



**GCAA**  
دولة الامارات العربية المتحدة  
الهيئة العامة للطيران المدني  
UAE General Civil Aviation Authority

AAIS Case Reference: 18/2012

# AIR ACCIDENT INVESTIGATION SECTOR

PRELIMINARY

## SERIOUS INCIDENT INVESTIGATION REPORT

### **Passenger Door Separation Inflight: SCF-NP: System/component failure or malfunction (non- powerplant)**

Diamond DA42NG Twin Star  
A6-HIC  
Al Ain  
United Arab Emirates  
12 October 2012

General Civil Aviation Authority  
of the  
United Arab Emirates



AIR ACCIDENT INVESTIGATION SECTOR STATEMENT

THIS INVESTIGATION HAS BEEN CARRIED OUT IN ACCORDANCE WITH THE GENERAL CIVIL AVIATION AUTHORITY CAR PART VI AND ANNEX 13 TO THE ICAO CONVENTION ON INTERNATIONAL CIVIL AVIATION.

THE SOLE OBJECTIVE OF THE INVESTIGATION OF AN ACCIDENT OR INCIDENT SHALL BE THE PREVENTION OF ACCIDENTS AND INCIDENTS.

IT SHALL NOT BE THE PURPOSE OF SUCH AN INVESTIGATION TO APPORTION BLAME OR LIABILITY.

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## ACCIDENT SYNOPSIS

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During a training flight from Al Ain International Airport [OMAL], a Diamond DA42NG Twin Star in the initial climb phase with a student and instructor onboard became aware of an unusual slipstream sound.

The noise was identified as coming from the rear door and a gap was visible between the door sill and the lower edge of the passenger door. The instructor attempted to hold the door closed, however the instructor stated that he had to release the grip on the door handle to manage the flight, soon after, during the turn to the left (West) to join the circuit, the rear door separated from the airframe.

The Instructor then assumed control as the Pilot Flying [PF] to control the aircraft, manage the descent and circuit, ATC communication, the high power demand to maintain level flight caused by the door separation and subsequent non-uniform aerodynamic loads.

The aircraft continued on to land without further incident.

## ABBREVIATIONS/PHRASES USED IN THIS REPORT

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AD	Airworthiness Directive
AFD	Auxiliary Flight Display
AFM	Airplane Flight Manual
AGL	Above Ground Level
CAS	Crew Alerting System
DFDR	Coordinated Universal Time
ECU	Engine Control Unit
FI	Flight Instructor
ICS	Integrated Cockpit System
OMAL	Al Ain International Airport
MSG	Message
PF	Pilot Flying
SP	Student Pilot
UTC	Coordinated Universal Time

Table 1. Abbreviations/Phrases Used In This Report

## FACTUAL INFORMATION INDEX

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ICAO Annex 13, part 1: Factual Information, has nineteen [19] sub-headings detailing each aspect of the investigation to be reported.

Were information in respect of any of the items in the Factual information is not available, or is irrelevant to the circumstances leading to the accident, the appropriate subheadings are excluded for clarity.

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Diamond DA42 NG Twin Star

# 1. FACTUAL INFORMATION

## 1.1. History of the flight

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The student completed the pre-flight and mass and balance, then completed engines start and taxied toward the holding line.

The Student completed the checklist items. The Flight Instructor [FI] took control of the radio as the aircraft was holding short of the holding point.

The student went through the pre take off checklist at the holding point. During the pre-take-off checks, the student reported that the door warning light was out, as per checklist. The FI corrected him, as the front canopy was still in the cooling gap position<sup>1</sup>. The student closed the front canopy door and rechecked the warning light.

The student received the take-off clearance and was instructed to line up on runway and completed the runway items checklist.

Commencing the take-off roll, the student advanced the throttles rapidly; the instructor stated that historically when the throttles are advanced rapidly there was a concern of an ECU failure indication which can lead to an aborted take-off.<sup>2</sup>

The take-off roll continued to rotation and the initial climb, a short time duration after establishing a positive climb rate and stabilised climb, the instructor noticed an unfamiliar slipstream sound which was increasing in volume; at approx. 200' AGL and 100 knots indicated, the noise was identified as emanating from the rear door.<sup>3</sup>

The instructor attempted hold the door handle to prevent the door opening further however the excessive aerodynamic loads generated by the door prevented this action and the instructor released the handle at around 400' AGL at which point the rear passenger door separated.

