

الهيئة العامة للطيران المدني
GENERAL CIVIL AVIATION AUTHORITY



Air Accident Investigation Sector

Accident

- Preliminary Report -

AAIS Case N°: AIFN/0008/2016

Runway Impact During Attempted Go-Around

Operator:	Emirates
Make and Model:	Boeing 777-31H
Nationality and Registration:	The United Arab Emirates, A6-EMW
Place of Occurrence:	Dubai International Airport
State of Occurrence:	The United Arab Emirates
Date of Occurrence:	3 August 2016



Occurrence Brief

Occurrence Reference	:	AIFN/0008/2016
Occurrence Category	:	Accident
Name of the Operator	:	Emirates
Manufacturer	:	The Boeing Company
Aircraft Model	:	777-31H
Engines	:	Two Rolls-Royce Trent 892
Nationality	:	The United Arab Emirates
Registration	:	A6-EMW
Aircraft Serial Number	:	32700
Date of Manufacture	:	27 March 2003
Flight Hours/Cycles	:	58169/13620
Type of Flight	:	Scheduled Passenger
State of Occurrence	:	The United Arab Emirates
Place of Occurrence	:	Runway 12L, Dubai International Airport
Date and Time	:	3 August 2016, 0837 UTC
Total Crewmembers	:	18 (two flight and 16 cabin)
Total Passengers	:	282
Injuries to Passengers and Crew	:	24 (one serious, 23 minor)
Other Injuries	:	One firefighter (fatal)
Nature of Damage	:	The Aircraft was destroyed

Investigation Objective

This Investigation is performed pursuant to the United Arab Emirates (UAE) *Federal Act No. 20 of 1991*, promulgating the *Civil Aviation Law, Chapter VII- Aircraft Accidents*, Article 48. It is in compliance with *CAR Part VI Chapter 3*, and in conformity with *Annex 13* to the Convention on International Civil Aviation.

The sole objective of this Investigation is to prevent aircraft accidents and incidents. It is not the purpose of this activity to apportion blame or liability.

This Preliminary Report is adapted from the Final Report format contained in *Annex 13* to serve the purpose of this Investigation. The information contained in this Report is derived from the data collected during the ongoing investigation of the Accident.



Later Interim Reports or the Final Report may contain altered information in case of appearance of new evidence during the ongoing investigation.

Investigation Process

The Air Accident Investigation Sector (AAIS) of the United Arab Emirates was notified about the Accident at 0840 UTC. The Occurrence was notified by Dubai air traffic control to the AAIS Duty Investigator (DI) hotline number +971506414667.

The occurrence was classified as an Accident and the AAIS assigned an Accident Investigation File Number AIFN/0008/2016 for the case.

The AAIS formed the Investigation team led by the investigator-in-charge (IIC) and members from the AAIS for different investigation areas. The National Transportation Safety Board (NTSB) of the United States, being the State of the Manufacture and Design, and the Air Accidents Investigation Branch (AAIB) of the United Kingdom, being the State of Manufacture of the engines, were notified of the Accident and both States assigned Accredited Representatives assisted by Advisers from Boeing and Rolls-Royce. In addition, the Operator assigned an Adviser to the IIC. The AAIS is leading the Investigation and will issue a Final Report.

This Preliminary Report is publicly available at:

<http://www.gcaa.gov.ae/en/epublication/pages/investigationReport.aspx>

Notes:

1. Whenever the following words are mentioned in this Report with first Capital letter, they shall mean the following:
 - (Aircraft)- the aircraft involved in this accident
 - (Investigation)- the investigation into the circumstances of this accident
 - (Accident)- this investigated accident
 - (Commander)- the Commander of this accident flight
 - (Copilot)- the Copilot of this accident flight
 - (Report)- this Preliminary Report.
2. Unless otherwise mentioned, all times in this Report are UTC time. Local time of the United Arab Emirates is UTC plus 4 hours.
3. The times stated in this Report are referenced to the flight data recorder.
4. Photos and figures used in this Report are taken from different sources and are adjusted from the original for the sole purpose to improve the clarity of the Report. Modifications to images used in this Report are limited to cropping, magnification, file compression, or enhancement of color, brightness, contrast, or addition of text boxes, arrows or lines.



Abbreviations

AAIB	The Air Accidents Investigation Branch of the United Kingdom
AAIS	The Air Accident Investigation Sector of the United Arab Emirates
ADF	Automatic direction finder
AEP	<i>Airport emergency plan</i>
AFS	Airport Fire Service (the name of the rescue and firefighting service provider in Dubai International Airport)
AOC	Air operator certificate
ARFFS	Airport rescue and firefighting service
ATC	Air traffic control
ATIS	Automatic terminal information system
CAR	<i>Civil Aviation Regulations</i> of the United Arab Emirates
CAT IIIB	Category approach
CSI	Cycles since installed
CSN	Cycles since new
CVR	Cockpit voice recorder
CSO	Cycles since overhaul
DCD	Dubai Civil Defense
DFDR	Digital flight data recorder
DME	Distance measuring equipment
DXB	Dubai
GPWS	Ground proximity warning system
FC	Flight cycles
FCOM	<i>Flight crew operations manual</i>
FCTM	<i>Flight crew training manual</i>
F/D	Flight director
FH	Flight hours
FMS	Flight management system
GCAA	The General Civil Aviation Authority of the United Arab Emirates
GNSS	Global navigation satellite system
GPS	Global positioning system
ICAO	International Civil Aviation Organization
IIC	Investigator-in-charge
IAS	Indicated airspeed
ILS	Instrument landing system
LH	Left hand



METAR	Meteorological terminal air report
MSN	Manufacturer serial number
NTSB	National Transportation Safety Board of the United States
OMDB	Dubai International Airport
PF	Pilot flying
PM	Pilot monitoring
QRH	<i>Quick reference handbook</i>
RA	Radio altitude
RAAS	Runway awareness advisory system
RH	Right hand
RNAV	Area navigation
SOP	Standard operating procedures
STAR	Standard terminal arrival route
TAF	Terminal aerodrome forecast
TSI	Time since installed
TSN	Time since new
TSO	Time since overhaul
UAE	The United Arab Emirates
UTC	Coordinated universal time
V_{REF}	Reference speed
VOR	Very high frequency omnidirectional radio range
VOTV	Trivandrum International Airport, India
WOW	Weight-on-wheels



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1. Factual Information

1.1 History of the Flight

On 3 August 2016, an Emirates Boeing 777-300 Aircraft, registration A6-EMW, operating a scheduled passenger flight EK521, departed Trivandrum International Airport (VOTV), India at 0506 for Dubai International Airport (OMDB), the United Arab Emirates. At approximately 0837, the Aircraft impacted the runway during an attempted go-around at Dubai.

