AAIS Case Reference: 16/2012

AIR ACCIDENT INVESTIGATION SECTOR

PRELIMINARY

SERIOUS INCIDENT INVESTIGATION REPORT

In Flight Turn Back – Engine Nacelle Fire

Abu Dhabi International Airport
United Arab Emirates
09th September 2012

General Civil Aviation Authority
of
United Arab Emirates

SERIOUS INCIDENT

NAME OF THE OPERATOR	:	Abu Dhabi Aviation
MANUFACTURER	:	Bombardier Inc., Canada
AIRCRAFT MODEL	:	DHC-8-315Q
NATIONALITY	:	United Arab Emirates
REGISTRATION	:	A6-ADB
STATE OF OCCURANCE	:	United Arab Emirates
LOCATION (PAN Call)	:	5000 feet after departure from Abu Dhabi Int'l Airport
DATE & TIME	:	09th September 2012, 0649 Local Time

Notes:

1. All times in the report are Local Time (Local time "LT" in UAE was UTC+ 4h)
2. The word "Aircraft" in this report implies the aircraft involved in the serious incident
3. The word "Team" in this report implies the Investigation Team

OBJECTIVE

This investigation is performed in accordance with the UAE Federal Act No 20 (1991), promulgating the Civil Aviation Law, Chapter VII, Aircraft Accidents, Article 48, CAR Part III Chapter 3 and in conformity with Annex 13 to the Convention on International Civil Aviation.

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

Reports are publicly available from :

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

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

The information contained in this preliminary report is derived from the factual information gathered during the ongoing investigation of the occurrence. Later interim reports or the final report may contain altered information in the case that new evidence appears during the ongoing investigation that requires changes to the information depicted in this report.

Any specific safety issues identified during the course of the investigation will be advised to all parties through the GCAA Safety Recommendations (SR) procedure.

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ABBREVIATIONS

A	Aeroplane
ADA	Abu Dhabi Aviation
AAIS	UAE GCAA Air Accident Investigation Sector
AFM	Aircraft Flight Manual
AMM	Aircraft Maintenance Manual
AMO	Approved Maintenance Organization
AMP	Approved Maintenance Program
AMS	Approved Maintenance Schedule
ATC	Air Traffic Control
ATCO	Air Traffic Controller
ATPL	Air Transport Pilot License
CAAP	Civil Aviation Advisory Publication
CAR	UAE Civil Aviation Regulation
CAR-OPS	UAE Civil Aviation Regulation – Flight Operation
CAVOK	Cloud and Visibility OK
CG	Centre of Gravity
C of A	Certificate of Airworthiness
CRM	Crew Resource Management
CVR	Cockpit Voice Recorder
CMR	Certificate of Maintenance Review
CPL	Commercial Pilot License
DFDR	Digital Flight Data Recorder
ELP	English Language Proficiency
ESN	Engine Serial Number
FDR	Flight Data Recorder

GCAA	UAE General Civil Aviation Authority
hrs	hours
ICAO	International Civil Aviation Organization
IFTB	In Flight Turn Back
IIC	Investigator In Charge
L	Local Time
LH	Left Hand
MME	Maintenance Management Exposition
MOE	Maintenance Organisation Exposition
MSN	Manufacturer Serial Number
OMAA	Abu Dhabi International Airport
OMAS	Das Island Airport
P&WC	Pratt and Whitney Canada
QNH	barometric pressure adjusted to sea level
QRH	Quick Reference Handbook
RH	Right Hand
SN	Serial Number
SOP	Standard Operating Procedures
STOL	Short Takeoff and Landing
TO	Take Off
TSO	Time Since Overhaul
TSN	Time Since New
UAE	United Arab Emirates
USA	United States of America
UTC	Co-ordinated Universal Time
VFR	Visual Flight Rules

SYNOPSIS

On September 09th, 2012, a Bombardier DHC-8-315Q aircraft, registration A6-ADB, operated by a UAE based Airline, departed from Abu Dhabi International Airport (OMAA) at 0645L on a scheduled passenger flight, duration approximately 35 minutes, to Das Island airport (OMAS). After a few minutes into the flight, before reaching FL 5000 feet, the Flight Crew declared PAN PAN emergency and requested OMAA ATC for an immediate return to OMAA airport due to a passenger observation and confirmation by the first officer, of an internal compartment fire and overheat with paint blistering on the inboard nacelle of #2 engine. The crew did not get any cockpit warning and after they confirmed that all engine indications were normal, performed an uneventful landing. Upon exiting the runway, #2 engine was shut down and after getting clearance from the fire services that there was no fire from #2 engine, continued taxing to the parking stand on the power of #1 engine. The passengers and crew disembarked normally from the aircraft. During the crew debriefing which occurred at the airport terminal, only then they were told that the observation made by the passenger on #2 engine also existed on #1 engine.

There were no injuries suffered by the passengers and the crew members and the aircraft was immediately grounded pending further inspections.

The GCAA AAIS were informed about the event via the Duty Investigator hot line, 050-6414667, and immediately dispatched an investigator to Abu Dhabi International Airport. Due to the nature of the event and as it has been classified as a serious incident in accordance with ICAO Annex 13, the GCAA AAIS has assigned an Investigation Team (Team). The State of the Manufacturer and Design, Canada, were notified and assigned an Accredited Representative to the investigation. The UAE GCAA will lead the investigation and issue the final report.

1 FACTUAL INFORMATION

1.1 History of the Flight

On 09th September 2012, an DHC-8-315Q operating on a scheduled passenger service, flight number xxx711, between Abu Dhabi International Airport (OMAA) and Das Island Airport (OMAS), declared a PAN PAN emergency and safely returned to OMAA as a result of a passenger observation and confirmation by the first officer of a fire and hot spot on an access panel located within #2 engine inboard nacelle.

This aircraft, owned and operated by the airline, is one of three aircraft that is contracted to an oil company to transport passengers and workers to Das Island, UAE, which is located in the Arabian Gulf approximately 196 kilometers from OMAA airport.

The flight was a normal service between OMAA and OMAS with a scheduled departure of 0630L. In preparation for the flight, the two pilots and one flight attendant reported as planned and after reviewing the flight plan and weather proceeded to the aircraft. Three, 3, flights were planned for the crew on this day and flight xxx711 was the first flight of the day for the crew as well as the aircraft. The aircraft previous flight was the day before on 08th September 2012 with some minor maintenance work performed by the airline engineering team during the night stop.

Before departure, the first officer did the external walk around of the aircraft which was uneventful. Departure fuel was 4200 kgs for the short flight estimated to be 35 minutes, weather was calm with good visibility, winds from 120 degs at speed of 05 knots and temperature of 29 degs C.

After the procedural cockpit checks were completed and upon ATC and ground clearances, the Engines were started. Off block was 0635L for taxi from the parking stand located next to the terminal building then to holding point at intersection E6. The crew was then given clearance for an immediate takeoff from runway 13R by ATC and the aircraft was airborne at 0645L. As per the flight crew, the engines start, taxi out, take off and climb out were all normal with the captain flying the aircraft.

Many of the 46 passengers on this flight have travelled this route many times as the facility located on Das Island mainly involves work in the oil and gas industry. One of the passengers, who witnessed the event unfolding and raised the awareness of the aircraft crew, had travelled back from his home country overnight to catch the early morning flight. The check in and boarding of all passengers went normally for an on time departure. As no seats are pre assigned for this short flight, the passenger choose a window seat on the right hand side of the aircraft at row 6.

Seated next to the passenger was his friend. Even after his overnight flight, the passenger remained awake and observed the Flight attendant safety announcements in preparation for the flight. From his seat he could see #2 engine enclosure panels, the propeller and parts of the landing gear. During #2 engine start, he noticed that there was fluid, which he believed was water, coming out of the forward part of the engine which he

thought it was due to condensation but he commented to his friend that this is not normal. The fluid dissipated after engine start and he saw the ground crew giving clearance to the flight crew for taxi.

