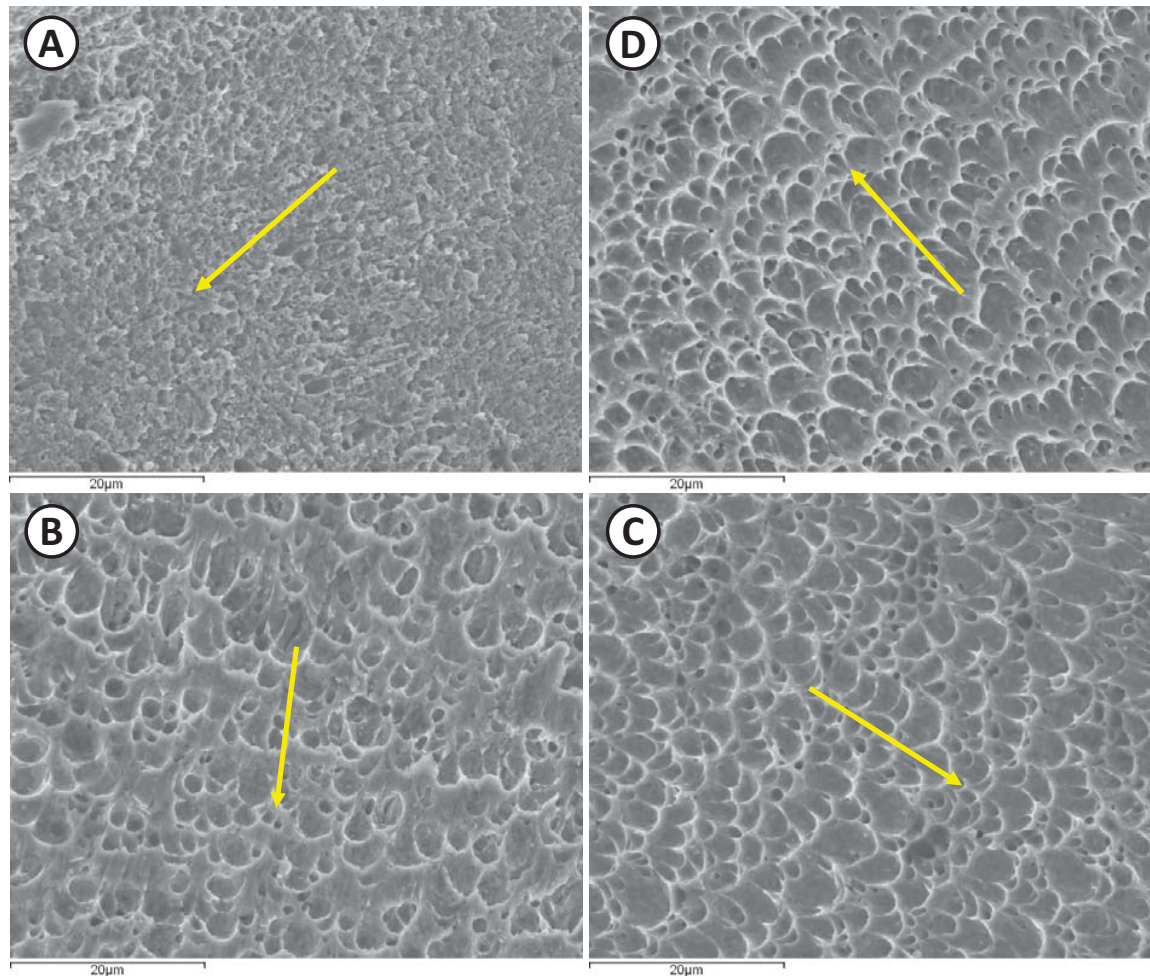


Figure 10.

(A-D) SEM images showing the fracture surface on the separated coupling shaft. The fracture features were indicative of torsional overload as indicated by the elongated dimples. The yellow arrows indicate the direction of rotation with respect to the mating fracture surface.

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Honeywell Restricted - Export Controlled

CMR Number	100764	Submission Date	10/17/2018
Status	Released	Desired Completion Date	10/17/2018
		Commit Date	10/17/2018
Requester Priority	High - NTSB teardown supported by Product Integrity		
Released By	[REDACTED]	Completion Date	10/17/2018
Disposition Statement	The data was processed in accordance with the detailed instructions.		
Requester	[REDACTED]	Requesting Site	Phoenix
Custom Id / Title	Oil Analysis P-36075C		
Labor Charge Number	[REDACTED]		
SAP Project	EI-000682	SAP Work Center	EEMAZZML
Program Key Code	21224	Program Name	Aero Product Integrity Accident Investigation (All Aero Sites)
Has HMR Milestones?	No	Is Flawless Launch?	No
Engineering Commitment	01-Execution Development	Engineering Priority	99 - Unassigned
HMR Milestone Index		Engine Serial #	P-36075C
Detailed Instructions	please conduct SOAP on oil sample provided.		
Distribution List	[REDACTED]		

Result

Specimen: 1063019458							Date: 10/17/2018
Property	Result	Units	LL	T	UL	SOP	Analyst
Test: SOAP							
Ag	<	ppm				W143	Bautista, Karla
Al	<	ppm				W143	Bautista, Karla
C	<	ppm				W143	Bautista, Karla
Cu	0.5	ppm				W143	Bautista, Karla
F	0.4	ppm				W143	Bautista, Karla
Mg	0.4	ppm				W143	Bautista, Karla
Ni	<	ppm				W143	Bautista, Karla
Pb	<	ppm				W143	Bautista, Karla
Si	16	ppm				W143	Bautista, Karla

[REDACTED]

APPENDIX B

Fuel Shutoff Valve Functional Test Results

2 Pages



SWP500280-X007

ACCEPTANCE TEST DATA SHEET**Lab Findings**

ATP-394230 Rev G

DS-394230-1,-2,-3,-4,-5,-6,-7,-8,-9AA

PART 394230-9

TECHNICIAN(S) Vincent MandoAMBIENT TEMPERATURE 76 °FUNIT SERIAL NUMBER 6141CTEST DATE 04-12-2019INSTRUMENTATION ACCEPT ☒AMBIENT PRESSURE 28.6 INHG ABS