There were a total of 300 people onboard the Aircraft, comprising 282 passengers, two flight crewmembers, and 16 cabin crewmembers.

The Commander, seated in the left hand (LH) seat, was the pilot flying (PF), and the Copilot was the pilot monitoring (PM).

As the flight neared Dubai, the crew received the automatic terminal information service (ATIS) Information Zulu, which included a windshear warning for all runways.

The Aircraft was configured for landing with the flaps set to 30, and approach speed selected of 152 knots ($V_{REF} + 5$) indicated airspeed (IAS) The Aircraft was vectored for an area navigation (RNAV/GNSS) approach to runway 12L. Air traffic control cleared the flight to land, with the wind reported to be from 340 degrees at 11 knots, and to vacate the runway via taxiway Mike 9.

During the approach, at 0836:00, with the autothrottle system in SPEED mode, as the Aircraft descended through a radio altitude (RA) of 1,100 feet, at 152 knots IAS, the wind direction started to change from a headwind component of 8 knots to a tailwind component. The autopilot was disengaged at approximately 920 feet RA and the approach continued with the autothrottle connected. As the Aircraft descended through 700 feet RA at 0836:22, and at 154 knots IAS, it was subjected to a tailwind component which gradually increased to a maximum of 16 knots.

At 0837:07, 159 knots IAS, 35 feet RA, the PF started to flare the Aircraft. The autothrottle mode transitioned to IDLE and both thrust levers were moving towards the idle position. At 0837:12, 160 knots IAS, and 5 feet RA, five seconds before touchdown, the wind direction again started to change to a headwind.

As recorded by the Aircraft flight data recorder, the weight-on-wheels sensors indicated that the right main landing gear touched down at 0837:17, approximately 1,100 meters from the runway 12L threshold at 162 knots IAS, followed three seconds later by the left main landing gear. The nose landing gear remained in the air.

At 0837:19, the Aircraft runway awareness advisory system (RAAS) aural message "LONG LANDING, LONG LANDING" was annunciated.

At 0837:23, the Aircraft became airborne in an attempt to go-around and was subjected to a headwind component until impact. At 0837:27, the flap lever was moved to the 20 position. Two seconds later the landing gear lever was selected to the UP position. Subsequently, the landing gear unlocked and began to retract.

At 0837:28, the air traffic control tower issued a clearance to continue straight ahead and climb to 4,000 feet. The clearance was read back correctly.

The Aircraft reached a maximum height of approximately 85 feet RA at 134 knots IAS, with the landing gear in transit to the retracted position. The Aircraft then began to sink back onto the runway. Both crewmembers recalled seeing the IAS decreasing and the Copilot called out "Check speed." At 0837:35, three seconds before impact with the runway, both thrust levers were moved from the idle position to full forward. The autothrottle transitioned



from IDLE to THRUST mode. Approximately one second later, a ground proximity warning system (GPWS) aural warning of “DON’T SINK, DON’T SINK” was annunciated.

One second before impact, both engines started to respond to the thrust lever movement showing an increase in related parameters.

At 0837:38, the Aircraft aft fuselage impacted the runway abeam the November 7 intersection at 125 knots, with a nose-up pitch angle of 9.5 degrees, and at a rate of descent of 900 feet per minute. This was followed by the impact of the engines on the runway. The three landing gears were still in transit to the retracted position. As the Aircraft slid along the runway, the No.2 engine-pylon assembly separated from the right hand (RH) wing. From a runway camera recording, an intense fuel fed fire was observed to start in the area of the damaged No.2 engine-pylon wing attachment area. The Aircraft continued to slide along the runway on the lower fuselage, the outboard RH wing, and the No.1 engine. An incipient fire started on the underside of the No.1 engine.

The Aircraft came to rest adjacent to the Mike 13 taxiway at a magnetic heading of approximately 240 degrees. After the Aircraft came to rest, fire was emanating from the No. 2 engine, the damaged RH engine-pylon wing attachment area and from under the Aircraft fuselage. Approximately one minute after, the Commander transmitted a “MAYDAY” call and informed air traffic control that the Aircraft was being evacuated.

Together with the fire commander, the first vehicle of the airport rescue and firefighting service (ARFFS) arrived at the Accident site within one minute of the Aircraft coming to rest and immediately started to apply foam. Additional firefighting vehicles arrived shortly after.

Apart from the Commander and the senior cabin crewmember, who both jumped from the L1 door onto the detached slide, crewmembers and passengers evacuated the Aircraft using the escape slides.

Twenty-one passengers, one flight crewmember, and one cabin crewmember sustained minor injuries, and a second cabin crewmember sustained a serious injury. Approximately nine minutes after the Aircraft came to rest, a firefighter was fatally injured as a result of the explosion of the center fuel tank.

Appendix A to this Report illustrates the final flightpath from over the threshold until the Aircraft came to rest.

1.2 Injuries to Persons

Table 1 indicates the number of injuries.

Table 1. Injuries to persons						
Injuries	Flight Crew	Cabin crew	Other crew	Passengers	Total onboard	Others
Fatal	0	0	0	0	0	1
Serious	0	1	0	0	1	0
Minor	1	1	0	21	23	8
None	1	14	0	261	276	0
TOTAL	2	16	0	282	300	9



1.2.1 Details of Injuries

1.2.1.1 Crewmembers

The Copilot suffered abrasions to his elbow.

The senior cabin crewmember required medical treatment and was hospitalized for five days as a result of smoke inhalation.

A cabin crewmember, who evacuated using the R2 door escape slide, sustained blisters to her feet that required medical treatment.

1.2.1.2 Passengers

Out of the 282 passengers, 21 suffered minor injuries and were transported to different medical facilities.

1.2.1.3 Others

A firefighter from the ARFFS sustained fatal injuries during firefighting activity, and eight firefighters required medical treatment for minor injuries.

1.3 Damage to Aircraft

The Aircraft was destroyed due to impact and subsequent fire.

1.4 Other Damage

1.4.1 Runway damage

The initial impact of the aft lower Aircraft fuselage caused surface damage to the runway at two areas abeam the November 7 taxiway. The runway surface was scored as the Aircraft and engine cowlings slid along it.

1.4.2 Aerodrome lighting and signage damage

As the Aircraft slowed and then began to turn to the right, it impacted several aerodrome lights and signs which required replacement as follows:

- Seven taxiway guidance signs (TGS) boards
- Four taxiway centerline lights
- Three taxiway edge lights
- Two runway centerline lights
- Three touchdown zone lights

1.4.3 Effect on the environment

The Accident site was contaminated by Aircraft structure decomposition, firefighting fluids, and spillage of Aircraft fuel.

