

NATIONAL TRANSPORTATION SAFETY BOARD
Vehicle Recorder Division
Washington, D.C. 20594

August 30, 2017

Digital Electronic Engine Controls

Specialist's Factual Report
By Bill Tuccio, Ph.D.

1. EVENT SUMMARY

Location: Teterboro, New Jersey
Date: May 15, 2017
Aircraft: Gates Learjet 35A
Registration: N452DA
Operator: Trans-Pacific Air Charter LLC dba Trans-Pacific Jets
NTSB Number: CEN17MA183

2. GROUP

A group was not convened.

3. DETAILS OF INVESTIGATION

The National Transportation Safety Board (NTSB) Vehicle Recorder Division received two Honeywell N1 Digital Electronic Engine Controls (DEECs); due to damage, neither the serial numbers or engine association (that is, left or right) could be determined.

3.1. Device Description

The N1 DEECs include an incident recorder which collects engine and aircraft operational data and records it into non-volatile memory (NVM)¹ for post-accident/incident download and analysis. The incident recorder provides a record of engine speeds, interstage turbine temperatures, aircraft parameters related to the engine, and control modes during operation. Some of the recorded data may come from direct measurement, while others may be calculated parameters; the method depends upon aircraft model. The DEEC casing is not designed to be crash worthy, and recorded data could be lost for a variety of reasons including, but not limited to, impact and fire damage.

The incident recorder collects data into ten memory buffers for the last 85 minutes and 20 seconds of engine ground and/or flight time. The recorder automatically powers off approximately five minutes after weight-on-wheels (WOW) is established. This feature

¹ Non-volatile memory is semiconductor memory that does not require external power for data retention.

prevents the DEEC from accidentally overwriting the data in memory if aircraft power remains on after the engines have been shut down.

The data set stored in the first memory buffer is recorded once per second for the last 512 seconds (8 minutes and 32 seconds) prior to power down or 5 minutes after weight on wheels. For data sets recorded beyond 512 seconds, individual scans are stored in nine additional buffers with decreasing frequency. As data points roll into the downstream buffers, certain data points are dropped. For example, the data points in the second buffer are two seconds apart and the data points in the third buffer are 4 seconds apart, and so on.

The data is recorded in data “buckets” to minimize the space required for data storage. With this recording methodology, the exact data parameter is not physically recorded to memory. A digital bit value that corresponds to a data parameter range is recorded to memory whenever a parameter is within a given range. For example, an N1 speed of 37% may be recorded as one data point in the “30-40” bucket for that given moment in time. This results in transient data being displayed in a “stair-step” fashion, and not the smooth transient change that actually occurs during operation. In addition, the same parameters from each engine, even though close in actual value, may appear as having a larger difference when plotted. For example, N1 speeds of 39 and 40% will be plotted as “30-40” and “40-50”, respectively. Some of the parameters have finer bucket ranges than others, giving some parameters greater resolution than other parameters.

3.2. Device Condition and Recovery Attempts

Upon arrival at the Vehicle Recorder Laboratory, an examination revealed the units had sustained significant impact, heat, and water damage. It was not possible to determine which engine was associated with which DEEC; therefore, the units were marked “A” and “B”. Figures 1 and 2 show units A and B, as received. Figure 3 shows DEEC B after the metal cover was removed. Figures 4 and 5 show the identification of the DEEC A and B NVM chips, respectively.

NTSB personnel removed the NVM chips from the board. The chips and boards were sent to Honeywell for recovery attempts. Attachment 1 contains field notes from the unsuccessful recovery attempts.

The chips were subsequently sent to the NVM chip manufacturer, Microchip, to attempt further recovery. Attachment 2 contains a report of the unsuccessful recovery attempts.

Figure 1. DEEC A, as received.



Figure 2. DEEC B, as received.



Figure 3. DEEC B, after metal cover removed.

