ATTACHMENT 7

Rockwell Collins CRASH INVESTIGATION REPORT FOR THE FMC-3000

Rockwell Collins
CABIN SYSTEMS

CRASH INVESTIGATION REPORT FOR THE FMC-3000

AIR-13-05

DATE:
LOCATION: South Bend Regional Airport, Indiana
AIRLINE CUSTOMER: DigiCut Systems
DATE OF INCIDENT: March 17, 2013
AIRCRAFT TYPE / TAIL: Beechcraft Premier 1A / N26DK SN: RB-226
DESCRIPTION / PART# / SERIAL#:
FMC-3000 / 822-0883-703 Rev - / SN: 28DPH
REPORTED PROBLEM: A Beechcraft Premier IA corporate jet, registered N24DK, was destroyed in a landing accident at South Bend Regional Airport, Indiana, USA. The NTSB requested that Rockwell Collins examine the FMC-3000 Flight Management Computer that were in the aircraft and retrieve the NVM (Non-volatile Memory) fault data if possible.
IFF Reported to (Authority) FAA

Test Date: March 25, 2014

Cognizant Engineer: Vance Munson

Avionics Certification Dept Representative: Robert (Wayne) Haug

Technician performing Teardown: Randy Pasker

Authorities to be present if any: Perry Ochsner and Tony Will from the FAA for inspection of the units and George Haralampopoulos from the NTSB for the reading of the NVM.

System Description:

Part of the Flight Management System (FMS) (Avionics Management System (AMS) for FMC-5000), the FMC-3000/4200/5000/6000 provides an interface between the left and right avionics systems and the Control Display Unit (CDU). The Flight (Avionics) Management System performs the following tasks typically attributed to the FMS:

- Building and editing flight plans.
- Lateral flight plan point-to-point navigation (using multiple NAV sensors).
- Vertical navigation (V/NAV).
- Flight parameter computations.
- Lateral/vertical steering command outputs to flight control system.
- Selecting navigation modes.
- Tuning navigation and communication receivers.
- Selecting the display formats presented by other cockpit display units.

Purpose:

The purpose of this document is to provide a plan to download and read the nonvolatile memory (NVM) from the FMC-3000 listed above. It describes a logical order to inspect, disassemble and download memory. It is clear from photographic evidence that the unit was physically stressed beyond its specifications.

Note that the FMC-3000 SN 28DPH has severe mechanical damage such that it might not be possible to be loaded into existing CTA-2028/2029/2030 test fixtures. If this proves true we will have to improvise a test equipment setup that may allow the CCA's to be loaded into for NVM download.

1. General Instructions/Guidelines

    a. The FMC-3000 is to remain in the custody of the Avionics Certification Department (ACD) until released by the (ACD) to engineering by a designated QA representative. No teardown, testing or analysis of the FMC-3000 may be done without the permission of the (ACD) or a designated QA personnel who shall be present, or delegate someone to present, to conduct this investigation. All disassembly/reassembly/testing of the FMC-3000 is contingent upon permission of the designated QA representative and or (ACD) at each step of the disassembly, reassembly, or power-up testing.

    Note: This Teardown Plan is to be filled out by the cognizant engineer of the example unit and submitted to the (ACD) for approval.

    This same person (ACD) is also responsible for communication and coordination with any government /regulatory agency that may be involved.

b. Each step of the investigation shall be documented with photographs and notes as appropriate.

c. All test equipment shall have the part numbers, serial numbers, and calibration dates recorded along with photographs of the test areas and the test equipment. Refer to page 8.

d. The FMC-3000 shall be handled on a certified ESD test bench. All personnel involved in handling the FMC-3000 must follow ESD practices and procedures. When the FMC-3000 is disassembled for the investigation, each sub-assembly/component removed shall be placed in a separate ESD bag. Any removable debris found in the FMC-3000 (whether dust, metal particles, paper, food, insects, etc.) shall be stored in a re-sealable bag for possible future analysis.

    i. ESD controls were used per Collins Workmanship Standard (CPN: 523-0778764).

e. All the packaged materials that came with the FMC-3000 shall be retained for reference.

    i. All materials were retained.

f. Ensure that all the necessary drawings are available on hand for review; those include top assembly, BOM, schematic, test procedures and ECNs.

