

**Air Accidents Investigation Branch**

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Department of the Environment, Transport and the Regions

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**Report on the incidents to  
HS748-2A, G-BIUV and G-BGMO  
on approach to Isle of Man (Ronaldsway) Airport  
on 6 June 1998**

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This investigation was carried out in accordance with  
*The Civil Aviation (Investigation of Air Accidents and Incidents) Regulations 1996*

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**Department of the Environment, Transport and the Regions**  
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18 January 2000

*The Right Honourable John Prescott MP*  
*Secretary of State*  
*for the Environment, Transport and the Regions*

Sir,

I have the honour to submit the report by Mr M M Charles, an Inspector of Air Accidents, on the circumstances of the incidents to HS748-2A, G-BIUUV and G-BGMO, on approach to Isle of Man (Ronaldsway) Airport on 6 June 1998.

I have the honour to be  
Sir  
Your obedient servant

**K P R Smart**  
Chief Inspector of Air Accidents

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## GLOSSARY OF ABBREVIATIONS USED IN THIS REPORT

AAIB	-	Air Accidents Investigation Branch	MAPt	-	Missed Approach Point
ADF	-	Automatic Direction Finder	mb	-	Millibars
AIC	-	Aeronautical Information Circular	MDA	-	Minimum Descent Altitude
AOC	-	Air Operator's Certificate	MDH	-	Minimum Descent Height
ATIS	-	Automatic Terminal Information Service	METAR(s)	-	Aviation routine weather report
ATSU	-	Air Traffic Services Unit	MHz	-	Megahertz
CAA	-	Civil Aviation Authority	NDB	-	Non-Directional Beacon
CAP	-	Civil Aviation Publication	RA	-	Radio Altimeter
CFIT	-	Controlled flight into terrain	RMI	-	Radio Magnetic Indicator
CVR	-	Cockpit Voice Recorder	RVR	-	Runway Visual Range
DME	-	Distance Measuring Equipment	SDF	-	Step Down Fix
DV	-	Direct Vision	SRA	-	Surveillance Radar Approach
FAF	-	Final Approach Fix	SRE	-	Surveillance Radar Equipment
FD	-	Flight Director	TAWS	-	Terrain Awareness and Warning System
FDR	-	Flight Data Recorder	TAF(s)	-	Terminal Aerodrome Forecast(s)
FOD	-	Flight Operations Department	TGT	-	Turbine Gas Temperature
GPS	-	Global Positioning Position	TRE	-	Type Rating Examiner
GPWS	-	Ground Proximity Warning System	UTC	-	Coordinated Universal Time
ICAO	-	International Civil Aviation Organisation	VAT	-	Target threshold speed
ILS	-	Instrument Landing System	VCR	-	Visual Control Room
IRE	-	Instrument Rating Examiner	VOR	-	VHF omni-directional radio range
LED	-	Light Emitting Diode			





**G-BIUV Parked at Isle of Man Ronaldsway Airport**



**View Westwards towards the Isle of Man VOR atop Spanish Head**



**View Eastwards from VOR location towards Runway 08**

## **Air Accidents Investigation Branch**

**Aircraft Accident Report No:**            **1/2000**                            **(EW/C98/6/2)**

Registered Owner and Operator:        Emerald Airways Ltd

Aircraft Type and Model:                Hawker Siddeley 748 – 2A

Nationality:                                 British

Registrations:                              G-BIUV and G-BGMO

Place of incidents:                        Approach to Runway 08,  
Isle of Man (Ronaldsway) Airport

Latitude:                                    54° 04' North

Longitude:                                 004° 45' West

Date and Times:                            6 June 1998 at 0515 hrs and 0732 hrs

    All times in this report are UTC

### **Synopsis**

Two similar serious incidents were notified to the Air Accidents Investigation Branch (AAIB) at 0630 hrs and 0740 hrs respectively on 6 June 1998, and the investigation commenced the same day. The AAIB team consisted of Mr M M Charles (Investigator in Charge), Mr P D Gilmartin (Operations) and Mr R James (Flight Recorders).

The two serious incidents occurred as each aircraft was making an instrument approach to Runway 08 at Ronaldsway Airport, Isle of Man. Both aircraft were using the Isle of Man VHF Omni-Directional Radio Range beacon and associated Distance Measuring Equipment for lateral navigation and distance information respectively. During the course of each of the approaches, each aircraft descended very significantly below the specified descent profile while over the sea to the west of high ground at the Calf of Man and Spanish Head. There was

extensive low cloud in the area at these times and in both cases initiation of a climb to avoid possible collision with the high ground occurred once the surface and coastline had been sighted by the pilots involved.

There were no injuries and no damage was sustained to either aircraft.

This report identifies the common features of both incidents in which weather conditions, crew resource management, flight deck equipment and layout, inadequate standard operating procedures and degraded human performance factors all played a contributory part, resulting in a loss of situational awareness on the part of each handling pilot coupled with a lack of timely and effective intervention by each non-handling pilot.

In the first incident (to G-BIUV), the flight crew had not noted that the aircraft's flaps were at an inappropriate setting for the phase of flight, which resulted in a perception that the aircraft was out of trim and that it required greater than normal power settings. This situation degraded the attention paid to the instrument flying panel scan. The primary flight instruments and navigation displays fitted to this aircraft were of an outdated, basic and ergonomically disadvantageous design, which contributed to the lack of crew awareness.

In the second incident (to G-BGMO), the aircraft was flying at an inappropriate airspeed at the commencement of the turn onto the final approach track, such that it flew through the approach centreline. This resulted in additional corrective attention by the commander, coupled with the task of reducing the airspeed to allow the selection of the landing gear and approach flap within the aircraft's normal operating limitations and the initiation of the descent. The workload associated with these simultaneous tasks resulted in the commander misreading the poorly located DME indication, which caused him to believe that the aircraft was significantly closer to the runway threshold than it actually was.

Nine safety recommendations have been made.

# **1 Factual information**

## **1.1 History of the flights**

### **1.1.1 General**

The aircraft were both owned by the same operator. The company's fleet comprised some 14 HS 748 aircraft, mostly engaged in contract cargo transport operations. Two of these aircraft were configured with passenger seating and were regularly engaged in public transport passenger operations. The company frequently operated flights into the Isle of Man (Ronaldsway) Airport.

The two serious incidents that occurred on 6 June 1998 were similar in nature, each involving the aircraft descending too low whilst at a greater range from the landing runway than was appreciated by each commander at the time. Each aircraft was carrying out a non-precision approach procedure to Runway 08 in conditions of low cloud base. This report first outlines the type of approach being carried out. Detail is then presented of the relevant features of each of the two flights. Section 2 of this report presents an analysis of each event and highlights some features which were common to both incidents. The investigation also found a number of differences between the two events and these are also highlighted in the analysis.

The first incident that occurred involved G-BIUUV (freighter aircraft) which was carrying out a cargo operation from Liverpool to the Isle of Man with two crew members and some 5,100 kg of newspapers on board.

The second incident occurred some 2 hours 17 minutes later as G-BGMO (passenger aircraft) on a scheduled passenger operation from Liverpool to the Isle of Man, with two pilots, two cabin crew and 47 passengers on board, was making the same type of approach.

### **1.1.2 Isle of Man Runway 08 instrument approach procedure**

Both of the incidents occurred as the aircraft were carrying out the VOR/DME<sup>1</sup> Instrument Approach Procedure for Runway 08, which has a runway threshold elevation of 29 feet amsl. In both cases, the aircraft had been given initial radar vectoring by the Ronaldsway Approach Controller onto the final approach track of

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<sup>1</sup> Very High Frequency Omni-Directional Radio Range/Distance Measuring Equipment

085°M towards the landing runway, then lateral tracking was continued by the flight crews with reference to the VOR bearing display in each aircraft. The flight crews determined the descent profile by reference to the DME range information and the aircraft's altimeters. The crews had reference to the approach chart produced by Aerad (see Appendix A, Figure 1).

Once established within 5° of the inbound track, the procedure specified descent from 1,930 feet amsl down to a minimum of 1,430 feet amsl until the aircraft had passed over the Final Approach Fix at the VOR/DME beacon. This was a mandatory Stepdown Fix at the VOR/DME beacon. This facility is located atop the headland adjacent to Spanish Head, at the south western tip of the Isle of Man and some 4.5 nm from the touchdown threshold of Runway 08. The highest obstacle at this location is 580 feet amsl. An island, known as Calf of Man, is also in the vicinity, with ground rising to 420 feet amsl.

Having passed over the VOR/DME location at a safe altitude, the procedure permitted descent in the final approach segment towards the Minimum Descent Altitude (MDA) of 480 feet amsl, with the proviso that the aircraft should not descend below 830 feet amsl until passing 2 nm DME from the beacon (ie between the beacon and the airfield, 2.5 nm from the runway landing threshold). This position is known as a Step Down Fix (SDF). Once past the SDF, the aircraft could safely descend, clear of terrain and obstacles, to the MDA. On reaching the MDA, if the runway was not sighted by the crew, the aircraft could be flown level (but not below the MDA) until reaching the Missed Approach Point (MAPt) at 4.5 nm DME (a position which, in this case, corresponded to the runway threshold location). Approaching that position, if the crew had no contact with the landing runway or airfield environment, or the aircraft was not suitably positioned to make a landing, a decision to initiate a go-around was required in accordance with the published procedure.

### 1.1.3 G-BIUV (freighter aircraft) incident

The crew reported for duty at 2330 hrs on 5 June 1998 in order to operate four flight sectors. The first was a cargo flight from Liverpool to Belfast International Airport, then a return flight with the empty aircraft to Liverpool. The crew was then to operate another cargo flight, from Liverpool to the Isle of Man. All of these flights were planned to be flown in G-BIUV. Another aircraft, registration G-AYIM, was to be flown by the crew empty from the Isle of Man to Liverpool to complete their night's duty. The planned final arrival time at Liverpool was

0625 hrs, giving a total planned Flight Duty Period of almost 7 hours, which was within the normal 9 hour maximum specified in the company's Flight Time Limitations scheme for a four sector night duty, as detailed in the company Operations Manual. After the event, the crew's duty finished some 20 minutes later than planned.

The first round trip to Belfast passed uneventfully and on schedule, returning to land at Liverpool at 0221 hrs. The weather at Belfast at midnight was reasonable, with a surface wind from 110° at 10 kt, visibility 5,000 metres, cloud overcast base 8,000 feet, temperature +13°C, dew point +10°C, mean sea level pressure 1010 mb. Runway 07 was used for arrival, which has a VOR/DME approach procedure. The crew noted on the post-flight Journey Log that the aircraft chart library did not contain an approach chart for this procedure at Belfast. The first officer indicated that the crew had reference to his personal back-up copy of the procedure chart while making that approach.

After a break in the company's airport office crew room, the crew operated the aircraft again, departing at 0441 hrs (four minutes ahead of the planned schedule) for the cargo flight from Liverpool to the Isle of Man. Takeoff was at 0445 hrs from Runway 27 and the planned flight time was 26 minutes at a cruising level of 8,000 feet (FL80<sup>2</sup>). Another aircraft, belonging to the same operator, was preceding G-BIUV into the Isle of Man by a few minutes.

During the cruise phase, the crew recorded the 0420 hrs METAR for the Isle of Man (from the London Volmet North transmission) as surface wind 090° at 17 kt, visibility 6 km in mist, overcast cloud base 900 feet, temperature +11°C, dew point +10°C, mean sea level pressure 1009 mb.

On initial contact with Isle of Man (Ronaldsway) Approach Control at 0501 hrs, the 0450 hrs METAR was passed by the controller as surface wind from 100°M at 20 kt, visibility 5,000 metres in mist, cloud base two okta 400 feet, four okta at 600 feet and eight okta at 800 feet. The QNH<sup>3</sup> was 1008 mb and the QFE<sup>4</sup> for Runway 08 was 1007 mb, temperature +11°C.

The aircraft was offered radar vectoring in order to position it around a right-hand circuit onto a final approach for the VOR/DME procedure for landing on

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<sup>2</sup> The aircraft altimeter, when set to the standard datum pressure of 1013 mb, indicates the aircraft Flight Level.

<sup>3</sup> The aircraft altimeter, when set to QNH, indicates the aircraft altitude above mean sea level.

<sup>4</sup> The aircraft altimeter, when set to QFE, indicates the aircraft height above the airfield/runway.

Runway 08. Descent clearance followed progressively as the aircraft got closer to the airfield and with regard to the preceding aircraft, which was to carry out the same type of approach.

The operating minima were annotated on the Navigation Log as being 470 feet Minimum Descent Height (MDH) and a minimum Runway Visual Range (RVR) requirement of 1,200 metres. The company Operations Manual specified that all instrument approaches were to be carried out with the primary altimeter setting reference as airfield (or runway threshold) QFE. The correct applicable MDH was 450 feet and RVR 1,300 metres. Subsequent investigation could not determine the reference source of the incorrect MDH 470 feet entry. The 1,200 metres RVR entry was that applicable to JAR-OPS criteria, not the then current operating standard of CAP360 criteria.

In this case, the Approach controller had given G-BIUV descent clearance to a height of 1,900 feet on the right-hand downwind leg. A right turn onto a heading of 010° was given at 0511 hrs to position the aircraft on a right-hand base leg. At 0512 hrs, the aircraft was given a continuance of the right turn onto a heading of 060° in order to close the inbound radial (085°M) from the right.

At 0513 hrs, the crew reported that the aircraft was established inbound at 4 nm DME. The Approach controller confirmed that the aircraft was 8 track miles from touchdown at 0514 hrs and that it was cleared to descend with the procedure. The aircraft was then transferred to Isle of Man (Ronaldsway) Tower control. At 0514 hrs, the first officer called the Tower controller and advised him that the aircraft was descending with the procedure. The next communication occurred at 0515 hrs, when the first officer called to inform the Tower controller that the aircraft was going around.

A conversation between the Tower controller and the Approach controller took place between 0515.5 and 0517 hrs during which it was indicated that the aircraft had disappeared from primary and secondary radar cover west of the high ground at the 'IOM' VOR. No specific 'mode C' height indication was mentioned during the conversation, but the controller later reported that he had observed an indication of 300 feet climbing when radar contact was regained. It was also mentioned in the conversation that the previous landing HS 748 aircraft had also seemed low. On further enquiry, this was confirmed to have been when that aircraft was on short final approach, inside 4.5 nm from touchdown.

After G-BIUV's go-around, the controller offered to provide a Surveillance Radar Approach (SRA) but the crew declined this in favour of a second attempt at the VOR/DME procedure. The aircraft was given radar vectoring around another right-hand pattern, turning onto base leg at 0520 hrs. At 0521 hrs, the aircraft was given a right turn onto a closing heading of 060° and was cleared to intercept the final approach track from the right with 12 miles to touchdown. At 0522 hrs, the first officer reported that the aircraft was established at 4 nm DME. The controller cleared the aircraft to descend with the procedure and confirmed that the range to touchdown was 8.5 nm.