Paragraph	Test	Requirement	Actual Value (Units of measure indicated in Requirement box)	Accept (✓)
3.1	Dielectric Strength			
3.1	Evidence of arcing	None		NA
3.1	Current drain at 1000 Vac	0.5 mA Max		NA
3.2	Proof Pressure and External Leakage			
3.2.1	Proof pressure valve closed	No evidence of deformation or deterioration		
3.2.1	External leakage valve closed	50 cc/min Max		
3.2.2	Proof pressure valve open	No evidence of deformation or deterioration		
3.2.2	External leakage valve open	50 cc/min Max		
3.3	Pressure Drop Test			
3.3	Inlet pressure	173 to 177 psig	175.0 psig	
3.3	Pressure drop	delta P 60 psi Max	54.0 psi	
3.4	Functional			
3.4	Auto position	Downstream pressure Greater than 300 psig	450.0 psig	
3.4	Off / auto position	Zero downstream pressure		✓
3.5	Electrical Minimum Voltage			
3.5.1	Opening	10.5 Vdc Max	opened @ 14.2V	X
3.5.2	Closing	17.0 Vdc Max		✓
3.6	Manual Closing			
3.6	To OFF position	7.5 to 11.0 lb-in		✓
3.6	To AUTO position	7.5 to 11.0 lb-in		✓
3.7	Outlet Port Leakage			
3.7.1	Manual	0.03 cc/2min Max		✓
3.7.2	Electrical	0.03 cc/2min Max	6.4 cc's ⁱⁿ 2min	X
3.7.2.1	Electrical with 1375 ±10 psig inlet	100 cc/min Max	11.2 cc's ⁱⁿ 2min	✓

Resort

Paragraph	Test	Requirement	Actual Value (Units of measure indicated in Requirement box)	Accept (✓)
3.8	Drain Port Leakage (-1 thru -8 only)	50 cc/min Max		NA
3.8.1	Drain port leakage with 50 ±1 psig inlet (-1 thru -8 only)	50 cc/min Max		NA
3.9	External Leakage			
3.9	Pressure decay	2 psi Max in 2 minutes		✓
3.9.1	Visual observation	No evidence of leakage		✓

UNIT ACCEPT (FT Stamp) REJECTED

APPENDIX C

Fuel Pump Assembly Functional Test Results

1 Page

0122

Allied-Signal Aerospace Company

Garrett Engine Division

DS-8983A,
1-13-89

FUEL PUMP ACCEPTANCE
TEST DATA
FOR P/N 869151-1 THROUGH -7,
897400-1 THROUGH -7,
897380-1 THROUGH -10
AND 895413-1 THROUGH -12

Used With
OHTI-869151
Rev E

^
E

DATE 03/07/19
LAB TEMP 72 F
FUEL TEMP 72 F

PART NO. 897400-5
SERIAL NO. P-121763c
STATION NO. 6

OHTI Paragraph No.					
3.1	Run-In Completed <u>N/R</u> Leakage Check Completed <u>✓</u>				
3.2	Input Shaft Speed (rpm)	Inlet Fuel Pressure (psig)	Discharge Pressure (psig)	Discharge Fuel Flow (lb/hr)	
				Minimum	Actual
	545 ±10	10 ±1	140 ±5	140	147
	2500 ±10	10 ±1	140 ±5	*	995
	2500 ±10	10 ±1	700 ±10	*	820
	4000 ±10	10 ±1	700 ±10	*	1480
	4536 ±10	10 ±1	140 ±5	*	1840
	4536 ±10	10 ±1	700 ±10	1350	1715
3.3	4536 ±10	10 ±1	1375 ±50	Actual Pressure <u>1115</u>	
3.4	Filter and Leak Check Completed <u>N/R</u>				
3.5	Input Shaft Torque 18 in-lb max. <u>13</u>				
4.0	Preservation - Completed <u> </u>				
UNIT TEST: Accept <u> </u> Reject <u>✓</u> Route to QA/ENG <u> </u>					
Remarks:		Signature		Date	
		Technician	<u>[Signature]</u>	<u>03/07/19</u>	
		Engineering			
		QA			
		Govt. Insp.			
* Record only upon special request from Engineering					

Akers

APPENDIX D

Fuel Control Unit Functional Test Results

9 Pages

CUSTOMER HONEYWELL ENGINES & SYSTEMS			INVESTIGATION NO 1144357		
CUSTOMER ORDER NONE		WOODWARD SALES ORDER 3559174		WOODWARD WORK ORDER 8259060	
CUSTOMER REJECTION DOCUMENT (CAR, QN RFA DMR, ETC.) N/A			WARRANTY DISPOSITION N/A		PRODUCT STATUS 1 RCVD
PROGRAM/ENGINE TYPE GARRETT			ITEM RECEIVED 8070-426		ENGINE MFR. MODEL RECEIVED N/A
PROGRAM CODE 82228		SERIAL NUMBER 1709648		ITEM SHIPPED 8070-426	
PARENT ITEM NUMBER 8070-426		PARENT ITEM SERIAL NUMBER 1709648		ENGINE MFR. MODEL SHIPPED 897780-18	
CUSTOMER SERIAL NUMBER N/A		APPLICATION N/A		LAST SHIPPED 17-AUG-1994	
		VESEL TYPE & VESSEL NUMBER G-164C/C N6674K		SITE & LOCATION GRID ID N/A N/A	
TIME/CYCLES SINCE NEW, OVERHAUL, OR REPAIR					
DATE REPORT OPENED 13-NOV-2018		DATE PART REMOVED N/A		DATE RECEIVED 08-NOV-2018	
TEAM MEMBERS (D1) Product Engineer: Brandon Bolley Customer QA Engineer: Jean Taylor Tech Advisor/Reviewer: Steven A. Krugler Customer Account Manager: Brent D. Lewis Customer Service Rep: Angelique Stuckey					
REASON FOR INVESTIGATION (D2) Reported Issue: ON APRIL 29, 2018 UNIT WAS REPORTED INVOLVED IN AN INCIDENT WHERE THE AIRCRAFT WAS SUBSTANTIALLY DAMAGED FOLLOWING A FORCED LANDING DUE TO A POWER LOSS NEAR MAXWELL CA. THE PILOT STATED THAT ABOUT 5 MINUTES INTO FLIGHT AT AN ALTITUDE OF ABOUT 200 FT. ABOVE GROUND LEVEL AND IN CLOSE PROXIMITY TO THE AIRPORT, THE ENGINE SURGED THREE TIMES, WHICH WAS FOLLOWED BY WHAT HE BELIEVED WAS A TOTAL ENGINE FAILURE. THE AIRPLANE WAS SUBSTANTIALLY DAMAGED WHEN IT NOSED OVER DURING THE LANDING ROLL. AIRCRAFT GRUMMAN CORWCHWEIZER G-164C/C. TAIL NUMBER N6674K					
CONTAINMENT/IMMEDIATE ACTIONS (D3)					
INVESTIGATION SUMMARY (D4) Confirmation Text: DID NOT CONFIRM REASON FOR INVESTIGATION/RETURN OR NO PREEXISTING FAULT FOUND Discrepant Item Number: NA Discrepancy: No Discrepancy Found Finding: No Findings Conclusion: S/N 1709648 was last shipped from Woodward as model 8070-426 in March 1996. The presence of foreign lockwire indicates that the unit was serviced by another facility since it was last shipped from Woodward. The unit was returned with the customer fittings and pressurizing valve installed. The Tt2 sensor assembly was also still installed on the FCU. These components were removed and a visual as-received inspection was performed. The fuel inlet filter was missing. There were some minor scratches on the housing near the Pt2 loading cap but no other damage was evident. The speed setting lever, power lever, and drive shaft were all intact and rotated freely. The bypass valve assembly was removed to inspect for contamination. Rust was observed on the shim beneath the bypass valve pilot but no contamination was observed in the valve. The piston was found to move and rotate smoothly. A slave inlet filter was installed and the unit was mounted on the test stand for as-received testing. A patch filter was installed in the discharge line between the fuel control and the nozzle simulator. Several test points were found to be slightly out of limits on the Accel schedules. The Standard Day Accel schedule had one point low out of limits by less than 1% and three points high out of limits by up to 3.3%. The 15,000 Foot Accel schedule, 35,000 Foot Accel schedule, and Hot Day Accel schedule each had one test point out high by less than 1%. The Cold Day Accel schedule had one point high by 1.4%. The Decel schedule had one test point low out of limits by 3.1%. The Underspeed Governor 73% Speed schedule showed lean fuel flow at 89 pph (Limits 118 +/- 5 pph). To achieve the required fuel flow the control had to be run at 72.2% speed. The speed setting lever max stop was found to be set at 42 degrees (Limits: 39 +/- .75 deg). At this setting the Underspeed Governor 95.5% Speed schedule had rich fuel flow at 428 pph (Limits: 194 +/- 5 pph). To achieve the required fuel flow the control had to be run at 97.8% speed. It is not known if the aircraft was rigged with the speed setting lever against the max speed stop when the power lever was in the cruise/high speed condition. This setting against the speed lever stop is close to the propeller governor speed setting.					

