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

November 26, 2003

Specialist's Factual Report of Investigation
Flight Data Recorder

NTSB Number:
FTW03LA195

A. EVENT

Location:	Houston, Texas
Date:	August 6, 2003
Aircraft:	Airbus A-340, D-AIGK
Operator:	Lufthansa

B. GROUP

N/A

C. SUMMARY

On August 6, 2003, approximately 2057 universal time coordinated (UTC), an Airbus A340-300 transport airplane, German registration D-AIGK, operating as Lufthansa Flight 440, encountered severe turbulence during cruise flight at flight level 310 (Walnut Ridge Vortac, ARG, 040 degree radial at 029 DME). The airplane was registered to and operated by Deutsche Lufthansa AG, Cologne, Germany. The scheduled international flight was operating under Code of Federal Regulations Part 129. The airplane sustained minor damage. Visual meteorological conditions prevailed for the flight, and an instrument flight rules (IFR) flight plan had been filed and activated. The flight originated at Frankfurt, Germany, at 1218 UTC.

D. DETAILS OF INVESTIGATION

On August 8, 2003, the NTSB Vehicle Recorders Division received the following flight data recorder (FDR):

Recorder Manufacturer/Model:	**Loral Fairchild Model F-1000**
Recorder Serial Number:	**01067**

Recorder Description

This model Solid State Flight Data Recorder (SSFDR) records airplane flight information in a digital format using solid-state Flash Memory as the recording medium. The FDR was configured to record 128 12-bit words of digital information every second. Each grouping of 128 words (each second) is called a subframe. Each subframe has a unique 12-bit synchronization (sync) word identifying it as either subframe 1, 2, 3, or 4. The sync word is the first word in each subframe. The data stream is "in sync" when successive sync words appear at proper 128-word intervals. Each data parameter (e.g. altitude, heading, airspeed) has a specifically assigned word number within the subframe.

Recorder Readout

The data were downloaded from the unit using the recorder manufacturer's software and then transferred to NTSB laboratory equipment for readout. The entire recorder download consisted of over 56 hours of data and the last recorded flight was identified as the event flight. During transcription, the data were converted from raw binary values to engineering units using documentation for an Airbus A-340 ED43B1D6 FDIU configuration[1]. Select parameters relevant to the event were reviewed and are plotted on the following pages.

The data on the plots is shown in universal time coordinated (UTC) time. The FDR subframe reference number[2] (SRN) was converted based on the recorded UTC parameter. At SRN 197015, the FDR recorded 20:54:35 UTC so an offset of -121740 seconds was applied to the SRN to display the data in UTC time (hh:mm:ss).

Data Description

According to the FDR data, the aircraft took off at 1218. At 2056, the aircraft was flying at an altitude of 31000 feet, an airspeed of 315 knots, and a magnetic heading of 218 degrees with the auto-pilot and auto-throttles engaged. About 45 seconds later, the aircraft started a left turn, rolling into a -5 degree bank. Shortly after 2057, the FDR data showed disturbances in several parameters. At 2057:04, while the aircraft's heading was 215 degrees, the vertical acceleration increased from 1.1 g's to a maximum recorded value of 2.3 g's, the lateral acceleration value increased to -.10 g's, and the roll parameter recorded -8 degrees. Shortly after 2057:06, the altitude parameter registered a maximum value of 31088 feet, the vertical speed parameter recorded over +1800 feet/minute, and the heading was 217 degrees. In the next second, the vertical acceleration had decreased to a minimum value of -.9 g's and the lateral acceleration registered a maximum value of +.12 g's. During the next several seconds, the acceleration parameters continued through some perturbations, the roll parameter varied between -3 degrees and -6 degrees, and the vertical speed decreased reaching -1695 feet/minute at 2057:14. The magnetic heading at this time was 214