The aircraft crossed the VOR at 0524 hrs and landed uneventfully at 0528 hrs with a surface wind from 100°M at 20 kt.

As the aircraft taxied in, the Tower controller requested that, once the aircraft had parked, the crew should contact the radar controller by telephone. No such contact took place. The crew changed aircraft and operated G-AYIM uneventfully from Isle of Man to Liverpool departing at 0609 hrs.

The commander was the handling pilot for the sector. He subsequently submitted an Occurrence Report form to the operator. In this report, he stated that with the aircraft established inbound on the procedure, the approach profile required unusually high power setting with 85% trim (power), flap 15° with the landing gear up, to maintain 1,900 feet. On commencement of the descent profile, with the landing gear down, the airspeed appeared to reduce on selection of approach flap. The aircraft descended below the approach profile. Moderate turbulence was experienced. The descent profile was regained but the attitude required was considered too excessive and a go-around was initiated. The airspeed increased only slowly despite flap retraction to 15°. A turn right was initiated above 1,000 feet due to windshear. Throughout the approach, the power setting required seemed to be excessive for an airspeed of 110 kt, approaching the Turbine Gas Temperature (TGT) limit. He reported that the aircraft was in and out of low stratus cloud and that ground contact was lost near the airport due to drifting low stratus. The second approach was uneventful.

The data obtained from the aircraft's Flight Data Recorder (FDR) is presented in Section 1.11.2.1. This revealed that the aircraft had in fact made both of its approaches with full Landing flap (27.5°) selected, instead of having the recommended Approach flap (22.5°) setting.

This incident was discussed between the AAIB and the two pilots involved during the day following the events. Further interviews with each pilot took place once the FDR data had been replayed and more detail about the events was available. In addition, subsequent to these interviews, the first officer involved made a detailed submission giving an analysis of his recollection of the events.

The commander of the previous landing HS748 aircraft was contacted during this investigation. That aircraft landed at 0517 hrs and the commander commented that some turbulence had been experienced at about 1,500 feet during the final descent but no windshear had been encountered on final approach. Some shower activity had been noted to the south of the airport by this crew.

#### 1.1.4 G-BGMO (passenger aircraft) incident

The crew reported for duty at 0615 hrs on 6 June 1998 in order to operate six flight sectors on scheduled passenger flights between Liverpool and the Isle of Man. Between each flight, there was a planned turnround time of 30 minutes. All of these flights were flown in G-BGMO. The planned final arrival time at Liverpool was 1300 hrs, giving a total planned Flight Duty Period of 6.75 hours, which was within the normal 9.5 hour maximum specified in the company's Flight Time Limitations section for a six sector duty commencing at the crew's report time. After the event, the crew's duty finished 5 minutes later than planned.

The incident occurred during the first sector of the duty. The aircraft departed from Liverpool on schedule at 0700 hrs and take off was at 0704 hrs from Runway 09. The planned flight time was 25 minutes, cruising at FL80. During the cruise phase, the 0650 hrs Isle of Man weather was copied from the London Volmet North broadcast as surface wind 080° at 19 kt, visibility 5,000 metres in mist, scattered cloud base 500 feet, overcast cloud base 800 feet. The temperature was +12°C, dew point +10°C and the QNH 1007 mb. Temporary changes were reported to a visibility of 3,000 metres, broken cloud base 400 feet. A Minimum Descent Height of 450 feet QFE and a minimum RVR requirement of 1,300 metres were correctly recorded on the Navigation Log.

Initial contact with Isle of Man Ronaldsway Approach control was made at 0719 hrs. The controller confirmed the altimeter pressure settings and indicated that the aircraft would be given radar vectoring around a right-hand pattern for a VOR/DME approach to Runway 08. The commander carried out a full approach briefing for this type of approach and this was fully understood by the first

officer. It was the commander's intention to carry out manual aircraft handling during the approach, rather than using the aircraft's autopilot. This was in order that the commander could practice handling skills in anticipation of his routine competency check, which was programmed for the following day.

The aircraft commenced descent from FL80 just before 0725 hrs. At 0727 hrs, descent clearance was given down to 1,900 feet on the QFE of 1006 mb. At that time, the aircraft was 10 nm south of the airport. At 0728.5 hrs, the aircraft was instructed to turn right onto a heading of 305°, and a further turn onto 360° was instructed at 0729.7 hrs. The controller then reported that the visibility was 3,000 metres in heavy rain with five okta (cloud) at 500 feet and eight okta at 800 feet. This was acknowledged by the crew at 0730 hrs. The controller enquired if the crew were happy to conduct the VOR/DME procedure or if they would prefer a Surveillance Radar Approach. The crew responded that the VOR approach would be fine.

Just after 0730.5 hrs, the controller instructed a turn onto a closing heading of 060°, to close the inbound radial from the right and to report when established. The commander recalled that the 'beam bar' centred as he applied bank to start the turn and the aircraft flew rapidly through the approach centreline. A few seconds later, the first officer reported that the aircraft was established on the inbound radial and the controller confirmed that the aircraft was cleared to descend with the procedure at 0731 hrs. The aircraft was then transferred from Approach control to Tower control.

The commander recalled reading the DME distance indication as 0.5 nm. The airspeed at that time was in excess of 180 kt, the maximum speed for any flap or landing gear operation. The commander therefore considered that he was high and fast. The pilot later recalled that the DME indication was probably actually 5.0 or 4.5 nm, not 0.5 nm. He pitched the aircraft down and reduced power. The maximum landing gear lowering speed was 160 kt so the commander reduced speed to achieve this and then lowered the gear. He called for the Landing checklist.

Approach flap, 22.5°, was selected and the aircraft continued to descend, reducing speed to below 140 kt. Subsequently, the commander could not recall any height calls from the first officer, and indicated that he may have made the 22.5° flap selection himself if the first officer had been busy with the checklist. The first officer indicated that he had informed the commander about the aircraft descending below 1,400 feet prior to the VOR/DME station passage.

By this stage, just before 0732 hrs, the first officer had changed frequency to Tower control. The aircraft was instructed to continue approach for Runway 08 and a surface wind check of 100° at 12 kt was passed at 0732 hrs.

In the next few seconds, the Tower controller queried the aircraft's level, to which the first officer responded that they were *'slightly low on the procedure'* and that they were *'just recovering that now'*. The Tower controller responded by passing a range check indicating that the aircraft was at 6.5 nm from touchdown at 0732.5 hrs. There was no response from the aircraft, so the controller queried the aircraft's height at 6 nm a few seconds later. The first officer responded to this just prior to 0733 hrs.

At about the same time, the first officer recalled that the sea surface and coastline came into view. The commander saw a ship (similar to a small cruise liner) which he knew was too large to be sailing in the bay adjacent to the airport. He recalled that on sighting the ship, the aircraft height was between 600 and 700 feet, and also recalled thinking that the cloudbase was higher than had previously been passed to the crew.

The commander glanced at the RMI indication and realised that the aircraft was still travelling towards the VOR with 2 nm to run at that stage. He considered that he had somehow reverted to the belief that the DME position was at the touchdown end of the runway.

He applied power progressively and pitched up into a climb, reducing the airspeed. He climbed up in order to pass over the VOR. As the aircraft continued towards the runway, the commander could not recall any height/distance calls from the first officer or any verbal communication.

Landing clearance was issued to the aircraft at 0734 hrs along with a surface wind check of 090° at 13 kt.

After passing the VOR, the approach continued normally, with ground contact being gained at about 500 feet. The runway was sighted as the aircraft got closer to the threshold. At 200 feet, flap 27.5° was selected and a normal landing followed at 0737 hrs. The passengers and cabin crew were unaware of the event.

A recording of the deskside telephone conversation that took place between the Tower controller and the Approach controller between 0733 hrs and 0733.5 hrs indicated that the aircraft's mode C height indication had gone down to 700 feet before it disappeared completely for half a mile behind the hill. The Tower

controller's Occurrence Report indicated that both Primary and Secondary Radar returns had reappeared at 5.5 nm from touchdown with the aircraft climbing to a height of 1,000 feet before landing (subsequently, this figure could not be correlated with the data from the FDR, whereas the commander recalled the lowest height as being about 600 feet and the climb to 700 feet, and the first officer recalled the lowest height as 450 feet).

According to the first officer, the commander made no comment about the approach until much later, probably during one of the subsequent sectors. The commander recalled that the two crew members had discussed the incident on the ground at the Isle of Man. The same VOR/DME approach was carried out two sectors later entirely normally and there were no other significant problems during the remainder of the duty.

The incident was discussed between the AAIB and the commander during the day following the events. The first officer was not available on that day but provided an initial written brief. Further interviews with both of the pilots took place once the FDR data had been replayed and more detail about the events was available. In addition, subsequent to these interviews, the first officer involved made a submission giving his analysis of his recollection of the sequence of events.

## **1.2 Injuries to persons**

There were no injuries sustained during either incident.

### **G-BIUV (freighter aircraft)**

The aircraft was operated by two flight deck crew. There were no other persons on board.

### **G-BGMO (passenger aircraft)**

The aircraft was operated by two flight deck crew. Two cabin crew members and 47 passengers were also on board.

## **1.3 Damage to aircraft**

Neither aircraft sustained any damage during the incidents.

## **1.4 Other damage**

There was no damage sustained during either incident.

## 1.5 Personnel information

### 1.5.1 The crew - G-BIUUV (freighter aircraft) incident

Commander:	Male, aged 41 years
Licence:	Airline Transport Pilot's Licence
Aircraft ratings:	HS748 series, DHC8, BAe Jetstream 31/32, Beech 58/95 series
Instrument Rating:	27 March 1998 valid to April 1999
Base Check:	27 March 1998 valid to September 1998
Line Check:	22 April 1998
Medical Certificate:	Class 1 issued 28 May 1998
Flying experience:	Total flying: 8,667 hours On type: 6,739 hours Last 90 days: 63 hours Last 28 days: 23 hours Last 24 hours: 2 hours
Previous rest period:	24 hours

Human Factors and Flight Deck Management course attended on 4 January 1994.

The commander had operated the HS 748 type for a number of years with various operators, both in the UK and abroad. He had accumulated over 6,700 hours flying on this type of aircraft with a total of six different operators. He had flown on a freelance part-time basis for Emerald Airways during 1994 and 1995. After brief periods working for two other UK operators on different aircraft types, he joined Emerald Airways on a full time basis in April 1998. He stated that he had completed about 18 line sectors after completion of his Line Training to the time of the incident. This was the first time that he had flown with this particular first officer.

First Officer:	Male, aged 27 years	
Licence:	Commercial Pilot's Licence	
Aircraft ratings:	HS748, GA7, PA28	
Instrument Rating:	13 March 1998 valid to April 1999	
Base Check:	13 March 1998 valid to September 1998	
Line Check:	20 April 1998	
Medical Certificate:	Class 1 issued 12 September 1997	
Flying experience:	Total flying:	1,060 hours
	On type:	100 hours
	Last 90 days:	80 hours
	Last 28 days:	30 hours
	Last 24 hours:	2 hours
Previous rest period:	96 hours	

There was no record of any Human Factors and Flight Deck Management course attendance in the pilot's Training File. The first officer indicated that he had not attended such a training course.

The first officer had been employed by the operator about three months before the incident. He had conducted a self study course in order to pass the Aircraft Type Technical examination, using sets of notes procured from other pilots. After successfully passing the examination, the flying training phase commenced. This took about one working week of two flights per day to complete. The Line Training phase was then entered. This took place during some 30 to 35 flights, mostly on night duties. No unusual difficulties were encountered during the training and progress was normal, with his Final Line Check being successfully completed on 8 April 1998. The first officer commented, with regard to flap selections, that he had never made any mis-selections of the flap lever during or after his training period.

### 1.5.2 The crew - G-BGMO (passenger aircraft) incident

Commander:	Male, aged 64 years
Licence:	Airline Transport Pilot's Licence
Aircraft ratings:	HS748, Boeing 737 series, BAe146 series, Viscount 800
Instrument Rating:	13 May 1997 valid until 12 June 1998
Base Check:	17 October 1997, valid to 12 June 1998
Line Check:	7 June 1997
Medical Certificate:	Class 1 issued 25 March 1998
Flying experience:	Total flying: 16,000 hours On type: 800 hours Last 90 days: 120 hours Last 28 days: 40 hours Last 24 hours: 3 hours
Previous rest period:	34 hours

Human Factors and Flight Deck Management Course attended on 26 May 1996.

The commander had joined the operator in 1996 at the age of 62, on his retirement from the operation of jet aircraft. His journey from home to the airport entailed a drive of some two hours duration. He had expressed a preference for night duty operations, the roster pattern of which enabled the commander to make the journey to work on an average of only four occasions per working week.

The commander had commenced duty at 0615 hrs on the morning of the incident. This was preceded by his usual two hour drive to the airport from home. He had gone to bed at 2030 hrs the previous evening. There was no noise disturbance but the commander awoke on several occasions during the night, concerned that he might oversleep for his planned wake up time of 0330 hrs. He had achieved less than seven hours sleep with three disturbances. Nevertheless, he was confident in his abilities to conduct his flying duty, but felt that perhaps he had 'lost the edge' of his performance.

The commander was a Line Training Captain for the company, and he was due to undergo a routine six monthly company Base Check the next day. In order to

practice his handling skills before this, he made the decision to carry out the VOR/DME procedure, rather than accept a Surveillance Radar Approach.

First Officer:	Male, aged 41 years
Licence:	Airline Transport Pilot's Licence
Aircraft ratings:	HS748 series, PA23 series, Cessna 150/172
Instrument Rating:	20 November 1997 valid to December 1998
Base Check:	12 May 1998 valid to December 1998
Line Check:	22 December 1997 valid to January 1999
Medical Certificate:	Class 1 issued 25 February 1998 Required to wear spectacles for distant vision
Flying experience:	<b>Total flying:</b> 1,527 hours <b>On type:</b> 563 hours Last 90 days: 122 hours Last 28 days: 37 hours Last 24 hours: 1 hours
Previous rest period:	31 hours

Human Factors and Flight Deck Management Course attended on 25 July 1995.

The first officer had joined the company in 1996, having completed a self study course with notes procured from other pilots in order to pass the CAA Type Technical examination on the HS 748. He then undertook five hours of flight training followed by the Base Check and Instrument Rating flight test. Line Training followed for 28 sectors including the Final Line Check.

