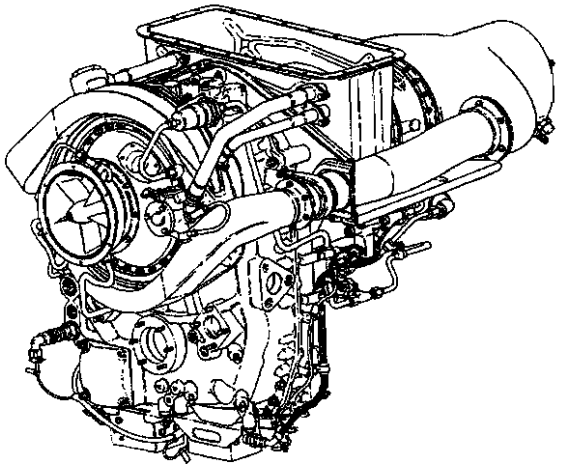
Rolls-Royce

Accident investigation (Engine Report)

Rolls-Royce Engine
Model 250-C47B
S/N CAE 847542



Med-Trans Corporation
Newberry, South Carolina

John J. Swift

John J. Swift
Accident Investigator

Accident date: July 13, 2004
Investigation Dates: July 13-16, 2004
Report date: October 29, 2004

2.11 Engine Information and Examination.

Manufacturer	Rolls-Royce Corporation
Engine Model	250-C47B
Rating:	650 Shaft Horsepower
Serial Number	CAE 847542
Engine Total Hours	710.3 Hours
Engine Total Cycles	1643

Engine Component Data

Component	Serial Number	Part Number	TSO	Total Time
Engine	CAE847542	23063392	New	710.3
Gearbox	CAG47542	23063393	New	710.3
Compressor	CAC45066	23065593	New	710.3
Turbine	CAT44786	23063354	New	710.3
HMU	JGALM0771	23072731	New	710.3
ECU	JG9ALK0570	23072790	New	710.3
Fuel Nozzle	1PS10531	6899001	New	710.3
Bleed Valve	FF59471	23005366	New	710.3

The following items were noted during the on-site inspection of the engine:

- Post impact fire either consumed or extensively damaged the cockpit, cabin and aft fuselage areas

- The engine compartment was extensively damaged with crushing/bending deformation noted on the engine deck, forward firewall and aft firewall. The side access doors and cowlings were not in place

- All engine mounts were bent and detached from their fuselage mounting points

- The engine electrical harness and all electrical wiring were consumed by fire

- The left and right compressor air discharge tubes were dented and crushed

- The exhaust collector showed crushing deformation on the right side

- The outer combustion case (OCC) was dented and deformed

- The accessory gearbox was entirely consumed by fire. All gears and bearings within the accessory gearbox were intact, but fire-damaged.

- The compressor remained attached to the turbine by the turbine-to-compressor coupling, spur adapter gearshaft and turbine to pinion gear coupling.

- The Hydromechanical Unit (HMU) was consumed by fire. The attached HMU pump was partially consumed. The pump driveshaft and splines were intact.

- The compressor assembly was in position at the forward end of the engine. All attachment bolts were in place with the gearbox helicoils on the bolts.

- The compressor impeller exhibited extensive foreign object damage (FOD). Multiple impeller blades were torn notched and bent opposite to the direction of rotation.

- The starter/generator driveshaft and splines were intact

- The 4th stage turbine wheel was intact with no damage noted

- The Electronic Control Unit (ECU) for the FADEC was recovered. The electrical connectors were damaged and the case was damaged and sooted, but there was no evidence of internal damage to the circuit boards. The ECU was shipped to Goodrich Pump and Engine Control

Systems (GPECS), West Hartford, CT, for the incident recorder EEPROM download

- Based on damage to engine and airframe components, to include main driveshaft, tail rotor driveshafts, Thomas couplings, main and tail rotor assemblies and main and tail rotor blades it was evident that the engine was producing power.

2.12 Engine Maintenance and Records. The engine logbook did not indicate and major maintenance work. Inspections were recorded on a regular basis and there were no indications of carried-over maintenance actions.