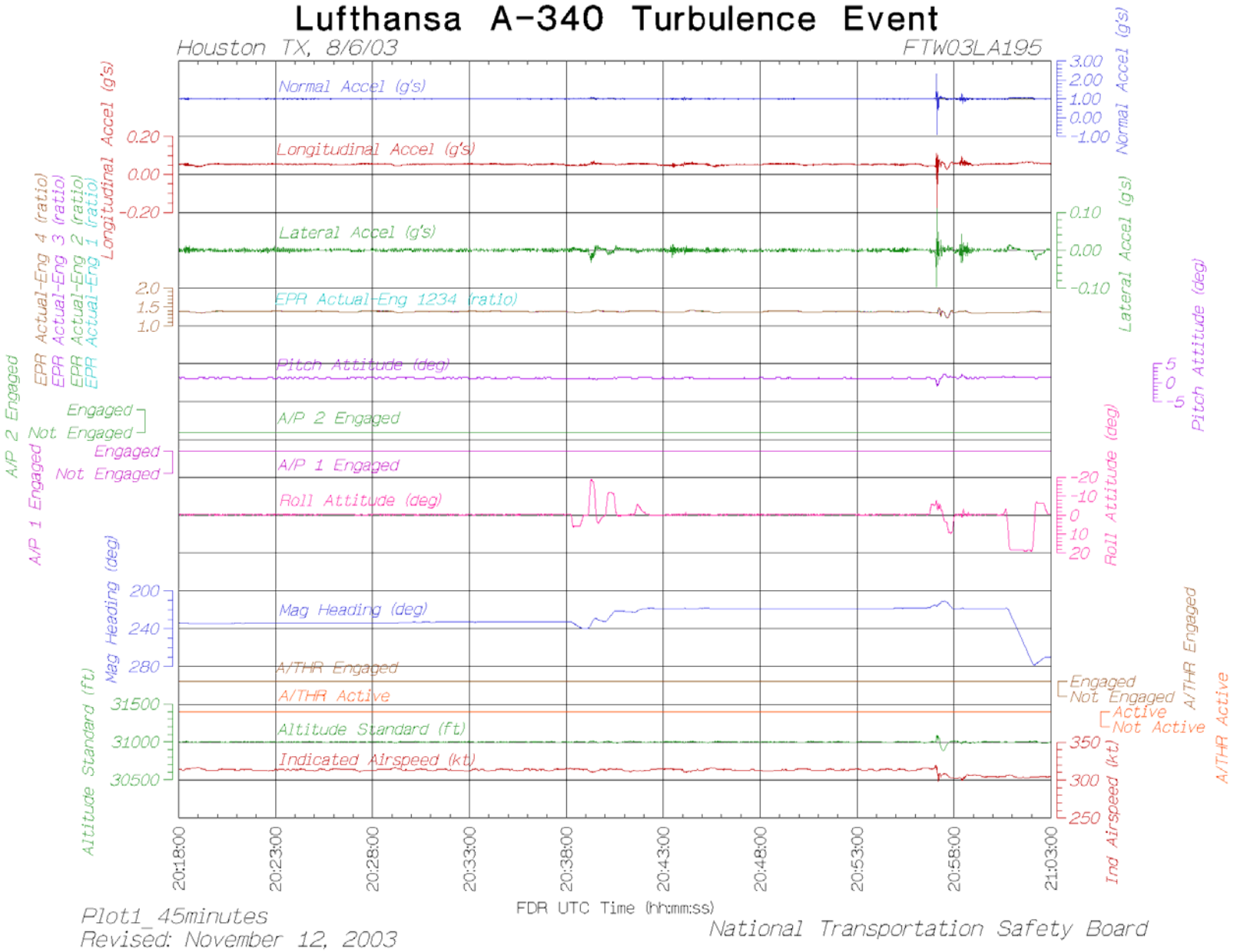
[1] The lateral acceleration parameter appeared to have a slight bias throughout the recorded data. A value of .039 g's was added to the original conversion formula in order to correct for this discrepancy.
[2] Subframe reference number (SRN) is a measure of relative time on the FDR. One SRN is equivalent to one second.