The first officer commented that his duty pattern during the previous few days had been from ground school on the Wednesday, early start on Thursday with a day stop followed by a late finish, rest day on Friday, followed by an early start on the Saturday morning, the day of the incident. He also noted that this change from early to late to early duty in the same week was tiring, but he did not feel tired or unfit to operate on the morning of the incident.

## 1.6 Aircraft information

### 1.6.1 Leading particulars G-BIUUV (freighter aircraft)

Manufacturer: Hawker Siddeley Aviation  
Aircraft type: HS 748 – 2A  
Constructor's serial number: 1701  
Year of manufacture: 1971  
Engines: 2 Rolls Royce Dart 534-2 turboprops  
Certificate of Airworthiness: Public Transport, valid to 16 June 1999  
Aircraft hours (since last check): 246:30  
Aircraft landings (since last check): 324

### 1.6.2 Leading particulars G-BGMO (passenger aircraft)

Manufacturer: Hawker Siddeley Aviation  
(British Aerospace)  
Aircraft type: HS 748 – 2A  
Constructor's serial number: 1767  
Year of manufacture: 1979  
Engines: 2 Rolls Royce Dart 534-2 turboprops  
Certificate of Airworthiness: Public Transport, valid to 22 April 1999  
Aircraft hours (since last check): 159:12  
Aircraft landings (since last check): 299

### 1.6.3 Weight and balance

#### 1.6.3.1 G-BIUV (freighter aircraft)

Maximum permitted Take-off Weight:	21,090 kg
Estimated Take-off Weight:	19,517 kg
Estimated Take-off Centre of Gravity (Laden Index):-25.4 units (approx. seven eighths forward cg within allowable envelope)	
Maximum permitted Zero Fuel Weight:	17,463 kg
Estimated Zero Fuel Weight:	17,047 kg
Total Traffic Load (Cargo):	5,100 kg
Maximum permitted Landing Weight:	19,504 kg
Estimated Weight at incident:	19,017 kg
Estimated fuel on board at incident:	2,000 kg

The Load Sheet had been prepared by the first officer and signed by the commander. The Load Sheet indicated that the cargo (newspaper bundles) was evenly distributed throughout the cabin, with 90 kg of ballast located in the rear hold. Even with this distribution, the centre of gravity was indicated to be close to the forward limit.

#### 1.6.3.2 G-BGMO (passenger aircraft)

Maximum permitted Take-off Weight:	21,090 kg
Estimated Take-off Weight:	19,682 kg
Estimated Take-off Centre of Gravity (Laden Index):-11.84 units (approx. two thirds aft cg within allowable envelope)	
Maximum permitted Zero Fuel Weight:	17,463 kg
Estimated Zero Fuel Weight:	17,332 kg
Total Traffic Load (47 passengers plus baggage):	4,257 kg
Maximum permitted Landing Weight:	19,504 kg
Estimated Weight at incident:	19,200 kg
Estimated fuel on board at incident:	1,900 kg

The load sheet had been prepared by the first officer and signed by the commander. A discrepancy was noted on the Load Sheet in the amount of fuel on

board at the time of departure. A total ramp fuel of 2,400 kg was actually on board for departure, but the load sheet indicated a take-off fuel of 1,950 kg. The figures presented above have been corrected to reflect the actual quantity of fuel on board the aircraft for this flight.

#### 1.6.4 Aircraft limitations

Both aircraft were subject to the following airspeed limitations:

Maximum speed, Flap 15°:	180 kt
Maximum speed for landing gear operation:	160 kt
Maximum speed, Flap 22.5°:	140 kt
Maximum speed, Flap 27.5°:	120 kt

#### 1.6.5 Recommended approach procedures

The recommended approach procedures for the HS748-2A aircraft are presented in Appendix B, taken from the manufacturer's Basic Handling Procedures booklet.

The operator had reproduced a similar diagram in the Operations Manual Volume Nine, Flying, Flight Profiles section (Appendix C), faithfully replicating the typographical errors of the original document, but with a custom amended vertical profile for the final approach phase.

The target threshold speed (VAT) for the estimated incident weight of 19,200 kg in the 27.5° Flap configuration was 96 kt. For the 22.5° Flap configuration, the VAT would have been 105 kt.

#### 1.6.6 Flight instruments, navigation displays and GPWS

##### 1.6.6.1 G-BIUV (freighter aircraft) equipment

The layout of the flight deck instrumentation is shown in Appendix D, Figure 1, along with detail of the commander's flight instrument panel.

This aircraft was fitted with three pressure altimeters. Two were of an older three pointer design mounted conventionally to the right of each pilot's Attitude Indicator. The third altimeter was electrically operated with a single pointer and digital display, mounted on the lower centre instrument panel, almost adjacent to

the commander's right knee position. None of the altimeters was fitted with an adjustable DH/MDH cursor.

For Category 1 precision approaches, and for all non-precision approaches, the DH/MDH is referenced to the aircraft's pressure altimeters with subscales set to QFE, and not to the aircraft's Radio Altimeter (RA).

The RA on this aircraft was fitted on the lower centre instrument panel, almost adjacent to the first officer's left knee position (Appendix D, Figure 2). It was fitted with an adjustable DH/MDH cursor. RA reads actual height above the ground directly beneath the aircraft, but is of limited value during non-precision approaches because the nature of the terrain under the approach path may not necessarily be level, flat or related to the runway threshold elevation in a meaningful way. The use of the RA height cursor for this type of approach is therefore of only secondary guidance value. An amber light was fitted which illuminated when the aircraft descended below the RA set on the adjustable cursor.

Only two Attitude Indicators were fitted, both of which were to an older design with no colour coding. The bank angle scales were displayed at the base of the instrument instead of the modern convention of displaying bank angle at the top of the instrument. Bank angle graduations were displayed only for 30° and 60° each way. No Flight Director (FD) system was fitted.

Only two Air Speed Indicators were fitted, being of the older single pointer double sweep type. There was no colour coding applied and no provision for an adjustable airspeed reference cursor.

Heading information was displayed by means of a gyro compass with adjustable heading selector. The commander had reference to both the No 1 system in the conventional location below the primary Attitude Indicator, the No 2 system display on the centre instrument panel, just to the right of the Rate of Climb/Descent indicator, and the Radio Magnetic Indicator on the lower left of the instrument panel. The first officer had only one heading display, being on his primary flight instrument panel (Appendix D, Figure 2).

Each pilot had reference to VOR/ILS information by means of an Omni Bearing Selector Display. Additionally, the commander had reference to a conventional two pointer Radio Magnetic Indicator (RMI) with the pointers being selectable to

display navigation data from either No 1 or No 2 VOR Navigation receiver or from No 1 or No 2 Automatic Direction Finder (ADF) receiver.

The aircraft had been fitted with a Global Positioning System (GPS) satellite navigation receiver, but the system had not yet been rendered serviceable for use. In any event, the system was not intended for use during instrument approaches such as the one being carried out at the time of the incident.

One indicator was fitted to display the information from the Distance Measuring Equipment (DME) system. This was positioned to the right of the commander's Altimeter (Appendix D, Figure 3). The display was of the rotating drum type, with three digits. One nautical mile progress towards a DME ground station was displayed as one tenth of a revolution of the rightmost drum. This scale was graduated with a 0.5 nm division between each numeral.

#### 1.6.6.2 G-BGMO (passenger aircraft) equipment

The layout of the commander's flight instrument panel is shown in Appendix E.

This aircraft was fitted with three pressure altimeters of a more modern standard than G-BIUUV, with single pointer and digital drum displays, but without any facility of an adjustable DH/MDH cursor.

A Radio Altimeter was fitted of similar type and in a similar location as that fitted to G-BIUUV.

Three Attitude Indicators were fitted. The two main Attitude displays were of modern design, colour coded and incorporating Flight Director and ILS deviation displays. The standby Attitude Indicator instrument was not colour coded.

Only two Air Speed Indicators were fitted, being of the older single pointer double sweep type. There was no colour coding applied and no provision for an airspeed reference cursor.

Heading information was displayed by means of a Horizontal Situation Indicator for each pilot. Alongside each of these was a twin pointer Radio Magnetic Indicator, enabling selection of either VOR or ADF navigation information.

The aircraft had been fitted with a Global Positioning System (GPS) satellite navigation receiver. The system had been rendered serviceable, but the crews had

not completed training on use of the system, so it was not in service at the time of the incident.

Two indicators were fitted to display the information from the Distance Measuring Equipment (DME) system. One was positioned in the lower left corner of the commander's instrument panel, located below the RMI. The commander commented that, in this position, his view of his display was blanked by the position of the control column, necessitating additional head movement in order to view the distance indication. On the first officer's instrument panel, the DME display was located on the lower right side of the panel, outboard of the Rate of Climb/Descent indicator. The displays were of the seven segment Light Emitting Diode (LED) type, with four digits, able to display hundreds, tens, units and decimals of nautical miles.

#### 1.6.6.3 Ground Proximity Warning System (GPWS)

Both aircraft were equipped with GPWS, which had five warning modes available. The GPWS was not designed to detect terrain or obstacles located ahead of the aircraft's position. The five available modes were:

- Mode 1 Excessive Descent Rate
- Mode 2 Excessive Terrain Closure Rate
- Mode 3 Altitude Loss after Take-off or Go-Around
- Mode 4 Unsafe Terrain Clearance while not in the Landing Configuration
- Mode 5 Below Glideslope Deviation Alert

No aural warnings from the GPWS were generated during either incident as the flight paths in both cases did not come within the designated warning envelopes.

The proposed Terrain Awareness and Warning System (TAWS), carriage of which is planned to be mandatory, will enhance these warning modes.

### 1.7 Meteorological information

#### 1.7.1 Aftercast

An aftercast, produced from the Meteorological Office Headquarters at Bracknell, indicated that the synoptic situation between 0600 and 0700 hrs showed an unstable southeasterly airstream established over the area. An area of

thunderstorms was moving northwards across the Irish Sea, with intermittent rain, heavy at times, reaching Ronaldsway at 0800 hrs. The visibility was about 5,000 metres, mean sea level pressure 1008 mb. The cloud was scattered base 500 feet, overcast base 800 feet. The surface wind was from 080°T at 20 kt gusting to 25 kt, temperature +12°C, dew point +10°C, and the upper wind at 1,000 feet amsl was estimated as being from 110°T at 22 kt, temperature +12°C. At 2,000 feet amsl, the wind was estimated as being from 130°T at 23 kt, temperature +12°C, dew point +8°C. At 3,000 feet amsl, the wind was from 150°T at 25 kt.

It was noted that a sharp temperature inversion existed between 1,000 feet and 1,600 feet amsl from +12°C to +14°C.

#### 1.7.2 Terminal Aerodrome Forecasts (TAFs)

The Terminal Aerodrome Forecast (TAF) for Isle of Man (Ronaldsway) Airport, issued by the Airport Met Office at 0300 hrs, and valid for the period 0500 to 1300 hrs, was for a surface wind from 110°T at 16 kt, visibility 8,000 km, cloud broken at 800 feet, temporarily visibility 3,000 metres in rain, broken cloud at 500 feet amsl, with a 30% probability, between 0700 and 1300 hrs, of thunderstorms with rain and broken cumulonimbus cloud base 800 feet.

This forecast had been included with the documentation issued to the crews of both aircraft involved in these incidents.

#### 1.7.3 Meteorology Aerodrome Routine weather reports (METARs)

The following observations were recorded at the Isle of Man Meteorological Office as the airfield METARS:

0450 hrs            Surface wind 090/19 kt, 5,000 metres visibility, mist, cloud base few at 400 feet, scattered at 600 feet, overcast at 800 feet, temperature +11°C, dew point +10°C, QNH 1008 mb.

0520 hrs            Surface wind 090°/20 kt, 5,000 metres visibility, mist, cloud base scattered at 400 feet, broken at 600 feet, overcast at 800 feet, temperature +11°C, dew point +10°C, QNH 1008 mb, temporary changes to broken cloud base 400 feet.

0550 hrs	Surface wind 090°/19 kt, 6,000 metres visibility, mist, cloud base few at 400 feet, broken at 600 feet, overcast at 800 feet, temperature +11°C, dew point +10°C, QNH 1008 mb.
0620 hrs	Surface wind 080°/19 kt, 5,000 metres visibility, mist, cloud base scattered at 400 feet, overcast at 700 feet, temperature +12°C, dew point +10°C, QNH 1008 mb, temporary changes to visibility 3,000 metres with broken cloud base 500 feet.
0650 hrs	Surface wind 080°/19 kt, 5,000 metres visibility, mist, cloud base scattered at 500 feet, overcast at 800 feet, temperature +12°C, dew point +10°C, QNH 1007 mb, temporary changes to visibility 3,000 metres with broken cloud base 400 feet.
0720 hrs	Surface wind 080°/16 kt, 5,000 metres visibility, rain, cloud base scattered at 500 feet, overcast at 800 feet, temperature +12°C, dew point +10°C, QNH 1008 mb, temporary changes to visibility 2,000 metres in rain with broken cumulonimbus cloud at 400 feet.
0750 hrs	Surface wind 090°/12 kt, 3,500 metres visibility, rain, cloud base scattered at 500 feet, overcast at 800 feet, temperature +12°C, dew point +11°C, QNH 1008 mb, temporary changes to visibility 2,000 metres, broken cumulonimbus cloud base 400 feet.

#### 1.7.4 Provision of weather information to pilots

At most UK airports handling significant numbers of commercial air transport movements, Met observations are taken and recorded at half hourly intervals. Interspersed with these, Special observations record intermediate changes in the weather conditions.

The Isle of Man Airport is especially well provisioned in this respect with the presence of the Airport Met Office in the Control Tower building.

With the rapid changes in weather conditions that are often experienced in the UK, it is vital that pilots are kept informed of significant changes which are liable to affect the safety of the aircraft in flight, and especially when taking off or landing. Appendix F gives a summary of the in-flight sources of weather

information available for each airport in the UK ranked in order of total numbers of Air Transport Movements for 1997.

Most airports experiencing higher traffic levels also provide the facility of an Automatic Terminal Information Service (ATIS) to provide pilots with significant operational data and the current METAR on a discrete radio frequency. This facility relieves controllers from much routine radio communication workload. It also has the added benefit that crews can obtain the information at the most convenient time with regard to flight deck workload and approach briefing considerations.

To aid pilots on longer sectors within UK airspace, weather information is also provided for a selection of the busiest airports by the VOLMET broadcast service. There are four VOLMET stations within the UK each providing weather observations, updated half hourly, for nine airports per station.

## **1.8 Aids to navigation**

1.8.1 Isle of Man (Ronaldsway) Airport is equipped with the following radio navigation aids:

1.8.1.1 Instrument Landing System (ILS), Runway 26:

It is coded 'IRY' and radiates on frequency 110.9 MHz. The Localiser is aligned with the final approach track for Runway 26 on a magnetic track of 265°M. The associated Glideslope signals, radiated on the frequency-paired channel 330.80 MHz, give a glidepath angle of 3°. It is a Category 1 installation.