The Overspeed Governor had lean fuel flow of 92 pph (Limits: 105 +/- 5 pph) at 106.3% and had to be run at 105.4% speed to achieve the required fuel flow.

The majority of test points on the Power Lever schedules were out of limits with the Max Power setting at 581 pph (Limits: 535 +/- 10 pph) and the Flight Idle setting at 171 pph (Limits: 214 +/- 5 pph). These are both normal customer adjustments. The Power Lever Angular Travels were also out of limits. The power lever angle at which the unit started to come off the flight idle flat in the decreasing direction was measured to be 32 degrees (Limits: 35-37 deg). In the increasing direction it was measured to be 40 degrees (Limits: 43-45 deg). The power lever angle at which the unit started coming off the max power flat was measured to be 90 degrees (Limits: 93-97 deg). These out of tolerance conditions are consistent with a 4 degree shift in the position of the power lever adaptor plate.

After as-received testing was completed, the patch filter was removed from the discharge flow line and found to have a minimal amount of small particles. There was no evidence of any contamination that would negatively affect the performance of the control. Since no malfunctions were observed during as-received testing it was decided not to disassemble the control.

ROOT CAUSE (D4)

Origin of Cause: NONE

General Cause: No Problem Found

Cause: No Problem Found or Identified

Cause Notes:

The control was functionally tested and no evidence of a pre-incident malfunction was found.

CORRECTIVE ACTION PLAN (D5)

General Corrective Action: None Required

Specific Corrective Action: None Required

Corrective Action:

CORRECTIVE ACTION IMPLEMENTATION (D6)

Corrective Action Status: NO ACTION

WOODWARD GOVERNOR COMPANY
Rockford, Illinois
CAGE 66503

TSP-7963
Page 2 of 8
Rev. D

Customer: AlliedSignal Engines, ASE PSC No. 897780

W.G.Co. SALES ORDER _____ Date 11-08-2018

BY Ron Ross

Prod. Order _____ W.G.Co. S/N 1709648

CASE# 8262

Test Stand No. 184

Test Condition except where noted:

Ambient pressure - 14.7 psia

Ambient temperature - 59 deg. F

NOTE: INPUT SETTINGS AND GAGE ACCURACIES.

Unless otherwise specified, use these tolerances when setting the following parameters:

Pt2 = ± 0.2 PSIA

Approach all inlet pressure settings from a lower pressure setting.

Tt2 = ± 2 Deg.
or .001 Mic. setting

Approach all inlet temperature settings from a higher temperature setting. (USE WT-118820)

Ps3 = ± 0.2 PSIA

Approach all compressor pressure setting from a lower pressure setting except when checking decel schedules.

PL = ± 0.5 Deg.

Approach all power lever angular settings from a lower setting.

Speed Setting Tolerance = ± 10 RPM

Underspeed Governor Lever (USG) Tolerance = ± 0.5 Deg.

PN = Fuel Discharge Pressure

GAGE ACCURACIES

Definition	Instrument Accuracy	Set Point Accuracy
Control Speed	± 5 RPM	± 5 RPM
Metered Flow(PPH)	$\pm 1\%$ of point	$\pm 1\%$ of point
Inlet Pressure(PSIG)	$\pm 5\%$ or 7.5 PSIG Whichever is greater	$\pm 5\%$ or 7.5 PSIG Whichever is greater
Differential Pressure(PSID)	± 0.5 PSID	± 0.5 PSID
Air Pressure(Pt2 and PS3)	± 0.25 PSIA	± 0.25 PSIA
Temperature	± 2 Deg. F.	± 2 Deg. F.
Pressure Gages	± 0.25 PSIA	± 0.25 PSIA

1.0 STANDARD ACCELERATION SCHEDULE

Sea level start flow checking procedure: (Test pt. 1.2 only). Start flows to be accomplished in the following sequence:

CAUTION: At no time in this calibration procedure is Pt2 to be set above Ps3.

- A. Preset speed, Tt2. Underspeed governor lever, power lever as specified on data sheet.
- B. Set Ps3 at 20 psia minimum.
- C. Set Pt2 from a low pressure to the required set point without overshoot.
- D. Reset Ps3 to 15 psia without undershoot.
- E. Read start fuel flow.

HOLD CONSTANT: T2 = 59 deg. F. P2 = 14.7 psia											
TEST POINT	INLET FLOW PPH REF.	REQ'D LEVER POSITIONS DEGREES		INPUT SPEED RPM	Ps3 PSIA	Pn PSIG REF.	PPH		PPH		Hysteresis
		USG	PL				SPEC'D	** RECORD INC/PS3 RECORD	** RECORD DEC/PS3 RECORD	SPEC'D	
1.1	450	Min	0	1000	15	150	60±2	57.5	—	—	—
1.2	450	Max	0	1000	15	150	60±2	58	—	—	—
1.3	1000	Max	0	1800	30	210	96±6	104	—	—	—
1.4	1400	Max	0	3000	50	245	232±9	249	—	—	—
1.5	1750	Max	0	3600	70	270	305±12	321	—	—	—
1.6	1950	Max	0	4000	90	300	352±14	359	361	5	2
1.7	1950	Max	0	4000	120	370	443±16	454	457	10	3
1.8	1950	Max	0	4000	135	490	528±21	531	—	—	—

Remarks: ** Hysteresis shall be from a low PS3 to a high, then decrease PS3. Record at decrease then subtract to achieve hysteresis point.

