

Accident / Incident Summary Report



Report No.: 15-078

Lewis Ag Aviation Inc.
Ayres S2R T34 Reg. N524SL
Climax, Georgia
9 July 2015
PT6A-34 Engine
S/N 56452

Written By:

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Investigator
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Date of Issue: 10 May 2016

Distribution: Leah Read (NTSB), Marc Hamilton (TSBC), Raymond Pelletier, Ron Ortuso, Peter Boyd, Chadi Tannous, Craig Huisson, File 15-078

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I ANALYSIS

1.0 ACCIDENT SYNOPSIS

On 9 July 2015, an Ayres Corporation S2R T34 Reg. N524SL, operated by Lewis Ag Aviation Inc. was substantially damaged when it made a forced landing immediately after takeoff from a private airstrip near Climax, Georgia on an aerial application flight. The pilot was not injured. The pilot stated that the takeoff power application and engine readings were normal. Shortly following breaking ground the aircraft "quickly settled to the ground as if the prop quit pulling." After coming to rest in an adjacent cornfield the engine continued to run at full power for about 30-45 seconds before the engine was secured.

2.0 SUMMARY OF FINDINGS

The engine displayed light impact damage. The power section was seized. The gas generator rotor turned freely by hand. The exhaust duct displayed light compressional and torsional deformation. The P3 filter and housing were not received. Otherwise the engine external controls and pneumatic lines were intact

Visual inspection determined that the gas generator section could be functionally tested with a slave power section with the original propeller governor was installed. The first start attempt resulted in a hung start. All pneumatic lines were checked and the P3 filter was checked with no anomalies found. The second start attempt again resulted in a hung start. Installation of a slave fuel control unit resulted in a normal start and test run of the engine. Bench testing of the fuel control showed normal operation, and disassembly and detail inspection showed all the internal components to be in normal condition. The cause of the hung start could not be determined.

Disassembly of the power section showed strong circumferential rubbing, with frictional heat discoloration and material smearing, displayed by the power turbine guide vane ring, the power turbine, and the power turbine shroud due to their making contact under impact loads and engine housing distortion.

There were no indications of any pre-impact operational dysfunction or distress to any of the engine components examined.

3.0 CONCLUSIONS

Functional testing of the engine with a slave power section and fuel control unit replacing the original impact damaged unit showed normal engine operation. Bench testing of the fuel control showed normal operation.

The engine displayed contact signatures to its internal components characteristic of the engine producing power in a high power range at the time of impact.

The engine displayed no indications of any pre-impact anomalies or distress that would have precluded normal engine operation prior to impact.



II FACTUAL INFORMATION

1. INVESTIGATION PARTICIPANTS

The powerplant investigation was performed on 14-15 October 2015 the Pratt & Whitney Canada (P&WC) Service Investigation Facilities at St. Hubert, Quebec, Canada. The following individuals participated in the investigation as representatives of their respective organisations:

Marc Hamilton	Senior Technical Analyst Systems and Engineering Sciences Transportation Safety Board Canada
David Barnard	Engine Controls and Accessories Technical Services P&WC
Thomas Berthe	Service Investigation P&WC

2. ENGINE HISTORY

PT6A-34 S/N 56452

Hours Since New: 27,414

Cycles Since New: Not available

Hours Since Overhaul: 5,981

Cycles Since Overhaul: Not available

The above engine hours are as of the last recorded maintenance for the engine, a 100 hour inspection completed on 18 June 2015 by Southerfield Aviation, Americus, Georgia. At 26,823 total hours the power section was repaired for a propeller strike by Turbines Inc., Terre Haute, Indiana, under W/O No. T5546 dated 30 April 2014. At 25,265 total hours the engine was repaired for foreign object damage by Turbines Inc. under W/O No. T5205 dated 8 February 2012. At 24,451 total hours the accessory gearbox was repaired by Turbines Inc. under W/O No. T4880 dated 15 February 2010. On 2 June 20008 at 23,598 total hours the current fuel control was installed as an overhauled unit. At 21,442 total hours the engine was overhauled by Turbines Inc. under W/O No. T4184 dated 7 July 2005.

The above information is taken from a PDF copy of the engine logbooks provided by Federal Aviation Administration.

Following the incident flight the engine was visually inspected at Southerfield Aviation, Americus, Georgia by Federal Aviation Administration representatives and a P&WC Field Service Representative. This included inspection of the engine external pneumatic lines and inspection of the P3 filter, with no anomalies noted. The P&WC representative stated the P3 filter and housing was removed from the engine by Southerfield personnel to facilitate engine mount clearance during the engine removal, and were not reinstalled prior to engine shipping.

3. **ENGINE EXAMINATION**

All positional references are in relation to view from aft looking forward. Upstream and downstream references are in relation to gas path flow from the compressor inlet to exhaust.

3.1 **External Condition**

The engine was received in a normal shipping container. The engine displayed light impact damage and no fire damage. The engine was placed in a normal disassembly stand for inspection. The power section was seized. The gas generator rotor turned freely by hand.

3.1.1 **External Cases**

Reduction Gearbox: Displayed no damage. The propeller shaft was seized. The reduction gearbox mounted controls and accessories were in place and intact.

Exhaust Duct: Displayed moderate compressional and torsional deformation.

Gas Generator Case: Displayed no apparent impact deformation. The gas generator case mounted controls and accessories were in place and intact.

Accessory Gearbox: Displayed no indications of distress. The accessory gearbox mounted controls and accessories were in place and intact.

Please refer to photos No. 1 through 5.

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Photo No. 1
Engine left hand forward view.



Photo No. 2
Engine left hand aft view.

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Photo No. 3
Engine right hand forward view.



Photo No. 4
Engine right hand aft view.