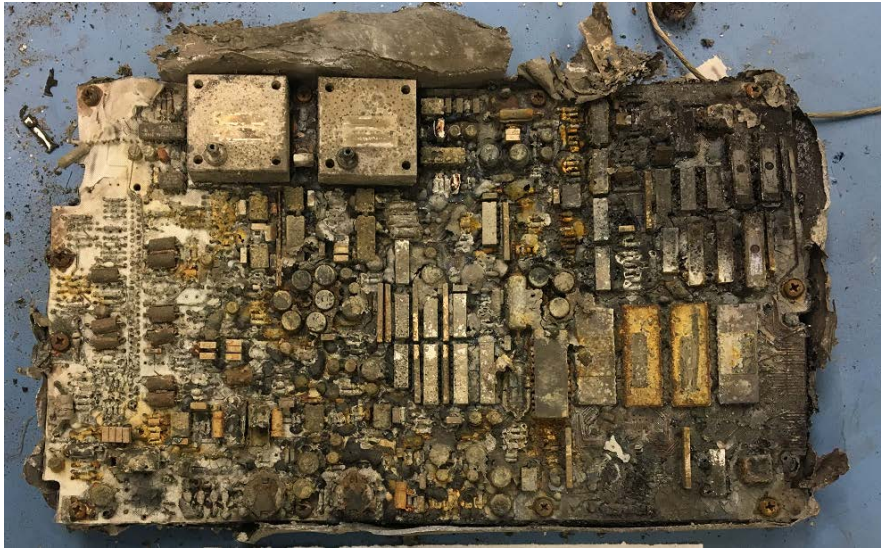


Figure 4. DEEC A NVM chip.

