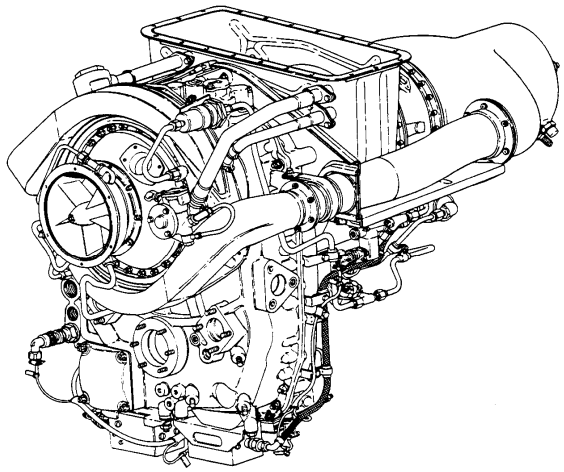
Rolls-Royce

Engine Investigation

Rolls-Royce Corporation
Model 250-C30
Engine CAE 900098

MD 369FF
Registration: N530RL



Pima County Sheriff's Department
Tucson, Arizona

David W. Riser

David W. Riser
Air Safety Investigator

Accident date: January 31, 2011
Investigation date: February 3-7, 2011
Report date: February 25, 2011

Report Enclosures:

Report Narrative

Appendix A, Photographs at Air Transport, Phoenix, Arizona

Appendix B, Engine Run Data

Appendix C, Engine Records

Background Information:

On January 31, 2011 at approximately 11:19 am local time, an MD 369FF helicopter, N530RL was involved in an accident. The helicopter was owned and operated by the Pima County Arizona Sheriff's Department. The weather conditions were reported to be VFR with an approximate temperature of 50 F. The helicopter was operating in mountainous terrain at an elevation of approximately 3550 feet MSL on a survey mission for tower locations. The helicopter was in the process of a pinnacle landing, when for unknown reasons the helicopter crashed. The helicopter was occupied by the pilot, a right front seat passenger and two rear seat passengers. The pilot sustained fatal injuries. The right front seat passenger sustained serious injuries. The left rear passenger sustained minor injuries and the right rear seat passenger was uninjured.

Airframe observations:

The author did not view the wreckage on site but was shown and provided photos of the accident scene. The author did examine the wreckage at the recovery location in Phoenix, Arizona. The airframe had received extensive overall crush damage resultant from rolling downhill with the most prevalent damage appearing on the nose of the aircraft in front of the left front seat position. Both left and right landing skids had been torn from the airframe. (Fig 1) All five main rotor blades had separated from the rotor head at or near the blade roots. Fractures were noted at each grip on the main rotor head with tearing and separation of the blades strap packs. (Fig 2) The tail boom had separated just forward of the vertical stabilizer with the tail rotor gear box remaining attached the tail boom. Both tail rotor blades exhibited rotational impact damage but remained attached to the gearbox. (Fig 3) The tail rotor drive shaft separated in overload forward of the tail rotor gearbox with circumferential scoring noted at various locations along the shafts length. (Fig 4)

Engine Observations:

An Allison Engine Company M250-C30 gas turbine engine, S/N CAE 900098, powered the helicopter. Initial inspection revealed the engine to have remained securely attached to the airframe. All mounting arms remained in position and exhibited no visible damage. (Fig 5) An Intec inlet barrier filter was incorporated in this application. (Fig 6) Upon removal of the engine from the airframe, the compressor module and turbine module were in position and exhibited no visible damage. (Fig 7) The accessory gearbox and exhaust collector support were also in position and displayed no visible damage. (Fig 8) The outer combustion case exhibited crush damage on the right shoulder area with additional denting to the dome area from the exhaust stack being forced down and into the dome. The right side compressor air discharge tube exhibited impact damage on the outboard side mid length with additional crush damage at and just forward of the outer combustion case mounting flange. (Fig 9) Engine accessories consisting of the fuel pump, compressor bleed

valve, fuel control unit, power turbine governor and fuel nozzle were all in position and displayed no visible damage. (Fig 10) Manual operation of the fuel control throttle arm and the power turbine governor arm resulted in smooth operation from stop to stop.

