الهيئـــة الـعـامـــة للطيـــران الـمـدنـــي
GENERAL CIVIL AVIATION AUTHORITY

United Arab Emirates

Air Accident Investigation Sector

Serious Incident

- Final Report-

AAIS Case Nº: AIFN/0008/2012

AIRPROX
(Loss of Separation)

Operators:	1. Air Arabia 2. flydubai
Make and Model:	1. Airbus A320-214 2. Boeing B737-800
Nationality and Registration:	The United Arab Emirates 1. A6-ABS 2. A6-FDK
Place of Occurrence:	5nm west of Dubai International Airport
State of Occurrence:	The United Arab Emirates
Date of Occurrence:	22 April 2012

الهيئة العامة للطيران المدني
GENERAL CIVIL AVIATION AUTHORITY

Air Accident Investigation Sector
General Civil Aviation Authority
The United Arab Emirates

Serious Incident Brief

AAIS Report No.	:	AIFN/0008/2012
Operator	:	1. Air Arabia
		2. Dubai Aviation Corporation trade name flydubai
Aircraft Type, Model	:	1. Airbus A320-214
		2. Boeing B737-800
Registration	:	1. A6-ABS
		2. A6-FDK
State Of Occurrence	:	The United Arab Emirates
Place	:	5nm west of Dubai International Airport
Date and Time (UTC)	:	22 April 2012, 1702:41

Investigation Objective

This Investigation was performed pursuant to the UAE Federal Act No 20 of 1991, promulgating the *Civil Aviation Law, Chapter VI-, Aircraft Accidents*, Article 48. It is in compliance with, *CAR Part VI Chapter 3*, in conformity with *Annex 13* to the Convention on International Civil Aviation, and in adherence to the *Air Accidents and Incidents Investigation Manual*.

The objective of this Investigation is to prevent aircraft accidents and incidents by identifying and reducing safety-related risk. The AAIS investigations determine and communicate the safety factors related to the transport safety matter being investigated.

All AAIS reports are publicly available from

http://www.gcaa.gov.ae/en/epublication/pages/investigationreport.aspx

It is not a function of the AAIS to apportion blame or determine liability.

The information contained in this Final Report is derived from the factual information gathered during the investigation of the occurrence. The exclusive objective of this work is to recommend the study and the adoption of provisions of preventative nature, and the decision as to whether they should be applied belongs to the Accountable Manager, President, Director, Chief or the one corresponding to the highest level in the hierarchy of the organization to which they are being forwarded.

This Final Report does not resort to any proof production procedure for the determination of civil or criminal liability, and is in accordance with item 3.1, Annex 13 to the Convention on International Civil Aviation, which was incorporated in the UAE legal system.

The use of this Final Report for any purpose other than that of preventing future accidents, may result in erroneous interpretations and conclusions.

Investigation Process

This Serious Incident was notified to the Air Accident Investigation Sector (AAIS) Duty Investigator (DI), Hotline +971 50 641 4667, by the Dubai Air Traffic Control Manager on the day of the event, 22 of April 2012, at 21:15 LT.

The Investigator-In-Charge (IIC), and the Investigation Team were nominated by the Director of Air Accident Investigation on the day following the occurrence. The IIC notified the States of Manufacturers and the International Civil Aviation Organization (ICAO) Both States of Manufacturers (France and the United States)[1] assigned Accredited Representatives to the Investigation.

The AAIS, which led the Investigation, sent copies of the draft Final Report to all concerned Stakeholders inviting their significant and substantiated comments and, after consideration of the replies, issued this Final Report.

This Final Report contains facts which have been determined up to the time of publish. Additionally, the information is published to inform the aviation Industry and the public of the general circumstances of the event. Extracts may be published without specific permission provided that the source is duly acknowledged, the material is reproduced accurately, and the extract is not used in a derogatory manner, or in a misleading context.

Notes:

1 Whenever the following words are mentioned in this Report with first letter Capitalised, they shall mean the following:

(Aircraft)- the aircraft involved in this serious incident.

(Investigation)- the investigation into the circumstances of this serious incident

(Incident)- this serious incident

(Report)- this Serious Incident Final Report

2 Unless otherwise mentioned, all times in this Report are Universal Time Co-ordinated (UTC), (UAE Local Time minus 4 hours).

3 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 colour, brightness, contrast, or addition of text boxes, arrows or lines.

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1 France Accredited Representative was from the Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile (BEA), and the Accredited Representative assigned by the United States was from the National Transportation Safety Board (NTSB)

Abbreviations

AAIS	UAE GCAA Air Accident Investigation Sector
ACAS	Airborne Collision Avoidance System
ACC	Area Control Center
AFM	Aeroplane Flight Manual
ANA	Air Navigation and Aerodromes
AIRPROX	Aircraft Proximity
AMM	Aircraft Maintenance Manual
AMO	Approved Maintenance Organization
AMS	Approved Maintenance Schedule
amsl	above mean sea level
ANS	Air Navigation Service
ANSIN	Air Navigation Services Information Notice
ANSP	Air Navigation Service Provider
ARR	Arrivals
ATC	Air Traffic Control
ATCO	Air Traffic Controller
ATCUs	Air traffic Control Units
ATM	Air Traffic Management
ATPL	Air Transport Pilot License
AVSA	Adjust vertical speed adjust
BEA	Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile (French authority responsible for safety investigations into accidents or incidents in civil aviation)
CAAP	Civil Aviation Advisory Publication
CAR	UAE Civil Aviation Regulation
CAR-OPS	UAE Civil Aviation Regulation – Flight Operation
CAT	Category
CAVOK	Cloud and Visibility Okay
CG	Centre of Gravity
C of A	Certificate of Airworthiness
COM	Communication
CPA	Closest Point of Approach
CRM	Crew Resource Management
CVR	Cockpit Voice Recorder
cm	centimetre
CMR	Certificate of Maintenance Review
CPA	Closest Point of Approach
CPL	Commercial Pilot License
CSS	Call sign Similarity
DAR	Digital Aids Recorder
DART	Dubai Approach Relocation and Transition
DEPN	Departures
DFDR	Digital Flight Data Recorder
DI	GCAA's Duty Investigator
Doc	Document

DXB DEP	Dubai Departure Air Traffic Control
EICAS	Engine Indicating and Crew Alerting System
ELP	English Language Proficiency
EU	European Union
EUROCAE	European Organisation for Civil Aviation Equipment
FAA	Federal Aviation Administration
FDIMU	Flight Data Interface Management Unit
FDR	Flight Data Recorder
ft	feet
FRL	Flight Refuelling Radar
GCAA	General Civil Aviation Authority of the United Arab Emirates
GMR	Ground Movement Radar
GMT	Greenwich Mean Time
GST	Gulf Standard Time
hrs	hours
ICAO	International Civil Aviation Organization
IIC	Investigator In Charge
ILS	Instrument Landing System
JAA	Joint Aviation Authorities
kg	kilogram
KIAS	Knots Indicated Air Speed
Km	kilometres
kts	knots
LDA	Landing Distance Available
Ldg	Landing
LH	Left Hand
LT	Local Time
m	metres
mb	millibars
MHz	Mega Hertz
MOPS	Minimum Operational Performance Standards
MSI	Major Structural Inspection
MSN	Manufacturer Serial Number
NTSB	National Transportation Safety Board
No.	Number
NPA	notice of proposed amendment
OJT	On the job training
OK	all correct
OMDB	Dubai International Airport
OMDW	Al Maktoum International Airport
OMSJ	Sharjah International Airport
QNH	barometric pressure adjusted to sea level
ORCAM	Originating Region Code Assignment Method
RA	Resolution Advisory
RH	Right Hand
RTCA	USA Radio Technical Commission for Aeronautics

SA	Situation (or situational) awareness
SN	Serial Number
SOP	Standard Operating Procedures
SSR	Secondary Surveillance Radar
STCA	Short Term Conflict Alert
TCAS TA	Traffic Collision Avoidance System Traffic Advisory
TCAS RA	Traffic Collision Avoidance System Resolution Advisory
TO	Take Off
TSO	Time Since Overhaul
TSN	Time Since New
UAE	United Arab Emirates
UAE ACC	United Arab Emirates Area Control Center
USA	United States of America
UTC	Co-ordinated Universal Time
VHF	Very High Frequency
VOR	Very High Frequency Omnidirectional Range (Navigation System)

Synopsis

On 22 April 2012, 5nm west of Dubai Airport, two aircraft registered and operated by UAE based airlines, which were under the control of Dubai Departure ATC, responded to Traffic Collision Avoidance System (TCAS) Resolution Advisory (RA) warnings generated by their onboard TCAS systems and both Aircraft took collision avoidance action. Both airline crews responded as required and their actions avoided any mishap. Both Aircraft continued their journey to their intended destinations uneventfully.

There were no reports of injury to the passengers or crew, or damage to the aircraft.

This report identifies:

The Air Accident Investigation Sector (AAIS) determined that the cause of this Serious Incident was the loss of minimum separation (AIRPROX) between the two aircraft, which were following instructions provided by ATC.

Contributing factors were: the structure of the airspace, the lack of alert provided to the ATCO of the imminent loss of separation, lack of a structured handover briefing between the two ATCOs, and the ATC clearance issued to the aircraft.

In addition to three Prompt Safety Recommendations (SR 17/2012, SR 18/2012 and SR 19/2012) issued in the Preliminary Report published, this Final Report contains one Safety Recommendation addressed to the General Civil Aviation Authority of the United Arab Emirates.

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1. Factual Information

1.1 History of the Flight

On 22 April 2012, both aircraft crewmembers reported for duty and were briefed in accordance with their companies' procedures and the relevant United Arab Emirates *Civil Aviation Regulations (CARs)*.

Both flights were prepared and, following passengers embarkation, departed uneventfully.

The Air Arabia Airbus A320, flight number ABY0281, departed from Sharjah International airport (OMSJ) runway (RWY) 30, en-route to Istanbul, Turkey (LTBA), at approximately 2058LT, whereas the flydubai Boeing 737-800 (B737), flight number FDB17, departed from Dubai International Airport (OMDB), en-route to Doha, Qatar (OTBD), at approximately 21:00LT.

The crew of the A320 contacted Dubai Departures Air Traffic Control (DXB DEP) and were instructed to continue straight ahead, whilst cleared to climb to 5,000 ft. After this, DXB DEP issued a series of instructions, including a left turn onto a heading of 210 degrees for sequencing and at 21:00LT requested a good rate of climb up to 5,000 ft. Thirty seconds later, the crew was instructed to maintain maximum speed of 250 kts, and to route direct to RANBI[2].

Shortly thereafter, of ATCOs changed over and the taking over ATCO assumed his duty in controlling and communicating with the aircraft. From the recorded conversations during this time, which were made available to the Team, it was noted that no formal handover briefing took place between the two air traffic controllers.

At 21:01:06LT, the crew of the B737 contacted DXB DEP after departing from Dubai airport runway 30R and was instructed to climb to an altitude of 5000 ft.

At 21:01:31LT, the A320 crew was instructed to increase speed to 300 kts and shortly thereafter, the B737 crew was given a left turn onto a heading of 210 degrees by the DXB DEP with a comment from the controller of "Delaying action through the RANBI gate." DXB DEP also restricted the B737 to a maximum speed of 250 kts.

Soon after, at 21:01:54LT, DXB DEP initiated a telephone call to the UAE Area Control Centre (ACC) for operational coordination of another, non-related aircraft. During this call, the ACC controller alerted DXB DEP that separation was about to be lost between the A320 and the B737.

DXB DEP immediately issued avoiding action to the crew of the A320 with an instruction to turn onto a heading of 270 degrees and issued further advisory information on the conflicting traffic and instructed the A320 crew to climb to 13,000ft.

At 21:02:33LT, the B737 crew was instructed to turn right onto a heading of 280 degrees. The crew on the B737 read back the right turn instruction and then interrupted their transmission to inform DXB DEP that they had a Traffic Collision Avoidance System-Resolution Advisory (TCAS-RA)[3] and informed DXB DEP that they were climbing as advised by the TCAS. Traffic information was then relayed to the B737 crew from DXB DEP.

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[2] RANBI is an airspace waypoint approximately 25 nautical miles west of Dubai International Airport

[3] The TCAS RA is cockpit display which provides the pilot with information on the vertical speed or pitch angle to fly in order to avoid an encounter (see section 1.18 of this Report for more information on the system).
FAA booklet: Introduction to TCAS II Version 7.1, dated February 2011.

Seventeen seconds later, the crew of the A320 also informed DXB DEP that they had received a TCAS RA warning and were descending as advised by TCAS. This was acknowledged by DXB DEP.

At 21:03:14LT, the A320 crew advised DXB DEP they were returning to their original assigned altitude of 13,000ft and heading 270 degrees. Four seconds later, DXB DEP advised the B737 that it was clear of traffic and instructed the Aircraft to climb to 13,000 ft, and maintain 210 degrees heading. The instruction was read back correctly by the crew.

The ATCO passed instructions to both aircraft. However, minimum vertical and lateral separation was not maintained and this led to the breach of separation, at approximately 21:01:45LT. The DFDR data indicated that both aircraft TCAS systems provided resolution advisories to the crew members. The first resolution advisory was provided to the B737 crew at 21:02:41LT.They were instructed to climb. At 21:02:50LT the A320 crew was instructed to descend.

Both aircraft involved in the AIRPROX[4], which occurred 5nm west of Dubai International Airport (OMDB), continued their journeys to their intended destinations uneventfully.

Shortly after the occurrence, the DXB DEP Controller was relieved from his assigned duties in accordance with the ATC unit's procedure and policy following such events.

1.2 Injuries to Persons

There were no reported injuries. The crew and passengers for each Aircraft were as follows:

For the A320: Crew 6 and passengers 147, total of 153.

For the B737: Crew 6 and Passengers 94, total of 100.

Table 1. Injuries to Persons

Injuries	Flight Crew	Cabin Crew	Other Crew Onboard	Passengers	Total On-board	Others
Fatal	0	0	0	0	0	0
Serious	0	0	0	0	0	0
Minor	0	0	0	0	0	0
None	4	8	0	253	265	0
TOTAL	**4**	**8**	**0**	**253**	**265**	**0**

1.3 Damage to the Aircraft

Neither aircraft sustained any damage.

1.4 Other Damage

There was no other damage and there was no damage to the environment.

4 An AIRPROX is a situation in which, in the opinion of a pilot or air traffic services personnel, the distance between aircraft as well as their relative positions and speed have been such that the safety of the aircraft involved may have been compromised. ICAO Doc 4444: PANS-ATM. Downloaded on 20 November 2014

1.5 Personnel Information

1.5.1 The A320 crew information

Table 2. A320 crew information		
	Commander	**Co-pilot**
Date of birth	13 September 1964	24 April 1986
GCAA License No.	ATPL 34686	MPL 26366
Class & Validity of medical	Class 1 Valid till 31 December 2012	Class 1 Valid till 31 December 2012
Flying Experience		
Total all flying hours	17300	279.63
Total flying hours on A320	6400	279.63
Total last 28 days	60.77	87.62
Total last 24 hours	8.72	8.70
Line & Proficiency Check	valid till 31 January 2013	valid till 30 June 2012
English Language Proficiency	Level 6	Level 6

1.5.2 The B737 crew information

Table 3. B737 crew information		
	Commander	**Copilot**
Date of birth	20 February 1958	26 May 1987
GCAA License No.	GCAA ATPL 33481	GCAA CPL 44200
Class & Validity of medical	Class 1. Valid till 28 February 2013	Class 1. Valid till 12 July 2012
Flying Experience		
Total all types	12,600	412.47
Total Command on all types	1,800	70
Total on type	7,100	186:47
Total last 30 days	64:55	41:58
Total last 24 hours	04:30	04:30
Line and proficiency check	Line Check: 17 April 2011 Proficiency Check: 13 March 2012	Line Check: 7 April 2012 Proficiency Check: 15 October 2011
English language proficiency	Level 6	Level 4

1.5.3 The Dubai Departures Air Traffic Controller

The Dubai ATC controller held a valid and current Air Traffic Control license which entitled him to exercise the privileges of an Air Traffic Control Service for a Radar Approach Rating.

