Havarikommissionen
Accident Investigation Board Denmark

REPORT

HCLJ510-2011-46	**Accident**		
(HCLJ510-000835)			
Aircraft:	Boeing 777F	Registration:	B - 2078
Engines:	2 – GE90 – 110B	Flight:	Cargo, IFR
Crew:	4 – no injuries	Passengers:	1 – no injuries
Place:	Copenhagen Airport, Kastrup (EKCH)	Date and time:	17.4.2011 at 1300 UTC

All times in this report is UTC.

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The Aviation Unit of the Danish Accident Investigation Board (AIB) was notified of the accident by the (EKCH) on 17.4.2011 at 1441 hrs. Area Control Centre (ACC) at Copenhagen Airport

1 FACTUAL INFORMATION

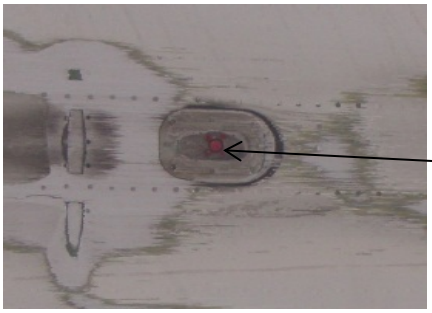
1.1 History of the flight

The accident occurred on a flight from Shanghai (ZSPD) to Copenhagen (EKCH). The flight was uneventful and a normal final approach was established to runway 22L at 1000 feet AGL with the A/P off and the auto throttle engaged. The airspeed was 152 knot and the vertical speed was 830 feet/min. During the flare the pilot flying (PF) started to correct the rate of decent by increasing the pitch attitude. At touchdown the pitch attitude was 4.6°, the computed airspeed was 143 knots, the vertical speed was 160 feet/min and the engine no. 1 N1 RPM was 58.19 % and engine no. 2 N1 was 57.44%. The aircraft touched down and bounced three times according to the QAR data. After the first bounce, the ground spoilers automatically retracted and the auto braking system disarmed. A second bounce occurred followed by a third bounce. After the third bounce, the speed brakes handle was pulled either by the PF or by thrust reverser command, which deployed the ground spoilers and the thrust reversers.

The reversers were deployed in 11 seconds and engine no. 1 N1 RPM was 34% and engine no. 2 N1 RPM was 33%. During the deceleration, the pitch angle gradually increased to 10.5° and the aircraft suffered a tailstrike. At the same time the PF felt an increasing pitch up attitude and decided to initiate a go-around (GA). After the ground spoilers were retracted and the reversers were stowed, the pitch angle was decreased to 7.0°. At that time, the indicated airspeed was 117 knots. Engine power was applied and as the airspeed increased, the pitch angle gradually raised from 7° to 11.9°. During the lift off at an IAS at 140 knobs, the second tailstrike occurred. During initial climb, the flight crew noticed a beeper aural warning and the tailstrike caution on the upper Engine Indication and Crew Alerting System (EICAS) display. The flight crew performed a tail strike Malfunction Check List and a GA Check List. The pilot not flying (PNF) informed ATC about the GA and the tailstrike indication and that the pilots didn't have control problems with the aircraft. A new approach was requested to runway 22L.The aircraft landed without further problems. The fire brigade was on standby.

1.2 Damage to aircraft

The damage in the belly section 47 and 48 was substantial and covered the area between stations 1980 in the front to station 2286 in the rear (approximate 8 meters). Several places on the fuselage skin were broken up and the inside of the aircraft was visible. The area at the aft dome pressure bulkhead was worn into the frame of the dome pressure bulkhead and there was visible damage in the frames and structure inside the aircraft.



1.3 Personel information

a) The commander.

The commander was Boeing 777 type rated on 15th of February 2010. Since the 20th of April 2010, the commander acted as classification A instructor. Since the 5th of June 2010, the commander acted as classification B instructor. The commander held a valid ATPL (Airline Transport Pilot License) and a valid medical certificate.

Flight experience until the day of the accident:

	Flight hours	Landings last 3 month	Total Flight hours
This type:	132:12	3	
All types:			11,636:54

b) The first officer

The first officer was Boeing 777 type rated on 27th of June 2010. The first officer held a valid ATPL (Airline Transport Pilot License) and a valid medical Certificate.

