ENGINEERING DEPARTMENT

GOODRICH

Pump & Engine Control Systems, Inc.
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SHORT REPORT SUMMARY	**PECS REPORT NO.** S-2203
REPORT TITLE: Air Methods Corp. EC135 helicopter accident EMC-35B Electronic Control Unit (ECU) S/N 2AMN0166CE, 4AMN0368CE	**DATE:** 19 August 2008
	DEPT. NO. D934

SCOPE OF REPORT: Detailed record of ECUs memory interrogation

BACKGROUND:

As reported by Turbomeca USA (TM USA) representative via Email, and later detailed in NTSB Preliminary report aviation ID CHI08FA128:

"On May 10, 2008, about 2245 central daylight time, a Eurocopter Deutschland EC135 T2+ air medical configured helicopter, N135UW, operated by Air Methods Corporation, was destroyed during an in-flight collision with trees and terrain near La Crosse, Wisconsin. The flight was conducted in accordance with Title 14 Code of Federal Regulations Part 135 without a flight plan. The helicopter's position was being monitored according to the operator's flight following procedures. Night visual meteorological conditions prevailed. The pilot, physician and flight nurse sustained fatal injuries. The flight departed La Crosse Airport (LSE), La Crosse, Wisconsin, at 2234. The intended destination was the University of Wisconsin Hospital Heliport (WS27) in Madison, Wisconsin… The accident site was located on a wooded hillside in a sparsely populated area approximately 4 1/2 miles southeast of LSE. Tree strikes and main rotor blade fragments were observed at the top of the ridgeline. The elevation of the ridge was approximately 1,160 feet at that location. The main wreckage came to rest on the east side of the ridgeline, on the descending hillside opposite the departure airport. It was about 600 feet from the initial tree strikes at the top of the ridgeline, at an elevation of approximately 930 feet "

DESCRIPTION:

An Investigation Team, lead by FAA Aviation Safety inspector Robert Coleman – on behalf of NTSB Air Safety Investigator Tim Sorensen- was assembled to oversee the memory interrogation of the recovered ECUs (S/N 2AMN0166CE and 4AMN0368CE), at Goodrich (GR).

The objective of the ECUs memory interrogation was to attempt the download any FADEC History data from the ECU non-volatile memory that might be relevant to the accident circumstances. Detailed interpretation and analysis of any Incident History data recovered is to be provided from Turbomeca (TM) – the flight software (including Incident History data management) design authority.

The ECU microprocessor has a real time capability to store FADEC History information in a non-volatile memory device (called EEPROM - at design position U40 on the computer board) to provide a "black box" type recording of previously detected FADEC System conditions.

The Team members arrived at GR on June 24, 2008 and consisted of:

Robert Coleman	Aviation Safety inspector, FAA
Ed Stockhausen	Director of Safety, Air Methods Corp.
Don Lambert	Director of Technical Services, Air Methods Corp.
Lindsay Cunningham	Accident Investigator, American Eurocopter
Archie Whitten	Accident Investigation and Safety, Turbomeca USA
Vincent Beaudoin	Control System Engineer, Turbomeca USA

GR team members included:

Bruce Millar	Product Support Team Leader (Electronics)
Al Eldanaf	Product Support Engineer (Electronics)

Both ECUs – packaged in a cardboard box- were hand-carried into GR facility by Robert Coleman on the morning of June 24, 2008 to begin the examination and memory interrogation.

Appendix A shows images of ECUs taken following their removal from the aircraft wreckage showing considerable physical damage sustained to ECUs. The images show the marking on each ECU housing relative to the engine which it was installed on: "L" for left engine on SN 4AMN0368CE and "R" for right engine on SN 2AMN0166CE.

Written by: [redacted] A. Eldanaf	Distribution: L. Pannullo, J. Barnett, R. Feller, T. Ziotas
Approved by: [redacted] 8/25/08 B. Millar	Approved by: [redacted] 8-25-08 W. Wattley

ECUs EXAMINATION RESULTS:
Under the observation of the investigation team, the ECUs were removed from the packaging and prepared for visual inspection (reference images in Appendix B). Both ECUs were wrapped in bubble wrap and stacked on one another in the package.

Visual examination of SN 4AMN0368CE (reference images in Appendix C)
The examination proceeded by removing the protective bubble wrap to find an anti-static bag tapped to the ECU via black electrical tape (Fig.C-1). The ECU cover bears a label affixed to it with relevant accident information; also noted that all but two of the cover screws were removed (Fig.C-2). The removed cover screws along with the lids of some integrated Circuit (IC) parts were found in the anti-static bag (Fig.C-3). It appears that following the ECU removal from aircraft; the ECU cover was removed –by unknown- to investigate a potential rattle emitting from inside the ECU, caused by the loose IC lids. The IC lids would have come loose as a result of the significant mechanical shock and loading exposure to ECU resulting in significant damage to ECU structure and internal assemblies (Fig.C-4).
To further investigate the source on the loose lids; the ECU cover was removed exposing the Computer board (CPU PCB), to find some ICs are missing their lids and are likely compromised. The EEPROM IC was examined and found to OK (Fig C-6)
The CPU PCB was later removed from ECU for EEPROM extraction (C-6).

Visual inspection of the ECU also revealed a single bent (folded over) pin on J2 receptacle (Fig.C-7, C-8). The folded pin is #14 of J2 receptacle (Airframe harness connection to ECU); and it serves as a lamp driver for the "Training Mode" indication lamp in the cockpit. The lamp driver acts as a switch to ground for the "training mode" lamp that is pulled up (or powered) by airframe voltage. When training mode on aircraft is selected; the ECU would activate this function which creates a path to ground for the electrical current to flow from Airframe power source thru the "training mode" lamp to ground; causing the lamp to illuminate.
The absence of this function or lack of connectivity to "training mode" lamp – as it is the case here- would cause no illumination of lamp in cockpit when training mode is selected. However, this condition would have no effect on training mode actual selection or operation, nor will it affect the ECU ability to safely and reliability controlling the engine. This function is deemed non-critical for ECU operation and no fault detection capability is available to determine whether or not the lamp is on.
The circumstances of how the pin was folded are unclear; but it is likely that it occurred during ECU installation on aircraft. It is plausible that this pin was slightly misaligned during ECU handling – possibly by an errant finger- and subsequently folded when the airframe harness was mated to ECU J2 receptacle. This would cause the pin be pushed against the bottom of J2 receptacle, that consists of blue rubber inlay over a glass surface, all non-conductive, precluding any short-circuit condition to ECU casing or other pins on J2 receptacle (all other pins mated properly with airframe connector).
The ECU log card (reference Appendix D) indicates that it was installed new (0 hours) on engine 32300 in December of 2006. No entries found on log card that indicate ECU removal or installation at a later date. The ECU had accumulated 516.3 Hours (TSN) up to the accident date. This suggests that the folded /bent event occurred at ECU initial installation – or during a troubleshooting or maintenance event at a later date that is not documented- and presented no flight safety or performance issues for the duration of time accumulated.