The day of the Incident was the controller's third consecutive day of duty, after his annual leave, but his first afternoon shift of a DDAANN (D- Day, A- Afternoon, N- Night) cycle. His shifts for the first two days were normal and on his first afternoon shift, he reported half an hour early to receive a briefing required for a Dubai Approach Relocation and Transition (DART) rehearsal between Dubai Airport (OMDB) and Al Maktoum Airport (OMDW).

Prior to his afternoon shift, due to social obligations, the controller stated that he was unusually busy, which affected his normal rest cycle. However, the controller felt that he could perform his duties normally and he reported on time for the DART briefing.

The rehearsal for the DART required a handover of some ATC functions and staffing from Dubai ATC to Al Maktoum Airport. The seating plan for the controllers at Dubai Airport was re-arranged based on the reduced staffing level for the DART rehearsal.

At 2100LT, the controller was assigned to the Departure position from the Planner position. This is standard procedure for staff rotation.

The AIRPROX took place approximately three minutes after the controller assumed duty at the Departures position.

1.6. Aircraft Information

1.6.1 Aircraft general information – the A320

The Airbus A320 is narrow-body aircraft powered by two wing pylon-mounted turbofan engines. This low-wing cantilever monoplane has a conventional tail unit with a single vertical stabilizer and rudder. Wing swept back at 25 degrees, optimized for maximum operating Mach number 0.82. The A320 features a single-aisle cabin of 155.5 inches (3.95 m) outside diameter.

Table 4 illustrates general data of the aircraft.

Table 4. A320 general data

Aircraft Type:	A320-214
Aircraft Manufacturer:	AIRBUS INDUSTRIE
Aircraft MSN:	4061
Max TO/Ldg Mass:	77000 / 66000
Date of the last C of A:	8 October 2012
Last C of A expiry date:	7 October 2012
C of A category	Passenger
Aircraft Station License	5 Sep 2012
Insurance Validity Period	16 November 2012
Last CMR date	8April 2012
Next Due CMR	30 July 2012
TCAS System Details	TCAS II Software Version 7 Mode S: 896298
Manufacturer	ROCKWELL INTL CORP COLLINS AVIONICS AND COMMUNICATIONS DIV
P/N	822-1293-322
S/N	168700

1.6.2 Aircraft general information- the B737

The Boeing 737 Next Generation, commonly abbreviated as Boeing 737NG, is the name given to the -600/-700/-800/-900 series of the Boeing 737 which was first produced in 1996. The aircraft two man cockpit crew, short- to medium-range narrow-body jet airliners, with a single aisle cabin with a seating capacity on the -800 aircraft from 162 typical two class to 189 dense single class configuration.

The B737-800 has a fuselage length of 129 ft 6 in (39.5 m), wing span 117 ft 5 in (35.7 m) with a 25.02° (437 mrad) sweepback angle, cruising speed of 0.785 MACH, maximum speed of 0.82 MACH and powered by two wing mounted CFM 56-7B27 producing max thrust of 27,300 lbf (121.4 kN).

Table 5 illustrates general data of the aircraft.

Table 5. B737 general data	
Aircraft Type:	B737-8KN
Aircraft Manufacturer:	BOEING COMPANY, SEATTLE, USA
Aircraft MSN:	40238
Max TO/Ldg Mass:	79,015 kg/ 66,361 kg
Date of the last C of A:	5th November 2011
Last C of A expiry date:	4th November 2012
C of A category:	Passenger
Aircraft Station License:	00569/11
Insurance Validity Period:	16th November 2012
TSN:	6093.06
Last CMR date: 2012	6th February
Next Due CMR	5th June 2012
TCAS System Details	TCAS II Software Version 7
Mode S:	8962B6
Manufacturer	Honeywell TCAS
P/N	940-0300-001
S/N	TPA03362

1.6.3 Aircraft ACAS II Installed

The ACAS II version 7.0 fitted to both aircraft had the required TCAS II computer, antenna, and Mode S Transponder, which provides both Traffic Advisories (TA) and Resolution Advisories (RA). Both aircraft systems were functional and serviceable and operated as per design. The TCAS RA alert required the A320 aircraft to descend and the B737 aircraft to climb, and the pilots of both aircraft responded correctly to the TCAS RA commands until they were both clear of conflict.

1.7 Meteorological Information

1.7.1 The weather information at Sharjah International Airport

The event occurred during night lighting conditions.

The weather report at Sharjah International Airport was southerly winds light and variable, haze and ground temperature of 26 degrees on the Celsius scale and dew point of 17 degrees on the Celsius scale. In more detail the meteorological information before and after the departure of the A320 from OSMJ was as follows:

Table 6 illustrates the meteorological Information for Sharjah International Airport and Table 7 illustrates the Terminal Aerodrome Forecast (TAF) report.

Table 6. Meteorological information (METAR/SPECI) for Sharjah International Airport		
SA	22/04/2012 18:00	METAR OMSJ 221800Z 19005KT 160V240 7000 NSC 26/18 Q1007=
SA	22/04/2012 17:00	METAR OMSJ 221700Z 26005KT 220V280 5000 DU NSC 26/17 Q1007=
SA	22/04/2012 16:00	METAR OMSJ 221600Z 25008KT 5000 DU NSC 26/18 Q1007=
SA	22/04/2012 15:00	METAR OMSJ 221500Z 26010KT 4000 DU NSC 27/18 Q1007=

Table 7. TAF information for Sharjah International Airport		
FT	22/04/2012 15:57->	TAF OMSJ 221557Z 2218/2324 22005KT 6000 NSC PROB30 2218/2305 4000 DU BECMG 2306/2308 27014KT BECMG 2316/2318 18005KT=

1.7.2 The weather information at Dubai International Airport

The weather data at Dubai International Airport was southerly winds light and variable, haze, ground temperature of 26 degrees on the Celsius Scale and dew point of 18 degrees on the Celsius scale. In more detail the meteorological information before and after the departure of the B737 from OMDB was as follows:

Table 8 illustrates the meteorological Information for Dubai International Airport and Table 9 illustrates TAF report.

Table 8. Meteorological information (METAR/SPECI) for Dubai International Airport		
SA	22/04/2012 18:00	METAR OMDB 221800Z 23006KT 190V270 8000 NSC 26/18 Q1008 NOSIG=
SA	22/04/2012 17:00	METAR OMDB 221700Z 22004KT 170V250 8000 NSC 26/18 Q1007 NOSIG=
SA	22/04/2012 16:00	METAR OMDB 221600Z 26006KT 200V280 8000 NSC 26/18 Q1007 NOSIG=
SA	22/04/2012 15:00	METAR OMDB 221500Z 27010KT 5000 DU NSC 26/18 Q1007 NOSIG=

Table 9. TAF information for Dubai International Airport		
FT	22/04/2012 19:57->	TAF OMDB 221557Z 2218/2324 27010KT 7000 NSC BECMG 2218/2220 21005KT PROB30 2218/2305 4000 DU BECMG 2306/2308 27014KT BECMG 2316/2318 18005KT=

1.8 Aids to Navigation

Ground-based navigation aids/on-board navigation aids/aerodrome visual ground aids and their serviceability were not a factor in this Incident.

Radar Snapshots of the AIRPROX

The following snapshots were taken from the radar recording and do not accurately represent exactly what the controller saw on the radar screen at the time of the Incident. In addition, the range scale varies between snapshots. The radar snapshot illustrated in figure 1 represents the calculated distance (approximate 2.6 nm) between the Aircraft at 2101:05LT. At that time, the incoming DXB DEP controller identified the B737 aircraft and instructed the crew to climb to altitude 5000 feet. At that moment, the B737 was climbing through 1800 feet and the A320 was climbing through 5000 feet.

Figure 1. Radar snapshot at 2101:05LT

The next radar snapshot indicates approximately the time when the crew of the B737 reported receiving a TCAS RA Climb command to DXB DEP. At approximately the same time, the A320 TCAS commanded the crew to Descend. The time of the snapshot was 1702:41LT and both Aircraft were at 5100 feet and the calculated horizontal separation was 1817 m (figure 2).

Figure 2. Radar snapshot at 2102:41LT

The next radar snapshot represents the position of the aircraft at 2102:58LT indicating approximately, when the A320 passed behind the B737 with a vertical displacement of 700ft, and a horizontal separation of approximately 796 m. The Minimum Separation Standard approved for use in the Dubai Control Zone is 1000 ft vertical or 3nm longitudinal by Radar.

Furthermore, both Aircraft continued increasing their separation distance as the B737 was climbing whereas the A320 was descending (figure 3).

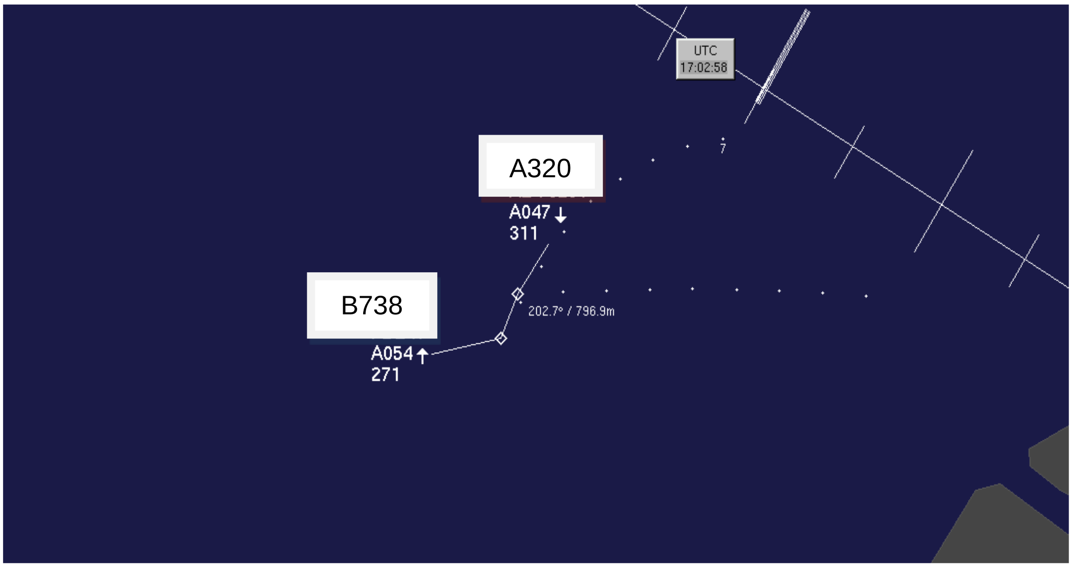

Figure 3. Radar snapshot at 2102:58LT

1.9 Communications

All communications between air traffic service (ATS) and the crew were recorded by ground based automatic voice recording equipment for the duration of the Incident. The quality of the aircraft's recorded transmissions was good.

Both aircraft were equipped with three very high frequency (VHF) radio communication systems. Each aircraft crew used two of the VHF radios for routine communications with air traffic control, and the remaining set was used for the aircraft communications addressing and reporting system (ACARS) data link system. All VHF radios were serviceable.

The ATC recordings and radar files were made available to the Investigation. In addition, throughout the following communications between DXB DEP and both aircraft, followed clear instructions from ATC and readback by both flight crews was clear and correct at all times.

1.10 Aerodrome Information

Sharjah International Airport has a single runway 12/30. The A320 departed from runway 30.

Dubai International Airport has two parallel runways 12L/30R and 12R/30L. The B737 departed from runway 30R.

1.11 Flight Recorders

Both aircraft were equipped with flight recorders, in accordance with the *Civil Aviation Regulations (CAR)* of the United Arab Emirates. Information was downloaded from both recorders at the AAIS flight recorder laboratory.

The flight paths derived from the flight recorders were examined during the investigation. Refer to subsection 1.1 'Sequence of events' for relevant extracts from the recorded data. The occurrence sequence is described with reference to timeframes of elapsed time.

Data set readouts from both aircraft were used to compile a flight animation which confirmed the separation distances captured on the radar snapshots.

In addition, the data confirmed the actions taken by the crews of both aircraft were in accordance with the TCAS RA messages.

1.11.1 AAIS Animation snapshot of the AIRPROX

Figure 4 illustrates, is a representation of the paths followed by the two aircraft based on their downloaded flight recorders' data. The red line represents the flight path of the A320, and the blue line represents the B737 flight path. The snapshot does not show the minimum separation between the two flight paths, indicating the TCAS commands received by the flight crew.

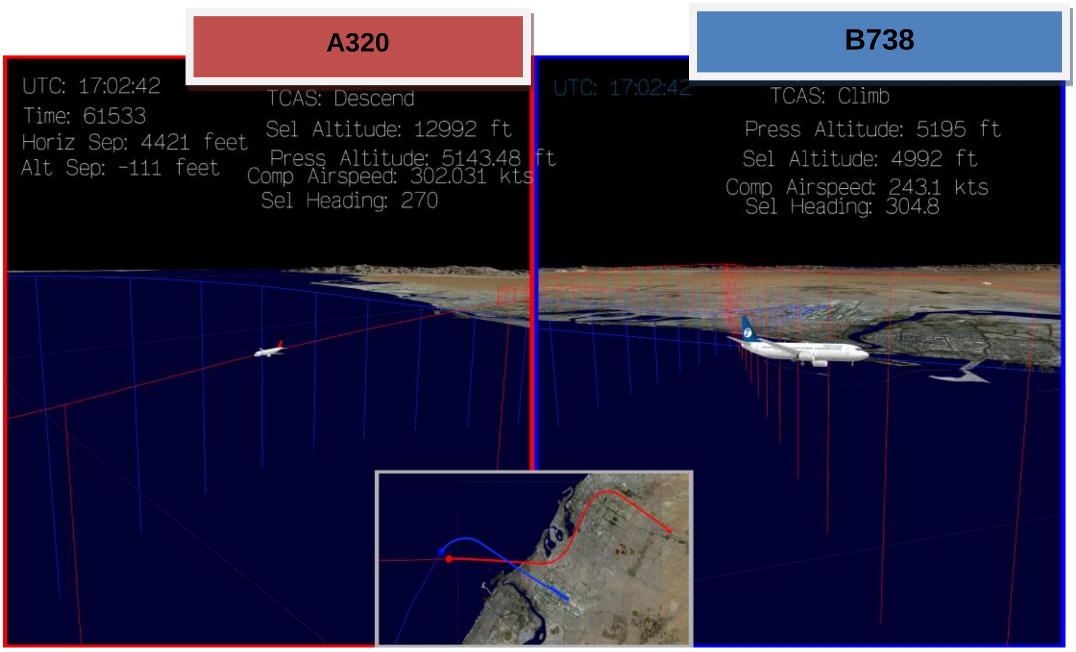

Figure 4. Snapshot from animation showing the aircraft relative flight paths

1.12 Wreckage and Impact Information

Both aircraft were intact.

1.13 Medical and Pathological Information

No medical or pathological investigations were conducted as a result of this Incident, nor were they required.

1.14 Fire

There was no fire.

1.15 Survival Aspects

Not applicable.

1.16 Test and Research

The Investigation performed a random review of five UAE certified Operators and it was revealed that these UAE Operators were not all fully aware of the recent changes and development of ACAS II, especially version 7.1. It was also found that a UAE Operator has had Version 7.1 already installed on some of its fleet since October 2011.

1.17 Organizational and Management Information

1.17.1 The A320 Operator's information

Air Arabia is a Sharjah based airline, with headquarters at Sharjah International Airport, UAE, operates a fleet of Airbus A320 aircraft powered by CFM-56 turbofan engines. The airline was established on 3 February 2003 by the Ruler of Sharjah, becoming the first low-fare airline in the UAE. Operations started later in the same year and on 28 October 2003, the airline operated its first flight from Sharjah to Bahrain International Airport.