Flight experience until the day of the accident:

	Flight hours	Landings last 3 month	Total flight hours
This type:	185:25	28	
All types:			5,867:12

1.4 Aircraft information

a) Weight and balance

The load sheet was made by the operator (All mass in kg)

MTOM:	347,451	Actual TOM:	341,893
MZFM:	248,115	Actual ZFM:	241,893
DOW:	141,558		
Total traffic load:	102,145		
Take of fuel:	99,476		
MLM:	260,815	Actual LM:	252,561(VREF 148 knots)
Landing fuel:	10,144		

Take of CG (%MAC) 28.9% and ZFW (% MAC) 28.6%

The aircraft was within the CG limit at the time of the accident

b) Flight Crew Training Manual (FCTM)

In the Boeing 777 FCTM chapter 5.66 Approach and Missed Approach it is stated:

If a go-around is initiated before touchdown and touchdown occurs, continue with normal go-around procedures. The F/D go-around mode will continue to provide go-around guidance commands throughout the maneuver.

If a go-around is initiated after touchdown but before thrust reverser selection, auto speed brakes retract and autobrakes disarm as thrust levers are advanced. The F/D go-around mode will not be available until go-around is selected after becoming airborne.

Once reverse thrust is initiated following touchdown, a full stop landing must be made. If an engine stays in reverse, safe flight is not possible.

c) Flight crew Training Manual

In the Boeing 777 FTM chapter 6.26 landing roll it is stated.

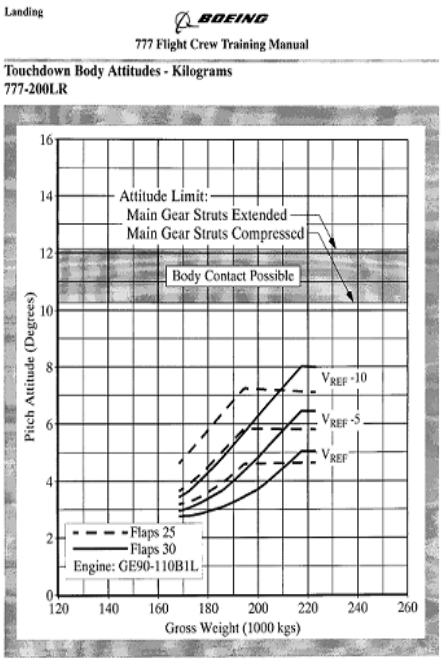
To avoid the risk of a tail strike, do not allow the pitch attitude to increase after touchdown. However, applying excessive nose down elevator during landing can result in substantial forward fuselage damage. Do not use full elevator. Use an appropriate autobrake setting or manually apply wheel brakes smoothly with steadily increasing brake pressure as required for runway condition and runway condition length available. Maintain deceleration rate with constant or increasing brake pressure as required until stopped or desired taxi speed is reached.

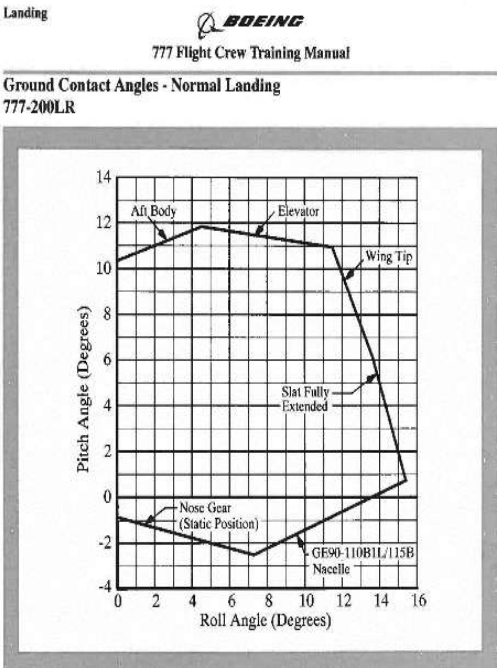
c) Flight Crew Operating Manual (FCOM) chapter NP 21.68

Ref: Normal procedures – Amplified Procedures

Landings roll Procedures:

Warning: After the reverse thrust levers are raised, a full stop landing must be made. If an engine remains in reverse, safe flight is not possible.





Info: The Boeing 777 Freighter has identical Principal Dimension as the Boeing 777-200LR

At first tailstrike the pitch angle was 10, 5° with a roll angle of – 0. 1°

At the second tailstrike, the pitch angle was 11, 9° with a roll angle of 3, 8°

1.5 Meteorological information

TAF and METAR EKCH

171100 TAF-FT ekch 171140z 1712/1812 30012kt 9999 sct025 tempo 1804/1807 4000 br becmg 1809/1811 03005kt=

171120 METAR ekch 1720z 30012 270v340 9999 sct025 12/06 q1023 nosig=

171150 METAR ekch 1250z 29013kt 9999 few024 bk027 12/06 q 1023 nosig=

171320 METAR ekch 1329z 31010 270v340 9999 bkn030 12/06 q 1023 nosig

1.6 Communications

Recorded communication between the aircraft and ATC was of good quality and was been used in the investigation.