1.5 Personnel Information

Detailed personnel information and competences of the flight crew, cabin crew, fire crew, air traffic controllers, and other relevant personnel will be added in the Final Report.

1.5.1 Flight crew information

Table 2 illustrates the flight crew data.



Table 2. Flight crew data

	Commander	Copilot
Age	34	37
Gender	Male	Male
Type of license	ATPL ¹	ATPL
Valid to	21 April 2023	4 March 2023
Rating	M/E LAND, A330 (P2), A340 (P2), B777/787	M/E LAND, B777/787 (P2)
Total flying time (hours)	7457.16	7957.56
Total on this type (hours)	5128.20	1296.55
Total last 90 days (hours)	194.4	233.22
Total on type last 90 days (hours)	194.4	233.22
Total last 7 days (hours)	13.56	19.30
Total on type last 7 days (hours)	13.56	19.30
Total last 24 hours (hours)	3.59	3.59
Last recurrent SEP ² training	30 May 2016	11 January 2016
Last proficiency check	17 March 2016	24 February 2016
Last line check	8 May 2016	10 March 2016
Medical class	Class 1	Class 1
Valid to	31 October 2016	16 July 2017
Medical limitation	VDL/VNL ³	Nil

1.6 Aircraft Information

1.6.1 Aircraft General Data

Tables 3 and 4 illustrate the Aircraft and engine data.

Table 3. Aircraft data

Manufacturer:	The Boeing Company
Model:	B777-31H
MSN:	32700
Date of delivery:	28 March 2003
Nationality and registration mark:	United Arab Emirates, A6-EMW
Name of the owner:	Wilmington Trust SP Services Dublin, Ireland
Name of the Operator:	Emirates
Certificate of registration	
Number:	05/03
Issuing Authority:	UAE GCAA
Issuance date:	28 March 2003. Reissued on 10 July 2014.

¹ ATPL: Air transport pilot license

² SEP: Safety and emergency procedures

³ VDL: Wear corrective lenses and carry a spare set of spectacles

VNL: Wear multifocal spectacles and carry a spare set of spectacles



Certificate of Airworthiness

Number:	EAL/66
Issuing Authority:	UAE GCAA
Issuance date:	28 March 2003. Reissued on 13 March 2013.
Valid to:	ARC issued on 10 March 2016. Expires on 27 March 2017.
Total hours since new:	58169:22
Total cycles since new:	13620
Last major inspection check, type, date and hours/cycles:	5C – 28 May 2015, 53900:42 / 12201 8A – 06 May 2016, 57281:07 / 13339 SV1 – 17 July 2016, 58002:50 / 13573
Total hours since last major inspection:	888:15 since 8A-check
Total cycles since last major inspection:	281 since 8A-check
Last inspection, type, date and hours/cycles:	Daily check: 2 August 2016 – 58165:37 / 13619
Maximum takeoff weight:	276,000 kg
Maximum landing weight:	237,682 kg
Maximum zero fuel weight:	224,528 kg
Fuel uplift	25,806 kg
Departure fuel	36,300 kg
Landing fuel	8,200 kg
Takeoff weight	257,789 kg
Landing weight	229,789 kg
Zero weight	221,489 kg

Table 4. Engine data

Engine manufacturer	Rolls-Royce	
	No.1 engine	No.2 engine
Model	TRENT892	TRENT892
Serial number	51208	51406
Date installed	7 September 2015	23 February 2016
TSN (hours)	51,529:34	50,682:11
CSN	14,071	12,185
TSI (hours)	5,425:27	1,613:22
CSI	4,083	517

1.6.2 Aircraft systems

During the landing and attempted go-around, the Aircraft was in a rapidly changing and dynamic flight environment. The initial touchdown and transition of the Aircraft from air to ground mode, followed by the lift-off and the changes in the Aircraft configuration in the attempted go-around, involved operational modes, logics and inhibits of a number of systems, including the autothrottle, the air/ground system, the weather radar, and the GPWS.

The characteristics of these systems, and others, will be examined during the course of the Investigation.

1.7 Meteorological Information

A windshear warning was issued by the National Center of Meteorology and Seismology as follows:



OMDB WS WRNG1 030735 VALID 030740/030900 MOD WS ALL
RWY FCST.

This windshear warning issued at 0735 was valid for the period from 0740 to 0900 and for all runways. This warning was broadcasted in 'Information Zulu' of Dubai International Airport ATIS at 0800.

In addition, the meteorological terminal air report (METAR) issued by the Dubai International Airport Weather Office Aviation Meteorology Section of the National Center of Meteorology and Seismology, on 3 August 2016, shows the weather condition for 0830 as follows:

OMDB 030830Z 11015KT 060V150 6000 NSC 48/06 Q0993 WS
ALL RWY TEMPO 35015KT 4000 DU.

The METAR indicated that the wind was from 110 degrees, 15 knots, variable between 60 and 150 degrees, visibility 6,000 meters, no significant cloud, temperature 48 degrees centigrade, dew point 6 degrees centigrade, barometric pressure adjusted to sea level (QNH) 993 Hectopascals, windshear on all runways, temporary wind from 350 degrees at 15 knots, visibility 4,000 meters and widespread dust.

A special METAR was issued at 0839 and showed the weather condition as follows:

OMDB 030839Z 12017KT 4000 DU NSC 48/06 Q0993 WS ALL
RWY TEMPO 35015KT 3000.

This METAR indicated that the wind was from 120 degrees at 17 knots, visibility was 4,000 meters with widespread dust, and no significant cloud. The temperature was 48 degrees centigrade, dew point was 6 degrees centigrade, QNH 993 Hectopascals with windshear on all runways. Temporary wind from 350 degrees at 15 knots and visibility 3,000 meters.

The terminal aerodrome forecast weather (TAF) issued on 3 August 2016 at 0505, and valid from 0600 of 3 August to 1200 of 4 August, showed the following forecasted information:

TAF OMDB 030505Z 0306/0412 08008KT 7000 NSC BECMG
0308/0310 36012KT BECMG 0314/0316 09008KT PROB30
0404/0411 09016G26KT 3000 DU PROB30 0410/0412 01012KT

The report indicated that the wind would be from 080 degrees at 8 knots, visibility 7,000 meters, no significant cloud, a gradual change in wind conditions to 360 degrees 12 knots was expected beginning 0800 and ending 1000. The gradual change was expected to occur at an unspecified time within this time period.