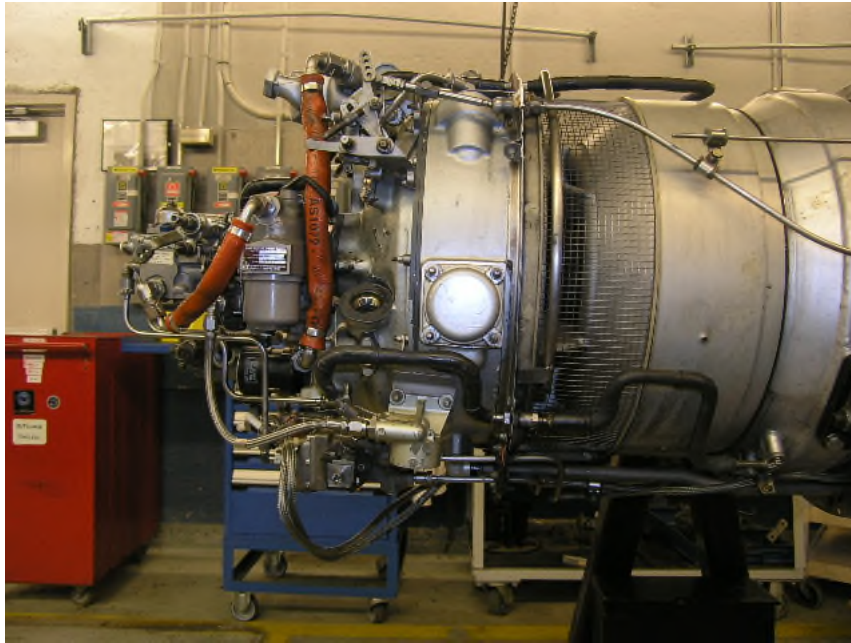


Photo No. 5

Engine accessory section, right hand view.

3.1.2 Power Control and Reversing Linkage

Displayed no distress. All connections and locking devices were intact. Please refer to photos No. 3, 4, and 5.

3.1.3 Pneumatic Lines

Compressor Discharge Air (P3): The P3 filter housing was not received. The P3 filter housing “B” nut fittings’ lock wire was separated. The connections were secure. Please refer to photos No. 5, 6.

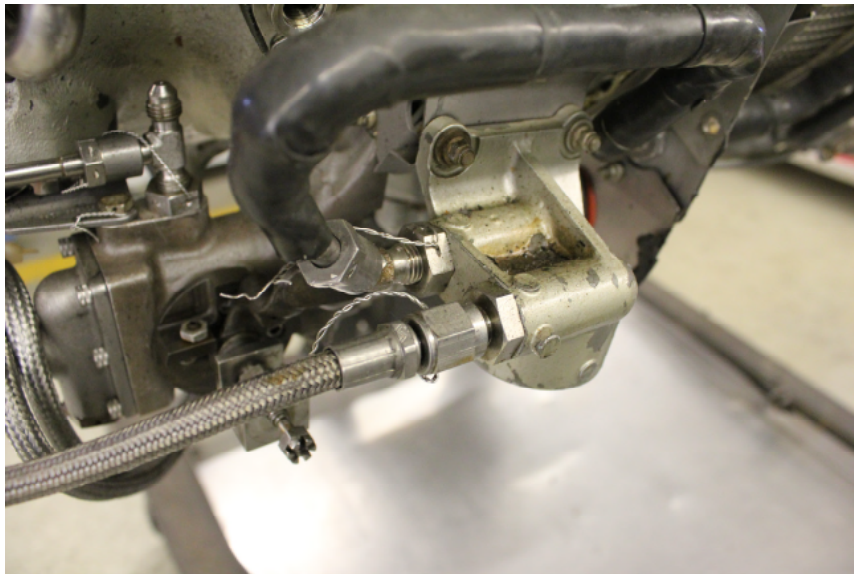


Photo No. 6
P3 filter housing mounting boss.

Power Turbine Control (Py): Displayed no distress. All connections and locking devices were intact. Please refer to photos No. 1, 3, 4, 7 and 8.



Photo No. 7
Propeller governor Py fitting, detail.

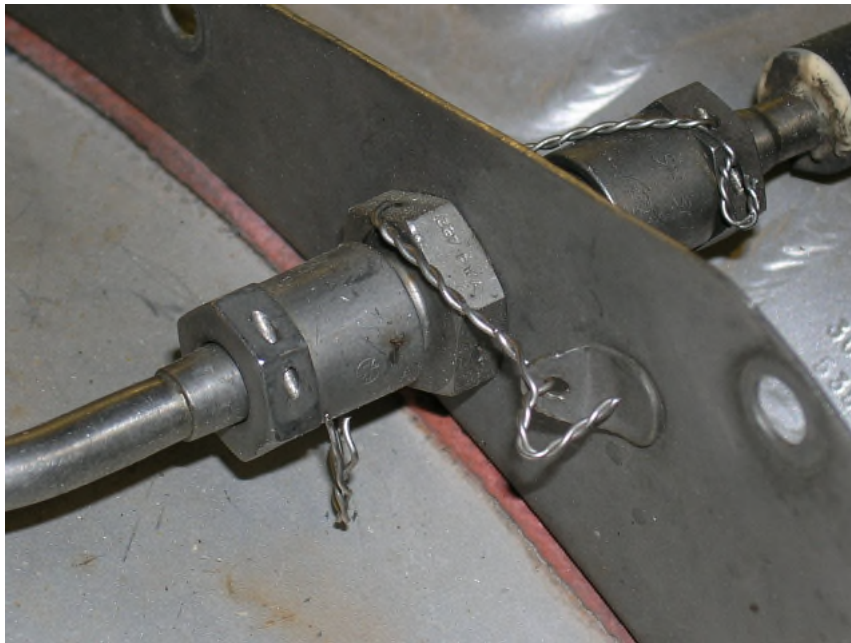


Photo No. 8
Py firewall seal fitting.

3.1.4 Chip Detectors and Filters

Reduction Gearbox Chip Detector: Clean. Please refer to photo No. 9.



Photo No. 9
Reduction gearbox chip detector.

Oil Filter: Clean. Please refer to photo No. 10.



Photo No. 10
Oil filter.

Fuel Filter: Clean. The residual fuel contained in the filter housing was clean. Please refer to photos No. 11 and 12.

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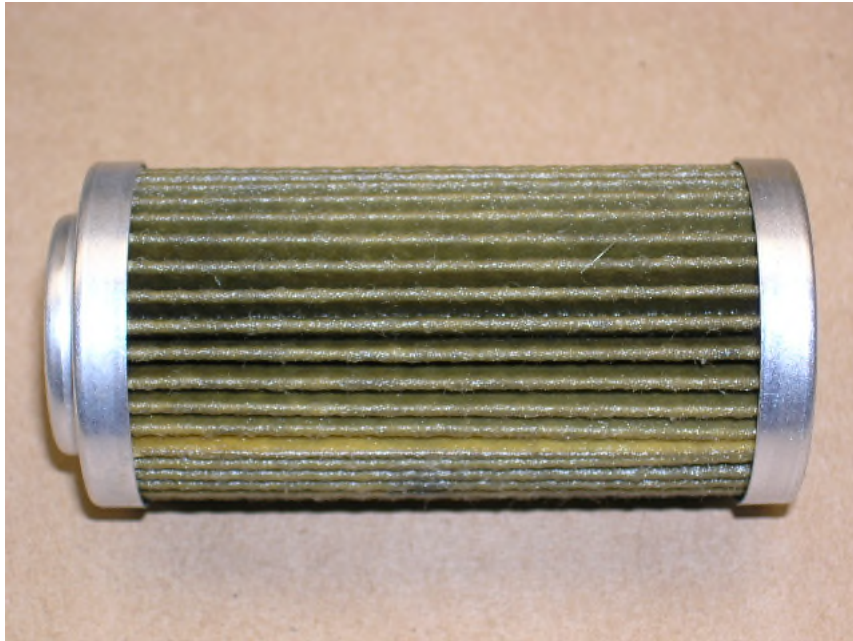


Photo No. 11
Fuel filter.