Engine Information:

The engine was installed on the accident airframe November 14, 2006 with 3478.4 hours engine TT. No recent major maintenance or component change was reflected in engine log books.

Manufacturer	Allison Engine Company
Engine Model	250-C30
Rating:	650 Shaft Horsepower
Serial Number	CAE900098
Engine Total Hours	3991.0
Last 150-Hour Inspection	April 13, 2010 @ 3881.9 engine TT

Component	Serial Number	Part Number	TSO	Total Time
Engine	CAE900098	23009300	New	3991.0
Gearbox	CAG90067S	23035179	512.6	3951.0
Compressor	CAC91258	23033193	512.6	3991.0
Turbine	CAT90677	23033195	512.6	5709.1
Fuel Control	330294	23065125	1323.1	Unknown
Governor	30424	23065125	512.6	Unknown
Fuel Pump	T300126	6896810	1848.0	Unknown
Fuel Nozzle	AG42359	23077188	512.6	Unknown
Bleed Valve	FF34550	23073359	580.1	Unknown

* All engine and component times were compiled from engine log and status sheet entries.

Engine Investigation:

On February 7, 2011 operational testing and power check of the engine was conducted at AeroMaritime, Mesa, Arizona in accordance with Rolls-Royce M250-C30 overhaul manual. Prior to the test the outer combustion case and the right side compressor air discharge tube were replaced with serviceable OEM parts for testing due to accident damage. (Fig 11) Examination at removal of both air discharge tubes and the outer combustion prior to installation of serviceable OEM parts revealed all components to have been properly positioned and secure. Visual examination into the compressor inlet revealed light scoring at the inducer in the impeller blade path of an approximate

90 degree arc between 3 and 6 o'clock positions, aft looking forward. (Fig 12) Examination of the combustor liner revealed it to be serviceable with no unusual burn patterns or streaking. External examination of the fuel nozzle revealed it to be serviceable with no excessive carbon on outer air shroud. A visual examination into the N1 turbine section through the number 1 turbine nozzle revealed no damage or anomalies. (Fig 13) The engine was then examined thoroughly with no discrepancies noted which would preclude the engine run. The engine was then placed into the test cell where it was motored and with a positive indication of oil pressure the engine started within both time and temperature specifications. During engine warm up at ground idle, vibration scans revealed all components to be within specification. A five point power calibration check was then conducted during which the engine met or exceeded specification at each point. A governor droop check was then conducted where the power turbine governor responded normally and within specification. The engine was then shut down normally with no discrepancies noted.

Summary of Findings:

During operational and performance testing, this engine was found to meet or exceed specification in both horsepower production and specific fuel consumption in accordance with the Rolls-Royce M250-C30 overhaul manual.