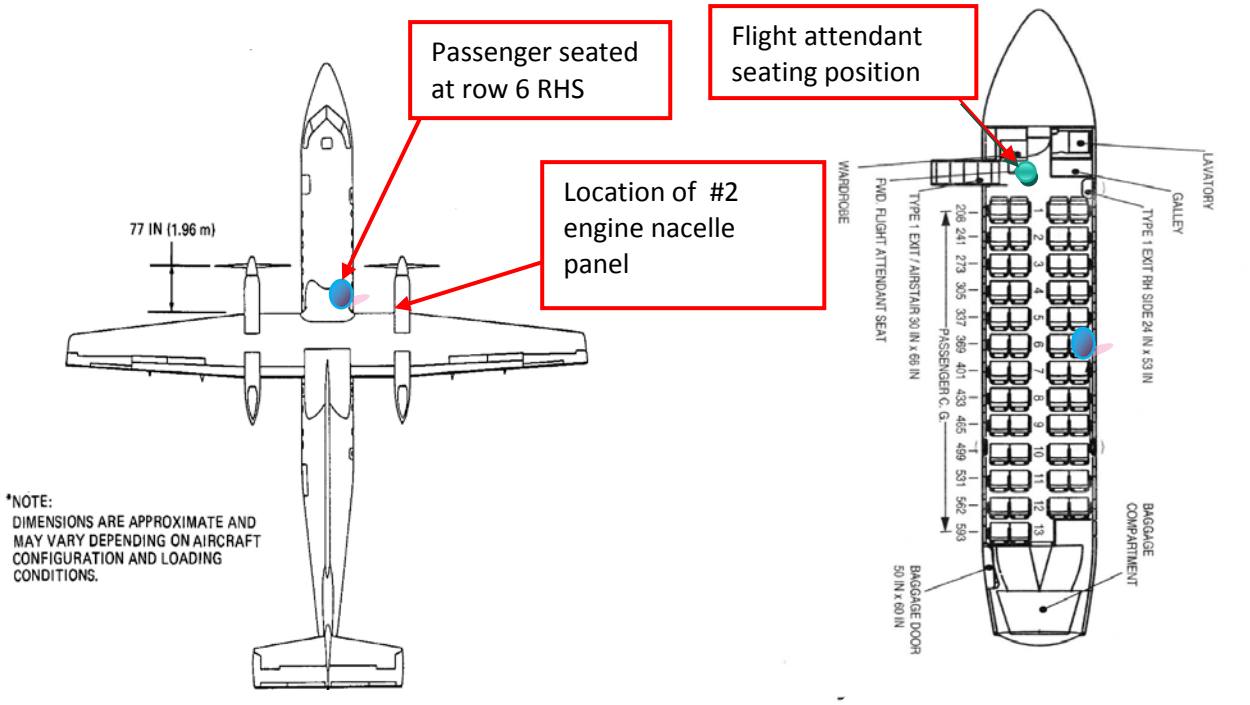

FIG 1
DHC8-315 Aircraft Diagram showing seating position of the passenger and flight attendant and location of the #2 engine nacelle panel

His attention was now focused on #2 engine nacelle panel as he could see a hot spot with fumes coming from the vents located on the panel. Initially he thought it may have been due to some residual fluid within the compartment and after a short while should have subsided. However as the aircraft continued its short taxi for takeoff, he noticed that the fumes were continuing and the color of the panel turning from white, original color, to brown then to black.

This was of great concern to him and as he was strapped in as well as the flight attendant, he tried to draw the attention of the flight attendant by waving his hand. Other passengers around him realized that something was not right. The aircraft was now in the take off roll as the flight crew was given an immediate take off from runway 13R at intersection E6.

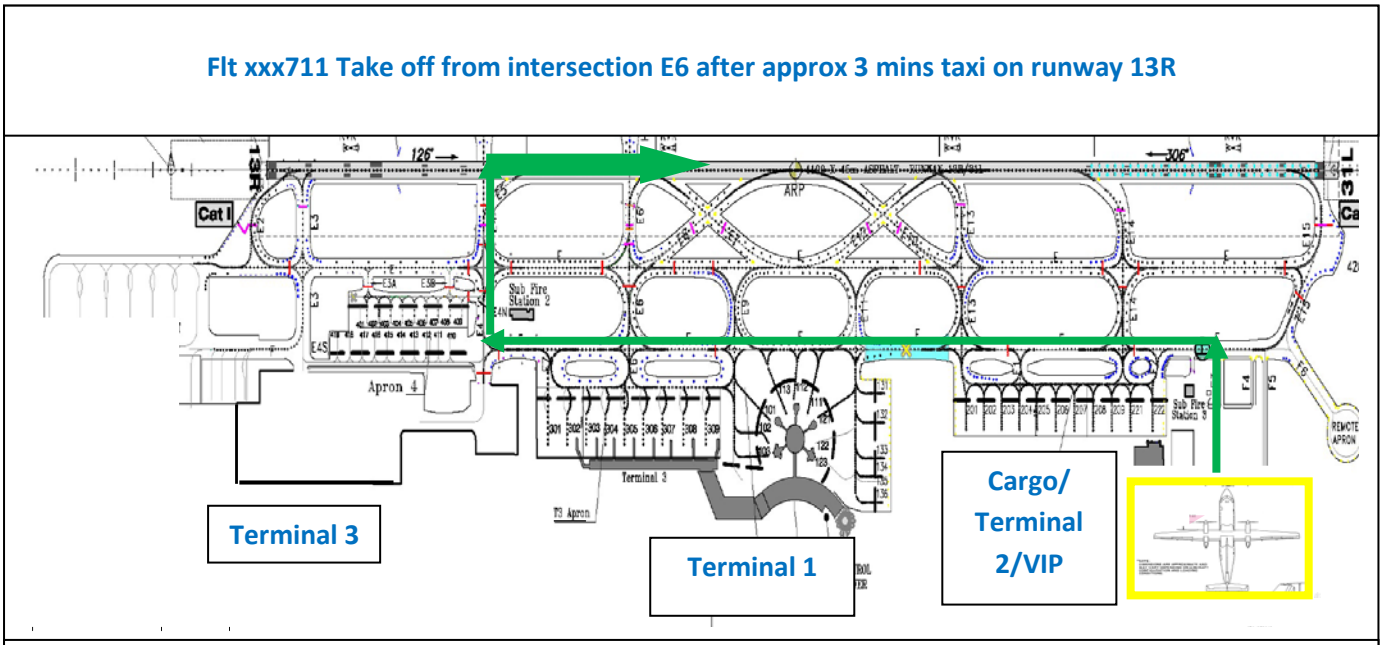

FIG 2
Abu Dhabi Airport (OMAA) - DHC8-315 flt# xxx711 boarding, taxi and take off positions.

Eventually the cabin staff did attend to the passenger and immediately reported to the flight crew that there was something wrong on #2 engine nacelle. The first officer, after takeoff at around FL 2300 feet, went to the passenger. At this point in the flight the paint on the exterior of the panel had already started to blister and the bare metal was now visible.

FIG 3
#2 Engine LH side Typical normal nacelle panel – 425AL

FIG 4
View of #2 Engine panel 425AL from row 6 RHS

Upon viewing what was taking place from the passenger windows, the first officer returned to the cockpit, briefed the Captain that there was a fire within #2 engine nacelle and the collective and right decision made was to return to Abu Dhabi Airport as soon as possible. The aircraft was now downwind passing through FL 4000 feet towards 5000 feet but parallel to Runway 13R. ATC were informed that there were signs of a fire on #2 engine and a PAN PAN emergency was declared by the flight crew. The flight attendant was informed to prepare the cabin and to inform the passengers that they will be returning to the OMAA for a normal landing. Passengers were requested to remain seated upon landing. Throughout the flight the crew confirmed that all engine indications were normal and that there were no cockpit warnings of engine compartment fire hence, the engine fire bottles were not used.

Unknowingly to the flight crew and the passengers, the same condition of overheating on a similar access panel was also taking place on #1 Engine nacelle but could not be seen in flight as the location was on the outboard side on #1 engine nacelle.

ATC informed the Abu Dhabi Airport fire services of the emergency and gave flight xxx711 #1 priority for landing by diverting all other air traffic. The crew discussed that they would perform a normal VFR landing with both engines then shut #2 engine after landing and vacate runway 13R at intersection E10. QRH was not required to be used as all systems were normal.

As per the passenger, after the crew lowered the landing gears in preparation for landing, he could see that the airflow appeared to have a positive effect on the hot spot area as it was not increasing. He was more relaxed and relieved as well as other passengers knowing that the decision was made to return to Abu Dhabi airport.

At approximately 0655L, the aircraft touched down on RWY 13R and the crew exited at taxiway E10 where the aircraft was brough to a stop. Even though the landing was normal and uneventful, the Captain was prepared to evacuate the aircraft if required. #2 Engine was shut down and thereafter the fire services approached the aircraft.

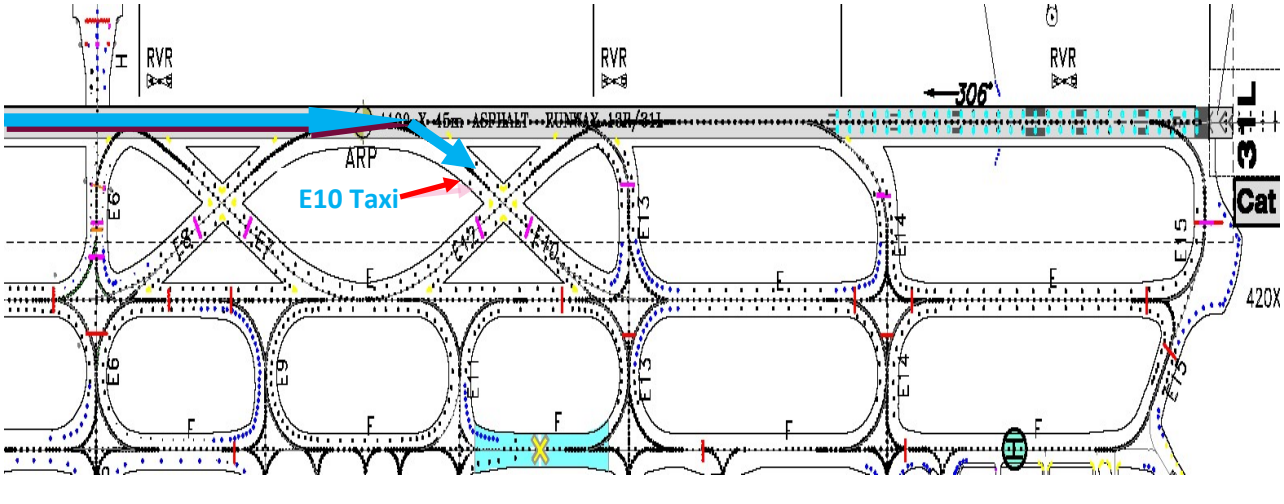

FIG 5
Abu Dhabi Airport (OMAA)- Aircraft landed on RWY 13R and stopped at E10 taxiway

Upon confirmation by the fire services that there was no fire, the crew then taxied the aircraft under the power of #1 engine back to the parking stand outside the terminal building.

