In accordance with Annex 13 of the International Civil Aviation Organisation Convention, European Union Council Directive 94/56/EC and Statutory Instrument SI 205 of 1997, the sole purpose of this investigation is to prevent aircraft accidents. It is not the purpose of the accident investigation nor the investigation report to apportion blame or liability.

FINAL REPORT

ACCIDENT DH248/RESCUE III

TRAMORE

AT 00:40 Hrs. Local Time

2 JULY 1999

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GLOSSARY

Term	Meaning
AAIB	Air Accident Investigation Branch (U.K.)
AAIT	Aircraft Accident Investigation Tool
AAIU	Air Accident Investigation Unit
AC	Alternating Current
ACFD	Air Corps Flying Directive
ACFO	Air Corps Flying Orders
ACHQ	Air Corps Headquarters
ADF	Automatic Direction Finding
AF	Army Form
AFCS	Automatic Flight Control System
AFISO	Aerodrome Flight Information Services Officer
AFM	Aircraft Flight Manual
AIP	Aeronautical Information Publication
AMSL	Above Mean Sea Level
ARCC	Aviation Rescue Co-ordination Centre
ASI	Air Speed Indicator
ATC	Air Traffic Control
ATCO	Air Traffic Control Officer
BFTS	Basic Flying Training School
"C" check	Major Inspection with calendar interval 8 years
CAA	Civil Aviation Authority (U.K.)
CAP	Caution Advisory Panel
CCR	Constant Current Regulators
CDU	Control Display Unit
CG	Centre of Gravity
CIC	Cranfield Impact Centre (U.K.)
COI	Court of Inquiry
CPL	Coupler
CVR	Cockpit Voice Recorder
DA	Decision Altitude
DC	Direct Current
DCP	Display Control Panel
Det Cmd	Detachment Commander
DF	Direction Finding
DFDR	Digital Flight Data Recorder
DH	Decision Height
DH248	Dauphin Helicopter 248
DME	Distance Measuring Equipment
DoD	Department of Defence
DOMNR	Department of the Marine and Natural Resources
DR	Dead Reckoning
EADI	Electronic Attitude Director Indicator
EFIS	Electronic Flight Instrumentation System
EHSI	Electronic Horizontal Situation Indicator
EIWF	Waterford Airport

ELT	Emergency Locator Transmitter
ETA	Estimated Time of Arrival
FD	Flight Director
FDP	Flight Duty Period
FTC	Fast Time Constant
FUEL.Q	Fuel Quantity
"G" check	Major Inspection with flying hour interval (3,600 hours)
GASU	Garda Air Support Unit
GDO	Group Duty Officer
GOC	General Officer Commanding
GPS	Global Positioning System
GS	Glideslope
G.SPD	Ground Speed
H-HT	Hover Height
HOV	Hover
hPA	Hectopascals
HSI	Horizontal Situation Indicator
HUMS	Health and Usage Monitoring Systems
IAS	Indicated Airspeed
IF	Instrument Flying
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
IMES	Irish Marine Emergency Services
JAA	Joint Aviation Authorities
JAR	Joint Aviation Regulations
LAF	Local Area Forecast
LDG	Landing
LE	Long Eireannach (Irish Naval Vessel)
LH	Left Hand
LHS	Left Hand Side
LOC	Localiser
MDA	Minimum Descent Altitude
MDH	Minimum Descent Height
MDI	Maintenance Deferred Item
METAR	Meteorological Actual Report
MGB	Main Gearbox
MMMF	Man Made Mineral Fibres
MRCC	Marine Rescue Co-ordination Centre
MSL	Mean Sea Level
MTOW	Maximum Take-off Weight
NCO	Non-commissioned Officer
NDB	Non-directional Beacon

OC	Officer Commanding
OM	Operations Manual
OPS	Operations
OPW	Office of Public Works
P1	Aircraft/Detachment Commander
P2	Co-Pilot
PAPI	Precision Approach Path Indicators
PRF	Pulse Repetition Frequency
QDM	Magnetic heading
QFE	Atmospheric pressure at aerodrome elevation
QNH	Altimeter setting to obtain elevation when on the ground
RCP	Radar Control Panel
RH	Right Hand
RHS	Right Hand Side
RIB	Rigid Inflatable Boat
RNAV	Area Radio Navigation
RVR	Runway Visual Range
RWY	Runway
S	Serviceable
SAR	Search and Rescue
SMI	Scheduled Maintenance Inspection
SOP	Standard Operating Procedure
SP	Support, e.g. No. 3 Support Wing
SRCH	Search
SSR	Secondary Surveillance Radar
TAF	Terminal Area Forecast
TAS	True Airspeed
TGB	Tail Rotor Gearbox
TO	Technical Orders
TRE	Type Rating Examiner
UTC	Co-ordinated Universal Time
U/S	Unserviceable
VFR	Visual Flight Rules
VHF	Very High Frequency
VL1	VOR/LOC Position 1
VL2	VOR/LOC Position 2
VLF	Very Low Frequency
VMC	Visual Meteorological Conditions
VOR	VHF Omni Range
VSI	Vertical Speed Indicator
Vx	Longitudinal Doppler speed, i.e. Fore and Aft
Vy	Lateral Doppler speed, i.e. Left and Right
Wx	Weather

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AAIU Report No.	2000/011
AAIU File No.	1999/0042
Aircraft Type and Registration:	Eurocopter AS365Fi Dauphin Air Corps No. 248
No. and Type of Engines:	Two, Turbomeca Arriel 1M
Aircraft Serial Number:	6203
Year of Manufacture:	1986
Date and Time (UTC):	01 July 1999, 23:40 hours approx.
Location:	Adjacent Tramore Strand, Co. Waterford 52º 09.061' N 007º 06.081' W.
Type of Flight:	Military Search and Rescue (SAR)
Persons on Board:	Crew - Four
Injuries:	Crew - Four Fatal
Nature of Damage:	Aircraft Destroyed
Commanders Licence:	Military
Commanders Age:	30 Years
Commanders Flying Experience:	Total All Types - 2910 hours Total on Type - 808 hours Last 90 days - 99 hours Last 28 days - 30 hours
Information Source:	ATC Watch Manager, Shannon Airport. AAIU Field Investigation.

SYNOPSIS

The accident was notified to the Air Accident Investigation Unit (AAIU) by the duty Watch Manager, Shannon ATC. It was agreed jointly by the Minister for Defence and the Minister for Public Enterprise that this fatal accident would be investigated under SI No. 205 of 1997 Air Navigation (Notification and Investigation of Accidents and Incidents) Regulations 1997 with the necessary modifications, including the modification that the investigation would be led by Lieutenant Colonel Thomas Moloney, a suitably qualified officer of the Air Corps. The Minister for Public Enterprise appointed Lt Col Moloney as an Inspector of Accidents and he, in turn, was appointed as Investigator-in-Charge

of this accident investigation by the Chief Inspector of Accidents, Mr. Kevin B. Humphreys.

The investigation team consisted of Inspectors of the AAIU, (Messrs Graham Liddy, Frank Russell, Jürgen Whyte and John Hughes), Air Corps Officers (Comdt. Paul Farrell and Comdt. Kevin Daunt), a Principal Inspector from the UK Air Accidents Investigation Branch (AAIB), Mr. R. StJ. Whidborne and the Head of Military Psychology from the Swedish Armed Forces, Ms. Kristina Pollack. As is common practice in investigations of this nature, notices were published in the national media inviting submissions from any interested party.

The Irish Air Corps Dauphin DH248 arrived at Waterford Regional Airport on 01 July 1999 to commence a dedicated 24 hour Search and Rescue (SAR) service based at the Airport. At 21:02 hrs on the same day, the Marine Rescue Co-ordination Centre (MRCC) Dublin phoned SAR Waterford with initial details of a tasking. A 15 foot yellow boat, hereafter called the casualty vessel, had become lost off Dungarvan, Co. Waterford in very bad visibility.

MRCC tasked the Helvick Inshore Lifeboat and the Dauphin crew at Waterford. The Lifeboat went to the scene but was initially unable to find the casualty as the Lifeboat was not radar equipped. DH248 was launched to assist in locating the casualty with its on-board radar equipment. In the event, Helvick Lifeboat located the casualty and subsequently requested DH248 to provide navigational assistance back to Helvick Pier, as the Lifeboat's GPS (navigation system) was not functioning correctly. This assistance was readily provided by DH248 as requested and the Lifeboat, with the casualty vessel in tow, made its way slowly back to Helvick Pier.

The crew were advised that the weather conditions at Waterford Airport were deteriorating and the Aircraft Commander decided to return to base. DH248 carried out two unsuccessful Instrument Landing System (ILS) approaches to Runway (RWY) 21 at Waterford Airport and carried out a go-around after each one. The Aircraft advised Waterford Control Tower that they were then going to carry out a "coastal approach". During a probable go-around from this approach, DH248 impacted sand dunes, some 14 metres high, adjacent to Tramore Strand. There were no survivors. The aircraft was destroyed. There was severe post-impact fire.

1. FACTUAL INFORMATION

The accident occurred at approximately 00:40 hrs. local time on Friday 2nd July 1999. However all times in this Report are Co-ordinated Universal Time (UTC) except where otherwise stated. As UTC was one hour earlier than local time, for the purposes of this Report the accident occurred at 23:40 hrs approximately on 1st July 1999.

The Irish Marine Emergency Services (IMES) has, since the date of the accident, become known as the Irish Coastguard. For the purposes of this Report the term IMES is used throughout.

1.1. History of the Flight

1.1.1. Background

The Minister for the Marine initiated a review of East Coast Marine Search and Rescue, which reported in June 1996 with a recommendation that a 24 hour medium load carrying helicopter should be based in Dublin. The report further recommended that, once this helicopter became available at Dublin, consideration should be given to redeploying a Baldonnel based Air Corps Dauphin helicopter to another location to be determined. Subsequently, a contract was awarded to a commercial operator for the Dublin based operation and it was decided by Government that the Dauphin would be re-deployed on the South/Southeast Coast.

The contracted S-61 commenced its Dublin deployment on 01 July 1998 and on the same day, the Air Corps deployed an Alouette III helicopter to Waterford for daylight-only SAR. This was due to a shortage of experienced Dauphin crews to maintain rosters at both Finner and Waterford, due in turn to personnel retiring from military service. The Air Corps undertook to commence the 24 hour service with a Dauphin on 01 July 1999 and DH248 deployed to Waterford Regional Airport on that date.

DH248 departed from the Air Corps base at Casement Aerodrome, Baldonnel at 09:24 hrs and it arrived at Waterford Airport at 10:02 hrs. There was a crew of seven with the Dauphin, the Detachment/Aircraft Commander (P1), the co-pilot (P2), the winch-operator and the winchman along with a three-man technical crew.

On arrival, the Detachment Commander set a standard fuel quantity for the detachment at 600 kg. The background to this standard quantity is given at para 1.18.7. After each flight of the day the aircraft was refuelled back to 600 kg. This was done using the Waterford Airport fuel supply. The Waterford Airport log for 01 July 99 shows three uplifts of Jet A1 Fuel by DH248, 330 litres, 180 litres and finally 360 litres. The fuel quantity was checked by the technical crew switching on the aircraft battery and checking the fuel state on the gauge after each refuelling operation. Fuel quality checks were carried out on the day by airport staff and the fuel was certified as serviceable.

During the day, DH248 performed an RTÉ (the national broadcasting service) publicity flight, airborne at 11:41 hrs and back on the ground at 12:16 hrs.

On the afternoon of 01 July 1999, the crew of DH248 carried out a training exercise over the sea to the Southeast of Tramore. This flight was an in-theatre familiarisation flight and was also part of the assessment of the P2 for Dauphin SAR Command with the Detachment Commander acting in his capacity as an Instructor.

The aircraft departed from Waterford at 14:11 hrs and carried out Trans-downs and simulated emergencies over the sea. The weather was recorded as being "fairly poor" in a proforma signed off by the Detachment Commander following the flight.

At 14:53 hrs DH248 called Waterford Tower level at 300 feet, 12.7 miles Distance Measuring Equipment (DME) from Waterford Airport on the 230º radial. They were routing inbound via Newtown Head and requested the latest weather. At that stage, the visibility was given as "generally 10 km, 4000 metres to the south". DH248 gave its intentions as "one or two approaches from over the water".

At 14:57 hrs Waterford Tower called DH248 and passed an estimated cloudbase at Tramore of 150 feet. The Dauphin had seven miles to run to the Airport at that time. At 14:59:57 DH248 called 3 miles DME level at 200 feet, and the Tower replied that the lights for Runway (RWY) 03 were on.

At 15:00:41, DH248 called 2.2 miles DME with visibility of 1 km. They were on the reciprocal of the 030º radial inbound to Waterford and level at 200 feet. At 15:02:30 DH248 called right downwind for RWY 21 and at 15:04 they were cleared to land. The Dauphin landed at 15:06 hrs. The crew kept the aircraft rotors running, embarked the winch operator, and departed for a reconnaissance of Waterford Regional Hospital landing facilities at 15:10 hrs, returning to the Airport at 15:20 hrs.

After each of the flights during the day, the Dauphin was signed off by the Detachment Commander as serviceable, denoted by the letter "S", on the AF 478 Flying Detail, and on the Aircraft Technical Log. No defects were reported by the P1 to the technical crew, nor were any defects recorded in the Aircraft Technical Log following these flights. A minor repair was carried out on the intercommunications system at one of the rear crew positions to remedy a minor, intermittent defect.

During the day, the Detachment Commander held a detachment brief for all the flying and technical crew members. This took place at approximately 13:00 hrs, and it was described by the senior technician as being a very good brief, with emphasis on the fact that it was the first Dauphin detachment to Waterford, and the need for an effective and efficient response to any call-out. The senior technician stated that there was a very good crew spirit, with a "can-do" attitude from all involved. However, he also stated that the Detachment Commander had expressed his view that the Irish Marine Emergency Service (IMES) might

try to "catch them out", especially with respect to the call-out times[1]. The call-out times agreed to by the Air Corps for the 24-hour Waterford detachment are set out in paragraph 1.17.7.

During the brief, the question of night operations was raised by one of the Air Corps technicians, since the Airport closes at 16:00 hrs UTC Monday to Friday. The Detachment Commander told the technician that the Control Tower and the Airport lighting would be his responsibility for night operations, and a brief with the Airport Manager was arranged. This brief was carried out in the Control Tower during the afternoon.

The technician who was briefed on the Tower and lighting had never before been in Waterford Airport, and he had no formal training in Control Tower, ATC or meteorological procedures, although he had previously carried out ground/air communications duties for the Dauphin SAR detachment when it deployed temporarily from Finner Camp to Carrickfinn Airport, Co. Donegal.