Photo No. 12
Fuel filter housing and residual fuel.



P3 Filter: The filter and housing were not received.

3.2 **Disassembly Observations**

Following the external inspection, the engine was separated at flange “C” and visual inspection of the compressor inlet and gas generator case interior determined that the gas generator section could be functionally tested with a slave power section. The propeller governor Py line connection was not disturbed in the removal of the power section, and the propeller governor was installed on the slave power section that was subsequently fitted. Please refer to section 3.3 for details of the engine functional test.

3.2.1 **Compressor Section**

The compressor 1st stage was visually inspected in-situ. There were no indications of operational distress. The compressor rotor turned freely by hand, and was continuous with the accessory gearbox. The compressor was not disassembled.

3.2.2 **Combustion Section**

Combustion Chamber Liner: Observed in-situ. Displayed no distress. Please refer to photo No. 13.

Large Exit Duct: Not accessed.

Small Exit Duct: Not accessed.

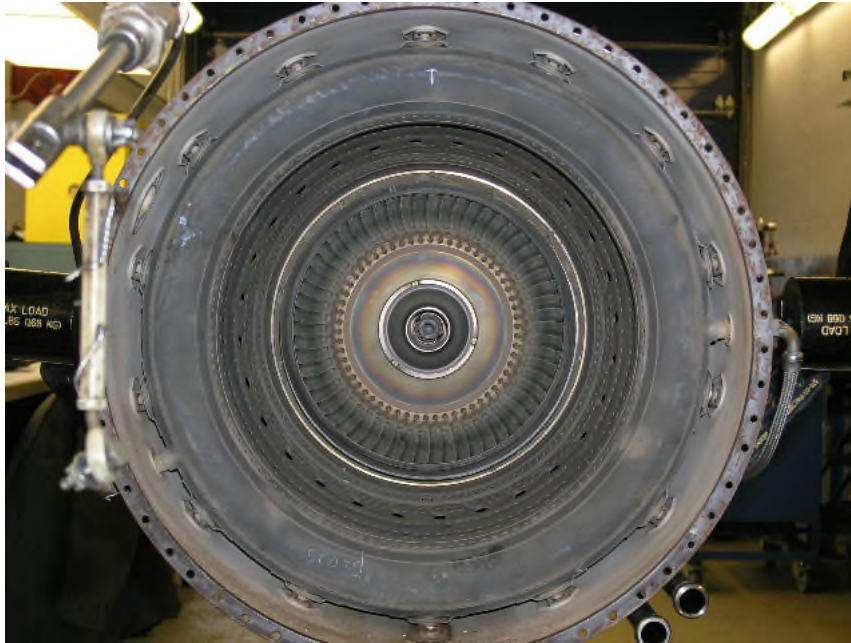


Photo No. 13

Gas generator case interior, combustion chamber liner and compressor turbine, in-situ.

3.2.3 Turbine Section

Compressor Turbine Guide Vane Ring: Observed in-situ, displayed no distress.

Compressor Turbine Shroud: Observed in-situ, displayed no distress. Please refer to photo No. 14.

Compressor Turbine: Observed in-situ. The disc and blade airfoils displayed no indications of distress. Please refer to photo No. 14.

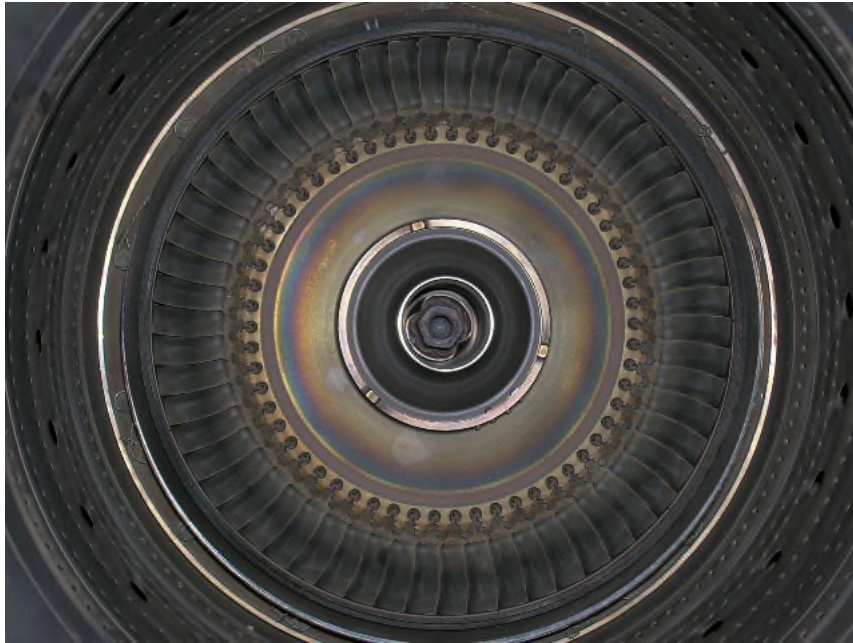


Photo No. 14
Compressor turbine, in-situ.

ITT Probes, Busbar, and Harness: Displayed no indications of distress.

Power Turbine Housing: Displayed no indications of distress.

Power Turbine Guide Vane Ring and Interstage Baffle: The vane airfoils were intact. The upstream side vane ring inner drum and interstage baffle face displayed no distress. The downstream side outer drum, inner drum, and baffle displayed circumferential rubbing, with frictional heat discoloration and material smearing, due to contact with the power turbine. Please refer to photos No. 15 through 17.



Photo No. 15

Power turbine guide vane ring and interstage baffle, upstream side.



Photo No. 16

Power turbine guide vane ring and interstage baffle, downstream side.



Photo No. 17

Power turbine guide vane ring and interstage baffle, downstream side.

Power Turbine Shroud: Displayed heavy circumferential rubbing, with strong frictional heat discoloration and material smearing, due to contact with the power turbine blade tips. Please refer to photo No. 18.