The TAF continued with a change, which was forecasted to commence on the 3 August at 1400 and be completed by 3 August at 1600. Wind direction was anticipated to be from 090 degrees at 8 knots with probability of 30 percent during the period between 0400 and 1100 of 4 August, the wind direction to be from 090 degrees at a speed of 16 knots gusting up to 26 knots and prevailing visibility 3,000 meters in dust. Moreover, there was a probability of 30 percent during the period between 1000 and 1200 of 4 August, wind direction from 10 degrees at a speed of 12 knots.

Table 5 illustrates the winds recorded at various locations at the airport, at the time of the Accident.



Table 5. OMDB prevailing wind conditions

Site	Wind			Headwind (HW) Component ⁴	
	Direction (degrees)	Speed (knots)	Gust (knots)	Steady (knots)	Gust (knots)
Tower	340	11		-8	
12L	315	9.1	29.2	-9	-28
30R	118	15.6	21.4	16	21
12R	131	13	22.2	13	22
30L	117	17.5	23.5	17	23
South	115	21.2	22	21	22

1.8 Aids to Navigation

The aids to navigation available for approach to runway 12L at Dubai International Airport were a CAT IIIB instrument landing system (ILS), distance measuring equipment (DME), and global navigation satellite system (GNSS).

The Aircraft navigation system consisted of global positioning system (GPS), air data inertial reference system (ADIRS), very high frequency omnidirectional range (VOR) receivers, DME receivers, ILS receivers, air traffic control transponder, weather radar, and flight management system (FMS) with two flight management computers (FMC) and two automatic direction finders (ADF). The Aircraft was also equipped with an autopilot flight director system.

The required aircraft equipment to fly the RNAV standard terminal arrival (STAR) 12L is one FMC and one GPS. In order to fly the RNAV GNSS 12L, two FMC and two GPS are required.

No ground based aids are required to fly either the STAR or the RNAV approach.

The Aircraft flew the RNAV STAR 12L and the RNAV GNSS 12L.

1.9 Communications

All communications between air traffic control and the flight crew were recorded by ground based voice recording equipment for the duration of the Accident flight and were made available to the Investigation.

1.9.1 ATC communication

During the period from 0800 to 0827 (10 minutes before the impact), 16 aircraft landed normally. At 0829 and 0831, two aircraft performed go-arounds. This was followed by another two aircraft that landed normally immediately before the Accident flight.

At 0831, the Dubai air traffic watch manager (WM) called the air traffic coordinator (COD) and informed him of the unusual wind conditions. The WM informed the COD that there had been two missed approaches and that a windshear warning had been issued on the ATIS.

At 0835 the approach controller and the WM discussed the current wind conditions in relation to the runway in use. At the time of the discussion, the surface wind displayed indicated a tailwind component on runways 12L and 30L (the alternative landing runway). The lowest indicated tailwind component was 8 knots on runway 12L (the landing runway). Both

⁴ The minus sign indicates a tailwind component



the Approach controller and the WM remarked on these wind conditions as being strange. Both agreed that runway 12L was the best option at that time.

At 0837:28, the air traffic control tower issued a clearance to EK521 "...continue straight ahead climb four thousand feet." At the same time, the approach controller called the WM to inform him that air traffic control radar would start the process of changing runways. Ten seconds later, the Accident occurred.

1.10 Aerodrome Information

Dubai International Airport was certificated by the General Civil Aviation Authority of the United Arab Emirates according to *Part IX- Aerodromes*, of the *Civil Aviation Regulations*.

The airport ICAO code is OMDB, its coordinates are 25°15'10"N 55°21'52"E, and it is located 4.6 kilometers east of Dubai city. The airport elevation is 62 ft.

The airport has two asphalt runways: 30R/12L and 30L/12R.

The airport rescue and firefighting services (ARFFS) is in compliance with Category 10 requirements of *Part XI- Aerodrome Emergency Services, Facilities and Equipment*, of the *Civil Aviation Regulations*, and in conformity with *Annex 14- Aerodromes*.

Table 6 illustrates the general data of the airport.

Table 6. Airport general data	
Aerodrome code (ICAO/IATA)	OMDB/DXB
Airport name	Dubai International Airport
Airport address	P.O. Box 2525, Dubai, the United Arab Emirates
Airport class	IIIB
Airport authority	Dubai Airports Company
Airport service	ADC/APP
Type of traffic permitted	VFR/IFR
Coordinates	251510N/0552152E
Elevation/reference temperature	62 feet/41°C
12L Runway length	4,050 meters (Threshold displaced 450 meters)
12L Runway width	60 meters
12L Stopway	126 meters
12L Runway end safety area	140X150 meters
Azimuth	121 degrees
Category for Rescue and Firefighting Service	10

The airport had an *Aerodrome Emergency Plan (AEP)* that consists of three parts and the most recent revision was incorporated in part 2 in February 2015.

The *AEP* listed various stakeholders for aircraft accidents, and for other classes of occurrences. The responsibilities of each stakeholder were listed in part 1 which also illustrated the *Operational Command and Control Structure* in case of aircraft accidents. The accident response structure consisted of three levels:

- The Bronze Command level: site-level, responsible for crash site management, rescue and firefighting.



- The Silver Command level: responsible for operational level support and coordination with the external agencies including government authorities.
- The Gold Command level: responsible for the strategic level of command and for the national crisis management.

The ARFFS, also known as Airport Fire Service (AFS), had three fire stations: a Main fire station located north of runway 30R, and two satellite fire stations located south of runway 30L.

The ARFFS was equipped with nine vehicles of varying capacity, including major foam tenders.

According to the *AFS Manual*: “The ARFFS will be deployed to ensure the response time operational objective of two minutes to the end of each runway, as well as other parts of the movement area, in optimum visibility and surface conditions is achieved aligned to regulatory requirements.”

1.11 Flight Recorders

The Aircraft was equipped with a digital flight data recorder (DFDR) and cockpit voice recorder (CVR) as mentioned in table 7.

Table 7. Flight recorders			
	Type	Part Number	Serial Number
CVR	L-3 Communications	2100-1020-00	000177778
DFDR	Honeywell	980-4700-042	SSFDR11503

During the Aircraft recovery, both flight recorders were found in the rear galley area but still attached to the original mounting trays, with signs of prolonged exposure to elevated temperatures. The damaged flight recorders were sent to the AAIB facility for data retrieval in the presence of AAIS investigators.

Both memory modules were removed from the recorders. Optical microscope examinations were performed on the memory modules including the recovery of the memory unit information cables, prior to performing the download and readout. After the serviceability of the memory modules had been established, they were attached to a new chassis allocated for each recorder in order to download the data. Data from the DFDR and CVR was successfully downloaded and read out.