Total flight time was 10 minutes and aircraft chock time was 31 minutes and was back on the parking stand at 0715L.

The flight crew were informed sometime after they had left the event aircrfat that that a similar condition also existed on #1 Engine nacelle.

Investigations and defect troubleshooting by the airline maintenance staff began as soon as the engine was shut down and it was clearly seen from the ground that the source of overheat was coming from inside the comparment behind the access panel which encloses the engine hot section. The latches of the access panel had to be forced open and once opened, it was confirmed that there was escape of hot gases through an open port on the engine. This was the similar finding on both engines. In this port should have been the LH side engine ignitor plug. These plugs were removed on the 08th September 2012 by the airline maintenance staff as part of the requiremnt to perform turbine water wash . Each engine has two ignitor plug and the LH igniter from both engines were found lying inside the engine compartment with the electrical harnesses disconnected. There was signs of overheating within the compartment including the structure and tubings.

After the incident, the aircraft was taken out of service pending further inspections and replacement of the affected parts. Communications was established by the airline engineering department and the manufacture as to what additional inspections, repairs and replacements were required before the aircraft went back into service.

1.2 Injuries to Persons

Injuries	Flight Crew	Flight Attendant	Passengers	Other	Total
Fatal	-	-	-	-	**-**
Serious	-	-	-	-	**-**
Minor	**-**	-	-	-	**-**
None	2	1	46	-	**49**
Total	Nil	Nil	Nil	Nil	Nil

1.3 Damage to Aircraft

Initial inspections revealed that there was overheating as a result of the escaping hot engine gases through the open igniter boss on the compartment structure, the access panels and associated lines. There were no signs of overheating seen on the compartment fire detectors which were located approximately 16.5 inches from the open port.

As a result of the overheating, several parts will be replaced before the aircraft is returned to service and this includes the following and are similar for both engines. This is only a summary and more details will be given as the investigation continues:

1. Engine struts located within the compartment
2. Fire seals
3. Hoses
4. Clamps
5. Fire detector support grommets
6. Access panels
7. Igniter harness

The fire detectors will also be replaced and the removed item will be tested to determine serviceability.

1.3.1 After flight - Ground crew observations

The following photos were taken ashortly after the incident and findings were similar on both engines. Identification is mentioned based on from the aft of the aircrfat looking forward (ALF):

FIG 6
#2 Engine LH side access panel 425AL showing discoloration

FIG 7
Close up view of 425AL with paint peeled off due to overheat

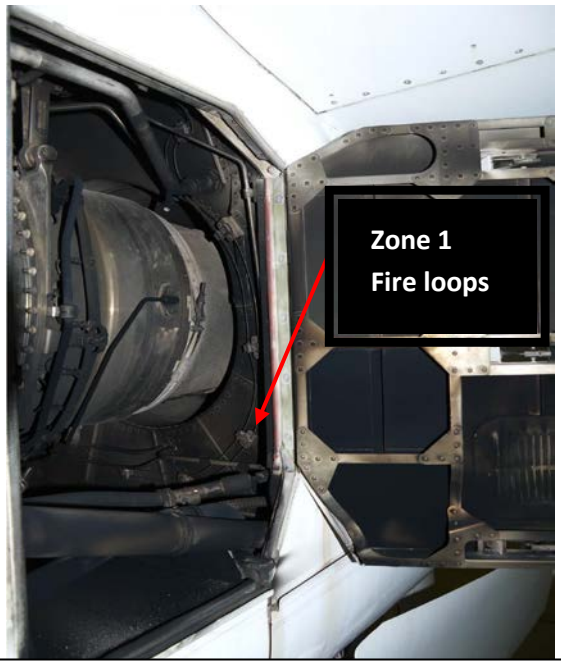

FIG 8
#2 Eng – LH side -Location of the engine fire detector loops on the compartment bulkhead

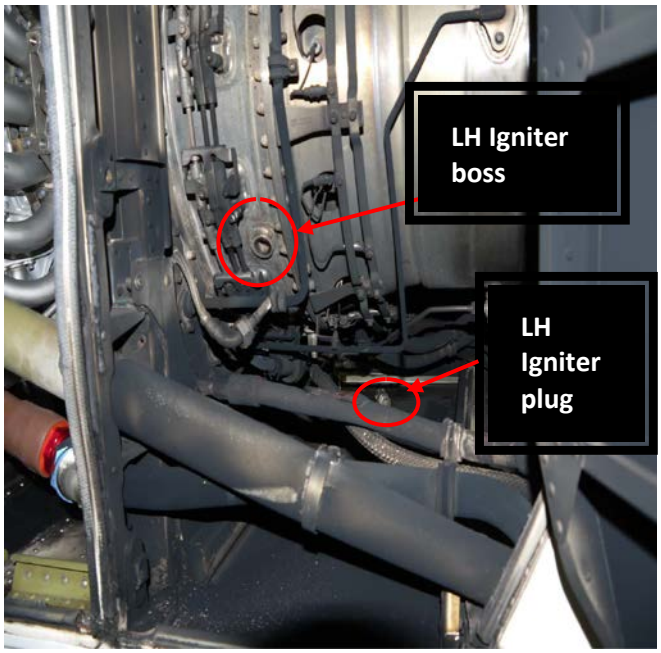

FIG 9
#2 Eng- LH side - Overheating of the lines/structure &LH igniter boss and igniter plug where it was found

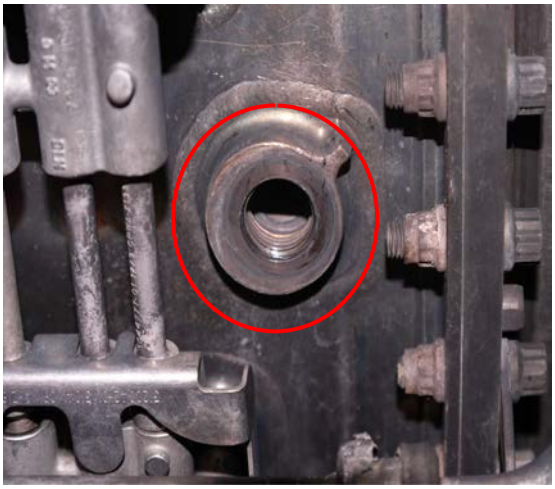

FIG 10
#2 Eng- LH side- LH igniter boss where the hot gases exited as the igniter plug was not fitted