Photo No. 18

Power turbine shroud, detail.

Power Turbine: The upstream side blade platforms, blade tip leading edges, and the disc hub displayed circumferential rubbing due to contact with the power turbine guide vane ring. The blade tips displayed circumferential rubbing, with frictional heat discoloration and material smearing, due to contact with the power turbine shroud. Please refer to photos No. 19 through 22.



Photo No. 19
Power turbine, upstream side.



Photo No. 20
Power turbine upstream side, detail.

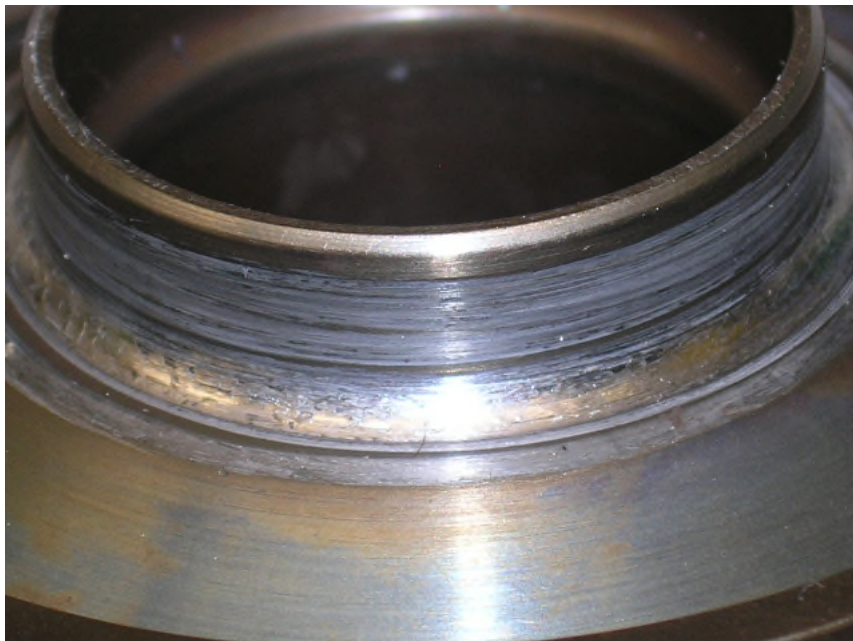


Photo No. 21
Power turbine upstream side hub, detail.

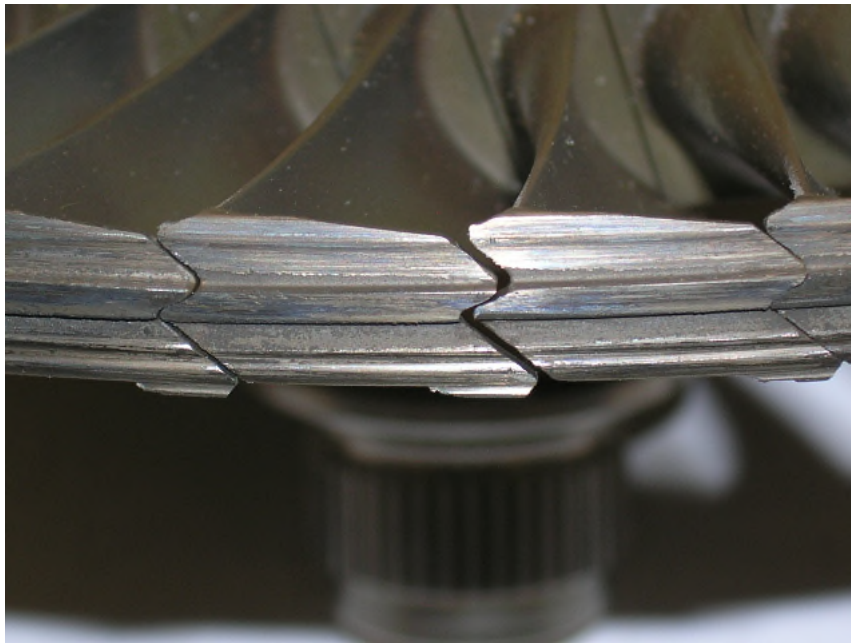


Photo No. 22
Power turbine blade tips.

3.2.4 Reduction Gearbox

The reduction gearbox 1st and 2nd stage gearing displayed no indications of operational distress. Please refer to photos No. 23 and 24.

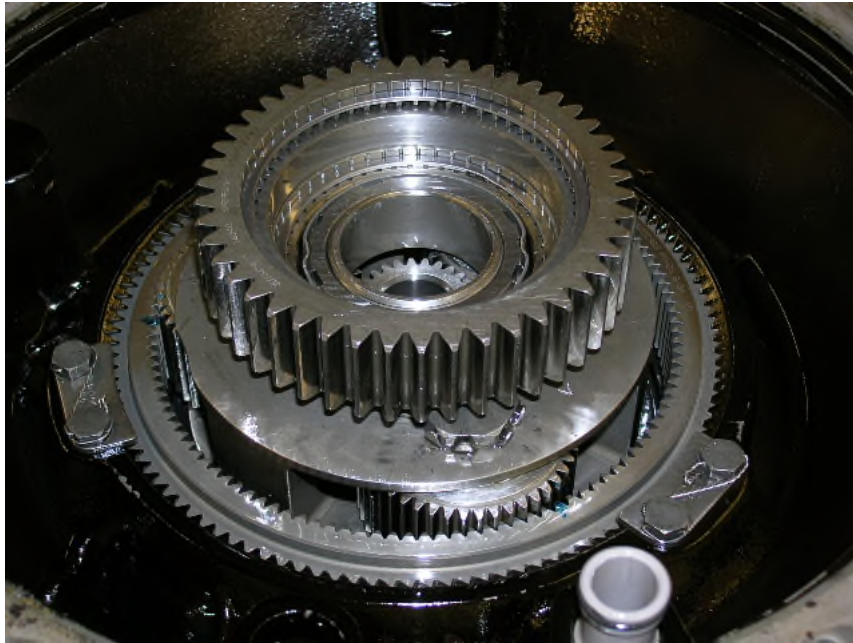


Photo No. 23
Reduction gearbox 1st stage gearing.