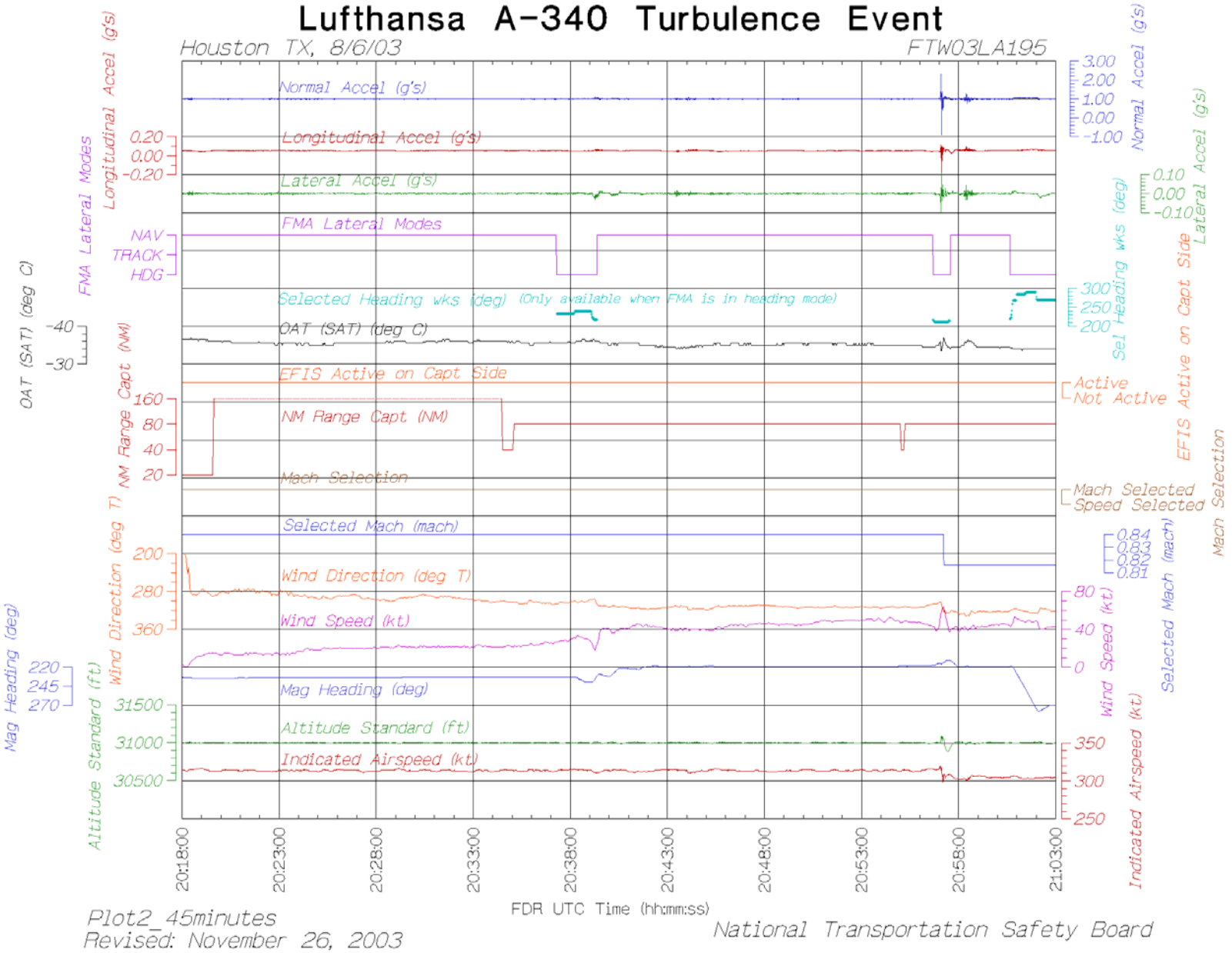
degrees. The altitude reached a minimum value of 30884 at 2057:25 and the magnetic heading was recorded as 211 degrees. By 2058, the recorded data parameters show that the aircraft altitude was again at 31000 feet, the magnetic heading was 219 degrees and the airspeed was around 300 knots.