2.0 15,000 FOOT ACCEL SCHEDULE

HOLD CONSTANT: Tt2 = 59 deg. F. Pt2 = 8.8 psia								
TEST POINT	INLET FLOW PPH REF.	REQ'D LEVER POSITIONS DEGREES		INPUT SPEED RPM	Ps3 PSIA	Pn PSIG REF.	PPH	
		USG	PL				SPEC'D	RECORD
2.1	450	Min	0	1000	8.8	150	57 ±5	52
2.2	1400	Max	0	3100	30	210	139 ±6	146
2.3	1950	Max	0	4000	60	250	227 ±9	233
2.4	1950	Max	0	4000	75	275	284 ±12	290
2.5	1950	Max	Max	4000	90	310	383 ±15	387

3.0 35,000 FOOT ACCEL SCHEDULE

HOLD CONSTANT: Tt2 = 59 deg. F. Pt2 = 3.5 psia								
TEST POINT	INLET FLOW PPH REF.	REQ'D LEVER POSITIONS DEGREES		INPUT SPEED RPM	Ps3 PSIA	Pn PSIG REF.	PPH	
		USG	PL				SPEC'D	RECORD
3.1	1950	Max	0	4000	25	200	92 ±4	95
3.2	1950	Max	0	4000	35	220	147 ±6	154

4.0 HOT DAY ACCEL SCHEDULE

HOLD CONSTANT: Tt2 = 103 deg. F. Pt2 = 14.7 psia								
TEST POINT	INLET FLOW PPH REF.	REQ'D LEVER POSITIONS DEGREES		INPUT SPEED RPM	Ps3 PSIA	Pn PSIG REF.	PPH	
		USG	PL				SPEC'D	RECORD
4.1	450	Min	0	1000	15	155	62 ±6	67
4.2	1600	Max	0	3400	50	250	242 ±10	254
4.3	1950	Max	0	4000	90	305	367 ±14	370
4.4	1950	Max	0	4000	130	495	521 ±21	516

5.0 COLD DAY ACCEL SCHEDULE

HOLD CONSTANT: Tt2 = -60 deg. F. Pt2 = 14.7 psia								
TEST POINT	INLET FLOW PPH REF.	REQ'D LEVER POSITIONS DEGREES		INPUT SPEED RPM	Ps3 PSIA	Pn PSIG REF.	PPH	
		USG	PL				SPEC'D	RECORD
5.1	450	Min	0	1000	15	135	58 ±6	58.5
5.2	1400	Max	0	3000	50	240	204 ±8	215
5.3	1850	Max	0	3800	90	290	309 ±12	314
5.4	1950	Max	0	4000	135	400	464 ±19	470
5.5	1950	Max	0	4000	145	500	529 ±21	526

6.0 UNDERSPEED GOVERNOR 73.0% SPEED

HOLD CONSTANT: PL = 0 deg. Tt2 = 59 deg.F Pt2 = 14.7 PSIA							
TEST POINT	USG LEVER POSITIONS DEGREES	INPUT SPEED ±5 RPM	INLET FLOW REF.	Ps3 PSIA	Pn PSIG REF.	PPH	
						SPECIFIED	RECORD
6.1	11.50 ± 2.50 12°	3210 Min	1300	50	225	215 Min	208
6.2	11.50 ± 2.50	3311	1300	50	225	118 ±5	89
6.3	11.50 ± 2.50	3333	1300	50	225	(1) 6.2-6.3	88
6.4	11.50 ± 2.50	3311	1300	50	225	118 (2)	89

NOTE: (1) A minimum of 5 PPH less than the fuel flow at DATA POINT 6.2.
(2) Subtract 6.2-6.4 must be within 10 pph.

Actual

3276

7.0 UNDERSPEED GOVERNOR 95.5% SPEED

HOLD CONSTANT: PL = 0 deg. T12 = 59 deg.F P12 = 14.7 PSIA							
TEST POINT	USG LEVER POSITIONS DEGREES	INPUT SPEED ± 5 RPM	INLET FLOW REF.	Ps3 PSIA	Pn PSIG REF.	PPH	
						SPECIFIED	RECORD
42°							
7.1	39.00 $\pm$.75	4232	2050	132	350	376 Min	505
7.2	39.00 $\pm$.75	4332	2150	120	320	194 $\pm$ 5	428
7.3	39.00 $\pm$.75	4420	2150	120	320	(3) 7.2-7.3	221
7.4	39.00 $\pm$.75	4332	2150	120	320	194 (4)	419
7.5	14 $\pm$ 1	3400(5)	1500	63	240	120 $\pm$ 3	15

Note: (3) A minimum of 5 pph less than the fuel flow at 7.2.
(4) Subtract 7.2-7.4 must be within 10 pph.
(5) Set speed and fuel flow. Record speed lever angle. Req. 14 $\pm$ 1 deg.

Actual

4436

8.0 OVERSPEED GOVERNOR

HOLD CONSTANT: T12=59 deg.F PL=max. P12=14.7 psia							
TEST POINT	USG LEVER POSITIONS DEGREES	INPUT SPEED ± 5 RPM	INLET FLOW REF.	Ps3 PSIA	Pn PSIG REF.	PPH	
						SPECIFIED	RECORD
8.1	Max.	4536	2300	155	580	—	590
8.2	Max.	4581	2350	155	560	* 8.1-8.2	583
8.3	Max.	4740	2400	155	360	248 $\pm$ 10	225
8.4	Max.	4824	2500	155	310	105 $\pm$ 5	92
8.5	Max.	4740	2400	155	360	** 248 $\pm$ 10	215

Notes: * Record 8.1-8.2, shall be no more than 12 PPH max.
** Subtract 8.3-8.5 must be within 10 pph

Actual

4734

4782

9.0 DECEL SCHEDULE

HOLD CONSTANT: T12 = 59 deg F. Inlet flow = 2300 REF. Speed = 4536. PL = 0. USG = Min.					
TEST POINT	P12 PSIA	Ps3 PSIA	Pn PSIG REF.	PPH	
				SPECIFIED	RECORD
9.1	14.7	135	325	166 $\pm$ 7	154
9.2	14.7	76	250	85 $\pm$ 7	81.5
9.3	14.7	44	215	68 $\pm$ 7	64.5