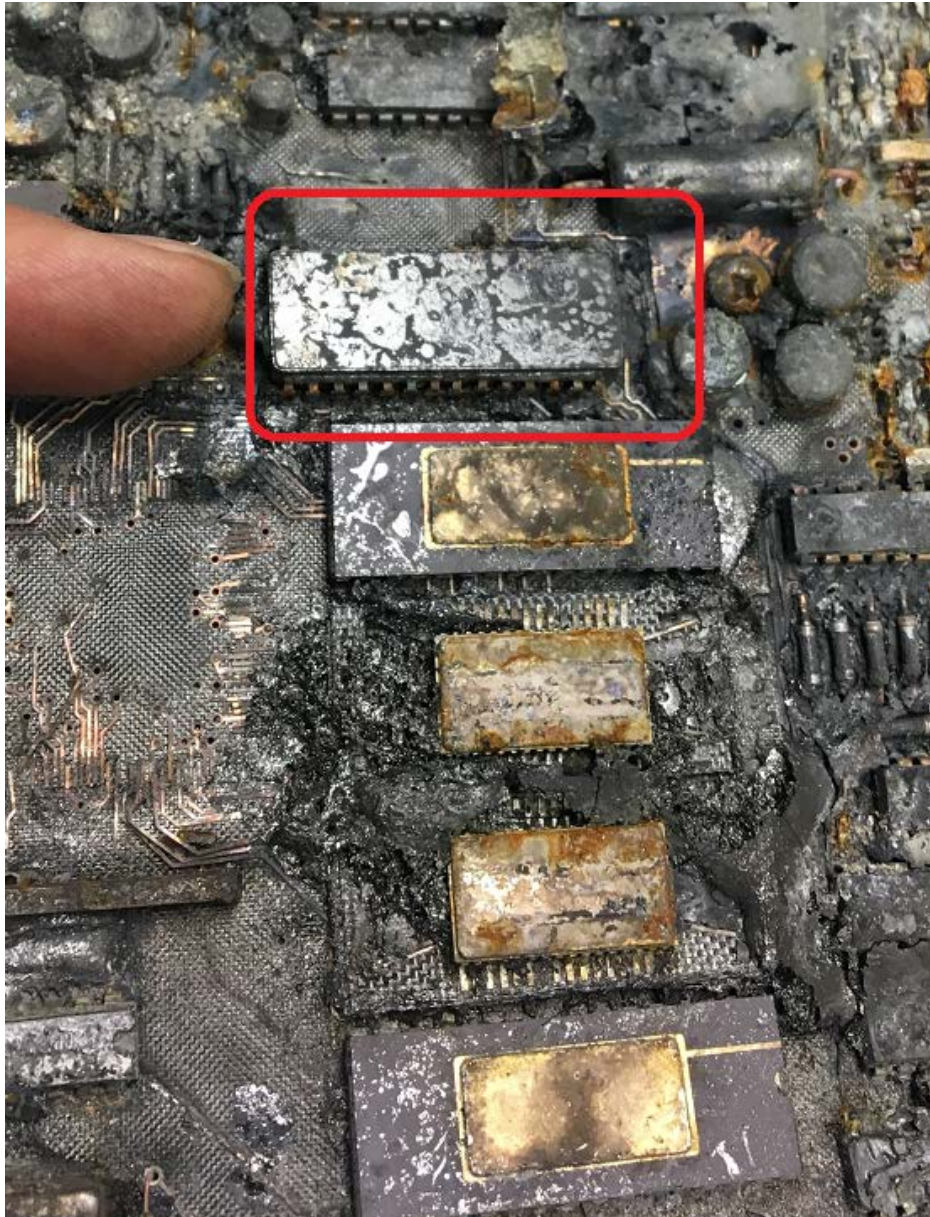
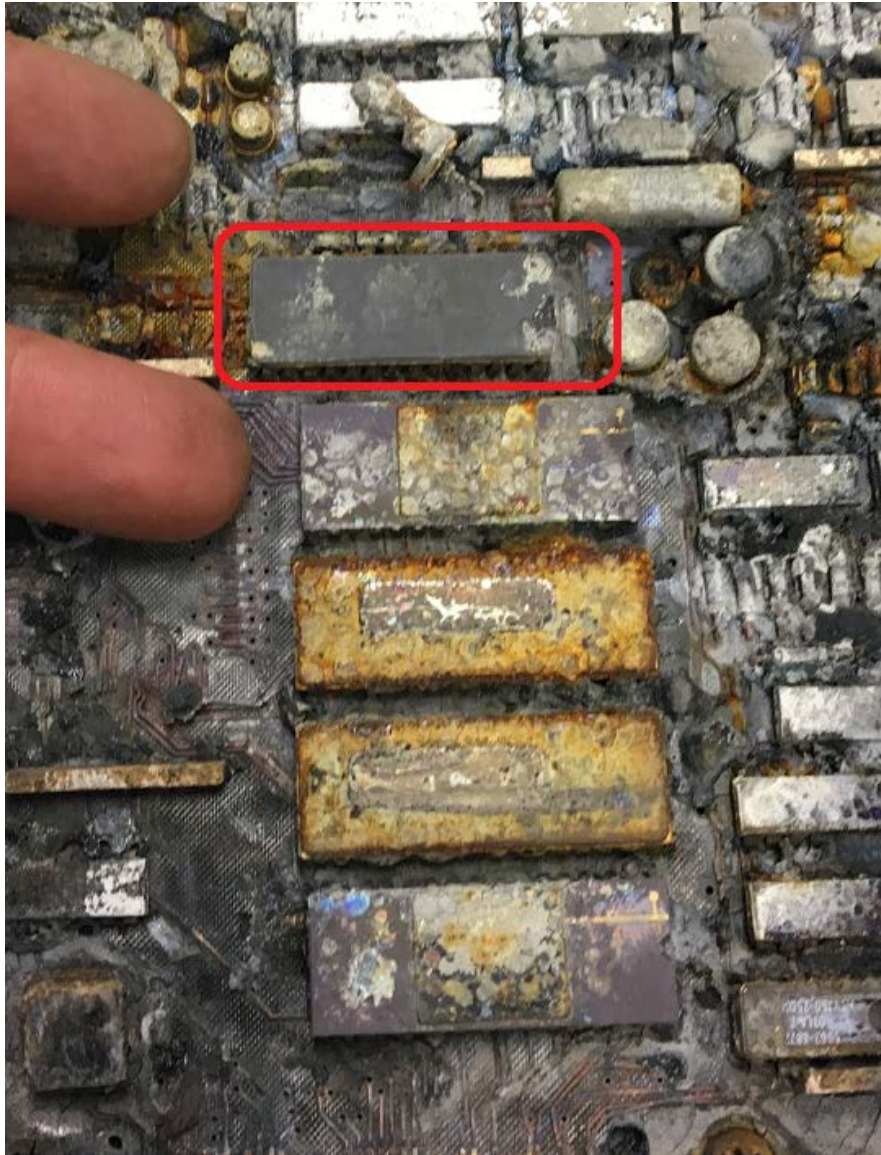


Figure 5. DEEC B NVM chip.



3.3. Data Description

The extent of the damage destroyed any electronic artifacts in the NVM. Therefore, no data recovery was possible.