g. Ensure and record that all the required personnel Avionics Certification Department (ACD), FAA, Cognizant Engineer and Technician performing the teardown are present. Proceed to perform each step of the investigation only if requisite authority grants permission.

    i. ACD: Robert (Wayne) Haug

    ii. FAA: Perry Ochsner and Tony Will were present for the initial inspection and opening of the unit.

    iii. NTSB: George Haralampopoulos was present for the reading of the NVM.

    iv. Cognizant Engineer: Vance Munson

    v. Technician: Randy Pasker

2. <u>Prior to opening the Shipping Container</u>

    a. Examine shipping container for any trace of abnormal smell or odor.

        i. Shipping container in good condition.

    b. Examine condition of the shipping container that houses the FMC-3000 for signs of wear & tear or any physical damage.

        i. Minor damage noted. Minor damage did not translate to any internal damage to units.

    c. Examine shipping container for signs of liquid spills or contamination on the container's surfaces.

        i. No signs of liquid spills or contamination.

d. Take photos of the Shipping Container and shipping paperwork.

    i. See Figure 3 through Figure 7 in Appendix A.

3. Open Shipping Container

    a. Immediately examine for any trace of abnormal smell as soon as the container is opened and record the finding.

        i. No abnormal smell noted.

    b. Take photos of the contents prior to removal from the shipping container.

        i. See Figure 8 through Figure 11 in Appendix A.

4. Remove contents of the Shipping Container

    a. Immediately examine for any trace of abnormal smell as soon as the FMC-3000 is removed from the container & packing material. Record the finding.

        i. No abnormal smell noted.

    b. Take photos of the contents immediately after removal from the container.

        i. See Figure 12 and Figure 13.

    c. Note any issue(s) with the packaging such as loose pieces or torn packaging walls, ESD compliance etc.

        i. Units were wrapped in bubble wrap. No damage to the packaging observed.

    d. Record the contents of the container. Compare the documents to paperwork received (such as Incident Report). Note any discrepancies.

        i. FMC-3000, SN's: 28DPH and 192TC.

5. Detailed External Inspection of the FMC-3000:

    a. Take photos of the FMC-3000 from all sides to show condition of the FMC-3000 being received. Include close-up photos of the ID tag(s) and its warranty seal.

        i. See Figure 14 through Figure 26 in Appendix A.

    b. Examine the FMC-3000 exterior for any possible damage or scratches, any sign of overheating, corrosion, liquid spill or discoloration. Note, record and photograph findings.

        i. Initial visual inspection showed extensive damage to the exterior covers and some foreign material was inside the unit. See Figure 14 through Figure 26 in Appendix A.

    c. Inspect the external connectors and check for ESD protection. Look for any signs of damages in the connector shells and pins for liquid spill, corrosion, overheating and discoloration. Note, record and photograph findings.

        i. Figures 21, 22, 24 and 25 show that there is some damage to the A1 CCA connector.

6. Depending upon the finding(s), decide the next steps whether seeing the FMC-3000 open up for further inspection examination is necessary, or if continuing with testing is prudent.

    a. Figure 27 through Figure 33 show considerable damage on the circuit card assemblies and the NVRAM batteries. It was decided to measure the NVRAM battery voltage to determine if downloading the NVRAM data would be viable. Battery voltage read 0Vdc. NVRAM data is not recoverable, further teardown on the unit is not necessary therefore teardown was stopped.

7. Before powering up the FMC-3000 for a preliminary diagnostic, record P/N and calibration date of the test equipment used and results found. Perform a continuity check at the I/O connectors to check for power to GND electrical shorts using a DMM (see Continuity check reference points below) ***prior to applying power***. Record each measurement and state if it passes or not.

    a. Continuity check at Rear Connector P1

        Use the Digital Multimeter (DMM) to verify for a short circuit (resistance reading less than 50 Ohm) in the following pairs on the rear connector (P1):

        i. A12 and A9 (Power GND and +12V DC)

        ii. A12 and A21 (Power GND and +5V DC)

        iii. A12 and A54 (Power GND and -12V DC)

    b. Preliminary testing

        If the FMC-3000 fails continuity check, proceed to open assembly for examination. Otherwise proceed to step 9.

