

On 1 June 2006 a Beechcraft Bonanza was on final approach to Bathurst Island, NT, at approximately 0845 CST, in VMC conditions, the aircraft sustained loss of engine power and crashed into bush land, approximately 1.2 km to the north-west of the Bathurst Island runway. The pilot was fatally injured.

The presentation will cover aspects of the accident investigation, paying particular attention to the recovery of data from a new type of engine indicating and recording instrument with a non-volatile memory.

The engine instrument recorded seven different engine parameters at six second intervals for up to twenty hours of flight time. The presentation will show how the data was downloaded and the information was analysed to draw conclusions about the accident.

EDM 700 Instrument

Instrument operation

An Engine Data Management instrument, the EDM 700 was found fitted to the aircraft. The instrument is predominantly an engine indicating device, it indicates the following parameters:

- Exhaust gas temperature from all cylinders in Fahrenheit (EGT)
- Cylinder head temperature from all cylinders in Fahrenheit (CHT)
- Differential EGT in Fahrenheit (DIF)
- Rapid cooling of cylinders in Fahrenheit (CLD)
- Fuel flow in gallons per hour (FF)
- Fuel used in gallons (USD)
- Battery bus voltage (BAT)

Figure 27: EDM 700



Photo courtesy of JPI

Figure 28: EDM 700 as fitted



The EDM 700 has a non-volatile long term memory for engine trend monitoring purposes. If the instrument is set to record, it will store all the information displayed once every six seconds or at a programmed interval between two to five hundred seconds.

The typical amount of data stored is 20 engine operating hours at 6 second intervals. When the memory becomes full, the oldest data will be discarded to make room for the newest data.

When the engine is started and the EGT reaches 500 degrees F, the instrument starts recording, the recordings are separated by engine start and stop sequences, each engine start and stop sequence is given a flight number, flight time and date, each six second recording is time stamped in Universal time co-ordinated (UTC).

The recorded data can be downloaded using manufacturer software and a standard computer. The instrument stops recording when the battery bus voltage falls below 11 volts DC, the radio master is switched off, or the electric power supply is cut.

Data Retrieved

Twenty-four separate flight events were recorded, including the accident flight sequence. The recordings were flight numbered, dated and time stamped. Seventeen different engine parameters were recorded at 6 second intervals.

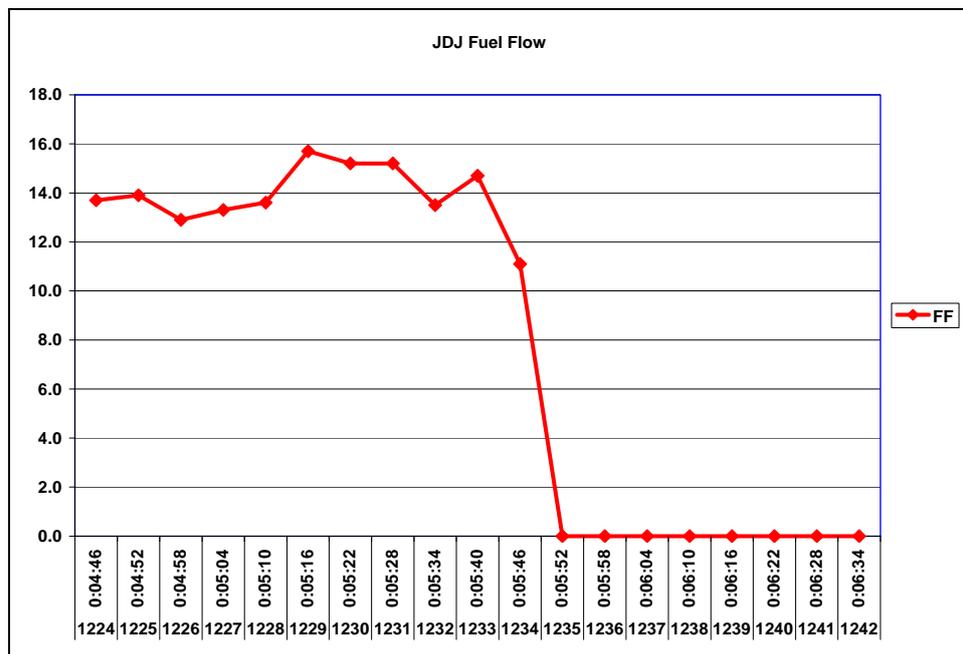
Figure 29 shows the last 114 seconds of raw data from the accident flight. Analysis of the data confirmed that in the last forty eight seconds of flight there was a zero fuel flow indication (highlighted in red) with a corresponding drop in EGT and CHT indications (highlighted in blue), this is consistent with a fuel starvation event taking place.