Visual examination of SN 2AMN0166CE (reference images in Appendix E)
The ECU clearly had been physically damaged. The ECU housing was cracked in more than one location; with one side completely missing fully exposing the ECU internal assemblies. The physical damage to the ECU internal assemblies is great showing major deformation and damage (Fig. E-2, E-3).
The ECU cover was removed to expose the CPU PCB (Fig. E-4, E-5) that had suffered significant shock damage as indicated by the de-lidded ICs (Fig. E-6). However, visual examination of the EEPROM IC found no apparent damage (Fig E-7).
The CPU PCB release from ECU was not possible without cutting it out on one end, since one or more of the retaining screws were deformed and binding (Fig. E-8). The PCB was removed from ECU to allow for EEPROM IC extraction.

ECUs MEMORY INTERROGATION:
Under the observation of the investigation team, The EEPROM ICs of the CPU PCBs of both ECUs were extracted (de-soldered) and visually inspected for damage. The ICs appear to be OK with no signs of physical damage.

The EEPROM devices were installed – one at a time- on the Computer board of an EMC-35B test ECU specially fitted with a socket to accept EEPROM ICs at design position U40. The unit was then connected to "DECU Loading and Teat Bench" for download of FADEC History data from the non-volatile memory (EEPROM), which was successfully completed

The FADEC History data stored in ECU EEPROM memory supports four types of information that is interpreted by TM software tools resulting in 36 pages of reporting:

1. Counters and Occurrences (1 page)
2. Maintenance (system fault) Events (24 Pages)
3. Other Engine Inoperable (OEI) Events (8 Pages)
4. Engine Overspeed Events (3 Pages)

Both the Maintenance and OEI data accommodate recording for up to eight events that are time-stamped with: the total number of ECU operating hours (ECUTotTime; resolution of 0.1 hours), and the total number of seconds since ECU power-up (PowTime; resolution of 1 second). This information enables the determination of which data record contains the latest or most recent data stored by ECU computer.
When new event data is to be stored; the ECU computer will determine the location in memory with most recent data -or the "initial"

location if memory is blank- then stores the new data in the next location. This process continues on -in sequential order- populating subsequent locations of memory (capacity of 8 locations) with new data as it emerges. To accommodates the recording of more than 8 events, the ECU computer will reuse the memory locations (in sequential order) to write new events data, thereby replacing old or not so recent data with recent data.

The downloaded FADEC History data is formatted in data "blocks" that are stored in memory upon events detection; be it: FADEC system faults that are sensed at any time the system is on, OEI (One Engine Inoperative) condition, or an engine overspeed condition. The blocks are designated relative to type of event detected; and so: FADEC system fault events are designated "maintenance" blocks, OEI events as: "OEI" blocks, and OverSpeed events as: "OverSpeed" blocks.
The FADEC history data contains eight (8) Maintenance blocks; eight (8) OEI blocks, and one (1) OverSpeed block
Each block –regardless of type- are composed of the following categories:

- Parameters: Lists magnitude of selected parameters, such as: speed, pressure, temperature, ECU time, etc. (OEI blocks parameters are different than those of Maintenance and OverSpeed blocks parameters).
- Discrete inputs: provides status (1= ON, 0 = OFF) of inputs to ECU, such as: selector switch position (flight, idle, etc.).
- Discrete Outputs: Provides status (1= ON, 0 = OFF) of indicators output by ECU, such as: Total failure, manual mode, etc.
- Failure flags (1 to 5): Identifies nature of fault detected by setting the flag status (1= fault triggered, 0 = fault not triggered). The failure flags encompass a wide range of faults related to FADEC system and ECU operation, such as: stepper motor loss of step, EEPROM fault, etc. This category is not reported in OEI blocks.

Initial examination of SN 2AMN0166CE (166CE) FADEC history data; showed the most recent block to be an OverSpeed block time-stamped (ECUTotTime) 398.9. FADEC history data of 4AMN0368CE (368CE) showed the most recent block to be a Maintenance block time-stamped (ECUTotTime) 516.3 hours. The time stamps of these most recent blocks were verified to be the total number of ECUs operating hours up to accident time. Also, these times represented an accumulation of 80 hours from the previous recorded blocks of both ECUs. This indicates that no faults were detected or recorded for 80 hours previous to accident date; and that the ECUs functioned properly exhibiting no malfunctions or degraded operation prior the accident.
The total number of seconds since the ECUs last power-up (PowTime) was shown to be 408 seconds (or 6.8 minutes) for both ECUs in the most recent blocks indicating that both ECUs were powered up at the same time prior the accident, accumulated the same time, and likely ceased functioning at the same time.
Stated above indicates that the most recent blocks of FADEC history data of both ECU are detected and recorded by ECUs as a result of the accident. The absence of additional blocks in fault histories data suggests that both ECUs stopped operating abruptly which may indicate that the accident event duration – start to end- was very brief (reference Appendix F, G for the most recent blocks of FADEC history data of both ECU 368CE and 166CE).