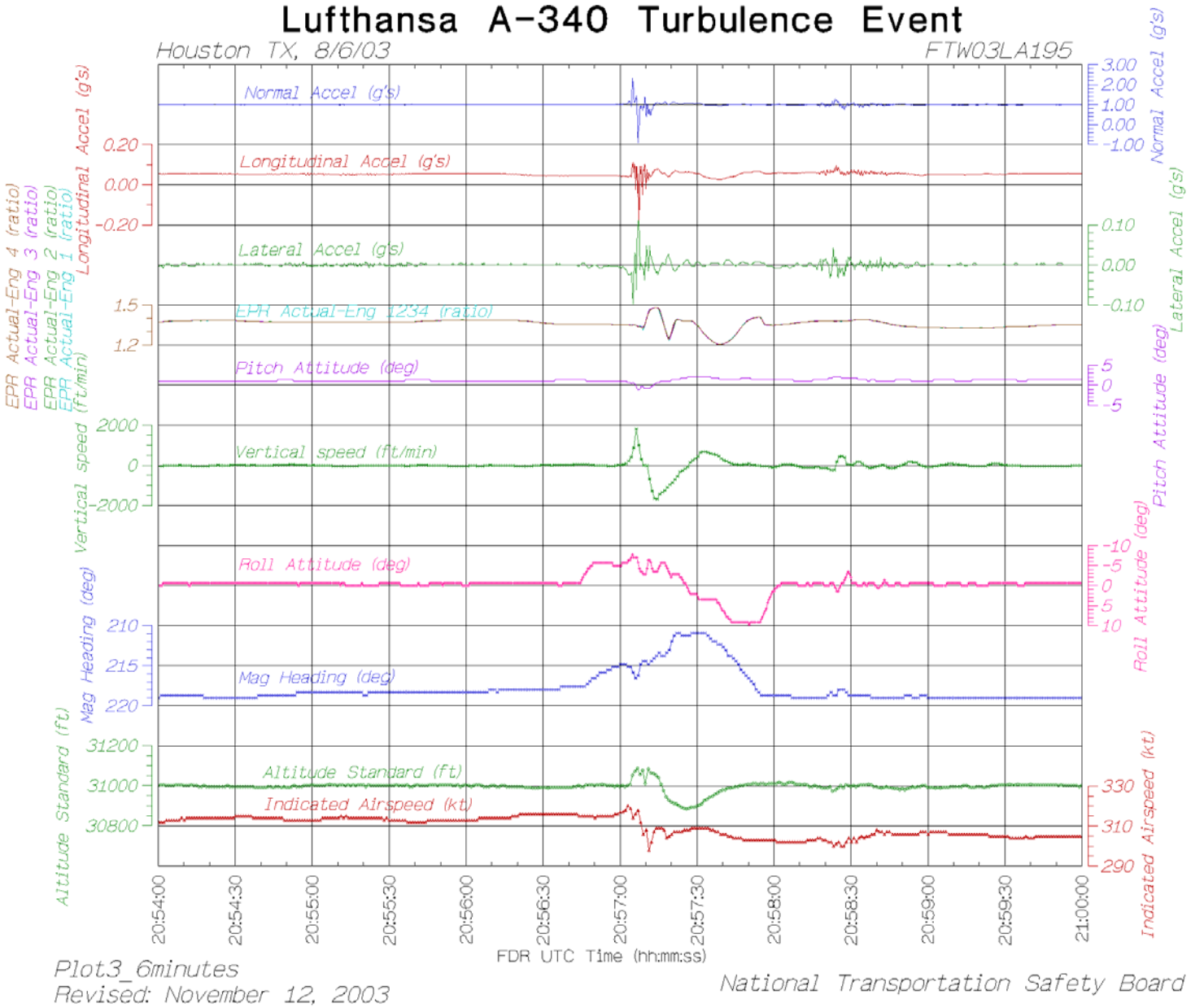
The autopilot and auto-throttle parameters remained engaged throughout the event. The captain side stick pitch, first officer side stick pitch, and first officer side stick roll parameters showed no movement during the disturbance. The captain side stick roll parameter moved -1 degree during 2057:07 and then returned to 0 degrees. The rudder pedal position and rudder parameters showed less than one degree of movement during the event sequence and the pitch and elevator parameters registered excursions of less than 1.5 degrees. The aircraft landed approximately 1 hour and 10 minutes after the upset at 2207.