1.7 Aerodrome information

Name:	Copenhagen Airport, Kastrup (see Appendix 2)
Location indicator:	EKCH
Position:	4.4 NM southeast of Copenhagen (55 37 04,50N / 012 39 21.50E)
Traffic permitted:	IFR/VFR
Firefighting / rescue:	Approved to category 9 (ICAO Annex 14) and rescue boats.
Runway 22L:	Asphalt, dimensions 3.300 x 45 m, elevation 8 ft. Slope less than 0,2%
Lighting runway 22L:	PAPI, ALS, THR, TDZ 22L, Centre line, Edge, End.
Navigation aids:	VOR, ILS, and DME.

The Copenhagen Airport is equipped with video security cameras situated at different places in the airport for security monitoring. The recordings were of good quality and used in the investigation.

1.8 Flight recorders

Cockpit Voice Recorder (CVR)

The aircraft was equipped with a Honeywell CVR, type SSCVR part number 980-6022-001 serial number 120-13412. On the day of the accident the CVR was removed from the aircraft. The data from the CVR was of good quality and was used in the investigation.

Quick Access Recorder (QAR)

The data from the QAR was of good quality and was used in the investigation.
(See Appendix 1 (Quick Access Recorder Data))

1.9 Fire

There was no fire, but at the second tail strike and skidding, intermittent sparks were observed by ATC and recorded by the airport security cameras.

1.10 Additional information

The aircraft touched down approximately 305 meters after the threshold to runway 22L. The GA was initiated approximately 1585 meters after the threshold to runway 22L.
The aircraft lift off was approximately 2530 meters after the threshold to runway 22 L with approximately 760 meters remaining runway length available.

2 ANALYSIS

The flight and the approach were uneventful. The PF felt that the rate of decent at 1000 feet AGL was a little high and began to correct the decent rate. The aircraft touched down with a rate of decent of 160 feet/min. The airspeed was 143 knots; 5 knots below the VREF speed of 148 knots to actual

landing weight (252 tons). According to the QAR data, the spoilers were automatically deployed at first touchdown and retracted at the first bounce.

After the third touchdown, the speed brake handle was activated either by the PF or by reverser thrust command. No increase in reverse thrust was recorded during the reverse sequence of 11 second where the first tail strike occurred. The PF decided to initiate a GA due to the increasing pitch angle which was approximately 7° before forward engine thrust was applied. At the time where the GA was initiated the IAS was 117 knots and there was approximately 1700 meters remaining available runway. The increase of the forward engine thrust caused a further nose up pitch moment, resulting in an increasing pitch angle.

It is the opinion of the Danish that the PF didn't prevent the increasing pitch angle by keeping a light sufficient forward yoke control pressure input to the elevator at both tailstrikes.

At the time where the GA was initiated there where approximate 1700 meters remaining runway available, with an IAS at117 knob. It is the opinion of the Danish AIB that the remaining runway was sufficient and safe to make a full stop.

An initiation of a GA after thrust reverser activation is very risky and not an option according to the Boeing 777 FCOM and the Boeing 777 FCTM.

During lift off the IAS were 140 knots which were 8 knots below the V2 calculated speed. The lower speed gave less lift and kept the main landing gear compressed. The result was less aft tail belly clearance, leading the second tail strike.