Based on the information provided by the team and NTSB preliminary report, the aircraft was destroyed following collision with trees and terrain, and tree strikes and rotor blades fragments were found at the top of the ridgeline where the aircraft came to first contact with trees. This suggests that the main rotor system came to contact with trees causing the rotor blades to disintegrate that might cause the power transmission shaft to break, further resulting in sudden unloading of the torque -due to the shaft break- which would drive the engines toward OverSpeed.
Subsequently, engine OverSpeed condition was detected by ECU 166CE first - suggesting Right side engine speed reached and exceeded OverSpeed ECU threshold of 114% speed first- and promptly activated the OverSpeed solenoid that shut-off the fuel supply to the Right side engine and effectively shutting-off the engine. ECU 166CE then signaled the ECU of the Left side engine (ECU 368CE) to inhibit operation of OverSpeed protection to prevent the left side engine – the only active engine- from being shutdown as a result of OverSpeed detection by ECU 368CE. Following ECU 166CE response to detected OverSpeed condition; a FADEC history record – OverSpeed block time stamped 398.9 hours- of the event was written ECU 166CE memory. The OverSpeed Block data indicated that at the time when the record was made; the selector switch was set to flight, torque matching mode authorized and Engine speed measured 117.69 % (above OverSpeed limit of 114%).
ECU 368CE also detected left engine OverSpeed; but since its OverSpeed protection function was disabled by ECU 166CE, no OverSpeed protection activation was possible to shutdown left side engine. Subsequently, a FADEC history record – Maintenance block time stamped 516.3 hours- of the event was written ECU 368CE memory. The Maintenance Block data indicated that at the time when the record was made, the selector switch was set to "flight"; "Fuel Metering Unit (FMU) out of neutral position", which is an indication of FMU reposition in response to a commanded – voluntary or involuntary- manual movement of pilot's twist grip. This also resulted in indication of "Mixed Mode" (FMU in Auto (ECU) and manual (pilot's) control – transition), and "Degraded Control"(reflecting the control status of FMU – ECU is NOT degraded). The block also shows "torque channel and indication failures" (due loss of torque),"External failure" (signal loss not caused by ECU), and "Fault 2" (set as response to degraded control). The engine speed measured 117.69 % (above OverSpeed limit of 114%).

A that point of the accident (loss of main rotor blades and shaft breakage), the aircraft was severely compromised and beyond recovery regardless of ECU's subsequent actions or responses. However, both ECUs performed "as designed" in response to the presented conditions.

The downloaded FADEC history data was subsequently turned over to TM – the flight software design authority (including Incident History data management) - for detailed analysis. TM's analysis is to be provided in a separate report.

Both ECUs and their corresponding EEPROM ICs (all hardware) were turned over to Robert Coleman at the conclusion of the examination activity; who in turn hand-carried out all hardware (ECUs and EEPROM ICs) from GR facility premises.
The examination activity concluded on June 25, 2008.

ECUs SERVICE HISTORY:
A review of the GR Integrated Information System (IIS) database records pertaining to SN 4AMN0368CE and 2AMN0166CE revealed the following:

SN 4AMN0368CE service history:

This ECU was never retuned to GR for service since it was shipped new (0 hours) – as Part Number 114370-1A3-0000- on May 28, 2004.

SN 2AMN0166CE service history:

This ECU was retuned to GR for service twice since it was shipped new (0 hours) – as Part number 114370-1A3-0000- on October 30, 2002.

Date Received	Reason for Return / Service Performed	Date Shipped
Jan 30, 2006	ECU returned for "flameout caused by overspeed due to Hydromechanical". ECU was checked and tested OK. It was returned to service – as Part Number 114370-1A3-0000- without any action taken.	Feb 15, 2006
Nov 27, 2006	ECU returned for "internal failure code DN1 and total failure at autotest". ECU was checked and tested OK. ECU was upgraded to PN 114370-1A6-0000 and returned to service.	Jan 18, 2007

CONCLUSION:
Both ECUs involved in the crash accident were extensively damaged, rendering them inoperable and un-repairable. A bent pin condition in the left hand engine ECU connector discovered at the "As Received" inspection was reviewed and found to be on a signal function that would not have had a direct affect on engine operation.

The EEPROM memory devices in both ECUs were undamaged, removed from the units and installed in a test unit for data retrieval. The fault and engine history data was successfully downloaded from the ECUs' memory, and delivered to TM for interpretation.

A preliminary interpretation of the accident related data recovered from the ECUs finds indication that the engine system was operating normally and at full power at the time the aircraft struck the tree line. As might be expected in this type of accident, ECU data reflect a Torque Sensor fault presumably from the initial rotor system tree strike causing instantaneously high torque readings. Within the same second of data recorded, engine overspeed conditions are indicated on both engines presumably due to the sudden loss of the rotor system engine loading. Both ECUs appear to have operated and performed correctly in accordance with design specifications in response to presented conditions.

Appendix A
ECUs Images after removal from aircraft

Figure A-1 – 4AMN0368CE

Figure A-2 – 2AMN0166CE

Figure A-3 – 4AMN0368CE

Figure A-4 – 2AMN0166CE

Figure A-5 – 4AMN0368CE

Figure A-6 – 2AMN0166CE

Figure A-7 – 4AMN0368CE

Figure A-8 – 2AMN0166CE

Appendix B

ECUs packaging « as received at GR »