No ILS system is currently installed for Runway 08.

1.8.1.2 Distance Measuring Equipment (DME)

Radiates on Channel 46X, coded 'IRY', frequency paired with the ILS for Runway 26, indicates zero miles at the touchdown point of Runway 26. An additional DME facility is available co-located with the Isle of Man VOR (see section 1.8.1.5).

#### 1.8.1.3 Non-Directional Beacons (NDB)

Two are located close to the airfield. On the airport is the 'RWY' NDB which radiates on frequency 359 kHz, operating range 20 nm. Also available is the Carnane 'CAR' NDB, frequency 366.5 kHz, operating range 25 nm.

#### 1.8.1.4 Surveillance Radar Equipment (SRE)

The airport facilities include a radar system which enables provision of a Surveillance Radar Approach to Runways 26, 08, 03 and 35 when required.

#### 1.8.1.5 Isle of Man VHF Omni Directional Radio Range and Distance Measuring Equipment (VOR/DME)

This is co-located on the headland at Spanish Head (position 54°04.01'N, 004°45.49'W) primarily as an en route navigation aid. The VOR radiates on a frequency of 112.2 MHz, coded 'IOM', and the associated DME on Channel 59X. The AIP entry indicates that the aerial elevation of the station is 600 feet amsl. This was the facility that was in use and was fully serviceable the time of both incidents.

### 1.9 **Communications**

A complete series of recordings and transcripts were available which allowed the progress of the flights within Isle of Man Control Zone to be monitored during each of the approaches made during the period covering both of the incidents.

### 1.10 **Aerodrome information**

#### 1.10.1 Physical characteristics

Isle of Man (Ronaldsway) Airport has three hard surfaced runways:

Runway 08/26 Asphalt/Concrete, 1,753 metres long, 46 metres wide.

Runway 03/21 Asphalt, 1,255 metres long, 46 metres wide.

Runway 17/35 Asphalt, 903 metres long, 27 metres wide.

Approach, threshold and runway lighting is provided for Runway 08/26. The runway threshold elevation for Runway 08 is 29 feet amsl.

### 1.10.2 Air Traffic Services Unit (ATSU)

The airport is equipped with a Plessey 1584 Watchman Radar system with a Cossor Secondary Surveillance Radar. The Approach control room is equipped with a 26 inch colour radar display monitor. During May 1998, the Secondary Surveillance Radar data display capability was brought into service. Additionally, in the Visual Control Room (VCR), a small repeater display is installed so that the Tower controller may have reference to aircraft range from touchdown. Aircraft altitude data information is also displayed on this unit.

There are normally three Air Traffic Control Officers on duty at the airport, one acting as Tower controller in the VCR, one as Approach controller (downstairs from the VCR in the Approach Room) and the third as relief for cover during rest breaks and to carry out other essential duties.

The Approach controller may be required to handle multiple arriving aircraft in order to radar vector them onto final approach for the chosen approach aid, or to provide Surveillance Radar Approach guidance.

The Manual of Air Traffic Services Part 1, Section 3-16 states that for aircraft conducting Non-Precision Approaches (such as a VOR/DME approach), a range check is required to be passed to the aircraft when it reports established followed by clearance for the approach. It further states that 'no further ranges or advisory heights are to be passed unless specifically requested by the pilot'.

### 1.10.3 Area radar data

Recorded Secondary Surveillance Radar data was obtained from St Annes Radar and Great Dun Fell being the two recorded stations closest to the location of the incidents. St Annes Radar had the coverage to the lowest altitude, but this was lost when each aircraft descended below about 3,500 feet.

There was no facility available to record the Airport Surveillance Radar data from the Isle of Man (Ronaldsway) Airport, nor was there a requirement for it to be recorded.

The Irish aviation authorities were contacted in order to determine whether the Dublin Airport Area Radar had any suitable coverage. Their assistance was provided in the form of a video recording of the replay of the Dublin Area Radar tapes, which gave good coverage of both incident aircraft down to an altitude of between 1,500 feet and 1,000 feet. This was sufficient to track both aircraft

until the time that they turned onto final approach and commenced their descents. Correlation of this information with that from the FDR from each aircraft enabled a geographically related reconstruction of the descent profiles to be produced.

## **1.11 Flight recorders**

Each aircraft was fitted with a 30 minute Cockpit Voice Recorder (CVR) and a MIDAS Flight Data Recorder (FDR). As both aircraft had operated for longer than thirty minutes subsequent to the incidents, both CVR recordings of the events had been over-written. The FDRs maintained data in excess of 30 hours before over-writing and so retained records of the entire incident flights.

### **1.11.1 Flight data recorder installation**

The MIDAS FDR installation consisted of aircraft transducers, a signal acquisition and conditioning unit, a cockpit mounted data entry panel and a crash-survivable tape recorder. The installation on the two subject aircraft provided transducers for airspeed, altitude, heading, normal acceleration, flap, pitch and roll. No transducers were provided for recording any engine parameters, nor were they required under the regulations.

This recording system was first introduced in the 1960's and converts sampled aircraft parameters into a frequency modulated waveform before being recorded onto tape. This method of recording is not digital and will be prohibited under the rules of JAR-OPS.

Due to the analogue nature of the recording process and the required complexity of the analogue test and replay equipment, the results of replays of these recorders were not entirely repeatable. Prior to a replay, each particular parameter channel on the replay equipment had to be re-calibrated and the stability of the analogue electronics was such that the calibration could drift from the start to the end of a replay. Data output from the replay was in the form of an analogue trace on thermal paper. Using lookup tables, the traces were then manually interpolated to provide data in engineering units. A photograph of the replay equipment is shown in Appendix G, Figure 1. Both FDRs from the incident aircraft were downloaded using the only known replay equipment available in the United Kingdom.

Taking into account the system errors detailed above, the flight recorder information stated in this report may be subject to more inaccuracies than that -

which may be expected from a digital FDR installation. Both aircraft were subject to a pitot / static system calibration after the incidents to improve the accuracy of the incident data. As far as possible, the data output was further refined with that from other sources, such as Mode C encoded radar returns from the Dublin radar head, ATC tapes and meteorological information.

It should be noted that, prior to the time of the incidents, the operator had instigated action on all its aircraft equipped with the MIDAS system to retrofit a digital flight recorder in compliance with the requirements of JAR-OPS.

#### 1.11.2 Incident flights

Altitude information recorded on the FDRs is based on a standard pressure setting of 1013 mb. All altitudes quoted in the following narrative are relative to mean sea level and have been corrected for the relevant mean sea level pressure of the morning, which was 1008 mb.

##### 1.11.2.1 G-BIUUV (freighter aircraft) incident

For the first approach, whilst level at 1,950 feet, 'UV turned right onto the base leg and 15° flap was selected. Whilst 6 nm west of the 'IOM' VOR, during the turn onto final approach, 22.5° flap was selected. The aircraft became almost established on the inbound radial at a position approximately 4.5 nm west of 'IOM' VOR; the nose was lowered, flap 27.5° was selected and a descent initiated. Dublin Area Radar contact was lost 2.5 nm before 'IOM' as the aircraft descended through about 1,000 feet. The lowest point of this initial approach was calculated to be at a position 1.5 nm west of 'IOM' at 630 feet. This position was determined to be within 0.5 nm of the highest point on the island Calf of Man, which has a spot elevation of 420 feet amsl. The aircraft was pitched up initially to 10° nose up, the flaps were retracted to 15° and the aircraft started to climb. A minimum airspeed of 103 kt was recorded shortly after the pitch up. Dublin Area Radar contact was regained during the climb at about 1,500 feet. The aircraft passed over the 'IOM' VOR with an increased airspeed of 118 kt.

Still in the climb, a right turn was initiated onto a downwind heading of 248°. The aircraft levelled at 2,000 feet during the turn and maintained this altitude (within 200 feet) for the duration of the downwind leg and the turn onto the Runway 08 extended centreline. It became established at a position 6 nm west of the 'IOM' VOR. At 4.5 nm from 'IOM', 22.5° flap was selected and 'UV began to descend, levelling at 1,350 feet by 2.5 nm to run to 'IOM'. Flap 27.5° was

selected and the aircraft flew level at 117 kt. Dublin Area Radar contact was lost when the final descent was initiated at a position approximately 0.5 nm before 'IOM' and the aircraft passed over the VOR at 1,130 feet. The descent continued, passing through 650 feet at a position 2 nm past 'IOM', until the aircraft made an uneventful landing on Runway 08.

Annotated tracks for the two approaches made by 'UV and a plot of the relevant FDR data from the same period are shown in Appendix G, Figures 2, 3 and 4.

#### 1.11.2.2 G-BGMO (passenger aircraft) incident

Whilst level at 2,200 feet and 5.5 nm west of 'IOM' VOR, 15° flap was selected and the aircraft began a right turn to intercept the final approach track. At the start of the turn 'MO began to descend; Dublin Area Radar contact was lost as the aircraft descended through about 1,400 feet and was not regained for the remainder of the flight. At a position calculated to be 4 nm west of 'IOM' VOR, the aircraft had descended to 960 feet and was slightly north of the Runway 08 extended centreline. Flap was selected to 22.5° at 840 feet and the descent continued to a lowest point of 380 feet at a position approximately 1 nm west of the highest point on the island Calf of Man (elevation 420 feet). The aircraft was pitched up to 10.7°, the airspeed reduced to a minimum of 95 kt and 'MO began to climb. Whilst passing over or abeam the northern coast of the Calf of Man, the aircraft had reached an altitude of, and levelled at, 570 feet. As it crossed the south-western tip of the Isle of Man the aircraft climbed again and levelled at 670 feet, passing over the 'IOM' VOR at that altitude. Final descent was initiated and the aircraft passed through 575 feet at a position 2 nm east of the 'IOM' beacon. Flap 27.5° was selected at 250 feet and the aircraft made an uneventful landing on Runway 08.

An annotated track for the approach made by 'MO and a plot of the relevant FDR data from the same period are shown in Appendix G, Figures 5 and 6.

#### 1.12 Wreckage and impact information

Not applicable.

#### 1.13 Medical and pathological information

Not applicable.

**1.14 Fire**

Not applicable.

**1.15 Survival aspects**

Not applicable.

**1.16 Tests and research**

Not applicable.

**1.17 Organisational and management information**

**1.17.1 The Operator**

The Air Operator's Certificate was issued in 1992 and operations commenced with a fleet comprising HS 748 and Piper PA31 aircraft. The operating base was relocated to Liverpool Airport in 1993. At that time, the company operated two HS 748 aircraft with a total of 10 flight crews. A new Chief Pilot and new Operations Manager joined the company during 1993 and its name was changed to the current title.

By September 1994, the fleet had expanded to eight HS 748 aircraft, being operated by a total of 12 flight crews. In 1995, this total increased to 14 flight crews.

During 1996, a new Chief Pilot was appointed and a Deputy Chief Pilot/Flight Safety Manager joined the management team. Management pilots continued to fly frequently and were also part of the training organisation.

On the date of the incidents, the company pilot employee status was: 28 full time Captains, three freelance Captains, 28 full time First Officers and one freelance First Officer. Out of the total of 31 Captains, four were designated as Type/Instrument Rating Examiners (T/IRE) and Line Training Captains. A further six Captains were designated as Line Training Captains.

Two of the four T/IRE Captains also held management positions as Chief Pilot and Deputy Chief Pilot respectively, the Deputy also holding the responsibility as Flight Safety Manager. Both of these pilots were also frequently engaged in pilot

conversion training and initial testing, recurrent training and testing as well as line flying operations, in addition to their administrative responsibilities.

The operation consisted of a fleet of some 14 HS 748 aircraft, (a mixed fleet of Series 1, Series 2A and Series 2B aircraft) which had mostly been procured individually over a period of years from a variety of different sources in different parts of the world. It was commented upon by several pilots that each aircraft was different in terms of its instrumentation, navigation and communication equipment and flight deck layout.

The checklists provided for the operation of the aircraft are presented in Appendix H. Two versions were in use, one for Cargo operations (Appendix H, Figure 1) and one for Passenger operations (Appendix H, Figure 2). After consideration of the circumstances of these two incidents, the operator slightly revised the content of the checklists as shown in Appendix H, Figures 3 and 4, for Cargo and Passenger operations respectively.

#### 1.17.2 The Operations Manuals

The operator's management had sourced the majority of the Operations Manual material about the operation of the HS 748 from the Operations Manuals of other, now defunct, operators of the same type of aircraft.

The Operations Manual was arranged in a total of 15 Volumes (two of which were reserved and not issued). The Introduction section of the Operations Manual indicated that each pilot was issued with Volumes 1 (General), 2 (Notices to Aircrew), 9 (Flying) and 12 (Quick Reference Handbook) for personal retention and updating. Cabin crew were similarly issued with Volumes 2 (Notices to Aircrew) and 10 (Cabin Crew Manual - abbreviated). All Volumes, except those relating to Training (Vol 6), the Instructor Pilot Handbook (Vol 7) and the Cabin Crew Manual (Vol 10), were to be available on each aircraft.

Crew members indicated that they had not, in fact, been issued with any Volumes of the Operations Manual.

It was also notable that Volume 14, entitled Flight Technical, was in fact a Minimum Equipment List and Dispatch Deviation Guide. No Aircraft Technical Manual was available for general reference by crews which contained detailed descriptions of the aircraft systems.

The operator indicated that it had issued Technical Notes to new pilots. However, further discussion with the crews on this subject indicated that these pilots relied on photocopied notes gleaned from colleagues, which were mostly procured during the period leading up to the Aircraft Type Technical examination. There was no formal method of keeping this information updated. Two 'Base Check Questionnaires' existed, one containing 24 Questions, the other 26 Questions about technical aspects of the aircraft, intended for pilot completion in conjunction with a six monthly flight check.

The Operations Manual, Volume 9, Flying, was intended to lay down the procedures to be used for flying the aircraft in a range of circumstances, for both Normal, Abnormal and Emergency Procedures. On inspection of the content of each section, it became apparent that all of the relevant material relating to a particular subject was spread between various sub-sections. For example, information on dealing with icing conditions and cold weather operations was presented in Section 9.3 (Aircraft Handling), Section 9.4 (Normal Procedures) and Section 9.11 (Operation from Contaminated Runways). In Section 9.3 (Aircraft Handling), procedures were presented which were mostly related to Abnormal or Emergency situations. Section 9.4 (Normal Procedures) contained mostly engine handling information but included potential cold weather flight control difficulties. Section 9.5 (Handling Normal) contained Abnormal and Emergency Procedures relating to Stalling, Emergency Descent and Abnormal Landing configurations. Information on Pilot Incapacitation procedures was contained in Section 9.2 (Flight Deck Management) and in Section 9.8 (Emergency Procedures), but these were not cross referenced. Section 9.10 (Emergency Equipment) gave detailed description of the Emergency Exits and Equipment carried on board, which is normally presented in the Aircraft Technical Manual.

