

NATIONAL TRANSPORTATION SAFETY BOARD

Vehicle Recorder Division
Washington, DC 20594

September 26, 2022

Engine Trend Recorder - Recorded Flight Data

Specialist's Factual Report By Sean Payne

1. EVENT

Location: Steamboat Springs, CO
Date: December 10, 2021, 18:09 mountain standard time (MST)
Vehicle: Piper PA-46-500TP
Registration: N744Z
Operator: Private
NTSB Number: CEN22FA069

2. DETAILS OF INVESTIGATION

On April 14, 2022, the National Transportation Safety Board (NTSB) Vehicle Recorder Division received the following devices:

Device Manufacturer/Model: **S-Tec/Meggitt Data Acquisition Unit (DAU)**
Serial Number: **0825-003**

2.1. Meggitt DAU Device Description

The Meggitt DAU is part of the Meggitt Avionics next Generation Integrated Cockpit (MAGIC) engine instrument display system that also includes dual instrument panel-mounted displays (EDU) and various engine and fuel tank sensors.

The DAU is a microprocessor-based signal-conditioning device. The unit will accept aircraft sensor data, perform signal conditioning and validation, and then present this information to the EDUs via RS-422, RS-232, and ARINC 429 compatible serial data buses. The system will also receive, via ARINC 429 compatible serial data buses, global positioning and air data information to support the exceedance and engine condition trend monitoring (ECTM) processing functions of the DAU.

The DAU supports four dual ARINC 429, two RS-422, and two RS-232 serial data buses. Information received includes altitude, airspeed, and global positioning data. Information transmitted includes engine parameters (tachometer(s), torque, inter turbine temperature, oil pressure, oil temperature, vacuum pressure, and fuel flow), fuel quantity (left and right tank groups), and global positioning data. Fuel quantity sensing and reporting functions are accomplished by independent (isolated) fuel quantity processing electronics. Also, the DAU includes built-in test, performance, and self-test functions.

2.1.1. Meggitt DAU Data Description

The DAU records and stores up to 256 engine exceedance events in non-volatile memory. The system also provides for and automatically gathers information for ECTM. Up to three ECTM records are stored per power cycle if either "Cruise 1" or "Cruise 2" states are achieved. One record for each of the following altitude ranges is stored:

- 15,000 to 20,000 feet
- 20,000 to 25,000 feet
- Above 25,000 feet

"Cruise 1" state is achieved when one of the above-mentioned altitude ranges is reached and the altitude has stabilized within ± 300 feet, an airspeed of greater than 140 knots is reached and has stabilized within ± 10 knots, and engine torque is greater than 49.5%. If "Cruise 1" conditions are met for two minutes, an ECTM record is stored for that particular altitude range.

"Cruise 2" state is achieved when "Cruise 1" conditions are valid, the altitude variation is within ± 100 feet, the airspeed variation is within ± 8 knots, engine torque variation has stabilized to within $\pm 3.8\%$, prop tachometer variation has stabilized to within $\pm 1.25\%$, and turbine tachometer has stabilized to within $\pm 1.0\%$. If these conditions are maintained for two minutes, the "Cruise 1" data is over-written for that particular altitude range.

Each ECTM record includes the following parameters and units:

- Date/Time
- Mode ("Cruise 1" or "Cruise 2")
- Altitude - feet (ft)
- Airspeed - knots (kt)
- Static Air Temperature - degrees Celsius ($^{\circ}\text{C}$)
- Torque - pound-foot (lb-ft)
- Propeller Speed (N_p) - percent (%)
- Turbine Speed (N_g) - percent (%)
- Inter Turbine Temperature (ITT)- degrees Celsius ($^{\circ}\text{C}$)
- Fuel Flow - pounds per hour (pph)

In the event an engine parameter exceeds a preset value for a predetermined time, an exceedance is recorded. The following is a list of parameters monitored and recorded if an exceedance occurs:

- Torque
- Inter Turbine Temperature (ITT)
- Propeller Speed (N_p)
- Turbine Speed (N_g)
- Engine Oil Temperature
- Engine Oil Pressure
- Each exceedance record includes the following parameters:

- Date/Time
- Exceedance Parameter
- Duration of Exceedance
- Peak Value
- Data Bus Label

2.1.2. Meggitt DAU Data Recovery

The S-Tec/Meggitt DAU arrived at the NTSB's Vehicle Recorders Laboratory in good condition with minimal visible damage, as shown in Figure 1.