Figure B-1

Figure B-2

Figure B-3

Figure B-4

Figure B-5

Figure B-6

Appendix C
Visual examination images of SN 4AMN0368CE

Figure C-1

Figure C-2

Figure C-3

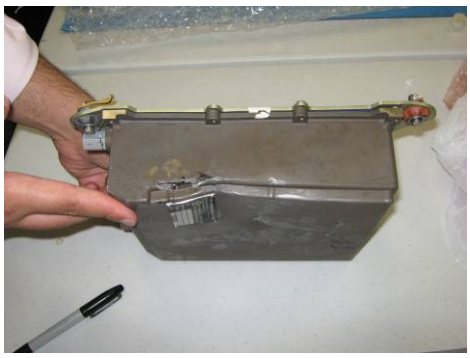


Figure C-4

Figure C-5

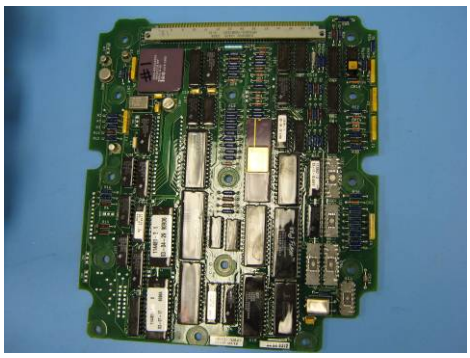


Figure C-6

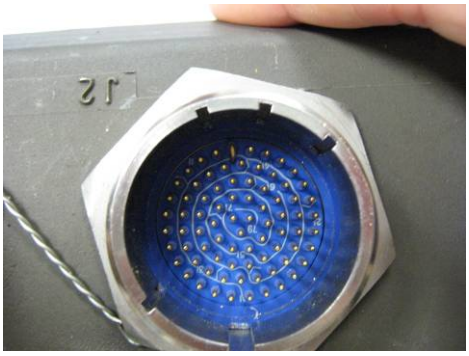


Figure C-7

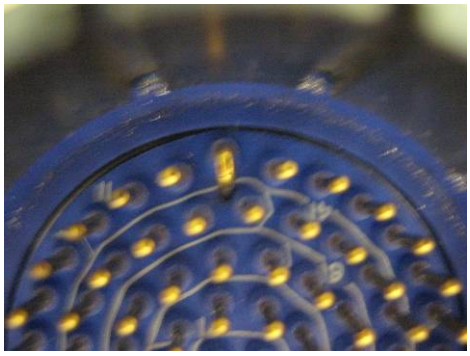
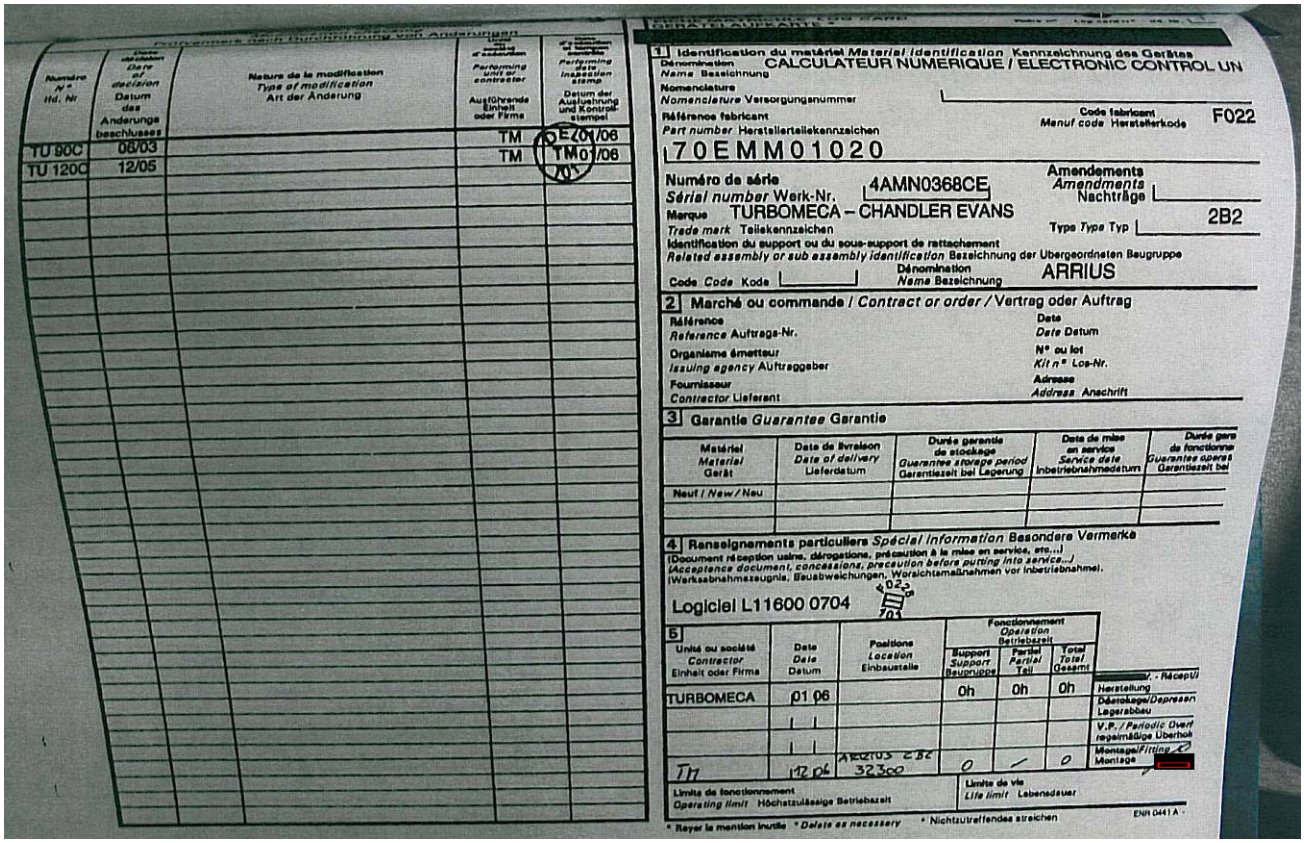


Figure C-8

Appendix D
SN 4AMN0368CE Log card



Numéro N° Ind. Nr	Date de déclaration Datum des Änderungsbeschlusses	Nature de la modification Type of modification Art der Änderung	Performing unit or contractor Ausführende Einheit oder Firma	Performing inspection stamp Datum der Ausführung und Kontrollstempel
TU 90C	08/03		TM	02/06
TU 120C	12/05		TM	TM01/06

1 Identification du matériel Material identification Kennzeichnung des Gerätes
Dénomination Name Bezeichnung: CALCULATEUR NUMERIQUE / ELECTRONIC CONTROL UN
Nomenclature Nomenclature Versorgungsnummer
Référence fabricant Part number Herstellerteilekennzeichen: 70EMM01020
Code fabricant Manuf code Herstellerkode: F022
Numéro de série Serial number Werk-Nr.: 4AMN0368CE
Amendements Amendments Nachträge
Marque Trade mark Teilekennzeichen: TURBOMECA – CHANDLER EVANS
Type Type Typ: 2B2
Identification du support ou du sous-support de rattachement Related assembly or sub assembly identification Bezeichnung der Übergeordneten Baugruppe
Code Code Kode
Dénomination Name Bezeichnung: ARRIUS

2 Marché ou commande / Contract or order / Vertrag oder Auftrag
Référence Reference Auftrags-Nr.
Date Date Datum
Organisme émetteur Issuing agency Auftraggeber
N° ou lot Kit n° Los-Nr.
Fournisseur Contractor Lieferant
Adresse Address Anschrift