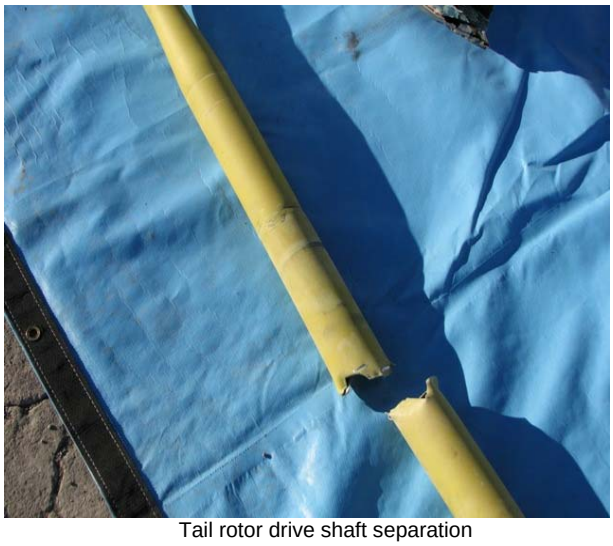
Appendix A,

Photographs at recovery Location

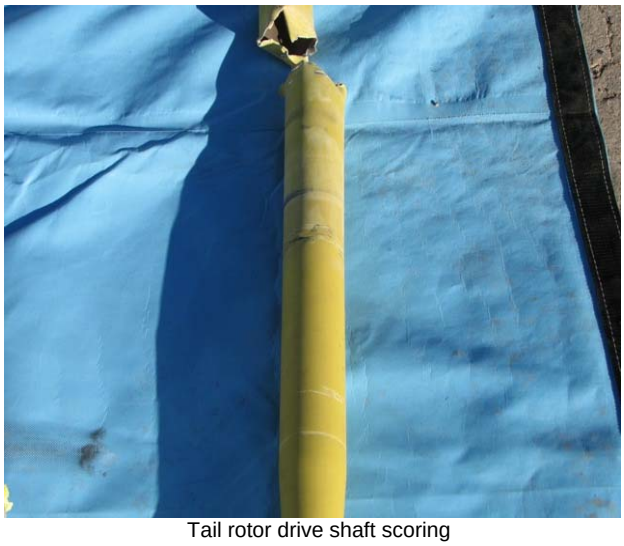
Tai rotor with gear box / tail rotor drive shaft

Tail rotor components

(Return)



Tail rotor drive shaft separation



Tail rotor drive shaft scoring

Inlet barrier filter

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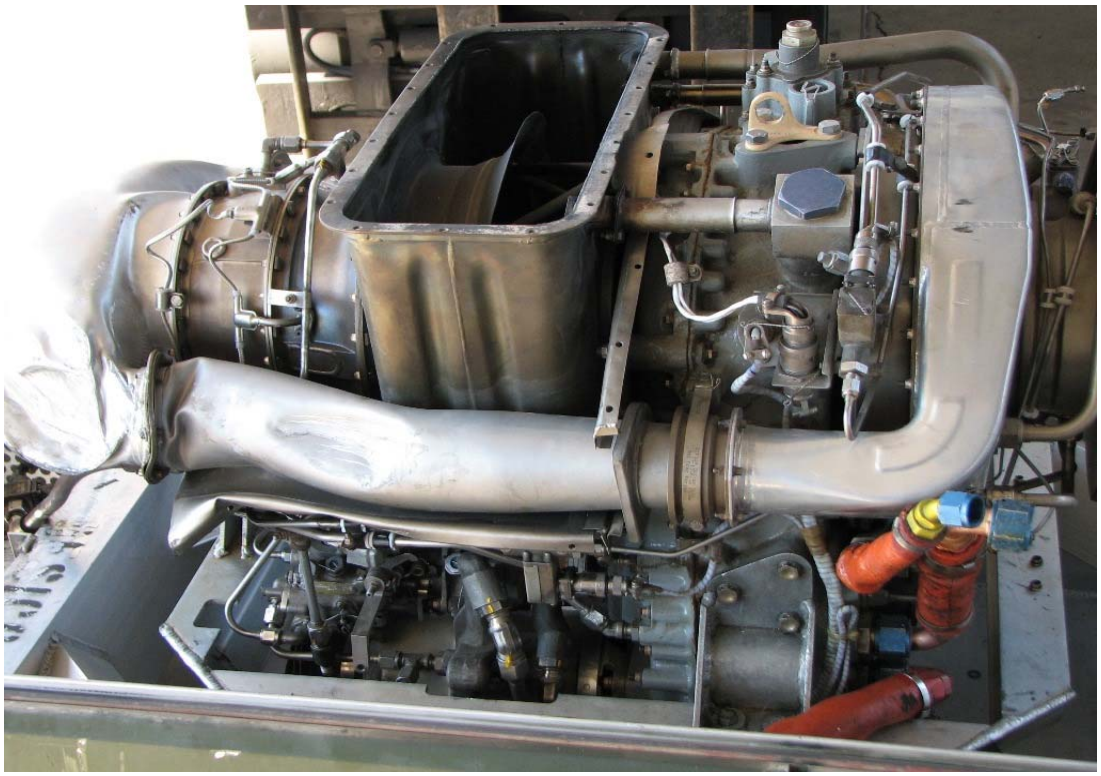