2.13 Additional Information. The FADEC Electronic Control Unit (ECU) was found in the wreckage with a damaged case and connectors. It was returned to Goodrich Pump and Engine Control Systems (GPECS) for download of the incident recorder data, which was conducted on July 21, 2004 in the presence of the NTSB IIC and other party members. The downloaded data showed that there were no FADEC fault conditions preceding the first Incident Recorder event. Snapshot data showed a Torque Rate Limit, Nr Droop Record, Torque Exceedence, NP Exceedence and Overspeed Solenoid Energised. Throughout the entire sequence, the data showed NG in the 97 to 99 percent range. Refer to the Goodrich report in Appendix 4.3 for additional information.

3. SUMMARY OF FINDINGS

3.1 Damage to the engine compressor impeller was consistent with engine power production when debris was ingested into the compressor

3.2 Downloaded EEPROM data from the FADEC ECU Incident Recorder showed that engine performance was normal and was operating in a steady state condition prior to Snapshot 1 indicating a Torque Rate Limit.

3.3 The FADEC Incident Recorder data had five Snapshot records showing (1) torque rate limit, (2) Nr droop record, (3) torque exceedence, (4) NP exceedence and (5) overspeed solenoid energized.

3.4 Gas Producer (NG) speed remained in the 97 to 99 percent range throughout the accident sequence.

GOODRICH
Pump & Engine Control Systems, Inc.
Charter Oak Boulevard
West Hartford, CT 06133
860 236 0651

SHORT REPORT SUMMARY	**PECS REPORT NO.** S-1824
REPORT TITLE: Newberry SC. Bell 407 Crash, EMC-35A Electronic Control Unit (ECU) JG9ALK0570 Investigation.	**DATE:** 10-22-04
	DEPT. NO. 934

SCOPE OF REPORT: Detailed record of the investigation proceedings, findings and interpretations.

BACKGROUND:

As reported by NTSB preliminary report CHI04MA182, during the early morning (5:35 AM) of July 13, 2004 a medi-vac Bell 407 departing an accident scene with an injured person, crashed into a wooded area shortly after take off resulting in four fatalities. The ECU was recovered from the aircraft wreckage and found to be significantly damaged both mechanically and by fire.

DESCRIPTION:

An investigation team was assembled to oversee the investigation of the recovered ECU (S/N JG9ALK0570) at Goodrich and to attempt to download the ECU non-volatile memory that may contain Engine Monitor, Fault History, and Incident Recorder data related to the final flight.

The team arrived at GPECS on July 21 2004 and consisted of:

John Swift,	Rolls-Royce Senior Air Safety Investigator
Jim Silliman,	NTSB Chicago
Mike Hauf,	NTSB Washington
Gary Horan,	FAA Engine Directorate

C PECS supporting personnel included:

William Snell	Senior System Engineer
David Huang	Systems Engineer
Greg Nelson	Manager, Product Support Engineering
Bruce Millar	Product Support Engineer

RESULTS:

Under the observation of the investigation team the ECU was removed from the shipment packaging and examined (reference images in Appendix I). Damage was clearly more severe at the I/O connectors, mechanical damage resulting in the breakout of the connectors from the housing and thermal damage with one of the 79 pin D38999 connectors no longer attached (missing) to the internal flexible printed circuit after the heat of the fire flowed the solder that was holding the connector to the flex so that the connector detached.

The ECU cover was removed to expose the ECU Computer printed circuit board assembly (CMP PCBA), which contains the non-volatile memory device (Electrically Erasable Programmable Read Only Memory ñ EEPROM) at design position U40. The CPU PCBA had several damaged (de-lidded) integrated circuit (IC) components but the U40 EEPROM appeared to be intact and undamaged. The CPU PCBA was removed from the ECU so that the EEPROM could be removed (de-soldered) and installed in an operating test ECU for the EEPROM download.

The EEPROM was successfully removed from the CMP PCBA, installed in the test ECU and downloaded. The Engine History data and Fault History data are included in Appendix II. The Fault History indicates that the i Last Engine Runî contained no faults, i Time Stamped Faultsî contained several Np Exceedance flags indicating Np values of greater than 102% that are not uncommon in the normal aircraft operating profile. The Engine History Data reflects an accumulation of time that Np exceeded the 102% threshold (1001.6 sec.) and a peak exceedance value of 109.5%. The CALDATA is recovered and confirms that there are no EEPROM fault (corruption) issues and the CPU foreground timer is as expected, less than 22 msec., verifying processor operation time.