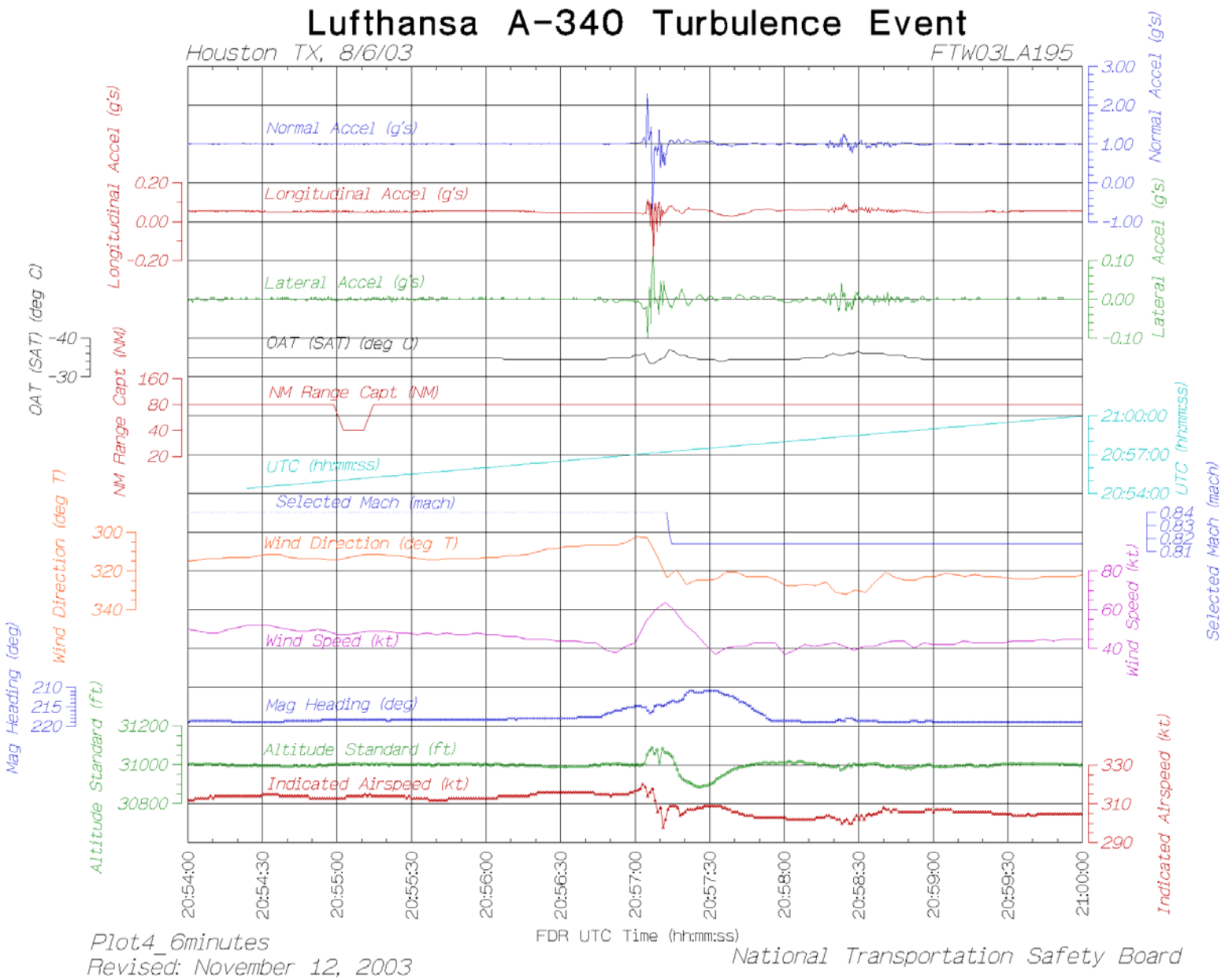
Plotted Data

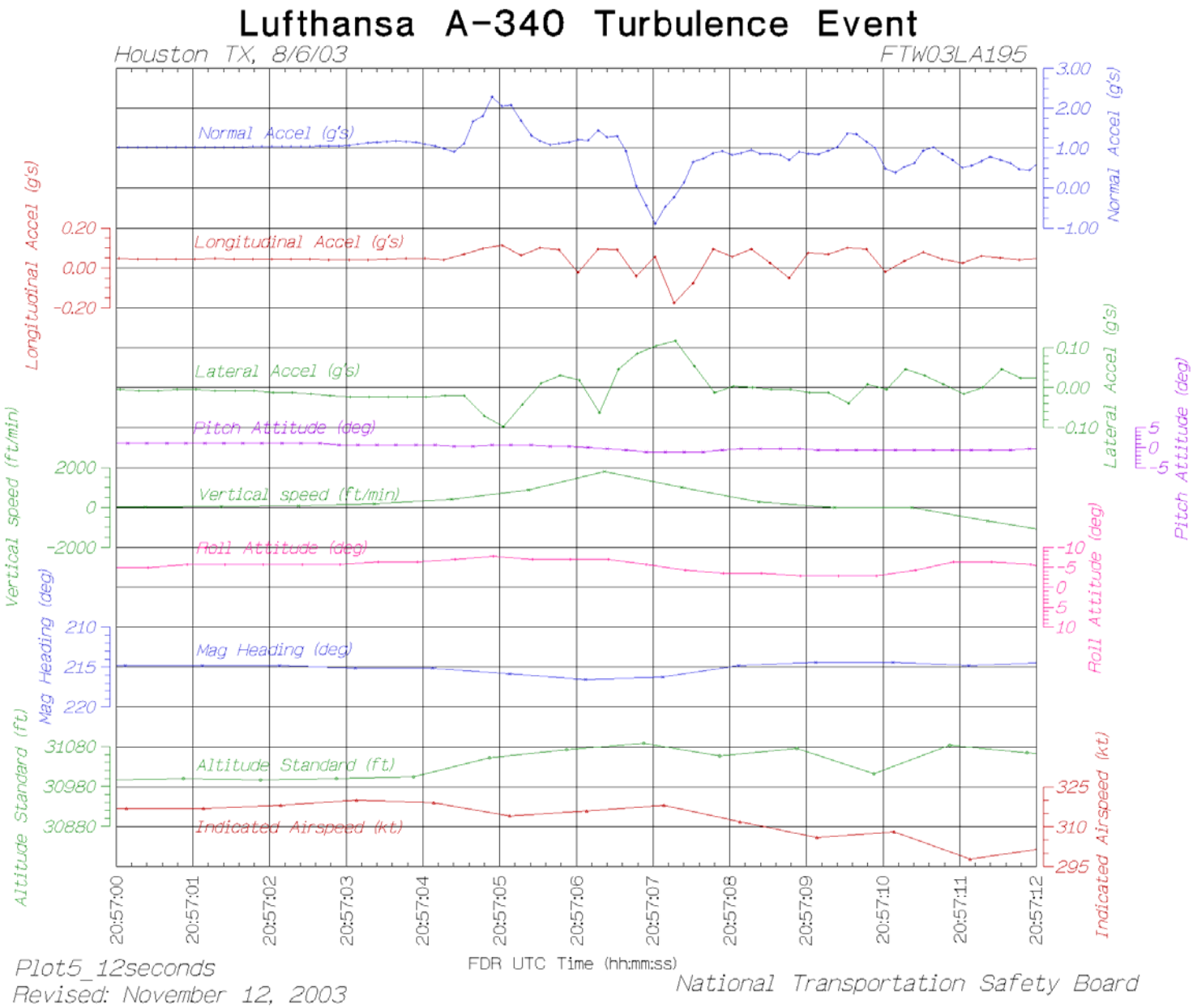
FDR parameters relevant to the investigation were plotted to graphically illustrate the data. The following six plots display different parameters in varying time scales. The first 2 plots show data in a 45 minute time period leading up to and including the event. The next 2 plots encompass parameters in a 6 minute time scale. The last 2 plots provide a close-up snapshot of the event illustrating data in a 12 second time base.