The examination of the DFDR and the CVR data showed that the recorders continued to record for a short period after the runway impact. The Investigation found that this portion of the recorded data was either invalid or missing information.

1.12 The Wreckage and Impact Information

The point of impact of the Aircraft with the runway was approximately 2,530 meters from runway 12L threshold, adjacent to the November 7 taxiway. Marks on the runway indicated that the Aircraft slid for approximately 800 meters along the runway with the three landing gears not fully up. The Aircraft came to rest adjacent to the Mike 13 taxiway, having turned to the right onto a heading of approximately 240 degrees.

The Aircraft aft fuselage lower section impacted first, followed by the engines, the lower section of the aircraft belly fairing, and then the forward fuselage and nose landing gear doors. The No.2 engine separated, moved laterally on the right wing leading edge, and remained near the right wingtip until the Aircraft came to rest.

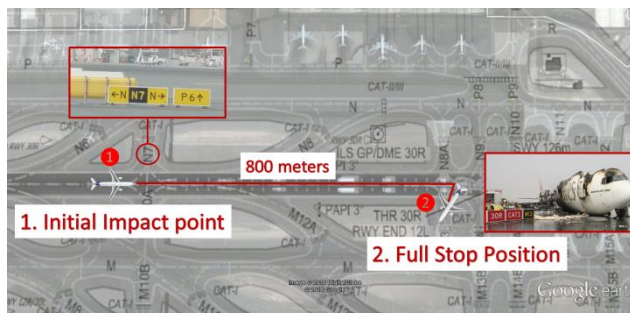


Figure 1. Aircraft Initial impact and final position

As it slid along the runway surface, various components detached from the Aircraft. These components included portions of the engine cowlings, secondary support structures and parts of the wing to body fairings, access panel doors, and systems components. (Figure 1).

When the Aircraft came to rest, the primary structure was intact with the exception of the No.2 engine-pylon assembly which had separated from the RH wing attachment.

1.13 Medical and Pathological Information

Post-accident blood tests did not reveal psychoactive materials that could have degraded the crew performance.

1.14 Fire

1.14.1 Fire origination and explosion

A runway camera recorded flame events, sparks, and smoke underneath the No.1 engine, at the separated No.2 engine, and at the damaged RH engine-pylon attachment.

After the Aircraft came to rest, fire continued on the detached No.2 engine, the damaged RH engine- pylon attachment area, the underside of No.1 engine and from under the Aircraft fuselage.

As the ARFFS crew were fighting the fire, an explosion occurred approximately nine minutes after the Aircraft had come to rest. The explosion occurred in the center wing tank, causing a large section, approximately 15 meters in length, of the RH inboard wing upper skin to be liberated and blown several meters above the runway surface. The liberated skin landed near to the RH wingtip.

Following the explosion, the dynamics of the fire altered with the fire migrating into the interior of the Aircraft cabin, and at a later stage, into the cargo compartments.

1.14.2 ARFFS response

The ARFFS watchroom duty officer witnessed the Aircraft impacting the runway and activated the fire alarm. The airport fire commander immediately moved to the site, and two major foam tenders were dispatched approximately 40 seconds after the impact. Following



this, the air traffic control tower called the watchroom on the hotline declaring three times 'Crash'. The Aircraft came to rest at 0838:10.

The fire commander arrived at the Accident site at approximately 0839, and the two main foam tenders arrived several seconds later and positioned at the aft RH side of the Aircraft, next to the R5 door. At 0839:36, the two fire tenders commenced fighting the fire by streaming foam from their roof mounted monitors. As foam was being streamed towards the RH wing, the passenger and crew evacuation was underway.

When the firefighters perceived that the fire was suppressed, they offloaded and started to use the sideline hoses for cooling the detached No.2 engine and the RH wing leading edge. One crew manager went to the R5 door in order to assist the evacuating passengers to step out the R5 escape slide lower end and guide them to the staging area. The fire commander went to the L5 door to assist evacuating passengers.

The passengers made their way from the staging area to the assembly point inside the Operator's maintenance hangar G, located approximately 500 meters from the Aircraft.

Six other ARFFS vehicles, with varying water capacities, arrived at the site shortly after the first two responding tenders. None of the ARFFS vehicles had encountered significant problems in reaching the Aircraft. The only difficulty was the need to maneuver the vehicles on the runway in order to avoid Aircraft debris.

When the initial two responding vehicles ran out of water, and after all of the occupants, except the Commander and the senior cabin crewmember, had evacuated the Aircraft, both vehicles moved to the hydrants to re-fill. The two firefighters who were using the sidelines, also moved with the vehicle to wrap the sideline hoses. When the Aircraft center wing tank explosion occurred, both firefighters left the hoses and ran for safety. However, one of the firefighters was fatally injured in the explosion of the Aircraft center tank.

The fire commander requested support from Dubai Civil Defense (DCD) and the first DCD fire vehicles arrived at the site approximately nine minutes after the impact.

At approximately 0855, the ARFFS watchroom called the Operator asking for the number of persons onboard. The number recorded in the watchroom logbook did not match the number documented in the passenger manifest. The incorrect figure was given to the fire commander.

At approximately 0907, the airport fire service category was downgraded by the fire commander due to the involvement of the fire equipment and crews in responding to the Accident.

More DCD tankers were requested by the fire commander at the site on several occasions. At approximately 0933, the DCD tankers ran out of water and departed to the main ARFFS station to re-fill.

At approximately 1022, the ARFFS reported low hydrant pressure at the Echo apron. Several minutes later, the manager of the water network advised that water was not available at that hydrant and recommended the use of three other hydrants at various different locations.

At approximately 1032, the fire commander asked the watchroom to check with the Operator as to whether there were dangerous goods onboard the Aircraft and the watchroom was told by the Operator that there were none. This information was given to the fire commander.

Full control of the fire was achieved approximately 16 hours after the impact.

During the firefighting, several heat stroke cases were reported by firefighters which required their transportation to the airport medical center, or to hospitals outside the airport.

1.15 Survival Aspects

1.15.1 The Aircraft

The Aircraft was configured in three zones with 12 first class seats, 42 business class seats and 310 economy class seats. There were 12 emergency exits comprising two cockpit evacuation windows, eight cabin door exits with slide rafts, and two over-wing exits with ramp slides.

The cabin doors were identified by their respective side and a number from 1 to 5 starting from the front of the Aircraft. Each door was fitted with a viewing window. All doors, except the L3 and R3 doors, were also fitted with an automatically inflating evacuation slide raft. Opening of L3 and R3 doors automatically activates the deployment of slide ramps, which are designed to facilitate over-wing evacuation.