1.17.2 The B737 Operator's information

'flydubai' is a Dubai based airline, with headquarters at Terminal 2, Dubai International Airport, UAE, operated a fleet of all B737NGs, powered by CFM56-7 engines. The airline was established in July 2008 by the Government of Dubai and the first flight was on 1 June 2009 with flights from Dubai Airport to Beirut, Lebanon and Amman, Jordan. Since then, the route network has been significantly expanded.

1.17.3 Dubai Air Navigation Service (DANS) – Air Traffic Control Approach Unit

At the time of the Incident, DXB ATC utilized a Flight Refuelling Radar (FRL) system to track aircraft position. However, this system did not provide Short Term Conflict Alert (STCA), to the ATC controller. As a result, the STCA was highlighted to the DXB DEP controller by the UAE Area Control Center (ACC) controller.

It was found during various audits (from 2005 to 2011) carried out by the GCAA that the FRL display did not provide STCA and Minimum Safe Altitude Warnings (MSAW) as required by paragraph 814 of ICAO *DOC 4444 PANS-ATM*, and paragraph 4.34(c)(4)of *CAR Part VIII, Subpart 4*.

As stated by Dubai ANS, on installation of the equipment, the system did not provide the required warnings as expected. Simulation showed that there was an unacceptable level of nuisance and false STCA alerts (trials carried out in the ATC Simulator in 2008). The STCA parameters could not be configured with the FRL software in use. The FRL did not progress the algorithms used, so it was therefore not possible to implement the warnings in a safe manner.

The GCAA required Dubai ANS to rectify the lack of Radar Alerts available and extended the resolution target date based on an agreed work plan and mitigation. This required a provision for enhanced procedures from the en-route ATC Unit to notify of any radar alerts. Following introduction of the Raytheon Auto Track 3 system in February 2013, a more advanced STCA capability proved to be an acceptable solution and has been operational since then. All UAE Civil ATC Radar positions now have the required alert capabilities and this is monitored for acceptable continued compliance on a regular basis by the GCAA.

1.18 Additional Information

1.18.1 AIRPROX

With reference *ICAO Doc 4444- PANS-ATM*, an AIRPROX is defined as "A situation in which, in the opinion of a pilot or air traffic services personnel, the distance between aircraft as well as their relative positions and speed have been such that the safety of the aircraft involved may have been compromised."

ICAO defines a series of classifications for AIRPROX events which have been reported and subsequently investigated by an appropriate body. It is required that this classification should be assigned on the basis only of actual risk, not potential risk. This means that only the residual risk after any avoiding action is considered.

The available classification categories are:

A- Risk of collision. The risk classification of an aircraft proximity in which serious risk of collision has existed. An AIRPROX Classification A may or may not be deemed to be a serious incident as defined by ICAO *Annex 13*.

B- Safety not assured. The risk classification of an aircraft proximity in which the safety of the aircraft may have been compromised.

C- No risk of collision. The risk classification of an aircraft proximity in which no risk of collision has existed.

D- Risk not determined. The risk classification of an aircraft proximity in which insufficient information was available to determine the risk involved, or inconclusive or conflicting evidence precluded such determination.

The definition and classification of an AIRPROX given above was agreed prior to the introduction of ground radar and airborne systems (ACAS) capable of measuring accurately the actual separation of the aircraft involved.

An AIRPROX may occur as a result of a level bust or airspace infringement. Safety nets such as ACAS and STCA mitigate the resultant risk of collision.

<u>Reporting and investigation of an AIRPROX</u>

ICAO requires the establishment of AIRPROX reporting and investigation procedures and these should be specified in national procedures.

Typically, national authorities establish a special committee to investigate an AIRPROX report which allocates the actual risk classification and to recommend further action. Some States use their *Annex 13* Accident Investigation Agency to also investigate all AIRPROX, not just those which are considered to be a serious incident.

An AIRPROX should be reported as soon as possible to facilitate investigation of the incident. If circumstances allow, the pilot should report the incident immediately to ATC using radiotelephony, the details will then be reported by ATC to the appropriate body. If it is not possible to report an AIRPROX in flight (e.g. because the frequency in use is too busy) the pilot should report the incident as soon as possible after landing. ATS units to whom AIRPROX incidents are reported should also report the circumstances of which they are aware to the appropriate body. In all cases, initial verbal reports should be followed up by full written reports using any prescribed form which may be in use for that purpose.

Depending on circumstances, an AIRPROX may qualify as a serious incident which will then require that it be reported to and investigated by a national accident investigation agency, under the terms of ICAO *Annex 13*, Chapters 4 and 5. Non-*Annex 13* AIRPROX investigations are essentially a special case of a State mandatory occurrence reporting and follow up by or in association with the applicable regulatory authority under the terms of ICAO *Annex 13* Chapter 8, whereas an *Annex 13* Investigation is independent of regulatory influence.

1.18.2 Airborne Collision Avoidance System (ACAS)

1.18.2.1 General description[5]

The Airborne Collision Avoidance System II (ACAS II) was introduced in order to reduce the risk of mid-air collisions or near mid-air collisions between aircraft. It serves as a last-resort safety net irrespective of any separation standards.

ACAS II is an aircraft system based on Secondary Surveillance Radar (SSR) transponder signals. ACAS II interrogates the Mode C and Mode S transponders of nearby aircraft (intruders) and from the replies tracks their altitude and range and issues alerts to the pilots, as appropriate. Non-transponding aircraft are not detected.

ACAS II works independently of the aircraft navigation, flight management systems, and ATC ground systems. While assessing threats, it does not take into account the ATC clearance, pilot’s intentions, or autopilot inputs.

Currently, the only commercially available implementations of ICAO standard for ACAS II are TCAS II versions 7.0 and version 7.1. ICAO *Annex 10* states that ACAS installation for new aircraft after 1 January 2014 must be version 7.1 compliant and existing aircraft must be upgraded to version 7.1 before 1 January 2017.

A typical schematic diagram of ACAS II aircraft equipment is shown in figure 5.

1.18.2.2 Information provided by ACAS

Two types of alerts can be issued by ACAS II: Traffic Advisory (TA) and Resolution Advisory (RA). The former is intended to assist the pilot in the visual acquisition of the conflicting aircraft and prepare the pilot for a potential RA.

If a risk of collision is established by ACAS II, an RA will be generated. Broadly speaking, RAs tell the pilot the range of vertical speed at which the aircraft should be flown to avoid the threat aircraft. The visual indication of these rates is shown on the flight instruments. It is accompanied by an audible message indicating the intention of the RA. A 'Clear of Conflict' message will be generated when the aircraft diverge horizontally.

[5] Information on ACAS from: http://www.skybrary.aero/index.php/Airborne_Collision_Avoidance_System_(ACAS) downloaded on 5 February 2015

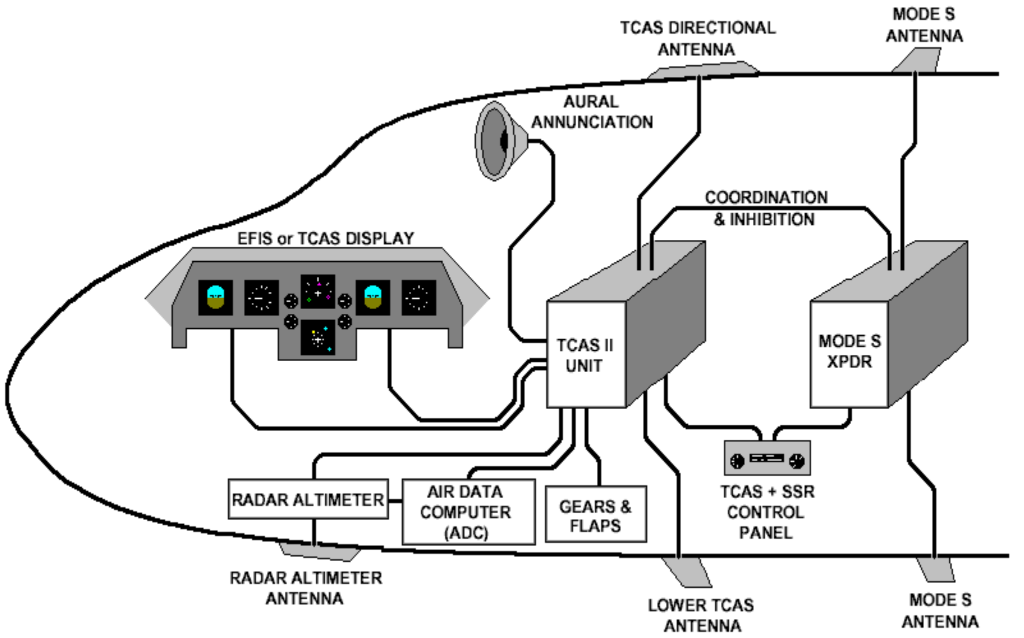

Figure 5. Typical equipment schematic diagram for ACAS II.

The vertical sense (direction) of the RA is coordinated with other ACAS II equipped aircraft via a mode S link, so that two aircraft choose complementary manoeuvres. RAs aim for collision avoidance by establishing a safe vertical separation (300 - 700 feet), rather than restoring a prescribed ATC separation.

ACAS II operates on relatively short time scales. The maximum generation time for a TA is 48 seconds before the Closest Point of Approach (CPA). For an RA, the time is 35 seconds. The time scales are shorter at lower altitudes (where aircraft typically fly slower). Unexpected or rapid aircraft manoeuvre may cause an RA to be generated with much less lead time. It is possible that an RA will not be preceded by a TA if a threat is imminent. The effectiveness of an RA is evaluated by the ACAS equipment every second and, if necessary, the RA may be strengthened, weakened, reversed, or terminated.

RAs can be generated before ATC separation minima are violated and even when ATC separation minima will not be violated.

A protected volume of airspace surrounds each ACAS II equipped aircraft. The size of the protected volume depends on the altitude, speed, and heading of the aircraft involved in the encounter. (Figure 6).

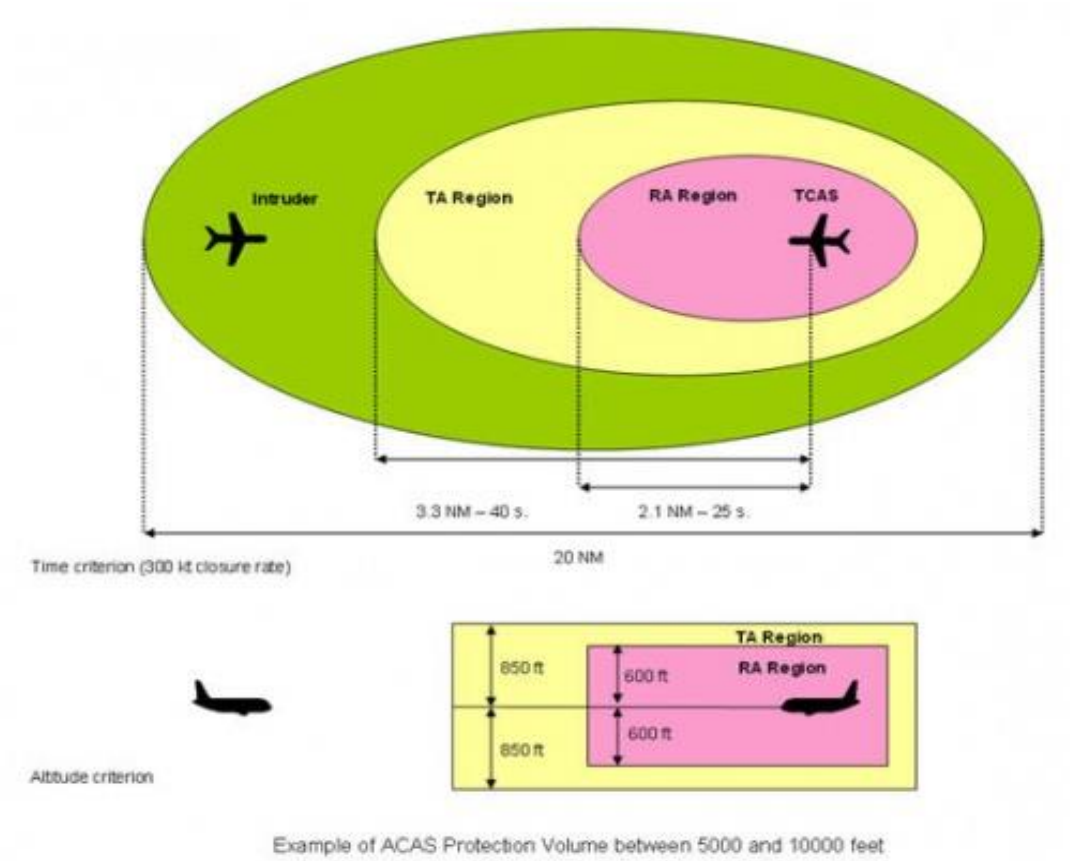

Figure 6. A protected volume of airspace surrounds each ACAS II equipped aircraft.

1.18.2.3 ACAS II version 7.0 commands

Upward sense			Downward sense		
RA	Required vertical rate (ft/min)	Aural	RA	Required vertical rate (ft/min)	Aural
Climb	1500	Climb, climb	Descend	– 1500	Descend, descend
Crossing Climb	1500	Climb, crossing climb; Climb, crossing climb	Crossing Descend	– 1500	Descend, crossing descend; Descend, crossing descend
Maintain Climb	1500 to 4400	Maintain vertical speed, maintain	Maintain Descend	– 1500 to – 4400	Maintain vertical speed, maintain
Maintain Crossing Climb	1500 to 4400	Maintain vertical speed, crossing maintain	Maintain Crossing Descend	– 1500 to – 4400	Maintain vertical speed, crossing maintain
Reduce Descent 1	0 – 500 – 1000 – 2000	Adjust vertical speed, adjust	Reduce Climb 1	0 500 1000 2000	Adjust vertical speed, adjust
Reversal Climb 2	1500	Climb, climb NOW; Climb, climb NOW	Reversal Descent 2	– 1500	Descend, descend NOW; Descend, descend NOW
Increase Climb 2	2500	Increase climb, increase climb	Increase Descent 2	– 2500	Increase descent, increase descent
Preventive RA	No change	Monitor vertical speed	Preventive RA	No change	Monitor vertical speed
RA Removed	—	Clear of conflict	RA Removed	—	Clear of conflict

1 Replaced by "Level off, level off" in version 7.1
2 Not possible as an initial RA

Figure 7. Typical commands for TCAS II Version 7.0 to the crew whenever an RA.

1.18.2.4 Complying with TCAS RAs

Pilots are required to immediately comply with all RAs, even if the RAs are contrary to ATC clearances or instructions.

If a pilot receives an RA, he/she is obliged to follow it, unless doing so would endanger the aircraft. Complying with the RA, however, will in many instances cause an aircraft to deviate from its ATC clearance. In this case, the controller is no longer responsible for separation of the aircraft involved in the RA.

On the other hand, ATC can potentially interfere with the pilot's response to RAs. If a conflicting ATC instruction coincides with an RA, the pilot may assume that ATC is fully aware of the situation and is providing the better resolution. But in reality ATC is not aware of the RA until the RA is reported by the pilot. Once the RA is reported by the pilot, ATC is required not to attempt to modify the flight path of the aircraft involved in the encounter. Hence, the pilot is expected to "follow the RA" but in practice this does not yet always happen.

Some States have implemented 'RA downlink' which provides air traffic controllers (ATCOs) with information about RAs posted in the cockpit obtained via Mode S radars. Currently, there are no ICAO provisions concerning the use of RA downlink by ATCOs.

1.18.2.5 International Standards for ACAS

ICAO is responsible for the global standardisation of ACAS.

ACAS equipment is available from different vendors. While each vendor's implementation is slightly different, they provide the same core functions and the collision avoidance and coordination logic contained in each implementation is the same. In order to be certified, ACAS equipment must meet the Minimum Operational Performance Standards (MOPS) laid down set in the Radio Technical Commission for Aeronautics (RTCA) requirements and the forthcoming European Organisation for Civil Aviation Equipment (EUROCAE) documents.