3 Garantie Guarantee Garantie

Matériel Material Gerät	Date de livraison Date of delivery Lieferdatum	Durée garantie de stockage Guarantee storage period Garantiezeit bei Lagerung	Date de mise en service Service date Inbetriebnahmedatum	Durée garantie de fonctionnement Guarantee operat Garantiezeit bei
Neuf / New / Neu				

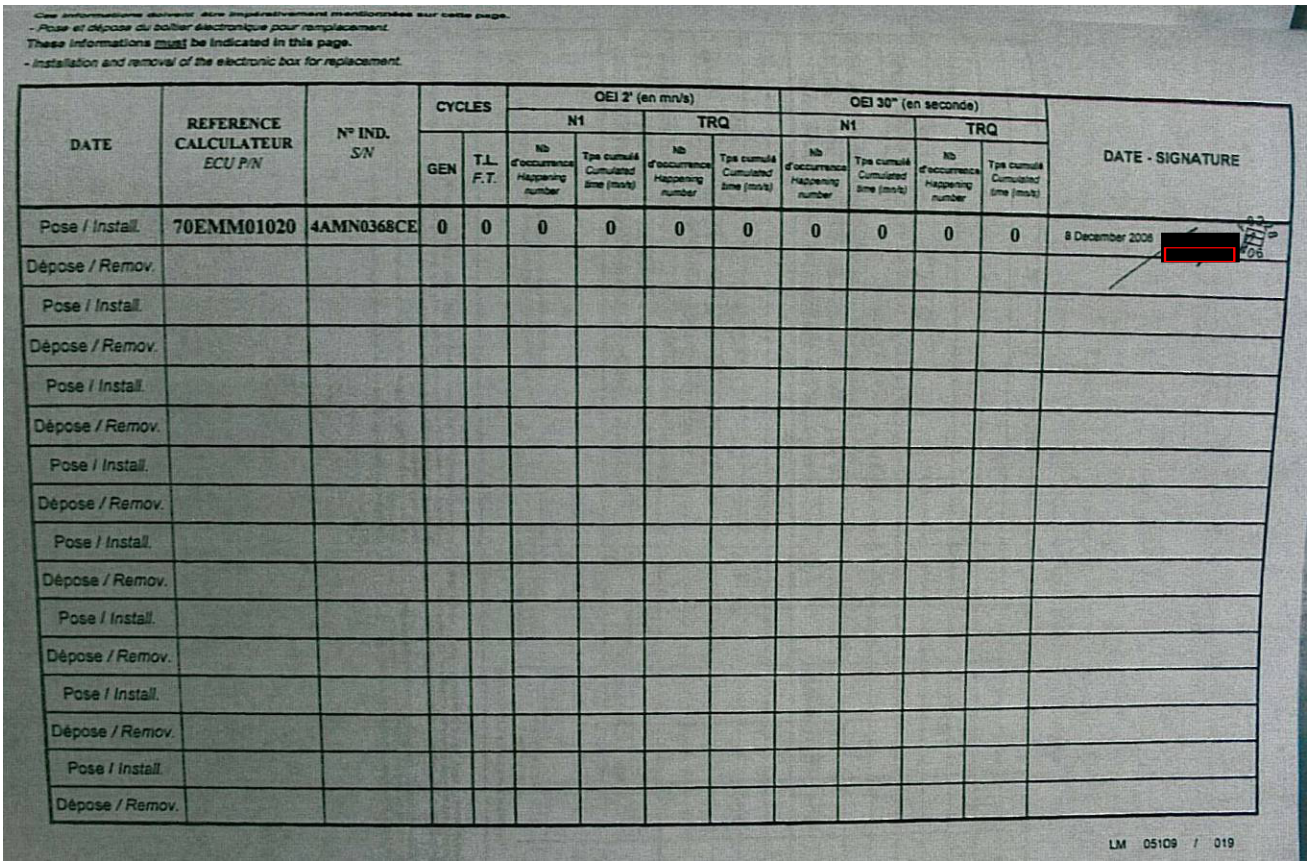
4 Renseignements particuliers Special information Besondere Vermerke
(Document réception usine, dérogations, précaution à la mise en service, etc...)
(Acceptance document, concessions, precaution before putting into service...)
(Werksabnahmezeugnis, Bausbweichungen, Vorsichtsmaßnahmen vor Inbetriebnahme).
Logiciel L11600 0704

5

Unité ou société Contractor Einheit oder Firma	Date Date Datum	Positions Location Einbaustelle	Fonctionnement Operation Betriebszeit: Support Support Beaufsicht	Partiel Partial Teil	Total Total Gesamt
TURBOMECA	01 06		0h	0h	0h
TM	17 06	ARRIUS 2B2 32300	0	—	0

Limite de fonctionnement Operating limit Höchstzulässige Betriebszeit
Limite de vie Life limit Lebensdauer
Hersteller/ - Récepti
Herstellung
Décollage/Depressen
Lagerabbau
V.P. / Periodic Overh
regelmäßige Überhol
Montage/Fitting
Montage
* Rayer la mention inutile * Delete as necessary * Nichtzutreffendes streichen
ENR 0441 A

Figure D-1



- Pose et dépose du boîtier électronique pour remplacement.
These informations must be indicated in this page.
- Installation and removal of the electronic box for replacement.

DATE	REFERENCE CALCULATEUR ECU P/N	N° IND. S/N	CYCLES GEN	CYCLES T.L. F.T.	OEI 2' (en mn/s) N1 Nb d'occurrence Happening number	OEI 2' N1 Tps cumulé Cumulated time (mn/s)	OEI 2' TRQ Nb d'occurrence Happening number	OEI 2' TRQ Tps cumulé Cumulated time (mn/s)	OEI 30" (en seconde) N1 Nb d'occurrence Happening number	OEI 30" N1 Tps cumulé Cumulated time (mn/s)	OEI 30" TRQ Nb d'occurrence Happening number	OEI 30" TRQ Tps cumulé Cumulated time (mn/s)	DATE - SIGNATURE
Pose / Install.	70EMM01020	4AMN0368CE	0	0	0	0	0	0	0	0	0	0	8 December 2006 [redacted]
Dépose / Remov.													
Pose / Install.													
Dépose / Remov.													
Pose / Install.													
Dépose / Remov.													
Pose / Install.													
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Pose / Install.													
Dépose / Remov.													
Pose / Install.													
Dépose / Remov.													