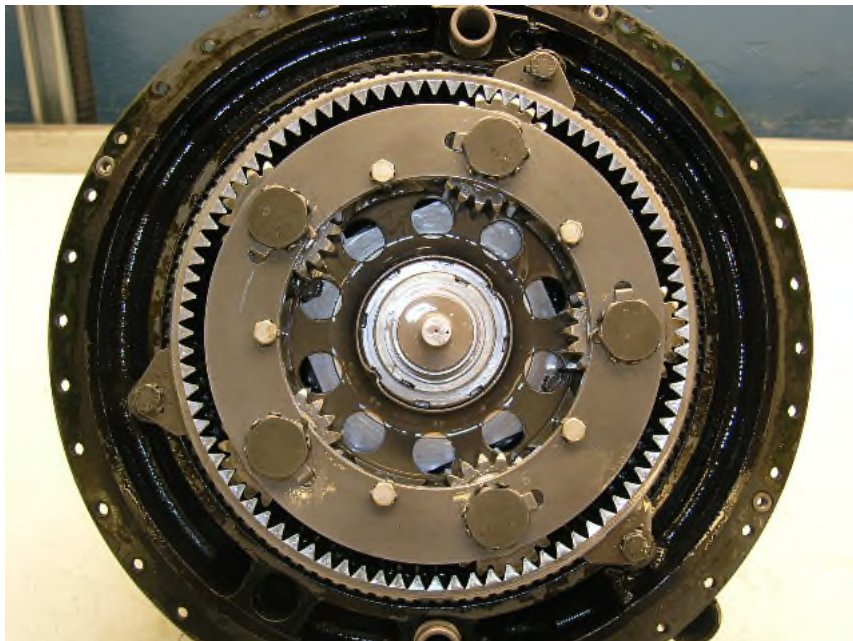


Photo No. 24
Reduction gearbox 2nd stage gearing.

3.2.5 Accessory Gearbox

The accessory gearing rotated freely by hand, and was continuous with all accessory drives. The accessory gearbox was not disassembled.

3.3 Controls and Accessories Evaluation

The engine functional test was conducted with a slave power section, using the original propeller governor assembly, and a slave P3 filter and housing, in a dynamometer test cell in accordance with P&WC Overhaul Manual P/N 3021243 Section 72-00-00 "Engine Testing" procedures. Details of the test are provided in reference (A) P&WC Log of Engine Test, W/O 188032, dated 14 October 2015.

The first start attempt resulted in a hung start. All pneumatic lines were checked and the P3 filter was checked with no anomalies found. The second start attempt again resulted in a hung start.

Installation of a slave fuel control unit resulted in a normal start and test run of the engine. The removed fuel control unit was retained for investigation.

3.3.2 Fuel System

Fuel Heater: Engine test cell run confirmed satisfactory operation.

Fuel Pump: Engine test cell run confirmed satisfactory operation.

Fuel Control Unit: P/N 2524440-7-6 S/N 2524440-7-6. Prior to functional testing the air adapter was removed to permit inspection of the Py orifice and Py bleed, and the P3 inlet elbow was removed to inspect the Px orifice. Oil contamination was evident at the air adapter gasket, but there was no contamination in the orifices or bleed. With the unit installed on the test stand, air was applied to the pneumatic system and a leak-test solution was applied to the flanges and joints to check for leaks. Slow bubbling, within inspection limits, was observed at the air adapter gasket. No other leaks were observed. The unit was tested in accordance with normal functional test protocol with no anomalies noted that would preclude normal unit operation and full fuel flow availability. The functional test included operation at a fixed speed, fixed throttle lever position and fixed P3 air steady state condition for 10 minutes while the fuel outlet flow was monitored for any variations which would indicate deterioration of the pneumatic bellows. No fuel flow variation was observed during the monitoring period. Following functional test the unit was disassembled and detailed inspected. The components displayed normal running wear, with no anomalies that would preclude normal operation. Please refer to photos No. 25 through 29.

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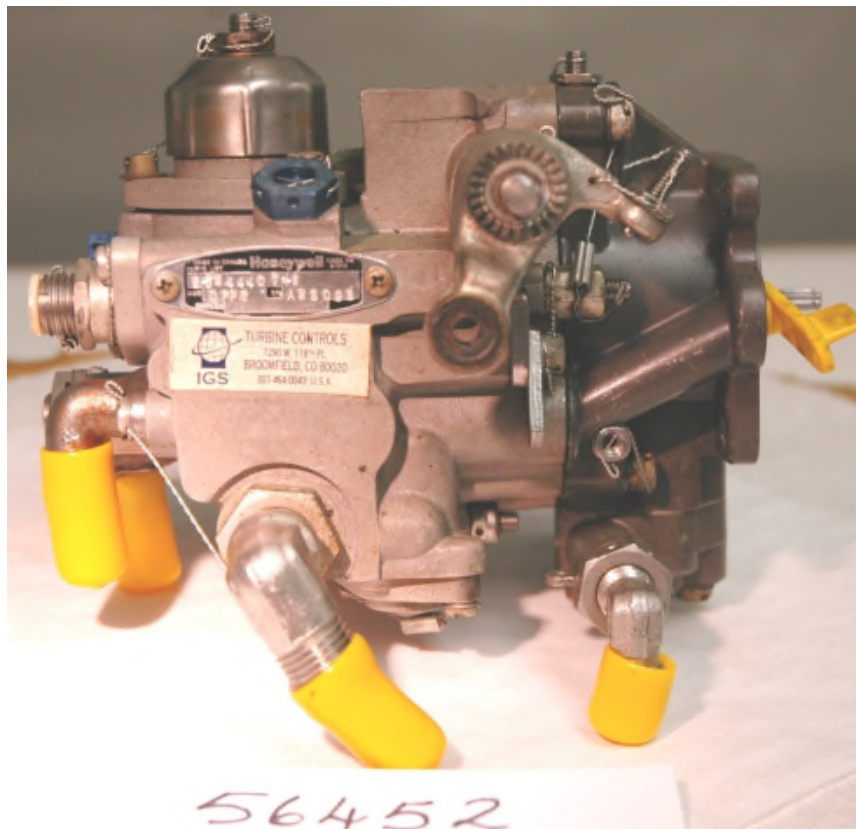


Photo No. 25
Fuel control unit as removed.

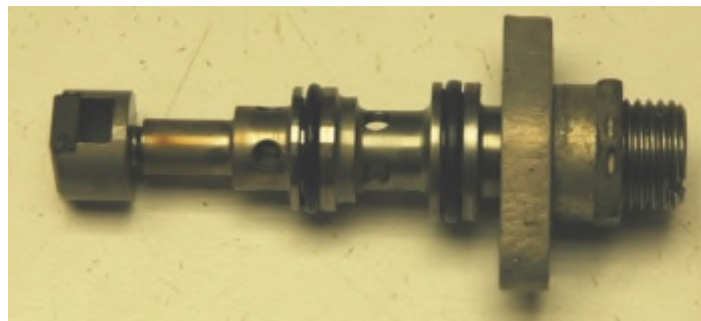


Photo No. 26
Fuel control unit metering valve.