8. <u>Open assembly for examination</u>

    a. Remove the five mounting screws that hold the covers together and carefully pull the two covers apart.

    b. Before proceeding further, visually examine the FMC-3000's interior and document any damage observed. Note and photograph the FMC-3000's interior.

    c. Remove the A3 card. Remove the nut and washer holding the A1 and A2 cards together and separate the cards. Examine each card for signs of overheating, or discoloration of traces, or components and document any damage observed. Take detailed photos of all three boards and note their condition.

    d. Review all photos for clarity. Retake pictures if necessary.

9. <u>Downloading NVM Data</u>:

    a. Test Equipment – See Reference below.

    b. If overheated, discoloration, charred or damaged components or traces are visible on any of the assemblies, record the abnormality. Look up the schematic (see reference below) to determine function(s) of each abnormal component or circuitry. Based on severity of damage and circuit function, determine whether to

proceed with power application. Take notes and photos as necessary to document the findings.

c. A laptop fixture will be used to extract the NVM contents from the FMC as shown in Figure 1 and 2.

d. Reference Figure 2, ensure the I/O Nav switch on the back of the 28 Vdc power box is set to the "Nav" position.

e. Reference Figure 2, ensure that 28 Vdc power to the FMC is turned on.

f. On the PC Desktop, open "FMS Loader" program (CPN: 832-0888-005).

g. Select "Dump Logs" tab.

h. Select location that "Dump Log" files will be sent to.

i. Name file as a text (.txt) file.

j. Note, problems downloading NVM data could be attributed to insufficient battery voltage. Verify battery voltage to see if this could be contributing to NVM data downloading problem.

Figure 1: Test fixture used to extract NVM from the FMC-3000

Figure 2: FMC-3000 in the mount used for extracting NVM

10. Assessment

SN 28DPH was removed from its shipping box. Initial visual inspection showed extensive damage to the exterior covers and some foreign material was inside the unit. The top and bottom covers were able to be removed from the unit without removing the cover screws. The cover screws on one of the covers were pulled through and were not holding the cover onto the CCA assembly. Applying a little pressure to the second cover allowed for the cover screw to detach from the cover.

The Center standoff was bent so a vice grip was used to aid in the removal of the damaged standoff. Reference Figure 3 through Figure 15.

Upon removal of the covers it was determined that the foreign material seen in the unit was insulation from the house that the aircraft crashed into. There was also considerable damage observed on the circuit card assemblies.

Due to the extensive damage and the condition of the NVRAM batteries it was decided to measure the battery voltage to determine if downloading the NVRAM data would be viable. Battery voltage read 0Vdc. NVRAM data is not recoverable. Further teardown of the unit is not necessary. Teardown stopped

Reference

1. Test Equipment:

Digital Multimeter (DMM) – Fluke 75 True RMS Multimeter (460-0206-091), Calibration Due Date: 11/30/2016.
CTA-2028 – CPN 822-0444-001
CTA-2029 – CPN 822-0445-001
CTA-2030 – CPN 822-0446-001
CTS-2000 – CPN 622-7412

2. Schematics/Assembly Drawings:

Part Number	Description
822-0883-703	FMC-3000, Top Level Assembly

3. ATP:

Part Number	Description
832-0838-002	Acceptance Test Procedure, FMC-3000

Test Log Table

Teardown Plan Section	Action	Results	Notes
7. Preliminary Power up Test	Continuity test: A12 and A9 A12 and A21 A12 and A54		

Appendix A: Investigation Results (March 25, 2014)