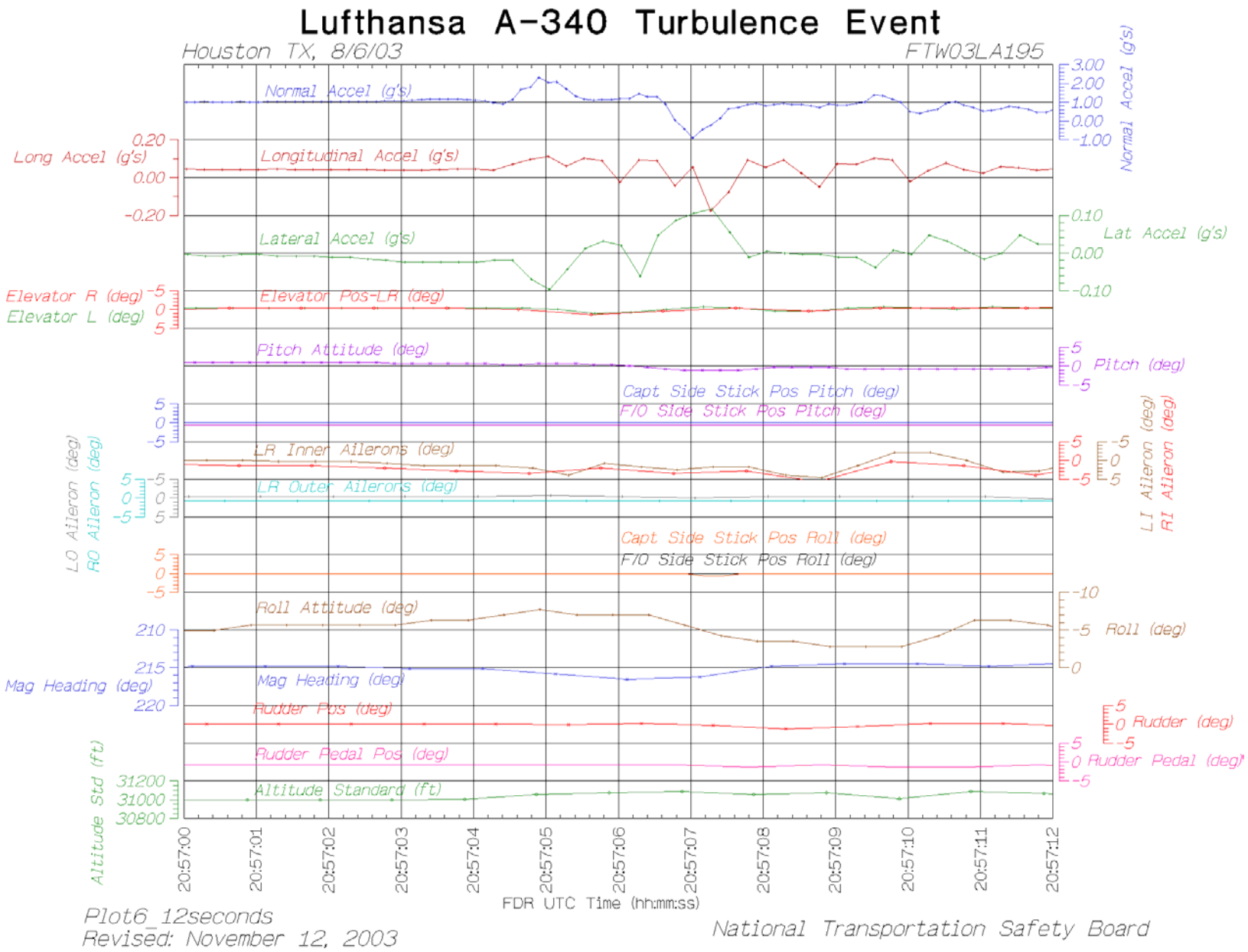

Lufthansa A-340 Turbulence Event
Houston TX, 8/6/03
FTW03LA195
Normal Accel (g's)
Longitudinal Accel (g's)
Lateral Accel (g's)
EPR Actual-Eng 1234 (ratio)
Pitch Attitude (deg)
A/P 2 Engaged
A/P 1 Engaged
Roll Attitude (deg)
Mag Heading (deg)
A/THR Engaged
A/THR Active
Altitude Standard (ft)
Indicated Airspeed (kt)
EPR Actual-Eng 4 (ratio)
EPR Actual-Eng 3 (ratio)
EPR Actual-Eng 2 (ratio)
EPR Actual-Eng 1 (ratio)
Engaged
Not Engaged
Active
Not Active
20:18:00
20:23:00
20:28:00
20:33:00
20:38:00
20:43:00
20:48:00
20:53:00
20:58:00
21:03:00
FDR UTC Time (hh:mm:ss)
Plot1_45minutes
Revised: November 12, 2003
National Transportation Safety Board


Lufthansa A-340 Turbulence Event
Houston TX, 8/6/03
FTW03LA195
Normal Accel (g's)
Longitudinal Accel (g's)
Lateral Accel (g's)
FMA Lateral Modes
NAV
TRACK
HDG
Selected Heading wks (deg) (Only available when FMA is in heading mode)
OAT (SAT) (deg C)
EFIS Active on Capt Side
NM Range Capt (NM)
Mach Selection
Selected Mach (mach)
Wind Direction (deg T)
Wind Speed (kt)
Mag Heading (deg)
Altitude Standard (ft)
Indicated Airspeed (kt)
Active
Not Active
Mach Selected
Speed Selected
20:18:00
20:23:00
20:28:00
20:33:00
20:38:00
20:43:00
20:48:00
20:53:00
20:58:00
21:03:00
FDR UTC Time (hh:mm:ss)
Plot2_45minutes
Revised: November 26, 2003
National Transportation Safety Board