Local date: 12-10-2012

local time: 0625 L

## 1.2 Injuries to persons

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<i>Injuries</i>	<i>Crew</i>	<i>Pax</i>	<i>Others</i>
Fatal	0	0	0
Serious	0	0	0
Minor/None	2	0	

Table 2. Injuries to Persons

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<sup>1</sup> The front canopy is hinged at the forward end of the cockpit, with a door closing latch above and behind the crew seats. The Cooling Gap Position' is a door configuration used in high temperatures where the door is put into a closed position but not locked to allow ventilation.

<sup>2</sup> A warning is displayed in the Alerts/Annunciator area of the PFD

<sup>3</sup> The instructors' statement refers to a gap between the aircraft frame and door.

### 1.3 Damage to aircraft

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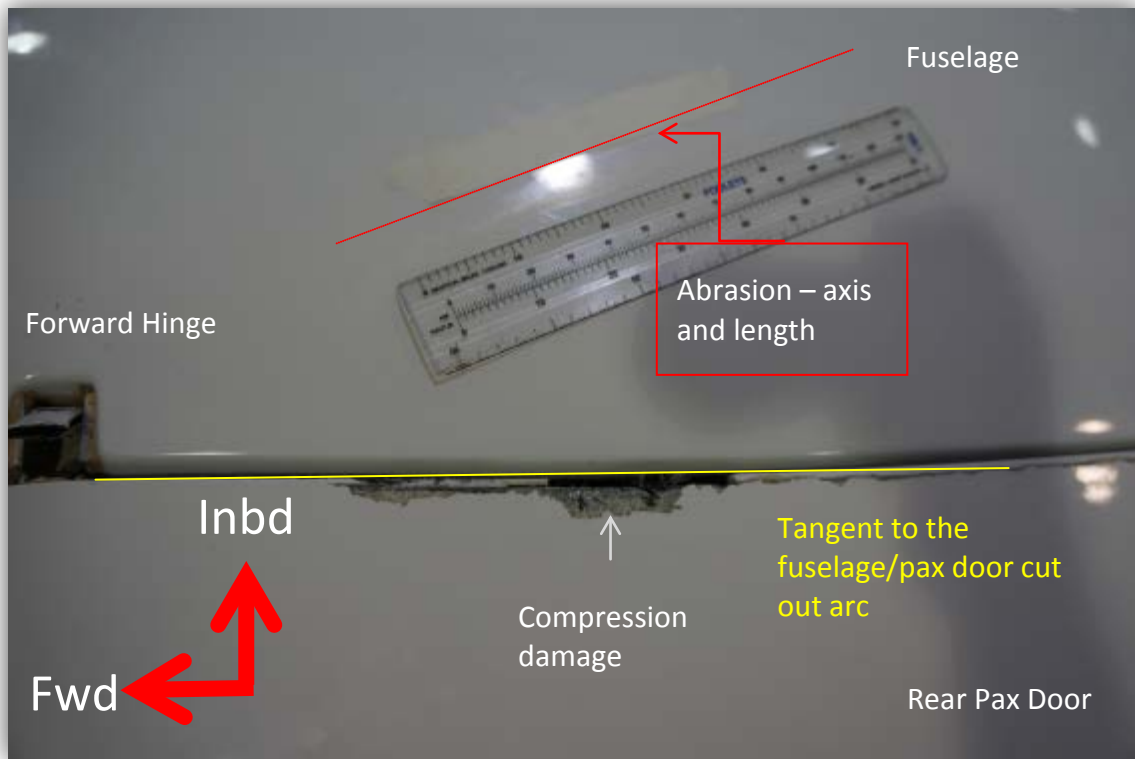
- 1.3.1 The passenger door separated from the fuselage in one piece as a complete door assembly
- 1.3.2 The passenger door lifted from the latched lower edge, extending up due to the aerodynamic loads before separating on the upper hinge line which failed beyond the hinge design limit load.