10.0 POWER LEVER SCHEDULE - T12 Correction

HOLD CONSTANT: P12 = 14.7 Psia. Inlet flow = 2300 PPH. REF. Speed = 4536 rpm. USG = Max. NOTE: Approach all PL settings from a lower setting.										
TEST POINT	PL Deg.	T12 REF. Deg.F	WT-118820 ±.001	Ps3 PSIA	Pn REF. PSIG	PPH				
						SPEC'D	(1) RECORD	(2) RECORD	Hysteresis	
									SPEC'D	REC'D (1-2)
10.1 **	101	103	.823	170	430	455 ±10	(519)	—	—	—
10.2	101	59	.800	170	530	535 ±10	(581)	591	18	10
10.3 **	101	38	.788	180	595	573 ±10	(607)	—	—	—
10.4	40	103	.823	90	265	193 ±5	(154)	—	—	—
10.5	40	59	.800	90	265	214 ±5	(171)	174	5	3
10.6	40	-60	.735	90	280	271 ±10	(233)	—	—	—

NOTE: Hysteresis shall be from a high T12 (column 1) to a low, then increase T12 (column 2). Subtract column 1 from column 2 to achieve hysteresis point.

** Fuel FLOW between T.P. 10.1 & 10.3 to be 118 PPH ± 8 PPH

Record (88)

11.0 POWER LEVER SCHEDULE - T12 CORRECTION - 15,000 ft.

HOLD CONSTANT: P12=8.8 PSIA Inlet Flow=2300 PPH REF. Speed 4536 RPM USG=Max. NOTE: Approach all PL settings from a lower lever setting.									
TEST POINT	PL POSITION Deg.	T12 REF. Deg.F	WT-118820 ±.001	Ps3 PSIA	Pn REF. PSIG	Fuel Flow = PPH			
						SPEC'D	RECORD	Delta SPEC'D	Delta REC'D
11.1	101	59	.800	120	330	320 ±10	(382)	—	—
11.2	101	103	.823	120	325	—	—	48 ±15	47
11.3	101	-65	.733	120	390	—	—	135 ±15	(159)

12.0 POWER LEVER SCHEDULE - P12 CORRECTION

HOLD CONSTANT: T12 = 59 deg.F. Speed = 4536 RPM. USG = MAX Inlet flow = 2300 PPH. REF. NOTE: Approach all PL settings from a lower lever setting.									
TEST POINT	PL POSITION Deg.	P12 Deg.F	Ps3 PSIA	Pn PSIG	PPH				
					SPEC'D	ACT.	ACT.	Hysteresis	
								SPEC'D	REC'D
12.1	101	3.5	55	235	127 ±10	(189)	—	—	—
12.2	101	16.0	180	595	582 ±10	(608)	610	10	2
12.3	40	8.8	50	250	128 ±5	123	—	—	—
12.4	40	17.6	90	270	256 ±10	(199)	201	4	2

NOTE: Hysteresis shall be from a low P12 (column 1) to a high, then decrease P12 (column 2). Subtract column 1 from column 2 to achieve hysteresis point.

13.0 LEVER SHAFT TORQUE

TEST POINT		SPEC'D TORQUE IN-LB	RECORD TORQUE RANGE
13.1	PL	7 Max.	4
13.2	USG	10 Max.	8

14.0 POWER LEVER ANGULAR TRAVELS

TEST POINT	FLAT		ANGLE DEGREES	
			SPECIFIED	RECORD
14.1	GI		0	0
14.2	FI	Min.	35-37	32
		Max.	43-45	40
14.3	M/P	Min.	93-97	90
14.4	M/P	Max.	101 ± .5 deg	102

15.0 MAX FUEL FLOW LIMIT

TEST POINT	INLET FLOW REF.	PL POSITION DEGREES	SPEED RPM	T12	Ps3	Pn PSIG	HOLD CONSTANT: P12=14.7 PSIA USG=Max.	
							PPH	
							SPEC'D	RECORD
15.1*	2300	0	4000	59	160	450	550 ±5	594
15.2	1950	0	4000	103	115	360	437 ±18	454
15.3	1950	0	4000	59	115	350	420 ±17	435

*Adjust accel limit Max. stop CW to achieve specified fuel flow.

16.0 MAX POWER ADJ. CHECK

Test Point

- 16.1 Record fuel flow at test point 11.1 RECORD _____
- 16.2 Adjust max power adjustment upward. Must be 30 PPH minimum more than 16.1 RECORD _____
- 16.3 Adjust max power adjustment downward. Must be 12 PPH minimum less than 16.1. RECORD _____

CUSTOMER HONEYWELL ENGINES & SYSTEMS		INVESTIGATION NO 1144358	
CUSTOMER ORDER NONE	WOODWARD SALES ORDER 3559171	WOODWARD WORK ORDER 8259056	
CUSTOMER REJECTION DOCUMENT (CAR, QN RFA DMR, ETC.) N/A		WARRANTY DISPOSITION N/A	PRODUCT STATUS 1 RCVD
PROGRAM/ENGINE TYPE ALLIEDSIGNAL ENGINE DIV.		ITEM RECEIVED 8901-013	ENGINE MFR. MODEL RECEIVED N/A
PROGRAM CODE 82228 SENSOR	SERIAL NUMBER 924276	ITEM SHIPPED 8901-013	ENGINE MFR. MODEL SHIPPED 869169-1
PARENT ITEM NUMBER 8901-013	PARENT ITEM SERIAL NUMBER 924276	FIRST SHIPPED N/A	LAST SHIPPED N/A
CUSTOMER SERIAL NUMBER N/A	APPLICATION N/A	VESSEL TYPE & VESSEL NUMBER G-164C/C N6674K	SITE & LOCATION GRID ID N/A N/A
TIME/CYCLES SINCE NEW, OVERHAUL, OR REPAIR			
DATE REPORT OPENED 13-NOV-2018		DATE PART REMOVED N/A	DATE RECEIVED 08-NOV-2018
TEAM MEMBERS (D1) Product Engineer: Brandon Bolley Customer QA Engineer: Jean Taylor Tech Advisor/Reviewer: Steven A. Krugler Customer Account Manager: Brent D. Lewis Customer Service Rep: Angelique Stuckey			
REASON FOR INVESTIGATION (D2) Reported Issue: ON APRIL 29, 2018 UNIT WAS REPORTED INVOLVED IN AN INCIDENT WHERE THE AIRCRAFT WAS SUBSTANTIALLY DAMAGED FOLLOWING A FORCED LANDING DUE TO A POWER LOSS NEAR MAXWELL CA. THE PILOT STATED THAT ABOUT 5 MINUTES INTO FLIGHT AT AN ALTITUDE OF ABOUT 200 FT. ABOVE GROUND LEVEL AND IN CLOSE PROXIMITY TO THE AIRPORT, THE ENGINE SURGED THREE TIMES, WHICH WAS FOLLOWED BY WHAT HE BELIEVED WAS A TOTAL ENGINE FAILURE. THE AIRPLANE WAS SUBSTANTIALLY DAMAGED WHEN IT NOSED OVER DURING THE LANDING ROLL. AIRCRAFT GRUMMAN CORWCHWEIZER G-164C/C. TAIL NUMBER N6674K			
CONTAINMENT/IMMEDIATE ACTIONS (D3)			
INVESTIGATION SUMMARY (D4) Confirmation Text: DID NOT CONFIRM REASON FOR INVESTIGATION/RETURN OR NO PREEXISTING FAULT FOUND Discrepant Item Number: NA Discrepancy: No Discrepancy Found Finding: No Findings Conclusion: The sensor was visually inspected and no damage was observed. The bellows was measured using tool WT-51467 to determine sensor calibration. The sensor measured 0.947 inches at -63 deg F, 1.022 inches at 79.5 deg F, and 1.043 inches at 115 deg F. Calibration requirements for the sensor are 0.949 +/- .002 at -60 deg F, 1.023 +/- .002 at 75 deg F, and 1.038 +/- .002 at 103 deg F. After correcting for the change in bulb temperatures, the bellows length at -60 deg F and at 103 deg F were within limits. At 75 deg F the dimensional shift from nominal corresponds to a temperature difference of approximately 6 degrees colder.			
ROOT CAUSE (D4) Origin of Cause: NONE General Cause: No Problem Found Cause: No Problem Found or Identified Cause Notes: Inspection found no evidence of a malfunction. The sensor did not leak and had only a slight change in position.			
CORRECTIVE ACTION PLAN (D5) General Corrective Action: None Required Specific Corrective Action: None Required Corrective Action:			
CORRECTIVE ACTION IMPLEMENTATION (D6) Corrective Action Status: NO ACTION			

