Air Accident Investigation Unit Ireland

SYNOPTIC REPORT

SERIOUS INCIDENT
DHC 6-300, C-GSGF
Weston Airport, Co. Kildare
15 August 2015

An Roinn Iompair Turasóireachta agus Spóirt

Department of Transport, Tourism and Sport

Foreword

This safety investigation is exclusively of a technical nature and the Final Report reflects the determination of the AAIU regarding the circumstances of this occurrence and its probable causes.

In accordance with the provisions of Annex 13[1] to the Convention on International Civil Aviation, Regulation (EU) No 996/2010[2] and Statutory Instrument No. 460 of 2009[3], safety investigations are in no case concerned with apportioning blame or liability. They are independent of, separate from and without prejudice to any judicial or administrative proceedings to apportion blame or liability. The sole objective of this safety investigation and Final Report is the prevention of accidents and incidents.

Accordingly, it is inappropriate that AAIU Reports should be used to assign fault or blame or determine liability, since neither the safety investigation nor the reporting process has been undertaken for that purpose.

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[1] **Annex 13**: International Civil Aviation Organization (ICAO), Annex 13, Aircraft Accident and Incident Investigation.
[2] **Regulation (EU) No 996/2010** of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation.
[3] **Statutory Instrument (SI) No. 460 of 2009**: Air Navigation (Notification and Investigation of Accidents, Serious Incidents and Incidents) Regulations 2009.

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In accordance with Annex 13 to the Convention on International Civil Aviation, Regulation (EU) No 996/2010 and the provisions of SI 460 of 2009, the Chief Inspector of Air Accidents on 15 August 2015, appointed Mr Paul Farrell as the Investigator-in-Charge to carry out an Investigation into this Serious Incident and prepare a Report.

Aircraft Type and Registration:	DHC6-300, C-GSGF	
No. and Type of Engines:	2 x Pratt & Whitney Canada PT6A-27	
Aircraft Serial Number:	642	
Year of Manufacture:	1979	
Date and Time (UTC)[4]:	15 August 2015 @ 07.52 hrs	
Location:	Weston Airport, Co. Kildare	
Type of Operation:	Aerial Work	
Persons on Board:	Crew - 2	Passengers - 1
Injuries:	Crew - 0	Passengers - 0
Nature of Damage:	Minor damage to mission equipment pod and pod nose cone	
Commander's Licence:	Airline Transport Pilot Licence (ATPL), issued by Transport Canada	
Commander's Details:	Male, aged 46 years	
Commander's Flying Experience:	7,180 hours, of which approximately 1,200 were on type	
Notification Source:	Duty Manager, Dublin Air Traffic Control (ATC)	
Information Source:	AAIU Report Form submitted by Pilot AAIU Field Investigation	

[4] **UTC**: Co-ordinated Universal Time. All timings in this report are quoted in UTC; to obtain the local time add one hour.

SYNOPSIS

On take-off from Weston Airport (EIWT), Co. Kildare the nose cone from the right hand mission equipment pod fell from the aircraft, which was carrying out a survey flight. The Flight Crew experienced a significant amount of yaw to the right which they felt through the flying controls. The aircraft diverted to Dublin Airport (EIDW) where it subsequently landed safely. There were no injuries.

1. FACTUAL INFORMATION

1.1 History of the Flight

The aircraft, which was on an Aerial Work, geological survey flight, departed EIWT at 07.50 hrs. Just after take-off, EIWT tower advised the aircraft that it appeared that the nose cone had fallen from the aircraft. The Flight Crew checked the aircraft and realised that the nose cone which had been reported falling from the aircraft had come from the right hand Electro Magnetic (EM) pod fitted to the tip of the right wing. The Flight Crew levelled the aircraft at 1,500 feet (ft) at which time they noted that aircraft control was being adversely affected by a significant amount of yaw to the right; this effect was felt through the flight controls. The Flight Crew transmitted a "PAN"[5] call and advised EIWT Tower that they would like to divert to EIDW. The aircraft was transferred to Dublin ATC and was cleared to land on RWY 28. On landing the aircraft was met by Airport Fire Service vehicles and was escorted to a parking location.