FIG 11
#2 Eng- RH Side nacelle panel 425AR – No external signs of overheat

FIG 12
#2 Eng- RH side- showing signs of soot deposit

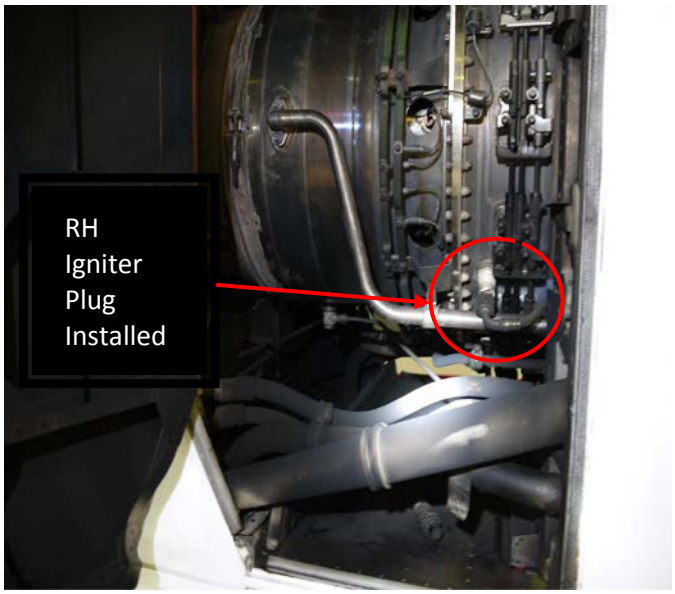

FIG 13
#2 Eng- RH side- Igniter plug fitted

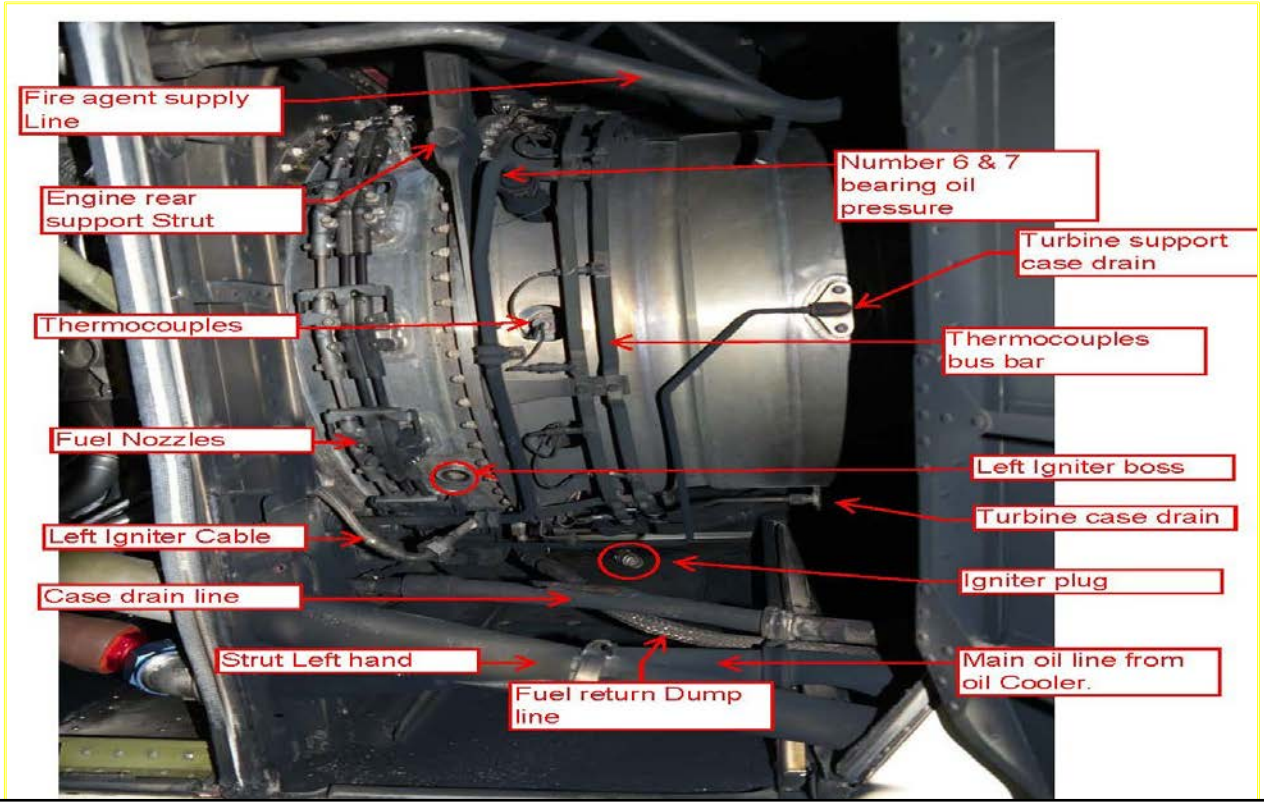

FIG 14 - #2 Eng LH Side (#1 Eng LH Side is symmetrical)
Fig shows location of parts. Some of these were affected as a result of the escaping hot gases from the igniter boss

1.4 Other Damage

There was no damage to any other non aircraft equipment including the airfield and the environment.

1.5 Personnel Information

1.5.1 The Pilot In Command

Date of birth	10th April 1965
GCAA Lic # & Validity	43792 & 02nd April 2020
Class and validity of medical	Class 1 till 05th October 2013
Flying experience	
Total all types	9500 hrs
Total Command on all types	4500 hrs
Total on type	4500 hrs
Total last 30 days	60 hrs
Total last 24 hours	Off Duty
Line and proficiency check	LINE CHECK- 05th April 2012 & Proficiency check – 18th April 2012
English language proficiency	ELP 6

1.5.2 The First Officer

Date of birth	31st January 1982
GCAA Lic # and validity	44235 & 25th April 2020
Class and validity of medical	Class 1 till 25th October 2012

Flying experience	
Total all types	2150 hrs
Total Command on all types	885 hrs
Total on type	1100 hrs
Total last 30 days	54 hrs
Total last 24 hours	Off Duty
Line and proficiency check	LINE CHECK-03rd May 2012 & Proficiency check – 17th April 2012
English language proficiency	ELP 6

1.5.3 The Flight attendant

The male Flight Attendant held a valid UAE GCAA crew member certificate and a flight cabin attendant licence and has been flying to Das Island many times as part of his job.

On the day of the incident, he had reported for duty on time and like the flight crew, had several flights scheduled this day with the first flight being the event flight.

He has also attended CRM training as part of his continued training program with the airline.

1.5.4 The Passenger

The male passenger is a mechanical engineer by profession and for the last eight years he has been working off shore on Das Island for a UAE based oil and gas company mainly involved with mechanical maintenance including health, safety and environment.

He had just returned from his rostered leave whereby he works 35 days on and 28 days off and the flight on 09th September 2012 at 0630L was his planned flight to Das Island. His initial flight to UAE required him to fly overnight on 08th September 2012 from his home country to Dubai International Airport and then take ground transport to Abu Dhabi International airport. His flight to Dubai arrived after midnight UAE time and by the time he got to Abu Dhabi Airport, it was around 0520L.

During the interview, he indicated that he has a habit of whenever he travels on an aircraft, he would always sit on the right side of the aircraft and when available, he would sit towards the front of the aircraft and at the window seat.

On the day of the event flight, the passenger together with his friend whom he met at the airport boarded the flight with the initial passengers and he was able to get the RH side window seat at row 6. The flight to Das island is normally 35 minutes and he even though he has made this flight many times and was tired from his

overnight journey, he remained awake and alert to the flight attendant safety briefing. He has seen many times that passengers take this opportunity to have a short nap especially as the flight is an early morning departure.

He commented that during the safety announcement, it was not easy to hear the flight attendant instructions and this became more difficult after engines were started.

With his technical background, he was able to describe the event including which engine was started first.

1.5.5 The Supervisor – Licensed Aircraft Maintenance Engineer

The male licensed aircraft maintenance engineer was also the supervisor on duty and held the appropriate license from the GCAA, company authorization to certify work performed on the aircraft and has been working on the DHC-8 aircraft series for many years.

His roster, similar to many other of the aircraft maintenance staff employed by the airline, requires him to work on a 8.5 or 9 hour shift per day for 56 days on rotating between early start day shift at 0600L to 1430L and late shift from 1330L to 2230L. After 56 days on, the staff is then off for 28 consecutive days. He had been on his leave cycle till 05th August 2012 and reported on 06th August 2012 to start his 56 days duty.

Similarly, two of the fitters who worked together with the supervisor on the late shift of 08th September 2012, one was away on leave till 17th August 2012 and reported for duty on 18th August 2012 and the other was on leave from 01st August 2012 till 06th September 2012 and reported for duty on 07th September 2012.

On 08th September, the supervisor had reported for duty at 1330L together with 1 licensed certifying engineer and 3 mechanics or fitters as they are called by the airline with planned work and incoming defects on four of the airlines DHC-8 series aircraft. Their duty time ended at 2230L and this was the supervisor's 3rd day on this shift pattern. The day before, he had worked on the event aircraft and stayed back till after midnight in order to complete the work being performed which was replacement of #2 engine.

In addition to his normal responsibilities as a licensed aircraft maintenance engineer, the supervisor also had the responsibility of ensuring that all work performed on the aircraft was certified as per Airline procedures as well as electronically entering all routine work and defect rectifications into the Airline's newly installed data base system called Russell Adams (RUSADA), a system that the airline staff commented that they are still learning.

1.6 Aircraft Information

1.6.1 Aircraft General Information

The Bombardier Dash 8 or Q-Series, previously known as the de Havilland Canada Dash 8 or DHC-8, is a two flight crew, twin-engined, medium range, turboprop aircraft. Introduced by de Havilland Canada (DHC) in 1984, they are now produced by Bombardier Aerospace. Over 1,000 Dash 8s of all models have been built, with Bombardier forecasting a total production run of 1,192 aircraft of all variants through to 2016.

The Dash 8 was developed from the de Havilland Canada Dash 7, which featured extreme short take-off and landing (STOL) performance. With the Dash 8, DHC focused on improving cruise performance and lowering operational costs. The engine chosen was the Pratt & Whitney Canada PW100. The Series 100 has a maximum capacity of 39, the Series 200 has the same capacity but offers more powerful engines, the Series 300 is a stretched, 50-seat version, and the Series 400 is further stretched to 78 passengers. Models delivered after 1997 have cabin noise suppression and are designated with the prefix, "Q". Production of the Series 100 ceased in 2005, and the Q200 and Q300 in 2009.