The Incident Recorder (IR) data recovered from ECU JG9ALK0570 finds several incident triggers indicting aircraft conditions at the time of the crash and are included with a graphical representation in Appendix III.

Explanation of IR Operation;

The IR operates by monitoring a particular set of engine control conditions, at the same rate as the engine control software (24 msecs. / set), for conditions that are determined to be abnormal or an i incidentî. The IR maintains a 12 second memory buffer, of the engine control condition sets being monitored, at 1.2 sec intervals (10 data sets) as pre-i incidentî data. All the IR monitoring and buffer data occurs in the volatile memory space of the microprocessor system. If an i incidentî is detected, the i incidentî data set is written to the system non-volatile memory space as i Snapshotî data. The IR then proceeds to write the 10 data sets of pre i incident i (buffered) data, and the next (post-i incidentî) 40 data sets (also at 1.2 secs. / set), to non-volatile memory (U40 EEPROM). Non-volatile data storage priority is given to the i Snapshotî data, so that additional i incidentsî detected, will be saved before completing the storing of pre or post incident data.

Written by: B. Millar	D. McBrine	Distribution
Approved by: G. Nelson		

Incident Recorder Data Interpretation:
The IR data recovered from ECU JG9ALK0570 was found to be incomplete due to the fairly immediate loss of power to the ECU as a result of aircraft damage from the crash. Because of this, pages 2 to 6 of the IR Data were empty and are not included in Appendix III.

The IR Snapshot Data contains five sets of data associated with five separate ì incidentsî detected at the time of the crash. The IR Incident Data contains two data sets (Records 10 and 11) of which Record 10 was not completed, indicated by the Time Stamp value, which is a calculated result of the values in the ì EngRnTmî and ì EngRnCtrî column. The other data indicated in Record 10 is believed to be accurate and at time 983:18:53 376 (1.2 seconds previous to Record 11 per the design).

Chronological Sequence of Events (less than 1.5 seconds):

Record	Time	Incident	Data	ESW Fault Condition
Data 10	983:18:53.376	N/A	N/A - flight is normal per data set	None
Snapshot 1	983:18:54.120	Torque Rate Lim	Torque from 84 to 94 % in 844 msec.	None
Snapshot 2	983:18:54.144	Nr Droop Rcrd.	Nr from 92 to 76% in 24 msec.	None
Snapshot 3	983:18:54.288	Torque Exceed. Hi Rcrd.	Torque at 134 % (from 94% in 144 msec.)	Nr Sensor, Nr Antis. Dsabl. Degrade Lamp
Snapshot 4	983:18:54.576	Np Exceed. Hi Rcrd.	Np at 109% (from 60% in 288 msec.)	Torque and Np2 Sensors
Data 11	983:18:54.576	Same Data as Snapshot 4		
Snapshot 5	983:18:54.648	Over Speed Sol. Energized	Np at 123% triggers OS Solenoid.	OS Event Lmp.

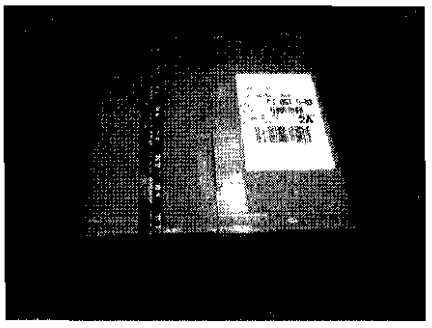
The following paragraphs present a timeline of what likely happened to the engine, FADEC, and aircraft during this brief period.