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Figure D-1

Appendix E
Visual examination images of SN 2AMN0166CE

Figure E-1

Figure E-2

Figure E-3

Figure E-4

Figure E-5

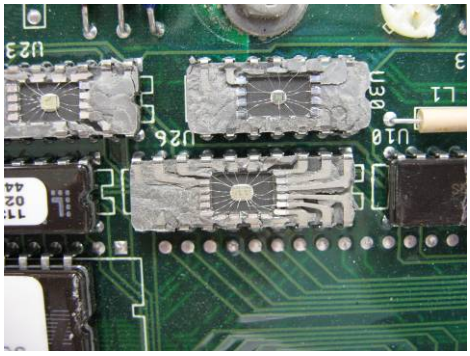
Figure E-6

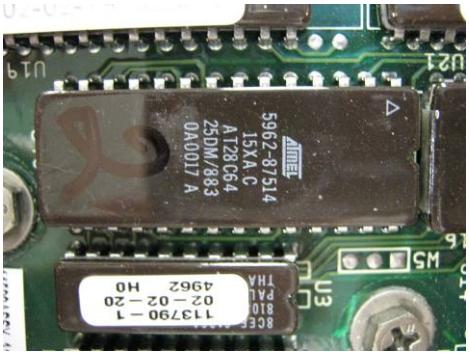

Figure E-7

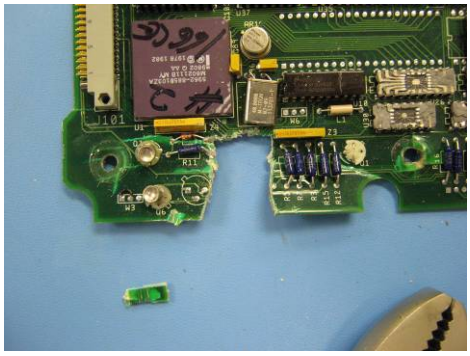
Figure E-8

Appendix F
Most recent record of FADEC history data downloaded from SN 4AM0368CE

INTERFACE SOFTWARE FOR EECU ARRIUS 2B2
Technical occurrences (ARINC 429) - TL0115G103
70EMM01010_4AMN0368CE_1.dmp

Name	al eldanaf
Company	Air Methods Corp.
Date	24/06/2008
Time	13:11:05
Place	W. hartford, CT
Engine - Designation	ARRIUS 2B2
Engine - Serial number	32300
EECU - Part number	70EMM01010
EECU - Serial number	4AMN0368CE

Maintenance Blocks : Parameters

EcuTotTime (h)	**516.3**
PowONTime (s)	**408**
N1 (%)	**89.69**
N2 (%)	**117.81**
P0 (mBar)	**956.8**
P3 (Bar)	**5.980**
T1 (Deg C)	**11.10**
T4 (Deg C)	**686.3**
XCP (%)	**71.95**
Torquemeter offset (daN.m)	**-0.38**
Torquemeter slope	**139.17**
Torque (daN.m)	**5.08**
XR (°)	**40.52**
N1 demand (%)	**60.79**
Fuel flow demand (l/h)	**127.4**
OS_IBIT_RAW (A)	**0.000**
VOS_RAW (V)	**0.00**

INTERFACE SOFTWARE FOR EECU ARRIUS 2B2
Technical occurrences (ARINC 429) - TL0115G103
70EMM01010_4AMN0368CE_1.dmp

Name	al eldanaf
Company	Air Methods Corp.
Date	24/06/2008
Time	13:11:05
Place	W. hartford, CT
Engine - Designation	ARRIUS 2B2
Engine - Serial number	32300
EECU - Part number	70EMM01010
EECU - Serial number	4AMN0368CE

Maintenance Blocks : Discrete words

Discrete inputs

Bit 01 :	**0**	Spare
Bit 02 :	**0**	Spare
Bit 03 :	**1**	FMU out of neutral position
Bit 04 :	**1**	FLIGHT input
Bit 05 :	**0**	IDLE input
Bit 06 :	**0**	STOP input
Bit 07 :	**0**	OEI 30s/2min topping selection
Bit 08 :	**0**	MANUAL input
Bit 09 :	**0**	Torque offset decrease input
Bit 10 :	**0**	Torque offset increase input
Bit 11 :	**0**	Spare
Bit 12 :	**0**	OEI TRAINING mode input
Bit 13 :	**0**	Spare
Bit 14 :	**0**	Spare
Bit 15 :	**0**	Category A mode input
Bit 16 :	**0**	Spare

Discrete outputs

Bit 01 :	**0**	TRAINING FLIGHT mode
Bit 02 :	**0**	TRAINING IDLE mode
Bit 03 :	**0**	MANUAL mode
Bit 04 :	**0**	Training authorisation
Bit 05 :	**0**	2min OEI Topping
Bit 06 :	**1**	Degraded control
Bit 07 :	**0**	Redundancy status
Bit 08 :	**0**	GROUND IDLE mode
Bit 09 :	**0**	Engine exceed
Bit 10 :	**0**	Total failure
Bit 11 :	**0**	Torque matching authorisation
Bit 12 :	**0**	Engine/helicopter limit exceedence
Bit 13 :	**0**	Power-up self test
Bit 14 :	**0**	Category A mode selected
Bit 15 :	**1**	Mixed mode
Bit 16 :	**0**	P3 bleed interdiction

INTERFACE SOFTWARE FOR EECU ARRIUS 2B2
Technical occurrences (ARINC 429) - TL0115G103
70EMM01010_4AMN0368CE_1.dmp

Name	al eldanaf
Company	Air Methods Corp.
Date	24/06/2008
Time	13:11:05
Place	W. hartford, CT
Engine - Designation	ARRIUS 2B2
Engine - Serial number	32300
EECU - Part number	70EMM01010
EECU - Serial number	4AMN0368CE