Figure 1. Top view of Meggitt DAU, as received.

The ECTM and exceedance data from both channels of the DAU were downloaded using the manufacturer's download software and NTSB lab equipment.

2.1.2.1. Meggitt DAU ECTM Data - Channel A

Channel A recorded 78 ECTM data events between July 22, 2021, and December 11, 2021.¹ The most recent recorded ECTM events from channel A, from November 9, 2021, to December 11, 2021, are shown in Table 1. The time zone of the recorded date and time could not be determined.

¹ Note that the last timestamp occurred after the reported accident time of 18:09 MST on December 10, 2021.

Table 1. ECTM events from November 9, 2021, to December 11, 2021.

Date	Time	Mode	Altitude (ft)	Airspeed (kts)	SAT (deg C)	Torque (lb-ft)	Np (%)	Ng (%)	ITT (deg C)	FuelFlow (pph)
12/11/2021	00:21:00	1	25014	171	-39	1183	101	92.2	644	261
12/8/2021	23:01:54	1	20004	180	-21	1155	101	91	631	272
11/18/2021	12:44:06	1	20004	172	-22	1074	101	90.1	617	259
11/12/2021	15:03:36	1	16548	172	-14	1029	101	89.1	603	265
11/12/2021	00:21:12	1	16742	173	-13	1072	101	89.6	612	270
11/11/2021	13:03:30	1	17997	178	-20	986	101	88.1	591	254
11/11/2021	00:27:24	1	24008	171	-35	1183	101	92.3	643	264
11/10/2021	14:21:42	1	23004	179	-33	1228	101	92.1	642	272
11/10/2021	00:40:54	1	20023	177	-17	1030	101	90.1	628	253
11/9/2021	13:11:06	1	19003	168	-16	1045	101	89.9	621	259

All ECTM data events recovered from the DAU are provided in comma-separated value (CSV) format as attachment 1 to this report.

2.1.2.2. Meggitt DAU Exceedance Data - Channel A

The exceedance data files for channel A were successfully exported from the DAU. Table 2 is a complete list of the exceedances recovered from channel A. Note that time zone information is not known. Also note that some timing information was recorded as "XX:XX:XX". The manufacturer did not provide a response for the missing timing information.

Table 2. A complete list of the exceedances recovered from channel A.

Parameter	Label	Start Time	Date	Duration	Peak
Oil Pres	317	XX:XX:XX	XXXXXX	0:00:53	139Psi
Oil Pres	317	XX:XX:XX	XXXXXX	0:00:27	140Psi
Oil Pres	317	XX:XX:XX	XXXXXX	0:00:22	138Psi
Oil Pres	317	XX:XX:XX	XXXXXX	0:00:05	136Psi
Oil Pres	317	XX:XX:XX	XXXXXX	0:00:36	139Psi
Oil Pres	317	XX:XX:XX	XXXXXX	0:00:12	139Psi
Oil Pres	317	XX:XX:XX	XXXXXX	0:00:24	137Psi
Oil Pres	317	XX:XX:XX	XXXXXX	0:00:39	138Psi
Oil Pres	317	XX:XX:XX	XXXXXX	0:00:10	137Psi
Oil Pres	317	XX:XX:XX	XXXXXX	0:00:19	137Psi
Oil Pres	317	XX:XX:XX	XXXXXX	0:00:20	138Psi
Oil Pres	317	XX:XX:XX	XXXXXX	0:00:18	140Psi
Oil Pres	317	XX:XX:XX	XXXXXX	0:00:11	138Psi
Oil Pres	317	XX:XX:XX	XXXXXX	0:00:44	139Psi
Oil Pres	317	XX:XX:XX	XXXXXX	0:00:13	136Psi
Oil Pres	317	XX:XX:XX	XXXXXX	0:00:10	139Psi