Finally, Section 9.12 (Flight Profiles) contained diagrams of the flight profiles to be flown under certain circumstances. Some of the same detail was contained in Section 9.2 (Flight Deck Management), but this was not cross referenced and contained some conflicting information on crew procedures.

In Section 9.12 (Flight Profiles), the diagrams relating to Single Engine Handling were mis-titled and this continued throughout the remainder of the section until the final page, which dealt with the non-precision airfield approach technique (shown in Appendix C). This was mis-titled, the correct title being positioned at the bottom of the previous page in the manual. The section entitled Fuel

Conservation Techniques, at the bottom of the diagram shown in Appendix C was not present in the manufacturer's handbook or in the company Operations Manual.

Additionally, the operator's redrawn final descent to MDH portion of the non-precision airfield approach technique (Appendix C) gave an indication that the preference was to conduct a rapid descent to the MDH and then to level off. This is contrary to best published advice, widely circulated in the industry, relating to the conduct of this type of approach, and has been cited as a causal factor into some CFIT accidents in the past.

All of the illustrated examples above were contained on pages amended or introduced during 1995.

### 1.17.3 Civil Aviation Authority Oversight Programme

The CAA Flight Operations Department (FOD) operates a programme of supervision and auditing of operating standards for all UK Air Operator's Certificate (AOC) holders. Each operator is subjected to a periodic series of checks and inspections in all relevant areas of the operation, particularly aircraft documentation, navigation logs, technical logs, training records and flight time limitations records. Checks on each of these aspects are normally performed at regular intervals.

In addition, periodic flight inspections are carried out for cabin and flight deck operations. There is an annual inspection of company and aircraft facilities and an annual inspection of company operations manuals.

There is also a system of periodic audits, which are intended to summarise the findings of these checks and inspections. An annual review is also carried out for each company.

When anomalies are encountered, these are usually dealt with by correspondence and mutual agreement between the operator and the CAA FOD. The operator's plans for corrective actions of notified shortcomings are then formulated and agreement on implementation timescales sought, dependant upon relevant external factors.

In the event that an operator does not conform to the CAA requirements in any significant particular area and it is considered that the situation may jeopardise flight safety, the CAA may vary the AOC with regard to the operator's nominated

post holders, the types of aircraft used, the nature of the operation and the area of operation. It also holds the ultimate sanction of the withdrawal of the AOC, effectively rendering the operator unable to perform commercial operations.

The latter is obviously a drastic action that is only taken in the most extreme cases.

#### 1.17.4 CAA Oversight Programme with this Operator

Emerald Airways had been subjected to the routine CAA schedule of checks and inspections as detailed in para 1.17.2.1.

Concern had arisen over certain aspects of the operating standards in the company. Notably, a potential subtle trend in poor Crew Resource Management was believed to have contributed to several reportable incidents of deviations from assigned altitudes, Standard Instrument Departure errors and runway excursions in the months prior to 6 June 1998.

In response, the company had issued a Notice to Aircrew which highlighted the importance of the avoidance of operational pressures that in turn could lead to procedural short cuts and omissions which contribute to such errors. The importance of the challenge and response technique throughout the flight deck operation of the aircraft was highlighted and it was emphasised that all pilots, whatever their status in the company, should be encouraged to intercede should there be any doubt whatsoever as to the progress of the flight or when recognising a potentially hazardous situation.

The operator was in the protracted process of changing from operations carried out under the specifications of CAP360, to those under the specifications laid down in JAR-OPS1. As a result of delays in the implementation of JAR-OPS1, the company had revisions to the Operations Manuals sections 'on hold' for up to two years in some cases. This led to an unduly large quantity of pilot notifications by means of Notices to Aircrew. The total number of Notices to Aircrew issued during 1997 was 31 and during 1996 37 Notices had been issued.

The CAA had not made critical reference to the diverse nature and ergonomic quality of the instrumentation and radio equipment fitted to each of the aircraft in the fleet, nor to the lack of availability of formally amended Aircraft Technical Manuals to the pilots, nor to the shortcomings in the Standard Operating Procedures or Flight Profiles content of the Operations Manual, Volume 9, Flying.

The CAA pointed out that it was not in a position to refuse to accept an aircraft, the equipment in which conformed to the requirements of ANO schedules 4 & 5 (or JAR-OPS Subparts K & L). With regard to the Operations Manual deficiencies, the CAA stressed that it is the operator that is responsible for the content of its manuals, and it is not the function of the CAA to ensure that all desirable material is available to the crews.

## **1.18 Additional information**

### **1.18.1 Previous research and analysis**

Accidents involving Controlled Flight into Terrain (CFIT) and during the Approach/Landing phase have been highlighted as major sources of aircraft accident fatalities worldwide. Various industry working groups have conducted studies of previous occurrences and highlighted potential problem areas which need to be addressed in order to reduce the frequency of these types of occurrences.

One such study was carried out by an industry task force for the Flight Safety Foundation. Its report, published in the Flight Safety Digest, November-December 1998 and January-February 1999, was based on an analysis of 76 Approach/Landing accidents/incidents between 1984 and 1997 (inclusive). The report highlighted the fact that CFIT accidents were often associated with non-precision approaches, conducted in the absence of a serviceable ILS facility. Leading the list of the most frequent causal factors were:

- poor professional judgement/airmanship (decision making).
- omission of action/inappropriate action (inadvertent SOP deviation).
- failure in crew resource management (cross checking/coordination).
- lack of positional awareness.
- poor aircraft handling.

Amongst the conclusions and recommendations were the need for the establishment and adherence to SOPs; crew education in the timely recognition of the need to execute a go-around when appropriate; the need to define constant angle stabilised approaches and educate crews as to the design criteria; improvements in communications and understanding between ATC specialists and flight crew; effective use of radio altimeters and the implementation of Flight Operations Quality Assurance programs to identify adverse performance trends.

Many of the causal factors highlighted in the Flight Safety Foundation Report were present in these incidents.

## 2

### **Analysis**

This analysis now considers the design of the approach procedure that was in use at the time of the incidents and the depiction of the procedure on the approach charts used by the crews involved. The status of the airport facilities is then considered.

The analysis then considers each aircraft incident individually and chronologically, highlighting the relevant contributory factors which led to the premature descents. The Standard Operating Procedures, the content of the Operations Manuals and the provision of Crew Resource Management training are then discussed. Finally, the effectiveness of the CAA oversight programme is considered.

#### **2.1 Isle of Man Runway 08 VOR/DME instrument approach procedure**

During the early phase of this investigation, the detail of the VOR/DME procedure for Runway 08 was discussed between the AAIB and the CAA Aerodrome Standards Department. The procedure, as published, was designed by the CAA and was in accordance with International Civil Aviation Organisation (ICAO) Document 8168, Procedures for Air Navigation Services (PANS), Aircraft Operations (OPS), Volume II, Construction of Visual and Instrument Flight Procedures.

For a non-precision approach, such as this procedure, the required minimum clearance from the published Obstacle Clearance Height (450 feet in this case) to the top of the highest obstacle within the final approach primary area is 75 metres (246 feet). The primary area considered for obstacle clearance begins at the Final Approach Fix (FAF), which is at the 'IOM' VOR in this case, and ends at the Missed Approach Point (MAPt), which is at 4.5 nm DME from the 'IOM' VOR/DME facility (also coincident with the Runway 08 threshold). The procedure designer may specify a greater requirement if it is judged necessary. The minimum height prescribed at the Final Approach Fix in this procedure is 1,400 feet. This is also a Minimum Descent Height (MDH) just as is the final procedural MDH based on the final published Obstacle Clearance Height.

In this case, the dominant obstacles for the procedure (after the Final Approach Fix) were the high ground and antennae adjacent to the VOR/DME transmitter, which were in the final approach primary area. In order to ensure that an aircraft making an approach in this area had safely cleared the dominant obstacles with

more than the specified minimum clearance, a Step Down Fix (SDF) had been placed at 2 nm DME between the VOR and the runway threshold, to be crossed **not below** a height of 800 feet (chosen to ensure compliance with the minimum obstacle clearance criteria). This is also a Minimum Descent Height, such that if the fix is not received, then it becomes the procedure MDH.

This procedure, when flown as published, thus ensured that the aircraft would have sufficient clearance from terrain and obstacles while conducting a stabilised 2.9° descent for the final approach phase or performing the go-around.

As a result of these incidents, possible improvements to the procedure were studied by the CAA.

A significant feature of the vertical profile was the initial descent from a height of 1,900 feet to 1,400 feet until the aircraft crossed the VOR/DME transmitter location. What was not defined was the position from which to commence this descent.

As both of these incidents had been initiated during the descent from 1,900 feet to the MDH at the Final Approach Fix, (ie before the VOR/DME transmitter had been passed), it was considered that a clear definition was required of the position at which to commence the descent in order to establish a stabilised approach profile, as there was no requirement to have a level platform while crossing the VOR/DME station. Therefore, a descent initiation point was defined at 1.3 nm DME west of the beacon, which has now become the Final Approach Fix. This point now enables a continuous nominal 3° descent path to be flown throughout the final approach, with no level segment crossing the beacon. The same beacon safe crossing height of 1,400 feet has been maintained, this now being a defined Step Down Fix. The Step Down Fix at 2 nm DME east of the beacon has been retained in order to ensure adequate clearance from the high ground in the vicinity of the beacon.

A warning note has also been applied to the chart stating that the '*IOM DME is co-located with the VOR (4.5 nm west of the aerodrome). DME does not provide distance to go to the aerodrome. Do Not descend below procedure minimum heights*'.

As a result of this study, the CAA issued a revised VOR/DME approach procedure chart, as shown in Appendix I. This was introduced for operations

from 10 September 1998. In turn, a revised procedure chart was issued by Aerad, as shown in Appendix A, Figure 2.

## 2.2 Chart data presentation

The CAA AIP information is routinely taken as a basis for the production of commercial chart libraries by companies such as Aerad (Appendix A) and Jeppesen (Appendix J), each of whom have a unique standard of presentation of the relevant data.

Of particular note is the fact that Aerad charts portray Minimum Safe Altitudes rather than specific terrain spot elevations, with areas of high ground being depicted in outline form in green on the plan view. This Jeppesen chart portrays terrain data and dominant obstacles in the form of spot elevations, but with no contouring. The CAA chart specification portrays areas of high ground with topographical contours together with associated spot elevation information (Appendix I). The international charting standards are prescribed in Annex 4 to the Chicago convention. However, these standards apply only to ICAO member states, and not to commercial charting organisations. ICAO has proposed additional common standards for the depiction of terrain and obstacles on approach charts, but these have not yet been agreed. However, when agreement is finally reached, they will apply only to member states, not to commercial charting organisations.

The unique nature of the terrain at the south western corner of the Isle of Man did not lend itself to accurate depiction using the Aerad terrain shading system. The relatively thin ridge-like nature of the high ground did not depict well on the chart (Appendix A). Therefore, in these circumstances, flight crews may not be fully aware of the exact nature of the terrain in the vicinity of the approach procedure to be flown. This is obviously not conducive to the ideal situation whereby crews have easily assimilable information with which to produce a mental picture of the horizontal and vertical profiles to be flown and their relationship to relevant terrain and obstacles.

Also of note was the fact that the Aerad had no specific chart legend to indicate the existence of the Step Down Fix at 2 nm DME from 'IOM'. This was depicted as a procedure altitude/height, in the same way as, for example, glidepath advisory altitudes/heights for ILS approaches. For ILS procedures, however, there is an allowable margin of deviation **below** the published glidepath before obstacle/terrain clearance is compromised. For procedure altitudes/heights

associated with non-precision approaches, they are **minimum** values to assure compliance with obstacle clearance criteria.

As a result of these shortcomings in the presentation of the Isle of Man approach charts, **it is recommended that Racal Aerad consider improvements to their approach chart design in order to clearly present the essential information, such that flight crews may build a comprehensive mental picture of the horizontal and vertical flight profiles to be flown and how these relate to significant terrain and obstacles relevant to the approach.**

The operator provided an approach chart library produced by the Aerad company. This library contained an approach minima summary for each airport entry in two forms, one based on Joint Airworthiness Authority Regulations (Operations) (JAR-OPS), (Appendix A, Figure 3), and an older version based on Civil Aviation Publication (CAP) 360 criteria (Appendix A, Figure 4).

The operator was in the protracted process of preparing to transfer its operations under the CAP360 criteria to those specified by JAR-OPS and the chart library contained both sets of pages (both sets were printed on the same shade of green paper). At the time of the incidents, operations were still being conducted in accordance with CAP360. Aircrew Notice Number 4/98 (dated 18 February 1998) had been issued which stated that crews were to refer only to the CAP360 criteria page for determination of relevant operating minima. The presence of both sets of pages in the aircraft chart libraries increased the probability that crews would select the wrong chart, as was demonstrated in the case of the G-BIUV incident.

## **2.3 Airport facilities and air traffic control**

### **2.3.1 Instrument Landing System, Runway 08**

The most frequently prevailing wind directions across the United Kingdom favour the use of westerly runway directions. For this reason, the Isle of Man (Ronaldsway) Airport has had the ILS facility available for Runway 26 for a number of years.

In general, the maximum acceptable tail wind component allowable for landing of most public transport aircraft is 10 kt (the HS748-2A type is an exception, with a 20 kt maximum tail wind limit). Therefore, the use of Runway 26 for landing is

precluded whenever easterly winds prevail which produce a tail wind component greater than this figure.

In situations where use of Runway 08 is necessitated by surface wind conditions, the consideration of cloud base and visibility is also required.

The Isle of Man (Ronaldsway) Airport, with its coastal location, is subjected to relatively frequent occurrences of low cloud conditions and reduced visibility in precipitation or fog. In general, the use of a precision approach aid will enable an aircraft to descend to a lower altitude/height (about 200 feet above the runway elevation) in order to allow the crew to attain the required visual sighting of the runway or approach lighting in order for the aircraft to continue for a landing. Where no precision approach facility is installed, this visual acquisition must occur some 250 to 300 feet higher (and consequently further away from the runway threshold). In the event that the crew are unable to sight the runway or approach lighting at the MDA/H, then a go-around must be flown and a possible diversion to another airport with better weather conditions.