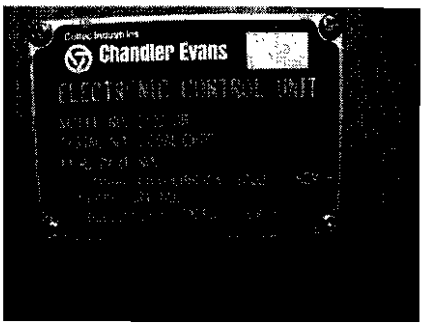
Elapsed Time from 1st Incident (secs)	**Description of FADEC, engine, and aircraft operation**
-0.744	Engine, FADEC, and aircraft all appear to be operating normally during this pre-incident snapshot. Ambient conditions are 76F at 14.02 psia. The throttle is positioned in the ëflyí position and collective pitch is at 62%. The FADEC is controlling the engine in auto mode (Mode =1) on the power turbine governor (NDOTWRCd=4) which, as expected, is holding Np/Nr steady at 100%. The engine is operating at steady-state with Ng at 98%, MGT at approximately 1300F, and torque at 84%. The fuel flow required to maintain the engine at this 596 SHP power level is approximately 380 pph.. The values for the engine parameters correlate closely with the model data supplied by Rolls-Royce for a nominal C47B engine. The six status words (ESW-ESW6) also indicate normal operation with no faults present
0.000	The ECU detects a torque rate incident, indicating that torque is increasing at more than 1500%/sec and that a rotor strike has likely occurred. This is supported by the fact that Nr has decreased to 92% and Np to 79%. The discrepancy between Nr and Np during this record is due to their 16 msec sampling skew and indicates a very rapid deceleration of the rotor. Fuel flow has dropped slightly to 364 pph and collective to 56%. Throttle position is advanced beyond the 70 degree ëflyí detent to 82 degrees.
0.024	The ECU detects a rotor droop incident as rotor speed falls below the incident limit of 92% to 76%. Fuel flow increases slightly to 376 pph in response to the drop in Np. Collective increases to 60%.
0.168	The ECU detects a high torque incident as torque climbs above the incident limit of 109%. An Nr fault (ESW3=0x0004) is detected due to an Nr rate fault. This results in a Nr decay anticipation fault (ESW4=0x8000) and degrade fault (ESW5=0x8092). The degrade lamp in the cockpit is illuminated. Collective decreases to 20% and throttle to 54 degrees. Fuel flow is held constant at 392 pph while a fault condition is being confirmed (NDOTWRCd =22).
0.456	The ECU detects a high Np incident as Np increases to 109%. This rapid turnaround in Np, even as Nr continues to decay, indicates that the power turbine shaft has failed. A torque fault and Np2 fault (ESW3=0x0806) are detected, both likely due to rate faults resulting from the shaft failure. Although Np is above 100%, the rapid change in collective to 100% has produced enough anticipation to keep fuel flow in the 400 pph range and accelerate the unloaded power turbine. The throttle is now positioned at 100 degrees.
0.528	The ECU detects an overspeed incident as the overspeed solenoid is activated (ESW5=0xA092) in response to Np reaching the 118% trip point.

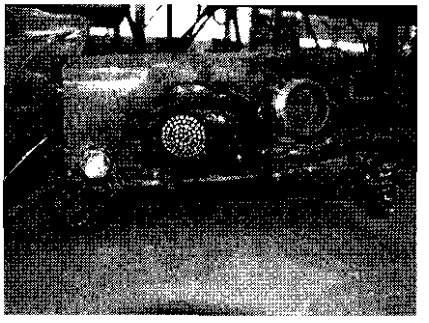
Conclusion:

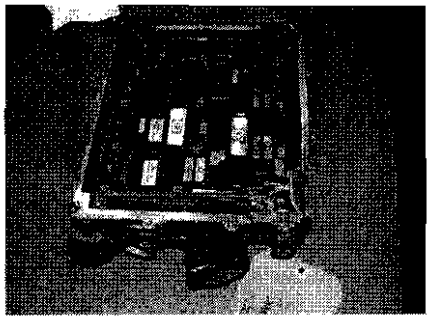
The data downloaded from the ECU indicates that there were no FADEC fault conditions preceeding the first IR incident that, is believed to have been caused by the aircraft rotor systems striking a grounded object(s).

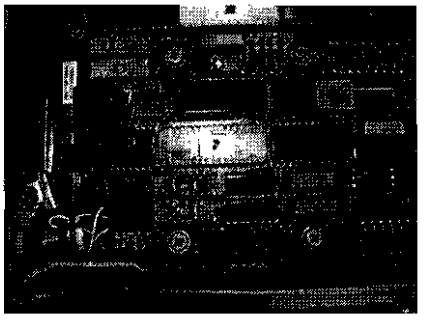
Appendix I.
ECU Investigation Images.