Exhaust collector support and accessory gear box

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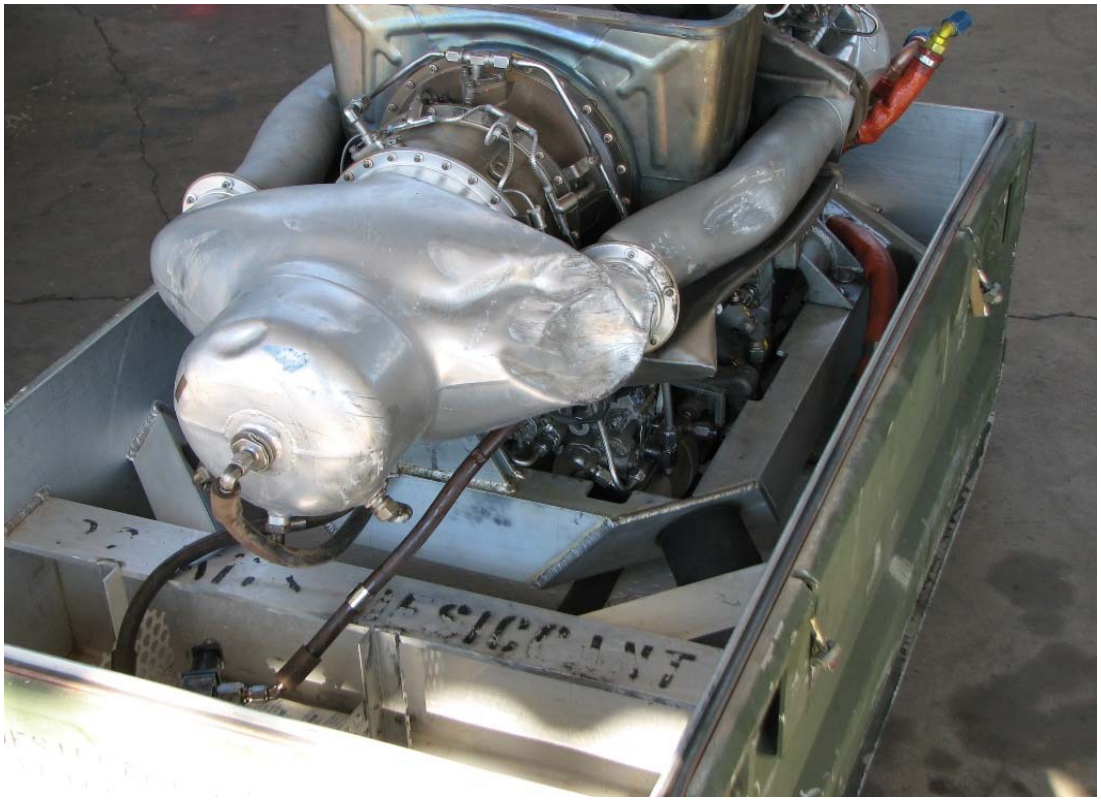


Outer combustion case / right side compressor air discharge tube

Compressor inlet

(Return)

