

From: Fred Barber [REDACTED]
Sent: Thursday, April 6, 2017 11:30 AM
To: Scott Arnold [REDACTED]
Cc: Mayer, Brannon [REDACTED]
Subject: RE: Meeker, CO, PFD and MFD data

Here's my first-cut analysis of the accident data. Nobody at Avidyne has reviewed it, so it's possible that it contains errors, grammatical issues, etc., but I think it gives a pretty clear picture of events on the flight.

As you'll see, based on the pilot's statement (in the preliminary accident report) that he'd had SIU problems and the specific engine data recorded on the accident flight, I looked through the historical engine data to get a sense of what was going on. This may bear further examination. (There were a few files in the engine logs that were truncated or had obvious garbage in them. I'm investigating this with our engineers but I'm confident that the accident file itself is entirely valid.)

From: Fred Barber [REDACTED]
Sent: Thursday, April 13, 2017 9:47 PM
To: Scott Arnold [REDACTED]
Cc: Mayer, Brannon [REDACTED]
Subject: RE: Meeker, CO, PFD and MFD data

I received additional information from Engineering today with regard to the log files about which I had questions.

In all cases where log files appeared to have garbage, the cause was a fundamental characteristic of the system and the Microsoft Windows operating system on which it runs. Windows is intended to be shut down "clean". Since we don't do so on the MFD, but simply remove the power, it's possible for files to have extraneous data at the end of the file. That's what we've seen here. I verified that in each case of garbage data, the garbage was at the end of the file and followed what was obviously a landing and taxi, which would naturally be followed by MFD and aircraft shutdown.

There were seven log files that ended exactly at midnight UTC. These were the subject of a known decoder bug; in some versions of the software, the decoder would run up to midnight and then stop, even though there was additional data. (This was actually introduced in an attempt to correct the deficiency described in the previous paragraph.) Engineering supplied the additional data and I hand-edited it into the affected files. There were no resulting changes to the analysis as previously presented with one exception.

In the flight of 1/6/17, the day preceding the accident flight, the pilot flew from his home airport to Provo. As noted in the original analysis, after engine start, cylinder five's EGT failed to come up to the normal range, then fell off to values below the SIUs range when power was increased for takeoff. CHT for the cylinder also ran low for the duration of cruise. The truncated log file ended while the airplane was in cruise.

In the newly recovered data, it became evident that cylinder five's EGT returned to the normal operating range during the descent, as power was reduced prior to landing. The cylinder's CHT came up following

the EGT. Given the overall sequence of events in this series of flights, this is clearly a highly significant finding.

I have amended the report to indicate this finding and have added graphs showing the engine data on the 1/6/17 flight. The changes are minimal, dealing with the finding described above, and are all in the last section with the exception of minor format tweaks to allow the addition of captions to the figures.

From: Fred Barber [REDACTED]
Sent: Friday, April 14, 2017 12:04 PM
To: Mayer, Brannon [REDACTED]; Scott Arnold [REDACTED]
Subject: RE: Meeker, CO, PFD and MFD data

The new "highly significant finding" is that the previously missing data from the flight the day before the accident, after midnight UTC, shows that cylinder five, which hadn't been working properly during the flight, came back online in the descent.

I stopped mostly short of injecting my personal conclusions in the report but it's perfectly obvious that after the last (apparent) SIU removal and replacement (from 10/26 to 12/29; there appear to have been several test runs on 10/26 before the unit was pulled), something was causing cylinders to actually stop working. This is shown in the data from *consecutive flights* on 12/29, 1/6 and 1/7. Cylinder five went dead on the first two flights, and on the accident flight three cylinders (four, then three, then one; cylinder five was unaffected!) went dead.

I believe we can discount instrumentation error in these cases because of the fact that after the EGT falls, the CHT drifts down over time. It's hard for me to imagine failure mode that would link EGT and CHT in that realistic way. (Had EGT fallen and CHT stayed up, I'd say the EGT reading might be faulty. Had EGT and CHT fallen together, I'd say there might be a common-mode failure that took them both out together. But EGT followed by a slowly falling CHT is exactly what you'd expect if the cylinder really failed.)

I can only speculate as to why these failures might have occurred – somebody smarter than me about engines will have to get into it. Maybe fuel system contamination (dirt? ice?) or air leakage into the fuel distribution lines or terrible leaning technique or arcing in one of the mags or bad timing or burned valves? And it's always suspicious when something starts working immediately following maintenance, even if the connection isn't immediately obvious. I really don't know.

The pilot, having seen what he interpreted as bogus CHT readings on numerous previous flights, and knowing that the airplane was just returned from related servicing, had decided not to trust anything he saw on the MFD, so when it showed (in my opinion) unambiguous indication of actual cylinder failures, he either wasn't looking or discounted the readings as erroneous.

Note that I have no way of knowing whether the high CHTs were truly erroneous or whether they were accurate. Some of those were so high for so long that I would think an engine teardown might show metallurgical changes in the affected cylinders, but again that goes way beyond my own area of expertise. I also have no way of knowing whether the "failing cylinder" signature noted above occurred prior to the period for which we have data.

As I said, I felt it was inappropriate to put that level of interpretation into the "formal" report, but it's how I read the data. If you guys disagree, I can add some of it in. It's also possible that a deeper dive into the data, possibly even combined with available data from the PFD, would be even more revealing.

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