The technician informed the investigation that it was his understanding, from his conversation with the Detachment Commander, that communications/ airfield lighting and other Tower functions would be his responsibility for any after hours call-outs. The technician stated that he had carried out a similar function previously in Carrickfinn Airport for a late night call-out, when the Air Corps had temporarily re-located the Finner-based SAR Dauphin to Carrickfinn.

The Airport Manager has informed the investigation that there was “no particular level of detailed discussion” during the day between himself and the Detachment Commander about night call-out roles. He has stated that the Detachment Commander was made aware during the day that there would be no ATC/AFISO personnel on-call for night call-outs. The Airport Manager’s understanding was that the Air Corps technician whom he briefed in the Control Tower would be performing Tower duties for any after-hours call-outs, while the Airport Manager would himself come in to provide a re-fuelling and limited Crash Rescue Service.

One potential problem area that was briefed by the Airport Manager to the Air Corps technician concerned the approach lighting. When this lighting is turned on at full intensity, this can trip a remote circuit-breaker located in the Fire Station, and cause a half pattern of the RWY 21 approach lighting to become inoperative until the circuit breaker is reset. This problem is further described in para 1.10.

[1] The Director of The Irish Coast Guard (formerly IMES), in response to the Draft Final Report, has written to the investigation stating the following:
“References are made in the report to a view , attributed to the Detachment Commander, to the effect that the tasking agency (IMES) might attempt to in some way “catch out” the crew in relation to response times. The Coast Guard wishes to place on record that, at all times and in respect of all taskings of declared facilities in the context of SAR incident management, the interest and safety of the crews are of paramount importance to MRCC and inform all its decisions.
No demands of an unreasonable nature nor any outside the terms of normal mutual understandings are made on declared facility crews.
The Coast Guard very sincerely regrets the loss of the Dauphin crew in the accident at Tramore on 2 July following its completion of a successful SAR mission.”

While the Dauphin was away on the afternoon training flight, one of the technicians, who had remained at the Airport, could see rolling sea fog in the distance near Tramore. When the Dauphin returned to the Airport, he asked the Detachment Commander if they had been caught up in it but the reply was that the "*conditions had been grand*".

Following the afternoon training flight, the aircraft was refuelled, washed down and towed into the Hangar, and the crew of seven departed the Airport to their Dunmore East accommodation at 16:15 hrs approx. They stopped at the shops en-route, and on arrival at the accommodation, the crew divided into three houses. The two pilots were in one house, the winch operator/winch-man in another and the three technical personnel in the third.

1.1.2 The SAR Mission

A chart of the Waterford/Dungarvan area is attached at **Annex A**.

At **21:02 hrs**, the Marine Rescue Co-ordination Centre (MRCC) Dublin, which is the IMES co-ordination and communications centre, phoned SAR Waterford (at Dunmore East), with the initial details of the mission. The Detachment Commander took the call. The initial brief was that a boat had become lost off Dungarvan in very bad visibility. The skipper had a mobile phone, but there were no VHF Communications with the vessel. The Helvick Inshore Lifeboat was being called out but it was not radar-equipped. The missing boat was thought to be off the Black Rock, Dungarvan and was said to be a 15 foot yellow boat. The Detachment Commander said that the crew would get going and MRCC requested that he ring them from the Airport to get more information. A transcript of this conversation is shown at **Annex B**. The seven crew members departed immediately from Dunmore East and headed for Waterford Airport in what were reported by the senior technician to be foggy conditions, in a minibus driven by the winch operator. Records indicate that en route the Detachment Commander phoned the Airport Manager to inform him of the call-out.

At **21:09 hrs** MRCC again phoned the Detachment Commander as the crew were in transit between Dunmore East and the Airport. The purpose of this call was to stand-down the mission as MRCC had now instructed the casualty vessel how to operate their Marine Band VHF radio via their mobile phone. However, following a discussion between the Detachment Commander and MRCC concerning the local weather and the proximity of the search area to the SAR base, it was decided that the mission would go ahead. A transcript of this conversation is shown at **Annex C**.

On arrival at the Airport the senior technician asked the Detachment Commander whether he was happy with the 600 kg of fuel on DH248. The Detachment Commander, in consultation with the co-pilot, stated that he was happy and no further fuelling was carried out. A fuel load of 800 kg would have brought the Dauphin to its maximum certificated take off weight.

At **21:30 hrs**, the P1 phoned MRCC from the Airport saying they were about to launch, and looking for updated information. MRCC informed them that the Helvick Inshore Lifeboat was now on-scene but was unable to find the casualty

vessel. He (the casualty vessel) had communications with MRCC on a mobile phone. He had a young child on board who was "very seasick". MRCC enquired whether the Dauphin could pick up the casualty vessel on radar and the P1 said that they might get a radar return. MRCC were also trying to get Ballycotton lifeboat on-scene with its radar equipment. At 21:31 hrs, MRCC tasked the Dauphin crew "*get under way, we can always call you back*". A transcript of this conversation is shown at **Annex D**.

The Airport Fire Officer, who responded to the call-out following a phone call from the Airport Manager, was on the ramp when the Dauphin departed. His estimates of surface visibility, along with those of the Air Corps technicians, are included in paragraph 1.7.8. The Fire Officer spoke to the helicopter crew prior to their departure and he has informed the investigation that there was no formal discussion of the visibility conditions.

At **21:41 hrs**, the Air Corps technician in the Tower passed the windspeed and direction and the QNH (an atmospheric pressure setting) to the crew as DH248 taxied out for take-off, callsign now Rescue 111. The senior Air Corps technician involved in ramp despatch subsequently stated that the P2 carried out a thorough walk-round pre-flight inspection, the aircraft was started using external ground power and that brake checks were carried out during the taxi. The aircraft lifted off from the taxiway, at **21.42 hrs,** and the technician described it as being a normal departure.

The Waterford Control Tower is equipped with a Marine Band radio in addition to the normal ATC transceivers. The personnel in the Control Tower were able to follow the progress of the SAR mission at all times on the marine band radio and therefore they did not feel it necessary to carry out a radio check with DH 248 every fifteen minutes, as is the standard operating procedure in Finner.

A transcript of the radio communications between DH248 and Waterford Tower is shown at **Annex E**. During the mission, the winch operator of DH248 communicated with MRCC Dublin through the Coastal Radio Stations Network and a transcript of these communications is attached at **Annex F**.

At **21:45 hrs**, DH248 called MRCC via Rosslare Radio on Marine Channel 16, en route to the search area, seeking further information. The aircraft fuel endurance and the number of persons on board were not passed to MRCC, nor was this information requested by MRCC. Notification of the SAR mission was not passed by MRCC to the Aviation Rescue Co-ordination Centre (ARCC) in Shannon as is required by MRCC Standard Operating Procedures (SOPs). Since no Flight Plan for the SAR mission was filed, neither ARCC nor Shannon Air Traffic Control Centre were aware of DH248's mission until after it had become overdue.

At **21:46 hrs**, DH248 was directed by MRCC to route to 5204N, 0731W, Carrickapaine Rock at the entrance to Dungarvan Harbour.

At **21:48 hrs**, DH248 passed an estimated time of arrival in the search area of approximately 5 minutes (to MRCC).

At **21.53 hrs**, MRCC advised DH248 that Ballycotton lifeboat was en-route and that Helvick lifeboat had been told to desist from firing flares since the helicopter was arriving.

At **21.55 hrs**, the Airport Manager, who had been phoned by the SAR crew, arrived at the Airport and went to the Control Tower. His presence in the Tower was not made known to the crew of DH248. The Airport Manager holds a Private Pilot's Licence and has extensive experience as a flight instructor. He was formerly a qualified Aerodrome Flight Information Services Officer (AFISO) and had set up that service at Waterford Airport. The Airport Manager has informed the investigation that he and the Airport Fire Officer had provided voluntary cover for night helicopter SAR missions off the southeast coast for a number of years.

The Airport Manager felt that the technician carrying out the Tower duties was performing satisfactorily and that there was no need to intervene in the communications with the helicopter. He assisted the technician by providing him with horizontal visibility assessments. These assessments were provided by the Airport Manager using his knowledge of distances to known reference points. It is noted that in the Finner Dauphin SAR operation, the detachment includes a qualified Air Corps Radio Operator, who carries out the communication, notification, flight following and visibility assessment functions for SAR missions.

At **21:55 hrs**, the casualty vessel reported that he could see the light of the lifeboat and was coming to it.

At **21:58 hrs**, Helvick lifeboat informed MRCC that they had located the casualty at position 5204294N and 072908W, and that they *"were going to check the tow line".*

At **21:59 hrs**, this updated position was passed by MRCC to DH248, and that the casualty vessel was being taken in tow. MRCC requested DH248 that *"if the visibility is still satisfactory there, we'd like you to continue to that position, and maybe just monitor it for a while".*

At **22:00 hrs**, DH248 informed MRCC: *"We're going to route to that position. We're going to maintain 500 feet overhead the target area. We're still in a lot of cloud, a lot of fog here. We'll remain overhead and if they get into trouble at any stage, we will then descend to the scene, over."*

At **22:03 hrs**, Helvick Lifeboat informed MRCC that they had the casualty vessel under tow. There were five persons on board the casualty vessel, four adults and one child. Their ETA at Helvick Pier was 20 minutes. MRCC advised them that the helicopter was on scene and would stay on scene for a while longer, up at 500 ft.

At **22:06 hrs**, MRCC requested Ballycotton Lifeboat: *"We'd like you to keep coming for a while yet please.*"

At **22:07 hrs**, another vessel (possibly a trawler) informed the Helvick Lifeboat that the fog had *"lifted a lot around the harbour"*, but the lifeboat replied that he

was still a couple of miles from the pier, and at **22:08 hrs** that "*we can't see our hand here now anyway*".

The Helvick lifeboat continued to tow the casualty vessel very slowly as the casualty boat was very light, the five persons were still on board, the seas were choppy and the child on the casualty vessel was seasick. DH248 continued to monitor the situation from overhead, and at **22:17 hrs**, it reported to MRCC "*Overhead Helvick Head this time, all ops normal.*" Position reports to MRCC were provided by the rear crew as per Standard Operating Procedure (SOP).

At **22:19 hrs**, Waterford Tower called DH248 on a radio check. DH248 responded that they were two miles Southeast of Helvick, and that they would be *"lodged in here for about another fifteen minutes"*.

At **22:20 hrs**, the Helvick Lifeboat requested navigational assistance from DH248 as follows: *"Just wondering what course you are steering at this moment for Helvick Pier. We want to verify it with our GPS, our signal is not that good".* DH248 took the position of the lifeboat by radio and then flew a pattern to overhead the lifeboat, requesting to be informed at the moment they passed overhead. At **22:24 hrs**, the lifeboat informed the Dauphin, *"You're just over us now"*, and DH248 replied, *"Your heading for Helvick Head would be 240º, over."*

At **22:31 hrs**, one of the lifeboat men went aboard the casualty vessel as the child had become cold. The lifeboat reported to MRCC that it was still taking it very slowly and gave an ETA at Helvick Pier of *"20 minutes maybe"*.

At **22:34 hrs**, the casualty boat reported to the Helvick Lifeboat that the child was OK, suffering a little from seasickness and cold.

At **22:35 hrs**, Ballycotton Lifeboat requested an update from MRCC. He was told that the Helvick lifeboat and the casualty vessel had about 1.5 miles to go in poor visibility. He was requested to standby a little longer by MRCC.

At **22:39 hrs**, DH248 reported to MRCC *"just by Helvick Head, all ops normal".*

At **22:41 hrs**, DH248 called Waterford Tower, to check *"any update on the weather, has it improved or dis-improved?"* Tower replied, *"Negative, she is staying the same. From what I can see from here out to the lights. QNH is still 1014, wind 220º at 7 knots".*

At **22:42 hrs**, Helvick Lifeboat reported to DH248 that the helicopter was just above them. DH248 replied that they had the lifeboat in sight, and that they had about a mile to run.

At **22:51:00 hrs**, Waterford Tower called DH248 and informed him that the *"weather (is) deteriorating slightly here, just to let you know*". DH248 replied, "*Roger copied that. Can you see the lights of Tramore at all?"* Tower replied *"Negative. We can just about hardly see the runway which is a distance of 300 metres from the Tower"*. DH248 replied, *"copied that. Listening out".*

At **22:51:40 hrs**, DH248 called Helvick Lifeboat: *"Can you see the lights of Helvick Head at this time?"* The lifeboat replied *"Negative on that".*

At **22:53:30 hrs**, DH248 called MRCC and requested *"permission to route towards Waterford Airport at this time. Conditions there are deteriorating and we'd like to get in before they close, over"*. MRCC replied, "*just standby*".

At **22:54:00 hrs**, MRCC released DH248 from the SAR mission and thanked them for their help and co-operation. DH248 replied: *"We're taking up a heading for Waterford Airport"*. At **22:55 hrs**, MRCC requested Ballycotton Lifeboat to standby the Helvick Lifeboat, until it reached the pier.

At **23:00 hrs**, DH248 reported to Waterford Tower that they were just inside six nautical miles from Waterford Airport DME station, and requested QNH. Tower passed him the QNH of 1014 and wind of 210º at 8 Knots. DH248 acknowledged this and reported "*we're just six miles this side of the field. We're going to route overhead out to eight miles and back in for an ILS to two one. Confirm all the lights are on for two one*". Tower replied, "*Roger that. Full lights, full illumination two one. ILS operational*". DH248 replied, "*Copied. Call you finals*".

At **23:06 hrs**, DH248 called, *"Just coming up to the turn for inbound"*, and checked the wind which was now 220º at nine knots.

At **23:12 hrs**, DH248 called *"Two point five miles out"*, and was given a wind check of 220º at eight knots.

At **23:14:37 hrs**, DH248 called that they had overshot the approach and that they were "*going to go around for one more*". DH248 asked if, *"as a matter of interest, could you see us at all?"* The Tower replied that they had one of the technicians out on the ramp keeping an eye out, but that he couldn't see them at all, and that the visibility was *"about 500 metres"*. DH248 acknowledged, *"Copied*".

The technician who was outside was actually on the Control Tower veranda, which is 50 feet above ground level. He subsequently described the weather at this stage as being like the "twilight zone". The rotating beacon on top of the control tower was reflecting back off the fog and he could barely see the far side of the ramp. He could just make out the glow of the runway lights; there was no direct visibility of the runway itself. The runway at its closest point is 300 metres from the Tower. The people on the veranda could hear the aircraft quite clearly but they could not tell the exact direction the noise was coming from. The Airport Manager, who was also on the veranda, stated that the approach seemed perfectly normal, but that he saw nothing of the helicopter.