Figure 3: Shipping Package

Figure 4: Shipping Package

Figure 5: Shipping Package

Figure 6: Shipping Package

Figure 7: Shipping Package

Figure 8: Shipping Package

Figure 9: Shipping Package

Figure 10: Shipping Package

Figure 11: Shipping Package

Figure 12: Shipping Package

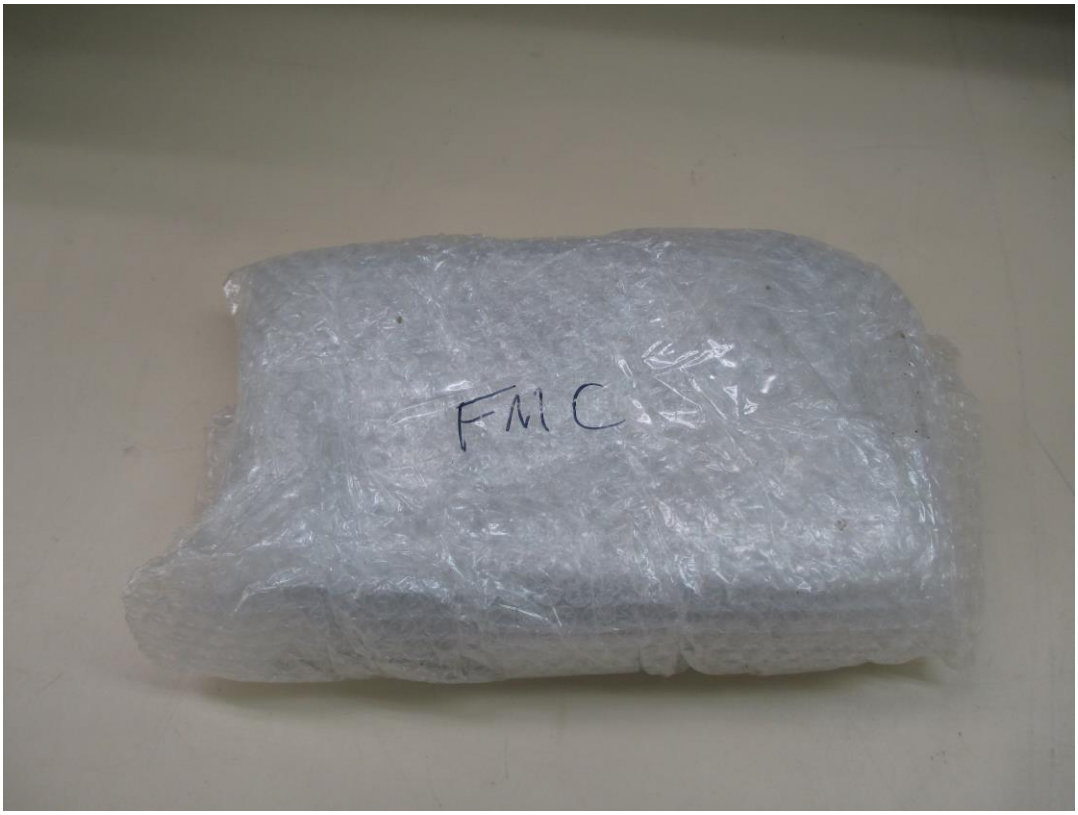

Figure 13: Shipping Package

SN 28DPH was removed from its shipping box. Initial visual inspection showed extensive damage to the exterior covers and some foreign material was inside the unit. The top and bottom covers were able to be removed from the unit without removing the cover screws. The cover screws on one of the covers were pulled through and were not holding the cover onto the CCA assembly. Applying a little pressure to the second cover allowed for the cover screw to detach from the cover.