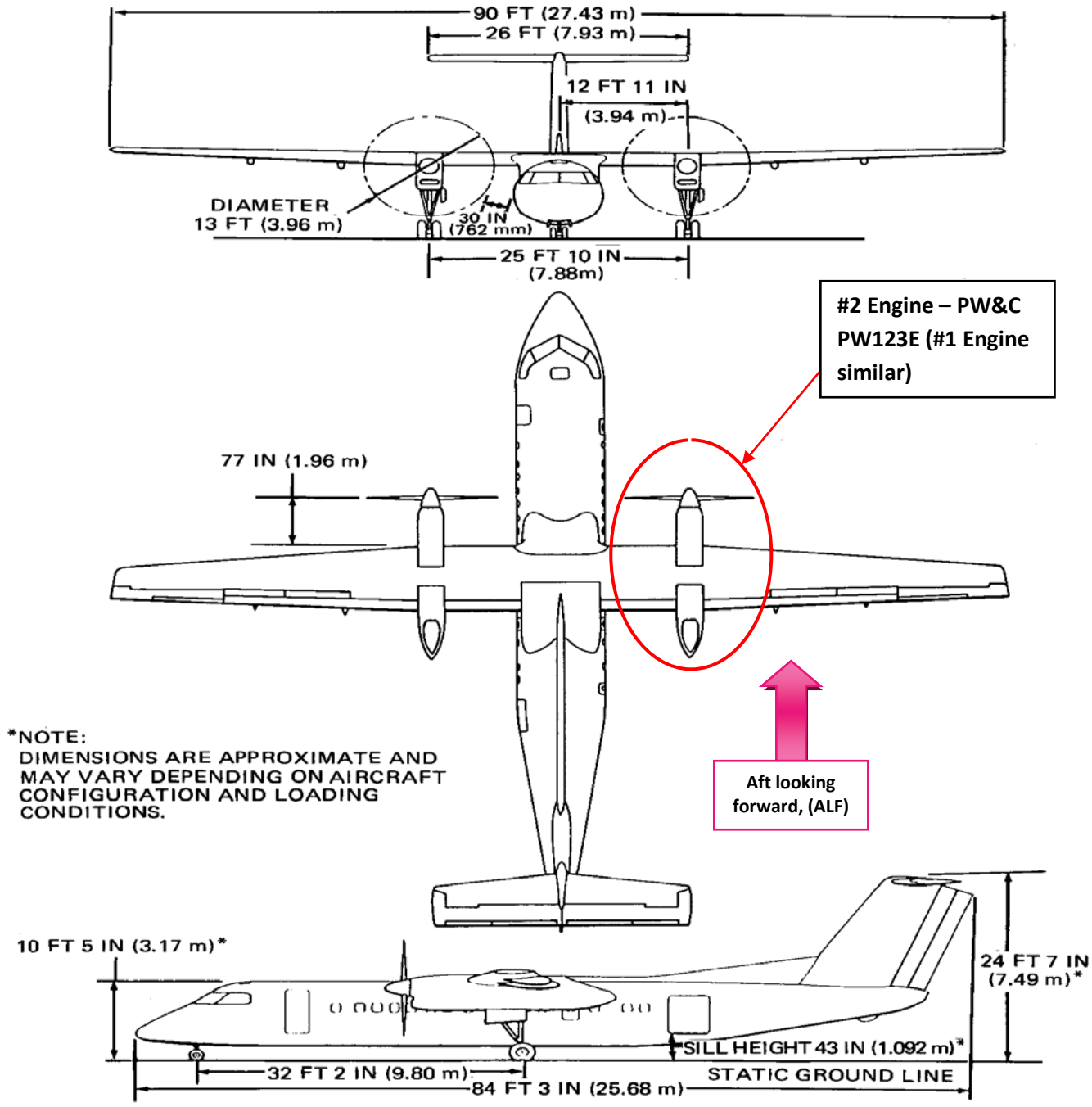

FIG 15
DHC-8-300Q Aircraft Dimensions

1.6.2 Aircraft Data

Aircraft Type:	DHC-8-315Q
Aircraft Manufacturer:	Bombardier Inc, Canada
Aircraft MSN:	650
Max TO/Ldg Mass kgs:	19505 / 19051
Date of Delivery :	04/ Oct/2007
TSN Hrs / CSN cycles	6262 / 11733
Date of the last C of A:	22/Oct/2011
C of A expiry date:	22/Oct/2012
C of A category:	Transport Passenger
Aircraft Station License:	GCAA 0014789/08 GCAA/ADB/0491/07
Insurance Validity Period:	15th October 2011 till 14th October 2012
Last CMR date:	23/May/2012
Next CMR Due:	22/Sep/2012
Last C check Date/FH/FC:	06/May/2010 at 2972 / 5546
Last Equalized Maintenance Program (EMP's) Check: Date/FH/FC	26/May/2012 at 5853 / 10979
Last Daily Check : Date/FH/FC	08/Sep/2012 at 6261.55 / 11731

1.6.3 Engines and Propellers

The two engines fitted to the DHC-8-300Q aircraft is the Pratt and Whitney engine model PW123E. It is a two-spool, centrifugal-flow, free-turbine turboprop engine and rated at 2380 shaft horse power. Both engines are wing mounted and drives a four bladed Hamilton Sundstrand constant speed propeller, which can be feathered and reversed.

FIG 16
DHC-8-300Q showing the PW123 Engine and Propeller

The first spool is a single Low Pressure (LP) centrifugal compressor which is shaft driven by a single LP turbine. The second spool is a high pressure (HP) centrifugal compressor, also shaft driven, by a single HP turbine. Power is provided to the propeller, via a reduction gear box, by a two stage free power turbines, PT, located at the rear of the engine. This shaft rotates clockwise and runs internally within the LP shaft, which in turn rotates anticlockwise within the clockwise rotating HP shaft. Each shaft is supported by various bearings throughout the engine.

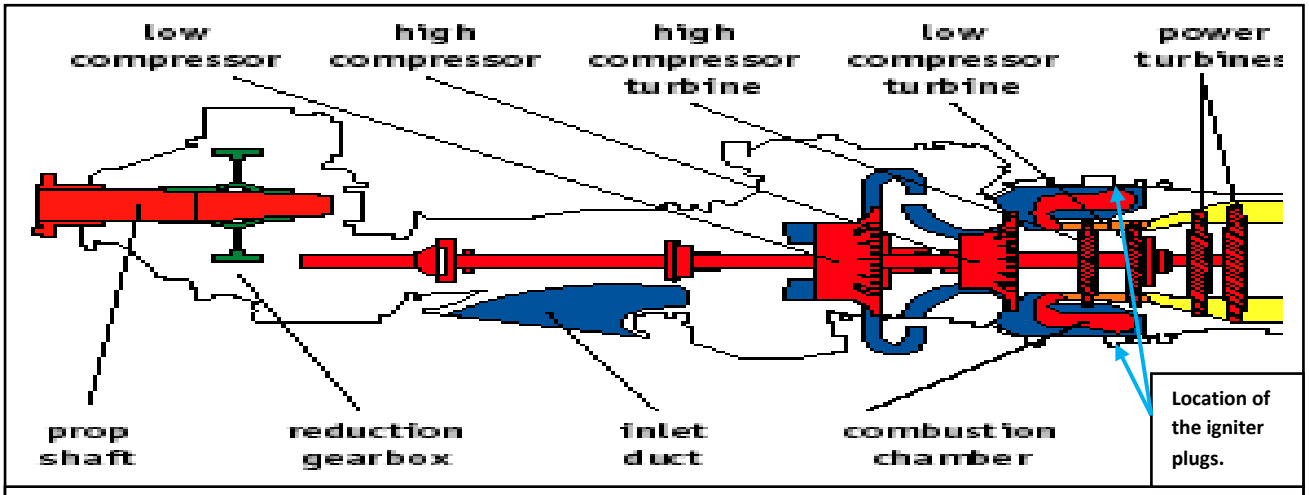

FIG 17
Basic Schematic of the PW123 engine

On the event aircraft, the engines and propellers fitted at the time of the incident are as mentioned:

SUBJECT/POS.	Manufacturer	Part Number	SERIAL NUMBER	TIME SINCE NEW	TIME SINCE FITTED	DATE INSTALLED
ENGINE #1	Pratt and Whitney Canada	PW123E	AR-005	8240:25	218:45	11 Jul 2012
PROPELLER #1	Hamilton Standard	14SF-23	961116	12875:40	1259:20	31 Oct 2011
ENGINE #2	Pratt and Whitney Canada	PW123E	AW-0135	5478:50	3:25	07 Sep 2012
PROPELLER #2	Hamilton Standard	14SF-23	961115	12979:45	434:30	18 May 2012

1.6.4 Relevant Engine history and Engine Washes

The airline has had several engine performance issues as a result of the local environment in which they operate and in order to extend the life of the engines on wing, the airline, in 2009, introduced engine performance enhancement water washes on the PW123 engines fitted to the DHC -8 series aircraft. This included daily turbine water washes on both engines which was performed after the last flight of the aircraft.

On the event aircraft, there were two engine changes within a short period as mentioned:

1. On 30th July 2012, #2 engine, ESN AW-0136, suffered a hot start and had to be replaced. New engine, ESN AW-0119 was installed on 03rd August which was on loan from another airline.
2. On 07th September 2012, #2 engine, ESN AW-0119, was removed and ESN AW-0135 installed. This engine had just returned from a hot section repair.

This task card[1] detailed the requirements to carry out engine turbine water wash as per the P&WC manual[2], but using method 2. The task was not included in the airlines' GCAA approved maintenance program and was issued from their planning department on a daily basis for each aircraft during its maintenance stop at its base facility. At the end of the work, the task card was signed off by the fitter and then certified by the engineer.

As per the airline comments, this task once introduced, showed an improvement of the engine performance and they were able to have a better a better life on wing thus extending the time between engine overhaul (TBO).

[1] Airline reference A7200/01 dated May 2009
[2] P&WC maintenance manual chapter 72-00-00

This task card was eventually withdrawn in order to reduce the volume of paperwork and instead, the airline issued a new procedure called procedure number FW 11 in December 2011 whereby the engine turbine washes would now be certified in the aircraft technical log book by the certifying engineer.