The equipment which meets the ACAS II *Standards and Recommended Practices (SARPs)* set in *Annex 6* is known as TCAS II, version 7. A joint RTCA/EUROCAE working group has finalized amendments to the MOPS, addressing three specific safety improvement changes related to the collision avoidance logic; these new MOPS will form TCAS II version 7.1 and are published as *RTCA DO-185B* and *EUROCAE ED-143*.

1.18.2.6 UAE standard for ACAS

The requirements for the ACAS are mentioned in Part IV of the UAE *CARs , CAR OPS 1*, Section 1.668, and the *Civil Aviation Advisory Publication (CAAP) 29*, . CAR-OPS 1 mandates ACAS II without version standardization.

CAR Part IV, CAR-OPS 1.668 states[6]:

> "Airborne Collision Avoidance System:
>
> (a) An operator shall not operate a turbine powered aeroplane:
>
> (1) Having a maximum certificated take-off mass in excess of 15000 kg or a maximum approved passenger seating configuration of more than 30 after 1 January 2000; or
>
> (2) Having a maximum certificated take-off mass in excess of 5700 kg, but not more than 15000 kg, or a maximum approved passenger seating configuration of more than 19, but not more than 30, after 1 January 2005, unless it is equipped with an airborne collision avoidance system with a minimum performance level of at least ACAS II."

[6] Revision date - Reissue 01 July 2011

Types of ACAS

ACAS I - Gives TAs but does not recommend any maneuvers. The only implementation of ACAS I concept is TCAS I. ICAO *SARPs* for ACAS I are published in *Annex 10*, volume IV but are limited to interoperability and interference issues with ACAS II. ACAS I is mandated in the United States for certain smaller aircraft.

ACAS II - Gives TAs and RAs in the vertical sense (direction). ACAS II *SARPs* are published in *Annex 10*. The only implementation of ACAS II concept is TCAS II Version 7.0.

The types of TCAS II are:

- TCAS II version 6.04a– old version of TCAS II never mandated in Europe still used by some military aircraft or foreign aircraft (which do not fall within the current European mandate)
- TCAS II version 7.0- currently mandated in Europe but to be gradually phased out and replaced by version 7.1
- TCAS II version 7.1- mandated in Europe as per *EU regulations 1332/2011*:
  - for all new aircraft as of 1 March 2012
  - and for all aircraft currently with version 7.0, before 1 December 2015.

1.18.2.7 TCAS II version 7.1 - mandated by *Annex 10*

Annex 10 states that:

- for all new aircraft as of 1 January 2014
- and for all aircraft currently with version 7.0, before 1 January 2017.

ACAS III - Gives TAs and RAs in vertical and/or horizontal directions. Also referred to as TCAS III and TCAS IV. Not currently implemented and unlikely to be in the near future. ICAO *SARPs* for ACAS III have not been developed. Currently, there are no plans to proceed with such a development."

1.18.3 Safety Benefits of ACAS II Version 7.1

1.18.3.1 Version 7.0 – Two Safety Issues identified

Following a series of mid-air encounters in which safety margins were lost, including accidents in Yaizu (Japan) in 2001 and in Überlingen (Germany) in 2002, studies concluded that with the current at that time airborne collision avoidance system software there is a probability of a mid-air collision risk of 2.7×10^{-8} per flight hour. Therefore, the current ACAS II version 7.0 is considered to be of an unacceptable safety risk[7].

The two main safety issues identified with version 7.0 were Adjust Vertical Speed, Adjust (AVSA) and Late TCAS Reversals.

[7] Reference *Commission Regulation (EU) No 1332/2011*

1.18.3.2 Version 7.0–Safety issue 1 with" Adjust Vertical Speed, Adjust" (AVSA)[8]

Since its introduction in Europe in 2000, TCAS II version 7.0 has been the subject of monitoring. In the course of analyzing recorded and reported events, many cases (as many as 23 per year) were found in which pilots did not respond correctly to the AVSA RAs.

The AVSA RA requires the reduction of vertical speed to 2000, 1000, 500, or 0 ft/minute., as indicated on the flight instruments. In those cases involving an incorrect response, the pilots increased their vertical speed instead of reducing it, consequently causing a deterioration of the situation. The AVSA RA is the only RA whose aural annunciation does not clearly communicate what exact maneuver is required. It is also the most common RA, representing up to two-thirds of total RAs, all of which increases the potential for incorrect pilot response (figure 8).

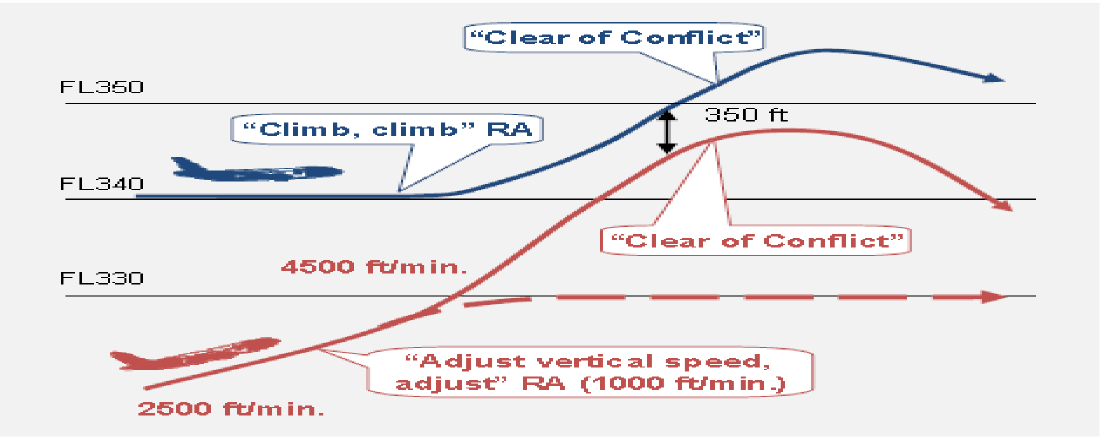

Figure 8. Incorrect response to AVSA RA

Additionally, there have been numerous cases of level bust when pilots following the AVSA RA went through their cleared level, often causing a follow up RA for the other aircraft above or below, and disrupting ATC operations (figure 9).

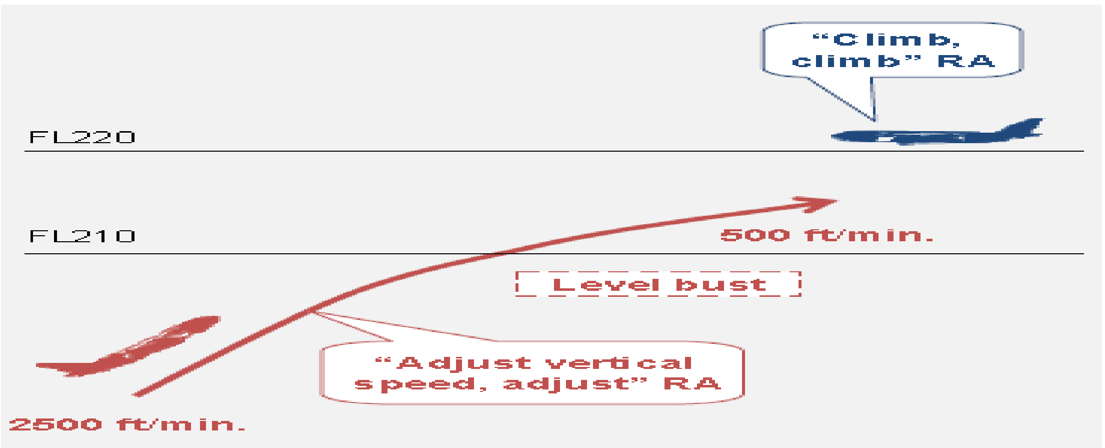

Figure 9. Level burst as a result of AVSA RA

[8] Federal Aviation Administration, *Introduction to TCAS II Version 7.1* booklet, dated 28 February 2011, downloaded from : http://www.faa.gov/documentLibrary/media/Advisory_Circular/TCAS%20II%20V7.1%20Intro%20booklet.pdf

1.18.3.3 Solution for Safety issue 1 - Version 7.1 - AVSA changed to "Level off, Level off"

The AVSA RA has been determined to be confusing, and there is a history of some pilots not responding to the AVSA RA as intended. The solution in Version 7.1 replaces four AVSA RAs with a single "Level Off, Level Off" RA. (Figure 10).

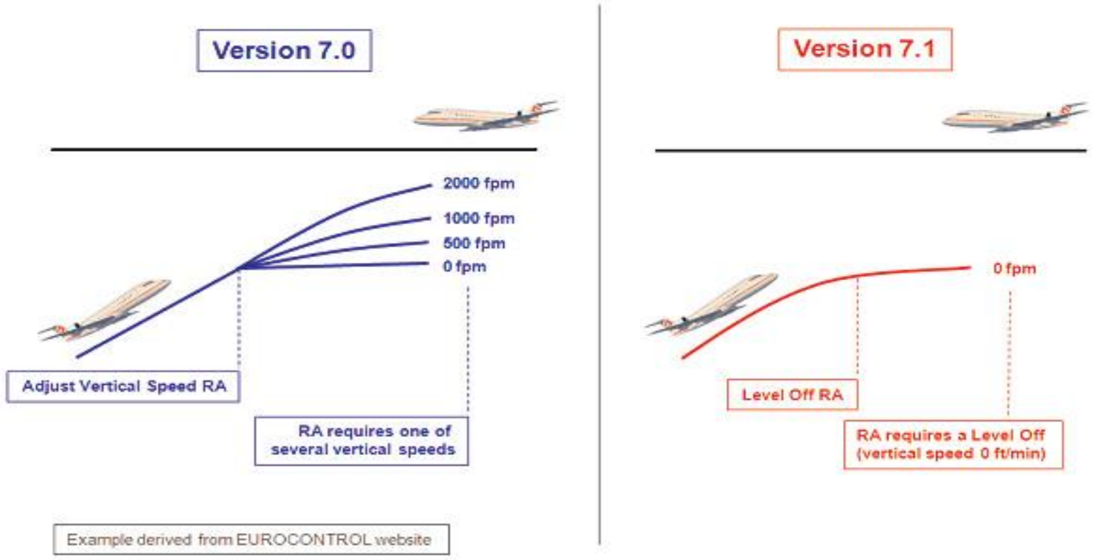

Figure 10. AVSA version 7.0 to "Level off" version 7.1

The aural message "Level off, level off" also has the benefit of being intuitive and the associated maneuver corresponds to the standard leveling off maneuver.

Additionally, replacing the multiple climb/descent rates of the AVSA RA, the 'Level off, level off' RA will minimize the altitude deviations induced by TCAS (level busts while "flying the green arc), thus reducing the impact on ATC operations. It will contribute to the overall reduction of RA occurrences because follow up RAs resulting from the 'green arc level bust' should not occur any more (figure 11).

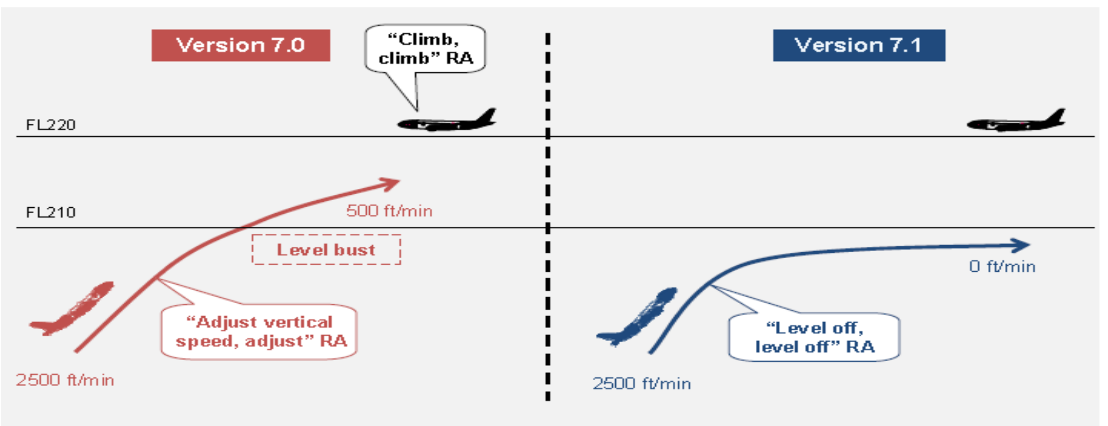

Figure 11. How the 'Level off, level off' RA will reduce instances of level bust

1.18.3.4 Safety issue 2 - Version 7.0 – TCAS RA Reversal Logic

The design of the current TCAS II version 7.0 allows for reversal RAs (i.e. 'Climb, climb NOW' and 'Descend, descend NOW') to be issued when the current RA is no longer predicted to provide sufficient vertical spacing.

However, there have also been a number of cases in which TCAS II version 7.0 failed to reverse an RA when two converging aircraft remained within 100 feet.

This type scenario can occur when one aircraft is not following the RA or is not TCAS II equipped and follows an ATC instruction or performs an avoidance maneuver based on visual acquisition.

A number of these types of cases have been discovered each year (as many as 7 per year) and the most notable events being the Yaizu[9] (Japan) midair accident in 2001 and the Überlingen (Germany)[10] midair collision in 2002.

1.18.3.5 Solution for Safety Issue 2 - Version 7.1 – TCAS RA Improved Reversal Logic

Version 7.1 will bring improvements to the reversal logic by detecting situations in which, despite the RA, the aircraft continue to converge vertically.

A feature has been added to the TCAS logic which monitors RA compliance in coordinated encounters (i.e. when both aircraft are TCAS II equipped). When version 7.1 detects that an aircraft is not responding correctly to an RA, it will issue a reversal RA to the aircraft which maneuvers in accordance with the RA.

In single equipage encounters (i.e. when only one aircraft is TCAS II equipped), version 7.1 will recognize the situation and will issue a reversal if the unequipped threat aircraft moves in the same vertical direction as the TCAS II equipped aircraft. Although the reversal logic change is transparent to flight crews, it will, nevertheless, bring significant safety improvements (figure 12).

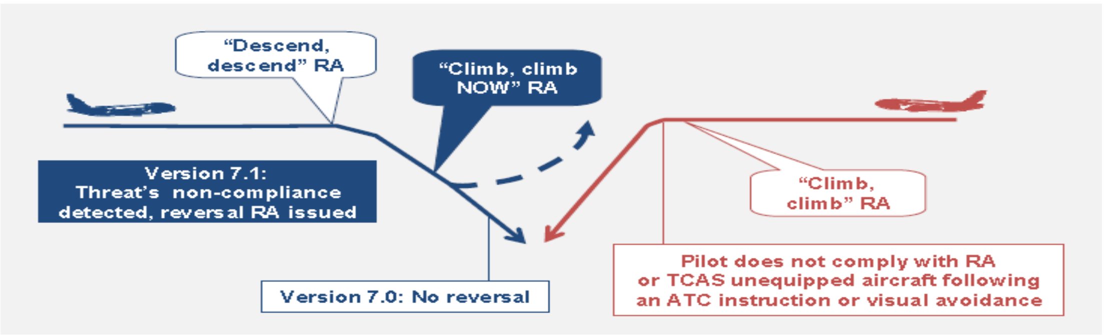

Figure 12. TCAS II version 7.1 improved reversal logic

1.18.4 Air Traffic Control Alerting System

1.18.4.1 Safety Nets for ATC

Listed are some of the ground safety nets that are utilized across ATC centers in order to aid ATCOs in performing their jobs safely especially with the demands of air traffic:

---

[9] Information downloaded from : http://aviation-safety.net/wikibase/wiki.php?id=147126 & http://www.asasi.org/papers/2005/Hiroaki%20Tomita%20-%20near%20collision%20in%20Japan.pdf Date 31 December 2014

[10] Information downloaded from : http://aviation-safety.net/database/record.php?id=20020701-0
http://wn.com/2002_Überlingen_mid-air_collision
http://www.skybrary.aero/index.php/T154_/_B752,_en-route,_Uberlingen_Germany,_2002_(LOS_HF)
https://www.youtube.com/watch?v=LJvEF2aRbdk Date 01 January 2015

- Short Term Conflict Alert (STCA), which assists the controller in preventing collision between aircraft by generating, in a timely manner, an alert of a potential or actual infringement of separation minima.
- Minimum Safe Altitude Warning (MSAW), which warns the controller about increased risk of controlled flight into terrain accidents by generating, in a timely manner, an alert of aircraft proximity to terrain or obstacles.
- Area Proximity Warning (APW), which warns the controller about unauthorised penetration of an airspace volume by generating, in a timely manner, an alert of a potential or actual infringement of the required spacing to that airspace volume.
- Approach Path Monitor (APM), which warns the controller about increased risk of controlled flight into terrain accidents by generating, in a timely manner, an alert of aircraft proximity to terrain or obstacles during final approach.