1.2 Pilot Interview

The Pilot In Command (Commander) informed the Investigation that a normal take-off was completed from RWY 25 at EIWT at 07.50 hrs with the Co-Pilot as the pilot flying (PF) and the Commander as the pilot not flying (PNF). At approximately 200 ft Above Ground Level (AGL), a right turn was initiated as per noise abatement procedures and at the same time EIWT ATC transmitted "*Survey One, you appear to have lost your nose cone*."

The Commander reported to the Investigation that the aircraft was "*in a climb configuration at approximately 90 knots (kts) Indicated Airspeed (IAS) and flaps extended to 10 degrees. No adverse flight characteristics were noticed by the PF at this time*." According to the Commander, the Flight Crew quickly realised that the nose cone that had become detached was in fact the right hand EM pod nose cone and he "*assumed control at 1100' ASL*[Above Sea Level]*. With the aircraft level at 1500' ASL …".* The Commander said that *"aircraft control had depreciated significantly and a great deal of yaw towards the missing nose cone could be felt in the flight controls*." The Commander decided that "*instead of making a right hand turn to land at Weston* [he] *would carry on straight and level try and sort out the controllability issues*". Following a brief discussion between the Flight Crew, a PAN call was made and the Co-Pilot advised EIWT ATC that they wanted to divert to EIDW for landing.

[5] **PAN**: In accordance with ICAO Annex 10, Volume II, the words "PAN PAN", repeated three times, are used at the commencement of an urgent radiotelephony communication.

The Commander's rationale was that the EIDW runway was longer, fire and rescue services were more comprehensive and that "*only making a left turn from downwind to final would be advantageous*". At this time the Flight Crew was instructed to switch to the EIDW frequency. The Commander said that the Flight Crew discussed the possibility of applying an emergency checklist to the situation, but concluded that a checklist specific to this situation did not exist. The Commander said that "*the flaps were left extended to 10 degrees, the propellers in the minimum position, and power levers were set in a split configuration so as to compensate for the yaw created by the open pod. Normal descent and pre-landing checklists were completed and it was discussed that a higher than normal approach speed would be used due to the uncertainty of the missing nose cone's effect on stall speed, etc. The crew was advised to secure all loose items and that seat belts should be tightened.*" The Commander went on to say that "*The aircraft landed at 08.01 hrs without incident at Dublin International and taxied to parking under escort of emergency vehicles. No injuries to the crew or further damage to the aircraft occurred*".

1.3 Aircraft Description

The aircraft was a de Havilland Canada, DHC 6, Twin Otter, Series 300, powered by two 680 shaft horsepower (SHP) Pratt & Whitney Canada PT6A-27 turboprop engines each driving a Hartzell three-blade propeller.

The aircraft had been fitted with a Geophysical Survey Installation in accordance with a Transport Canada approved Supplemental Type Certificate (STC) No. O-LSA11-155. This STC includes an Airplane Flight Manual Supplement (AFMS) No. SGL1298, Rev. A, dated 4 September 2014. This STC involves the installation of, *inter alia*, a wingtip mounted, EM pod containing sensor equipment and wiring (**Figure No. 1**).