Figure 29: Extract of data downloaded from the accident flight

INDEX	TIME	E1	E2	E3	E4	E5	E6	C1	C2	C3	C4	C5	C6	DIF	CLD	BAT	FF	USD
1224	0:04:46	1382	1383	1383	1392	1375	1363	339	349	328	340	328	356	29	0	28.2	13.7	28.0
1225	0:04:52	1382	1378	1388	1392	1375	1363	339	351	328	342	328	356	29	0	28.2	13.9	28.0
1226	0:04:58	1423	1420	1432	1434	1415	1402	342	353	330	342	328	358	32	0	28.2	12.9	28.0
1227	0:05:04	1444	1445	1457	1458	1438	1427	344	353	330	344	330	360	31	0	28.2	13.3	28.0
1228	0:05:10	1403	1402	1411	1413	1395	1386	347	355	333	346	330	360	27	0	28.2	13.6	28.2
1229	0:05:16	1349	1352	1359	1364	1349	1339	350	357	335	346	333	362	25	0	28.2	15.7	28.2
1230	0:05:22	1321	1323	1330	1339	1321	1311	352	357	335	346	333	362	28	0	28.2	15.2	28.2
1231	0:05:28	1321	1323	1330	1339	1321	1311	352	359	337	348	335	364	28	0	28.2	15.2	28.2
1232	0:05:34	1288	1290	1294	1300	1287	1278	352	359	337	348	335	364	22	0	28.2	13.5	28.2
1233	0:05:40	1288	1285	1289	1300	1280	1268	348	357	335	345	332	362	32	-12	28.2	14.7	28.2
1234	0:05:46	1295	1294	1289	1307	1280	1273	344	355	333	342	329	359	34	-32	28.2	11.1	28.2
1235	0:05:52	831	850	846	873	836	849	339	349	329	337	323	354	42	-28	28.2	0.0	28.2
1236	0:05:58	551	578	579	614	565	588	329	339	321	328	314	345	63	-67	28.2	0.0	28.2
1237	0:06:04	421	447	452	488	450	468	319	331	314	320	306	337	67	-91	28.2	0.0	28.2
1238	0:06:10	349	372	376	413	379	392	308	323	306	313	298	329	64	-83	28.2	0.0	28.2
1239	0:06:16	304	326	332	368	337	347	299	315	299	307	291	322	64	-77	28.2	0.0	28.2
1240	0:06:22	274	295	300	335	306	315	290	308	292	300	284	315	61	-72	28.4	0.0	28.2
1241	0:06:28	251	270	275	310	282	289	282	301	286	295	278	308	59	-68	28.2	0.0	28.2
1242	0:06:34	234	253	256	289	263	270	275	294	279	289	272	302	55	-61	28.2	0.0	28.2

Figure 30 is a fuel flow graph of the last 114 seconds of flight. The last 48 seconds shows a clear drop in fuel flow to zero.

Figure 30: Fuel flow graph for the last 84 seconds of flight



Although there was zero indicated fuel flow in the last 48 seconds of flight, the engine was still turning. This is indicated in the data, by battery voltage remaining constant (refer to figure 29, the green column titled BAT).

If the engine had completely stopped, the alternator would have stopped turning, this would have caused a corresponding drop in indicated voltage from the battery bus, from 28.2 volts DC to a maximum of 24 volts DC, which is the maximum discharge voltage of the battery.

The propeller may have continued turning because it was windmilling or perhaps the engine was receiving just enough fuel to keep the engine running at a severely reduced rate.

Figure 31 shows the EDM 700 connected to a DC power supply, the power supply output voltage was 24.2 as indicated on the instrument. This shows that the instrument was indicating the correct voltage.

Figure 31: EDM 700 indicating battery voltage



The time set on the instrument, when compared to UTC, was found to be forty-nine minutes fast in UTC time, therefore given the last recorded time was 0:06:34 - 0:49:00 = 23:18:34 UTC time. To calculate UTC to local time, which was Central Standard Time (CST) you must add 9.5 hours, therefore 23:18:34 UTC + 9.5 hours = 08:48:34 CST. The time of the crash within a minute of accuracy was 08:48:34 CST.

The flight time on the accident sector was indicated to be 2:07 hours and the fuel used was indicated to be 28.2 US gallons. The aircraft was refuelled at the start of the previous sector which was 1 hour and 36 minutes in duration, using 18.8 US gallons of fuel. The total amount of fuel used since the last refuel was 47 US gallons, which converts to approximately 178 litres.