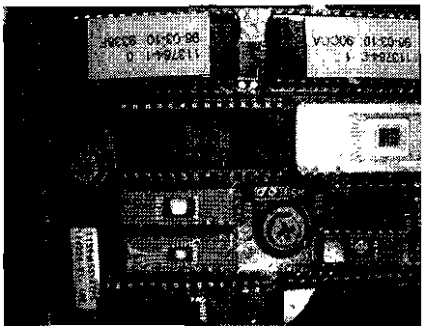












Appendix II.
EEPROM Engine History Data.

Engine History Data at 7/21/04 9:49:29 AM

Data Source: ECU
Aircraft Model: Bell 407
ECU Version: 257-5202
User Name: B. Millar
ECU S/N: JG7ALK0570
Turbine S/N: CAT-44786
Eng Gearbox S/N: CAG-47542

Data Time: 7/21/04 9:49:29 AM
Engine Model: 250-C47B
ID: 33B6
Engine S/N: CAE-847542
Compressor S/N: CAC-45066
HMU S/N: JGALM0771
Aircraft ID: 503MT

Parameter	Value	Units	Description
ECUOpTm	458.40	Hours	ECU Operating Time (counter)
EngRnTm	983.20	Hours	Engine Operating (Running) Time (counter)
MGTLmPk	0.0	Deg F	MGT Limit Exceedance Peak
MGTLmTm	0.00	Seconds	MGT Limit Exceedance Time
MGTRLmPk	0.0	Deg F	MGT Run Limit Exceedance Peak
MGTRLmTm	0.00	Seconds	MGT Run Limit Exceedance Time
MGTSLmPk	0.0	Deg F	MGT Start Limit Exceedance Peak
MGTSLmTm	0.00	Seconds	MGT Start Limit Exceedance Time
MGTSRLmPk	0.0	Deg F	MGT Start Run Limit Exceedance Peak
MGTSRLmTm	0.00	Seconds	MGT Start Run Limit Exceedance Time
NgLmPk	0.00	%Ng	Ng Limit Exceedance Peak
NgLmTm	0.00	Seconds	Ng Limit Exceedance Time
NgRLmPk	0.00	%Ng	Ng Run Limit Exceedance Peak
NgRLmTm	0.00	Seconds	Ng Run Limit Exceedance Time
NpQNppkExLm	0.00	%Np	Np Peak Value During NpQ Exceedance Limit Advisor
NpQNppkRnLm	0.00	%Np	Np Peak Value During NpQ Run Limit Advisory
NpQQpkExLm	0.0	%Q	Q Peak Value During NpQ Exceedance Limit Advisory
NpQQpkRnLm	0.0	%Q	Q Peak Value During NpQ Run Limit Advisory
NumStrt	1717	Starts	Number of Engine Starts
OEITMInd	FALSE	Boolean	Maintenance indication of a 2 minute event (EEPRO
OEITSInd	FALSE	Boolean	Maintenance indication of a 30 second event (EEPR
OSCyc	B	Boolean	Overspeed Cycle
QLmPk	0.0	%Q	Q Limit Exceedance Peak
QLmTm	0.00	Seconds	Q Limit Exceedance Time
QRLmPk	0.0	%Q	Q Run Limit Exceedance Peak
QRLmTm	0.00	Seconds	Q Run Limit Exceedance Time
SgCtr	0	Surges	Number of Surge Occurrences Counter
TMTmExcFlg	FALSE	Boolean	Maintenance Flag (EEPROM) to Indicate Excessive u
TSTmExcFlg	FALSE	Boolean	Maint Flag (EEPROM) Indicating Excessive Use of 3
TMEvents	0	Events	Total Number of 2 min Events (EEPROM)
TMLmTm	0.00	Seconds	Total Time (counter) at 2 min OEI Power
TSEvents	0	Events	Total Number of 30 Second Power Events (EEPROM)
TSLmTm	0.00	Seconds	Total Time (counter) at 30 sec OEI Power
EngRunCtr	0.00	Seconds	Engine Run Time Interval Counter
NpLmPk	109.52	%Np	Np Limit Exceedance Peak Value
NpLmTm	1001.57	Seconds	Np Limit Exceedance Time
OSCtr	0	Events	Engine Overspeed Counter
SpareData1	0	packed word	
SpareData2	0	packed word	
SpareData3	0	packed word	
EmData_Chksum	33341	packed word	

CALDATA.rtd File.