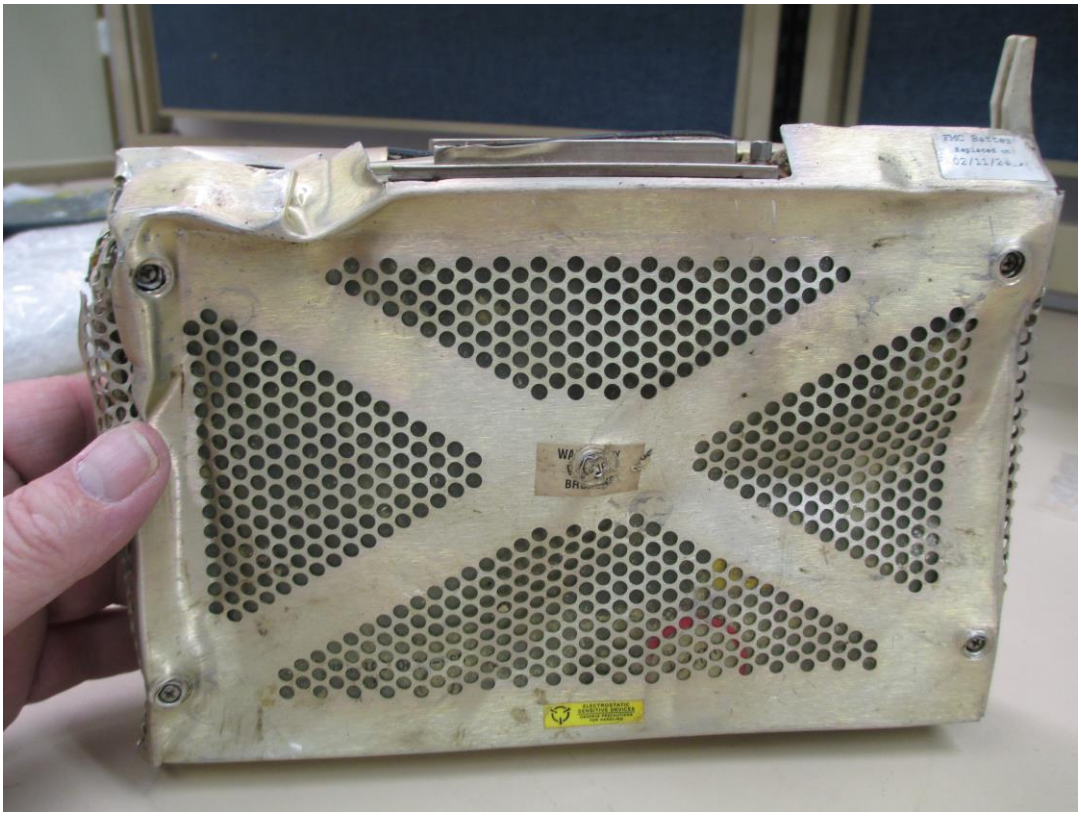

Figure 14: SN 28DPH

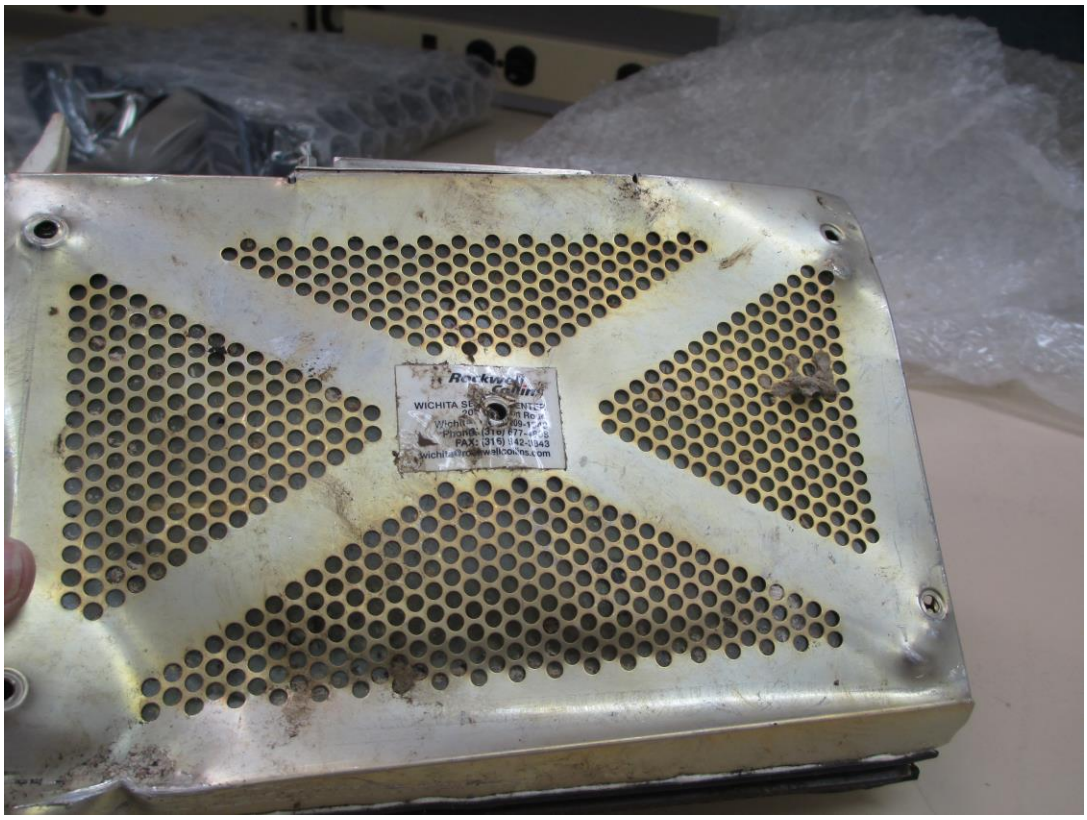

Figure 15: SN 28DPH

Figure 16: SN 28DPH

Figure 17: SN 28DPH

Figure 18: SN 28DPH

Figure 19: SN 28DPH

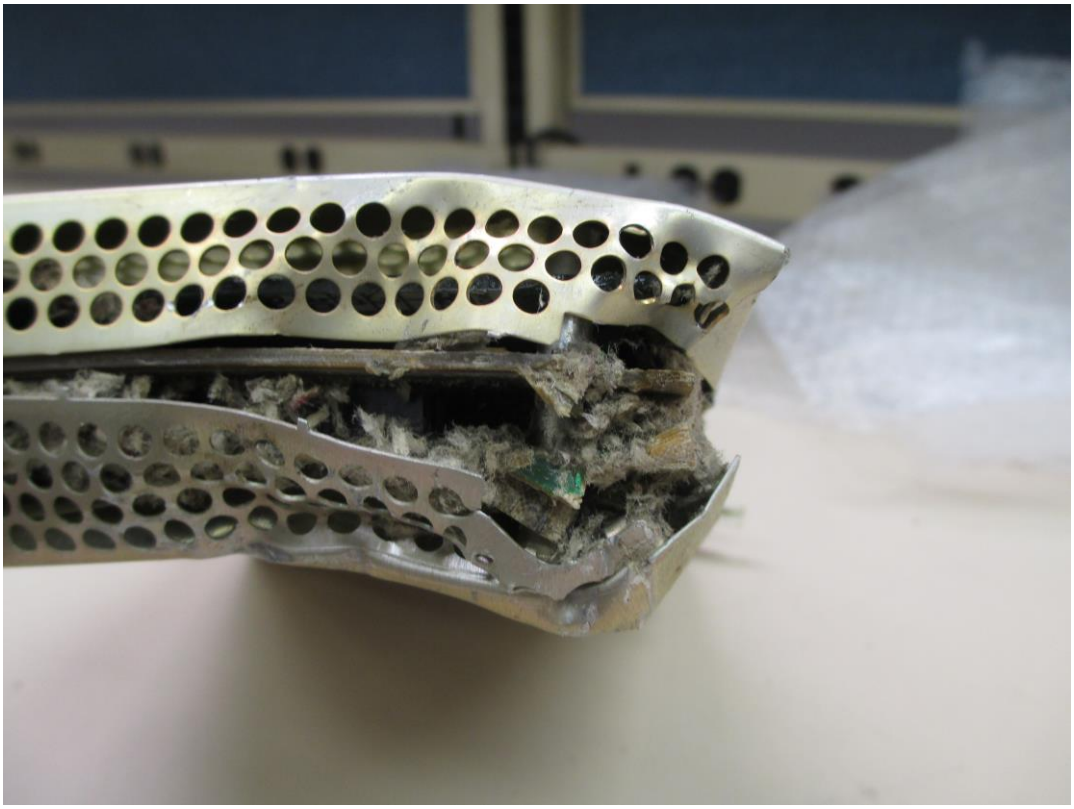

Figure 20: SN 28DPH