The Aircraft was configured to seat 16 cabin crewmembers on jump seats located at each cabin door and in the forward cabin between L1 and R1 doors. Additional seats were located in the aft galley between L5 and R5 doors. The senior cabin crewmember's jump seat was located at L1 door, opposite the cabin crewmember jump seat. L2 door was equipped with an additional jump seat facing aft. All of the jump seats were occupied by cabin crewmembers (figure 2).

Onboard the Aircraft, there were two flight crewmembers, 16 cabin crewmembers, and 282 passengers, including seven infants. Out of the 282 occupants 13 passengers were seated in business class, and 269 in economy class. No passengers were seated in first class.

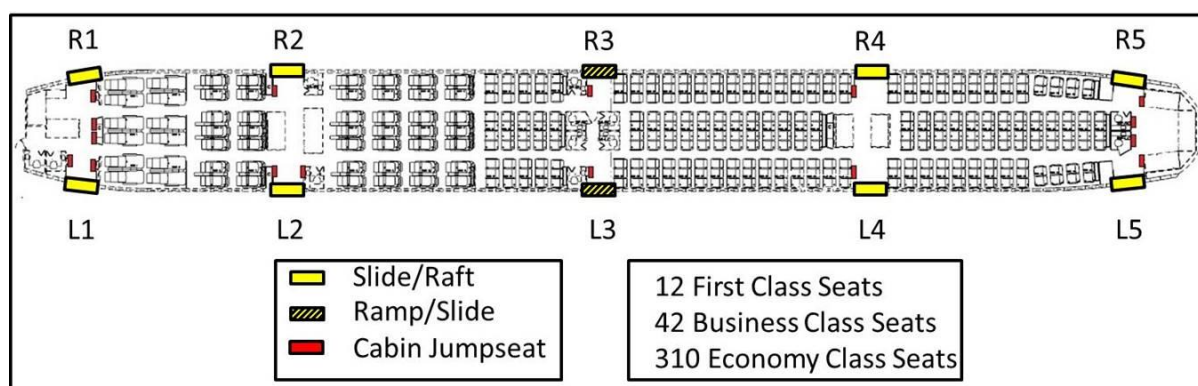


Figure 2. Cabin layout with door location
(Note: The cockpit evacuation windows are not shown)

1.15.2 Cabin safety and evacuation

All of the cabin crewmembers stated that the flight was normal with some turbulence during the final part of the landing. Cabin crewmembers seated towards the rear of the Aircraft indicated that they thought the main landing gear contacted the runway only for the Aircraft to become airborne again until it impacted the runway.

The cabin crewmember at the L1 door reported that during the impact, her seat base broke and folded downwards. The senior cabin crewmember, sitting opposite her, confirmed that the cabin crewmember was hanging in her seat harness after the impact. He also noticed that the cockpit door had swung open. The cabin crewmembers at positions L1A and R1A reported that their seats had moved forward during the impact, and the cabin crewmember at the R5 door reported that a cabin panel had detached and fell in front of the door exit. The window blinds in first class had moved to their closed position during the impact.

Several passenger oxygen masks deployed after the impact.



After the Aircraft came to rest, the Commander announced “Attention Crew at Stations” via the passenger announcement system. Shortly after, he commanded the evacuation of the Aircraft.

The cabin crewmember at the L1 door was unable to open the door and requested assistance from the senior cabin crewmember and the cabin crewmember from the R1 door. Together they were able to open the door and the escape slide deployed, but detached from the Aircraft. The cabin crewmember consequently blocked the L1 door.

A cabin crewmember opened the R1 door and the escape slide deployed automatically. During the deployment, the slide was blown up by the wind and blocked the exit. As a result, the cabin crewmember blocked the door. At a later time during the evacuation, this slide settled on the ground and became available for some passengers and crew. The door was again blocked as the slide deflated.

The L2 door required two crewmembers to open. The slide deployed automatically but did not touch the ground. The cabin crewmember consequently blocked the door. The slide was blown up against the door afterwards, preventing any evacuation attempt through this door. No passengers or crew evacuated via this exit.

The R2 door was opened by a cabin crewmember and the escape slide deployed automatically. There was a lot of smoke in the area of that door and the cabin crewmember redirected passengers to another door. When the smoke cleared, passengers and crew evacuated through that exit.

The cabin crewmember at the L3 door did not attempt to open the door as there was smoke outside. She blocked the door and redirected passengers to the R2 door.

The R3 door was opened, but the cabin crewmember noticed fire outside and she blocked the door while two passengers assisted in closing the door. She redirected passengers to the aft of the Aircraft.

The cabin crewmember at the L4 door opened the door and the slide deployed automatically. The slide was immediately blown up against the Aircraft, which resulted in the cabin crewmember blocking the L4 door.

The cabin crewmember at the R4 door did not hear the “evacuate” instruction because of the noise level in the cabin, but she opened the door after she observed the L4 cabin crewmember opening her door. Several passengers evacuated from the R4 door, but they became stuck on the slide because it was filled with firefighting water. As a consequence, the R4 cabin crewmember redirected the other passengers to the R5 door.

The L5 door cabin crewmember opened the door and the escape slide automatically deployed. Initially, some passengers evacuated using this slide, but towards the end of the evacuation the slide was blown up against the door preventing further evacuation.

The R5 door cabin crewmember opened the door and the escape slide automatically deployed. However, the slide was lifted off the ground by the wind. As a result, the cabin crewmember redirected passengers to the L5 door. A firefighter noticed the problem and held the slide down allowing the cabin crewmember to redirect passengers to the R5 door for evacuation.

The Commander and senior cabin crewmember were the last to exit the Aircraft. They stated that they were still searching the cabin for any remaining passengers. When the center fuel tank exploded, causing intense smoke to fill the cabin, they attempted to evacuate from the cockpit emergency windows. However, as the cockpit was filled with smoke, they were unable to locate the evacuation ropes. Consequently, both evacuated by jumping from the L1 door onto the slide laying on the ground.



Table 8 summarizes slide usability during the evacuation.

Table 8. Summary of slide usability			
Door	Door Open/Closed	Slide deployed Yes/No	Slide Used/Not Used
L1	Open	Yes	Not used (detached from door sill. Commander and a cabin crewmember evacuated from this door.)
R1	Open	Yes	Used (the slide deflated after several passengers had evacuated.)
L2	Open	Yes	Not used (wind affected.)
R2	Open	Yes	Used (same side as the fire.)
L3	Closed	No	Not used (door was not opened.)
R3	Closed	No	Not used (door partially opened then closed due to the external fire.)
L4	Open	Yes	Not used (wind affected.)
R4	Open	Yes	Used (blocked due to passenger congestion. The slide was filled with water as a result of firefighting activity.)
L5	Open	Yes	Used (used only at the start of the evacuation. Wind affected.)
R5	Open	Yes	Used (temporarily blocked when the slide was wind affected.)