APPENDIX E

Fuel Flow Divider Valve Functional Test Results

3 Pages

ACCEPTANCE TEST DATA SHEET

DS-394408-88

UNIT S/N

P5741C

TEST DATE

7/4/2019

ATP-394408, REV.

INSTRUMENTATION ACCEPT

PART 394408 - B

TESTED BY

STATION NO.

Test
Procedure
Paragraph

- 4.3 PROOF PRESSURE: Accept NA
- 4.4 PRIMARY DRAIN VALVE FUNCTIONAL: Accept YES
- 4.4.1 Begins to open: 3 to 20 psig Inlet, Actual 7.9 psig
- 4.4.2 Internal Leakage: 45 $\pm$ 5 lb/hr Total Flow; 2.0 $\pm$ 0.5 psig Primary Outlet;
50.0 cc/min Max (Port D), Actual 0.0 cc/min
- 4.4.2.1 20.0 psig Primary Outlet; 0.5 cc/min Max (Port D), Actual 0.0 cc/min
- 4.4.3 Drain Mode: Accept YES
- Inlet 1.5 psig Min, Actual 4.0 psig
- 4.5 FLOW DIVIDER FUNCTIONAL TEST: Accept NO
- 4.5.1 Begins to open: 58 lb/hr Min Primary Flow, Actual 61 lb/hr
- 4.5.2 Calibration: 70 $\pm$ 2 lb/hr Primary Flow; Actual 70 lb/hr
180 to 185 lb/hr Total Flow; Actual 308 lb/hr
- 4.5.3 Secondary Leakage: zero to 30 lb/hr Primary Flow;
2 cc/min Max (Port S), Actual 2.6 cc/min
- 4.6.1 Secondary Pressure Drop: 600 lb/hr Total Flow;
 Δ P 65 psid Max, Actual Secondary Δ P 134 psi
- 4.6.2 Primary Pressure Drop: 65 to 73 lb/hr Primary Flow;
 Δ P 40 $\pm$ 10 psid, Actual Primary Δ P 40 psi
- 4.7 SECONDARY DRAIN VALVE FUNCTIONAL: Accept YES
- 4.7.1 Internal Leakage: 2.0 $\pm$ 0.5 psig Secondary Outlet;
50 cc/min Max (Port D), Actual 11.4 cc/min
- 4.7.1.1 10 psig Secondary Outlet; 0.5 cc/min Max (Port D), Actual 0.0 cc/min
- 4.7.2 Drain Mode: Accept YES
- Secondary Outlet 1.5 psig Min, Actual 4.0 psig
- 4.8 DRAIN VALVE TOTAL LEAKAGE: Accept 3.6
- 4.8.1 70 to 550 psig Inlet; 0.5 cc/min Total Leakage (Port D), Total 3.6 cc/min
- 4.8.2 Primary Outlet Port Leakage: 3 psig Inlet; 2 cc/min Max, Actual 0.0 cc/min
- 4.9, 4.10 PRIMARY ONLY ORIFICE CALIBRATION: Accept NA
- 4.11.1 Begins to open at 90 to 100 lb/hr Primary Flow, Actual _____ lb/hr
- 4.11.2 Total Flow >500 lb/hr at <900 psig Inlet, Actual Total Flow _____ lb/hr
- 4.12 EXTERNAL LEAKAGE: Accept _____

UNIT ACCEPT/REJECT



ACCEPTANCE TEST DATA SHEET

SWP500280-X007

Lab Findings

ATP-394408 Rev -

DS-394408-8B

PART 394408-8

TECHNICIAN(S) Vincent Mando

UNIT SERIAL NUMBER P-5741C

TEST DATE 06-20-2019

INSTRUMENTATION ACCEPT ✓

AMBIENT PRESSURE 28.6 INHG ABS

Paragraph	Test	Requirement	Actual Value (Units of measure indicated in Requirement box)	Accept (✓)
4.3	Proof Pressure	No evidence of deformation or deterioration		NA
4.4	Primary Drain Valve Functional			
4.4.1	Begins to open	Inlet 3 to 20 psig	NA	NA
4.4.2	Internal leakage 45 ±5 lb/hr total flow 2.0 ±0.5 psig primary outlet	(Port D) 50.0 cc/min Max	NA	NA
4.4.2.1	20.0 psig primary outlet	(Port D) 0.5 cc/min Max	NA	NA
4.4.3	Drain mode	Inlet 1.5 psig Min	NA	NA
4.5	Flow Divider Functional Test			
4.5.1	Begins to open - Primary flow	58 lb/hr Min	56.9 lb/hr	X
4.5.2	Calibration Primary flow	68 to 72 lb/hr	70.5 lb/hr	
4.5.2	Total flow	180 to 185 lb/hr	251.5 lb/hr	X
4.5.3	Secondary leakage 0 to 30 lb/hr primary flow	(Port S) 2 cc/min Max	0.0 cc/min	
4.6.1	Secondary pressure drop 600 lb/hr total flow	delta-P 65 psid Max	55.0 psid	
4.6.2	Primary pressure drop 65 to 73 lb/hr primary flow	delta-P 30 to 50 psid	45.0 psid	
4.7	Secondary Drain Valve Functional			
4.7.1	Internal leakage 2.0 ±0.5 psig secondary outlet	(Port D) 50 cc/min Max	9.8 cc/min	
4.7.1.1	10 psig secondary outlet	(Port D) 0.5 cc/min Max	0.0 cc/min	
4.7.2	Drain mode	Secondary outlet 1.5 psig Min	3.0 psig	
4.8	Drain Valve Total Leakage			
4.8.1	Total leakage 70 to 550 psig inlet	(Port D) 0.5 cc/min Max	2.6 cc/min	X
4.8.2	Primary outlet port leakage 3 psig inlet	2 cc/min Max	0.0 cc/min	
4.11	Primary Only Orifice Calibration			
4.11.1	Begins to open	Primary flow 90 to 100 lb/hr	83.3 lb/hr	X