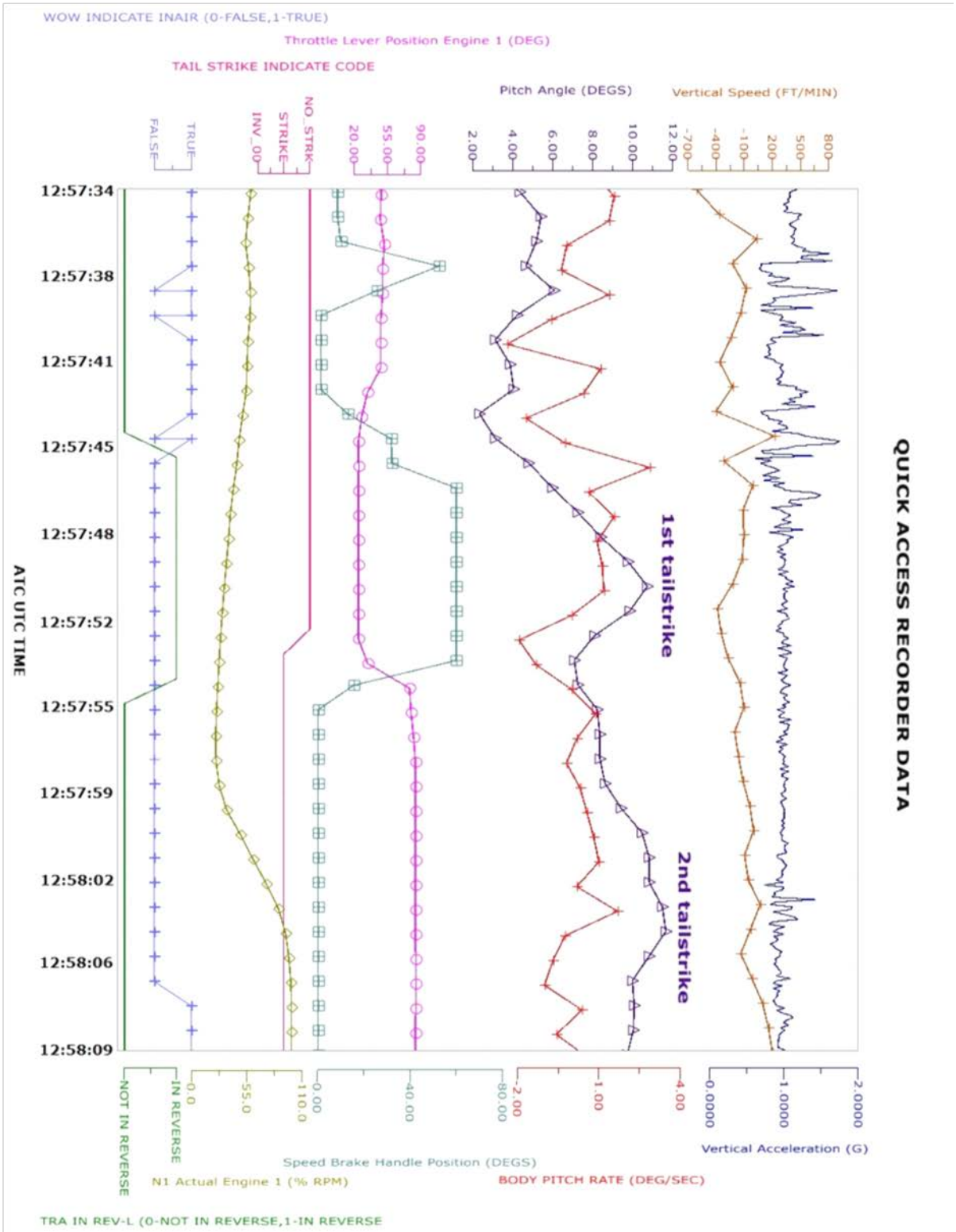
The flight crew decision to initiate a GA could be a result of a landing sequence, where the flight crew at first experienced a landing with three bounces, secondly an increasing pitch angle which wasn't corrected properly by elevator input and consequently leading to the tail strike. After the first tailstrike, the pitch angle increased to 10. 5° which gave the flight crew a very limited forward view and probably caused an uncertainty of how much remaining runway was available for a full stop.