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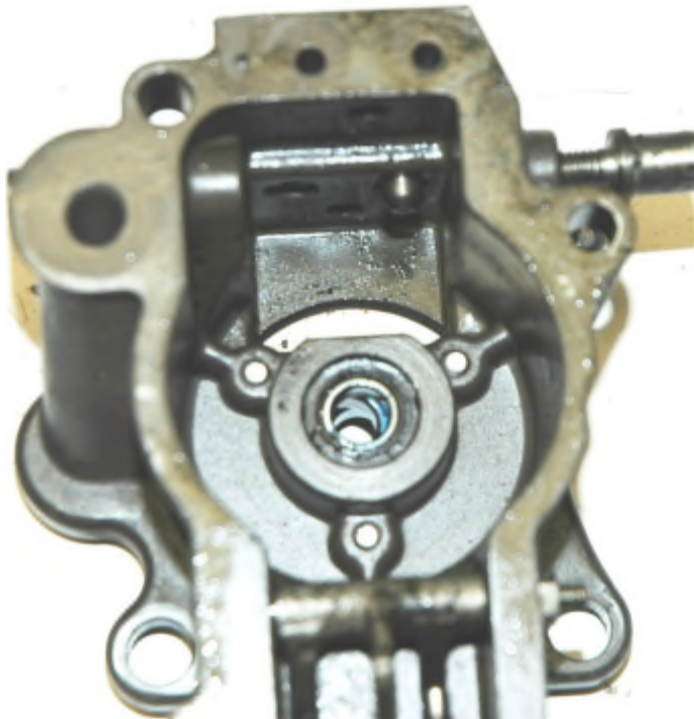


Photo No. 27
Fuel control unit drive body interior.



Photo No.28
Fuel control unit flow body.



Photo No. 29

Fuel control unit as disassembled.

Flow Divider: Engine test cell run confirmed satisfactory operation.

Fuel Nozzles: Engine test cell run confirmed satisfactory operation.

3.3.3 Air System:

Compressor Bleed Valve: Engine test cell run confirmed satisfactory operation.

3.3.4 Oil System:

Propeller Governor: P/N 8210-002-01, S/N 11933427. The engine test cell run confirmed satisfactory operation. The unit was partially disassembled in order to check for contamination in the pneumatic section or obstruction of the Py flapper. There was no debris in the pneumatic section, the Py bleed, or in the ball-head cavity. A small piece of metallic debris was present on the underside of the flyweight table. There was no obstruction at the Py flapper. There were no scars on the ball-head cavity. The ball-head was complete and the weights fell evenly and freely. Please refer to photos No. 30 through 33.



Photo No. 30
Propeller governor as removed.

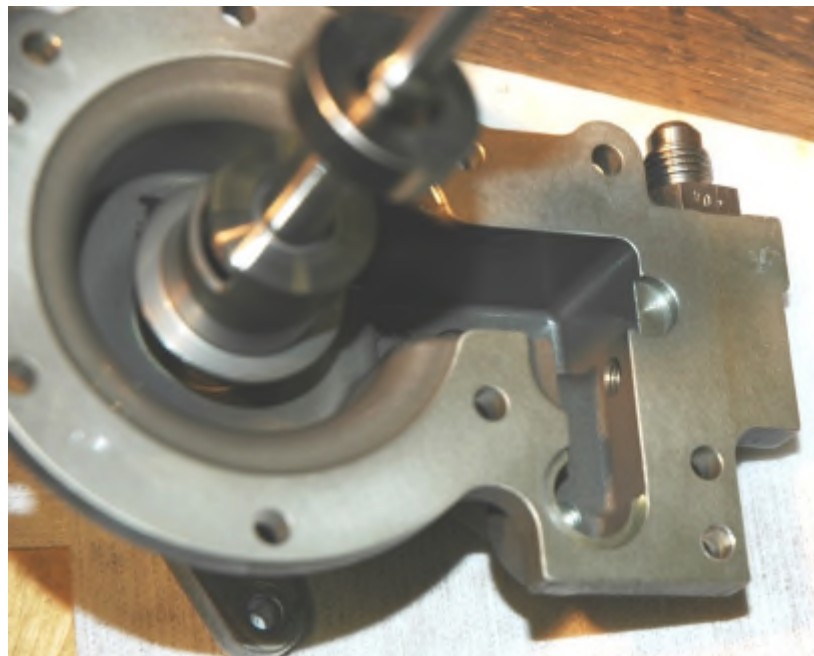


Photo No. 31
Propeller governor cover interior

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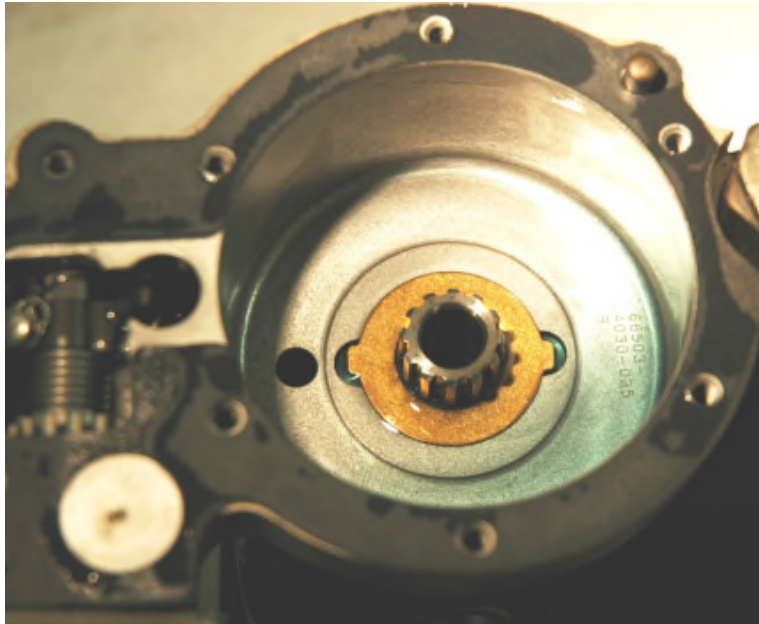


Photo No. 32
Propeller governor ball-head cavity.