Scoring at tip path

Appendix B,

Engine Run Data

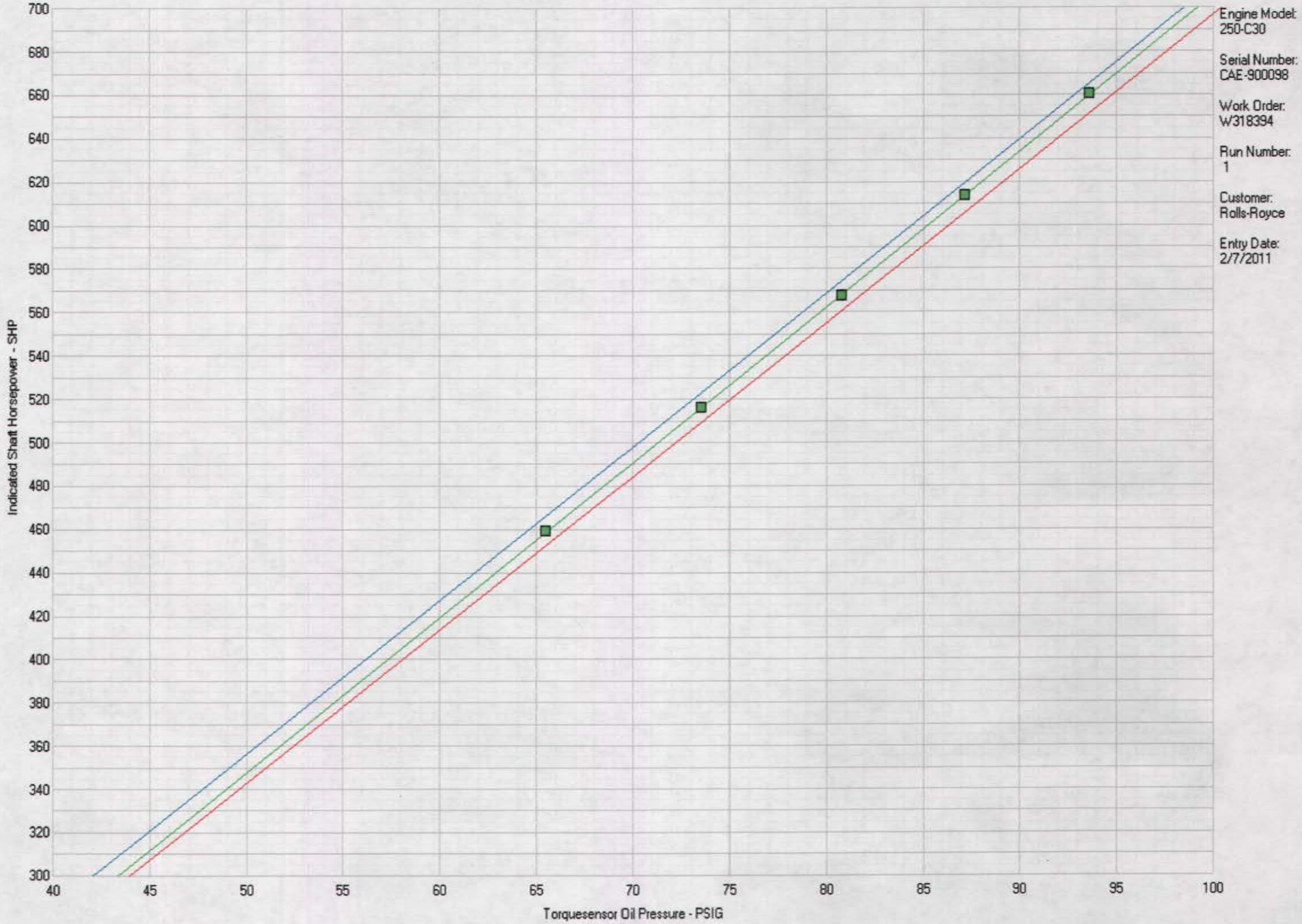
Engine Model	250-C30	Compressor SN	CAC-91258	Accel:	X
Manufacturer	Rolls Royce	Gearbox SN	CAG-900675	BV Chk:	OK
Serial Number	CAE-900098	Turbine SN	CAT-90677	AI Chk:	OK
Work Order	W318394	Fuel Control SN	330294	Preserved:	OK
Entry Date	2/7/2011	Governor SN	30424	Comment:	OK
Customer	Rolls-Royce	Fuel Temp	72	# Starts:	1
Operator : Andrew Wong		SG at Fuel Temp	0.82	Coastdn:	
Assistant : Charlie Hall		LHV (BTU/LB)	18280	Orifice:	AR
Run Number	1	Engine TT	N/K		
Oil Flow in CCs					
Run Comments	Functional test of engine plus five points for power.				