1.15.3 Protective breathing equipment (PBE)

A total of five PBE units were used during the evacuation. Some of the cabin crewmembers reported that they had experienced difficulty in opening the PBE containers, or the PBE protective bags.

1.15.4 Passenger behavior and carry-on baggage

The cabin crewmembers stated that when the Aircraft impacted and slid along the runway, passengers started to unfasten their seatbelts and stand up. An announcement was made for the passengers to remain seated. When the Aircraft came to rest, some passengers were screaming, grabbing their belongings, and asking the cabin crewmembers to open the doors.

The cabin crewmembers followed the Operator's safety instructions that prohibit passengers taking their carry-on baggage during an evacuation, and they instructed the passengers to leave their bags behind. However, several passengers evacuated the Aircraft carrying their baggage. Footage of the evacuation showed a number of passengers outside the Aircraft with their baggage.

1.16 Tests and Research

To be discussed in the Final Report.

1.17 Organizational and Management Information

1.17.1 Emirates

Emirates was established in March 1985, and was granted air operator certificate (AOC) No. AC-0001 issued by the General Civil Aviation Authority of the United Arab Emirates.



1.17.2 Go-around procedure

The current *flight crew operating manual (FCOM)* and the *flight crew training manual (FCTM)* used by the Operator contained go-around procedures and the applicable training guidance.

The *FCOM* systems description under the heading *Automatic Flight – Go-Around*, chapter 4.20.17, (appendix B to this Report), states that “Pushing either TO/GA switch activates a go-around. The mode remains active even if the airplane touches down while executing the go-around.” In addition, the *FCOM* states that “The TO/GA switches are inhibited when on the ground and enabled again when in the air for a go-around or touch and go.”

The *FCOM* normal *Go-Around and Missed Approach* procedure, chapter NP.21.56, (appendix C to this Report), describes the actions and call-outs required by the PF and the PM.

In the *FCTM* under the heading *Rejected Landing*, chapter 6.28, it is stated that the *FCOM/QRH* does not contain a procedure or maneuver titled ‘rejected landing’ and the requirements for maneuver can be accomplished by doing a go-around procedure if it is initiated before touchdown. The following is stated in the *FCTM*:

“Rejected Landing

A rejected landing maneuver is trained and evaluated by some operators and regulatory agencies. Although the *FCOM/QRH* does not contain a procedure or maneuver titled Rejected Landing, the requirements of this maneuver can be accomplished by doing the Go-Around Procedure if it is initiated before touchdown. Refer to Chapter 5, Go-Around after Touchdown, for more information on this subject.”

The *FCTM* under the heading *Go-Around and Missed Approach – All Engines Operating*, chapter 5.67, states that the go-around and missed approach shall be performed according to the *Go-Around and Missed Approach* procedure described in the *FCOM*. The *FCTM* also states that “During an automatic go-around initiated at 50 feet, approximately 30 feet of altitude is lost. If touchdown occurs after a go-around is initiated, the go-around continues. Observe that the autothrottle apply go-around thrust or manually apply go-around thrust as the airplane rotates to the go-around attitude.” Below this statement, there is a note which states that “An automatic go-around cannot be initiated after touchdown.”

The *FCTM Go-Around after Touchdown*, chapter 5.69, states that:

“If a go-around is initiated before touchdown and touchdown occurs, continue with normal go-around procedures. The F/D [flight director] 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, continue with normal go-around procedures. As thrust levers are advanced auto speedbrakes retract and autobrakes disarm. The F/D go-around mode will not be available until go-around is selected after becoming airborne.”

1.18 Additional Information

The Final Report will contain the necessary additional information.



2. Ongoing Investigation Activities

The Investigation is ongoing and will include further examination and analysis of:

- Aircraft performance
- Aircraft technical and engineering
- Operator policy, procedure, management, and organization
- Air navigation service provider policy, procedure, management, and organization
- Airport airside operations, and rescue and firefighting services
- Meteorology
- Any other safety aspects that may arise during the course of this Investigation.

The Investigation will carry out in-depth analysis of:

- Contextual factors
- Human factors
- Organizational factors.



3. Safety Concerns and Actions

None issued at this stage of the Investigation. During the course of this Investigation, any immediate safety concerns will be addressed by prompt safety recommendations.

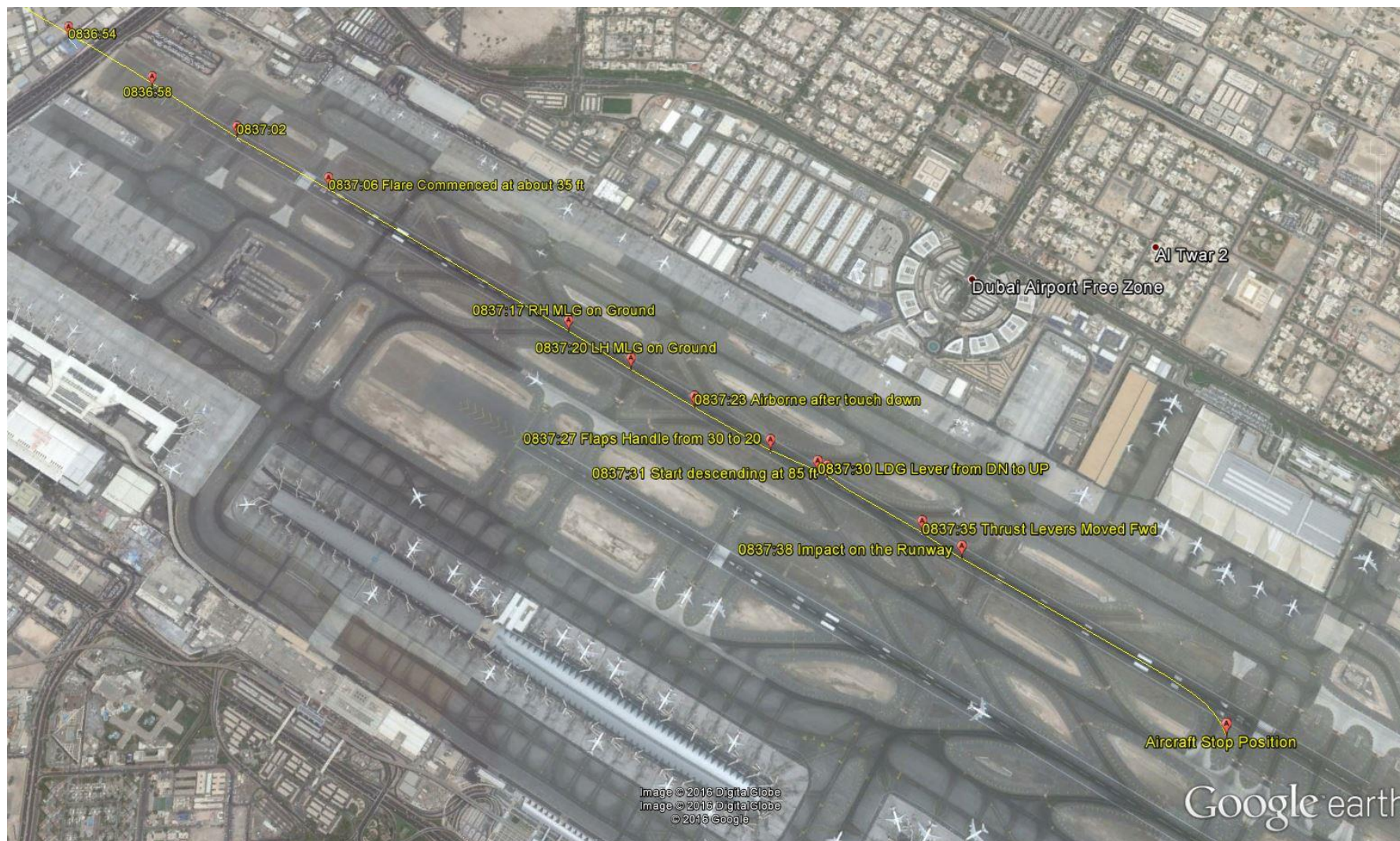
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The United Arab Emirates**