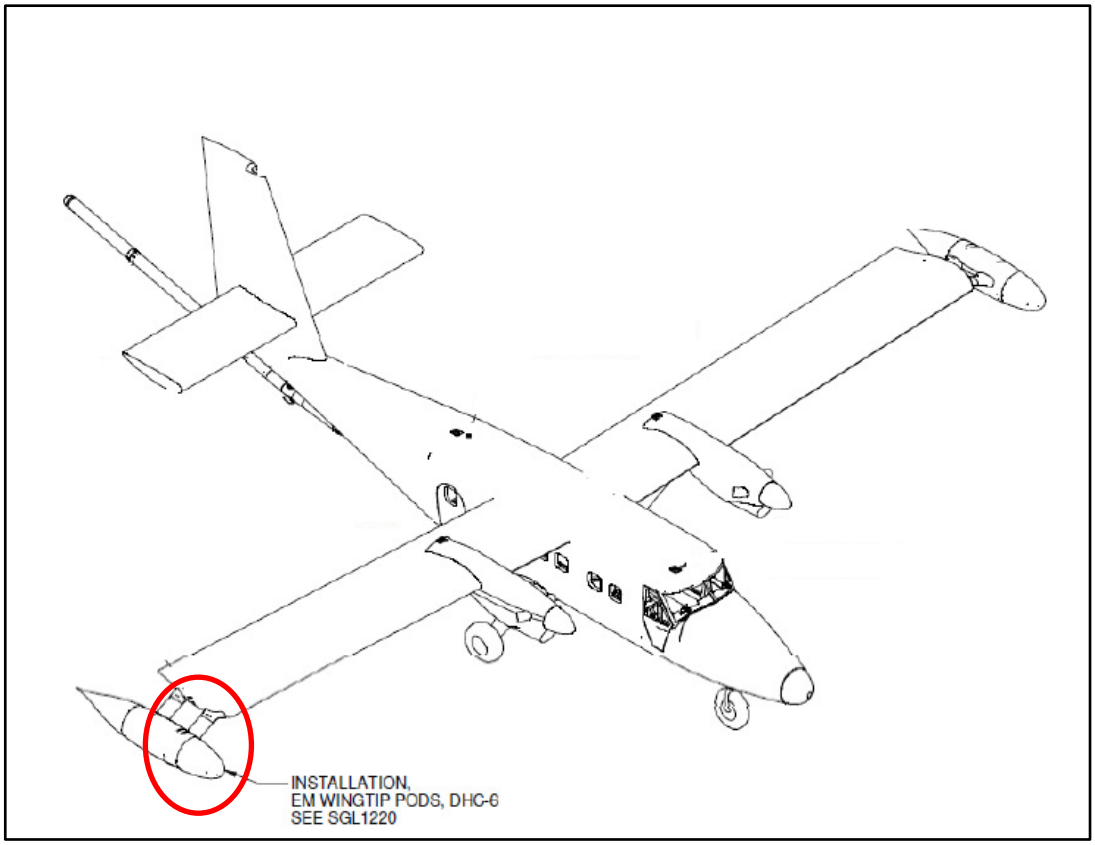

Figure No. 1: Aircraft schematic showing the EM pod installation, nose cone circled in red.

1.4 Maintenance

On 14 August 2015, the day before the event, in accordance with the maintenance instructions prescribed in the STC, the aircraft underwent a 125 hour Supplementary Inspection. This inspection called, *inter alia*, for the removal of "*the EM pod nose and tail cones*" and inspection of "*the pod internal frames for cracks or other damage*". The personnel who carried out this check advised the Investigation that the Operator's standard practice calls for the fitting of flagging tape when parts are removed and that the flagging tape should only be removed following re-installation of the removed part(s). On this occasion the personnel involved advised the Investigation that flagging tape was not fitted.

It was reported that during the EM Pod maintenance, while the nose cone was being re-installed, a fault was detected with its sensor system. Re-installation of the nose cone was halted pending identification of the cause of the fault and consequently only the top two nose cone retaining screws were re-installed. Troubleshooting subsequently traced the origin of the sensor problem to a location inboard of the pod and the fault was rectified. The Inspection was then completed but the 14 remaining nose cone retaining screws were not re-installed.

Following the event, the nose cone which had been retrieved at EIWT was inspected and it was noted that two of the retaining screw holes had been torn through (**Photo No. 1**).

Photo No. 1: Nose cone with two retaining screw holes torn through.

The Investigation noted the presence on the matching surface of the aircraft pod of two retaining screws and the torn out material. The Investigation further noted that the two screws which were installed were positioned at the twelve-o-clock position/top of the EM pod (**Photo No. 2**), and as such could not be seen from the ground when the nose cone was installed.