At **23:15 hrs**, the Tower asked DH248 *"Did you get the runway lights OK then?"* DH248 replied *"Negative*". The technician who was acting as Tower Operator said that he could try to assist with a higher beam light from the Tower, but that he didn't know how bright it was going to be (this referred to a spotlight he found in the Control Tower). DH248 replied, that *"If the lights are up full that's the best you can do".*

At **23:18:35 hrs**, DH248 called, *"just turning finals again*", and requested QNH. This was given as *"still 1014 and wind 220º at eight"*.

At **23:20 hrs**, one of the technicians, on his own initiative, phoned Baldonnel Tower and received the actual weather report for Baldonnel. This weather was not passed immediately to DH248 since the technicians in the Tower felt that the crew would be very busy during the ILS approach and they did not want to disturb them.

At **23:27 hrs**, the Tower called DH248. They replied, *" we've overshot, we're going to go around for a coastal approach"*. The Tower replied that they couldn't see the helicopter coming in, but they could hear it going away *"just as I called you".*

Several witnesses contacted the investigation and were interviewed. With the exception of one witness, located at Faithlegg, none of the witnesses saw any sign of DH248, due to the poor visibility. The witness at Faithlegg, some 4.4 nm from the RWY 21 threshold, reported seeing "*a high powered light, like a car headlamp, making a creamy coloured, bright haze in the fog, but not penetrating the fog to the ground*". The witness only saw the light for a brief time, estimated by him to be at 23:24 hrs, and the aircraft moved away southwards towards the airport. Witnesses living in close proximity to the airport heard the Dauphin flying overhead at low level but were unable to see it.

Some of the witnesses commented that the sound of the aircraft was unusual. This was probably their first time to hear a Dauphin helicopter at night. The Dauphin has certain distinctive normal sound profiles particularly a high pitched whine/screech from the fenestron and a high level of main rotor blade "slap" in certain manoeuvres. The technicians at Waterford Airport, who are familiar with Dauphin sounds, heard the aircraft passing on both ILS approaches and reported that the sounds were normal.

At **23:28 hrs**, the Tower asked DH248 if they wanted him to change the approach lights over to RWY zero three. This was agreed, *"yes please"* by DH248, and the lights were changed over by the Air Corps Technician under the supervision of the Airport Manager. Tower reported *"full beam at zero three over"*.

At **23:33 hrs**, DH248 asked the Tower to confirm if the weather was improving at the Airport. The Tower replied *"Negative on the weather improving here. QNH same, wind 210º at eight"*. DH248 acknowledged this and stated "*we're just er in a left hand er we're descending here now in the bay, and we are going to do a coastal approach in to Tramore. We may land in Tramore"*.

At **23:34 hrs**, the Tower informed DH248 that the weather in Baldonnel was *"Fine to get in there if all need be"*. DH248 replied "*Roger, don't have the juice"* (at **23:34:13 hrs**), an indication of insufficient fuel remaining to allow for such a diversion.

At **23:35:25 hrs**, DH248 reported to MRCC "*We've had to overshoot Waterford Airport due to weather, we can't get in. We're doing an approach to Tramore Bay this time and if we can get down, we're going to land in the bay area*

somewhere". MRCC acknowledged this and requested to be kept updated. This was acknowledged by DH248 (at **23:35:50 hrs**).

This was the last voice transmission from DH248.

At **23:38:30 hrs**, MRCC called DH248 - there was no reply.

At **23:39:27 hrs**, there was a burst of transmission with no voice, on the Waterford Tower frequency. This transmission was analysed by the UK Air Accidents Investigation Branch in Farnborough. There were two elements to this final transmission, a "whoosh" noise and then the rotor blade noise.

At **23:43:20 hrs**, MRCC called DH248 again. There was no reply. Several more calls from both Waterford Tower and MRCC followed, all with no reply. At **23.55 hrs** both MRCC and the Waterford Airport Manager reported the situation to the Gardai in Tramore, requesting a search of the beach. A Mayday relay for the missing helicopter was broadcast by MRCC on Rosslare Radio at **00.05 hrs** and the local IMES coastal rescue teams were called out shortly after that.

When the personnel in the Control Tower realised that the aircraft was missing they tuned one of the Control Tower's VHF airband radios to the emergency frequency 121.5 MHz. However no SARBE (SAR beacon) or ELT (Emergency Locator Transmitter) transmissions were heard on the frequency by the Tower personnel. When the local ATC operator arrived at the Airport later to assist with the arrival of the IMES S61, he adjusted the radio and was able to hear a faint ELT transmission. The ELT was also heard by overflying aircraft in the early hours of the morning of 2 July 1999.

At **01.00 hrs** approximately, the wreckage of DH248 was located by an IMES coastal search team in the sand dunes approximately 3 kilometres east of Tramore town.

1.2. Injuries to Persons

Injuries	Crew	Passengers	Others
Fatal	4	-	-
Serious	0	-	-
Minor/None	0	-	-

1.3. Damage to Aircraft

The aircraft was destroyed.

1.4. Other Damage

The aircraft impacted in an area of sand-dunes and there was an intense post-crash fire. Following removal of the wreckage, damage to the area was repaired.

1.5. Personnel Information

Commander:	Male aged 30 years	
Licence:	Military	
Type Ratings:	SA316B Alouette	02 Feb 1999
	AS365Fi Dauphin	14 Aug 1998 (P1 SAR)
Instructor's Rating:	AS365Fi Dauphin	14 Aug 1998 (Class 1)
	SA316B Alouette	16 Jan 1998 (TRE on type)
Instrument Rating:	AS365Fi Dauphin	15 Oct 1998 (Green)
Last Simulator Check:	24/25 May 1999	
Medical:	Fit for Flying Duties	
Flying experience :	Total all types	2,910 hours
	Total on type	808 hours, 523 as 1st Pilot.
	Total on type Night	138 hours
	Total Instrument Flying	305 hours
	Last 90 days	99 hours
	Last 28 days	30 hours
Duty Time:		16 hrs 40 min
Rest period before duty:		15 hrs 40 min
24 hr Stand/By Duties last 60 days:		11 duties.

Co-Pilot:	Male aged 28 years	
Licence:	Military	
Type Ratings:	SA316B Alouette	02 Feb 1999
	AS365Fi Dauphin	16 June 1999 (one month extension).
Instructor's Rating:	SA316B Alouette	02 Feb 1999 (Class1 TRE)
Instrument Rating:	AS365Fi Dauphin	04 March 1999. (Green)
Last Simulator Check:	Sept 1998	
Medical:	Fit for Flying Duties.	
Flying experience:	Total all types	2,326 hours
	Total on type	387 hours
	Total on type Night	59 hours
	Total Instrument Flying	215 hours
	Last 90 days	89 hours
	Last 28 days	23 hours
Duty Time:		16 hrs 40 mins
Rest period before duty:		15 hrs 40 mins
24 hr Stand/By Duties last 60 days:		13 duties.

Appendix A summarises the operational experience profiles of the two pilots.

Winch Operator:	Male aged 34 years.
Qualifications:	Winch Operator and SAR Air Crew Rating Examiner.
Flying Experience:	3,500 Flying Hours as Rear Crew.

Winchman:	Male aged 25 years.
Qualifications:	Winchman.
Flying Experience:	175 Flying Hours as Rear Crew.

1.6 Aircraft Information

Leading Particulars

Type:	Eurocopter AS365Fi Dauphin
Constructors Number:	6203
Date of Manufacture:	1986
Certificate of Registration:	Registered in the name of Minister For Defence, Ireland
Certificate of Airworthiness:	Military
Total Airframe Hours:	4562:00
Engines (2):	Turbomeca Arriel 1M Free Turbine Turboshaft Engines
Maximum Weight Authorised for Take-off:	4,120 kg
Estimated Start-up Weight:	3,919 kg
Estimated Weight at time of Accident:	3,427 kg
Estimated Fuel Remaining at time of Accident:	108 kg
Centre of Gravity (CG) Limits	3.84 metres to 4.00 m @ 4120 kg.
Centre of Gravity at time of Accident:	3.95 metres (est.) aft of Datum

1.6.1 General Description

The Eurocopter AS365Fi Dauphin is a twin-engined helicopter certified for two pilot IFR operation. The pilot (P1) occupies the front right-hand seat while the co-pilot (P2) occupies the front left-hand seat. Dual flight controls and flight instruments are provided, one set for each pilot. On Search and Rescue (SAR) operations a winch operator and a winchman occupy the rear cabin. The winch operator also operates the Marine Band VHF Radio during a SAR mission, except during winching operations or whilst occupied on other mission-related duties.

The AS365Fi is unique in terms of design, incorporating hybrid analog/digital avionic systems. The only five built were specifically for the Irish Air Corps. Consequences of this fact include difficulty with product support/spares availability as the aircraft age, and non-availability of a representative simulator facility for pilot training.

The engines are two Arriel 1M turboshaft engines mounted side by side aft of the main gearbox (MGB) inside two heat-insulated and fireproof engine bays. The main rotor has four glass-resin laminate blades, which rotate in a clockwise direction when viewed from above at a nominal speed of 350 rpm. They are attached to a semi-rigid fibreglass main rotor head. The diameter of the rotor disc is 11.930 metres (39' 2"). The shrouded tail rotor, known as a "Fenestron" is located in the tail fin and it comprises 11 composite blades rotating in a clockwise direction when viewed from the right hand side of the aircraft. The tail rotor diameter is 1.1 m (3' 7").

The transmission system includes the main gearbox, two engine-to-MGB coupling units, a tail rotor driveshaft and a tail gearbox. The dual input MGB transmits engine power to the main and tail rotors, and it drives the main rotor head at a nominal speed of 350 rpm after reduction from the input speed of 6000 rpm. The tail gearbox, which is mounted at the end of the tail boom in the tail rotor duct, is designed to drive the tail rotor at 3665.4 rpm.

Flight controls include three hydraulic servo units for the main rotor blades and a single servo for the tail rotor. Two primary hydraulic systems supply hydraulic pressure to the servo units controlling the main rotor collective and cyclic pitch, and to the tail rotor servocontrol. These are two separate and independent systems which both continuously supply the main servocontrols and both are capable of compensating for a failure of the other system.

DC electrical power is supplied by two engine-driven 4.8 kW starter-generators and a main aircraft battery. There is also an AC electrical system with power supplied by two alternators, each supplying a three-phase output, and by two transformers supplying single-phase outputs. The single-phase loads are generally avionic equipments while the three-phase supply is used for windshield de-icing and cabin ventilation.

1.6.2 Aircraft Systems

Key aircraft systems, which have been considered in the Analysis are detailed in **Appendix B**. These systems include the fuel system with fuel jettison facility, the Automatic Flight Control System (AFCS) including the ILS approach modes and SAR modes, the airborne radar, the navigation systems, the radio altimeter system and the aircraft hydraulic systems.

1.6.3 Weight Data

The weight figures for the mission have been estimated as follows:

Items	**Weight (Kg)**
Basic Weight DH248	2740
Hoist	67
Locator	12
SAR kit	180
Crew (4)	320
Total	**3319**
Fuel	600
Start-up Weight	**3919**.

The max take-off weight (MTOW) for the AS365Fi is 4,120 kg.

The estimated weight at the time of the accident was 3,427 kg. approximately.

The Centre of Gravity at the time of the accident is estimated to have been 3.95 metres aft of Datum, which is within the limits specified for the aircraft.

1.6.4 Maintenance Records

At the time of dispatch of the SAR Mission, DH248 had accumulated 4,562 flying hours. It was maintained under Air Corps Technical Orders and in accordance with the Maintenance Manuals of the airframe and engine manufacturers. A system of equalised maintenance was in place whereby the 400 hour airframe inspection had been divided into eight modules, two of which were performed together every 100 hours.

The previous Scheduled Maintenance Inspection (SMI) carried out on DH248 was an E5/E6 carried out at a flying time of 4,549.55 hours. The aircraft was returned to service from this SMI on 25 June 1999. The next SMI due was a 50 hour inspection at 4,599.55 hours.

The aircraft had been flown relatively intensively in the days before the accident and a number of Maintenance Deferred Items (MDIs) were notated in the Technical Log. These are minor defects, which are recorded by the flight crew for the information of the maintenance crew and subsequent flight crews but on which maintenance action is deferred and the aircraft thus remains in service. This system is regulated for under Air Corps Technical Order (TO.) No. 25 "Deferred Defects".

On the 28 June 1999, the aircraft flew three times with three different crews. On the first flight of the day, three MDIs were entered on the Technical Log "for information":

Collins Comms (No.1 System), very poor quality
CAP (Caution Advisory Panel) Landing Light not illuminating,
Landing Light "ON"
Coupler Light top right U/S (Unserviceable).

No further defects were entered on the subsequent two flights. The final flight of the day was a winching training detail with the same flight crew as on the accident flight.

On the 29 June 1999, DH248 flew five times, the first three flights were a VIP mission to Belfast with the two pilots from the accident flight as crew. One defect was noted on the Technical Log, concerning the Emergency Locator Transmitter (ELT) and this was rectified on the return to base. The senior technician who was on the 01 July 1999 SAR detachment to Waterford flew as aircrew on the VIP mission. After the mission, the Detachment Commander told him that the aircraft was flying particularly well and to try to get DH248 for the forthcoming Waterford SAR detachment.

The Detachment Commander flew again on DH248 that day on a winching training detail and then a fifth flight was flown by a different crew who noted two MDIs:

Landing Light on CAP U/S (as noted previously)
Coupler Light U/S (bottom right)

On 30 June 1999, DH248 flew once with the Detachment Commander as training captain on another winching detail. No defects were noted. A "100-operations" hoist inspection, required after 100 hoist operations, was also carried out on that date.

The aircraft flew three times on 01 July 1999 before the accident flight, with the SAR detachment crew. On each occasion, no defects were noted in the Technical Log and the aircraft was marked "S" (serviceable) on both the Aircraft Technical Log and on the Flying Detail.

On arrival into Waterford from Baldonnel, DH248 flew an ILS approach to RWY 21. The detachment avionics technician stated that he specifically watched this approach on the P1's EFIS screens and he said that a very accurate approach was displayed and flown.

Other items on the Technical Log include:

24 June 1999	Nadir takes 15 minutes to switch on - Nadir Computer changed
25 May 1999	Nadir unserviceable. Nadir CDU changed
15 May 1999	Radar unserviceable. Antenna drive unit changed twice.

This 15 May 1999 radar defect occurred on SAR detachment at Finner again with the P1 and P2 from the accident flight as crew. The aircraft was flown again on the 16 May 1999 by the same crew and marked serviceable.

1.7 Meteorological Information

1.7.1 An after-cast of the weather conditions in the Tramore Bay area at 0000 hrs UTC on 02 July 1999 (i.e. midnight UTC on 1/2 July 1999, 20 minutes after the accident) was provided by the Aviation Office of Met Eireann (the Irish Meteorological Service) at Shannon Airport.

Meteorological situation

The area lay in a moist South/Southwesterly airstream with a warm front lying just North of the area and moving slowly northeastwards. A second warm front was located over the North of the country.