Picture 1 Door Hinge Location



Picture 2 Damaged Door Reinstalled Fit Check



Picture 3 Door - Fuselage Interface

## 1.5 Personnel information

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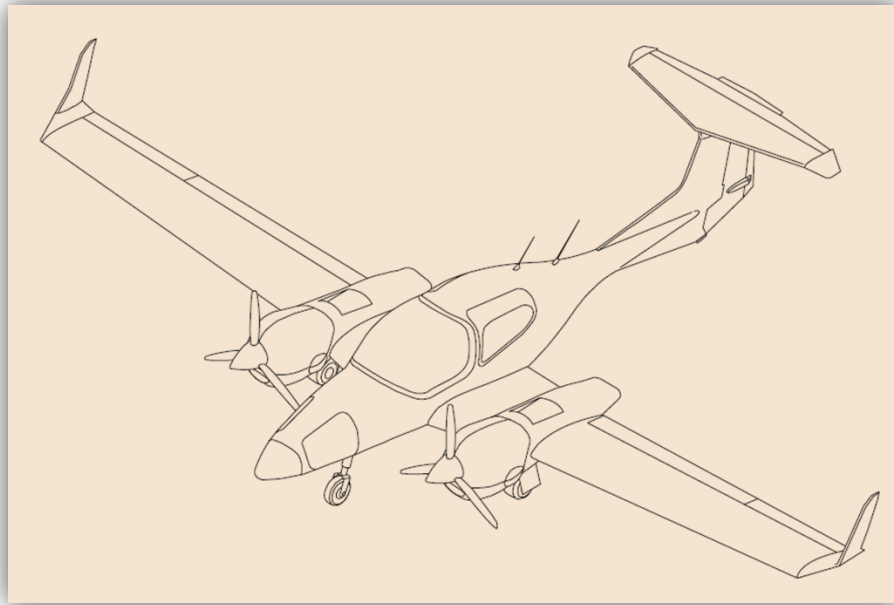
1.5.1. Both FI and the SP held current licences and medical certificates at the time of the event

## 1.6 Aircraft information

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1.6.1 The aircraft concerned is a Diamond DA42NG Twin Star, manufactured by Diamond Aircraft Industries, Austria.

1.6.2 The DA 42 NG is a twin-engine, four seat, low wing mono-plane. It has a cantilever wing and a 'T' tail. The airplane structure is fiber reinforced plastic composite.



Picture 4 DA42NG Twin Star General Configuration

### 1.6.3 Passenger Door - description

The one-piece canopy has a large quantity of wrap-around glazing. This gives a good all-round view from the cockpit. A glazed rear passenger door on the left side of the airplane gives access to the rear seats. The passenger door lifts up to give good access and is supported in the open position by a gas strut.

1.6.4 The aircraft was airworthy at the time of the accident.  
GCAA Airworthiness certificate was revalidated on 29 April 2012.

1.6.5 Aircraft Information

Type	Diamond DA42NG Twin Star
Registration	A6-HIC
S/N	42N045
State of Design	Austria
State of Manufacture	Austria
Year manufactured	May 2011
Engine	Austro Engine E4/AE300

Table 2 Aircraft Information

1.6.6 Cockpit Systems

The DA 42 NG has a full range of flight instruments contained in an integrated cockpit system (ICS).

The ICS has 2 display screens. Both of them are able to show all the airplane flight instrumentation data, navigation data, engine data and other airplane system data.

The ICS also displays all the airplane warnings, cautions and alerts.

The ICS can also be configured to show ground and flight check lists.

1.6.7 Door Handle and Latching System

The passenger door is a CFRP moulding with inner and outer frames. The frames bond together with thickened resin.

Each part of the frame has layers of carbon cloth and one layer of glass cloth. Areas of high stress have extra layers of carbon cloth. Mounting bushes for the locking bolts bond to the inside of the frame with thickened resin.