There is also the enhanced flight safety benefit in the relative ease with which the ILS deviation display is interpreted on board the aircraft. These displays give a continuous accurate pictorial representation of the aircraft's position relative to the runway centreline and ideal approach glidepath and (when associated with a DME facility at the touchdown threshold) a direct indication of distance to run to the runway. An added benefit is that it is also possible to fly the approach using the aircraft's autopilot system (where fitted) to the Decision Altitude/Height, thus relieving the flight crew of some of the workload and allowing more time for monitoring of the approach progress. Had an ILS facility been available for Runway 08, then these incidents would not have occurred.

Studies into the circumstances where controlled flight into terrain has occurred have shown that the lack of a serviceable ILS is a significant contributory factor, especially when coupled with poor flight deck procedures and poor Crew Resource Management.

It is therefore desirable for both Runway 08 and 26 at the Isle of Man (Ronaldsway) Airport to have the benefit of an ILS installation. It is worthy of note that the airports at Guernsey and Jersey, with similar maritime climates and similar overall aircraft diversion rates, have ILS facilities serving both ends of their runways.

The provision of ILS equipment for Runway 08 has been considered by the airport management and is being actively progressed since these incidents occurred.

**It is recommended that the Isle of Man Government, Department of Transport, arrange for the installation of an Instrument Landing System facility for Runway 08 at the Isle of Man (Ronaldsway) Airport.**

### 2.3.2 Area radar data

Approach Surveillance Radar coverage in the Isle of Man area was detailed in Section 1.10.3. Additional data from these sources could have greatly assisted these investigations. The upgrade of the ATC recording facility to a digital system is planned within the next few years. At that time, it will become feasible to incorporate a Secondary Surveillance Radar recording facility.

**It is recommended that the Isle of Man Government, Department of Transport, arrange for the Ronaldsway Airport Secondary Surveillance Radar data be recorded and preserved for a suitable period of time.**

### 2.3.3 Provision of weather information to pilots

The automated weather information sources available to pilots when airborne were described in Section 1.7.4.

Isle of Man Airport does not have an ATIS facility, but is included in the London VOLMET North broadcasts. The provision of an ATIS facility for the airport had already been planned at the time these incidents occurred, but implementation was awaiting suitable equipment procurement.

Unless the current weather has recently been noted by a flight crew from the VOLMET broadcast, the current weather information must be passed verbally by the Approach controller. This adds to the workload of both ATC and the flight crew. An added benefit of an ATIS system is that it enables the flight crew to obtain the content of the broadcast at an operationally more advantageous time, taking account of workload, RTF and briefing requirements.

**It is recommended that the Isle of Man Government, Department of Transport, arrange for Ronaldsway Airport to be equipped with an Automatic Terminal Information System (ATIS) facility.**

## **2.4 G-BIUV (freighter aircraft) incident**

### **2.4.1 Crew complement**

The commander was a very experienced HS748 pilot. However, there had been a break in his flying career when he had been operating other aircraft types before returning to full time employment with this operator. He had only been back on line on the HS748 for about two months at the time of the incident. The first officer was in his first airline post and was only a few weeks beyond the line training phase.

Neither pilot had conducted the VOR/DME procedure to Runway 08 at the Isle of Man in instrument weather conditions.

The first two sectors of the night duty were flown uneventfully. The lack of a required navigation chart (Belfast International VOR/DME 07) highlighted the need for pilots to confirm that the relevant charts are on board the aircraft prior to departure. In this case, it was fortunate that the first officer was carrying a personal backup copy of the relevant chart.

On return to Liverpool, there was a break of about two hours before the departure time of the next (incident) sector. This may have been sufficient to reduce the crew's alertness prior to the start of the next sector. Experience suggests that this situation is not uncommon with long turnround times during long crew duty periods, especially at night, and is generally highlighted during Crew Resource Management courses.

### **2.4.2 Aircraft loading and centre of gravity**

The Centre of Gravity was probably close to forward limit, as indicated on the aircraft Load Sheet. Therefore, the use of a large amount of nose up trim should not have surprised the commander prior to the commencement of the approach, unless he had been previously unaware of it or unless the load had been distributed in a more forward location than indicated on the Load Sheet, leading to CG being more forward than indicated.

Anecdotal evidence from other pilots suggested that loading errors were not uncommon during night freight operations, highlighting the need for the operator to conduct frequent and rigorous audits of loading operational procedures and for flight crews to visually confirm the loading status prior to departure.

### 2.4.3 Preparation for the approach

The crew's entry of 470 feet MDH and 1,200 metres RVR on the Navigation Log was not in accordance with the company Aerodrome Operating Minima scheme. For CAP360 operations, the correct figures were 450 feet and 1,300 metres respectively. For JAR-OPS operation, the correct figures would have been 450 feet and 1,200 metres respectively. Neither scheme specified 470 feet as a MDH. This error highlighted the need for operators to minimise the potential for crew mis-selection of charts during flights, especially at times of high workload.

There was a discrepancy between the recollections of the two pilots regarding the Approach Briefing. The commander recalled that he had given a full briefing to the first officer. However, the first officer could not recall that any such briefing took place. When queried as to why he had not prompted the commander to give a detailed briefing, the first officer indicated that he was reluctant to question the commander on this as he had only been in the company for a short period of time. The disparity in the two pilots' descriptions of the Approach Brief was not reconcilable as there was no Cockpit Voice Recording available which covered the incident flight and which would have recorded the content of any approach briefing.

Better Crew Resource Management prior to the approach would probably have enabled the first officer to discuss any lack of an approach briefing with the commander. Certainly, a thorough approach briefing would have fully prepared both crew members for the sequence of events that would follow during the approach.

Since these incidents, the operator has worked to produce a specifically tailored in-house Crew Resource Management Training Module for its pilots. Suitable training of this type should ensure that this sort of reticence to speak out is minimised and enable crew members to communicate any misgivings more freely.

The turbulence experienced during the initial approach phase had an apparent effect on propeller synchronisation which may have distracted the first officer, as he had not experienced this before.

#### 2.4.4 Conduct of the first approach

The aircraft achieved a good turn on to the inbound radial, with the speed stabilised at about 125 kt IAS. The FDR data indicated that the selection of approach flap (and, by implication, the landing gear) occurred just prior to the start of the descent from 1,900 feet. However, instead of the recommended approach flap setting of 22.5°, the flaps travelled to the full 27.5° setting, thus maximising the aircraft drag. This was not noticed by either crew member, but does serve to explain the apparently poor aircraft performance and the commander's perceived handling difficulties.

On attempting to level off before crossing the VOR, the aircraft was at about 650 feet instead of 1,400 feet. The aircraft had been pitched down to about 5° nose down during the descent which achieved an average descent rate of about 1,100 feet per minute, whereas a descent rate of 500 feet per minute or less should have been adequate under normal circumstances. The speed began to decay as the nose was raised during the attempt to level off. As the nose was raised above the horizon, the aircraft began to climb away, but the speed initially continued to reduce to about 110 kt, which verified the commander's recollection of the event. Once the pitch attitude had stabilized at about 5° nose up, the aircraft climbed away and the speed increased.

The approach controller's report that the aircraft had re-entered radar coverage climbing through 300 feet (Mode C) could not be reconciled with the FDR data. Had any recording of the Isle of Man Secondary Surveillance Radar data been available, it would have been possible to resolve this point.

As the aircraft climbed through about 1,400 feet and with a speed of about 115 kt, the FDR indicated that the flaps were retracted to 15° (the recommended setting) and remained there until the second approach. This confirmed the commander's recollection that the aircraft handling became 'normal' after the flap retraction sequence was commenced during the go-around phase.

#### 2.4.5 Conduct of the second approach

At about the time that the second descent was initiated, the flaps again travelled to the 27.5° setting instead of the recommended 22.5° approach position. Again, this was not noted by the crew. This time, the commander flew the approach at a slightly faster airspeed and there was no repeat of the handling problems that had occurred during the first approach. However, the FDR data indicated that the

minimum crossing heights at the VOR and at the Step Down Fix were not achieved, and the aircraft would have had less than the prescribed minimum obstacle clearance at these positions.

#### 2.4.6 Consideration of flap mis-selection

The detail of why 27.5° Landing Flap was selected for both approaches, instead of the company standard procedure of using 22.5° Approach Flap until on short final approach, cannot be confirmed by any hard evidence. The poor quality of the FDR flap position recording system did not assist with this aspect of the investigation. The apparent 'pause' in the flap position at 22.5° (evident for both of G-BIUV's approaches) cannot be explained, although this may have been simply a function of the mechanics of the flap position sensors used to provide the signals for the recording.

This particular aircraft was unusual in that it was equipped with an emergency flap override selector switch at the rear of the centre console (Appendix D, Figure 3). Operation of a Master Switch from Normal to Emergency activated a Flaps Up - Flaps Full Land selector switch, intended for use when the normal (electrical) flap positioning system was inoperative. The possibility was considered that mis-selection of the emergency system could have occurred, but inadvertent selection was thought implausible because the selection occurred twice during the flight on separate occasions, with an intervening flap retraction to 15°. No anomalies with the aircraft's flap system were reported prior to, or since, the incident flight.

Neither pilot could recall monitoring the flap movements. The first officer could not be sure which pilot had selected the flaps. It was indicated that, in some circumstances, the handling pilot would also make changes to the flap selection at times when the other pilot was occupied by some other task. Discussion with some of the operator's other pilots also indicated that this was the case. If so, this can lead to the non-handling pilot being out of the information loop with regard to the aircraft configuration which can, in turn, result in a breakdown of monitoring. This is another important area that is required to be addressed during the improved CRM training programmes.

In any event, the need for a handling pilot to require an immediate flap selection would indicate a possible lack of forward planning and awareness. The usual procedure of the non-handling pilot making all of the changes to the flap and landing gear status is rendered impossible on this type of aircraft as the landing

gear selector is located in such a position that it can only be operated by the pilot in the left-hand seat. However, there is no reason why the first officer, as non-handling pilot, would not have been able to make the required flap selections on the command of the handling pilot.

The first officer subsequently indicated that he had never previously inadvertently mis-selected the flaps, even during his initial training. He indicated that he had carried out some research in a similar aircraft (on the ground) with regard to possible reasons for a flap mis-selection. He concluded that because of the nature of the flap gate system (illustrated in the flight deck photograph in Appendix D Figure 3) and the direction and radius of movement of each pilot's arm, it was more likely that a mis-selection of 27.5° instead of 22.5° would occur if the flaps lever was moved by the pilot in the left-hand seat.

Again, with the limited data available from the FDR and no CVR recording, it was not possible to resolve this point. However, it was clear that the actual achieved flap position should have been noted by at least one of the pilots during the course of the approaches.

In order to ensure that this would become standard practice, the operator has since introduced revised Standard Operating Procedures for crews, which includes the non-handling pilot making the flap selection leaving one hand on the selector lever until the flaps have finished travelling and then a positive confirmation of the achieved flap position by the handling pilot after any selection has been made.

#### 2.4.7 Consideration of the non-handling pilot's workload

The first officer also detailed the items that contribute to a high workload for the non-handling pilot during the approach phase, such as cross-flight deck communication, ATC communication, radio frequency change, reading descent profile data from the approach chart, carrying out checklist actions on a challenge and response basis, and (in this case) checking the single DME indicator reading on the centre instrument panel. The operator's checklists, for Cargo and Passenger operations are presented in Appendix H, Figures 1 and 2 respectively. Too much attention focused on these items would tend to detract from the monitoring function. The selection of approach flap and landing gear down was the usual cue for the non-handling pilot to perform the Landing Checklist.

In this case, the first officer recalled that he had been very busy performing the checks and making the radio calls, but indicated that he was performing

intermittent instrument panel scans in his attempt to monitor the progress of the approach. There was a period of about 30 seconds after the aircraft descended below 1,400 feet when this monitoring did not take place. The first officer indicated that he had just realised the aircraft's situation and was about to inform the commander when the aircraft broke cloud and the crew gained visual contact with the coastal features and terrain.

One checklist item in particular was singled out for being time consuming to perform. For cargo operations, it was necessary to manually depressurise the aircraft by switching the Spill Valve selector to Manual then manually opening the Spill Valves while monitoring the pressurisation state of the aircraft. This could take some two to three minutes to complete. (The passenger aircraft in the fleet were fitted with automatic systems). When completed, the first officer was required to gently open the Dump Valve lever located in the right footwell whilst monitoring the pressurisation.

The operator has since considered the content of the checklists and issued revised versions (Appendix H, Figures 3 and 4). The operator has now amended the standard operating procedures such that flight crews are encouraged to configure the aircraft with approach flap and landing gear down prior to the commencement of the final descent, thus allowing extra time for the completion of the Landing checklist items.

#### 2.4.8 Approach design and crew situational awareness

The other major factor in the incident was the lack of appreciation of the aircraft's position relative to the VOR/DME station. This VOR/DME approach procedure is unusual in the United Kingdom in that it involved the DME indication counting down during the initial descent phase of the final approach, to the point of beacon passage, then counting up again as the aircraft continued the approach and final descent between the beacon and the runway.

It is more usual for the DME transmitter to be located on the airfield, such that a continuously decreasing distance to run indication is displayed, as is the case for the ILS/DME installation for Runway 26 at the Isle of Man Airport. This is certainly the more frequently encountered situation and one which could be regarded as 'normal' for the Isle of Man, with approaches to Runway 26 in the statistically more predominant westerly airflows.

In this incident, there was a lack of situational awareness demonstrated by the handling pilot, perhaps due to some mental reversion to the 'DME to touchdown' perception rather than the actual geography. This, in turn, resulted in the belief that the aircraft was high on the approach profile, until the reality became apparent as the aircraft broke cloud and the terrain came into view. Such a lapse of situational awareness was probably accentuated by the other perceived problems of excessive nose up trim requirement and the apparently excessive power requirements.

Had the non-handling pilot been less distracted from the task of monitoring the flight instruments, then he would have had a better (continuous) mental picture of the aircraft's situation and would have been able to advise the handling pilot accordingly.

#### 2.4.9 Aircraft flight instrumentation

The effect of the standard of aircraft instrumentation was also considered to be a factor. In particular, the Attitude Indicator was of an old design, with no pitch scale. Interpretation of this instrument probably accounted for much of the cyclic variation in the aircraft's airspeed during the approaches (Appendix G, Figure 4). A three pointer Altimeter was fitted which required additional interpretation to determine the 'thousands' indication. These are now only rarely found on public transport category multi-crew aircraft. The DME indicator had a very coarse distance scale on a rotating drum and was not conducive to easy accurate interpretation at a glance, nor was it in such a position that its reading could be continuously monitored by both crew members. The primary flight instrumentation and navigation radio equipment fitted to this aircraft may have complied with the intent of the legal requirements for IFR flight within controlled airspace, but they did nothing to contribute to the ease of setting and interpretation of information that more modern designs have achieved.