3 CONCLUSIONS

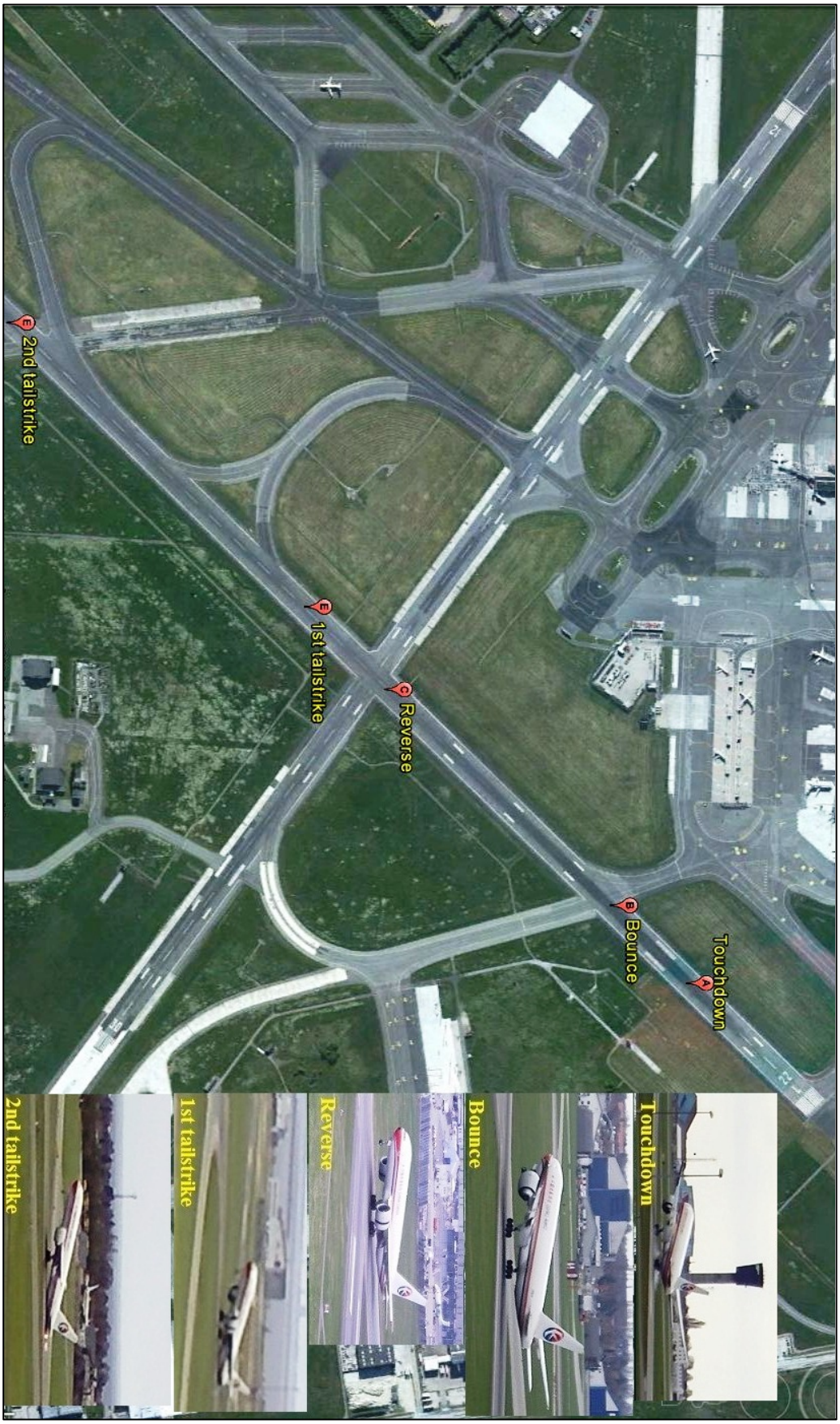
After the third bounce and at touch down, the PF didn't prevent the pitch angle to increase. The lack of forward elevator control input caused the first tail strike.

During the GA, the aircraft was rotated to a pitch angle of 10.2° which caused the second tail strike. The tail strike was prolonged as the pitch angle increased to 11.9° with a V2 speed minus 8 knots, which prolonged the time with a compressed main landing gear and less aft tail clearance.

Appendix 1


WOW INDICATE INAIR (0-FALSE,1-TRUE)
Throttle Lever Position Engine 1 (DEG)
TAIL STRIKE INDICATE CODE
Pitch Angle (DEGS)
Vertical Speed (FT/MIN)
FALSE
TRUE
INV_00
STRIKE
NO_STRK
20.00
55.00
90.00
2.00
4.00
6.00
8.00
10.00
12.00
-700
-400
-100
200
500
800
12:57:34
12:57:38
12:57:41
12:57:45
12:57:48
12:57:52
12:57:55
12:57:59
12:58:02
12:58:06
12:58:09
ATC UTC TIME
1st tailstrike
2nd tailstrike
QUICK ACCESS RECORDER DATA
NOT IN REVERSE
IN REVERSE
0.0
-55.0
-110.0
0.00
-40.00
-80.00
-2.00
1.00
4.00
0.0000
1.0000
2.0000
Vertical Acceleration (G)
Speed Brake Handle Position (DEGS)
N1 Actual Engine 1 (% RPM)
BODY PITCH RATE (DEG/SEC)
TRA IN REV-L (0-NOT IN REVERSE,1-IN REVERSE

Appendix 2


Touchdown
Bounce
Reverse
1st tailstrike
2nd tailstrike
Touchdown
Bounce
Reverse
1st tailstrike
2nd tailstrike