The entry in the entry in the aircraft tech log was :

Defect : 'Engine turbine wash required'

Action Taken: "Engine turbine water wash c/o IAW P&WC MM 72-00-00 Engine cleaning Step C, Turbine water wash, Method 2." This statement would then be certified by the approved engineer.

1.6.4.1 Engine Turbine Wash Procedure

The turbine wash procedure requires that after opening engine nacelle access panels 415AL and 425AL, the LH igniter electrical harness is disconnected and then the corresponding igniter plug is removed. Water under pressure is then introduced to the engine turbine via an in house assembled engine wash rig connected to a wash nozzle that is placed inside the open port (boss) from where the igniter plug is removed. Once the temperature of the engine was below 65 degs Celsius, each engine is motored for approximately 20 secs and during this motoring, water is introduced into the turbine from the rig via the wash nozzle. After the rig is turned off, the engine would then be motored for another 30 seconds to disperse the excess water within the engine. Upon normalizing the engine, an engine ground run is performed but only if the engine was not started within the next 12 hours. The P&WC maintenance manual gives the engine run after this wash as optional. As most of the washes took place in the late shift, and the aircraft normally flew early morning, the first engine starts would normally be during the next scheduled flight for the aircraft.

1.6.4.2 Engine Wash Discussion by the Airline Engineering staff

During the investigations, it was revealed that additional washes were instituted by the airline engineering staff but only on the event aircraft. This was introduced after #2 engine change in July 2012 and the new requirement was to be performed was engine compressor water wash. This compressor wash was in addition to the already existing turbine water wash but was only applicable on the event aircraft. There was consensus amongst the airline engineering staff that the on wing life could have been further extended by implementing this additional wash.

There was no evidence produced of any specific task card and recorded entries of this work actually being performed for the compressor washes.

Information dissemination on this additional requirement of the engines fitted to the event aircraft was communicated verbally. As some of the staff was away on their annual leave including the Fixed Wing Base Manager, some staff was not aware of this new requirement. In the absence of any reference task card, this information was relayed verbally.

1.6.5 Brief Aircraft Maintenance History before the event on 09th Sep 2012

On 08th September 2012, the aircraft had a scheduled night stop at the airline main facility at Abu Dhabi Airport. There were 2 defects reported by the crew and also a maintenance requirement for aircraft external

wash. One defect required toilet servicing and the other defect required adjustment of the nose steering system cables and this job required the aircraft to be in the hangar.

During the time the aircraft was inside the hangar, as per the airline requirements, both engines were prepared for turbine engine water washes[3]. This requires that access panels 415AL on #1 engine and 425AL on #2 engine nacelles to be opened by releasing the 3 latches, after which the LH engine igniter electrical harness is disconnected and then the corresponding igniter plug is removed.

This is when both igniter plugs were removed and left inside the engine compartment.

After rectification of the nose wheel steering, the aircraft was towed out from the hangar for the aircraft external wash. In preparation for this wash, the engine panels 415AL and 425AL were closed. The external wash was performed by one of the fitters and his assistant. During this time, the supervisor had returned to the document control room in order to complete the necessary paperwork and enter data in the airline electronic system, Russell Adams.

During the course of the supervisors' paperwork write ups and data entry, another two fitters volunteered to perform the engine washes.

These two fitters had already performed turbine engine washes during this shift on another 2 of the airlines' DHC-8 aircraft and they were aware that the event aircraft had a new requirement for engine wash. Their knowledge of the event aircraft on that shift was that the engines were not prepared for engine compressor water washes and thus proceeded with the removal of the single access plug[4] , fig 18, on the external engine compressor casing. The compressor washes does not require panels 415AL and 425AL to be opened but another 2 adjacent panels, 413AL for #1 engine and 423AL for #2 engine in order to access these plugs. They actioned the compressors washes and then normalized the engines compressor plugs, sense lines and closed the engine panels.

However, the turbine water wash was not performed.

[3] The reference for this work can be found in PW&C Maintenance manual 72-00-00 Engine Cleaning, Step C – Turbine Wash, and the airline follows Method 2
[4] Pratt & Whitney Canada Maintenance Manual 72-00-00 fig 704

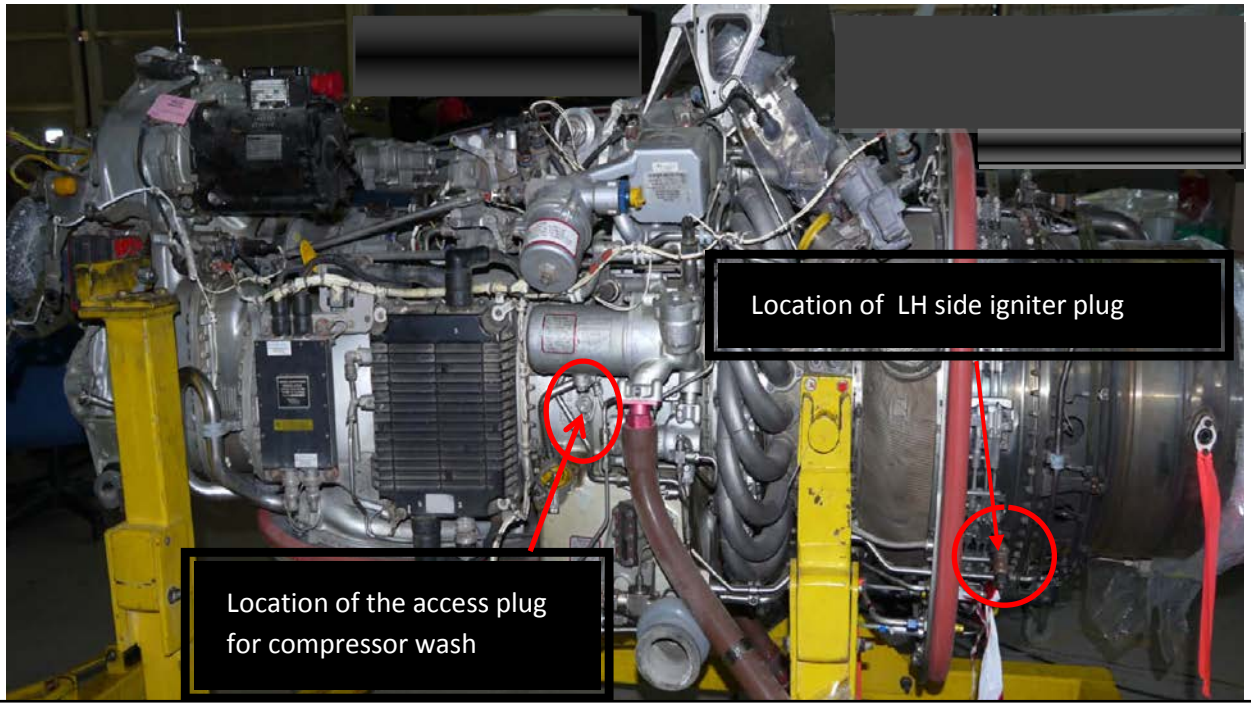

FIG 18 – PW123E engine on work stand
Location of the compressor wash access plug and LH igniter plug

As per normal practice, the fitters reported back to the control room and information was passed to the supervisor that the engine washes were completed. Based on that verbal confirmation, the supervisor certified in the aircraft log book that Engine turbine water wash c/o IAW P&WC MM 72-00-00 Engine cleaning Step C, Turbine water wash, Method 2."

Thereafter, the daily check was signed off in the aircraft technical log and the aircraft was now declared serviceable and airworthy for its early morning flight at 0630L on 09th September 2012.

The supervisor completed the handover log and together with the other 4 staff on duty on the late shift left work at around 2230L.

On the morning of the flight, another maintenance crew reported for work at 0600L on 09th Sep 2012, and departed the event aircraft for its flight xxx711.

1.6.6 P&WC PW123 Engine Zones and fire/overheat warning

During the entire period from engine start, taxi, take off and return to OMAA, there was no fire/overheat warning reported by the flight crew.