1.18.4.2 Short Term Conflict Alert (STCA) [11]

The STCA is a function integrated into an ATC radar system. It assists the controller in preventing collision between aircraft by generating, in a timely manner, an alert of a potential or actual infringement of separation minima. In the STCA function the current and predicted positions of aircraft with pressure altitude reporting capability are monitored for proximity. If the distance between the positions of two aircraft is predicted to be reduced to less than the applicable separation minima within a specified time period, a warning will be generated to the controller. The parameters for determining when STCAs are generated are left for the local ANS unit to define based on fine tuning out nuisance alerts.

There is no direct connection that exists between STCA and ACAS II although the aircraft transponder provides data for both TCAS II computer and ATC radar system. Although normally very effective in alerting controllers about actual or potential separation loses, STCA is not as efficient as ACAS II in providing collision avoidance.

1.18.4.3 ATS Surveillance Services –*CAR Part VIII 4.34(c)* and ICAO *Document 4444*

As stated in the *CAR Part VIII- Air Navigation Regulations*, subpart 4.34[12]:

> "(c) The applicant for an air traffic service certificate shall establish procedures to ensure that, where radar or automatic dependent surveillance is used to support the provision of an air traffic service:
>
> 1. All surveillance separations are in accordance with the requirements of Appendix A.1 and PANS -ATM;
>
> 2. Mode A SSR code allocation shall be made by the ATC units in accordance with the Originating Region Code Assignment Method ORCAM[13] allocation procedures.
>
> 3. Full information is made available to pilots and aircraft operators on:
>
> i. The nature and extent of the surveillance services provided;
>
> ii. Any significant limitations regarding such surveillance services;

[11] Information downloaded from: https://www.eurocontrol.int/articles/resources , dated 4 April 2015.
[12] Revision November 2009
[13] SSR codes used by Air Traffic Control for radar services

4. The information displayed at individual surveillance operating positions is that required for the air traffic services to be provided, including the display of safety related alerts and warnings, where the Authority has determined that the facility is required; and

5. The surveillance system used shall be provided and maintained in accordance with the provisions of Subpart 5 of the Civil Aviation Rules."

Reference for ATS surveillance systems capabilities with safety related alerts and warnings is also highlighted in ICAO *Document 4444 PANS-ATM*[14], 8.1.4, 8.4.1, 15.7.2[15]

1.18.5 Other Occurrence in the same area[16]

Table 10. Aircraft involved in an occurrence on 16 October 2014

Call sign	Type	Departure	Destination	Squawk	Rwy
YYY533	B772	VOCI	OMDB	4705	30L
XXX472	A320	VOMM	OMSJ	4041	30L
XXX372	A320	Unknown	OMSJ	Unknown	Unknown

During this investigation of the event that occurred on the 16 October 2014, the arrival session sequence had several aircraft coming into land. “Departure North controller was working all the Sharjah arrival aircraft on frequency 126.2 MHz. The Planner had set up 20nm spacing for all OMSJ arrivals via the inbound gates approximately 25 minutes prior to the event. Even with the flow in place, the departures (DEPN) controller had to vector traffic off the Standard Arrival (STAR) in order to achieve the required in trail spacing required by OMSJ tower.

XXX372 and XXX472 were consecutive arrivals on vectors for OMSJ. XXX472 was on heading 220˚ for positioning in traffic. This heading brought them in conflict with YYY533 on downwind for OMDB. The DEPN controller noticed the conflict and instructed XXX472 to turn left heading 090˚. Similar call signs contributed to the DEPN controller initially issuing avoiding action to XXX372 instead of XXX472. XXX372 informed DEPN that they were maintaining 2000 feet. The DEPN controller then issued turn instructions to XXX472. The Arrival controller issued avoiding action to YYY533. The separation between XXX472 and YYY533 reduced to 1.7nm and 100 feet.”

Furthermore, the report contained the following investigation findings:

- A loss of separation occurred between YYY533 and XXX472, with minimum distance between the two aircraft to be 1.7nm (horizontal) and 100 feet (vertical). The planner had requested the ACC to space the arrival traffic at 20nm. This coordination was performed 25 minutes before the loss of separation. At the time of the event there were 5 OMSJ arrivals in the CTA.
- The DEPN controller put both aircraft on radar headings in order to achieve in trail spacing required by OMSJ tower. This increased the workload of the controller and the complexity of the traffic scenario.
- Similar sounding call signs XXX372 and XXX472 were consecutive arrivals for RWY 30L at OMSJ.

[14] Procedures for Air Navigation Services Air Traffic Management
[15] Fifteenth Edition, dated 2007, downloaded 31 December 2014
[16] As per the ATC Unit Investigation Report (20735-141016-ATC)

- While the DEPN controller issued XXX372 with the base turn instructions he noticed that XXX472 was still on heading toward traffic on the outer trombone of the OMDB STAR.
- The DEPN controller noticed the conflict prior to the Conflict Alert being activated on the radar display and immediately pointed the conflict out to the ARR controller.
- Similar sounding call signs contributed to the DEPN controller then issuing traffic information and avoiding action to the wrong aircraft. The avoiding action was issued to XXX372 instead of XXX472.
- The ARR controller issued avoiding action and traffic information to YYY533.
- When the Red Conflict Alert was activated there was so much clutter on the display that it was very difficult for the DEPN controller to see the traffic scenario clearly.
- The system is not designed for the ATCO to deselect -'Conflict Alert' in order to see their traffic clearly.
- The controller could not see the distance between YYY533 and XXX472 due to the screen clutter.

1.18.6 Civil Aviation Regulations on Human Factors Training for Air Traffic Controllers

Human Factor training and principles are mentioned in *CAR Part VIII, Subpart 4*[17]*- Air Traffic Control Organisations*:

CAR 4.35- *AIRCRAFT EMERGENCIES AND IRREGULAR OPERATIONS*

"(c) In communications between ATS units and aircraft in the event of an emergency, Human Factors principles, as shown in ICAO Document 9683, should be observed."

Appendix 2.1- *ATC COURSE APPROVALS*

"(c) Training courses for ATS personnel shall:

1. take due regard of Human Factors requirements, as contained in ICAO Documents 9683 and 9758[18],

2. take due regard for Threat and Error Management, as contained in ICAO Circular 314."[19].

Appendix 2.7- *CONTINUATION TRAINING REQUIREMENTS*

"(d) ECT [ ] courses shall include the following:

6. Human Factors principles, in relation to communication between ATS units and aircraft subject to emergencies."

Appendix 2.10- *COMPETENCE OF AIR TRAFFIC CONTROLLERS*

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[17] Issue 03 Revision 00, date of Issue June 2014, date of Revision June 2014.

[18] ICAO *Document 9683* is the Human Factors Training Manual, and *Document 9758* is the Human Factors Guidelines for Air Traffic Management.

[19] ICAO *CIR 314* Treat and Error Management (TEM) in Air Traffic Control. This circular describes an overarching safety framework intended to contribute to the management of safety in aviation operations and known as TEM. The main objective of introducing the TEM framework to the ATS community in general, and the ATC community in particular, is to enhance aviation safety and efficiency. This is achieved by providing an operationally relevant and highly intuitive framework for understanding and managing system and human performance in operational contexts.

"k) Before a CoC [certificate of competency] is issued or renewed an air traffic controller shall demonstrate satisfactory competence in the following areas by completing a CoC examination.

1. Satisfactory knowledge in the following subjects:

iv. human factors, fatigue, and threat and error management relevant to Air Traffic Control including handling of an aircraft in an emergency."

Appendix 3.6- *REQUIRED KNOWLEDGE, SKILLS AND EXPERIENCE*

"(a) The knowledge required to be demonstrated by an air traffic controller or a student air traffic controller, shall be at an appropriate standard for a holder of an Air Traffic

Controller Licence, and include at least the following subjects:

4. Human Factors, performance limitations, e.g. fatigue, relevant to ATC;"

1.18.7 Call sign Confusion

Call sign confusion was not a factor in this Incident, however it was identified as a safety issue on another AIRPROX event that occurred at the same area (see paragraph 1.18.5). The use of similar call signs by aircraft operating in the same area on the same radiotelephony frequency often gives rise to potential and actual flight safety incidents. This hazard is usually referred to as 'call sign confusion'.

The following are some examples of the more common causes for call sign confusion[20]:

- Airlines allocate commercial flight numbers as call signs; these are normally consecutive and therefore similar (e.g. RUSHAIR 1431, RUSHAIR 1432, etc.)
- Airlines schedule flights with similar call signs to be in the same airspace at the same time.
- Call signs coincidentally contain the same alphanumeric characters in a different order (e.g. AB1234 and BA 2314).
- Call signs contain repeated digits (e.g. RUSHAIR 555).
- Alpha-numeric call signs end in two letters which correspond to the last two letters of the destination's ICAO location indicator (e.g. RUSHAIR 25LL for a flight inbound to London Heathrow);

Call sign confusion has multiple level of involvement and may potentially create a loss of partially loss of communication, increases the workload of ATCOs and pilots along with associated possibility of loss of separation, level bust, AIRPROX or midair collision. Many organisations currently and in the past have addressed the issues, which are complicated to solve and eliminate, if possible.

1.19 Useful or Effective Investigation Techniques

This Investigation was conducted in accordance with the UAE *Civil Aviation Law* and *Regulations*, and the AAIS approved policies and procedures, and in accordance with the *Standard and Recommended Practices* of *Annex 13* to the Chicago Convention

[20] Downloaded from skybrary : http://www.skybrary.aero/index.php/Call-sign_Confusion , date 22 February 2015

2. Analysis

2.1 General

Available investigation literature shows that TCAS RAs occur during routine operation. However, TCAS RAs may lead to an unsafe condition especially when the two aircraft crewmembers have to take 'avoidance action'.

This analysis will discuss the issues identified during the Investigation as the most significant causal issues such as: recommended training requirements, recommended training for air traffic controllers, UAE Operators - GCAA *CAR OPS 1.668* and *CAAP 29*, UAE ANSPs awareness of ACAS Version 7.1, Dubai STCA, actions taken by pilots and the air traffic controllers, and the airspace

This section of the Report explains the contribution of every Investigation aspect to the occurrence of the Incident. The analysis also contains safety issues that may not be contributory to the Incident but are significant in adversely affecting safety.

As per *CAR Part IV, CAR OPS*, and in accordance with ICAO PAN *Doc.4444-Procedures for Air Traffic Management,* when a flight crew receives a TCAS RA, alert ATC ceases to have control over the affected aircraft until such as the crew reports that they are clear of conflict, as advised by the aircraft TCAS system. However, the crew should inform ATC that they are responding to a TCAS RA climb or descend instruction. These policies were adhered to by both airline crewmembers involved in this AIRPROX Incident.

Both aircraft were equipped with the mandatory version 7.0 of ACAS II and both systems were serviceable. The commands generated by TCAS II for any RA event are mentioned in paragraph 1.18.2.3 and the crews were trained to respond to these commands. However, neither crew reported that there had been a TCAS TA (Traffic Avoidance) prior to the activation of the TCAS RA and this may be due to the fact of immediate need for avoidance action.

In mitigation of the risk involved with all TCAS RA events since 2002 when the crew fails to follow the TCAS RA commands, or follows ATC instructions instead of TCAS RA commands or one of the aircraft is not TCAS equipped, studies initiated by EUROCONTROL[21] discovered two safety issues with the current TCAS II version 7.0, which led to the development of version 7.1.

This development was undertaken jointly by the Radio Technical Commission for Aeronautics (RTCA) in the United States and by the European Organization for Civil Aviation Equipment (EUROCAE) in Europe with support and contributions from several other organizations, including airlines and air navigation service providers (ANSPs).

2.2 Recommended Training Requirements for ACAS II with Version 7.1[22]

The mandate of *EU regulation 1332/2011* requires aircraft flying in European airspace to be equipped with ACAS II Version 7.1 for all new aircraft above 5,700 kg maximum take-off mass or authorized to carry more than 19 passengers as of 1 March 2012. An extended

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[21] EUROCONTROL is an international organisation founded in 1960 and composed of Member States from the European Region, including the European Community which became a member in 2002. It is the European Organisation for the Safety of Air Navigation, is an intergovernmental Organisation with 41 Member States, committed to building, together with its partners, a Single European Sky that will deliver the air traffic management performance required for the twenty-first century and beyond. Over 1,900 highly qualified professionals spread over four European countries work at EUROCONTROL, deploying their expertise to address ATM challenges.
Downloaded from: https://eurocontrol.int/articles/who-we-are (dated 23 February 2015)

[22] Reference Eurocontrol *ACAS II Bulletin # 14*

deadline (to 1 December 2015) was granted to aircraft with an individual certificate of airworthiness issued before 1 March 2012 and equipped with version 7.0.

The EU *Implementing Rule* sets an earlier equipment requirements than those published in ICAO *Annex 10* (1 January 2014 new installations, 1 January 2017 existing units).

As the regulation also affects UAE operators as well as ANSP units, the requirement for pilots and ATC controllers training has been recommended as mentioned hereunder.

2.2.1 Recommended Training for Pilots

Before the new version of TCAS is deployed to its fleet aircraft, operators should ensure that crews are:

- aware of the TCAS version upgrade
- trained on the new 'Level off, level off' RA and understand how to respond to this RA correctly.

2.2.2 Recommended Training for Air Traffic Controllers

Before the new version of TCAS mandate takes effect (before 1 March 2012), ANSPs should ensure that air traffic controllers are:

- aware of the TCAS version upgrade
- understand the effect that the new 'Level off, level off' RA will have on ATC operations (i.e. some aircraft may level off hundreds of feet before the cleared level as a result of the "Level off, level off" RA.

Besides that, there are no differences (visible to controllers) between version 7.0 and version 7.1.

The GCAA published *an Air Navigation Services Information Notice (ANSIN) 005/12-Introduction of TCAS II, Version 7.1,* on 5 July 2012, which included the requirement for ATS providers and training organizations to include TCAS II, version 7.1 training in their initial and continuity training for all radar controllers. [23].

2.3 UAE Operators - *CAR OPS 1.668* and *CAAP 29*

The current revisions of the *CAR OPS Part IV section 1.668*, together with *CAAP 29*, provide the requirements and guidance on ACAS II to be fitted on UAE operators' aircraft. It should be noted that the European Union, *Regulation No 1332/2011*[24], also impacts UAE based operators.

The GCAA, as the UAE regulator, should impose the ACAS airspace standard and this can be accomplished, by ensuring that all airlines, operating in out and above of the UAE, are in compliance through the oversight efforts exercised by the GCAA.

During the course of this Investigation, preliminary indications revealed that the UAE operators are not fully aware of the recent changes and development with ACAS II, especially version 7.1. It was also revealed that one UAE operator had already equipped its fleet with version 7.1 since October 2011.