Estimated Weather Conditions at Crash Location

Surface wind	200º/10 kt
1000 ft wind	200º/15 kt
2000 ft wind	220º/17 kt
Visibility	0300 - 1000 metres (m) occasionally 0100 m
Weather	Light rain, drizzle and fog
Cloud	Broken/overcast stratus 100 - 200 ft. Locally 50 ft.
Temperature	14º C
Dewpoint	14º C
Mean Sea-level Pressure	1013 hPA
Freezing level	12,500 ft

No warnings or sigmets were in operation.

Note:- In aviation meteorological terms “Fog” is defined as surface visibility of less than 1000 metres.

1.7.2 Synoptic Reports were also provided by Met Eireann for 0000 hrs on 2 July 1999 for Rosslare Harbour and Cork Airport as follows :-

Rosslare Hbr	220º/10kt. Visibility 0900 m. Fog. Overcast 100 feet 14/14C MSL 1013.5 hPA.
Cork Airport	170º/04kt. Visibility 0300 m. Fog Rain/Drizzle Vertical Visibility 100 ft. 14/14C MSL 1013 hPA.

1.7.3 The applicable forecast for Waterford Airport was a Local Area Forecast (LAF) issued at 16:00 hrs and valid from 18:00 until 24:00 hrs on the 1st July 1999.

Local Area Forecast (LAF) for Waterford (EIWF)

Valid	01/1800 hrs to 01/2400 hrs
Wind	230º/12 kt becoming 180º/10 kt by 2000 UTC
Visibility	3 - 8 km Locally 0500 metres after 2000 UTC
Weather	Rain and drizzle, Local fog later
Cloud	Scattered 300 ft broken 1000 ft becoming scattered 300 ft overcast 500 ft by 2000 UTC Locally broken 200 ft later.

Cloud Height given above Mean Sea Level (MSL)

1.7.4 Fax records for the Met Eireann terminals on 01/07/99 show that at 07:10 hrs the following documents were faxed to the Air Corps SAR base at Waterford:

LAFs including Waterford Airport valid 0600 -1500 on 1/07/99

Latest Irish Long and Short Terminal Area Forecasts (TAFs)

Latest Irish METARs (Met Aerodrome Reports) and Synoptic Station Reports

Low level Significant Weather Chart (Valid at 1200 hrs, 1/7/99)

Tabular Wind chart (Valid at 1200 hrs, 1/7/99).

At 1143 hrs the LAFs including Waterford Airport valid 1200-2100 hrs were faxed to Waterford Regional Airport Control Tower and at 1646 hrs the LAFs including Waterford Airport valid 1800-2400 hrs (i.e. that shown above at 1.7.3) were faxed to Waterford Regional Airport Control Tower.

Meteorological information received at Waterford Regional Airport is placed in a designated flip-chart in the Airport Operations Room which is always open to crews. The Airport Fire Officer informed the investigation that the crew visited the Airport Operations Room prior to departure on the SAR mission.

1.7.5 Records indicate that there was no telephone briefing or fax communication between the Dauphin crew and Met Eireann before the SAR mission.

1.7.6 LAFs are issued by Met Eireann daily at 04:00, 10:00 and 16:00 hrs and are generally valid for 9 hours. They are a simple, broad synopsis of what the weather is expected to be. The Meteorological Office do not issue TAFs (Terminal Area Forecasts) for airports which do not have permanent Meteorological Observers on duty. Waterford Airport falls into this category, and therefore only receives a LAF.

1.7.7 Waterford Airport has the following meteorological sensing instrumentation:

Instantaneous windspeed and direction instrument
QNH and QFE readouts.

In terms of horizontal visibility measurement, the Waterford Airport staff, two of whom are qualified Meteorological Observers, have produced a chart relating visible objects and lighting (i.e. runway lights, house lighting, the town of Tramore, etc) to distance. Neither of these staff members were on duty on the night of the accident and the chart was not seen by the Air Corps technician on communications duty nor was he briefed on it during the afternoon brief.

However, the Airport Manager, who was present in the Tower from 21.55 hrs onwards, provided him with assessments of horizontal visibility. For vertical visibility/cloudbase measurement, a hand-held cloud spotlight is available in the Tower. However, it was not used on the night in question, nor was it appropriate to use it due to the fog. There is no cloudbase measurement device at the Airport.

1.7.8 When the crew arrived at the Airport at 21:20 hrs approximately to prepare for the SAR mission, the senior Air Corps technician, who towed the aircraft out of the hangar onto the ramp and who watched its departure, said that the weather was very misty with little wind and with visibility of maybe 1,000 metres. He recalled that he said to one of his colleagues " *I don't know if they'll go or not*". He also said that by the time the Airport Manager arrived at 21:55 hrs approx, there was rolling fog on the airfield with intermittent poor visibility. He felt that there was still some natural light remaining (i.e. twilight) up to the departure and this had the effect of enhancing visibility somewhat.

The Airport Manager felt that the visibility, when he arrived, was about 300 metres with only three of the runway edge lights visible at 22:00 hrs. The Airport Manager is of the firm opinion that between his arrival and 23:59 hrs there was no significant deterioration in the visibility.

The Air Corps technician who acted as Tower Communications Operator stated that, at departure (21:40 hrs) the whole runway length down to the RWY 03 threshold was visible from the Tower. This indicated a visibility of 1,000 metres approx. At 22:51 hrs, he passed a message to the Dauphin crew that he could *"just about hardly see the runway, which is a distance of 300 metres from the Tower*". At 23:14 hrs, he passed a visibility of 500 metres to the crew.

The Airport Fire Officer was on the ramp when the Dauphin departed. He felt that the visibility was only 100 metres or so and that on a pre-departure runway check, i.e. at ground level, he could see two lights into the distance, i.e. 120 metres. This runway check was carried out in accordance with Waterford Airport normal operating procedures. The Fire Officer reported to the helicopter crew prior to their departure and he has informed the investigation that there was no formal discussion of the visibility conditions.

1.7.9 There was no weather-related communication between the Dauphin crew and Waterford Control Tower until one hour into the mission at 22.41 hrs when the crew requested an update on the weather, "*has it improved or dis-improved?*" The Tower replied "*Negative, she's staying the same. From what I can see from here out to the lights* ".

At 22.51 the Tower reported "*weather deteriorating slightly here*" to the Dauphin crew, who responded "*Can you see the lights of Tramore at all?*" The answer was "*Negative"*. They were informed that the visibility was about 300 metres at that time as the personnel in the Tower could barely see the runway, which is 300 metres from the Tower. Tramore is 4 Km approximately from the Airport.

Three minutes later, the Dauphin departed the search area for Waterford Airport, saying to MRCC that conditions there were deteriorating and they wanted to get in before the Airport closed.

The lifeboat crew subsequently stated that the sea state during the search operation was choppy.

1.7.10 Witness Reports on Conditions at the Accident Location

The IMES shore rescue team commenced their search at Tramore town at 00:30 hrs approx. and made initial contact with the burning wreckage at 01:00 hrs approximately. The team leader described the visibility near the accident site as being 10 - 15 feet, although the fog was not as dense at the town (western) end of the beach.

One of the team stated that using the mobile phone in his hand was hampered by the fog. They found the wreckage by seeing a red orange glow in the dunes. The fog was less severe in the immediate vicinity of the wreckage, which was still burning. The team stated that they had become disorientated in their search of the beach area due to the fog.

A second shore rescue team went down the beach about an hour later and described the conditions as "desperate" with visibility of 20 yards at most. One of the search team described becoming disorientated in the fog, walking down the beach. The team said that they got lost on the beach and by-passed the accident site due to the fog.

The Air Corps senior technician arrived on the scene at 02:30 hrs approx. and he described the conditions at Tramore as being "significantly worse" than at Waterford Airport. He described considering a need to link arms with ground search team members during the walk eastwards along the beach.

1.7.11 Following the accident, one of the meteorologically qualified licensed ATC Operators from Waterford Airport came into the Tower to provide ATC cover for the Dublin-based S-61 SAR helicopter which had been called in (by MRCC) to assist in the search for the missing Dauphin. The presence of the local ATC Operator had been requested by the Aviation Rescue Co-ordination Centre (ARCC) at Shannon.

The ATCO had been on the beach near Tramore town at 01:30 hrs and he said that the visibility there was less than 100 metres with non-existent vertical visibility. When he arrived in Waterford Airport Tower, he recorded the visibility as follows:

03:00 hrs 300 m in fog, vertical visibility 100 feet

03:13 hrs 400 m light rain and fog

03:24 hrs 400 m

04:43 hrs 500m fog, vertical visibility 100 feet or less.

The S-61 was airborne from Dublin Airport at 01:12 hrs and was overhead the accident scene at 02:00 hrs approximately. The crew could see flashing blue lights at the crash-site when they overflew it at 200 feet. They stated that the fog went up to 1000 feet vertically. The S-61 landed at Waterford Airport following an ILS approach to RWY 21 at 03:42 hrs. The Commander stated that they just made visual contact with the approach lighting at their DH of 310 feet, and were able to continue down. When they landed on the runway they were unable to see the Airport buildings. This approach and landing was approximately 4 hours after the accident.

1.7.12 The MRCC Operations Memorandum for helicopter tasking dated 21 September 1993 states at para 2: "Obtain flight forecast from Met Shannon for ALL MISSIONS". However this was not done for this SAR mission. IMES management have stated that some years ago the Air Corps told IMES that there was no need for MRCC to provide a weather forecast for Air Corps SAR missions and at that time the practice ceased. This may have related to the fact that an automatic weather terminal was installed at Finner Camp SAR base some years ago and that this provides immediate weather data to Finner crews on request. No such facility was installed at the Waterford SAR Office. MRCC continue to provide weather forecasts for commercial operators' S-61 SAR missions.

A formal arrangement was in place between the Air Corps and Met Eireann to have actual and forecast weather data faxed to the Waterford SAR Operations Room at 07:00 hrs and 13:30 hrs each day. The Air Corps had not sought any further daily weather updates to be routinely faxed by Met Eireann to the SAR Operations Room.

Fax transmission logs at the Shannon Meteorological Office indicate that weather data were not sent to the SAR Waterford Ops. Room at 13:30 hrs UTC on 1 July 1999. This transmission would have included the low-level significant weather chart valid for 18:00 hrs UTC and the LAF for Waterford Airport valid for 12:00 – 21:00 hrs UTC. This LAF was transmitted to Waterford Airport Control Tower at 11:43 hrs UTC. The LAF valid 18:00 – 24:00 hrs UTC was transmitted to Waterford Airport Control Tower at 16:46 hrs UTC. Met Eireann were unable to determine the reason for the failure to transmit the data at 13:30 hrs UTC on 1 July 1999 as scheduled.

1.7.13 Weather Prevailing at Potential Alternate Airports

Attached at **Appendix C** are

- Terminal Area Forecasts (TAFS) issued at 15:00, 18:00 and 21:00 hrs on 01 July 1999 by Met Eireann for Dublin, Baldonnel, Cork and Shannon airports.
- Relevant station meteorological aerodrome reports (METARs) for Dublin, Cork and Shannon airports, and for Casement Aerodrome Baldonnel.
- Significant weather charts for Ireland below flight level 200 valid for 18:00 hrs on 1 July 1999 and 00:00 hrs on 02 July 1999.
- 18 hour forecast valid for 18:00 hrs on 01 July 1999 and the 12 hour forecast (Wind and temperature charts) valid for 00:00 hrs on 02 July 1999.

1.8. Aids to Navigation

1.8.1. Radio Aids

The Dauphin was equipped with dual VHF Omni-Range/Instrument Landing System (VOR/ILS) receivers, Distance Measuring Equipment (DME), Automatic Direction Finding (ADF), and Direction Finding (DF) for all frequencies between 100 and 400 MHz. A Nadir navigation computer was installed (see appendix B.4). A Transponder was installed with altitude encoding (Mode C). Dual radio altimeters with a single antenna system were fitted (see appendix B.6). A radar system with weather and search modes was also installed (see appendix B.3).

1.8.2 Instrument Landing System (ILS) and Other Navigation Aids at Waterford Airport

Waterford Airport is equipped with a Category One ILS on RWY 21. The Localiser (Loc) operates on 110.90 MHz and the Glideslope (GS) is on 330.80 MHz. The nominal Loc width is 4.66º and the nominal GS angle is 3.20º. There is also Distance Measuring Equipment (DME) and a Non-Directional Beacon (NDB) on the airfield. The published Decision Height (DH) for the ILS/DME is 422 feet above mean sea-level (AMSL), 310 feet above the runway threshold.

Normally the DH for Category One ILS is 200 feet above the runway threshold but at Waterford Airport because of terrain on the approach, the degree of land survey and an abbreviated approach lighting system the DH is higher. There is also a 1000 m runway visual range requirement for Category A aircraft (this includes all helicopters) as per a Jeppesen publication annotated "*JAA minimums*". The approach lighting is abbreviated with the result that at the Missed Approach Point an aircraft is 741 m, line-of-sight, from the first element of the approach lights.

The ILS/NDB/DME approach chart for RWY 21 is shown at **Annex G**. It is noted that this Irish Aviation Authority (IAA) Aeronautical Information Publication (AIP) chart does not stipulate a visibility requirement for this approach. A copy of the Jeppesen publication is at **Annex H**. This document is part of the publications kit carried on Dauphin SAR missions.

There is also a published NDB/DME Approach to RWY 03. This approach has a Decision Height of 530 feet amsl, 444 feet above the runway threshold.

A Certificate of Compliance for the ILS, DME, NDB and VHF Comms system was issued by the Irish Aviation Authority on 10 March 1999 and it was valid until 31 December 1999.

Following the accident, the Air Accident Investigation Unit (AAIU) arranged a flight calibration of the ILS. This was completed on 09 July 1999, by an agency approved by the UK CAA, and the system was found to be satisfactory. The delay in carrying out the calibration was due to unsuitable weather conditions and availability of the calibration aircraft.

The Airport Manager reported that on his arrival in the Control Tower at 21:55 hrs on 01 July 1999, he found that the localiser had tripped off on the radio aids control panel in the Tower. He reset it and it remained on-line with no further problems. There is a monitor in the Control Tower, which reports the status of the radio aids.

1.8.3 Coastal Approach Chart

A coastal approach procedure for Waterford Airport, which had been developed within No 3 Sp Wing, had an 'initial point' at 7 nm DME from the Airport on an inbound heading of 028º magnetic. This was developed to allow the approach to be initiated well clear of the high ground Southwest of Tramore town and also Brownstown Head. The coastal approach would then bring the Dauphin over the eastern part of Tramore Bay to the Airport. This procedure had been developed several years ago and had been used successfully for training and operations in the intervening period.