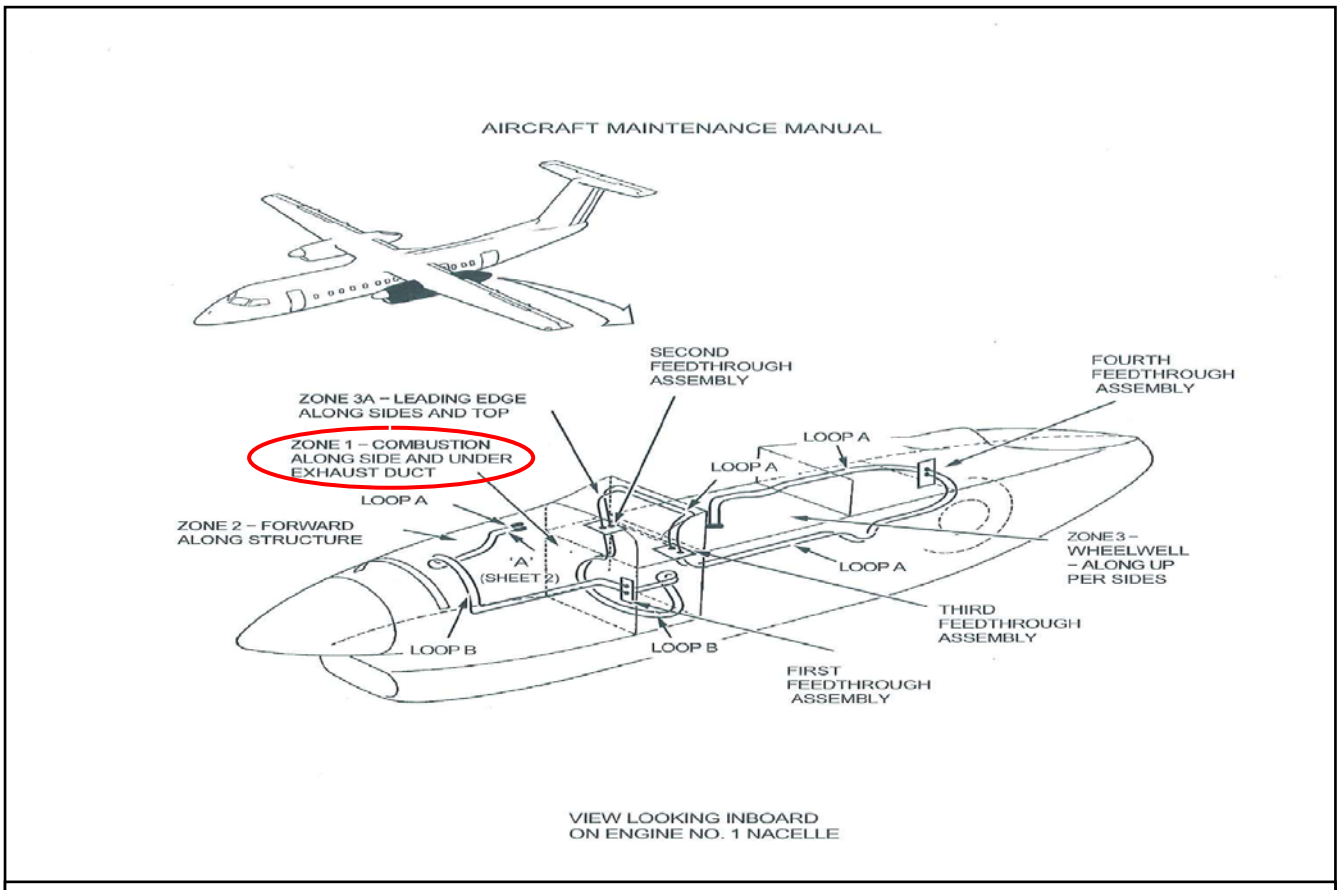

FIG 18 - #1 engine shown (#2 engine similar)
Engine Zones and location of fire detector sensors.

There are two fire detector loops located within the engine compartment, zones, for monitoring and indicating a fire or overheat condition to the flight crew[5]. Whenever the temperature within the zone reaches a predetermined temperature, as per the component maintenance manual[6] the temperature range is between 177 to 221 degrees Celsius, a warning is triggered in the flight deck indicating an overheat or a fire in the engine area.

[5] De Havilland Dash 8 series 300 Aircraft Maintenance Manual 26-11-00
[6] Meggitt Safety Systems Component Maintenance Manual 26-10-88

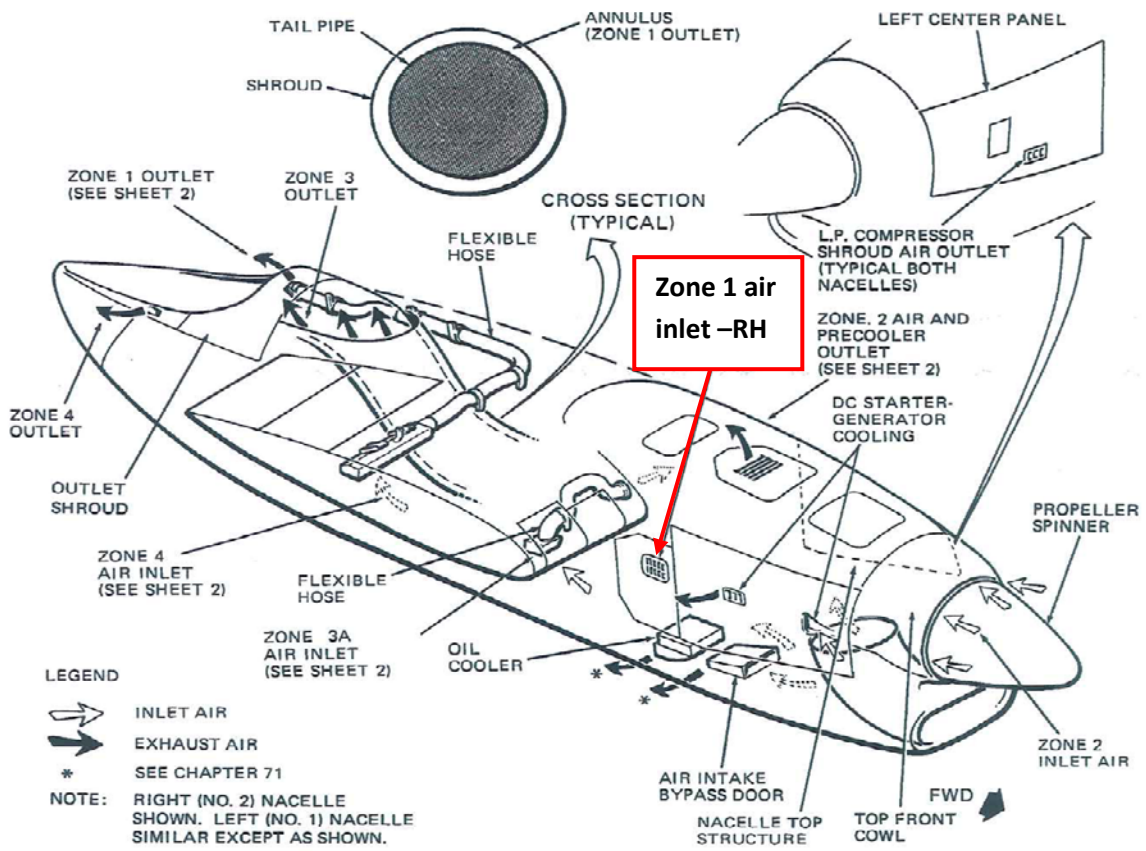

FIG 19 – Cooling Air - #2 engine shown (#1 engine similar)
Engine Zones and location of air inlet and exhaust air

The engine compartment is divided into zones and the zone where the hot gases were exiting in this event, is known as zone 1. This is the engine hot end and tail pipe area and includes the combustion zone. Zone 1 consist of a continuous shroud surrounded by a firewall and is made of fire proof material as mentioned in the manufacture aircraft maintenance manual[7].

Zone 1 is also cooled by ambient air which enters the area via the forward facing louvers located on the nacelle access panels 415AL, 416AR for # 1 engine and 425AL, 426AR for #2 engine. The ambient air is circulated within the zone and cools and ventilates the compartment. The air is then exhausted from the annulus formed between the engine tail pipe and the compartment shroud.

As per the manufacture of the engine, Pratt and Whitney Canada, the temperature of the hot gases escaping would have been in the range of approximately 500 degrees Celsius.

[7] De Havilland Dash 8 series 300 Aircraft Maintenance Manual 75-20-00

In-situ testing of the fire detectors was performed when the aircraft came into the hangar after the event and the test was successful.

Additional testing is being looked at to determine if the fire detectors should have sensed an overheat condition within this zone of the engine.

1.7 Meteorological Information

The weather report at Abu Dhabi International Airport at the time of the incident was as mentioned:

201209090100 METAR OMAA 090100Z 11005KT CAVOK 29/13 Q1000 A2955 NOSIG=
201209090200 METAR OMAA 090200Z 13003KT CAVOK 29/11 Q1001 A2956 NOSIG=
201209090300 METAR OMAA 090300Z 13003KT CAVOK 30/11 Q1001 A2958 NOSIG=
201209090400 METAR OMAA 090400Z 12003KT CAVOK 32/09 Q1002 A2959 NOSIG=

1.8 Aids to Navigation

The crew did not need any special navigational aid and performed a VFR approach and landing.

1.9 Communications

The ATC recordings and radar files were made available to the Team.

1.10 Aerodrome Information

Abu Dhabi international airport, OMAA, has two parallel runways 13R/31L and 13L/31R, both 4100 metres in length. Both runways were available at the time of the event. The airport fire services department are fully equipped to manage any type of emergency.

Das Island airport, OMAS, has a single runway 15/33 with a length of 1078 metres and width of 30 metres.

1.11 Flight and Cockpit Recorders

The Flight Data Recorder (FDR) and Cockpit Voice Recorder was removed from the aircraft and sent to the General Civil Aviation Authority Air Accident Investigation Laboratory in order to download the data for the investigation purpose.

FDR Data:
Part number: 2100-6022-001
Serial Number: 306392

The FDR data was downloaded successfully at the GCAA laboratory. Initial review of that flight did not indicate any abnormal parameters, however the FDR data will be reviewed in more details.

CVR Data:
Part number: 980-6022-001
Serial Number: CVR120-09497

Information pertaining to the incident captured on the CVR will be discussed as the investigation continues.