	Cruise C	Cruise B	Cruise A	Normal Cruise	Max Cont	2 ½ Min
SPEC GPTOT	0	0	0	1282	1368	1424
PRED SHP @ SPEC MGT	0	0	0	587	672	724
SPEC SHAFT PWR	334	418	501	557	650	700
% DELTA FROM SPEC PWR	0.0	0.0	0.0	5.3	3.3	3.5
Predicted SFC	0.700	0.643	0.609	0.586	0.572	0.567
SPEC SFC	0.719	0.665	0.624	0.607	0.592	0.588
% DELTA FROM SPEC SFC	-2.7	-3.3	-2.4	-3.4	-3.3	-3.6

Date		2/7/2011	2/7/2011	2/7/2011	2/7/2011	2/7/2011	2/7/2011	2/7/2011	2/7/2011	2/7/2011	2/7/2011	2/7/2011
Time		1:22:43 PM	1:35:09 PM	1:38:03 PM	1:40:30 PM	1:42:59 PM	1:45:37 PM	1:48:33 PM	1:51:28 PM	1:52:06 PM	1:53:01 PM	2:12:16 PM
Setting		Ground Idle	Seal Run In	1st Power Point	2nd Power Poir	3rd Power Poin	4th Power Poin	5th Power Poin	Anti Ice Off	Anti Ice On	Governor Droo	Idle Before Shutdown
Run Time	HH:MM:SS	00:03:40	00:16:06	00:19:00	00:21:28	00:23:56	00:26:34	00:29:30	00:32:25	00:33:03	00:33:58	00:53:13
N1 RPM	RPM	33342	52444	48811	49782	50724	51610	52392	50335	50308	42683	33240
N1 PCT	%	65.4	102.8	95.7	97.6	99.5	101.2	102.7	98.7	98.6	83.7	65.2
N1 RPM Corrected	RPM	0	51863	48226	49208	50139	51062	51824	49685	49694	43522	43522
N2 RPM	RPM	21049	30597	30600	30597	30598	30592	30591	30592	30594	31773	21951
N2 PCT	%	68.7	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	103.7	71.6
Dyno Torque	FT-LBS	38.0	581.1	401.2	451.3	496.3	536.9	577.5	475.7	473.0	128.9	36.0
Dyno Out Temp	°F	62.0	110.0	100.0	107.0	113.0	119.0	123.0	116.0	116.0	88.0	78.0
Dyno RPM	RPM	4141	6018	6019	6018	6018	6018	6018	6018	6018	6250	4320
Dyno HP	HP	29.9	664.5	458.8	516.1	567.5	613.8	660.2	543.9	540.8	153.1	29.5
Engine Torquemeter	PSIG	6.8	94.3	65.5	73.6	80.8	87.2	93.6	77.3	76.8	21.6	5.8
HP Corrected	HP	0.0	688.6	473.6	533.1	587.2	636.2	684.6	561.9	559.1	230.4	230.4
Fuel Temp	°F	72.0	62.0	63.0	63.0	62.0	62.0	62.0	63.0	63.0	64.0	68.0