A portion of a ½ inch to 1 statute mile Ordnance Survey map recovered from the wreckage showed another point marked at 3 nm DME from the Airport on this inbound heading of 028º magnetic. The co-ordinates of this point were written on the map as "52º08.4' 007º06.9' ". This point is approximately 1 km south of the Tramore Beach shoreline. The track of this approach passes over the beach and the sand dunes about 300 metres to the West of the impact point.

A reconstruction of this coastal approach is shown on two charts of different scales attached at **Annex I** and **Annex J**.

1.9. Communications

The Dauphin is equipped with two communications transceivers, one is a dedicated Aero-VHF transceiver and the second is a multi-band radio covering all frequencies between 30 and 400 MHz. Both radios were in use during the mission, the airband unit on Waterford Tower frequency and the multi-band unit on Marine VHF Channels 16 and 67.

The Dauphin crew was in communications with Air Corps personnel in Waterford Airport Control Tower during the SAR mission, on Tower Frequency 129.85 MHz.

The first voice transmission from DH248 was made at 21:41 hrs as the Dauphin taxied for take-off and the final voice transmission on Tower Frequency was at 23:34 hrs.

At 23:39 hrs, there is a short burst of carrier only transmission on the Tower frequency which has been confirmed as coming from the aircraft. This was the final transmission from the Dauphin.

A transcript of these communications is attached at **Annex E**.

There is no recorded evidence of any radio communications between DH248 and Shannon or Cork ATC Centres during the SAR mission.

The crew were in communications with Coastal Marine Radio Stations, Rosslare Radio and Minehead Radio and with the Helvick Lifeboat during the mission. These stations are the Southeast coast transmitters for the IMES Marine Rescue Co-ordination Centre (MRCC) in Dublin.

The first transmission from the Dauphin on Channel 16 was at 21:45 hrs to MRCC via Rosslare Radio, routing to the search area and requesting further information. There were many messages passed on Channels 16 and 67 between the Dauphin, the Helvick Inshore Lifeboat and the two coastal radio stations as the mission progressed.

The final marine band transmission from DH 248 was made on Channel 16 at 23:35:50 informing MRCC of an approach to Tramore Bay.

MRCC, via Rosslare Radio, called DH248 at 23:38:30 and 23:43:20 with no reply heard.

A transcript of these communications is attached at **Annex F**.

1.10. Aerodrome and Approved Facilities

1.10.1 Waterford Airport Lighting System

Airfield lighting consists of high intensity elevated runway edge, threshold and stop bar lighting, high intensity approach lighting out to 705 metres distance on RWY 21 and 360 metres on RWY 03, high intensity Precision Approach Path Indicators (PAPIs) on both approaches and a white flashing aerodrome beacon, located on top of the Control Tower.

The airfield lighting had been inspected by a UK based Flight Inspection Company on the 29 April 1999 and had been found satisfactory.

The runway lighting is controlled from a panel in the Control Tower. On the night of the accident, this was done by an Air Corps technician following an

afternoon brief from the Airport Manager. There were no indications in the Control Tower of the correct operation of the lights, the only check possible was a visual check of the lighting itself. While indicator lights to monitor the correct operation of the airfield lighting were in position in the Control Tower, these had not been electrically connected at the time of the accident. To check on the operation of the PAPIs and approach lighting, reflectors had been installed which can be seen from the Tower. On the night of the accident the reflector of the RWY 21 approach lighting was not visible from the Tower due to the fog.

There are six constant current regulators (CCRs) in the airfield fire station for the airfield lighting. Two 6 kva CCRs, one manufactured by HPT (1981) Ltd. and the other by Thorn are used for the RWY 21 approach lighting. Half of RWY 21's approach lighting is driven by the HPT CCR and the other half of RWY 21's approach lighting is driven by the Thorn CCR. There are two interleaved circuits for this approach lighting, each circuit being driven from its own CCR. The use of two interleaved circuits ensures that a representative approach lighting system is maintained should one circuit fail.

One of the CCRs (HPT) can trip out when the runway lighting is switched on. When this happens, half of the RWY 21 approach lighting is inoperative. There was no warning of this in the Control Tower, apart from visual sighting of the reflector in the approach lighting. If this trip-out occurs then the CCR must be reset physically in the fire station, which is some distance from the Control Tower.

There is a note in the Tower log at 11:46 hrs on 01 July 1999 of an intermittent fault on the RWY 21 approach lighting, which required a CCR to be reset in the fire station. This intermittent fault is recorded as having happened twice that day.

When the Airport Fire Officer was called in to the Airport for the SAR call-out, by the Airport Manager, he selected all the RWY 21 lighting on from the Fire Station and he then carried out a visual inspection of the lighting and it was then all operational. He returned to the Fire Station and switched the lighting to "Standby/Remote" mode so that it could be selected from the Tower. The Air Corps technician subsequently selected the lighting "on" from the Tower. After this there was no further visual check of the approach lighting and it was not visible from the Tower due to the fog. However when the IMES S-61 helicopter was approaching Waterford Airport at about 03:40 hrs on 02 July the local Waterford Airport ATCO, who had been called in by ARCC Shannon to assist, discovered that there was a problem with the RWY 21 approach lighting. He realised this when he observed that the light plume, penetrating the fog from the approach lighting area, was of lower intensity than he expected. It was necessary for one of the approach lighting CCRs to be re-set at the Fire Station by the Airport staff.

Since the lighting was switched from RWY 21 to RWY 03 following the two ILS approaches and then back to 21 for the S-61 approach, it cannot be stated definitively whether or not the full approach lighting was operational for the two ILS approaches of DH248. However it is possible that only one circuit was operational which would allow the centreline and two crossbars to remain

although only half the number of lights in the centreline and crossbars would be illuminated.

Following the two unsuccessful ILS approaches to RWY 21, the lighting was switched over to RWY 03. The Airport Manager has confirmed that he saw the 03 approach lighting operating correctly when he was out on the airfield following loss of contact with the Dauphin. The 03 lighting is controlled only by the Thorn regulator.

1.10.2 Waterford Airport Communications Facilities

The Control Tower is equipped with two VHF airband transceivers. One is set on the Tower frequency while the second is frequency selectable. There is also a VHF marine band radio in the Tower.

There is no Surveillance or Approach Radar installed at Waterford Airport.

1.11 Flight Recorders

DH 248 was not fitted with either a Flight Data Recorder or a Cockpit Voice Recorder. It was not required to be so under Air Corps Orders.

Examination of the radar tapes at Shannon ATC subsequent to the accident showed that Shannon Secondary Surveillance Radar (SSR) recorded transponder returns from DH248 as it returned from the SAR mission overhead Waterford Airport and turned towards the ILS for RWY 21 and again picked up returns as it headed back for the second ILS. First contact was at 23:01:32 at 2100 feet, groundspeed 141-138-137 knots respectively heading northeast. The signal was lost at 23:05:07 when the aircraft was 5 miles Northeast of Waterford and descending. The signal was picked up again at 23:15:56 at 1600 feet groundspeed 94-101 knots. The aircraft climbed back to 2100 feet heading northeast at up to 140 kts and the signal was lost again at 23:18:11 in the turn back towards the Airport. The visual transcript of the radar tape is given at **Annex K**.

The investigation sought the assistance of the UK AAIB in determining whether any Radar evidence was available from any UK based Radar sites. However, due to topographical considerations, no evidence was available.

1.12 Wreckage and Impact Information

1.12.1 Impact Damage

The aircraft, on a heading of 130º magnetic (122º true), impacted with a sand dune. The crest of the dune was approximately 14 metres (45 feet) above sea level.

The main rotor blades contacted the dune approximately 1 metre (m) below the crest. The initial impact displaced approximately 1 ton of wet sand creating a

sizeable crater in the face of the dune. Remnants of the fuel tanks were found in the crater. A small amount of other wreckage, including the Emergency Locator Transmitter (ELT) and the Main Rotor Blade leading edge strips, was scattered immediately outside the crater. The signal from the ELT was transmitting and was subsequently disabled at the site by removal of its battery.

More wreckage, including the hoist hook (sheared from the cable), aircraft battery and pilot's door, was strewn between the initial impact and the crest of the hill.

The majority of the wreckage (including engines & Main Gearbox, hoist, shells of line replacement units) was strewn down the back slope of the dune, and scattered in the valley at the base of the back slope.

Many components from the aircraft tail were found in the valley including the Fenestron shroud/tailfin, tail rotor head, and starboard horizontal stabiliser.

The bodies of the four crew members were found amongst the wreckage, on the back slope, near the crest.

There was evidence of intense fire both at the initial impact point and along the back slope. Many of the Aluminium items had melted indicating exposure to temperatures in excess of 600^0 Centigrade. Due to the prevalence of composite materials in the Dauphin aircraft much of the aircraft was completely consumed by the fire and the entire site was littered with charred debris. Components in the valley at the end of the back slope had mostly escaped fire damage.

A small number of components were found outside of the main wreckage area; these included the right hand portion of the instrument panel, cowlings, doors and Main Rotor Blade tip-weights. A schematic overview showing the positions of the principal components is attached at **Annex L**.

A detailed search of the surrounding ground was conducted, with particular emphasis on the possible flight path before impact. No evidence of ground contact before impact was found. It was noted that given the final heading, any approach path would, of necessity, have involved crossing over higher terrain than that of the final impact site.

In the search of the impact area and the examination of the wreckage, no evidence was found of any pre-impact break-up, fire or explosion.

A land survey of the impact site was carried out using a taken bench-mark.

Track marks from the main undercarriage were found immediately in front of the main crater. Each mark was 1.25 m long (approx.), and the marks were staggered with the right leading the left by 0.5 m i.e. the right mark started 0.5 m before the left. The land survey showed that the right mark was 0.38 m (approx.) higher than the left mark. No evidence of nose undercarriage impact was found due to the disruption of the ground caused by the fuselage impact.

1.12.2 Wreckage Examination

The wreckage was removed from the site and brought to Casement Aerodrome Baldonnel for detailed examination. This location was chosen because of the ready availability of Dauphin expertise and documentation. On arrival, and prior to the laying out of the wreckage, a third party specialist company was contracted to carry out essential cleaning operations to minimise the health and safety risks posed to investigators by the presence of Man Made Mineral Fibres on the wreckage.

Detailed technical examination was conducted on all components/items, which were amenable to such examination.

The main rotor blades all suffered destruction due to impact with the sand dune.

The tail rotor blades had all fractured at their roots due to impact with the fenestron shroud. The fenestron shroud had suffered reciprocal damage from the tail rotor blades.

The tail rotor head/gear box/servo assembly had remained intact. Examination of the spider actuating shaft revealed a clear witness mark where the tungsten coating had flaked away due to impact.

A preliminary inspection of the engines was carried out at Baldonnel. The engines were subsequently removed to the manufacturer's facility for disassembly and inspection. Two members of the investigation team travelled with the engines and witnessed the work. The engines were found to have been turning and capable of delivering normal power for flight, as demanded by the pilot, at impact.

An examination of the three undercarriage legs and their actuators revealed that the three undercarriage legs were down and locked at the time of the accident.

The right hand rear crew sliding door was found to have exited the upper sliding rail in the mid-position i.e. the door was between the open and closed positions. All other doors were found to have been closed.

The only light-bulbs recovered were from the portion of the right hand side (P1’s) instrument panel, which was thrown well clear of the aircraft.

1.12.3 Examination of Transmission Components

The Main Rotor Gearbox was recovered in a reasonably intact condition but with quite severe fire damage. It was brought to the aircraft manufacturer's facilities in France where it was stripped down and examined under the supervision of the investigation team. No faults or pre-existing defects were found.

There were differences in the damage pattern on the two free-wheel couplings in that the right hand freewheel coupling showed evidence of some flat areas

on the bearing rollers along with a worn area inside the outer housing and marks on the shaft cams.

The left hand freewheel coupling did not display these damage patterns, but only showed damage due to the post crash fire. The damage pattern seen on the right hand freewheel was consistent with a sudden high torque increase which could be caused by sudden Main Rotor Blade stoppage concurrent with engine(s) delivering torque. This assessment was based on experience gained on other Eurocopter accident investigations.

As a result of this anomaly, the investigation team had an independent examination carried out on the left hand engine by the Materials Technology Department at Enterprise Ireland. This examination concluded that the damage observed on individual components of the left hand engine/drive train, particularly the drive shaft, was consistent with the engine driving at the time of impact. The Enterprise Ireland report also stated that no conclusion could be drawn from the different damage patterns to the two freewheel couplings, and that there were indications that the damage caused to the rollers on the right hand side (RHS) freewheel coupling might have been caused by some misalignment induced in the RHS coupling during the impact.

The Main Rotor Shaft assembly was also stripped and examined under the supervision of the investigation team. The assembly had been partially destroyed by the post crash fire. Disassembly did not show any evidence of pre-existing defects.

The Main Rotor Head was similarly examined. It was severely damaged by the post accident fire, but there was no evidence of pre-impact failure.

The Tail Rotor Gearbox (TGB) and hub were thrown clear of the post accident fire and were recovered in an unburned condition. They were subjected to strip examination at the aircraft manufacturer's facility under the supervision of the investigation team.

The TGB was found to be in good working order with no evidence of any pre-existing defects. An impact witness mark on the TGB control shaft indicated that the Tail Rotor pitch was about +11º. Examination of the Tail Servo Control at the servo manufacturer's showed that the Tail Rotor pitch was 11 to 11.5º at impact. These two figures were arrived at independently and are highly consistent. Evaluation of this pitch angle indicates that the helicopter was flying at a speed of 60 to 80 kts at impact, if an assumption is made of straight flight.

The Tail Rotor Hub showed no evidence of pre-existing defects. All the Tail Rotor Blades were broken, either in the Kevlar spar close to the blade root or in the blade airfoil. The indications are that all the blades were rotating on impact and came into contact with the Fenestron shroud carbon skin, which then broke the blade airfoils or spars.

The three main flight control hydraulic servo actuators were taken to the servo manufacturers and stripped and examined under the supervision of the investigation team. The servos were all severely damaged by the impact, and

two of them in particular had also been badly damaged by the post-impact fire. Examination of the servos did not reveal any pre-impact defects.

The positions of the three servo actuators were measured at the servo manufacturer's laboratory and were then forwarded to the aircraft manufacturer's aerodynamic specialists for analysis. It was hoped that this analysis could provide some indication of the helicopter attitude at impact. However, it was concluded that there were still too many unknown quantities to arrive at a plausible scenario.

This was especially so because of the double impact nature of the accident, i.e. the helicopter struck one side of the dune in an initial severe impact and then impacted heavily a second time on the far side of the dune. It could not be concluded with any degree of certainty whether the final servo dimensions related to the initial or final impact.