The door has an acrylic glass window. A special flexible adhesive bonds the window to the door frame.

A flexible filler seals the small gap between the edge of the window and the frame.

Two hinges attach the door to the top of the fuselage near the centre-line. The hinges bolt to the door frame.

The front hinge can be removed from inside of the cabin in an emergency. With the front hinge removed, the passenger door can be forced open from the top.

A gas strut attaches to a bracket at the rear of the door and to the fuselage. The gas strut holds the door open.

→ A door unlocked warning caption on the ICS display operates when the door is unlocked.

A handle on the left of the door operates two locking bolts. The locking bolts are at the bottom front and rear corners of the door.

The handle has two parts. The inner handle is red and has a double lever. The outer handle is red and attaches to the inner handle with two roll pins.



Picture 5 Pax Door External Handle/Latch

A long connecting rod attaches to the rear of the double lever.

The other end of the long connecting rod attaches to the inside of the rear locking bolt.

A safety lock is fitted to prevent accidental movement of the handle.

You must lift the safety handle before you can operate the red handle from inside the passenger compartment. To operate the red handle from the outside you must push the button next to the red handle to lift the inner safety lock.

A short connecting rod attaches to the front of the double lever. The short connecting rod goes to the front locking bolt. If you pull the canopy handle away from the canopy frame, these things happen:

- The double lever turns to pull the both of the connecting rods.
- The long connecting rod pulls the rear locking bolt forward.
- The short connecting bolt pulls the front locking bolt aft. The aft movement of the locking bolt operates a micro switch for the warning caption located on the ICS.

The door can be pushed up and out to open. With the door fully closed, push the door handle towards the door frame. This engages the locking bolts in the fuselage holes. The forward locking bolt operates the door unlocked micro switch. When the handle is flush with the door frame, the door is locked.

Push outwards on the bottom of the door frame to make sure that it is locked. A key operated lock can be used to secure the door in the closed position when the airplane is parked.