Parameter	Label	Start Time	Date	Duration	Peak
Oil Pres	317	XX:XX:XX	XXXXXX	0:00:25	138Psi
Oil Pres	317	XX:XX:XX	XXXXXX	0:00:28	138Psi
Oil Pres	317	XX:XX:XX	XXXXXX	0:00:27	138Psi
Oil Pres	317	XX:XX:XX	XXXXXX	0:00:10	138Psi
Oil Pres	317	XX:XX:XX	XXXXXX	0:00:12	139Psi
Oil Pres	317	XX:XX:XX	XXXXXX	0:00:32	138Psi
Oil Pres	317	XX:XX:XX	XXXXXX	0:00:19	138Psi
Oil Pres	317	XX:XX:XX	XXXXXX	0:00:19	139Psi
Oil Pres	317	XX:XX:XX	XXXXXX	0:00:33	137Psi
Oil Pres	317	XX:XX:XX	XXXXXX	0:00:12	140Psi
Oil Pres	317	XX:XX:XX	XXXXXX	0:01:12	140Psi
Oil Pres	317	XX:XX:XX	XXXXXX	0:00:33	138Psi
Oil Pres	317	XX:XX:XX	XXXXXX	0:00:54	139Psi
Oil Pres	317	XX:XX:XX	XXXXXX	0:00:11	139Psi
Oil Pres	317	XX:XX:XX	XXXXXX	0:00:18	140Psi
Oil Temp	316	23:03:48	7/16/2021	0:05:41	116Deg C
Oil Pres	317	XX:XX:XX	XXXXXX	0:00:36	141Psi
Oil Pres	317	XX:XX:XX	XXXXXX	0:00:05	138Psi
Oil Pres	317	XX:XX:XX	XXXXXX	0:00:21	137Psi
Oil Pres	317	XX:XX:XX	XXXXXX	0:00:15	136Psi
Oil Pres	317	XX:XX:XX	XXXXXX	0:00:24	138Psi
Oil Pres	317	XX:XX:XX	XXXXXX	0:00:17	140Psi
Oil Pres	317	XX:XX:XX	XXXXXX	0:00:26	138Psi
Oil Pres	317	XX:XX:XX	XXXXXX	0:00:19	137Psi
Oil Pres	317	XX:XX:XX	XXXXXX	0:00:14	138Psi
Oil Pres	317	XX:XX:XX	XXXXXX	0:00:17	140Psi
Oil Pres	317	XX:XX:XX	XXXXXX	0:07:10	140Psi
Torque	336	16:42:48	9/12/2020	0:00:08	1401.63Lb-Ft
Oil Pres	317	15:03:30	6/16/2020	0:22:00	18Psi
Torque	336	14:45:30	6/16/2020	0:00:06	1473.02Lb-Ft
Oil Pres	317	XX:XX:XX	XXXXXX	0:00:41	138Psi
Torque	336	20:19:24	3/12/2019	0:00:25	1350.75Lb-Ft
Oil Pres	317	XX:XX:XX	XXXXXX	0:00:45	138Psi
Oil Pres	317	XX:XX:XX	XXXXXX	0:00:27	137Psi
Oil Pres	317	XX:XX:XX	XXXXXX	0:00:34	138Psi

All exceedance events recovered from the DAU are provided in comma-separated value (CSV) format as attachment 2 to this report.

2.1.2.3. Meggitt DAU ECTM & Exceedance Data - Channel B

The download process to recover data from channel B did not produce data. The software produced an error message "Error reading from target hardware!"

The manufacturer was contacted regarding this issue. The manufacturer described the DAU as a legacy device. The manufacturer provided documentation describing the download method already in use by the lab. Channel B was attempted to be accessed multiple times using this process. Each attempt resulted in the error message "Error reading from target hardware!" No ECTM or exceedance data was recovered from channel B.