1.12.4 Avionics and Instruments

Almost all of the Dauphin's avionics equipment and flight instruments were destroyed in the post crash fire. In particular, the Nadir navigation computer was recovered in a completely burned out condition and the GPS satellite navigation receiver was recovered, unburned, but severely damaged and with several of its printed circuit boards missing. In previous investigations it has sometimes been possible to decode the memory of navigation computers to obtain final navigational data. Due to the extent of the damage to the navigation units in this case, this has not proved possible.

A portion of the right hand side of the instrument panel (P1’s side) broke off in the impact and was thrown clear of the main wreckage area and was therefore recovered in an unburned condition. This was found some 50 metres from the initial impact. The instruments, which were in this part of the panel were the P1's Radio Altimeter Indicator and Vertical Speed Indicator (VSI).

The Alarm light, Limit light, Landing Gear warning light and the three Coupler light assemblies located over the EADI were also in this section of instrument panel. In addition, the P1's Airspeed Indicator (ASI), a Torquemeter and a Rotor RPM instrument were found in the grass, again having been thrown clear of the burned out wreckage. A schematic of the Instrument Panel is included at **Annex P**. In the schematic the Alarm Light is denoted as item 1, the Limit Light is item 2, the AFCS Coupler Annunciator Lights as item 4 and the Landing Gear Light as item 5.

The co-pilot's ASI and Radio Altimeter Indicator were also recovered, but in a very burned condition.

The two ASIs, the VSI, Rotor RPM Gauge, the Torquemeter and P1 Radio Altimeter Indicator, were taken to the manufacturer's facilities in France for examination. Because of internal damage to the instruments, reliable information was not available from the ASIs, VSI, Rotor RPM Gauge or Torquemeter.

On the P1 Radio Altimeter Indicator, the DH bug was found to be at 160 feet approximately. Paint marks were also found on the front face of the instrument corresponding to the same indication. Also there were indications on the badly burned P2 Radio Altimeter Indicator that the DH bug setting was at 150 feet.

1.12.5 Light Bulb Examination.

A number of bulbs were recovered from the portion of instrument panel thrown clear of the main wreckage area. Examination of the P1's Alarm Light and Limit Light indicated that they were ON.

A flashing Alarm Light illuminates in front of each pilot when a red warning light on the Caution Advisory Panel lights up. These red warning lights indicate:

- Engine 1 or 2 Fire Warning
- Engine 1 or 2 Oil Pressure drop
- MGB Oil Pressure drop
- Excessive Oil Temperature in engine or MGB
- Hydraulic Pressure drop (1 or 2)
- Overpressure in Auxiliary Hydraulic System
- Low Hydraulic reservoir level
- Main Servocontrol overload or jammed
- High Battery temperature
- Cargo Bay fire
- Landing Gear Pump overpressure
- Fuel Feeder Tank low level
- Failure of both Generators
- Autopilot failure or manual cut-off.

The Limit Light illuminates in flight during manoeuvres when the load factor reaches excessive values.

Examination of the Landing Gear Warning Light indicated that it was OFF at impact. This light illuminates when the airspeed drops below 55 kts while the gear is retracted and the radio altitude is below 300 feet. It is noted that the landing gear was extended at impact.

Some of the P1's side Coupler Annunciator Lights were recovered. These lights indicate whether the collective, pitch and roll channels are active in either flight

director and/or coupler modes. There is an associated pair of amber lights for each channel, which indicate manual recovery of the corresponding lane due to system cut-off or malfunction. Examination indicates that all of these bulbs were OFF with the exception of the collective active bulb, which was ON.

Indications are that the DH bulb in the P1 Radio Altimeter Indicator was ON.

1.13 Medical and Pathological Information

Post-mortem examinations were performed on each of the deceased crew members at Waterford Regional Hospital on 2 July 1999.

In each case, the opinion of the Regional Histopathologist was that death was due to multiple traumatic injuries, which were consistent with injuries received as a result of a helicopter accident.

The post-mortem examinations of the two pilots revealed no evidence of any pre-existing medical condition, which could have contributed to the accident.

Samples amenable to further pathological analysis were only obtainable from one of the deceased. Testing revealed that no ethanol was detected in the blood of the P2.

1.14 Fire

There was evidence at the initial impact pit of burning probably caused by combustion of the fuel tanks, which are located in the belly of the Dauphin. The aircraft broke up on impact and showed evidence of an intense fire, which destroyed most of the aircraft including the cabin area. The two engines, the transmission and the main rotor blades all exhibited severe fire damage.

The tail section of the Dauphin broke clear of the remainder of the fuselage and was undamaged by fire. Also some other components including a small part of the instrument panel, doors, a generator, the Emergency Locator Transmitter and some broken off pieces of composite fuselage broke clear of the fuselage and were not damaged by fire.

1.15 Survival Aspects

The accident was not survivable.

The following points concerning the post-accident search and rescue operation are noteworthy.

Following loss of communications with DH248, the Waterford Airport Manager and MRCC both informed the Tramore Gardaí at 23:55 hrs that the helicopter was overdue. A Mayday Relay was broadcast by MRCC on Rosslare Radio at 00:05 hrs. The local IMES coastal search team were called out at 00:13 hrs

and had assembled at Tramore Strand (at the town end) by 00:30 hrs. They made initial contact with the wreckage at 01:00 hrs approximately.

After the aircraft was reported missing there was a degree of confusion at MRCC regarding the location of Waterford Airport and the endurance of the helicopter.

The rescue services who arrived on-scene in the hours following the accident, including the IMES teams, the Gardaí and the Fire Service were not aware of the hazards/risks posed by the accident site. These hazards included a potential magnesium fire, prevalence of burned/burning man made mineral fibres (MMMFs), burned synthetic fluids (oils and hydraulic), assorted pyrotechnics and compressed gas cylinders which had been exposed to very high temperatures. Advice in these matters was provided by the Air Corps senior technician when he arrived at the scene.

1.16 Tests and Research

Due to the lack of precise information regarding the final impact speed and attitude, a computer simulation was commissioned from the Cranfield Impact Centre (CIC) Limited, a campus company based at Cranfield University in the UK.

CIC have a generic impact modelling tool called the Aircraft Accident Investigation Tool (AAIT). The AAIT has a library of aircraft models which represent aircraft as lumped masses linked by spring stiffnesses. The tool was used productively by the U.K. Air Accident Investigation Branch (AAIB), in their investigation of the Kegworth Boeing 737 accident, in the UK.

Although the Dauphin was not available as a computer model, the Lynx helicopter library model was deemed to be representatively similar for simulation purposes, although a model for the effects of blade impact has not yet been developed. Based on the land survey conducted at the crash site, a model of the ground was constructed. Simulations were run with speed 125 Knots and 12 degrees nose down pitch, 50 Knots and 0 degrees nose down pitch and 87.5 knots and 6 degrees nose down pitch.

In all cases the model showed that the aircraft pitched nose-over-tail i.e. the aircraft impacted, slid up the dune, became airborne again, the tail came under the cabin and the aircraft slid tail-first down the back slope where the majority of wreckage was recovered. It is CIC's opinion that any combination of speed and initial angle of pitch in the range specified would behave in the same way.

CIC stated that this accident represents the most damaged case to which the AAIT has yet been applied. Based on the model results, and accepting its obvious limitations, CIC state that the actual speed of the real aircraft may be towards the lower end of the suggested speed range i.e. nearer to 50 Knots than 125 Knots.

1.17 Organisational and Management Information

1.17.1 Irish Air Corps

The Air Corps is the aviation element of the Irish Defence Forces operating a variety of rotary and fixed-winged aircraft. In July 1999, Air Corps Headquarters (ACHQ) was in central Dublin, while the main Airbase was located at Casement Aerodrome, Baldonnel, Dublin 22. The General Officer Commanding (GOC) Air Corps and his staff were located at ACHQ while the senior officer at Casement Aerodrome was the Group Commander, an officer of Colonel rank. Some changes were subsequently made to the above arising out of the 1998 Price Waterhouse Report on the Air Corps.

There are operational and support Wings located at Casement Aerodrome. No 3 Support Wing is the Operational Wing tasked with all helicopter activity. Prior to the accident No. 3 Support Wing operated five AS365Fi Dauphins, seven Alouette IIIs, two Gazelles and one AS355N Squirrel for the Garda Air Support Unit (GASU). The roles of the Wing include among others SAR, Air Ambulance, Army Co-operation, Naval Service Co-operation, Aid To The Civil Power, VIP Transport and Island Relief. There is a strong commitment to training from initial conversion onto rotary types through to advanced night training such as night SAR. In fact all Air Corps rotary training is the responsibility of, and is carried out by, No. 3 Support Wing.

No 3 Support Wing is made up of four Squadrons, one of which is Search and Rescue (SAR) Squadron. Each Squadron is commanded by a senior officer, usually of Commandant rank. The duties and responsibilities of Squadron Commanders are laid down in Air Corps Flying Orders (ACFOs), Air Corps Flying Directives (ACFDs), Unit Standing Orders and Unit Standard Operating Procedures (SOPs). One of these responsibilities is to ensure that annual type, SAR and instrument ratings are completed in accordance with ACFOs.

Between 1997 and 1999, the appointment of Wing Commander No. 3 Support Wing was held by five different officers.

In the same period, four different officers held the appointment of OC SAR Squadron, primarily because of the loss to civilian employment of Dauphin pilots. Dauphin pilots are not necessarily members of SAR Squadron, for example the Detachment Commander on the accident flight was the Unit Quartermaster with responsibility for procurement of a variety of equipment and services for the Wing. The P2 was an instructor in the Helicopter School.

OC SAR Squadron is responsible for producing the duty rosters, one for the Dauphin SAR detachment at Finner Camp, and commencing on the 01 July 1999, a second Dauphin detachment to Waterford Airport. Prior to, and subsequent to the accident to DH248, the Waterford detachment has been operated by an Alouette III.

The duty Dauphin SAR crew consists of two pilots, two winch crew and a technical support team. The senior pilot is the Detachment Commander, and essentially his crew works as an autonomous team. Daily routine normally includes one or two training flights, often with a local vessel contracted by the

Department of Defence. The Finner crew are on a response time of 15 minutes by day and 45 minutes by night, and they live in purpose built accommodation on-site. The Waterford crew were accommodated in Dunmore East and along with the standard 15 and 45 minute response times, they had an additional 35-minute response time, during daylight hours but outside Airport opening times, during which time the crew were to be located at Dunmore East. (See paragraph 1.17.7).

While on detachment to Finner and Waterford, the helicopters are "declared assets" to the Irish Marine Emergency Service (IMES) and are effectively under the operational control of IMES. When a SAR callout is required, IMES makes direct contact with the Detachment Commander and tasks the mission. The Detachment Commander then makes the final decision to launch the mission. The criteria for this decision, including distance and weather, are laid down in the Dauphin Operations Manual (OM). Air Corps Group Headquarters at Baldonnel is normally informed through the Group Duty Officer (GDO) but they have no executive role in the launching of the mission or in mission following. Operational control is vested in IMES.

1.17.2 Irish Marine Emergency Service (IMES)

IMES is a branch of the Department of the Marine and Natural Resources (DOMNR), which is tasked with co-ordination of marine SAR. It was redesignated as the Irish Coastguard in early 2000. It has "declared assets" around the country which are on standby to assist in SAR as required. These assets currently include two civil S-61s operated under contract and based at Dublin and Shannon Airports, an Air Corps Dauphin at Finner, an Air Corps Alouette III (daylight only) at Waterford Airport, the RNLI Lifeboats, six community inshore rescue services equipped with Rigid Inflatable Boats (RIBs), and about fifty IMES coastal rescue teams. The IMES control room in Dublin city centre is known as the Marine Rescue Co-ordination Centre (MRCC). MRCC communicates with shipping and other traffic on VHF Marine frequencies through coastal radio stations. On the 1 July 1999 the stations involved in the Dungarvan SAR were Rosslare Radio and Minehead Radio. The majority of IMES operational personnel are drawn from maritime backgrounds.

1.17.3 Procurement of the Dauphins

Five Dauphins were ordered from Aerospatiale (now Eurocopter) by the Department of Defence in 1982 and were delivered to Baldonnel in 1986. DH248 was the final delivery arriving in Ireland in December 1986.

Prior to the arrival of the Dauphins, the Air Corps had a fleet of eight single-engined Alouette IIIs, which entered service with the Air Corps in 1963, used for daylight operations only including inshore SAR, Air Ambulance, Mountain Rescue as well as Army and Garda (national police force) Co-operation and several other auxiliary activities. Two single-engined Gazelles have also been operated, primarily in a training role, since 1980.

Two of the five Dauphins were configured for shipborne operations and the other three (including DH248) were ordered as "Alouette replacements", although the Alouettes were not retired and remain in service today. The Alouettes are single-engined daylight VFR helicopters with limited capabilities.

Examination of Board Reports produced by the Alouette III Replacement Board, circa 1982, shows that the Board considered that “an Alouette III replacement helicopter, perhaps of similar type to the shipborne variant, will (also) be unsuitable in the overall Economic Zone SAR task due (again) to inadequate range”. The Board Report also stated that “particular attention has been paid to offers from those manufacturers who have also offered (viable) naval variants in view of the Convening Authority’s instruction concerning commonality between shipborne and Alouette III Replacement types where possible”.

The five Dauphins were specified to a very high level, with an advanced Automatic Flight Control System, incorporating SAR modes including Transition Down, Hover Hold, etc, dual Navigation Computers with Doppler and Omega inputs and various other systems required for night and IMC operations in SAR and other roles.

Following a period of intensive training, a Dauphin was deployed to Shannon Airport on the West coast of Ireland in 1989 to provide 24 hour SAR coverage.

In 1990 the Government set up a Review Group on Air/Sea Rescue Services, known as the Doherty Group. Arising out of the Doherty Report, many changes were made as to how SAR would be dealt with in Ireland. For example, the IMES was established in the Department of the Marine, with responsibility for marine search and rescue.

The Doherty Report recommended the purchase of two medium-lift helicopters for operation by the Air Corps. It further recommended that, in the interim and pending purchase, delivery and deployment of the Air Corps medium range helicopters, that a private contract for a medium range helicopter service should be negotiated urgently and that this service should be located at Shannon. The Report also recommended that, once the Shannon medium-range service was in place, the Dauphin then at Shannon should move to Finner Army Camp in Co. Donegal for 24 hour SAR operations covering the Northwest coast.

While many of the Doherty recommendations were implemented, including the establishment of IMES, an order for the purchase of the two medium-range helicopters for the Air Corps was never placed.

In 1991, the Government awarded a SAR contract to a commercial operator, which placed an S-61 in Shannon. The Dauphin relocated to Finner and a 24 hour SAR operation was established there. The Air Corps also provided a daylight only Alouette III SAR aircraft in Baldonnel. This arrangement remained in place until 1995 when the East Coast Review Group was established by the Minister for the Marine.