Maintenance Blocks : Failure flags

Failure flags 1

Bit 01 :	**0**	Stepper motor: loss of step
Bit 02 :	**0**	XCP consistency failure
Bit 03 :	**0**	Selector failure
Bit 04 :	**0**	N2 Trim failure
Bit 05 :	**0**	Collective pitch failure
Bit 06 :	**0**	T45 channel failure
Bit 07 :	**0**	T1 channel failure
Bit 08 :	**0**	P3 channel failure
Bit 09 :	**1**	Torque channel failure
Bit 10 :	**0**	Torque conformation failure
Bit 11 :	**0**	Delta N1 indication failure
Bit 12 :	**0**	Torque offset trim input failure
Bit 13 :	**1**	Torque indication failure
Bit 14 :	**0**	Internal failure (EECU)
Bit 15 :	**1**	External failure (harness or sensor)
Bit 16 :	**0**	P0 failure

Failure flags 2

Bit 01 :	**0**	Resolver channel failure
Bit 02 :	**0**	Stepper motor channel failure
Bit 03 :	**0**	CAT A switch fault
Bit 04 :	**0**	X-talk failure
Bit 05 :	**0**	N2 B channel failure
Bit 06 :	**0**	N1 B channel failure
Bit 07 :	**0**	N2 A channel failure
Bit 08 :	**0**	2min OEI topping selection consistency failure
Bit 09 :	**0**	Training switch consistency failure
Bit 10 :	**0**	P0 consistency failure
Bit 11 :	**0**	Alternator failure
Bit 12 :	**0**	28 Volts AIRFRAME failure
Bit 13 :	**0**	Non volatile RAM full
Bit 14 :	**0**	Fuel shut off Electro-valve failure
Bit 15 :	**0**	P3 shift or engine flame-out
Bit 16 :	**0**	T1 consistency failure

Failure flags 3

Bit 01 :	**0**	Fault 1
Bit 02 :	**1**	Fault 2
Bit 03 :	**0**	RAM fault
Bit 04 :	**0**	PROM fault
Bit 05 :	**0**	Watchdog init fault
Bit 06 :	**0**	Slowtask loss
Bit 07 :	**0**	Fast task loss
Bit 08 :	**0**	Background task loss
Bit 09 :	**0**	Conf table error (Config_Fit)
Bit 10 :	**0**	Serial link fault
Bit 11 :	**0**	EEPROM fault
Bit 12 :	**0**	Spare
Bit 13 :	**0**	Actuator blocking power supply fault
Bit 14 :	**0**	Actuator displacement demand fault
Bit 15 :	**0**	12 bits A/D converter fault
Bit 16 :	**0**	8 bits A/D converter fault

Failure flags 4

Bit 01 :	**0**	F/D converter fault (N1a/N2b)
Bit 02 :	**0**	F/D converter fault (Tq2/MP count)
Bit 03 :	**0**	F/D converter fault (N1b/N2a)
Bit 04 :	**0**	Low alternator voltage (<10V)
Bit 05 :	**0**	Phase A actuator Vbit error
Bit 06 :	**0**	Phase B actuator Vbit error
Bit 07 :	**0**	Phase C actuator Vbit error
Bit 08 :	**0**	Phase D actuator Vbit error
Bit 09 :	**0**	Actuator current fault (SMIBiT)
Bit 10 :	**0**	N1A continuity fault
Bit 11 :	**0**	N2A continuity fault
Bit 12 :	**0**	N2B continuity fault
Bit 13 :	**0**	TQ2 continuity fault
Bit 14 :	**0**	Chopped power supply inactive
Bit 15 :	**0**	5V power supply fault
Bit 16 :	**0**	15V power supply fault

Failure flags 5

Bit 01 :	**0**	Overspeed triggered (OS3_VBIT)
Bit 02 :	**0**	Overspeed triggered (OS4_VBIT)
Bit 03 :	**0**	O.S. system fault (OS_SYS_FLT)
Bit 04 :	**0**	O.S. current measurement fault (VOS_VALID)
Bit 05 :	**0**	O.S. power supply fault (VOS_VALID)
Bit 06 :	**0**	Spare
Bit 07 :	**0**	Spare
Bit 08 :	**0**	Spare
Bit 09 :	**0**	Spare
Bit 10 :	**0**	Spare
Bit 11 :	**0**	Spare
Bit 12 :	**0**	Spare
Bit 13 :	**0**	Spare
Bit 14 :	**0**	Spare
Bit 15 :	**0**	Spare
Bit 16 :	**0**	Spare

Appendix G

Most recent record of FADEC history data downloaded from SN 2AMN0166CE

INTERFACE SOFTWARE FOR EECU ARRIUS 2B2
Technical occurrences (ARINC 429) - TL0115G103
70EMM01010_2AMN0166CE_1.dmp

Name	Al Eldanaf
Company	Air Methods Corp.
Date	24/06/2008
Time	13:24:17
Place	W. Hartford, CT
Engine - Designation	ARRIUS 2B2
Engine - Serial number	32309
EECU - Part number	70EMM01010
EECU - Serial number	2AMN0166CE

Overspeed Block : Parameters

EcuTotTime (h)	**398.9**
PowONTime (s)	**408**
N1 (%)	**81.02**
N2 (%)	**117.69**
P0 (mBar)	**957.4**
P3 (Bar)	**4.140**
T1 (Deg C)	**11.10**
T4 (Deg C)	**669.4**
Pitch (%)	**61.34**
Torquemeter offset (daN.m)	**-0.08**
Torquemeter slope	**135.25**
Torque (daN.m)	**10.91**
XR (°)	**40.69**
N1 demand (%)	**47.43**
Fuel flowdemand (l/h)	**123.8**
OS_IBIT_RAW (A)	**0.000**
VOS_RAW (V)	**0.00**

INTERFACE SOFTWARE FOR EECU ARRIUS 2B2
Technical occurrences (ARINC 429) - TL0115G103
70EMM01010_2AMN0166CE_1.dmp

Name	Al Eldanaf
Company	Air Methods Corp.
Date	24/06/2008
Time	13:24:17
Place	W. Hartford, CT
Engine - Designation	ARRIUS 2B2
Engine - Serial number	32309
EECU - Part number	70EMM01010
EECU - Serial number	2AMN0166CE