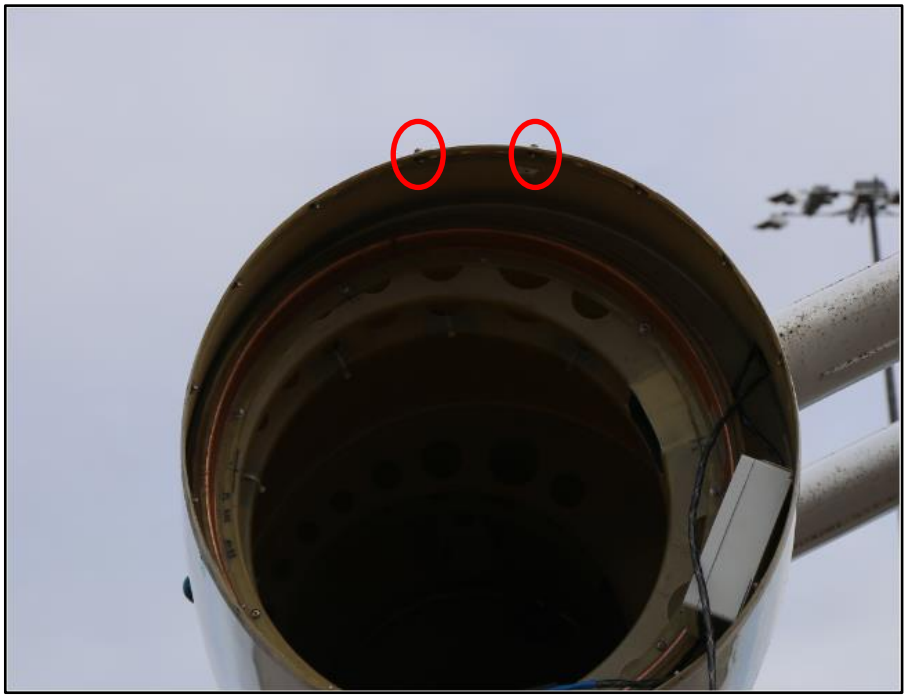

Photo No. 2: Two top screws installed on EM Pod.

The missing screws were located in a container at the Operator's maintenance facility (**Photo No. 3**).

Photo No. 3: Missing nose cone retaining screws as located at the Operator's premises at EIWT.

1.5 Pre-flight Inspection

1.5.1 Commander

The Commander reported that the *"First Officer did a walkaround*[6]" and "*two engineers at Weston did a walkaround*" while the Commander was talking to two ATC units for flight planning. When the Commander came out to the aircraft he was advised by the engineers that they had carried out an inspection on the airframe on the previous day so he "*looked over*" the engines and the airframe. The Commander said that he "*had a cursory look at the pods but there's not any moving parts on the pods. I had a cursory look at the pods probably from about fifteen feet ahead of the pods and from my vantage point I didn't notice anything unusual*". As the Commander got closer to the wing he said that both engineers approached him to brief him on tests that "*they wanted to run prior to the aircraft departing*"; this took the form of a briefing underneath the right hand pod when the Commander was "*a third into*" his walkaround, after which the Commander continued with his walkaround "*looking at the tyres, the surfaces, the engines, those sort of things*".

1.5.2 Co-pilot

The Co-pilot confirmed that he had completed a separate walkaround of the aircraft and that he had not noticed anything untoward about the EM pod nose cone.

1.5.3 Maintenance Engineers

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The two maintenance engineers who were responsible for the maintenance carried out on the previous day also carried out a pre-flight check of the aircraft on the morning of the event. The Investigation noted that the Aircraft Technical Logbook (ATL) entry simply stated "*Supplemental Inspection 125 Hr requirements carried out as per MSA PAH-6656-DHC-6 – Satisfactory*". The engineers informed the Investigation that it would not have been clear to the pilots from the ATL that the EM pod nose cone had been removed.

1.5.4 Prescribed Requirements

AFMS No. SGL1298 prescribes, *inter alia*, the preflight Inspections to be carried out on the EM Pods. Of particular relevance to this Investigation is the requirement to "*check that all visible attaching fasteners are installed and secure*".

1.6 Human Factors Training

All personnel who completed walkaround inspections on the morning of the event had completed a third party, computer based Aviation Maintenance Human Factors courses which met the mandatory element of the maintenance training requirement as stipulated in standards 426.45, 573.06 and 726.12 of the Canadian Aviation Regulations. The Operator advised the Investigation that the training syllabus includes:

[6] **Walkaround**: This term describes an inspection of the aircraft, primarily visual in nature, which is accomplished by the relevant person while they are walking around the outside of the aircraft. The term is often used to describe pre-flight inspections.