Wf Observed	PPH	103.1	384.5	287.2	312.6	336.6	359.7	381.8	325.2	328.8	171.0	99.1
Wf Corrected	PPH	0.0	393.3	293.0	319.2	344.0	368.1	390.6	331.7	335.7	172.2	172.2
SFC Corrected	LBS/HP/HR	0.0000	0.5711	0.6186	0.5988	0.5859	0.5785	0.5705	0.5902	0.6004	0.7472	0.7472
CIP	" HGA	28.70	28.72	28.74	28.74	28.72	28.72	28.72	28.72	28.72	28.74	28.74
Exhaust Static Prs	" HGA	28.68	28.74	28.74	28.72	28.72	28.74	28.76	28.72	28.72	28.70	28.70
Baro	" HGA	28.70	28.74	28.74	28.74	28.74	28.74	28.74	28.74	28.74	28.74	28.74
CIT	°F	70.7	70.7	71.7	71.2	71.2	70.2	70.4	72.7	71.9	73.4	71.7
CDT	°F	317.5	660.1	589.5	608.4	627.5	642.6	659.7	621.0	624.4	476.5	319.9
CDP	" Hg	48.6	214.7	178.3	188.4	198.5	206.6	214.7	194.5	192.4	105.3	48.6
GPTOT	°F	985	1426	1219	1272	1323	1373	1420	1302	1322	1082	956
GPTOT Corrected	°F	0	1385	1175	1230	1281	1334	1380	1255	1277	1069	1069
Main Oil Pressure	psig	120.0	125.0	124.0	124.0	125.0	125.0	125.0	124.0	124.0	118.0	97.0
Scavenge Oil Pressure	psig	24.0	34.6	32.3	33.1	33.6	33.7	35.7	32.8	33.5	28.3	22.4
Oil In Temp	°F	115.0	186.0	185.0	188.0	186.0	187.0	185.0	185.0	186.0	186.0	184.0
Oil Out Temp	°F	137	267	257	260	263	266	269	263	263	252	220
Gear Box ST Prs	" H2O	5.30	1.80	3.70	2.70	2.10	2.20	1.70	2.70	2.60	9.10	7.10
Compressor Vibration	IPS	0.17	0.45	0.42	0.51	0.39	0.36	0.39	0.49	0.51	0.17	0.16
Gearbox Vibration	IPS	0.08	0.26	0.22	0.22	0.26	0.26	0.30	0.26	0.25	0.11	0.04
Turbine Vibration	IPS	0.08	0.83	0.52	0.52	0.52	0.56	0.56	0.52	0.56	0.20	0.12
Accel/ Decel Time	Seconds	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Anti Ice Line	°F	80.0	112.0	111.0	112.0	115.0	119.0	118.0	119.0	208.0	215.0	105.0
Comp Seal Vent Press	" Hg	5.1	25.9	17.8	19.0	19.8	20.0	20.0	17.3	17.3	8.2	2.4
Airflow Corrected	PPM	0.00	5.78	5.22	5.38	5.56	5.67	5.80	5.50	5.41	3.84	3.84
Comments 1												
Comments 2												
Comments 3												