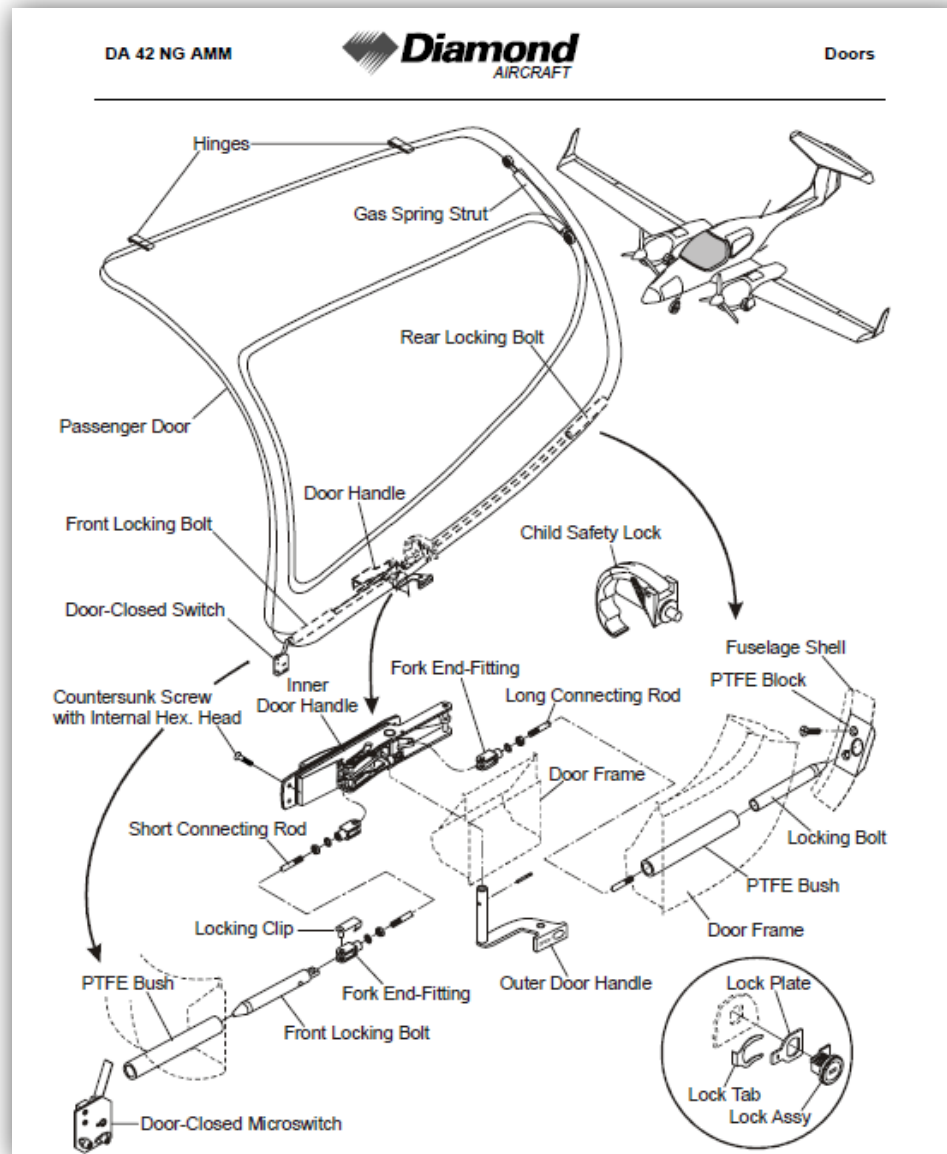


Figure 1 Rear Passenger Door Latching System

1.6.8 Airworthiness Directive [AD] 2010-0235R1 - Rear Passenger Retaining Bracket Replacement was incorporated during factory manufacture of this aircraft

1.6.9 Doors – Rear Passenger Door Retaining Bracket – Replacement

AIRWORTHINESS DIRECTIVE - AD No.: 2010-0235R1

Since 2004, more than 30 reports have been received of in-flight loss of a rear passenger door on Diamond aeroplanes, the majority of which were DA 40. In addition, at least 18 doors have been replaced because of damage found on the hinge.

Diamond Aircraft Industries conducted analyses and structural tests to determine the root cause of the door opening in flight.

The conclusions were that the primary locking mechanism provided adequate strength to react to the loads in flight.

It was also determined that the root cause was the crew not properly securing the rear passenger door by the main locking mechanism, prior to flight.

Damage to the hinges has been caused primarily by external loads (wind gust conditions) while the aeroplane was parked.

All DA 40 and DA 42 aeroplanes have a system installed that provides a warning if the main door latch is not fully closed and a secondary safety latch (with retaining bracket) design feature.

The initial intended design function of this latch was to hold the rear passenger door in the "near closed" position

while on the ground, protecting the door from wind gusts. However, the original retaining bracket Part Number (P/N) DA4-5200-00-69 might not hold the door in this "near closed" position while in flight.

To address this problem, DAI have designed an improved retaining bracket, P/N DA4-5200-00-69-SB,

which has been satisfactory tested to hold the door closed in flight. In addition, DAI have revised the Airplane Flight Manual (AFM) emergency door unlocked/open procedure.

This condition, if not corrected, could result in the rear passenger door opening and departing the aeroplane in flight.

For the reasons described above, this AD requires implementation of amendment of the AFM procedures for flight with the door unlocked/ open, and replacement of the passenger door retaining bracket with an improved part.

This AD has been revised to specify that the use of the latest revision of the applicable AFM, if properly revised, is acceptable to comply with the AFM update requirements of this AD.

### 1.6.10 Crew Alerting System [CAS]

The DA42NG Twin Star has a Crew Alerting System to advise both visually and audibly if the doors are open and unlocked.

Door Open Warning Caution and Alerting System, Diamond DA42NG Twin Star:  
Warning Alerts on the G1000 are as follows:

#### WARNING, CAUTION AND ADVISORY MESSAGES

Crew Alerting System (CAS) - The G1000 crew alerting system (CAS) is designed to provide visual and aural alerts to the flight crew.