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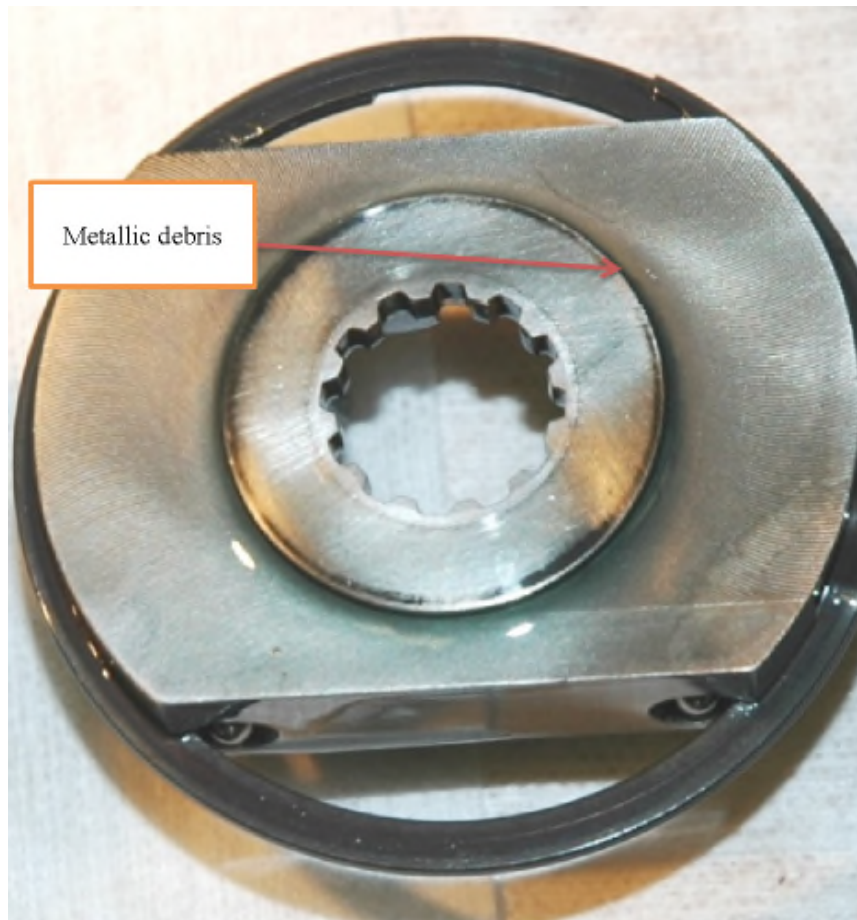


Photo No. 33

Propeller governor flyweight table.

Overspeed Governor: P/N A210507W S/N 1297984. Functional testing in accordance with normal test protocol was satisfactory, with minor variations not affecting normal operation. Please refer to photo No. 34.

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Photo No. 34
Propeller overspeed governor, as received.

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4. REFERENCES

- (A) P&WC Log of Engine Test, W/O 188032, dated 14 October 2015.

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ECL: ZK03 ECCN: N/A PECCN: 9E991 USML: N/A PUSML: N/A

Pratt & Whitney Canada G.G S/N: 56452 Fuel Type: JET A-1 Test Type: REPAIR CT Vane: U/K Page: 1 OF 2
LOG OF ENGINE TEST G.G W/O: 188032 Fuel LHV: 18586 BTUs/Lb Test Nature: AS RECEIVED PT Vane: U/K Date: 14-OCT-2015
Testcell: 0502 P.S S/N: SC-34-1 Fuel SG: 0.797 @ 64.6 Degf Cavity: U/K
Customer: PWC INVESTIGATION P.S W/O: 188032 Fuel Tank: 517 RGB Vib: 2028323 RGB Sen: 0.326
Eng. Mod.: PT6A-34 Build: 2 Oil Type: BP2380 AGB Vib: 2086280 AGB Sen: 0.303
OHM Rev: U/K Build Spc: U/K

TIME	HG.BARO	V.RGB G	NG	T1 F	FF 1	NG.COR	T1 F	T5 F	Plen PSI	HG P3	.
COND	HG.TQ	SHF.CORR	NP	T7 F	FF10	WF1.DC	FF PSI	PLA	Prop PSI	RATIO	
		PT6AGB1E	MOT	MOP	BOT	SCF			AGB.ST		
16:56:19	ALARM LIMITS SET FOR MODEL: PT6A-34.										
16:56:19	OVERSPEED: NG=102.0%, NF=105.0%										
16:56:19	OVERTORQUE TRIP SETTING: 134.0 "HG.										
16:56:51	ENGINE DRESSED & INSTALLED ON BED (OIL LEVEL AT MAX)										
16:56:56	ENGINE & TEST-CELL AREA CLEANED FOR F.O.D PREVENTION										
16:58:01	29.621	3.3	7808	60.7	136	7795	66.7	67	0.11	0.1	
	1.28	0	1763	65	137	85	22.0	1.0	-6		
		0.03	69	60.6	67	6.8			1.711		
16:58:07	WET MC'S C/OUT										
16:59:45	DRY MC'S C/OUT										
17:00:27	TRIM STICK CL 20 ALREADY INSTALLED										
17:04:52	ENGINE STARTED.										
17:05:25	**** TTI EXCEEDED 35 SECONDS!!										
17:05:25	TTL = 7.0 SEC. TTI = 42.0 SEC. MAXT5 = 919.4 DEGF.										
17:05:30	ENGINE STOPPED.										
17:05:56	RDT NG = 29.0 SEC. RDT NF = 20.0 SEC.										
17:05:56	<< ENSURE RDT IS WITHIN LIMITS >>										
17:10:25	UNABLE TO REACH GROUND IDLE										
17:11:03	ALL P3 LINE CHECK, FOUND ACCEPTABLE										
17:11:50	TRANSIENT T, condition number 0001 starting. (MAX recording time: 00:12:17)										
17:12:02	ENGINE STARTED.										
17:12:35	ENGINE STOPPED.										
17:12:35	**** TTI EXCEEDED 35 SECONDS!!										
17:12:35	TTL = 5.3 SEC. TTI = 40.3 SEC. MAXT5 = 923.9 DEGF.										
17:12:52	Transient T, condition number 0001 Completed										
17:13:01	RDT NG = 26.0 SEC. RDT NF = 18.0 SEC.										
17:13:01	<< ENSURE RDT IS WITHIN LIMITS >>										
17:13:25	UNABLE TO REACH GROUND IDLE AGAIN										
17:30:31	ORIGINAL FCU S/N:A25098 REMOVED										
17:30:53	SLAVE FCU S/N:20 INSTALLED										
17:32:27	ENGINE STARTED.										
17:32:42	TTL = 4.7 SEC. TTI = 21.7 SEC. MAXT5 = 1012.5 DEGF.										
17:32:49	===== GROUND IDLE =====										
17:33:08	29.630	0.0	21161	56.1	114	21220	67.6	883	0.11	0.0	
	12.36	39	16254	763	114	112	21.3	20.6	363		
		0.13	76	106.2	86	19.1			1.831		