62.8

70.6

182.9

Paragraph	Test	Requirement	Actual Value (Units of measure indicated in Requirement box)	Accept (✓)
4.11.2	Total flow at <900 psig inlet	Total flow Greater than 500 lb/hr	605.8 lb/hr	
4.12	External Leakage	No evidence of leakage from drain valve cover plate or any other joint		NA

UNIT ACCEPT (FT Stamp) _____

APPENDIX F

Propeller Governor Functional Test Results

2 Pages

CUSTOMER HONEYWELL ENGINES & SYSTEMS		INVESTIGATION NO 1144359	
CUSTOMER ORDER NONE	WOODWARD SALES ORDER 3559173		WOODWARD WORK ORDER 8259059
CUSTOMER REJECTION DOCUMENT (CAR,QN RFA DMR,ETC.) N/A		WARRANTY DISPOSITION N/A	PRODUCT STATUS 1 RCVD
PROGRAM/ENGINE TYPE GARRETT SMALL PROP GOVERNOR		ITEM RECEIVED 8210-263	ENGINE MFR. MODEL RECEIVED N/A
PROGRAM CODE 83344 SML	SERIAL NUMBER 2248565	ITEM SHIPPED 8210-263	ENGINE MFR. MODEL SHIPPED 897410-16
PARENT ITEM NUMBER 8210-263	PARENT ITEM SERIAL NUMBER 2248565	FIRST SHIPPED 31-JUL-1990	LAST SHIPPED 31-JUL-1990
CUSTOMER SERIAL NUMBER N/A	APPLICATION N/A	VESSEL TYPE & VESSEL NUMBER G-164C/C N6674K	SITE & LOCATION GRID ID N/A N/A
TIME/CYCLES SINCE NEW, OVERHAUL, OR REPAIR			
DATE REPORT OPENED 14-NOV-2018		DATE PART REMOVED N/A	DATE RECEIVED 08-NOV-2018
TEAM MEMBERS (D1) Product Engineer: BRIAN SIVAK Customer QA Engineer: Jean Taylor Tech Advisor/Reviewer: Steven A. Krugler Customer Account Manager: Brent D. Lewis Customer Service Rep: Angelique Stuckey			
REASON FOR INVESTIGATION (D2) Reported Issue: ON APRIL 29, 2018 UNIT WAS REPORTED INVOLVED IN AN INCIDENT WHERE THE AIRCRAFT WAS SUBSTANTIALLY DAMAGED FOLLOWING A FORCED LANDING DUE TO A POWER LOSS NEAR MAXWELL CA. THE PILOT STATED THAT ABOUT 5 MINUTES INTO FLIGHT AT AN ALTITUDE OF ABOUT 200 FT. ABOVE GROUND LEVEL AND IN CLOSE PROXIMITY TO THE AIRPORT, THE ENGINE SURGED THREE TIMES, WHICH WAS FOLLOWED BY WHAT HE BELIEVED WAS A TOTAL ENGINE FAILURE. THE AIRPLANE WAS SUBSTANTIALLY DAMAGED WHEN IT NOSED OVER DURING THE LANDING ROLL. AIRCRAFT GRUMMAN CORWCHWEIZER G-164C/C. TAIL NUMBER N6674K			
CONTAINMENT/IMMEDIATE ACTIONS (D3)			
INVESTIGATION SUMMARY (D4) Confirmation Text: NO REPORTED PROBLEM Discrepant Item Number: 8210-263 Discrepancy: MECHANICAL PERFORMANCE/ FUNCTION/ TESTING NOT TO SPEC Finding: LOW/ HIGH/ INCORRECT SETTINGS, ADJUSTMENTS Conclusion: The as-received inspection revealed only light dents and scratches on the unit. The as-received test revealed that the max and min control lever stops had been adjusted in the field, resulting in the max RPM setting to be 33 RPM high and the min RPM setting to be 28 RPM low out of limits. Woodward is aware that the max speed stop can be normally adjusted during rigging and may or may not be contacted when the power lever is in the maximum speed condition. Actual speed setting of the propeller governor may have been at a lower setting on the aircraft. The governor functioned as required. The electrical speed change function of the electrical coil was found to be low out of TSP limits, but this function was not in use on the single engine aircraft as it is used for prop synchronization. The unit was returned with the lead wires for the magnetic pickup and electrical coil tied off and bundled together.			
ROOT CAUSE (D4) Origin of Cause: FIELD / END CUSTOMER (OWNER) General Cause: NONE Cause: NOT REQUIRED Cause Notes: Governor was adjusted in the field.			
CORRECTIVE ACTION PLAN (D5) General Corrective Action: None Required Specific Corrective Action: None Required Corrective Action: No corrective action is required of Woodward.			

WOODWARD, Inc.
Rockford, Illinois
CAGE 66503

TSP-1674
Page 14
Rev. AD

TEST REPORT for 8210-115 and 8210-263

☐ Woodward I/N: 8210-115 Customer P/N: 897410-7, -9 Customer Spec. PSC 897410
☒ Woodward I/N: 8210-263 Customer P/N: 897410-11, -16 Customer Spec. PSC 897410
 Woodward Sales Order No. _____
 S/N 2248565 Technician Mark Harris Date 11/08/2018