Figure 21: SN 28DPH

Figure 22: SN 28DPH

Figure 23: SN 28DPH

Figure 24: SN 28DPH

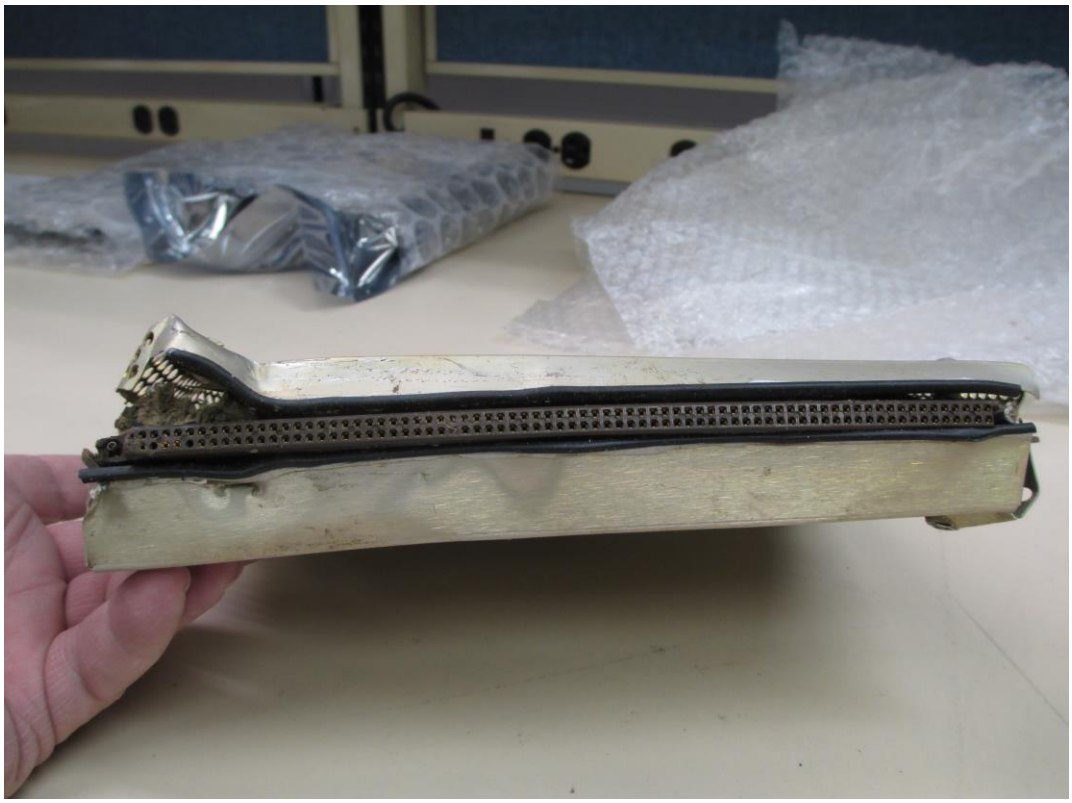

Figure 25: SN 28DPH

Figure 26: SN 28DPH

Upon removal of the covers it was determined that the foreign material seen in the unit was insulation from the house that the aircraft crashed into. There was also considerable damage observed on the circuit card assemblies. Due to the extensive damage and the condition of the NVRAM batteries it was decided to measure the battery voltage to determine if downloading the NVRAM data would be viable.