Alerts are divided into three levels as follows:

- **WARNING**
- **CAUTION**
- **ADVISORY**

Alert Levels, Level Text Color Importance & Audible Tone:

- Warning indicator text which is **Red** may require immediate corrective action
- Warning chime tone which repeats without delay until acknowledged by the crew

DOOR OPEN	The annunciation is used to indicate to the pilot if the baggage-, canopy- or rear door is open.
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- The Primary Flight Display has a door open warning<sup>4</sup>
  - A red door warning message on the PFD
- Audible Alarm through the cockpit speaker and the headset if connected
  - An audible alarm

Crew alerts will appear in the alerts window on the PFD. In this window warnings will appear at the top, followed by cautions and advisories, respectively.

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<sup>4</sup> See Picture 6



Picture 6 Primary Flight Display ICS Crew Alerts

Within the criticality levels, messages will appear from newest (top) to oldest (bottom).

At the low right corner of the display there is a MSG (message) soft key.

The MSG key provides two functions in the CAS:

1. Pressing the MSG key acknowledges a new master warning / caution / advisory indication.
2. An additional MSG key press with no master alert indication active will open a pop-up auxiliary flight display (AFD) page that contains information for all active alerts.

This structure allows the crew to scroll through all system alerts if the alerts window overflows.

This approach displays the most critical alerts close to the pilot's primary field of view at all times, with the option of allowing lower criticality alerts to overflow and be accessible from the pop-up AFD page/window.

1.6.11 Emergency Checklists – Doors Open

inadvertent door opening is covered in the DA42NG Emergency Checklist and Abnormal Checklist, operators Emergency Procedures/Emergency Checklists.

Several examples of rear passenger doors opening inflight has been addressed by the manufacturer through an Airworthiness Directive [AD] 2010-0235R1.

Following a root cause analysis of the door separation causal mechanism, the manufacturer has determined an Emergency Checklist for: Door Open

1.6.12 Manufacturers Emergency Checklist:

The Rear Passenger Door checklist specifies reducing the speed to  $\leq 140$  KIAS with a specific instruction to the crew 'do not try to lock the door in flight'

**DOOR OPEN** **UNLOCKED DOORS**

- Reduce airspeed immediately
- Check canopy visually
  - If open:
    - ⇒ airspeed below 140 KIAS, land at nearest suitable airfield
- Check rear door visually
  - If open:
    - ⇒ airspeed below 140 KIAS, land at nearest suitable airfield
    - ⇒ do not try to lock door in flight
- Check front baggage doors visually
  - If one or both open:
    - ⇒ reduce airspeed to keep door(s) in stable position, land at nearest suitable airfield

Figure 2 Manufacturers Emergency Checklist AFM

1.6.13 Operators Emergency Checklist – Door Open: Unlocked Doors

**Door Open** ----- **UNLOCKED DOORS**

1. Reduce airspeed
2. Check canopy and rear door visually
3. If unable to latch
4. Land ASAP
5. Check front baggage doors visually
6. If one or both open Land ASAP

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Figure 3 Operators Emergency and Abnormal Short Checklist

## 1.7 Meteorological information

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1.7.1. Meteorological Information for Al Ain International Airport [OMAL] 04 September 2012 was as follows:

Time 00:00-06:00 UTC<sup>5</sup> on October 12 for OMAL [Al Ain].

### **METAR/SPECI OMAL for 12th October 2012**

201210120000 METAR OMAL 120000Z 03006KT 3000 HZ NSC 23/21 Q1012 A2990=  
201210120100 METAR OMAL 120100Z 04006KT 3500 HZ NSC 23/20 Q1013 A2991=  
201210120200 METAR OMAL 120200Z 04007KT 5000 HZ NSC 23/20 Q1013 A2992=  
201210120300 METAR OMAL 120300Z 05004KT 5000 HZ NSC 25/19 Q1014 A2994=  
201210120400 METAR OMAL 120400Z 04007KT 5000 HZ NSC 26/19 Q1014 A2996=  
201210120500 METAR OMAL 120500Z 04006KT 8000 NSC 31/16 Q1014 A2996=  
201210120600 METAR OMAL 120600Z 36004KT 320V030 CAVOK 34/06 Q1014 A2996=