THIS SHEET R.T.: 0:01:52

TOTAL R.T.: 0:01:53

Operator

Inspector

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ECL: 2X03 ECCN: N/A PECCN: 9E991 USML: N/A PUSML: N/A

Pratt & Whitney Canada G.C S/N: 56452 Fuel Type: JET A-1 Test Type: REPAIR CT Vane: U/K Page: 2 OF 2
 LOG OF ENGINE TEST G.O W/O: 188032 Fuel LHV : 18586 BTUs/Lb Test Nature: AS RECEIVED PT Vane: U/K Date: 14-OCT-2015
 Testcell: 0502 P.S S/N: SC-34-1 Fuel SG: 0.797 @ 64.9 DegF Cavity: U/K
 Customer : PWC INVESTIGATION P.S W/O: 188032 Fuel Tank: 517 RGB Vib: 2028323 RGB Sen: 0.326
 Eng. Mod.: PT6A-34 Build: 2 Oil Type: BP2380 AGB Vib: 2086280 AGB Sen: 0.303
 OHM Rev: U/K Build Spc: U/K

TIME	HG.BARO	V.RGB G	NG	T1 F	FF 1	NG.COR	TF1 F	T5 F	Plan PSI	HC P3	
COND	HG.TQ	SHP.CORR	NF	T7 F	FF10	WF1.DC	FF PSI	PLA	Prop PSI	RATIO	
		PT6AGB1E	MOT	MOP	SOT	SOP			AGB.ST		
17:33:48	***** OIL WARM-UP *****										
17:37:09	INCREASE TO MAX POWER										
17:39:40	29.635	0.0	37106	53.9	462	37289	78.6	1332	0.09	0.0	
	127.24	798	32575	1113	462	464	15.6	68.6	371		
		0.20	151	98.3	173	36.2			2.385		
17:40:23	***** GROUND IDLE *****										
17:40:37	29.636	0.0	19781	55.9	97	19841	77.3	900	0.08	0.0	
	11.55	31	13830	875	97	97	21.4	17.9	335		
		0.12	141	95.5	155	19.7			1.892		
17:44:46	ENGINE STOPPED.										
17:46:12	RDT-NG = 0.0 SEC. RDT-NP = 0.0 SEC.										
17:46:12	<< ENSURE RDT IS WITHIN LIMITS >>										
17:46:13	RDT NORMAL										
17:46:20	END OF TEST										

THIS SHEET R.T.: 0:11:36

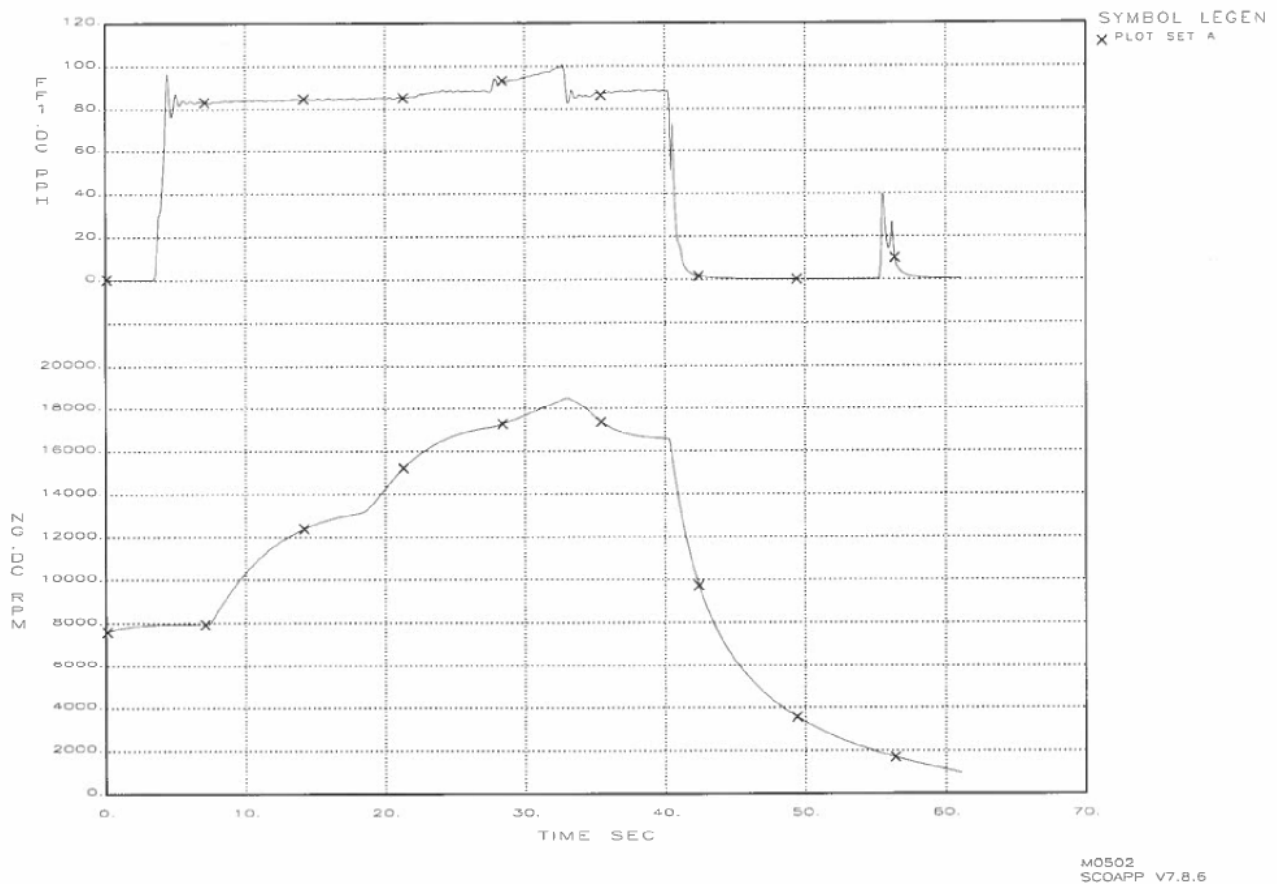
Operator SC W16g

TOTAL R.T.: 0:13:31

Inspector SC

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RDG 0001 056452 002 TC0502 14-OCT-15 17:11 S: 10

P&WC Log of Engine Test, W/O 188032, dated 14 October 2015, Page 3.