CALDATA.rtd at 7/21/04 9:45:24 AM

Data Source: ECU
Aircraft Model: Bell 407
ECU Version: 257-5202
User Name: B. Millar
ECU S/N: JG7ALK0570
Turbine S/N: CAT-44786
Eng Gearbox S/N: CAG-47542

Data Time: 7/21/04 9:45:24 AM
Engine Model: 250-C47B
ID: 33B6
Engine S/N: CAE-847542
Compressor S/N: CAC-45066
HMU S/N: JGALM0771
Aircraft ID: 503MT

Parameter	Value	Units	Description
KinP1Cal	-16	Counts	P1 Offset Correction
KinP1Gn	1.003	unitless	P1 Gain Correction
KinQCal	-10	Counts	Q Offset Correction
KinQGn	0.995	unitless	Q Gain Correction
EECalFlt	FALSE	Boolean	EEPROM Calibration Data Fault
EEPROMFlt	FALSE	Boolean	EEPROM Hardware Fault
MaxRTUsed	18.609	msec	Maximum Cycle Time Used in any Control Cycle

Appendix II.
Time Stamped Faults.

Time Stamped Faults at 7/21/04 9:48:48 AM

Data Source: ECU
Aircraft Model: Bell 407
ECU Version: 257-5202
User Name: B. Millar
ECU S/N: JG7ALK0570
Turbine S/N: CAT-44786
Eng Gearbox S/N: CAG-47542

Data Time: 7/21/04 9:48:48 AM
Engine Model: 250-C47B
ID: 33B6
Engine S/N: CAE-847542
Compressor S/N: CAC-45066
HMU S/N: JGALM0771
Aircraft ID: 503MT

Fault Time	Fault Name	Description
980:58:15.792	NpLmTOut	- Np Limit Exceedance
969:25:50.064	NpLmTOut	- Np Limit Exceedance
969:19:25.944	NpLmTOut	- Np Limit Exceedance
968:18:00.984	NpLmTOut	- Np Limit Exceedance
966:40:10.512	NpLmTOut	- Np Limit Exceedance
966:08:53.904	NpLmTOut	- Np Limit Exceedance
965:58:32.400	NpLmTOut	- Np Limit Exceedance
965:11:56.544	NpLmTOut	- Np Limit Exceedance
965:11:46.944	NpLmTOut	- Np Limit Exceedance
964:56:12.480	NpLmTOut	- Np Limit Exceedance
964:26:40.032	NpLmTOut	- Np Limit Exceedance
963:11:15.792	NpLmTOut	- Np Limit Exceedance
963:05:24.960	NpLmTOut	- Np Limit Exceedance
962:45:12.768	NpLmTOut	- Np Limit Exceedance
961:29:59.688	NpLmTOut	- Np Limit Exceedance
960:55:20.232	NpLmTOut	- Np Limit Exceedance
959:38:32.880	NpLmTOut	- Np Limit Exceedance
959:24:35.088	NpLmTOut	- Np Limit Exceedance
959:05:23.472	NpLmTOut	- Np Limit Exceedance
958:58:38.808	NpLmTOut	- Np Limit Exceedance
958:02:54.192	NpLmTOut	- Np Limit Exceedance
957:32:19.224	NpLmTOut	- Np Limit Exceedance
955:59:11.928	NpLmTOut	- Np Limit Exceedance
955:04:47.112	NpLmTOut	- Np Limit Exceedance
954:17:03.672	NpLmTOut	- Np Limit Exceedance
954:17:02.328	NpLmTOut	- Np Limit Exceedance
954:17:00.216	NpLmTOut	- Np Limit Exceedance
953:12:08.016	NpLmTOut	- Np Limit Exceedance
951:01:48.048	NpLmTOut	- Np Limit Exceedance
950:21:53.040	NpLmTOut	- Np Limit Exceedance

Last Engine Run Faults.