1.17.4 Background to and Set-up of the Waterford SAR Detachment

Following a fishing trawler accident at Howth Harbour, Co. Dublin, in November 1995, the then Minister for the Marine ordered a review of the adequacy of Marine SAR Coverage on the East Coast of Ireland. The Review Group submitted an interim report on 01 March 1996 which recommended: "That the East Coast has coverage by a 24 hour, multi-engined Marine Search and Rescue (SAR) Helicopter with an all weather capability as soon as possible, considering the high intensity, marine, aviation and littoral area activities".

The Review Group's Final Report was submitted to the Minister on 07 June 1996. The Group welcomed the enhanced SAR coverage of the East Coast provided by an Air Corps Dauphin helicopter since December 1995 (as an undeclared asset i.e. subject to crews and machines which might not always be available) and the intention to provide a declared (i.e. guaranteed availability and under operational control of IMES) 24 hour Dauphin SAR capability by the end of summer 1996, based in Baldonnel.

The Review Group went on to recommend that, considering the casualty potential on the Irish Sea, the SAR function should be carried out by a 24 hour, multi-engined, medium load marine emergency helicopter, with all weather capability and a radius of action of 200 Nautical Miles and survivor capacity of at least 15 persons, to be based at Dublin. The existing Dauphin helicopter did not meet most of these specifications.

The Review Group further recommended that, once the required asset became available at Dublin, the Air Corps Dauphin at Baldonnel should be re-deployed.

The Review Group Report also recommended that Marine SAR helicopters should continue to be retained in a state of readiness for deployment as follows:

a. not more than 15 minutes for 07:30 - 21:00 hrs local time, and

b. not more than 45 minutes outside these hours 24 hours a day throughout the year.

In November 1996, the Ministers for Defence and the Marine announced that, with the provision of the medium load-carrying helicopter at Dublin, the SAR capability on South/Southeast Coasts would be increased by the relocation of Air Corps resources. An Air Corps study of January 1997 stated that from a flying perspective, Waterford Regional Airport would appear to be the most suitable location. Also in January 1997 Waterford Airport Company produced a document arguing the case for basing the Dauphin at Waterford Airport.

In September 1997, the Minister for the Marine announced that the expected start-up date of the new 24 hour medium-load SAR service at Dublin would be 01 July 1998, and that the aircraft would be operated by civilian and also by Air Corps crews following the necessary conversion training. The Minister also requested the co-operation of the Minister for Defence in ensuring a "back-to-back" move, i.e. a simultaneous move of the Dauphin from Baldonnel to the

South/Southeast location, to commence 24-hour SAR operations also on 01 July 1998.

In November 1997, the Minster for Defence stated in a letter to the Minister for the Marine and Natural Resources that it would seem appropriate for the Department of the Marine and Natural Resources (DOMNR) to fund any necessary works to make ready the required infrastructural facilities for the Air Corps SAR unit to be redeployed to the South/Southeast.

On 4th December 1997, the Minister of State at DOMNR announced the location and start-date of the new South and Southeast Coast SAR operation, Waterford Airport on 01 July 1998. However, concurrent with these activities and announcements, it became clear that the Air Corps would not be in a position to provide pilots for the new 24-hour East Coast medium-load service due to the unprecedented rate of retirement of Dauphin pilots from the Air Corps, including some of the most senior Dauphin pilots, mainly to take up flying positions with commercial airlines.

As a result, it was also accepted that the Waterford operation should go ahead on 01 July 1998 utilising the SAR Alouette III helicopter for daylight VFR operations only. The Minister for the Marine and Natural Resources stated that he wished to have the service upgraded to a full 24 hour capability using the Dauphin helicopter at the earliest possible date.

In December 1997, a Working Group on the Waterford SAR service was established within the Air Corps/Department of Defence (DoD). It produced its first Report in January 1998, which detailed the situation with regards to Dauphin Commanders (P1s), Co-pilots (P2s) and Winchcrew. It concluded that ten (10) P1s should be available by mid 1999 and that training of new P2s would continue, in order to sustain the ongoing Finner Camp, Co. Donegal, Dauphin SAR service and to provide the same crewing levels for the new Waterford service.

The Report concluded that a daylight Alouette III service would be in position by 01 July 1998 but that it would not be possible to commence the 24 hour Dauphin service before 01 July 1999, and then only if there were no further outflows of experienced pilots.

The Report examined the facilities needed at Waterford Airport, and listed requirements for hangarage with maintenance facilities, crew accommodation, catering facilities, operations offices, and actual airport services such as aviation fuel, crash rescue, weather and flight information.

The Report stated that the Airport Company could provide Air Traffic Control (ATC) and Crash Rescue Service (CRS) outside the Airport's published opening hours of 09.00 - 17.00 hours daily, for an agreed hourly fee (Waterford Airport, like all non-State Airports, does not operate on a 24 hour basis). The report also stated in January 1998 that a dedicated crew accommodation block (there was no suitable accommodation at the Airport) was essential to support the 24 hour service and that "*failure to complete the accommodation building before 01 July 1999 will impact on the start date for a dedicated 24 hour Dauphin service"*.

In the event, overnight accommodation for the SAR Alouette III and subsequently for the crew of DH248 was provided in rental holiday homes in Dunmore East, approximately 5 miles drive from Waterford Airport.

The Alouette III SAR operation went ahead as scheduled on 01 July 1998, and, as previously noted, Airport services were only provided during normal opening hours as agreement on a call-out allowance had not been reached between the Airport Company and its employees providing the ATC/AFISO and CRS services. When circumstances required, the Air Corps Alouette detachments operated after-hours missions independently of Waterford Airport ground services.

In November 1998, the Officer Commanding (OC) No 3 Support Wing (the Air Corps Helicopter Wing) wrote to his superiors pointing out the restricted services then available at Waterford Airport and indicating that once the Dauphin 24 hour operation commenced that the Airport-provided services of ATC and Fire Crew would be required on a 45 minute on-call basis during airport closing times, "*the same as the SAR crew*".

He stated that these issues needed to be addressed in the near future in order to achieve the target commencement date of 01 July 1999 for the Dauphin detachment. This requirement was passed by the Department of Defence to Waterford Airport management in January 1999. Negotiations were entered into by management and staff with a view to reaching agreed after hours call-out rates.

Waterford Airport Company have informed the investigation that they intended to meet the Air Corps requirement for ATC services by means of either qualified Air Traffic Control Officers (ATCOs) or qualified Aerodrome Flight Information Service Officers (AFISOs).

Sanction for the public funding of the call-out allowance was communicated by the Department of Finance to the DoD on 25 June 1999 and from there to the Airport management. However agreement to provide after hours Airport services was not reached between Airport management and employees by 1 July 1999[2].

Air Corps management including OC No 3 Support Wing have stated subsequent to the accident that they were unaware that this matter had not been resolved.

The DoD officials who had dealt with the move to Waterford have informed the investigation that the provision by Waterford Airport of Air Traffic Control services after hours was seen by them as “a matter of fact”. The officials have informed the investigation that on two separate occasions during June 1999

[2] Staff members at Waterford Airport, in response to the Draft Final Report, have stated to the investigation that there was no discussion of the call-out allowance between Airport Management and staff between 25 June 1999 and 01 July 1999. They have also stated that they would have been happy to voluntarily respond to after-hours SAR call-outs pending resolution of the call-out allowance issue, but that they had not been asked to do so. However, Airport Management have informed the investigation that no such offer of voluntary response was forthcoming during the negotiations.

they were informed by the Airport Manager that ATC services after hours would, in any event, be provided.

On the night of the accident, two members of the Airport management, the Airport Manager and the Fire Officer, responded to the call-out. The Airport Manager has informed the investigation that pending resolution of the call-out allowance issue, he and the Fire Officer would be providing a basic level of cover for after-hours call-outs. He stated that on 1 July 1999 there was “no particular level of detailed discussion” during the day between himself and the Detachment Commander about night call-out roles. He also stated that the Detachment Commander was made aware during the day that there would be no ATC/AFISO personnel on-call for night call-outs but that he himself would come in. The Airport Manager’s understanding was that the Air Corps technician whom he briefed in the Control Tower would be performing Tower duties for any after-hours call-outs, while the Airport Manager would himself come in to provide a re-fuelling and limited Crash Rescue Service. Neither the Airport Manager nor the Fire Officer are qualified ATCO/AFISO although the Airport Manager was formerly a qualified AFISO.

Communications with DH248 were carried out by Air Corps aircraft technicians, who had no formal training in ATC/AFISO, Tower Procedures or meteorological observations.

In summary, the Air Corps/DoD Working Group reported in January 1998 on the crewing requirements and facilities required to be in place at Waterford Regional Airport in order for a 24 hour Dauphin SAR operation to commence. The Air Corps did not have the aircrew resources to support both the Finner and Waterford Dauphin SAR detachment simultaneously in 1998. The Waterford Dauphin operation was put back to 01 July 1999 with the Alouette III in place as an interim and limited solution. The Air Corps utilised the intervening period from July 1998 to June 1999 to train and convert pilots and crewmen onto the Dauphin helicopter, to achieve the target of ten (10) operational crews.

The issue of the Waterford Airport facilities was taken up by the DoD, as a policy matter, on behalf of the Air Corps. DoD, and subsequently IMES and others, convened a number of meetings to which all interested parties were invited and the infrastructural requirements were clearly spelled out. At least twelve such meetings were held between March 1998 and mid 1999 to discuss the facilities required. Representatives from the DoD, IMES as the national co-ordinator of SAR, Waterford Airport management, the Office of Public Works (OPW), Defence Force HQ and the Air Corps, attended these meetings as appropriate.

The provision of a hangar and accommodation block took up much meeting time and correspondence. It was not until May 1999 that agreement was reached with the Waterford Airport Company on a site for the accommodation block. Planning Permission was then applied for on 21 June 1999. However the important issue of call-out allowances for local ATC/AFISO and other support personnel remained unresolved as of the commencement date of the operation.

1.17.5 Air Corps Flight Safety

At the time of the accident, there was no formalised flight safety organisation in the Air Corps establishment. A flight safety committee, chaired by a Flying Officer of Lt. Colonel rank, and made up of representatives from the operational units, ATC and the engineering unit met periodically, but the flight safety role was very much a part-time function for all those involved[3]. There was no infrastructure in terms of a flight safety office, accessible flight safety library or dedicated telephone line. There was no specific flight safety budget.

Air Corps accidents and incidents are reported internally in accordance with Air Corps Flying Order (ACFO) No. 7 (1987). However, the type of incidents reported on are generally those which are clear cut, e.g. heavy landings, damage to aircraft incurred in flight or on the ground, engine problems, etc. There seem to be few reports of incidents of a "Human Factors" nature being submitted through the channels. Incidents may well be highlighted at local Squadron or Wing level but they generally do not go beyond Unit level. The reporting chain for incidents as laid down in ACFO No. 7 does not include the Flight Safety Committee.

Minutes of flight safety committee meetings held before the accident show that specific aircraft operational issues/incidents were rarely reviewed. Rather the committee dealt with issues more of a Health & Safety nature such as crash rescue services, bird activity, ramp lighting, etc.

Accidents in the Air Corps are investigated under a procedure known as a Court of Inquiry (COI). A COI is a generic military mechanism for inquiring into accidents/incidents, and its terms of reference include, inter alia, determining responsibility for the accident/incident, whether negligence was a causal factor and the cost to the State of the accident/incident. Findings of Courts of Inquiry, even those directly relating to flight safety, are not made public, and if the findings include safety recommendations no mechanism exists to promulgate these to flying/technical personnel.

Formal flight safety audits within the organisation have been far less frequent and comprehensive than the auditing of administrative functions carried out on cash and ordnance. The last formal internal flight safety audit was conducted in 1986.

The Flight Safety Committee have not conducted any safety audit(s) on new operations, and had no involvement in the setting up of the Waterford operation.

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[3] The Air Corps Group Commander, in response to the Draft Final Report, stated the following in a letter to the investigation :
"The 1980 Air Corps Establishment made provision for a Flight Safety Officer of Captain rank in Group HQ. The appointment was never filled as a result of the imposition of an unworkable phasing system of deferred appointments.
Circa 1993/94 a determined attempt by RACO (the Representative Association of Commissioned Officers) to have the results of Courts of Inquiry into Air Corps air accidents published in the interests of flight safety was refused. The matter was raised by Air Corps RACO as a result of pressure from the general body of Air Corps pilots."

However, while structural weaknesses undoubtedly exist, there is a high level of commitment to flight safety by individuals across the organisation at all levels. The culture is indoctrinated during basic training in BFTS, Apprentice School, ATC and the crash rescue training.

The structural weakness was recognised in the February 1998 Price-Waterhouse Review of the Air Corps, and they recommended that one of the more senior positions in ACHQ should be "dedicated full-time to the maintenance of a proactive aviation safety programme, including the monitoring of compliance." This position has not yet been established by the Department of Defence, who control such appointments.

1.17.6 Waterford Detachment Work-Up

There was no specific period of local training or work-up by Air Corps Dauphin crews prior to the detachment commencing on 01 July 1999. No. 3 Support Wing management have informed the investigation of the practical difficulties, which would have been associated with such a work-up, including the multi-role taskings placed on the Dauphin fleet. It had been planned that crews would carry out in-theatre training over the weeks following 01 July 1999 and this had commenced on the afternoon of the deployment when the crew went on a training flight to the South of Waterford Airport. This flight included a coastal approach to the Airport from the South in "poor visibility".

The co-pilot had himself been Detachment Commander of the Alouette detachment to Waterford on nine occasions since 01 July 1998 with the final occasion being on 4-7 June 1999. The Winch Operator had completed ten Alouette detachments at Waterford and the Winchman had completed four Waterford Alouette detachments. The Pilot roster for the Waterford Detachment was issued approximately six weeks in advance of the Dauphin mission commencement date.

While an Operational Order and Standard Operating Procedures had been put in place for the daylight only Alouette Waterford SAR Detachment which commenced in July 1998, these had not been revised to take account of the 24-hour Dauphin operation.

No formal Service Level Agreement (SLA), to define the exact level of services required and to be provided, and consequent responsibilities, was in place between the Dept. of Defence/Air Corps/IMES and Waterford Airport.

1.17.7 Callout Response.

On 24 June 1999, the Air Corps stated in writing, to the Director of IMES, its intention to commence the Waterford 24 hr Dauphin SAR detachment at midday on 1 July 1999. The letter stated that, since the agreed infrastructure was not yet in place, it was the Air Corps' intention to observe the following "*maximum*" reaction times (times are specified in local time);

a. *“Between 0900 and 1700 daily, except Saturday 1000 to 1800 (Airport opening hours) at 15 minutes to airborne.*

b. *Outside 0900 to 1700, but still in daylight, 35 minutes to airborne.*

c. *By night at 45 minutes to airborne"*.