- Error Management
- Human Performance
- Organizational Failures
- Dirty Dozen Factors
  - Fatigue
  - Distractions
  - Stress
  - Pressure
  - Norms
  - Complacency
  - Lack of teamwork
  - Lack of Resources
  - Lack of Knowledge
  - Lack of Communication
  - Lack of Assertiveness
  - Lack of Awareness

1.7 Changes since the Event

The Operator informed the Investigation that at the time of the event the use of flagging tape was a standard practice but was not in the Operator's Policy Manual.

Since the event the Operator's Policy Manual has been updated to include a documented policy mandating the use of flagging tape and also of cloth bags to hold hardware that are attached to the parent component to aid as a visual cue.

The Operator issued a maintenance memorandum requiring all attaching hardware to be painted the same colour as its background. The Operator believes that this will provide an enhanced visual cue in the event of required hardware not being installed.

The Operator also informed the Investigation that it is in the process of building its own Human Factors (HF) course with details and content tailored to the Operator's specific roles and aircraft. Further they stated that this internal course will include more case studies of actual Operator events and scenarios likely to be encountered by its pilots and maintenance personnel.

1.8 Human Factors

"*Confirmation Bias*" is a known, subconscious behaviour whereby humans seek and "*see*" evidence that supports their own belief. In aircraft maintenance, personnel who believe that they have completed a task correctly may, due to confirmation bias, not notice visual cues which would suggest otherwise, or which they might notice if they did not have confidence that the task had been completed correctly.

"*Habituation*" is the response of a human to a stimulus which they experience repeatedly and whose effect on them is unremarkable either in a good or bad way. Habituation is a natural way for our brains to separate (filter) the matters which demand our attention (because they are of critical significance), from those which don't (because they are not critically significant). In aviation maintenance, where certain checks e.g. a daily walkaround inspection, are repeated frequently without any findings of significance, it is possible for the individual carrying out the checks to become habituated and this may compromise their ability to detect an anomalous condition. Habituation can lead to items of significance which the eye "*detects*" not being "*perceived*" by the brain as something warranting further action.

"*Distraction*" and "*Interruptions*" during an inspection upset the work flow and concentration of the person doing the inspection and can cause items to be missed or not properly considered during an inspection.

Visual detection of an installation error is often accomplished by identifying and noting something which stands out from its surroundings; for example, if six bolts secure a housing and only five are installed an observer will usually notice the vacant hole which "*stands out*" amongst the other five, installed bolts. In the case of the nose cone, none of the screws in the fourteen positions which are visible from the ground had been installed. Consequently, all the holes visible from the ground would have "*looked the same*" even though fourteen screws were missing.

2. ANALYSIS

When the nose cone was being refitted during maintenance the installation process was stopped for troubleshooting reasons and consequently the re-installation of all retention screws was not completed. When a maintenance task is interrupted in this way the risk of an installation error is increased. Furthermore, the Operator's standard practice of attaching flagging tape to indicate that parts had been removed and re-installation was not followed. Such flagging tape, had it been fitted, would not have been removed until all screws had been correctly re-installed and its continued presence may have alerted maintenance personnel to the incomplete re-installation procedure.

The initial maintenance error was not detected during separate walkaround inspections by engineering personnel, the Co-Pilot and the Commander. All personnel who completed walkaround inspections on the morning of the event had completed computer based Aviation Maintenance Human Factors courses which met the mandatory element of the maintenance training requirement as stipulated in standards 426.45, 573.06 and 726.12 of the Canadian Aviation Regulations.

The AFM Supplement requires personnel to "*check that all visible attaching fasteners are installed and secure*". However the Investigation notes that the two screws which were installed, at the top of the nose cone, would not be visible from the ground. With none of the "*visible*" screws installed, someone viewing the nose cone from the ground would not have noticed any difference between adjacent holes on the nose cone even though fourteen screws were missing.