Last Engine Run Faults at 7/21/04 9:46:52 AM

Data Source: ECU
Aircraft Model: Bell 407
ECU Version: 257-5202
User Name: B. Millar
ECU S/N: JG7ALK0570
Turbine S/N: CAT-44786
Eng Gearbox S/N: CAG-47542

Data Time: 7/21/04 9:46:52 AM
Engine Model: 250-C47B
ID: 33B6
Engine S/N: CAE-847542
Compressor S/N: CAC-45066
HMU S/N: JGALM0771
Aircraft ID: 503MT

Fault Name	Description
No Faults Found	

Appendix III.
IR Snapshot Data.

IRSnapshot.eep - Snapshot Data Page 1 of 1

EEM Version: C-402257-5202 3.06 Date Extracted: 07/23/04 16:58:46 UTC
Description: JSC#A40578 Incident Investigation 7-21-04

Snapshot	TypeHdr0	TypeHdr2	Time Stamp HH:MM:SS.mmm	HighAlarm Volts	HiAlarm Volts	MidAlarm Deg F	QLAlarm kΩ	LoAlarm Volts	HiDetAlarm ppb	MOOPFilt Volts/Sec	PTAlarm psia	Mode	CPAlarm MCP	ES01 Counts	ES02 Counts	ES03 Counts	ES04 Counts	ES05 Counts	ES06 Counts	MBVRMON	PKAlarm Deg PEA	TTAlarm Deg F	EngDelTm	EngDelTm2	Spare1	Spare2	Spare3	Spare4
1	0x0498	0x0000	903:18:54.120	97	92	1260	94	779	369	-1.7	14.04	1	56	0x0001	0x0000	0x0000	0x0000	0x0090	0x0000	23	82	76	7374	17255	0	0	0	0
2	0x0002	0x0000	903:18:54.144	97	76	1260	94	76	376	-1.1	14.04	1	60	0x0001	0x0000	0x0000	0x0000	0x0090	0x0000	28	78	76	7374	17256	0	0	0	0
3	0x0420	0x0000	903:18:54.200	97	60	1220	134	60	392	3.1	14.15	1	20	0x0001	0x0000	0x0004	0x0000	0x0092	0x0000	22	54	78	7374	17262	0	0	0	0
4	0x0000	0x0000	903:18:54.376	99	38	1400	18	1089	404	5.7	14.09	1	100	0x0001	0x0000	0x0006	0x0000	0x0092	0x0000	7	1000	78	7374	17274	0	0	0	0
5	0x1000	0x0000	903:18:54.640	99	34	1420	52	1223	412	7.2	13.86	1	80	0x0001	0x0000	0x0005	0x0000	0x2092	0x0000	16	58	78	7374	17277	0	0	0	0
6	0x0000	0x0000	00:00:00.000	0	0	0	0	1	0	0.0	0.00	0*	0	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0*	0	0	0	0	0	0	0	0
7	0x0000	0x0000	00:00:04.000	0	0	0	0	0	0	0.0	0.00	0*	0	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0*	0	0	0	0	0	0	0	0
8	0x0000	0x0000	00:00:00.000	0	0	0	0	0	0	0.0	0.00	0*	0	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0*	0	0	0	0	0	0	0	0
9	0x0000	0x0000	00:00:00.000	0	0	0	0	0	0	0.0	0.00	0*	0	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0*	0	0	0	0	0	0	0	0
10	0x0000	0x0000	00:00:04.000	0	0	0	0	0	0	0.0	0.00	0*	0	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0*	0	0	0	0	0	0	0	0

IRSnapInt.exp - Incident Data Page 1 of 6

ECU Version: C-00257-5202 3186 Date Extracted: 07/21/04 16:50:46 UTC
Description: ACSALA00574 Incident Investigation 7-21-04