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23 Reference: www.gcaa.gov.ae

24 Commission Regulation *(EU) No 1332/2011* of 16 December 2011 laying down common airspace usage requirements and operating procedures for airborne collision avoidance may be downloaded from : http://uaecis.com/files/1332-2011.pdf (date verified 23 February 2015)

The preliminary report of this Investigation included a Safety Recommendation (SR17/2012) to the GCAA to provide clear guidance regarding the version of ACAS that should be used, preference to Version 7.1, without excluding the earlier version that is acceptable in accordance with Industry standards for all aircraft flying inUAE airspace.

2.4 UAE ANSPs Awareness of ACAS Version 7.1

ATC units depend on feedback from the flight crew regarding TCAS RA events and are instructed not to give any instructions during such events. With ACAS II Version 7.1, controllers need to be aware that there are changes in commands for the pilots to follow during a TCAS RA depending on the TCAS version.

As aircraft have already started flying within UAE airspace with ACAS Version 7.1, ATC units should be made aware of the effect of the new 'Level off, level off' RA will have impact on ATC operations (i.e. some aircraft may level off hundreds of feet before the cleared level as a result of the 'Level off, level off' RA).

2.5 Dubai STCA

It was found during GCAA audits that the Flight Refueling Radar (FRL) system Short Term Conflict Alert (STCA) warnings were not being actioned by Dubai ANS. Simulation testing of the STCA conducted by Dubai ANS in the ATC Simulator in 2008 revealed there was a level of nuisance and false alerts, which Dubai ANS determined was unacceptable. Dubai ANS Management stated that the STCA parameters could not be configured with the FRL current software so as to reduce the number of false alerts to a level that would be deemed acceptable for the operational environment.

Following introduction of the Raytheon Auto Track 3 system in February 2013, a more advanced STCA capability proved to be an acceptable solution, and has been operational since then.

During another TCAS RA event the conflict alert worked, during a busy traffic period, and gave the ATCO a red warning because of the loss of separation. However, the red warning of the conflict alert prevented the ATCO from seeing the traffic clearly and providing traffic information. In addition, the system had no provision for the ATCO to acknowledge the red warning conflict alert and remove it. Therefore, it is evident that during busy periods of time with traffic, the conflict alert obstructs the ATCO’s vision and consequently the ability to continue providing traffic information to the aircraft.

As this problem was observed with a specific radar system an effort should be undertaken to determine whether this alert can be modified to minimise the possibility of the ATCO losing visibility of vital information, such as distance, while the alert is active. A solution must also be provided for all other ATC units’ systems in order to ensure that the conflict alert warning does not limit the information visible to ATCOs. This action may only be undertaken by the GCAA. The result should ensure that when an alert is activated, it does not mask the traffic information on all UAE Civil ATC radar screens and that ATCOs can continue to control aircraft by maintaining visibility of all available traffic information.

2.6 Actions by the pilots

The pilots of both aircraft followed the ATC clearances provided and performed as expected by the regulations. They maintained their situational awareness[25] which assisted in

[25] Situation awareness is defined as “The perception of elements in the environment within a volume of time and space, the comprehension of their meaning and the projection of their status in the near future” in Endsley, M. R. (1995b). Toward a theory of situation awareness in dynamic systems. Human Factors, 37(1), 32–64.

good decision making and performance. Automation assisted both crews in good decision making, which allowed them to manage the situation as it developed. Someone might have a concern with the effects of widespread automation and advanced information systems on the ability of humans to take in and comprehend exactly what is going on without becoming confused, overloaded, or error-prone[26].

2.7 Actions by the Air Traffic Controllers

The Air Traffic Controller took over his position and soon after he had to manage and control the two aircraft that were flying in his area of control. As he had to work to provide adequate separation between the two Incident aircraft and to issue instructions that were followed by both flights.

A common understanding is that ATCOs having to deal with dynamic and complex tasks, that are constantly changing, such as ATC tasks, create a mental representation of the changing environment, which makes it possible to keep the relevant but transient information in their working memory[27]. Pattern recognition plays a central role; the ATCO groups aircraft in a certain way to memorize their positions. These traffic flow patterns help them to create order, which others might think is a chaotic situation. However ATCOs streaming traffic flow, always working in accordance with their previously received training and the ATC Unit's procedures, instructions, guidelines, etc.

Much research has been done on how controllers develop this three-dimensional mental picture of the traffic situation. This is usually referred to as situation (or situational) awareness (SA)[28]. SA is considered the product of the process of situation assessment that takes place at three levels: perception, interpretation and anticipation.

Air Traffic Control Units have developed many ways to support their staff in maintaining SA. Human Factors Training is one of them, others are SOPs, newsletters, meetings and exercises, one of which was practiced during the day of the Incident. Human Factors training aims to enhance perception interpretation and anticipation all of which influence the SA of the human.

The lack of a structured handover briefing between the two ATCOs prior to the serious incident did not allow the ATCO who was coming on duty, to develop an accurate mental model to assist him in determining the actions that he should take in order to organize the traffic. The ATCO who took over was not well prepared to commence his shift.

He was an experienced and well-trained controller but he did not manage the situation so as to avoid an airprox involving the two aircraft. It is evident that he needed more time to organize and prepare himself, both mentally and physically, to assume the position of an active ATCO.

That is why more efforts have to take place in order to ensure that the Human Factors training is effective and is performed in a way that fits the needs of the ATCOs. In case the same training is presented during recurrent training, the training material loses its effectiveness, over time. In case the changing training needs of the ATCOs are not met, then

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26 Henk van Dijk , Koen van de Merwe & Rolf Zon (2011) A Coherent Impression of the Pilots' Situation Awareness: Studying Relevant Human Factors Tools, The International Journal of Aviation Psychology, 21:4, 343-356.

27 Garland, D. J., Stein, E. S., & Muller, J. K. (1999). Air traffic controller memory: Capabilities, limitations and volatility. In D. J. Garland, J. A. Wise, & V. D. Hopkin (Eds.), *Handbook of aviation human factors* (pp. 455–496). Mahwah, NJ; Erlbaum.

28 Endsley, M. R. (1988, October). *Design and evaluation for situation awareness enhancement*. Paper presented at the Human Factors Society 32nd annual meeting, Santa Monica, CA. Endsley, M. R. (1995). Towards a theory of situation awareness in dynamic systems. *Human Factors*, *37*(1), 65–84.

the performed training may not be considered useful. Furthermore the everyday operation has to be supported by the theoretical training.

2.8 The Airspace

As indicated in the same area there was at least another event, which occurred after the Incident under Investigation (see paragraph 1.18.5 of this Report). That is why as there are two airports relative close to each other; a management decision was made for Dubai Departure to coordinate both airports departing traffic. This way all traffic flow of aircraft and separation may be better managed thus separated. As utilizing one frequency, all flights will listen out to the same frequency and one Air Traffic Controller will manage the area. This way miscommunications are avoided. In case the area was managed by different controllers, by utilizing different frequencies, delays and potential unsafe conditions might be created as ATCOs would have to delay the control of the flights, because the different ATCOs would have to utilize many different media, such as telephone lines, microphones, etc.

However having to operate within a confined and congested air space and having to control aircraft within a limited area, generates other issues that every ATCO has to manage in order to provide safe and efficient services. Air Traffic Services need to take into consideration, not only safety and orderly, but also efficiency. Nowadays all airlines require their aircraft to be controlled with the minimum time delay and track miles flown. In other words and ideally, flights would prefer to fly directly to their destination after departure. Needless to mention that better Airspace structure and Air Traffic Control Coordination allows aircraft to fly a more efficient route and descent/ascent in dense traffic areas, thus reducing fuel burn and Carbon Dioxide (CO_2)[29] emissions. Ideally flights should be able to fly to and from any point without burning any excess fuel, other than to what was pre-calculated for the indented flight.

To do this ATCOs have to work in order to organize the flow in the optimal way possible, taking into account the needs of the airlines, thus the travelling public. However in order to operate in that optimal manner, the airspace has to be organized in an optimum manner. Having the knowledge of at least two events that lost their separation, efforts have to be undertaken in order not to have aircraft coming close in the future. One may argue, correctly, that such an issue is impossible and there will be aircraft crossing each other track in such a small space of airspace that the UAE Air traffic controllers have to manage the increasing traffic, that will most probably will continue to increase in the future.

That is why other methods may be taken into account in order to minimize the possibility of having two aircraft crossing the same route, at approximately the same height. Especially when the same airspace serves aircraft departing and arriving from two busy airports (such was our case under Investigation). Reducing crossing and/or conflicting routes will reduce risk of loss of separation or TCAS generated events; however no one may expect airspace with no TCAS warnings, because aircraft on the same route in the same direction can have a loss of separation due to differing speeds, level changes, or other interventions. Needless to mention that airspace with TCAS warnings is ideal, however efforts should be undertaken in order to approach that ideal system.

These efforts may include methods such as processes that departing traffic from one airport climbs to a certain altitude and above, while the traffic from the other airport would

[29] CO_2 is the chemical formula for carbon dioxide, a heavy odorless gas (CO2) formed during respiration and by the combustion or decomposition of organic substances; it is absorbed from the air by plants in photosynthesis. The formula itself, pronounced out, is often used instead of the full name, especially with reference to fire extinguishers using this gas for fire suppression; as, a CO2 extinguisher (Webster's Revised Unabridged Dictionary, published 1913 by C. & G. Merriam Co downloaded from : http://www.thefreedictionary.com/CO2 at 21 December 2014)

climb to a certain altitude and below. That way the possibility of loss of separation is reduced, especially when the two aircraft depart from airports with different frequencies.

However, as the Incident under investigation proved, even two aircraft in an area are enough for these two aircraft to loss separation. That is why the airspace organizer should avoid or at least minimize the possibly of reoccurrence and the airspace structure could be one of the methods. The aim of such airspace would be to ensure an efficient, flexible and dynamic airspace structure without compromising safety. Because of the complexity of such project a detail in-depth needs analysis, based on multi-option routings, could be developed, supported by a possible adaptable ATC creation of sectors; that will accommodate future air traffic demands and meet the performance requirements in terms of capacity and flight efficiency, in a cost-effective manner.

Such efforts should be undertaken by the GCAA ANA, that have the required expertise and could take into account the information contained in this Report and to review the associated ATS route network optimization program in order to evaluate if a need to introduce the changes that may deem appropriate. The GCAA ANA having the authority needed to interact with different entities, both nationally and internationally would be the ideal entity to review the possibility of such project.

The annual increase in traffic demand places permanent pressure on the current system to make the best use of existing capacity and, where capacity is insufficient, to develop airspace structures to provide additional capacity to keep pace with demand.

That is why the system has to be flexible, adaptable to the developments which are constantly changing with the Strategic focus of being engaged in the development of proposals for enhanced capacity for the future and to solve permanent issues. Such as group of professionals should have the capacity to analyze the current operation of the ATM system at a national, regional and sub-regional level. Appropriate mathematical models could be utilized in the development of such routes, models that could significantly improve capacity and provide solutions to workload management. However a group of experts (with members all stakeholders involved) could be developed to coordinate the proposals and the need for further amendments of development. Such a group could be the platform of debate and ideas development that the GCAA could further capitalize.

2.9 ATCO Decision Support Tool.

All ATC Units around the world have developed tools, to assist ATCOs exercising their duties. UAE ATC Units have now developed tools such as Alerts, Stripless Flight Data Systems, Arrival Management Systems, Information Supporting Monitors, Checklists for Handovers and Handling of Emergency Situations, In-Flight-Emergency-Response (IFER) Manual.

Furthermore a decision support tool, may be developed to assist air traffic controllers achieve increased accuracy in traffic delivery. These tools influence controllers' performance, workload, and situation awareness. Studies were performed evaluating in a real-time simulation and in an operational trial. The findings indicate that this additional system support is necessary to achieve higher accuracy without increasing the controllers' workload. At the same time, controllers must stay in the loop to maintain situation awareness. This must be kept in mind while designing and or introducing any decision support systems[30].

[30] Koen van de Merwe , Esther Oprins , Fredrik Eriksson & Akos van der Plaat (2012) *The Influence of Automation Support on Performance, Workload, and Situation Awareness of Air Traffic Controllers,* The International Journal of Aviation Psychology, 22:2, 120-143, DOI: 10.1080/10508414.2012.663241

Aviation and Air Traffic Control process control tasks more particular are tasks that are considered highly complex and dynamic[31]. Complex cognitive processes are required to handle the large amount of dynamically changing information in a three-dimensional environment[32]. Therefore, ATC is also called a complex cognitive or high-performance skill[33]. Much air traffic management (ATM) research[34] focuses on the design of decision support tools that make it possible for controllers to handle larger amounts of traffic with reduced workload.

Any decision support tool provides controllers with speed and route advice, with which a higher punctuality of flights can be achieved while keeping the controller workload at an acceptable level. However, a potential risk is the possible decrement in the controllers' SA as shown in previous research on automation of ATM systems[35] .

The human factor impacts on performance, workload, and SA must be addressed and evaluated when designing new decision support tools.

Studies indicated that ATCO working methods changed more than expected, moving toward time-based operations. However, it was noticed that more familiarity with Decision Support Tools improved the controllers' SA and decreased their workload. In the future, Decision Support Tool could be further developed in such a way that controllers remain in the loop to avoid a possible loss of SA, for instance, by offering various solutions from which the controllers can choose. The specific design of the tool and the controllers' familiarity with it determine the degree to which a sufficient SA can be maintained.

However, in the current system, and likely in the future, humans play a central role[36] in the air traffic control system.

2.10 Call Sign Confusion

Although infrequent, miscommunication between pilots and controllers is a persistent problem in any Air Traffic Management System. Communication problems arise, in part because complex air traffic control messages sometimes overload pilot memory[37] or because humans (ATCO and/or pilots) misunderstand/misinterpret ATC messages. For example, incorrect read backs tend to increase with message length, in part because longer messages increase the chance of confusion or interference among its constitute message elements.[38]

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31 Oprins, E. (2008). *Design of a competence-based assessment system for ATC training* (Doctoral dissertation). Maastricht University, Maastricht, Netherlands.

32 Garland, D. J., Stein, E. S., & Muller, J. K. (1999). Air traffic controller memory: Capabilities, limitations and volatility. In D. J. Garland, J. A. Wise, & V. D. Hopkin (Eds.), *Handbook of aviation human factors* (pp. 455–496). Mahwah, NJ; Erlbaum.

33 Schneider, W. (1990). Training high-performance skills: Fallacies and guidelines. In M. Venturino (Ed.), *Selected readings in human factors* (pp. 297–311). Santa Monica, CA: Human Factors Society.

34 SESAR. (2007). Deliverable 3: The ATM Target Concept (Tech. Rep. No. DLM-0612-001-02-00a). SESAR Consortium. Downloaded from http://www.eurocontrol.int/sesar/gallery/content/public/docs/ DLM-0612-001-02-00.pdf and NextGen. (2007). *Concept of operations for the next generation air transport system* (Version 2.0). Downloaded from http://www.jpdo.gov/library/nextgen.v2.O.pdf

35 Metzger, U., & Parasuraman, R. (2006). Effects of automated conflict cuing and traffic density on air traffic controller performance and visual attention in a datalink environment. *International Journal of Aviation Psychology*, *16*(4), 343–362. Miller, C. A., & Parasuraman, R. (2007). Designing for flexible interaction between humans and automation: Delegation interfaces for supervisory control. *Human Factors*, *49*(1), 57–75.

36 Parasuraman, R., & Wickens, C. D. (2008). Humans: Still vital after all these years of automation. *Human Factors*, *50*(3), 511–520.

37 Morrow, D., & Rodvold, M. (1998). Communication issues in air traffic control. In M. Smolensky & E. Stein (Eds.), Human factors in air traffic control (pp. 421–456). New York: Academic.

38 Prinzo, O. V., & Britton, T. W. (1993). ATC/pilot voice communications: A survey of the literature (Office of Aviation Medicine Tech. Rep. No. DOT/FAA/AM-93/20). Washington, DC: Federal Aviation Administration.