"*Confirmation bias*" may have compromised the technical personnel's walkaround inspection since they believed that they had correctly re-installed the nose cone on the day prior to the event. "*Habituation*" may have played a role in compromising all the walkaround inspections as those involved were used to inspecting the EM pods and not finding any anomalies. Finally, the Commander's report that as he got closer to the wing both engineers approached him for a briefing underneath the right hand pod "*a third into*" his walkaround, may have been an "*interruption*"/"*distraction*".

In light of the fact that three walkaround inspections by three different persons, all of whom had completed appropriate Human Factors training, did not detect the missing screws, and given the range of human factor issues which may have played a role in compromising the various walkaround inspections, the Investigation makes the following Safety Recommendation to the Operator:

Safety Recommendation No. 1

Sander Geophysics should ensure that Human Factors training includes a case study on this event and specific information on confirmation bias, habituation, interruptions and distractions.

(**IRLD2016001**)

The Investigation notes the Flight Crew's comments that they "*discussed the possibility of applying an emergency checklist to the situation, but concluded that a checklist specific to this situation did not exist*." The Investigation's Draft Report included a proposed Safety Recommendation to Transport Canada in this regard. In response to the proposed Safety Recommendation Transport Canada stated:

> *Transport Canada has not provided Aircraft Flight Manual (AFM) procedures that cater to structural failures resulting from maintenance. Transport Canada meets requirements as detailed in the Airworthiness Standard for AFMs and include emergency procedures based on the system safety analysis and probable system failures. Including procedures for all potential issues related to improper maintenance is considered inappropriate.*

The Operator was also not in favour of a Safety Recommendation in relation to this issue. However, the Operator does "*propose amending our training curriculum to include details of what occurred in this incident and what techniques were effective in this case*".

In light of the responses received from Transport Canada and the Operator, and given that the Operator proposes to provide training and information to crews in relation to the techniques that were found to be effective by the Flight Crew involved in this event, the Investigation is not making a Safety Recommendation in relation to this matter.

3. CONCLUSIONS

(a) Findings

1. The right hand EM pod nose cone separated from the aircraft shortly after take-off from EIWT.

2. The Flight Crew experienced significant yaw to the right which they could feel through the flight controls.

3. The AFM supplement for the EM pod STC did not contain a Flight Crew checklist or procedure to be followed in the event that an EM pod nosecone was lost.

4. The Flight Crew made a PAN call, diverted to EIDW and landed safely.

5. The aircraft underwent maintenance on the day before the event which involved removal of the right hand EM nose cone.

6. The Operator's standard practice for removed parts was not followed and flagging tape was not used to indicate that parts had been removed and re-installation had not been completed.

7. Only two of the nose cone retaining screws were re-installed and the nose cone material failed at these two points.

8. None of the personnel who carried out a walkaround inspection noted that the screws were missing from the right hand EM pod nose cone.

9. All personnel who completed walkaround inspections on the morning of the event had completed computer based Aviation Maintenance Human Factors courses which met the mandatory requirements of the Canadian Aviation Regulations.

10. The Operator has instituted changes in maintenance policy and practice, and is instituting changes in HF training, to address issues arising from this event.

(b) Probable Cause

1. The right hand side EM pod nose cone was not properly re-installed after the 125 hr Supplementary Inspection.

(c) Contributory Cause(s)

1. The Operator's standard practice of attaching flagging tape to highlight when components are removed during maintenance was not followed.

2. None of the personnel who carried out a walkaround inspection noted that the screws were missing from the right hand EM pod nose cone.

4. SAFETY RECOMMENDATIONS

No.	It is Recommended that:	Recommendation Ref.
1.	Sander Geophysics should ensure that Human Factors training includes a case study on this event and specific information on confirmation bias, habituation, interruptions and distractions.	IRLD2016001

View Safety Recommendations for Report 2016-002

- END -

In accordance with Annex 13 to the Convention on International Civil Aviation, Regulation (EU) No. 996/2010, and Statutory Instrument No. 460 of 2009, Air Navigation (Notification and Investigation of Accidents, Serious Incidents and Incidents) Regulation, 2009, the sole purpose of this investigation is to prevent aviation accidents and serious incidents. It is not the purpose of any such investigation and the associated investigation report to apportion blame or liability.

A safety recommendation shall in no case create a presumption of blame or liability for an occurrence.

Produced by the Air Accident Investigation Unit

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