Overspeed Block : Discrete words

Discrete inputs

Bit 01 :	**0**	Spare
Bit 02 :	**0**	Spare
Bit 03 :	**0**	FMU out of neutral position
Bit 04 :	**1**	FLIGHT input
Bit 05 :	**0**	IDLE input
Bit 06 :	**0**	STOP input
Bit 07 :	**0**	OEI 30s/2min topping selection
Bit 08 :	**0**	MANUAL input
Bit 09 :	**0**	Torque offset decrease input
Bit 10 :	**0**	Torque offset increase input
Bit 11 :	**0**	Spare
Bit 12 :	**0**	OEI TRAINING mode input
Bit 13 :	**0**	Spare
Bit 14 :	**0**	Spare
Bit 15 :	**0**	Category A mode input
Bit 16 :	**0**	Spare

Discrete outputs

Bit 01 :	**0**	TRAINING FLIGHT mode
Bit 02 :	**0**	TRAINING IDLE mode
Bit 03 :	**0**	MANUAL mode
Bit 04 :	**0**	Training authorisation
Bit 05 :	**0**	2min OEI Topping
Bit 06 :	**0**	Degraded control
Bit 07 :	**0**	Redundancy status
Bit 08 :	**0**	GROUND IDLE mode
Bit 09 :	**0**	Engine exceed
Bit 10 :	**0**	Total failure
Bit 11 :	**1**	Torque matching authorisation
Bit 12 :	**0**	Engine/helicopter limit exceedence
Bit 13 :	**0**	Power-up self test
Bit 14 :	**0**	Category A mode selected
Bit 15 :	**0**	Mixed mode
Bit 16 :	**0**	P3 bleed interdiction

Technical occurrences (ARINC 429) - TL0115G103
70EMM01010_2AMN0166CE_1.dmp

Name	Al Eldanaf
Company	Air Methods Corp.
Date	24/06/2008
Time	13:24:17
Place	W. Hartford, CT
Engine - Designation	ARRIUS 2B2
Engine - Serial number	32309
EECU - Part number	70EMM01010
EECU - Serial number	2AMN0166CE

Overspeed Block : Failure flags

Failure flags 1

Bit 01 :	0	Stepper motor: loss of step
Bit 02 :	0	XCP consistency failure
Bit 03 :	0	Selector failure
Bit 04 :	0	N2 Trim failure
Bit 05 :	0	Collective pitch failure
Bit 06 :	0	T45 channel failure
Bit 07 :	0	T1 channel failure
Bit 08 :	0	P3 channel failure
Bit 09 :	0	Torque channel failure
Bit 10 :	0	Torque conformation failure
Bit 11 :	0	Delta N1 indication failure
Bit 12 :	0	Torque offset trim input failure
Bit 13 :	0	Torque indication failure
Bit 14 :	0	Internal failure (EECU)
Bit 15 :	0	External failure (harness or sensor)
Bit 16 :	0	P0 failure

Failure flags 2

Bit 01 :	0	Resolver channel failure
Bit 02 :	0	Stepper motor channel failure
Bit 03 :	0	CAT A switch fault
Bit 04 :	0	X-talk failure
Bit 05 :	0	N2 B channel failure
Bit 06 :	0	N1 B channel failure
Bit 07 :	0	N2 A channel failure
Bit 08 :	0	2min OEI topping selection consistency failure
Bit 09 :	0	Training switch consistency failure
Bit 10 :	0	P0 consistency failure
Bit 11 :	0	Alternator failure
Bit 12 :	0	28 Volts AIRFRAME failure
Bit 13 :	0	Non volatile RAM full
Bit 14 :	0	Fuel shut off Electro-valve failure
Bit 15 :	0	P3 shift or engine flame-out
Bit 16 :	0	T1 consistency failure

Failure flags 3

Bit 01 :	0	Fault 1
Bit 02 :	0	Fault 2
Bit 03 :	0	RAM fault
Bit 04 :	0	PROM fault
Bit 05 :	0	Watchdog init fault
Bit 06 :	0	Slowtask loss
Bit 07 :	0	Fast task loss
Bit 08 :	0	Background task loss
Bit 09 :	0	Conf table error (Config_Fit)
Bit 10 :	0	Serial link fault
Bit 11 :	0	EEPROM fault
Bit 12 :	0	Spare
Bit 13 :	0	Actuator blocking power supply fault
Bit 14 :	0	Actuator displacement demand fault
Bit 15 :	0	12 bits A/D converter fault
Bit 16 :	0	8 bits A/D converter fault

Failure flags 4

Bit 01 :	0	F/D converter fault (N1a/N2b)
Bit 02 :	0	F/D converter fault (Tq2/MP count)
Bit 03 :	0	F/D converter fault (N1b/N2a)
Bit 04 :	0	Low alternator voltage (<10V)
Bit 05 :	0	Phase A actuator Vbit error
Bit 06 :	0	Phase B actuator Vbit error
Bit 07 :	0	Phase C actuator Vbit error
Bit 08 :	0	Phase D actuator Vbit error
Bit 09 :	0	Actuator current fault (SMIBiT)
Bit 10 :	0	N1A continuity fault
Bit 11 :	0	N2A continuity fault
Bit 12 :	0	N2B continuity fault
Bit 13 :	0	TQ2 continuity fault
Bit 14 :	0	Chopped power supply inactive
Bit 15 :	0	5V power supply fault
Bit 16 :	0	15V power supply fault

Failure flags 5

Bit 01 :	0	Overspeed triggered (OS3_VBIT)
Bit 02 :	0	Overspeed triggered (OS4_VBIT)
Bit 03 :	0	O.S. system fault (OS_SYS_FLT)
Bit 04 :	0	O.S. current measurement fault (VOS_VALID)
Bit 05 :	0	O.S. power supply fault (VOS_VALID)
Bit 06 :	0	Spare
Bit 07 :	0	Spare
Bit 08 :	0	Spare
Bit 09 :	0	Spare
Bit 10 :	0	Spare
Bit 11 :	0	Spare
Bit 12 :	0	Spare
Bit 13 :	0	Spare
Bit 14 :	0	Spare
Bit 15 :	0	Spare
Bit 16 :	0	Spare

Note:

The fault history download files (36 pages per file) for both ECUs SN 2AMN0166CE and 4AMN0368CE will be archived for future reference with this report original file.

Fault History
4AMN0368CE

Fault History
2AMN0166CE