(e.g., heading and speed instructions) in working memory. Furthermore similar call signs, used by operators, in the same area, create the potential of either pilot or air traffic controllers to either read back or provide instructions that may be followed by another aircraft, that wasn't intended to do. That will not only create more confusion between and among other flights that will not have the appropriate time to respond but another flight might fly, turn or ascent inappropriately, before the air traffic controller, has the time (or even understands that he has to) correct the flight's path. In short: call sign confusion. The GCAA along with its stakeholders identified the need to address this issue and appropriate safety actions were taken to address the issue that are described in 4.

2.11 Fatigue

The Investigation took into account the Incident ATCO's statement that he was usually busy with social obligations, the morning of his swift (see 1.5.3 The Dubai Departures Air Traffic Controller). Fatigue is a well-known stressor in aviation operations and its interaction with mental workload needs to be understood.

Defining fatigue in humans is extremely difficult due to the large variability of causes. Causes of fatigue can range from boredom to circadian rhythm disruption to heavy physical exertion. In lay terms, fatigue can simply be defined as weariness. However, from an operational standpoint a more accurate definition might be: "*Fatigue is a condition characterized by increased discomfort with lessened capacity for work, reduced efficiency of accomplishment, loss of power or capacity to respond to stimulation, and is usually accompanied by a feeling of weariness and tiredness*"[39].

In a variety of real-world settings, fatigue may be caused from long duty hours, insufficient sleep, and circadian factors which can seriously degrade both the alertness and performance of operators, which wasn't evident in the Investigation of this Incident. In aviation-related occupations, on-the job sleepiness is particularly dangerous because fatigue-related errors in the cockpit can lead to crew-member and passenger fatalities as well as the loss of the airframe itself[40].

Chronic fatigue, refers to marked and prolonged fatigue, for which no identifiable cause can be found and lasting for duration of six months, or longer[41]. No such issue was identified during the Investigation, nor was observed.

Fatigue in air traffic control has become an even greater topic of increased interest due to controller napping incidents in the United States that have led to the FAA decision to end the practice of single controller midnight shifts by adding another controller to the midnight shift, in 2011[42]

There is research available[43] directly and indirectly associated with fatigue as part of an effort to identify the gaps in research on fatigue and performance in air traffic control. This

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[39] Medical Facts for Pilots Publication # OK-07-193, by G.J. Salazar Prepared by the FAA Civil Aerospace Medical Institute, downloaded (date 1 March 2015) from: http://www.faa.gov/pilots/safety/pilotsafetybrochures/media/Fatigue_Aviation.pdf

[40] Caldwell, J. A., Caldwell, J. L., Brown, D. L., Smythe, N. K., Smith, J. K., Mylar, J. T., Mandichak, M. L., & Schroeder, C. (2003). The effects of 37 hours of continuous wakefulness on the physiological arousal, cognitive performance, self-reported mood, and simulator flight performance of F-117A pilots. USAF Research Laboratory Technical Report No. 2003-0086. Brooks City-Base, TX: Air Force Research Laboratory.

[41] A Revelas MD, PhD General Practitioner & E Baltaretsou MD (2013) Chronic fatigue syndrome: diagnosis and treatment, South African Family Practice, 55:1, 53-55.

[42] Federal Aviation Administration Press Office. (2011, April 13). The FAA announces additional staffing at 27 control towers. Downloaded (date 1 March 2015) from http://www.faa.gov/news/press_releases/news_story.cfm?newsId=12664

[43] Megan A. Nealley & Valerie J. Gawron (2015) The Effect of Fatigue on Air Traffic Controllers, The International Journal of Aviation Psychology, 25:1, 14-47, DOI: 10.1080/10508414.2015.981488

research discusses the identified research and synthesizes the body of knowledge on air traffic controller fatigue[44].

It is known that increased workload has been related to fatigue[45], which is expected; more complex task or more workload it would be expected to be associated with the development of fatigue. However the task involved in this Incident, could not be characterized as complex, nor difficult, as two aircraft were flying in the airspace, at the time.

Furthermore there are factors identified as affecting ATCOs' sleep and fatigue[46] which are work and non-work related: shiftwork, sleep disorders, shift length (time on task), family responsibilities[47], type of work being performed, social and leisure engagements, workload, emotional stress, work environment (heat, noise, light, and humidity levels), individual factors (personality characteristics, health, diet), break frequency and length, age, night shifts and circadian rhythms[48]. However none of these issues where observed. In addition there was no indication that could raise an issue, with the ATCOs involved in the Investigation.

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44 Office of Inspector General. (2013). FAA's controller scheduling practices can impact human fatigue, controller performance, & agency costs (Rep. No. AV-2013-120). Washington, DC: Author.

45 Marcil, I., & Vincent, A. (2000). Fatigue in air traffic controllers: Literature review (Tech. Rep. No. TP 13457). Ottawa, Canada: Transport Canada, Transportation Development Centre.

46 EUROCONTROL. (2007). Fatigue and sleep management: Personal strategies for decreasing the effects of fatigue in air traffic control. Retrieved from http://www.eurocontrol.int/sites/default/files/content/documents/nm/safety/fatiguesleep-management-personal-strategies-for-decreasing-the-effects-of-fatigue-in-atc-brochure.pdf
Costa, G. (2009). Fatigue and biological rhythms. In J. A. Wise, V. D. Hopkin, & D. J. Garland (Eds.), Handbook of aviation human factors (2nd ed. pp. 11-3–11–23). Boca Raton, FL: Taylor & Francis.
McCulloch, K., Baker, A., Ferguson, S., Fletcher, A., & Dawson, D. (2008). Developing and implementing a fatigue risk management system (Tech. Rep. No. TP 14575E). Ottawa, ON, Canada: Transport Canada.
Orasanu, J., Nesthus, T. E., Parke, B., Hobbs, A., Dulchinos, V., Kraft, N. O, Mallis, M. (2011). Work schedules and fatigue management strategies in air traffic control (ATC). Proceedings of the Human Factors and Ergonomics Society Annual Meeting, 55, 1.
Performance Review Commission and the Air Traffic Organization Strategy and Performance Business Unit. (2009). U.S./Europe comparison of ATM-related operational performance (Tech. Rep. No. 2009-AJG-333). Retrieved (01 March 2015) from http://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/systemops/ato_intl/benchmarking/media/pdf/us-europe-comparison-of-atm-related-operational-performance.pdf and http://www.eurocontrol.int/articles/performance-review-commission

47 Cruz, C. E., Schroeder, D. J., & Boquet, A. J. (2005). *The relationship of age and shiftwork to sleep, fatigue and coping strategies in air traffic controllers*. 76th scientific meeting of the Aerospace Medical Association, Kansas City, MO.

48 The study of circadian rhythms retrieved (date 01 March 2015) from : http://www.nigms.nih.gov/Education/Pages/Factsheet_CircadianRhythms.aspx
Circadian rhythm is a daily rhythmic activity cycle, based on 24-hour intervals, that is exhibited by many organisms. The American Heritage® Dictionary of the English Language, Fifth Edition. Copyright © 2011 by Houghton Mifflin Harcourt Publishing Company. Published by Houghton Mifflin Harcourt Publishing Company. Retrieved (date 01 March 2015) from : http://www.sciencedaily.com/articles/c/circadian_rhythm.htm

Other organizations[49] made efforts to access, survey[50], measure[51] or create and validate a biomathematical model.

However the above issues were not observed, nor identified with the ATCOs involved in the Investigation.

Therefore it is evident that the Investigation didn't reveal any fatigue, tiredness or any other preoccupation, that didn't allow the ATCOs to perform their duties and maintain the required separation, between the two Aircraft.

Therefore the Investigation the Team didn't proceed any further investigating this issue further in order to review the possibility for an Fatigue Risk Management System similar to what is already regulated for flight crew members and coming into European Regulations for maintenance personnel.

3. Conclusions

3.1 General

From the evidence available, the following findings, causes and contributing factors were made with respect to this Serious Incident. These shall not be read as apportioning blame or liability to any particular organization or individual.

To serve the objective of this Investigation, the following sections are included under the conclusions heading:

- **Findings-** are statements of all significant conditions, events or circumstances in this Serious Incident. The findings are significant steps in this Serious Incident sequence but they are not always causal or indicate deficiencies.
- **Causes-** are actions, omissions, events, conditions, or a combination thereof, which led to this Serious Incident.
- **Contributing factors-** are actions, omissions, events, conditions, or a combination thereof, which, if eliminated, avoided or absent, would have reduced the probability of the accident or incident occurring, or mitigated the severity of the consequences of the accident or incident. The identification of contributing factors does not imply the assignment of fault or the determination of administrative, civil or criminal liability.

[49] Air Traffic Shiftwork and Fatigue Evaluation (AT-SAFE) was a study that lasted 21 days and collected data from Air Traffic Controllers on sleep, mood, fatigue, and cognitive performance to assess how shift times and time off between shifts were associated with these factors. Over a period of 21 days, wrist activity monitors (WAMs) were worn by 71 Full Performance Level (FPL) controllers and logs of sleep duration and quality, as well as Positive and Negative Affect Schedule (PANAS) mood ratings and Stanford Sleepiness Scale (SSS) sleepiness ratings were kept. On Days 2 through 14 of the study, the complete CogScreen Aeromedical Edition battery was completed by the participants at the beginning, 3 hour into, and at the end of their shift. Data from the AT-SAFE field study revealed that sleep quality corresponded to sleep duration, with less time associated with poorer quality ratings. Sleep duration was seen to be least prior to midnight shifts (starting between 8 p.m. and 1 a.m.), with an average of 2.3 hour, and prior to early morning shifts (starting before 8 a.m.) with an average of 5.8 hour of sleep, and most prior to midday shifts (starting between 10 a.m. and 12:59 p.m.) with an average of 7.7 hour. Positive mood ratings (measured with the PANAS) were overall higher before a shift compared to after.

[50] Rhodes, W., Heslegrave, R., Ujimoto, K. V., Hahn, K., Zanon, S., Marino, A., Pearl, S. (1996). *Impact of shiftwork and overtime on air traffic controllers—Phase II: Analysis of shift schedule effects on sleep, performance, physiology and social activities* (Tech. Rep. No. TP 12816E). Montreal, Canada: Transportation Development Centre.
Rhodes, W., Szlapetis, I., Hahn, K., Heslegrave, R., & Ujimoto, K. V. (1994). *A study of the impact of shiftwork*

[51] Actigraphy is a non-invasive method of monitoring human rest/activity cycles. An actigraph is a small, wristwatch-sized device. It is lightweight and typically worn on a limb, such as at the wrist or ankle.

3.2 Findings

3.2.1 Findings related to both aircraft

(a) Both aircraft had a valid Certificate of Airworthiness, was certified, equipped, and maintained in accordance with the existing the *Civil Aviation Regulations* of the United Arab Emirates.

(b) Both aircraft were airworthy when dispatched for the flight.

(c) There was no evidence of any airframe failure defect or malfunction on both aircraft that could have contributed to the Incident.

(d) The flight deck lighting and other electrical services were operating normally.

(e) The airlines had the required ACAS II Version 7.0 equipment fitted to the aircraft.

(f) The TCAS systems of both aircraft were serviceable.

3.2.2 Findings related to pilots

(a) The pilots were properly licensed, medically fit, qualified and adequately rested to operate the flight, in accordance with existing regulations.

(b) The pilots were in compliance with the flight and duty time regulations.

(c) There was no evidence that incapacitation or physiological factors affected the pilots' performance.

(d) There was no evidence that the pilots suffered any sudden illness or incapacity which may have affected his ability to control the Aircraft.

(e) Toxicological tests for common drugs and alcohol were not performed.

(f) Based on the available reports and information, there was no evidence to indicate that the pilots' performance was degraded by psychological factors.

3.2.3 Findings related to the Operators

(g) Both operators were in compliance of *CAR OPS 1.668* and *CAAP 29*.

(h) Both flights were following predetermined clearances.

(i) Both flights' crewmembers followed the ATC instructions.

(j) Both flights' crewmembers took avoiding actions.

3.2.4 Findings related to Operations

(k) There is ACAS II version requirement mentioned in the documents of the *CAR OPS 1.668* and *CAAP 29*.

(l) ACAS II Version 7.1 training requirements for both pilots and ATC controllers is provided by the operators and ANS units.

(m) GCAA has not published clear guidelines to the UAE AOC holders regarding the ACAS II version to be utilised.

3.2.5 Findings related to ATC

(a) *ANSIN 005/12* covers the requirement for ATS providers and training organisations to include TCAS II Version 7.1 training in their initial and continuity training for all radar controllers.

(b) Following introduction of the Raytheon Auto Track 3 system in February 2013 replacing the Flight Refuelling Radar system a more advanced STCA capability proved to be an acceptable solution to the previous system's shortcomings and has been operational since then.

(c) Traffic Information is shown when the Alert Activates.

(d) There was no handover briefing during the change of ATCOs prior to the Incident.

(e) When there is numerous traffic on the Radar Display, the labels will clutter and may mask each other if the Auto Label Deconflict is not operational.

(f) ATCOs may choose to not use the Auto Deconflict, and they manually move labels clear when they need to read the label.

(g) Fatigue was not observed in this Incident.

3.3 Causes

The Air Accident Investigation Sector determines that the cause of this AIRPROX Serious Incident was the loss of minimum separation between the two aircraft, which were following the instructions provided by ATC.

3.3.1 Contributing factors

Contributing factors to this Serious Incident were:

(a) The structure of the airspace,

(b) The lack of an alert provided to the ATCO to the imminent loss of separation,

(c) The lack of a structured handover briefing between the two ATCOs prior to the serious incident and

(d) The ATC clearance issued to the aircraft.

4. Safety Recommendations

4.0 Introduction

This section of the Report contains the analysis of the information documented in the 'Factual Information' and which is relevant to the determination of conclusions and causes. The elaboration of this Analysis was conducted taking into account the contributing factors and hypotheses raised.

4.1 Safety Action Taken (Preventive Actions Taken)

The UAE GCAA

- Has established a working group with industry partners in order to implement measures to mitigate the risk associated with call sign similarity and confusion
- Continues to participate in a regional working group (the CALL SIGN CONFUSION AD-HOC WORKING GROUP) under the ICAO MID[52] which has already met once[53] and has a working future plan until 2016 in order to establish "Mitigation Measures for Call Sign Similarity and Confusion" at a regional level. The UAE GCAA also established a working group with participating members, as the UAE is implementing measures to mitigate the risk associated with call sign similarity and confusion.
- Has established the National Airspace Advisory Committee (NASAC). The objective of NASAC is to provide an industry-wide representation forum for developing the industry position on airspace matters as the basis for strategic advice to the GCAA, regarding the development and implementation of the UAE ATM Strategic Plan and to foster a collaborative airspace management process involving all aviation stakeholders. NASAC continues to meet regularly 3 to 4 times per year, with the 15th NASAC Meeting being conducted 25 Feb 2015. Through the NASAC, recognising the deficiencies in the UAE Airspace and structure, the GCAA conducted an airspace study to evaluate the gaps between current capacity versus demand and future capacity versus demand. In 2014/2015 two additional projects were completed – one project for the conceptual restructure and design of the UAE lower airspace and the second for the conceptual restructure and design of the upper airspace.
- Amended the Regulations regarding the Air Traffic Control Organisations so current *CAR PART VIII Subpart 4*[54] *– Appendix 2 - A.2.7- Continuation Training*, requires ATS units to provide fatigue management, SMS, team resource

52 ICAO MID is the ICAO Middle East (MID) Office, a Regional Office, which is one of seven regional offices (wings) of ICAO and is located in Cairo, Egypt. It was established based on an agreement between ICAO and the Egyptian Government signed in 1953. MID Regional Office is accredited to 15 MID ICAO Members States (Bahrain, Egypt, Islamic Republic of Iran, Iraq, Jordan, Kuwait , Lebanon, Libya, Oman, Qatar, Saudi Arabia, Sudan, Syrian Arab Republic, United Arab Emirates and Yemen) and provides them all possible guidance in order to meet the needs of the Region for safe, regular, efficient and economical air transport. Downloaded from http://www.icao.int/mid/Pages/default.aspx & http://www.icao.int/MID/Pages/mid-responsibilities.aspx (date 23 February 2015).