1.12 Wreckage and Impact Information

Not applicable to this investigation.

1.13 Medical and Pathological Information

Not Applicable to this investigation.

1.14 Fire

No external fire was involved in this incident and the overheat condition within the engine compartment did not show any signs of additional ignition or burning.

1.15 Survival Aspects

All crew and passengers disembarked the aircraft normally and there were no fatalities nor injuries suffered.

1.16 Tests and Research

As the investigation progresses, test and research will be addressed.

1.17 Organizational and Management Information[8]

Established in 1975, the Airline is the largest commercial helicopter operator in the Middle East, operating 54 helicopters (16 Augusta Westland AW139s, 15 Bell 412s, 19 Bell 212s and 4 Bell 206s), 3 fixed-wing aircraft (DHC-8). The company employs over 800 personnel, including 150 pilots and 150 aircraft maintenance engineers. The bulk of the company's business activity is in support of Abu Dhabi Offshore Oil and engineering and construction companies. Other business activities include medical evacuation, survey, photography and charter. Additionally, all aerial spraying of crops in the UAE and the majority of aerial spraying in Oman is carried out by ADA.

By 1983, the fleet size had increased to a total of 34 aircraft, flying over 38,800 hours annually, an average of over 100 hours per day.

[8] Information from the Airlines' web site: http://www.abudhabiaviation.com/about-us/overview.aspx

In 1985, The Airline was authorized to operate fixed-wing aircraft and to conduct third-party aircraft maintenance.

In 1991, The Airline was awarded its first fixed-wing aircraft contract. This contract, with the largest oil company in the UAE, is now operated with three new DHC-8 aircraft.

Since its inception, the Airline is now approaching the 1,000,000th flight hour mark in helicopters and over 55,000 flight hours in fixed wing aircraft. Bell Helicopter awarded The Airline with a plaque to commemorate the completion of 700,000 helicopter hours. The high intensity of offshore oil support work has required an annual average of approximately 200,000 landings and take-offs. In an average month, 15,000 passengers and 162,000kgs of freight are transferred to and from offshore areas. In addition, over 11,000 passengers are moved between various offshore locations.

1.18 Additional Information

1.18.1 ICAO Annex 6

ICAO Annex 6 part 1 chapter 8 paragraphs 8.1 and 8.8 states:

8.1 Operator's maintenance responsibilities
8.1.1 Operators shall ensure that, in accordance with procedures acceptable to the State of Registry:
a) Each aeroplane they operate is maintained in an airworthy condition;
b) The operational and emergency equipment necessary for an intended flight is serviceable; and
c) The certificate of airworthiness of each aeroplane they operate remains valid.

8.8 Maintenance release
8.8.1 A maintenance release shall be completed and signed to certify that the maintenance work performed has been completed satisfactorily and in accordance with approved data and the procedures described in the maintenance organization's procedures manual.
8.8.2 A maintenance release shall contain a certification including:
a) Basic details of the maintenance carried out including detailed reference of the approved data used;
b) The date such maintenance was completed;
c) When applicable, the identity of the approved maintenance organization; and
d) The identity of the person or persons signing the release.

1.18.2 GCAA Civil Aviation Regulations Part V Chapter 3

Under the GCAA CARs Part V Chapter 3 – CAR 145 the following is stated with reference to maintaining an airworthy aircraft and to minimize human errors:

CAR 145.50 Certification of maintenance
(a) A certificate of release to service shall be issued by appropriately authorized certifying staff

on behalf of the organization when it has been verified that all maintenance ordered has been properly carried out by the organization in accordance with the procedures specified in CAR145.70, taking into account the availability and use of the maintenance data specified in CAR 145.45 and that there are no non-compliances which are known to endanger the flight safety.
(b) A certificate of release to service shall be issued before flight at the completion of any maintenance.

CAR 145.65 Safety and quality policy, maintenance procedures and quality system
(a) The organization shall establish a safety and quality policy for the organization to be included in the exposition under CAR 145.70.
(b) The organization shall establish procedures agreed by the Authority taking into account human factors and human performance to ensure good maintenance practices and compliance with this Part which shall include a clear work order or contract such that aircraft and components may be released to service in accordance with CAR 145.50.
1. The maintenance procedures under this paragraph apply to CAR 145.25 to CAR145.95.
2. The maintenance procedures established or to be established by the organization under this paragraph shall cover all aspects of carrying out the maintenance activity, including the provision and control of specialized services and lay down the standards to which the organization intends to work.
3. With regard to aircraft line and base maintenance, the organization shall establish procedures to minimize the risk of multiple errors and capture errors on critical systems, and to ensure that no person is required to carry out and inspect in relation to a maintenance task involving some element of disassembly/reassembly of several components of the same type fitted to more than one system on the same aircraft during a particular maintenance check. However, when only one person is available to carry out these tasks then the organization's work card or worksheet shall include an additional stage for re-inspection of the work by this person after completion of all the same tasks. Maintenance organization must also establish procedures for duplicate inspections as per CAR Part V, Chapter 2, Section 9.
4. Maintenance procedures shall be established to ensure that damage is assessed and modifications repairs are carried out using data approved by the Authority or by an approved CAR 21 design organization, as appropriate.
(c) The organization shall establish a quality system that includes the following:
1. Independent audits in order to monitor compliance with required aircraft/aircraft component standards and adequacy of the procedures to ensure that such procedures invoke good maintenance practices and airworthy aircraft/aircraft components. In the smallest organizations the independent audit part of the quality system may be contracted when authorized by the authority to another organization approved under this Part or a person with appropriate technical knowledge and proven satisfactory audit experience who is specifically authorized by the authority for this task; and
2. A quality feedback reporting system to the person or group of persons specified in CAR 145.30(b) and ultimately to the accountable manager that ensures proper and timely corrective action is taken in response to reports resulting from the independent audits established to meet paragraph (1).

AMC 145.65(a)

The safety and quality policy should as a minimum include a statement committing th organization to:
- Recognize safety as a prime consideration at all times
- Apply Human factors principles
- Encourage personnel to report maintenance related errors/incidents
- Recognize that compliance with procedures, quality standards, safety standards and regulations is the duty of all personnel.
- Recognize the need for all personnel to cooperate with the quality auditors.

AMC 145.65(b)(3)

3. In order to prevent omissions, every maintenance task or group of tasks should be signed off.
To ensure the task or group of tasks is completed it should only be signed-off after completion. Work by unauthorized personnel (i.e. temporary staff, trainee) should be checked by authorized personnel before they sign-off. The grouping of tasks for the purpose of signing-off should allow critical steps to be clearly identified.

NOTE: A "sign-off" is a statement by the person performing or supervising the work, that the task or group of tasks has been correctly performed. A sign-off relates to one step in the maintenance process and is therefore different to the release to service of the aircraft. "Authorized personnel" means personnel formally authorized by the maintenance organization approved under CAR 145 to sign-off tasks. "Authorized personnel" are not necessarily "certifying staff".

1.18.3 Airline Maintenance Management Exposition- MME

The following are relevant sections, Part 2, from the Airlines MME with guidance on recording work done on the aircraft and critical tasks:

2.15 RECTIFICATION OF DEFECTS DURING BASE MAINTENANCE.

Aircraft defects, whether reported by the aircrew or arising from a maintenance inspection, will be recorded on the aircraft technical log and an additional worksheet may be raised as required. It is company policy that all defects will be recorded and reported as part of the inspection process. Rectification of defects will be effected at the earliest possible opportunity.
If there is any doubt regarding the need for action, the Engineering Director is to establish a suitable course of action. For full details cross-refer to Part 2.10 of this MME.

2.23 CONTROL OF CRITICAL TASKS

In order to avoid the possibility of an error being repeated during disassembly / reassembly of components of the same type fitted to more than one system, maintenance of this type is to be carried out as detailed below:
Whenever possible different personnel are to be responsible for the disassembly / reassembly of like components fitted to more than one system on the aircraft during a particular maintenance check. If circumstances dictate that only one person is available to carry out these actions then, as deemed necessary by the Engineering Director, a stage/ duplicate inspection shall be carried out by an independent engineer. All stage / duplicate inspection shall be carried out in accordance with Company Procedure GEN 39.

1.19 Useful or Effective Investigation Techniques

Not applicable at this stage of the investigation.

Final Report Notification

Upon completion of the factual data collection, analysis, determination of the root cause and causal factors associated with the investigation's conclusions, the Air Accident Investigation Sector will determine which safety recommendations are required.

GCAA Investigation General Information

The GCAA Air Accident Investigation Sector [AAIS] will provide updates on the investigation in line with the recommendations of ICAO Annex 13.

If no cause has been identified within 12 months of this accident, an Interim Accident Report will be published to update on the progress of the investigation.

Any specific safety issues identified during the course of the investigation will be advised to all parties through the GCAA Safety Recommendations (SR) procedures.

Contact Information

Air Accident Investigation Sector
P.O.BOX: 6558
ABU DHABI - UNITED ARAB EMIRATES
TEL: +971 2 444 7666
FAX:+971 2 449 1599
E-mail: accid@gcaa.gov.ae

Web: http://www.gcaa.gov.ae/en/departments/airaccidentinvestigation/pages/default.aspx

To report an aircraft accident or serious incident contact the GCAA Duty Investigator (24/7) on this number +971506414667 immediately.