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Appendix A. Final Flightpath






Appendix B. FCOM- System Description- Automatic Flight – Go-Around

Note. The references contained in appendices B and C to this Report have been extracted from the Boeing 777 FCOM. This is the current revision as used by the Operator, and has been inserted with the permission of The Boeing Company.



Emirates



BOEING

Automatic Flight –
System Description

777 Flight Crew Operations Manual

Automatic Flight –
System Description

Automatic Flight - Go-Around

TO/GA is armed when flaps are out of UP or glideslope is captured. The reference thrust limit changes to GA when flaps are extended out of UP, flaps are extended to landing position, or glideslope is captured. The reference thrust limit is locked in GA when flaps are in landing position or glideslope is captured.

With flaps out of up, but not in landing position, activation of VNAV in VNAV PTH changes the reference thrust limit to CRZ. However, pressing TO/GA changes the reference thrust limit to GA and GA thrust is available.

Pushing either TO/GA switch activates a go-around. The mode remains active even if the airplane touches down while executing the go-around.

When the flight director switches are not on, pushing either TO/GA switch displays the flight director bars.

The TO/GA switches are inhibited when on the ground and enabled again when in the air for a go-around or touch and go.

With the first push of either TO/GA switch:

- roll and pitch activate in TO/GA
- autothrottle activates in thrust (THR) to establish a minimum climb rate of 2,000 fpm
- the AFDS increases pitch to hold the selected speed as thrust increases
- if current airspeed remains above the target speed for 5 seconds, the target airspeed is reset to current airspeed (to a maximum of the IAS/MACH window speed plus 25 knots).

with an LNAV path available, LNAV automatically activates:

- above 50 feet radio altitude when autopilot is not engaged, or
- above 200 feet radio altitude when autopilot is engaged.

Note: During go-around from a LAND 2 or LAND 3 approach, automatic LNAV engagement causes disconnect of autopilot rudder control. If executing an engine out missed approach with TAC inoperative, manual rudder control may be required to prevent large roll and yaw excursions.

With the second push of either TO/GA switch:



- the autothrottle activates in the thrust reference (THR REF) mode for full go-around thrust.

When an LNAV path is available, LNAV activates above 50 feet RA with no autopilot engaged; and above 200 feet RA, LNAV activates with an autopilot engaged.

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Appendix C. FCOM- Normal Procedures – Go-Around and Missed Approach Procedures

Normal Procedures – Amplified Procedures			
777 Flight Crew Operations Manual			
Go-Around and Missed Approach Procedure			
Pilot Flying		Pilot Monitoring	
At the same time:			
<ul style="list-style-type: none"> • push the TO/GA switch • call “FLAPS 20”. 			
		Position the flap lever to 20.	
Verify:			
<ul style="list-style-type: none"> • the rotation to go-around attitude • that the thrust increases. 			
		Verify that the thrust is sufficient for the go-around or adjust as needed.	
		Verify a positive rate of climb on the altimeter. Call “POSITIVE CLIMB.”	
Verify a positive rate of climb on the altimeter and call “GEAR UP.”			
		Set the landing gear lever to UP and confirm the F/Ds are ON.	
Limit bank angle to 15 degrees if airspeed is below minimum maneuver speed.			
Above 400 feet radio altitude, select or verify a roll mode.		Verify that the missed approach altitude is set.	

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Normal Procedures –
Amplified Procedures

777 Flight Crew Operations Manual

Continued from previous page

Pilot Flying	Pilot Monitoring
Verify that the missed approach route is tracked. Note: If a go-around/missed approach is required, ensure LNAV is re-engaged immediately. <ul style="list-style-type: none"> • if an LNAV path is available, LNAV automatically arms and engages: <ul style="list-style-type: none"> • above 50 feet radio altitude when autopilot is not engaged, or • above 200 feet radio altitude when autopilot is engaged Note: Route discontinuities after the missed approach will prevent LNAV from engaging. <ul style="list-style-type: none"> • go-around remains the engaged roll mode until LNAV automatically engages or another mode is selected. • “verify that the missed APP route is tracked” 	
Verify that the missed approach altitude is captured. Set speed to the maneuver speed for the planned flap setting.	
Call “FLAPS___” according to the flap retraction schedule.	Set the flap lever as directed. Checklist display switch PUSH.
After flaps are set to the planned flap setting and at or above flap maneuvering speed, select FLCH or VNAV as needed.	
Verify that climb thrust is set.	
Call “AFTER TAKEOFF CHECKLIST.”	Do the AFTER TAKEOFF checklist.

Landing Roll Procedure

Pilot Flying	Pilot Monitoring
Verify that the thrust levers are closed. Verify that the SPEEDBRAKE lever is UP.	Verify that the SPEEDBRAKE lever is UP. Call “SPEEDBRAKES UP.” If the SPEEDBRAKE lever is not UP, call “NO SPEEDBRAKES.”
Monitor the rollout progress.	

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