53 In Abu Dhabi, 16-18 February 2015.

54 Issue 3, revision 0, date of revision June 2014, downloaded from : https://www.gcaa.gov.ae/en/ePublication/_layouts/GCAA/ePublication/DownloadFile.aspx?Un=/en/epublication/admin/Library Pdf/Civil Aviation Regulations (CARs)/CAR PART VIII - AIR NAVIGATION REGULATIONS/CAR PART VIII SUBPART 4 - AIR TRAFFIC CONTROL ORGNISATIONS.pdf (date 23 December 2014)

management (TRM) and threat and error management (TEM) training at intervals not exceeding 2 years.

Current *CAR PART VIII Subpart 4 - 4.9* states:

"(a) The applicant for an air traffic service certificate shall establish a procedure to ensure that-

1. Adequate time is provided at the beginning and end of each shift for the performance of those duties required-

   i. before providing an air traffic service including ATC briefing;

   ii. after ceasing to provide an air traffic service; and

2. Adequate time is provided for each transfer of position responsibility at an operational ATS position through mandatory use of a position relief checklist that includes the current status of position related equipment and operational conditions or procedures. This information is to be clearly visible from the control position at all times."

Current *CAR PART VIII Subpart 4* supports the issue of masking the alerts:

- *CAR 4.10* states:

  "(f) The applicant shall establish procedures to ensure that any equipment, maps, charts, monitors and displays used by air traffic service personnel are positioned with due regard to the relative importance of the information displayed and ease of use by the staff concerned."

- *CAR 4.34* states:

  "(c) The applicant for an air traffic service certificate shall establish procedures to ensure that, where radar or automatic dependent surveillance is used to support the provision of an air traffic service:

  4. The information displayed at individual surveillance operating positions is that required for the air traffic services to be provided, including the display of safety related alerts and warnings, where the Authority has determined that the facility is required;

  (g) The display system shall provide a continuously updated presentation of the surveillance information.

  (i) Safety related and automated coordination information shall be displayed in a clear and distinct manner to facilitate ease of recognition."

CAR Part VIII, Subpart 4 has been reviewed by GCAA Air Navigation and Aerodromes (ANA) in the second half of 2015 and notice of proposed amendment (NPA) 18/2015 was subsequently published accordingly. Following the NPA period external stakeholders have agreed or made no comments to the amendments of Subpart 4 related to Human Factor training. The below extracts are from the revised Subpart 4 as it is expected to be published in the beginning of 2016. Particularly Appendix 2 to Subpart 4 has been reviewed and revised significantly, i.e. A.2.9, A.2.10 and A.2.13.

CAR 4.35 AIRCRAFT EMERGENCIES AND IRREGULAR OPERATIONS

(c) In communications between Air traffic Control Units (ATCUs) and aircraft in the event of an emergency, Human Factors principles, as shown in ICAO Doc 9683, should be observed.

A.2.9 INITIAL TRAINING

(c) ATCUs shall ensure that the initial training programmes listed above for Ab-initio ATC Students include training in the following subjects:

1. Threat and Error Management;

2. Human Factors including Team Resource Management (TRM), fatigue management and stress management;

3. Theoretical and practical training and assessment in Alerting Service and In Flight Emergency Response.

Note: Guidance material on the application of threat and error management and human factor is found in the ICAO Doc 9868 Procedures for Air Navigation Services — Training, Attachment C to Chapter 3; Doc 9683 Human Factors Training Manual, Part II, Chapter 2; Circular 314, Threat and Error Management in Air Traffic Control and Circular 241 Human Factor Digest no. 8 Human Factor in ATC.

A.2.10 UNIT TRAINING

(b) Prior to commencing OJT the licence holder shall have completed training and assessment in the following subjects:

3. Abnormal and emergency situations, i.e. Emergency Continuation Training;

5. Human factor including Team Resource Management, fatigue management and stress management;

A.2.13 DEVELOPMENT AND CONTINUATION TRAINING

(b) The ATCU shall ensure that ATCOs complete the following training courses annually:

2. Emergency Continuation Training (ECT);

(c) The ATCU shall ensure that ATCOs attend the following training courses at least once every 3 years:

1. Threat and Error Management;

2. Human Factors including Team Resource Management (TRM), fatigue management and stress management.

Note: ATCUs shall ensure that scheduled training plans are documented in the Training and Competency Manual.

(g) Emergency Continuation Training (ECT)

3. ECT should include (as applicable to the rating):

i. Handling of aircraft emergencies and unusual/abnormal situations;

ix. Unexpected occurrences, and ATC errors, requiring avoiding action and the passing of traffic information, to prevent loss of separation, or to re-establish separation as well as TCAS actions;

xii. Human Factors principles, in relation to communication between ATCUs and aircraft subject to emergencies;

xiii. Theoretical and practical training in Alerting Service, In Flight Emergency Response (IFER) and Search and Rescue (SAR) requirements to adequately assess ATCOs knowledge, understanding and ability to practically meet the phase declaration requirements;

A.2.14 CERTIFICATE OF COMPETENCE (CoC) EXAMINATION

(e) Before the issue of a CoC for the first or subsequent issue of a licence and rating the student shall have demonstrated a level of knowledge and compliance with appropriate to the holder of an ATC licence, in at least the following subjects:

4. Human performance

i. Human performance, including principles of human factors, i.e. fatigue, threat and error management relevant to ATC including handling of aircraft subject to an emergency.

Note: Guidance material to design training programmes on human performance, including threat and error management, can be found in the Human Factors Training Manual (Doc 9683).

- Issue of Safety Alerts regarding Human Factors within the ATC environment
  - Safety Alert 06/2014[55] was issued on 9 September 2014, due to deficiencies, which were observed in the way of implementation of Human Factors principles among Air Navigation Services

[55] SAFETY ALERT 06/2014 can be downloaded from: https://www.gcaa.gov.ae/en/ePublication/_layouts/GCAA/ePublication/DownloadFile.aspx?Un=/en/epublication/admin/Library Pdf/Safety Alerts/SAFETY ALERT 06-2014 HUMAN FACTORS IN AIR NAVIGATION SERVICES.pdf (date 23 December 2014)

Providers in the UAE. The Safety Alert provided information and guidance regarding Human-centred Automation, Situational Awareness, and Error Management. In more detail the GCAA identified that adequate and effective implementation of requirements and processes relating to Human Factors need to be further addressed by Air Navigation Services Providers, informing them that more focus on Human Factors will be included in future audits.

- Safety Alert 01/2015 [56], was issued on 29 January 2015, highlights the ATCOs responsibilities for a high standard of surveillance and situation awareness. Furthermore it alerts controllers in order to focus on accuracy while controlling aircraft. It provided guidance and information on controllers' attention, surveillance tools and includes recommendations to controllers, and air traffic management services.

- Review of Dubai ATC Conflict Alert Format

The Dubai Alert System, SCTA Data Block deconflict requirement was written in mid-2013 and was first provided to Raytheon through the procurement agent (DAEP) in the 4th quarter of 2013. DANS awaits EP to finalize the commercial negotiations with Raytheon. Projected timeline of contract awarded is in June 2015 and with work completion in March 2016.

At present, the Label Frame of any Window that obscures a track with a 'special state' (jurisdiction/alert/warning/etc…) will change colour to highlight a potentially "hidden" condition. Therefore a review does need to be conducted by Dubai ANS to ensure that essential aircraft label track information is available to the controller in the event that a STCA activates.

- Review of Abu Dhabi Conflict Alert Format

Abu Dhabi system: the STCA alert comes up as an additional field of the aircraft label. It says "SA" on the top of the aircraft label. The STCA alerts are not separate alerts/labels but an extension of the normal aircraft label. This way the STCA alert can never overlap its own aircraft label. However, if there are a lot of aircraft labels in close proximity the normal problem where the labels can overlap and garble does exist. This happens of course when a lot of aircraft are close to each other like in holding situations. The ATCOs are trained to be aware of these situations and instructed to manage the labels by manually moving the label to a clear position in such situations.

4.2 Implemented Prompt Safety Recommendations

Shortly after the occurrence, the Investigation issued a Preliminary Report with three Prompt Safety Recommendations (SR17/2012, SR18/2012, and SR19/2012) in order to enhance safety. Following are the Safety Recommendations along with the actions taken; all Prompt Safety Recommendations are now considered closed.

SR17/2012

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56 SAFETY ALERT 06/2014 can be downloaded from: https://www.gcaa.gov.ae/en/ePublication/_layouts/GCAA/ePublication/DownloadFile.aspx?Un=/en/epublication/admin/Library Pdf/Safety Alerts/SAFETY ALERT 01-2015 ATC Human Factors and use of surveillance tools.pdf (date 25 February 2015)

GCAA to provide clear guidelines with minimum ACAS II version for aircraft flying within UAE FIR.

Action taken by the GCAA:

New revision of CAR-OPS 1.668 now contains the following requirement for UAE certified operators regarding the Airborne Collision Avoidance System (See also interpretative/ explanatory material (IEM) OPS 1.668. In addition CAAP 29 was updated in support of the new requirements.

> "An operator shall not operate a turbine powered aeroplane:
>
> (a) Having a MCTOM (maximum certificated take-off mass) in excess of 5700 kg or a MAPSC (maximum approved passenger seating configuration) of more than 19 unless it is equipped with an airborne collision avoidance system (ACAS) II Change 7.0. From 31 January 2015 such aeroplanes shall be equipped with ACAS II, Change 7.1.
>
> (b) Manufactured after 31 December 2012 and having a MCTOM in excess of 5700 kg or a MAPSC of more than 19 unless it is equipped with ACAS II, Change 7.1."

SR18/2012

The GCAA to immediately ensure that all UAE Civil ATC units equipped with radar and ADS-B displays shall provide and utilise safety related alerts and warnings, appropriate to the service provided, and units which have not yet complied shall provide alternative measures, acceptable to GCAA, which achieve an equivalent level of safety in the interim.

Following SR18/2012 the GCAA Air Navigation and Aerodromes Department informed the Investigation Team on the 16 August 2012 that the "GCAA CAR Part VIII, Subpart 4, paragraph 4.34. (c).4 requires that.'' The information displayed at individual surveillance operating positions is that required for the air traffic services to be provided, including the display of safety related alerts and warnings , where the Authority has determined that the facility is required.''

The SZC and all Approach units, with the exception of Dubai Approach, have satisfactory STCA in place. Previous ANA audits of Dubai approach recognized the deviancy and required a safety assessment of alternative means of compliance in order to determine if these would be acceptable to the GCAA to be provided by 31 March 2012.

The Dubai response was not acceptable to ANA and, after an inspection of the Approach Control unit, and considerable correspondence, Dubai was notified that the installed STCA was to be made operational, pending the provision of full safety related alerts and warnings in the new AT3 radar displays to be operational within 3 months.

An initial safety assessment of the requirement to make the STCA operational led to a number of issues, many of which not be resolved prior to the introduction of the AT3, therefore Dubai has been required to provide either:

1. A revised safety assessment providing adequate information of how the unit is continuing operations safely, without the current STCA System activated, for ANA review and acceptance, or

2. Activate the current STCA System, set to parameters which will alert ATCO when separation is lost, to minimize false alerts. This option is to be preceded with provision of a

formal request letter and safety assessment for approval of operational use of the current STCA system, to the ANA Department for review."

SR19/2012

The GCAA to provide Air Navigation Service Information Notice (ANSIN) to all UAE Civil ATC Units, requiring ANS Management to include awareness of the new ACAS11 version 7.1 capabilities and limitations, in their initial and continuation ATCO training syllabus.

Following SR19/2012, the GCAA Air Navigation and Aerodromes (ANA) Department informed the Investigation Team, on the 16 August 2012, that ANA issued an Air Navigation Services Information Notice (ANSIN number 005/12)[57] which had the following information:

1. "INTRODUCTION

   i. A revision to TCAS II version 7.0 was recognized as being required as a result of analysis of the parlance of version 7.0, especially in response to a near mid-air in japan in 2001 and the Ueberlingen mid-air collision in 2002. In both these cases a pilot maneuvered the aircraft in the opposite sense to the displayed RA.

   ii. Separate to the above events, a review of other operational experiences had shown that pilots occasionally manoeuvre in the opposite direction to that indicated in the ''adjust vertical speed, adjust (AVSA) '' RA. To mitigate the risk of pilots increasing their vertical rate in response to an ''AVSA'' RA, all AVSA RAs were replaced in TCAS version 7.1 by ''level off, level off '' RAs.

   iii. ICAO has mandated TCAS 7.1 for all new installations after 1 January 2014 and for all units after 1 January 2017.

   iv. TCAS 7.1 is mandated in Europe for all new aircraft from March 2012 and for all aircraft after December 2015.

   v. All UAE registered aircraft are TCAS II equipped.

   vi. There is no need for an ATCO to know which version of TCAS an aircraft operates as the systems are compatible, so that proper TCAS coordination between aircraft will take place in coordinated encounters and therefore the provision of ATS to all TCAS equipped aircraft should be identical to those not TCAS equipped.

2. PURPOSE

   i. The purpose of this ANSIN is notifying ANSP organizations and controllers of the changes in how an aircraft equipped with TCAS version 7.1 will respond to an RA.

   ii. Safety issues with version 7.0 were identified as follows:

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[57] Downloaded from https://www.gcaa.gov.ae/en/ePublication/_layouts/GCAA/ePublication/DownloadFile.aspx?Un=/en/epublication/admin/Library Pdf/ANS Information Notice (ANSIN)/ANSIN 2012/ANSIN 005.pdf

a) Unintentional opposite pilot response to an AVSA RA were the pilot increased the rate of change rather than reducing it,

b) Level busts following AVSA RAs whereby the increased rate of level change contributed to a level bust which may otherwise not have occurred,

c) Flaws in the reversal logic.

iii. TCAS II Version 7.1 will address these safety issues through:

a) 'Level off'’’ RAs

b) Improvements to the reversal logic.

3. What is new?

i. A new ’’level off, level off ’’ RA introduced in version 7.1 replacing the AVSA RA, whereby pilots will be required to reduce the vertical rate promptly to zero ft./min.

a) This applies to both initial and weakening RAs.

b) In version 7.0, pilots were instructed to adjust vertical speed by one of several options when receiving an AVSA RA. In version 7.1, the only option will be in instruction to level off.

c) An RA will weaken when the response the initial RA increases vertical spacing and will require a level off prior to notification of ’’clear of conflict’’.

d) Level off will not increase the number of conflicts with third party aircraft created by the current TCAS version.

e) The level off, level off RA will reduce the instances of RAs as follow up RAs are less likely and will also reduce the number of level busts.

ii. Improvements to the reversal logic which recognizes when:

a) Two aircraft remain within 100 feet vertically and are converging, or

b) One aircraft is not the RA or is not equipped.

The reversal RA (either climb NOW or Descend descend NOW) will be issued to the aircraft correctly following the previous RA.

Improvements to the logic will be transparent to pilots and controllers.

4. Requirements and recommendations

i. ATS Providers and training organizations shall include TCAS ll, version 7.1 training in their initial and continuity training for all radar controllers at the earliest opportunity.

Reference sources to assist in providing this CT are listed below. Reference 5.5 is a link to the latest ACAS Bulletins and safety messages.

ii. A further reference ''replay interface for TCAS Alerts '' (RITA2) is available in the downloads section of the GCAA website, however this does not cover version 7.1."

4.3 Final Report Safety Recommendations

4.3.1 The General Civil Aviation Authority of the United Arab Emirates-

SR01/2016

Ensure that when an alert is activated it does not mask the traffic information on all UAE Civil ATC radar screens and that ATCOs have the ability to continue to control aircraft by maintaining visibility of all available traffic information.

Air Accident Investigation Sector
General Civil Aviation Authority
The United Arab Emirates