Lufthansa A-340 Turbulence Event
Houston TX, 8/6/03
FTW03LA195
Normal Accel (g's)
Longitudinal Accel (g's)
Lateral Accel (g's)
EPR Actual-Eng 1234 (ratio)
Pitch Attitude (deg)
Vertical speed (ft/min)
Roll Attitude (deg)
Mag Heading (deg)
Altitude Standard (ft)
Indicated Airspeed (kt)
EPR Actual-Eng 4 (ratio)
EPR Actual-Eng 3 (ratio)
EPR Actual-Eng 2 (ratio)
EPR Actual-Eng 1 (ratio)
3.00
2.00
1.00
0.00
-1.00
0.20
0.00
-0.20
0.10
0.00
-0.10
1.5
1.2
5
0
-5
2000
0
-2000
-10
-5
0
5
10
210
215
220
31200
31000
30800
330
310
290
20:54:00
20:54:30
20:55:00
20:55:30
20:56:00
20:56:30
20:57:00
20:57:30
20:58:00
20:58:30
20:59:00
20:59:30
21:00:00
FDR UTC Time (hh:mm:ss)
Plot3_6minutes
Revised: November 12, 2003
National Transportation Safety Board


Lufthansa A-340 Turbulence Event
Houston TX, 8/6/03
FTW03LA195
Normal Accel (g's)
Longitudinal Accel (g's)
Lateral Accel (g's)
OAT (SAT) (deg C)
NM Range Capt (NM)
UTC (hh:mm:ss)
Selected Mach (mach)
Wind Direction (deg T)
Wind Speed (kt)
Mag Heading (deg)
Altitude Standard (ft)
Indicated Airspeed (kt)
FDR UTC Time (hh:mm:ss)
Plot4_6minutes
Revised: November 12, 2003
National Transportation Safety Board


Lufthansa A-340 Turbulence Event
Houston TX, 8/6/03
FTW03LA195
Normal Accel (g's)
Longitudinal Accel (g's)
Lateral Accel (g's)
Pitch Attitude (deg)
Vertical speed (ft/min)
Roll Attitude (deg)
Mag Heading (deg)
Altitude Standard (ft)
Indicated Airspeed (kt)
3.00
2.00
1.00
0.00
-1.00
0.20
0.00
-0.20
0.10
0.00
-0.10
5
0
-5
2000
0
-2000
-10
-5
0
5
10
210
215
220
31080
30980
30880
325
310
295
20:57:00
20:57:01
20:57:02
20:57:03
20:57:04
20:57:05
20:57:06
20:57:07
20:57:08
20:57:09
20:57:10
20:57:11
20:57:12
FDR UTC Time (hh:mm:ss)
Plot5_12seconds
Revised: November 12, 2003
National Transportation Safety Board


Lufthansa A-340 Turbulence Event
Houston TX, 8/6/03
FTW03LA195
Normal Accel (g's)
Longitudinal Accel (g's)
Lateral Accel (g's)
Elevator Pos-LR (deg)
Pitch Attitude (deg)
Capt Side Stick Pos Pitch (deg)
F/O Side Stick Pos Pitch (deg)
LR Inner Ailerons (deg)
LR Outer Ailerons (deg)
Capt Side Stick Pos Roll (deg)
F/O Side Stick Pos Roll (deg)
Roll Attitude (deg)
Mag Heading (deg)
Rudder Pos (deg)
Rudder Pedal Pos (deg)
Altitude Standard (ft)
Long Accel (g's)
Elevator R (deg)
Elevator L (deg)
LO Aileron (deg)
RO Aileron (deg)
Mag Heading (deg)
Altitude Std (ft)
Normal Accel (g's)
Lat Accel (g's)
Pitch (deg)
LI Aileron (deg)
RI Aileron (deg)
Roll (deg)
Rudder (deg)
Rudder Pedal (deg)
20:57:00
20:57:01
20:57:02
20:57:03
20:57:04
20:57:05
20:57:06
20:57:07
20:57:08
20:57:09
20:57:10
20:57:11
20:57:12
FDR UTC Time (hh:mm:ss)
Plot6_12seconds
Revised: November 12, 2003
National Transportation Safety Board

Tabular Data

The tabular data associated with the graphical plots, FTW03LA195_tabular.csv, is a comma delimited electronic file and is contained in Attachment I.

Erin Gormley
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Vehicle Recorders Division

Attachment

Attachment I: FDR Tabular Data