The operator's standard operating procedures did not require significant reference to the Radio Altimeter indication during the approach phase. Reference to this instrument, and cross checking with the pressure altimeters, can confirm adequate clearance from and rate of closure with ground or water beneath the aircraft. This was a valuable resource which was not referred to by the crews in either of these incidents.

It is also significant that the operator's aircraft were not fitted with the facility to set an adjustable instrument cursor on either the airspeed indicator (to indicate minimum safe operating speeds) or on the pressure altimeters (to indicate minimum safe Descent Height/Altitude during instrument approaches). Such facilities give crews an immediate visual presentation of the proximity to the safe lower limits of operation. In both of these events, the aircraft came close to both the final approach Minimum Descent Height for the procedure being carried out, and close to the minimum threshold speed (VAT) for the operating weights and flap configurations, despite each aircraft being outside the final approach fix at the time.

**It is recommended that the CAA require the provision and use of suitable adjustable cursor devices for the primary flight instruments (airspeed indicators and pressure altimeters) on all UK registered Public Transport aircraft.**

In total, this standard of instrument panel would have increased the interpretation workload of the handling pilot at a critical phase of the flight, thus reducing the available capacity for assimilating the aircraft's progress along the final approach track, with the associated potential for loss of situational awareness through being mentally overloaded.

It was also the case that there was a large variation in the type and location of instrumentation fitted to the various aircraft in the operator's fleet. Of the 14 aircraft in the fleet, there were two sets of two aircraft with identical instrument and avionics equipment. There were therefore 12 different flight deck layouts with 7 different types of DME indicator across the fleet. This variation could have the effect of making the crews feel less familiar with the flight deck layout than would be the case if the fleet had a common standard of instrumentation in identical locations. Additionally, the nature of the radio selector panels in the flight deck roof, with no pre-selection facility, had the effect of causing the non-handling pilot's attention to be focussed away from a periodic scan of the flight instruments in front of him while making frequency selections overhead. This would also increase the probability of the non-handling pilot also having reduced situational awareness.

**It is recommended that Emerald Airways Ltd achieve a greater degree of standardisation of its fleet with a common, more modern, design of flight deck instrumentation, communication and navigation receivers in order to afford its flight crews an ergonomically satisfactory layout that is easy to operate and to interpret during instrument flying conditions.**

## **2.5 G-BGMO (passenger aircraft) incident**

### **2.5.1 Crew considerations**

This incident was somewhat different in nature from that described in the case of G-BIUUV. In this case, there was a well experienced crew, who had flown together previously. In addition, they were operating one of the aircraft in the fleet which was equipped with a more modern design of instrumentation and avionics equipment.

The commander's restless night and long drive to work were probably factors which resulted in a possible loss of alertness and, consequently, situational awareness. Because the roster patterns were more favourable, the commander preferred to do night flights on cargo operations in order that he could travel fewer times per week. On this relatively unusual occasion, he had been rostered to conduct an early morning duty.

The first officer had suffered a change of roster pattern during the previous few days which may have left him more tired than usual at the start of the duty period. However, neither pilot felt that their performance was going to be impaired by these factors prior to the flight.

### **2.5.2 Preparation and initial approach phase**

The initial part of the flight was normal and, prior to the start of descent, a good clear approach briefing occurred, according to both pilots. There was no hint of confusion over the planned approach at the briefing stage. The commander's decision to fly the aircraft for the approach, rather than use the autopilot, was influenced by his wish to gain additional practice in preparation for his renewal Base Check which was planned for the following day.

The aircraft was given a turn onto final approach somewhat later than was needed to achieve a smooth turn onto the inbound radial. This was, in part, probably due to the prevailing south-easterly wind at that altitude, from 130°T at 23 kt. There was no instrumentation fitted in the aircraft which would give any wind information to the crew, nor was there any available to the Ronaldsway Approach Radar controller, apart from a Met forecast. The Approach controller may have anticipated that the aircraft would decelerate prior to the commencement of the turn, but this did not occur.

Also affecting the quality of the turn onto final approach was the fact that the aircraft was flying at a faster speed than in the G-BIUV incident (180 kt prior to the commencement of the turn onto final approach), which was above the approach flap and landing gear limiting speeds, and above the speed recommended in the company Operations Manual. The aircraft manufacturer's recommended technique (Appendix B) and the operator's Flying Manual (Appendix C) both indicate that the Intermediate approach phase should be flown with 15° flap selected, at a speed of 125 kt.

The width of the approach beam at 4 nm from the VOR station is 0.7 nm each side of the centreline, to give full scale (10°) deflection on the OBS with the inbound course selected. For an aircraft travelling with a ground speed of 180 kt, and assuming that a rate one turn is carried out, the radius of turn is almost 1.5 nm. At 120 kt ground speed, the radius is about 1 nm.

The turn onto final approach occurred later than was required for a smooth intercept and was conducted at a significantly faster speed which, when added to the existing tailwind component, resulted in the aircraft flying through the inbound centreline track.

The result was that the aircraft crossed through the inbound radial during the turn onto final approach, necessitating additional concentration on regaining the inbound course by the commander for a period of about one minute. Had the autopilot been in use at this stage, the commander would have had a greater chance of maintaining his situational awareness until the final approach track was established. In fact, use of the autopilot throughout the approach phase, subject to Flight Manual limitations, is desirable in IMC conditions.

### 2.5.3 Descent phase

While the aircraft was in the process of regaining the correct inbound track, the descent was commenced, achieving an average descent rate of about 1,500 feet per minute below 1,900 feet, even though less than 500 feet per minute would have been necessary under normal circumstances. The flaps were selected to 15° at the start of the descent at a speed of 180 kt (the flap limiting speed). Further flap selection to 22.5° (and, by implication, selection of the landing gear down and the initiation of the Landing checklist) occurred as the aircraft was decelerating through 160 kt (the landing gear operating limit speed) and passing about 800 feet. By the time that Flap 22.5° had been achieved, the speed had reduced below 140 kt, which was the limiting speed for this flap setting. This

relatively late selection would have caused a considerable increase in the workload of the non-handling pilot at this stage of the approach, although the intermediate level-off height (intermediate Minimum Descent Height) of 1,400 feet had already been passed by this time, thus compromising the prescribed obstacle clearance criteria.

This scenario is typical of the 'rushed approach' where the aircraft is travelling too fast to be correctly configured in a timely manner in anticipation of the next phase of the approach. In this situation, the handling pilot was subjected to additional mental tasks caused by the need to correct the horizontal navigation, achieve a correct aircraft configuration and achieve the correct vertical profile while maintaining a comprehensive instrument scan, thus creating the conditions where errors are likely to occur.

The commander indicated that he had suffered a loss of situational awareness and reverted to a belief that the DME facility was at the runway threshold and that the aircraft was higher and faster than it should have been at that stage of the approach. This was probably compounded by his misinterpretation of the DME indicator display at the start of the descent (see Section 1.1.4). The commander commented that he (and probably other pilots also) had misread this type of display on several other occasions, but these had always been corrected prior to any deviation from the normal flight path.

The first officer noted that the aircraft had descended below the required profile and recalled highlighting this to the commander, but the commander did not respond. The first officer indicated that he then looked across the flight deck to see if the commander was incapacitated but concluded that he was just concentrating on flying the aircraft. The commander did not recall any voice prompt having been made. Before the first officer could make any further input, the aircraft broke cloud and the approaching coastline came into view.

Without firm evidence from the CVR, it was not possible to confirm the exact sequence of events that took place during the approach. Neither was it possible to reconcile the first officer's recollection of the events with the data from the FDR. He had considered that after the aircraft descended through 1,400 feet, only 5 seconds elapsed when he was monitoring the flight instruments without a communication taking place or when not visually checking that the commander was not incapacitated, and that a total of 17 seconds elapsed during the time the aircraft descended to the point where he considered that the commander initiated the recovery at an estimated 850 feet, some 5 to 7 seconds after the 'altitude' call.

From the FDR evidence, the aircraft's average rate of descent during this initial period was about 1,500 feet per minute and, at the time the aircraft descended through 800 feet, the flaps were selected to 22.5°. The rate of descent was reduced and about 25 seconds then elapsed to the start of the recovery from the descent.

The initiation of the recovery, at about 500 feet, was coincident with the flaps having reached the 22.5° position (the MDH for the approach was 450 feet). The data shows that, during the recovery, the aircraft may have descended slightly below the final approach MDH before any climb was achieved. However, the data was subject to the inaccuracies detailed in Section 1.11.1.

If the aircraft had not fortuitously broken cloud, it is possible that it would have collided with terrain or obstacles in the vicinity of the VOR/DME transmitter. From the crew reports, the aircraft continued towards the airport without the crew being able to maintain continuous visual contact with the surface. The actual obstacle clearance achieved as the aircraft passed over the VOR/DME transmitter was probably less than the minimum specified in the non-precision approach design criteria. On breaking cloud and realising that this error had occurred and that it was not possible to maintain visual contact with the surface for the remainder of the approach, the commander should have initiated a full go-around procedure.

#### 2.5.4 Summary of significant features leading to this incident

- The effects of a disturbed night's rest on the commander and the cumulative effect of the varied roster pattern on the first officer led to them both probably performing at a less than optimum level on the morning of the incident;
- The decision by the commander to fly a manual VOR/DME non-precision approach procedure in preparation for the following day's renewal check flight;
- The perceived pressure resulting from the knowledge that the aircraft had only a 30 minute turnround period before the next scheduled operation and that use of Runway 08 involved an increased flight time before landing, thus potentially reducing the turnround time to an unachievable level;
- The late initiation of the radar vectored turn onto the final approach track.

- The aircraft being incorrectly configured for the approach and flying at an inappropriate airspeed at the commencement of the turn onto final approach in the presence of a tailwind component. This resulted in the aircraft flying through the inbound track during the turn and it subsequently took the commander's attention for about one minute to correct this condition;
- During this correction phase, the descent was commenced while the commander attempted to decelerate the aircraft sufficiently to allow selection of the landing gear down and approach flap while remaining within the operating limitations of the aircraft;
- The first officer became fully occupied with the aircraft configuration and the completion of the landing checklist, such that he was unable to make a verbal input in a timely manner to prevent the aircraft descending below the published intermediate Minimum Descent Height while the aircraft was still to the west of the VOR/DME station;
- Because of the commander's high workload brought about by the above factors, his situational awareness became confused, he mis-read the DME indication and reverted to the belief that the DME reading was the distance to the runway threshold, not to the VOR/DME station 4.5 nm from the runway.

## **2.6 Standard Operating Procedures**

Since these incidents, the operator has introduced revised procedures with regard to the selection and monitoring of flaps. Recommended techniques have also been issued to ensure that earlier configuration of the aircraft takes place prior to a non-precision approach, in order to allow the non-handling pilot more time in which to complete the checklist items and to then monitor the progress of the approach.

## **2.7 Company Operations Manuals**

The adaptation of the company's operations from CAP360 specifications to those of JAR-OPS1 was a protracted process, during which many amendments to the Operations Manual were delayed. This led to a significant number of Notices to Aircrew being issued.

Additionally, the management pilot team were heavily involved in the day to day flying tasks including training and testing. Sufficient management time needed to

be allocated to the required administrative processes. A consultant had been employed by the company since 1995 in order to edit the Operations Manuals and to control the amendment process. Despite this, it appeared that the company's management team was under resourced.

Subsequent to these incidents, further personnel have been introduced to additional management positions.

The shortcomings in the content and presentation of the Operations Manual Volume 9 Flying were detailed in Section 1.17.2. These may have discouraged continued reference by pilots when beyond their training phase. The lack of provision of these manuals to pilots, in the manner that was detailed in the Volume 1 General, would not have encouraged their continued use as a reference source. Once training had been completed, without easily referenced Operations Manuals and detailed Standard Operating Procedures, there can be a tendency for personal habits, preferences and non-standard operating techniques to appear during day to day (or night to night) operations. With a mix of flight crews and less than full standardisation, the effectiveness of a two crew flight deck is severely diminished.

**It is recommended that Emerald Airways Ltd revise the content of its Operations Manual (Flying), in order to lay out in logical and correct form the whole of the Normal, Abnormal and Emergency operational details for the aircraft being operated. Also highlighted clearly should be any significant differences between the operation of the range of HS748 aircraft and the instrument/avionics equipment fitted to each.**

The operator's method of conducting technical training for the aircraft type rating was also detailed in Section 1.17.2. This system has shortcomings in terms of maintaining control over currency of manual content and the applicability of the information across a diversely equipped fleet of aircraft, as well as the continuing general availability to crew members for reference purposes.

These documents should then form the foundation of an integrated training system and provide a basis of reference for crews after their training has been completed. They should be regularly amended in order to remove the reliance on 'photocopy culture'.

**It is recommended that Emerald Airways Ltd produce a suitable Operations Manual, Aircraft Technical, to contain detailed technical descriptions and systems diagrams for all of the relevant aircraft systems. It should also include a detailed description of the significant differences which remain in aircraft equipment over the diverse fleet. This manual should then be issued to all crew members for reference purposes.**

## **2.8 Crew Resource Management Training**

Before these incidents occurred, most of the operator's pilots had undertaken external Crew Resource Management training courses provided by a third party training organisation. The operator has now decided to conduct its own training courses in this subject, specifically tailored to its own operations. A new Crew Resource Management Course has now been drafted. The first officer involved in the G-BIUUV incident had not received any Crew Resource Management training prior to the incident.

## **2.9 CAA Oversight Programme**

The current oversight programme (for CAP360 operators) used by the CAA is comprehensive in its nature but, as demonstrated in this case (section 1.17.4), may not be robust enough to deal with the types of shortcomings revealed during this investigation, particularly in terms of aircraft equipment standards and commonality, company operations manual provision and content, flight crew procedures etc.

With the move towards JAR-OPS1 requirements for a Quality Audit approach to operations management, it will become vital for operators to realise that responsibility for flight safety rests with them.

Primary responsibility for corrective action will therefore lie with the operator. The CAA must also ensure that its continued oversight of AOC holders is detailed and robust enough to ensure that the operators' systems for dealing with identified shortcomings are timely and effective.

In addition, any shortcomings that may be present, but not specifically identified by an operator or reported internally, will need to be indentified by the oversight programme. Those improvements which are considered to be beneficial as

industry 'best practice' will also require to be highlighted during CAA oversight process.

**It is recommended that the CAA should review the effectiveness of its current AOC Holder Oversight Programme. In particular, the CAA should determine whether there is a need to introduce additional methods of ensuring timely compliance with identified potentially safety-related shortcomings in the AOC Holder's operations.**

## **2.10 CAA Action with regard to Controlled Flight into Terrain Risk Avoidance**

Following the work of the Flight Safety Foundation study into Approach & Landing Accidents and Controlled Flight into Terrain, the CAA published two documents highlighting all of the relevant aspects of the study and providing suggestions and recommendations to operators and pilots with regard to their own practices.