Record	Time Stamp HH:MM:SS.mmm	MpInAccrd Mhj	MnInAccrd Mhr	MGTInAccrd Deg F	QInAccrd Hz	MpInAccrd Mhp	WFactInAccrd ppb	MOOTFilt Mhj/Sec	PInAccrd psia	Mode	CPInAccrd MCP	ESN Counts	ES02 Counts	ES03 Counts	ES04 Counts	ES05 Counts	ES06 Counts	MOOTMACd	PLAInAccrd Deg PLA	TIInAccrd Deg F	EngHealth	EngHealCtr	Spare1	Spare2	Spare3	Spare4
1	00:00:00.000	0	0	0	0	0	0	0.0	0.00	0	0	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0	0	0	0	0	0	0	0	0
2	00:00:00.000	0	0	0	0	0	0	0.0	0.00	0	0	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0	0	0	0	0	0	0	0	0
3	00:00:00.000	0	0	0	0	0	0	0.0	0.00	0	0	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0	0	0	0	0	0	0	0	0
4	00:00:00.000	0	0	0	0	0	0	0.0	0.00	0	0	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0	0	0	0	0	0	0	0	0
5	00:00:00.000	0	0	0	0	0	0	0.0	0.00	0	0	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0	0	0	0	0	0	0	0	0
6	00:00:00.000	0	0	0	0	0	0	0.0	0.00	0	0	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0	0	0	0	0	0	0	0	0
7	00:00:00.000	0	0	0	0	0	0	0.0	0.00	0	0	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0	0	0	0	0	0	0	0	0
8	00:00:00.000	0	0	0	0	0	0	0.0	0.00	0	0	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0	0	0	0	0	0	0	0	0
9	00:00:00.000	0	0	0	0	0	0	0.0	0.00	0	0	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0	0	0	0	0	0	0	0	0
10	27:27:60.000	98	100	1300	84	100	380	0.1	14.02	1	62	0x0001	0x0000	0x0000	0x0000	0x0090	0x0000	4	72	76	206	0	0	0	0	0
11	903:18:54.576	99	38	1400	18	109	404	5.7	14.09	1	100	0x0001	0x0000	0x0046	0x0000	0x4092	0x0000	7	100	78	7374	17274	0	0	0	0
12	00:00:00.000	0	0	0	0	0	0	0.0	0.00	0	0	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0	0	0	0	0	0	0	0	0
13	00:00:00.000	0	0	0	0	0	0	0.0	0.00	0	0	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0	0	0	0	0	0	0	0	0
14	00:00:00.000	0	0	0	0	0	0	0.0	0.00	0	0	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0	0	0	0	0	0	0	0	0
15	00:00:00.000	0	0	0	0	0	0	0.0	0.00	0	0	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0	0	0	0	0	0	0	0	0
16	00:00:00.000	0	0	0	0	0	0	0.0	0.00	0	0	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0	0	0	0	0	0	0	0	0
17	00:00:00.000	0	0	0	0	0	0	0.0	0.00	0	0	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0	0	0	0	0	0	0	0	0
18	00:00:00.000	0	0	0	0	0	0	0.0	0.00	0	0	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0	0	0	0	0	0	0	0	0
19	00:00:00.000	0	0	0	0	0	0	0.0	0.00	0	0	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0	0	0	0	0	0	0	0	0
20	00:00:00.000	0	0	0	0	0	0	0.0	0.00	0	0	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0	0	0	0	0	0	0	0	0
21	00:00:00.000	0	0	0	0	0	0	0.0	0.00	0	0	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0	0	0	0	0	0	0	0	0
22	00:00:00.000	0	0	0	0	0	0	0.0	0.00	0	0	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0	0	0	0	0	0	0	0	0
23	00:00:00.000	0	0	0	0	0	0	0.0	0.00	0	0	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0	0	0	0	0	0	0	0	0
24	00:00:00.000	0	0	0	0	0	0	0.0	0.00	0	0	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0	0	0	0	0	0	0	0	0
25	00:00:00.000	0	0	0	0	0	0	0.0	0.00	0	0	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0	0	0	0	0	0	0	0	0
26	00:00:00.000	0	0	0	0	0	0	0.0	0.00	0	0	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0	0	0	0	0	0	0	0	0
27	00:00:00.000	0	0	0	0	0	0	0.0	0.00	0	0	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0	0	0	0	0	0	0	0	0
28	00:00:00.000	0	0	0	0	0	0	0.0	0.00	0	0	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0	0	0	0	0	0	0	0	0

Appendix III.
Incident Recorder Plotted Data.