AERO MARITIME

Acceptance Signature _____ Rejection Signature _____



Engine Model:
250-C30

Serial Number:
CAE-900098

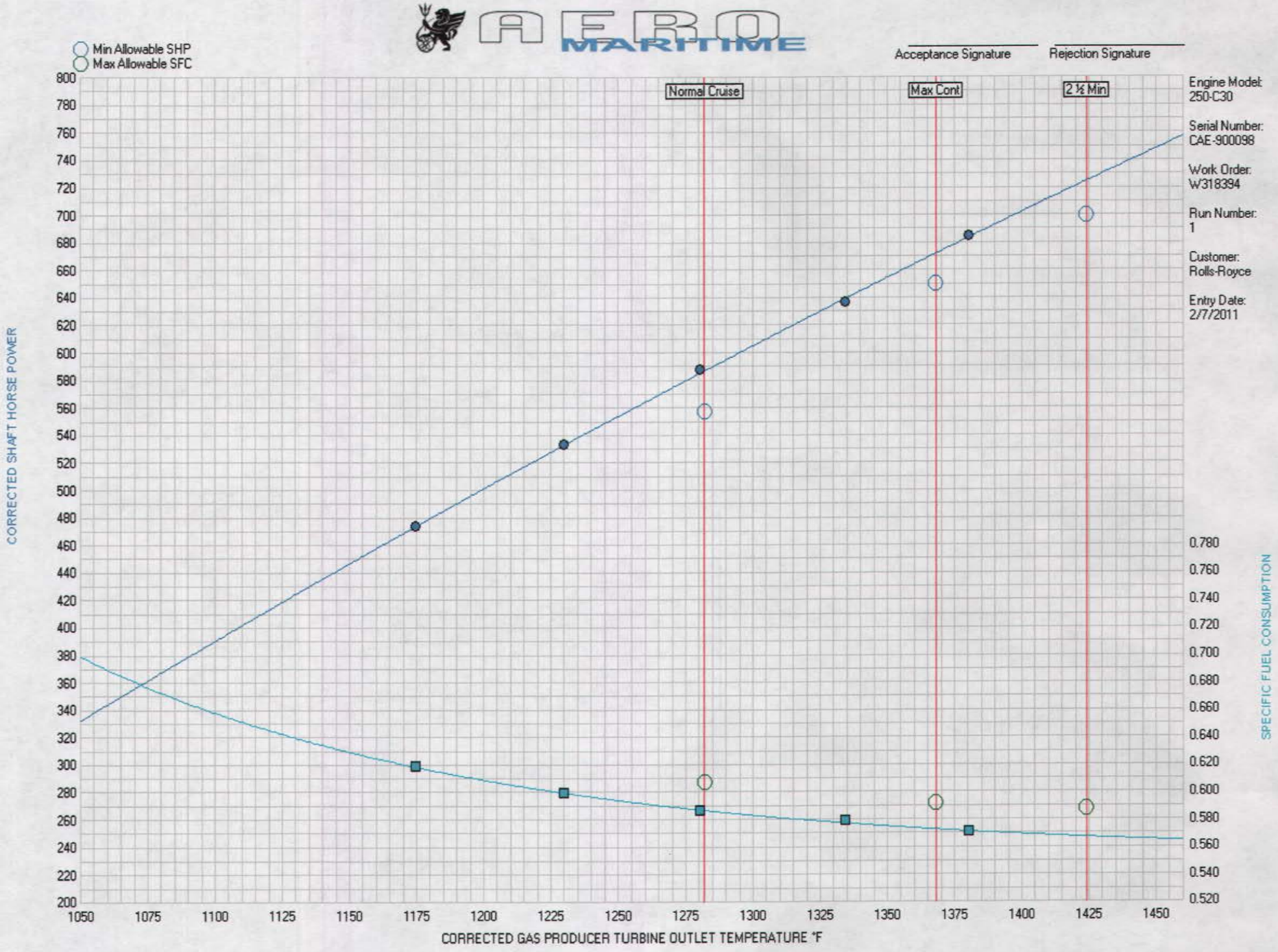
Work Order:
W318394

Run Number:
1

Customer:
Rolls-Royce

Entry Date:
2/7/2011

AeroMaritime America Inc. Repair Station #XZNR915L


AERO MARITIME
Min Allowable SHP
Max Allowable SFC
Acceptance Signature
Rejection Signature
Normal Cruise
Max Cont
2 ½ Min
Engine Model:
250-C30
Serial Number:
CAE-900098
Work Order:
W318394
Run Number:
1
Customer:
Rolls-Royce
Entry Date:
2/7/2011
CORRECTED SHAFT HORSE POWER
SPECIFIC FUEL CONSUMPTION
CORRECTED GAS PRODUCER TURBINE OUTLET TEMPERATURE °F
AeroMaritime America Inc. Repair Station #XZNR915L