In April 1999, Aeronautical Information Circular (AIC) 38/1999 (Pink 191) was published. The aim of this was to identify what can and should be done by pilots and by aircraft operators to minimise the risk of CFIT accidents. The contents were intended to apply to all types of operations and detailed 'best practice' by flight phase.

At about the same time, the CAA Flight Operations Department issued a communication to all UK AOC holders (FODCOM 6/99), which detailed CFIT Operational and Training Considerations, referring to the 'best practice' in the document detailed above.

### **3 Conclusions**

#### **(a) Findings**

##### *The aircraft*

- (1) Both G-BIUUV and G-BGMO were serviceable with no significant defects and neither aircraft suffered any systems failures or malfunctions which would have caused uncommanded descents.
- (2) According to the Load Sheets, the estimated weight and loading of each aircraft was indicated to be within the normal operating limits at the time of the incidents. There was sufficient fuel on board each aircraft to conduct the approach, go-around, hold and then to divert if necessary.
- (3) Each aircraft's pressure altimeters were not fitted with any adjustable cursor which could have been set to indicate the Minimum Descent Height for the approaches being carried out. Each aircraft's airspeed indicators were not fitted with any adjustable cursor which could have been set to indicate the minimum safe flying speed for the landing flap configuration.
- (4) The Ground Proximity Warning System was not designed to provide a warning to the crew that the aircraft was too low while in the landing configuration and descending on an approach at normal descent rates over relatively flat terrain or over water. The proposed Terrain Awareness and Warning System (TAWS), carriage of which is intended to become mandatory, will lead to enhanced crew awareness and warning capability in these circumstances.
- (5) Each aircraft was fitted with a Radio Altimeter, but the operator's procedures did not require reference to it during non-precision approaches.
- (6) In the case of G-BIUUV, the aircraft was equipped with an outdated design of primary flight instruments and radio navigation systems which contributed to the loss of situational awareness of the crew at a time of high crew workload.
- (7) In the case of G-BGMO, the aircraft was equipped with a DME indicator which was located on the instrument panel such that the commander's view of its display was obstructed by the control column.

*The crew - G-BIUV (freighter aircraft) incident*

- (8) The crew was properly licensed and medically fit to conduct the flight.
- (9) The pre-flight rest period was adequate. The flight duty period at the time of the incident was well within the normal company flight time limitation scheme. The two hour turnaround time in the middle of the night at Liverpool may have subtly reduced the alertness levels of the two pilots.
- (10) The lack of a CVR recording covering the period leading up to the incident left some unresolved discrepancies in the detail of the events, such as the content of the Approach Briefing, as perceived by each crew member.
- (11) The commander was concerned that the aircraft required a higher than usual amount of nose up trim and additional power in order to maintain level flight at the start of the final approach phase. This probably caused a degree of distraction from his flight instrument panel scan which continued during the descent and contributed to the commander's loss of situational awareness.
- (12) Neither pilot noted that the flaps had travelled to the Landing (27.5°) setting, instead of the required Approach (22.5°) setting.
- (13) The relatively inexperienced first officer was distracted from the task of monitoring the progress of the approach by the high workload associated with the need to conduct the Landing Checklist items and conduct the radio communications. The company Standard Operating Procedures did not adequately define the need to ensure an earlier selection of the landing gear down, in order that the Landing Checklist could be actioned in good time.
- (14) It was fortuitous that, because of the nature of the low stratus cloud, the crew saw the approaching coastal features before the aircraft came into close proximity to the terrain.
- (15) The Standard Operating Procedure of the non-handling pilot monitoring the progress of the approach was not effective in preventing the aircraft from descending below the published approach profile.

*The crew - G-BGMO (passenger aircraft) incident*

- (16) The crew was properly licensed and medically fit to conduct the flight.

- (17) The flight duty period at the time of the incident was well within the normal company flight time limitation scheme. The rostered pre-flight rest period conformed to the operator's Flight Time Limitations scheme.
- (18) In the case of the commander, a disturbed night's sleep had probably subtly reduced his efficiency to operate the aircraft. In the case of the first officer, a variable working hours pattern during the previous few days had resulted in his feeling less well rested than usual at the start of this flight duty period. Neither pilot had considered, prior to the incident, that their performances would be impaired by these factors.
- (19) The aircraft was flying at too great an airspeed to configure it correctly for the approach at the time that the radar controller instructed it to commence the turn onto final approach. The timing of this instruction, combined with a tailwind component on base leg and the aircraft's speed, resulted in the aircraft flying through the approach centreline during the turn.
- (20) The commander's attention was then occupied for about one minute in returning the aircraft to the correct inbound course, during which the initial descent commenced and continued (at an average rate of about 1,500 feet per minute) through the required intermediate Minimum Descent Height of 1,400 feet.
- (21) By the time the aircraft had decelerated, the landing gear and the approach flap (22.5°) had been selected, the aircraft had descended significantly below the prescribed intermediate Minimum Descent Height.
- (22) The lack of a CVR recording covering the period of the incident left some unresolved discrepancies in the detail of the events, as perceived by each crew member.
- (23) The relatively experienced first officer was distracted from the task of monitoring the progress of the approach by the high workload associated with the need to conduct the Landing Checklist items and conduct the radio communications somewhat later than usual during the approach sequence.
- (24) The Standard Operating Procedure of the non-handling pilot monitoring the progress of the approach was not effective in preventing the aircraft from descending below the published approach profile.

- (25) It was entirely fortuitous that, because of the nature of the low stratus cloud, the crew saw the approaching coastal features before the aircraft came into close proximity to the terrain.

*Air Traffic Control*

- (26) The Approach/Approach Radar controllers were properly licensed, medically fit and correctly rated to provide the service.
- (27) All of the aerodrome approach aids and lighting facilities were serviceable at the time of the incidents.
- (28) The controllers' decisions to offer the aircraft VOR/DME approaches to Runway 08, were reasonable given the weather conditions prevailing at the times of the approaches.
- (29) The radar vectoring given to each aircraft was appropriate in order to position each of them onto the inbound course at a reasonable range from touchdown, from where the procedure could be continued.
- (30) The radar systems at Isle of Man (Ronaldsway) Airport have the facility for indicating the altitude and range of aircraft on final approach. It is not a required function for controllers (Approach or Tower) to monitor an aircraft's progress during a non-precision approach, unless requested specifically by the pilot.
- (31) In the case of G-BGMO, the inappropriate descent was noted and was queried by the Tower controller at about the time the aircraft broke cloud and recovery was initiated.

*Airport facilities*

- (32) Isle of Man (Ronaldsway) Airport is not equipped with an Automatic Terminal Information System.
- (33) Isle of Man (Ronaldsway) Airport is not equipped with a facility to record the Secondary Surveillance Radar. This lack of data significantly impaired the reconstruction of the aircraft's descent profiles, especially given the limited information available from the FDRs fitted to the aircraft.
- (34) Isle of Man (Ronaldsway) Airport is not equipped with an Instrument Landing System precision approach aid for Runway 08.

### *The Operator*

- (35) The operator's pilot management team, in addition to carrying out day-to-day flying duties and crew training tasks, was responsible for the adaptation of the company's operations to JAR-OPS1 specifications. This process had taken a prolonged period of time, thus delaying amendment of the Operations Manual, which had resulted in an unduly large number of pilot notifications by means of Notices to Aircrew.
- (36) The operator did not conform to the statement contained in its Operations Manual Volume 1 General regarding the provision of appropriate sections of the Operations Manual to each of its pilots.
- (37) The operator did not provide a suitable Aircraft Technical Operations Manual to each of its pilots.
- (38) The operator did not provide suitable technical information to crews regarding the diverse standards of navigation, communication and instrument equipment fitted to each of the aircraft in the fleet.
- (39) The Operations Manual, Volume 9, Flying, did not provide suitable guidance as to the detailed Standard Operating Procedures to be followed by each crew member during a non-precision approach. There was also inadequate specified provision for the monitoring of aircraft configuration changes.
- (40) There were shortcomings in the content and layout of the Operations Manual, Volume 9, Flying, which discouraged continued reference by pilots beyond their training phase.
- (41) The Crew Resource Management training arranged by the operator did not promote good flight deck communication in these cases.

### *CAA oversight*

- (42) The oversight programme conducted by the CAA on this operator had identified deficiencies in the Crew Resource Management aspects of the company's operations. However, the programme was ineffective in producing sufficient, timely improvement. If it had been successful, these incidents could have been prevented.

- (43) The oversight programme had not addressed the subject of the diverse nature of the operator's fleet of aircraft, in terms of the primary flight instruments, navigation equipment, flight deck layout and their suitability for modern two crew public transport operations.
- (44) The oversight programme had not addressed the issue of the operator's provision of an Aircraft Technical manual and its availability to flight crews.
- (45) The oversight programme had not been effective in correcting the published errors in, or producing an improvement to, the operator's Standard Operating Procedures, especially with regard to the conduct of non-precision approaches.

**(b) Causes**

The following causal factors were identified:

- (i) Both flight crews allowed their aircraft to descend significantly below the intermediate Minimum Descent Height at the Final Approach Fix during VOR/DME approaches to Runway 08 at Isle of Man (Ronaldsway) Airport, in conditions of overcast low cloud. The descents occurred too far out from the runway and were continued below the promulgated Minimum Descent Height at the VOR/DME station, well before reaching that fix. During these descents, the crews did not have the appropriate visual reference to the surface, the approach lighting or the runway threshold.
- (ii) The lack of suitably detailed company defined Standard Operating Procedures resulted in the non-handling pilot having to cope with an excessive workload at the commencement of the descent during an instrument approach. As a result, the monitoring function performed by the non-handling pilots, during each of these approaches was ineffective in preventing the excessive descents.
- (iii) Despite the existence of a Crew Resource Management training programme, the first officer on G-BIUUV had not received such training. It was apparent that there were some deficiencies in cross-flight deck communications during each of the approaches.

- (iv) The company Standard Operating Procedure of cross checking altimeter height indications during the approach was not apparently observed until each aircraft had descended below the specified minimum heights for the approach.
- (v) In the case of G-BIUV (freighter aircraft), neither crew member noted that the flap selection had resulted in the aircraft making the approach with full Landing flap deployed, instead of the recommended Approach flap setting. This occurred during both the incident approach and the subsequent approach.
- (vi) In the case of G-BIUV, the commander lost his situational awareness as a result of concerns about the aircraft's handling characteristics in terms of pitch trim and as a result of the inappropriate flap setting, while simultaneously carrying out an instrument flying panel-scan.
- (vii) In the case of G-BIUV, the crew's workload, while carrying out the instrument flying panel-scan, was increased by the nature of the primary flight instruments and navigation displays fitted to the aircraft. These were of an outdated, basic and ergonomically disadvantageous design.
- (viii) In the case of G-BIUV, the performance of the flight crew was possibly subtly degraded as a result of the two hour turnround time prior to the operation of the incident flight, in the middle of a night duty period.
- (ix) In the case of G-BGMO (passenger aircraft), the commander's performance was probably subtly degraded as a result of sleep disturbances during the previous night. The first officer's performance was also probably less than optimal as a result of the varied roster pattern that had been worked during the days prior to the incident.
- (x) In the case of G-BGMO, the aircraft's schedule for the duty period, with a series of 30 minute ground turnround times, would have resulted in additional pressure on the crew members to complete the flight as rapidly as possible.
- (xi) In the case of G-BGMO, the aircraft's speed had not been sufficiently reduced prior to the start of the final approach, such that it flew through the correct inbound course and the selection of approach flap and landing gear was required to be delayed until the speed had reduced to be within the operating limitations for the aircraft.

- (xii) In the case of G-BGMO, the commander's workload was increased by the need to navigate the aircraft back onto the correct approach course and to reduce the airspeed in order to make the landing gear and flap selections while, at the same time, commencing the initial descent and performing the instrument flying panel-scan. This resulted in his loss of situational awareness.
  
- (xiii) In the case of G-BGMO, the commander recalled that he had misread the poorly located DME indication, which caused him to believe that the aircraft was significantly closer to the runway threshold than it actually

## **4 Safety recommendations**

The following safety recommendations are made:

- 4.1 It is recommended that Racal Aerad consider improvements to their approach chart design in order to clearly present the essential information, such that flight crews may build a comprehensive mental picture of the horizontal and vertical flight profiles to be flown and how these relate to significant terrain and obstacles relevant to the approach.

[Safety Recommendation No 99-54]

- 4.2 It is recommended that the Isle of Man Government, Department of Transport, arrange for the installation of an Instrument Landing System facility for Runway 08 at the Isle of Man (Ronaldsway) Airport.

[Safety Recommendation No 99-55]

- 4.3 It is recommended that the Isle of Man Government, Department of Transport, arrange for the Ronaldsway Airport Secondary Surveillance Radar data be recorded and preserved for a suitable period of time.

[Safety Recommendation No 99-56]

- 4.4 It is recommended that the Isle of Man Government, Department of Transport, arrange for Ronaldsway Airport to be equipped with an Automatic Terminal Information System (ATIS) facility.

[Safety Recommendation No 99-57]

- 4.5 It is recommended that the CAA require the provision and use of suitable adjustable cursor devices for the primary flight instruments (airspeed indicators and pressure altimeters) on all UK registered Public Transport aircraft.

[Safety Recommendation No 99-58]

- 4.6 It is recommended that Emerald Airways Ltd achieve a greater degree of standardisation of its fleet with a common, more modern, design of flight deck instrumentation, communication and navigation receivers in order to afford its flight crews an ergonomically satisfactory layout that is easy to operate and to interpret during instrument flying conditions.

[Safety Recommendation No 99-59]

4.7 It is recommended that Emerald Airways Ltd revise the content of its Operations Manual (Flying), in order to lay out in logical and correct form the whole of the Normal, Abnormal and Emergency operational details for the aircraft being operated. Also highlighted clearly should be any significant differences between the operation of the range of HS748 aircraft and the instrument/avionics equipment fitted to each.

[Safety Recommendation No 99-60]

4.8 It is recommended that Emerald Airways Ltd produce a suitable Operations Manual, Aircraft Technical, to contain detailed technical descriptions and systems diagrams for all of the relevant aircraft systems. It should also include a detailed description of the significant differences which remain in aircraft equipment over the diverse fleet. This manual should then be issued to all crew members for reference purposes.

[Safety Recommendation No 99-61]

4.9 It is recommended that the CAA should review the effectiveness of its current AOC Holder Oversight Programme. In particular, the CAA should determine whether there is a need to introduce additional methods of ensuring timely compliance with identified potentially safety-related shortcomings in the AOC Holder's operations.

[Safety Recommendation No 99-62]

M M Charles  
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