### **TAF OMAL for 12th October 2012**

201210112300 TAF OMAL 112300Z 1200/1306 05006KT 4000 HZ NSC  
PROB40 1201/1205 VRB02KT 0200 FG VV///  
BECMG 1204/1206 8000 NSW  
BECMG 1208/1210 32012KT  
BECMG 1218/1220 09007KT=  
201210120500 TAF OMAL 120500Z 1206/1312 05006KT 8000 NSC  
BECMG 1208/1210 32012KT  
BECMG 1218/1220 09007KT  
BECMG 1308/1310 30011KT=

## 1.11 Flight Recorders

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1.11.1. No data recorders are required to be carried on this aircraft

## 1.12 Wreckage and Impact Information.

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- 1.12.1. The rear passenger door was recovered from the desert adjacent to the active runway, relatively intact with door edge damage due to the ground contact
- 1.12.2. The upper hinges for the rear passenger door has damage consistent with failure beyond limit load
- 1.12.3. The door support/gas operated strut retainer had failed under load.
- 1.12.4. There was an impact damage line abrasion/scuff mark on the top surface of the fuselage consistent with the angle of elevation of the pax door as it was lifted due to the aerodynamic loads and the door hinge geometry. The abrasion line indicates the door elevation restraint mechanism - the gas sprung strut – had failed.<sup>6</sup>

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<sup>5</sup> Add +4 hours for Gulf Standard Time [GST]

<sup>6</sup> It is not the design function of the gas sprung strut to prevent the door opening, it is to support the door open under normal ground operating conditions

### **1.13 Medical and Pathological Information.**

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1.13.1. GCCA regulations dictate a post-incident/accident medical is completed with screening for alcohol and drugs. This has been completed.

### **1.14 Fire**

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1.14.1. There was no serious incident fire resulting from the door separation.

### **1.15 Survival Aspects**

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1.15.1. The rear passenger door separation and the potential for empennage contact is under investigation to determine the risk and safety case

1.15.2. The high engine power demands with a passenger door missing as reported in the instructor's statement will be investigated for control and stability limitations, in particular how this relates to the operating environment of the UAE with seasonal high density altitudes and if any performance limitations for abnormal flight conditions can be identified.

### **1.18. Additional Information**

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Similar Serious Incidents involving inflight rear passenger door separation of Diamond DA42NG Twin Star passenger door

- Since 2004, more than 30 reports have been received of in-flight loss of a rear passenger door on Diamond aeroplanes, the majority of which were DA 40. In addition, at least 18 doors have been replaced because of damage found on the hinge.
- Diamond Aircraft Industries conducted analyses and structural tests to determine the root cause of the door opening in flight. The conclusions were that the primary locking mechanism provided adequate strength to react to the loads in flight. It was also determined that the root cause was the crew not properly securing the rear passenger door by the main locking mechanism, prior to flight. Damage to the hinges has been caused primarily by external loads (wind gust conditions) while the aeroplane was parked.
- All DA 40 and DA 42 aeroplanes have a system installed that provides a warning if the main door latch is not fully closed and a secondary safety latch (with retaining bracket) design feature. The initial intended design function of this latch was to hold the rear passenger door in the "near closed" position while on the ground, protecting the door from wind gusts. However, the original retaining bracket Part Number (P/N) DA4-5200-00-69 might not hold the door in this "near closed" position while in flight. To address this problem, DAI have designed an improved retaining bracket, P/N DA4-5200-00-69-SB, which has been satisfactory tested to hold the door closed in flight. In addition, DAI have revised the Airplane Flight Manual (AFM) emergency door unlocked/open procedure.
- This condition, if not corrected, could result in the rear passenger door opening and departing the aeroplane in flight.

## **Final Report Notification**

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- i 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.
- ii These will be detailed in the Final Investigation report which will be published within one year of the accident

## **GCAA Investigation General Information**

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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](mailto: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 Inspector (24/7) on this number **+971506414667** immediately.