Oil Inlet Temp. 140 +/- 5 deg. F Oil Inlet Pressure: 95 +/- 10 PSIG

PT	Section No.	DESCRIPTION	SPEED RPM		OIL PRESSURE PSIG		OIL FLOW QPM	
			REQUIRED	ACTUAL	REQUIRED	ACTUAL	REQUIRED	ACTUAL
1	3.1	Check Valve	0	0	15 Max.	10	Start Flow	Start Flow
2	3.2	Relief Valve	3400 +/- 15	3400	485 +/- 15	460	0	0
3	3.2.1	Back Pressure	3400 +/- 15	3400	545 Max.	495	0	0
4	3.3	Maximum Speed	3754 +/- 10	3797	150 +/- 5	150	Use Bleed Orifice	
5	3.4	Minimum Speed	3604 +/- 10	3566	150 +/- 5	150		
6	3.5	Control Lever at Max. 84 +/- 5 deg.			PT4 to PT5 10 +/- 2 deg.			
7	3.6	Overspeed(Check/Sec. 3.6)	4017 +/- 40	4058	150 +/- 5	130		
8	3.7	Increase Speed to Obtain		3769	350 +/- 5	4658 150		
9	3.7	Increase Speed to Obtain		3822	50 +/- 5	350	11/08/2018	
10	3.7	Pressure Gain = PT 9 - PT 8	60 +/- 20	53		50		
11	3.8	Decrease Speed to Obtain		3768	350 +/- 5	350		
12	3.8	Speed Hysteresis = PT 8 - PT 11	-15 to +40	1				
13	3.9	Pump Capacity	3400 +/- 15	3400	150 +/- 20	150		
14	3.10	Internal Leak	As Required	3819	150 +/- 5	150	10.9 QPM Min.	12.3
15	3.11	Magnetic Pickup Voltage	3700 +/- 10	3700	4.5 volts +/- 0.5 Peak to Peak		New 2.0 QPM Max. ~1.8	
16			375 +/- 10	375	0.4 volts Peak-to-Peak Min.		Repair 2.4 QPM Max. .8	
17		Frequency	3700 +/- 10	3700	925 +/- 3 Counter Reading		4.0	Volts
18	3.12	Electrical Speed Change	3.12.1	3587	3.12.3	3426	925	Hz
19		Electrical Hang-up	3.12.3	3426	3.12.4, 50 +/- 5 RPM		39	RPM
20	3.13	External Leakage	3000 +/- 50	3000	3.12.6	3430	5	RPM
21	3.14	Total Leak	0	0	100 +/- 10	100	0	0
22	3.15	Return Spring Check	0	0	200 +/- 10	200	0.5 QPM Max.	3
					High to Low Speed Stop, Unassisted		Check for Pass	

APPENDIX G

Solenoid Functional Test Results

1 Page



OVERHAUL MANUAL 692545

- A. (5) Install spring washer (7), spring (6), coil assembly (5), nameplate side (4), housing side (3) and cover assembly (2) to body (17) with screws (1x).

7. Fits And Clearances (See Figure 1.)

Table IV. Spring Data

Item No.	Working Length (in.)	Load at Working Length (lb)	Free Length (in.)
6	0.690	0.031 to 0.037	0.830
	0.790	0.09 to 0.11	
11	0.076	0.05 to 0.07	0.125

8. Testing

- A. Use Aircraft Fuel Systems Calibrating Fluid, MIL-PRF-7024, Type 2, for all tests. Conduct all tests at a room temperature between 16 and 27 C (60 and 80 F)
- B. Mount the valve in vertical position with coil assembly (5) facing upward. Check for proper operation of valve when actuated by 16 vdc.
- C. Proceed with tests as outlined in test procedure table and write the results in Table V. Test Procedure.

Table V. Test Procedure

Test	Valve Position	Pressure Applied to	Procedure	Press. (psig)	Requirements	Actual Valve	Accept (✓)
Proof pressure	Open	Inlet	Cap outlet port, maintain press. 3 min.	1500	No external leakage.		N/A
External leakage	Closed	Inlet	Outlet port open, maintain press. 3 min.	0.5 and 1000	No external leakage.		✓
Internal leakage	Closed	Inlet	Outlet port open, maintain press. 3 min.	0.5	Leakage 0.5 cc/hr max	0.05	
Internal leakage	Closed	Inlet	Outlet port open, maintain press. 3 min.	1000	Leakage 1.0 cc/hr max	0.05	

FINDINGS AS RECEIVED 4/4/19 M. SIATNER
EO10893

APPENDIX H

Fuel Manifold and Nozzle Assembly Functional Test Results

1 Page

Honeywell

MAINTENANCE MANUAL
TPE331-10 (REPORT NO. 72-00-27)

SET _____

DATE _____

P/N _____

OPERATOR _____

PRIMARY NOZZLE

ATOMIZER NUMBER	TEST PRESS PSIG	FLOW DISTRIBUTION		RELATIVE QUANTITY (DIFFERENTIAL)	SPRAY CHARACTER- ISTICS
		INITIAL C. C.	FINAL C. C.		
1	100 ±2	-2	900	898902	STKS
2		0	953	953	
3		10	915	905	↓
4		15	970	955	L STKS
5		7	950	943	STKS
6		3	900	897	↓
7		12	960	948	
8		0	962	962	
9		-2	958	960	
10		6	968	962	↓
TOTAL FLOW PPH =		56.7			

Leak E-7
Primary

*PERCENTAGE DIFFERENTIAL 6.76 %
(12% MAXIMUM)

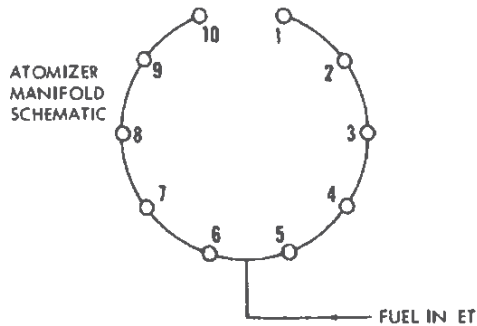
FLOW LIMITS 57.5 ± 4.5 PPH

SECONDARY NOZZLE

ATOMIZER NUMBER	TEST PRESS PSIG	FLOW DISTRIBUTION		RELATIVE QUANTITY (DIFFERENTIAL)
		INITIAL C. C.	FINAL C. C.	
1	100 ±2	-2	940	947
2		0	929	929
3		10	933	923
4		15	948	933
5		7	952	945
6		3	939	934
7		12	950	938
8		0	940	940
9		-2	932	934
10		6	925	919
TOTAL FLOW PPH =			344.7	

*PERCENTAGE DIFFERENTIAL 2.75 %
(10% MAXIMUM)

FLOW LIMITS 350 ± 18.0 PPH



AFT LOOKING FORWARD

FLOW RATE TESTS

ACCEPT ☒

REJECT ☒

**LEAK CHECK AT
400 PSIG ± 2**

ACCEPT ☒

REJECT ☐

F-44G-923

NOTE: *Percentage differential shall be in accordance with:

$$\text{PERCENTAGE DIFFERENTIAL} = 100 \times \frac{(\text{LARGEST RELATIVE QUANTITY} - \text{SMALLEST RELATIVE QUANTITY})}{\text{LARGEST RELATIVE QUANTITY}}$$

Fuel Manifold and Nozzle Assembly Test Data Sheet
Figure 210

73-10-09

Page 238
Feb 29/00