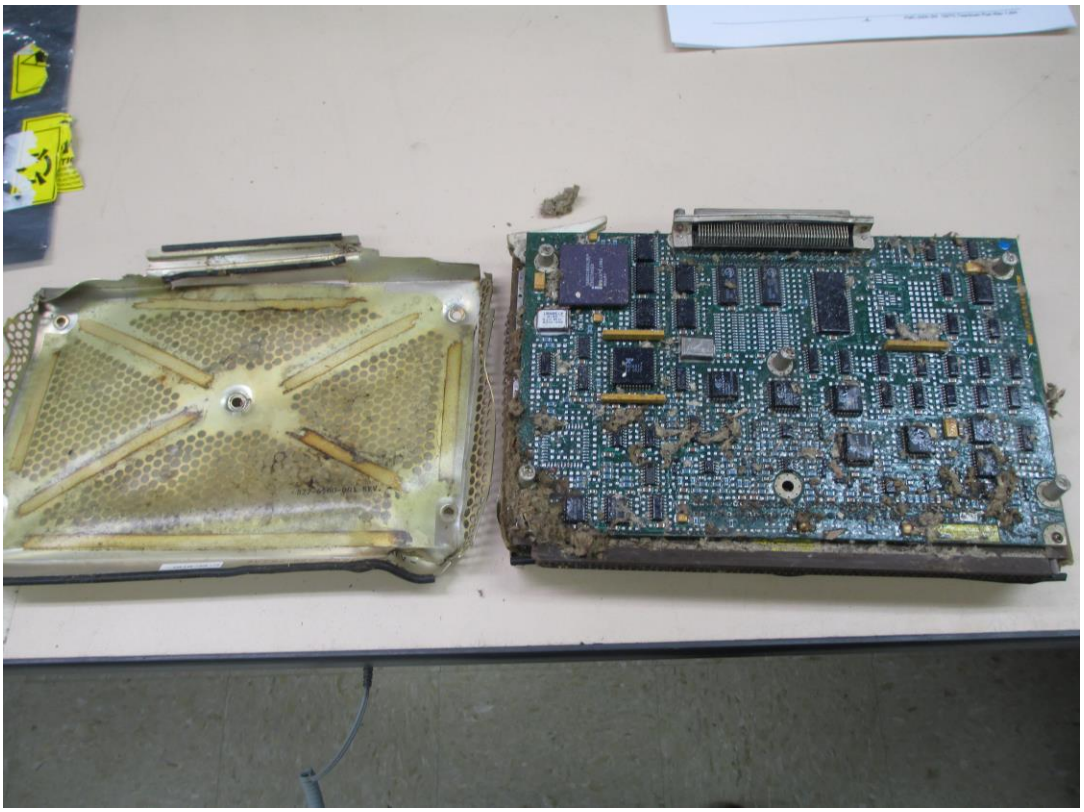

Figure 27: SN 28DPH

Figure 28: SN 28DPH

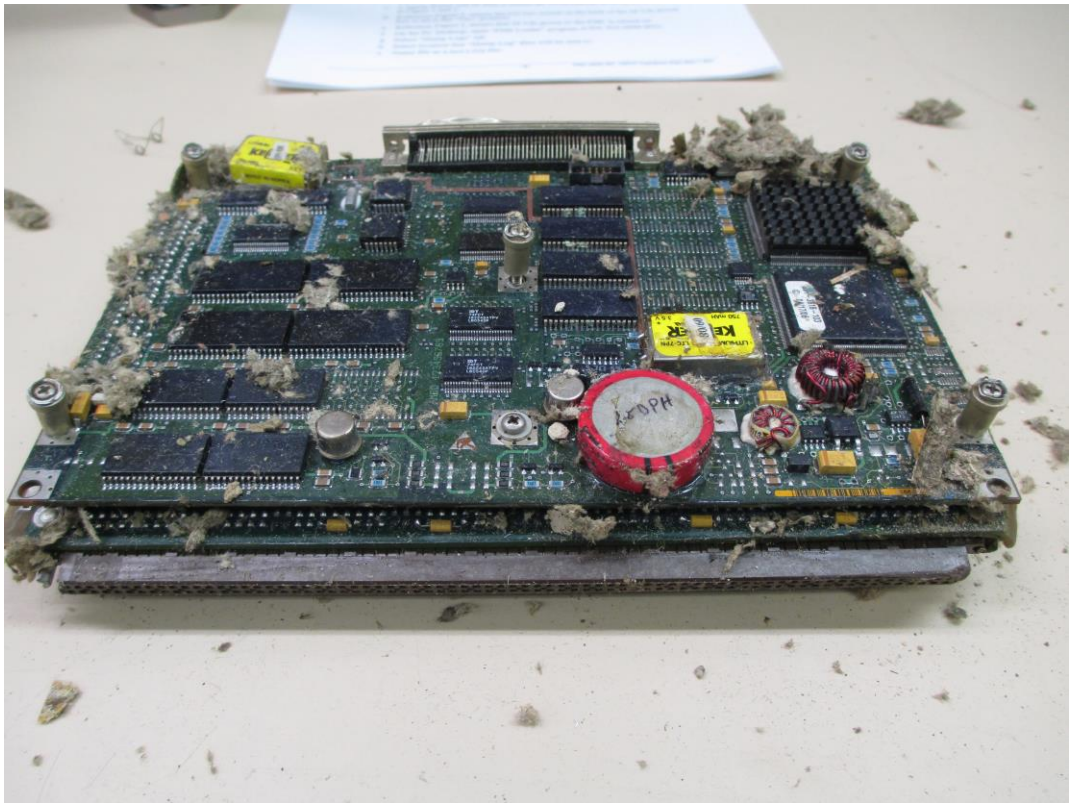

Figure 29: SN 28DPH

Figure 30: SN 28DPH

Figure 31: SN 28DPH

Figure 32: SN 28DPH

Figure 33: SN 28DPH