The letter concluded by stating, that when the proposed Waterford accommodation block was completed and occupied, the Air Corps would be in a position to adopt the Finner reaction criteria of 15 minutes by day and 45 minutes by night.

In relation to 'b' above, the additional 20 minutes was to allow time for the crew to get from the Dunmore East accommodation to the Airport, to open up and to carry out any additional work which might be necessary by virtue of not being in-situ when the call came in.

The response times of 15 and 45 minutes are the internationally recognised periods for times-to-airborne in the SAR arena. Whilst on 15 minutes standby, the crew are normally on-site and in an advanced state-of-readiness. The additional 30 minutes by night is intended to allow a crew to wake, if applicable, make their way to the operations room, to conduct detailed flight planning if required and to gather all the necessary latest information concerning the mission.

On the evening in question DH 248 was airborne approximately 40 minutes after the initial call from MRCC. According to the technicians who travelled in the minibus, fifteen to twenty minutes of this were used travelling from their accommodation in Dunmore East to Waterford Airport. No. 3 Support Wing management have informed the investigation that a planned travel time of twelve minutes had been allowed for the drive in, under normal circumstances.

With regard to the call-out time the Director of IMES has stated that, in any case where there was a difficulty in meeting the call-out time, IMES had never made an issue of this with the Air Corps.

1.17.8 Crew Accommodation

Crew rest facilities have been provided for SAR crews at Waterford Airport since 01 July 1998. These facilities consist of one large room with armchairs, TV, coffee & tea making facilities. This is in addition to the dedicated office accommodation provided for the SAR crew at the Airport.

The Dauphin OM, at section 8.2, paragraph 3, lays down the standard of crew accommodation, which should be provided for 24-hour Dauphin SAR crews. It states "A suitable furnished bedroom, with single occupancy which is subject to minimum noise, is well ventilated and should have the facility to control the levels of light and temperature". On 01 July 1999, no accommodation available to the SAR crew at Waterford Airport met this standard.

As has been stated above, an on-site accommodation block, which would have incorporated suitable rest facilities as per the O.M. definition, was not built by 01 July 1999 and overnight accommodation was provided for the crew in rental holiday homes in Dunmore East.

1.17.9 Dauphin Crew Rosters

Since the first Dauphin detachment to Shannon in 1989 it has become SOP for Dauphin crews to rotate to/from Baldonnel from/to the SAR base on Monday and Friday every week. Therefore, a crew which departs from Baldonnel on Monday morning is effectively on SAR call (15 minutes by day, 45 by night) for 96 hours until Friday morning when they are relieved by the next crew. Unit regulations lay down minimum rest periods in the event of multiple call-outs.

In the case of the crew of DH248, their detachment to Waterford was to have been until Monday 5 July 1999.

1.17.10 Fatigue

The Dauphin Operations Manual (OM), Chapter 8 deals with the issue of crew fatigue as it pertains to Naval, General and SAR Operations. While specific Flight Duty Periods (FDPs) are outlined for both Naval and General Operations, the OM recognises that "due to the nature of detachments in Finner, it is impossible to comply with standard Flight Duty Periods" (Chap 8, Annex B, para 2). The Waterford detachment was similarly affected. The Manual outlines a sample daily programme designed to minimise crew fatigue, and gives general guidelines on maximum flying hours to be flown in a 12 and 24 hour period. This includes recommendations to sleep if possible between 11.30 hrs and 12.45 hrs or between 15.00 hrs and 17.00 hrs.

Because of the nature of SAR operations Flight Duty Periods (FDPs) are not laid down for SAR in the OM. However maximum FDPs are laid down in the OM for general operations. For an FDP starting between 07.00 hrs and 13.59 hrs (local time), the maximum length of FDP allowable is 12 hours. The general operation FDP can be extended by a rest period in excess of 2 hours splitting a duty. An extension equal to half the duration of the rest period up to a maximum extension of 5 hours is allowable. However an absolute maximum general operation FDP of 16 hours is laid down in the OM, irrespective of reporting time.

Crew Schedule on 01 July 1999

Schedule	Time UTC
Approx time of awakening	06:30
Start of FDP	07:00
Report to Baldonnel	08:00
Depart for Waterford	09:24
Land Waterford	10:02
Depart on RTÉ Co-op	11:41
Land Waterford	12:16
Full Crew Briefing	13:00
Depart on Training Flight	14:11
Land Waterford	15:06
Depart on Hospital Recce	15:10
Land Waterford	15:20
Depart Waterford for Accommodation (via shops)	16:15

Callout from IMES	21:02
Takeoff on SAR mission	21:41
Time of Accident	23:40

The total FDP of the crew at the time of launch decision was 14 hrs 30 mins and at the time of the accident it was 16 hrs 40 mins.

A Royal Air Force (RAF) flight safety magazine published in 1999 cited a medical study, which found that "after 16 hours of continual wakefulness starting at 0700 hrs, response times are degraded by up to 7 % on vigilance and sustained attention tasks".

1.17.11 IMES/Air Corps Crew Relationships

Some Air Corps SAR crews expressed a feeling to the investigation that the Air Corps had been sidelined to an extent by IMES in the development of helicopter SAR services around the coast. This feeling mainly stemmed from the situation whereby IMES had contracted two medium-load helicopters (S-61Ns) to be operated by civilian contractors based at the two main Civil Airports in the State, with 24-hour ATC, weather reporting, crash rescue services, etc. and which are equipped with high specification ILS, approach radar and other sophisticated systems to aid operations.

They contrasted this with the situation whereby the two medium-load SAR helicopters recommended by the Doherty Report to be purchased for the Air Corps were never ordered. The Dauphins, classed as a short-range SAR helicopter and with much less range, endurance and lifting capability than the civilian S-61Ns were located at Finner, an Army Camp with no precision landing aids and at Waterford Airport which had highly restricted opening hours and far less in the way of approach and landing aids than Dublin or Shannon Airports, where the S-61Ns are based.

Crews felt that, having pioneered helicopter Search and Rescue in Ireland in the 1960s, that there was a developing possibility that the Air Corps could lose out entirely on Search and Rescue if the 24-hour deployment at Waterford did not successfully go ahead on 01 July 1999.

The Air Corps had been unable to provide crewing for the Dublin S-61N operation and the back-to-back move of the Baldonnel-based Dauphin to Waterford, in addition to the on-going Finner SAR detachment. The 24 hour Waterford deployment was seen as being essential if the Air Corps was to maintain credibility in the national SAR picture.

The need for a successful commencement of the 24 hour Waterford deployment was stressed by the Detachment Commander in his briefing to the crew on the afternoon of the initial day at Waterford. It was reported that he had mentioned the need not to be caught out on response times by IMES.

The Director of IMES, on the other hand, sees no problem in the relationship of his organisation with the Air Corps. He stated that the declared policy of DOMNR is to use State assets whenever possible. He also stated that DOMNR had incorporated clauses for Air Corps personnel to train with and operate as

part of the crew in several previous SAR contracts with civil helicopter operators. However the Air Corps have been unable for various reasons to take up these opportunities. He further stated that IMES had never taken issue with the Air Corps in the event of a response time exceeding that laid down.

There is no formal service level agreement between IMES and the Air Corps setting areas of responsibility and operational deliverables for both sides.

1.17.12 Self Regulation in the Air Corps

The Air Corps as a military operator, provides its own regulatory framework, i.e. aircraft are operated and maintained under Air Corps produced orders and standard operating procedures, e.g. Flying Orders and Technical Orders, in accordance with the manufacturer's recommendations. There is very little input from external regulatory organisations into how the Air Corps carries out its mission. This has the considerable advantage of providing maximum flexibility for the carrying out of Air Operations.

At an operational level, such as within No 3 Support Wing, all crew proficiency checking, instrument procedure ratings and SAR ratings are done internally within the Wing. Largely because of the loss of experienced personnel to civilian employment, there is no cadre of ex-Dauphin commanders who are now in Headquarters or Staff appointments and who could provide a degree of independent checking on standards within the Wing. No system is in place for proficiency checking of Dauphin pilots by external sources.

1.17.13 Loss of Dauphin Experience

Between 01 January 1996 and 31 December 1998, twelve Dauphin pilots, of whom ten were SAR rated aircraft commanders, retired from the Air Corps. Six of these commanders retired in 1998 alone. Most of the personnel took up positions in the civil aviation sector.

These twelve Dauphin pilots had a total flying time between them of over 37,000 flying hours of which almost 17,000 hours were on Dauphin.

This loss of experience coincided with a period during which No 3 Support Wing was being allocated additional taskings, including providing pilots and technicians for the Garda Air Support Unit AS355N Squirrel and the Waterford SAR detachment.

In general, Flying Officers may not retire until they have completed a service commitment following their Wings Course. This is usually 10 or 12 years. Consequently it is invariably the more experienced personnel who seek to retire from service.

The Air Corps situation contrasts sharply with that obtaining in the civil SAR sector generally. In this case, the responsible agency lays down minimum qualifications in terms of experience that civil pilots must possess but crews can also be remunerated, within the terms of the SAR contract, comparably to civil aviation rates generally.

So, while the Air Corps is constantly attempting to catch up in terms of the apparently inevitable loss of pilot experience, the civil sector can set its own flying experience requirements at a level of its own choosing and then directly employ crews accordingly.

As a direct result of this loss of senior Dauphin pilot experience, there has also been a very high turnover of Officer Commanding (OC) SAR Squadron. Between 1997 and 1999 four different Officers of Commandant rank have held this appointment. OC SAR Squadron is responsible for monitoring and assessing the ratings of the Dauphin SAR crews. These ratings are required by Air Corps Flying Orders to be renewed every twelve months. This high rate of turnover was in addition to a similarly high rate of turnover of Officer Commanding No. 3 Support Wing.

The loss of Dauphin experience also has the general effect that management structures within the Unit are over-stretched because middle-management Squadron Commanders are heavily involved in rostered duties away from Baldonnel.

1.17.14 Dauphin Multi-Roles

The Air Corps Dauphins have been tasked to perform multiple roles including:

Search and Rescue (Land and Sea)

VIP Transport

Air Ambulance

Training (Conversion and Role)

Army Co-operation

Naval Co-operation, including operations on LE Eithne

Aid To Civil Power.

1.17.15 Availability of Dauphin Hours

The avionics suite on the AS365Fi is unique to the Irish Air Corps. It was designed in 1982 and many of the avionic components are now obsolescent. Therefore it has become difficult to support the aircraft in terms of spares availability. In practice, this means that when an avionic system is unserviceable, that aircraft is grounded until the required parts can be procured or the parts repaired.

It has become regular practice that aircraft will be grounded and "cannibalised", (i.e. parts removed) to allow them to be fitted to other aircraft to make them available for operations. The overall effect of this shortage of spare parts and cannibalisation is to severely reduce the availability of the aircraft for operations but particularly for training.

Personnel shortages, including in particular a lack of Aircraft Inspectors and technical NCOs, have also led to situations where Dauphins are delayed in being returned to service following scheduled or unscheduled maintenance. The Air Corps has, for many years, sought an increase in the establishment for Aircraft Inspectors in No 3 Support Wing from the Department of Defence, which controls such appointments, but without success. The lack of technical NCOs is exacerbated by the requirement for technically proficient personnel to successfully complete military training courses prior to promotion. These military courses are usually held away from Baldonnel and have very limited places available to the Air Corps. The establishment of the Operating Unit was not increased to take account of new taskings, e.g. the GASU helicopter and Waterford SAR outstation.

In the six months between 1 January 1999 and 30 June 1999, DH248 had flown 247 hours. This contrasts favourably with other Dauphins in the fleet. An annual flying hour output of 350 Hrs per annum would be representative. This can be contrasted with the annual flying rate of more than 900 hours achieved by the Garda Air Support Unit AS355N Squirrel, which is also maintained and operated by No 3 Support Wing. This is due in part to the relative ages of the two aircraft types, and also to the extremely focused nature of the GASU operation including its unique (in Air Corps terms) "power by the hour" product support and a generous allotment of technicians.

1.17.16 Air Corps SAR Currency Requirements

Air Corps Flying Order (ACFO) No. 25 lays down the SAR Rating currency requirements for Dauphin pilots. The Order requires a monthly flying time of 7 hrs 30 mins for Aircraft Commanders, which includes seven different disciplines.

The P1 had flown 99 hrs in the previous 3 months and 30 hrs on Dauphin in June 1999 alone, including two Finner SAR detachments. His log book record does not indicate that he had completed a night Trans-down during each Finner detachment as per the Air Corps Flying Order 25. He had flown 3.5 hours actual Instrument Flying (IF) in June 1999 and a period of Visual Flight Rules (VFR) and Instrument Flight Rules (IFR) during simulator training in Switzerland in late May 1999.

The P2 had flown 89 hours in the previous 3 months and 13.9 Dauphin hours and 9.2 Alouette hours in June 1999, including one Finner Dauphin detachment. He had flown 2.0 hours IF (simulated and actual) during the month and his log book does not indicate a night Trans-down as per the ACFO.

It is known that the crew flew an ILS approach to Waterford Airport on their arrival from Baldonnel that morning as it was watched by the avionics technician. Video evidence also suggests that they had flown another ILS approach during the RTÉ flight that day.

1.18. Additional Information

1.18.1. Applicable Regulations

As a search and rescue mission being operated by a military aircraft, the flight was regulated by the Dauphin Operations Manual issued by GOC Air Corps. The conduct of SAR operations and training is covered in Chapter 1 of the Operations Manual (OM). This provides comprehensive guidance for the planning and conduct of SAR operations using the Dauphin.

1.18.1.1 Crew Briefing

OM Section 1.1 paragraph 2 sets out the requirements for SAR standby crew briefing. It is known that the Detachment Commander held a briefing on the afternoon of the 1st July following the handover of duty to the first Dauphin crew. Evidence from the technical crew confirms that this was a comprehensive and thorough briefing and that it included emphasis on the prestigious nature of the first day of the new Dauphin detachment.

All members of the crew were aware that their performance had to be exemplary if the tasking agencies were not to be critical of them or their equipment. The 45 minute to airborne call-out time from Dunmore East was also emphasised as being of high importance.

1.18.1.2 SAR Scramble

OM Section 1.1 paragraph 6 states that all requests for SAR must be approved by Group Operations Baldonnel. The OM requirement is that, where possible, this should occur prior to take-off, but that, where immediate life-saving action is required, take-off should not be delayed and Group Operations should be contacted as soon as practicable. This latter course of action is what happened on the evening of July 1st.

The GDO Log shows that at 21:35 the GDO was informed of the departure of DH248 on a SAR mission to Dungarvan. This message was passed to the GDO by one of the technical crew and effectively was a message for information rather than for approval. Such a procedure had become the norm for SAR call-outs.

1.18.1.3 Crew Responsibilities

These are laid down in OM Section 1.1 paragraph 7 for all members of the crew. Among the pilot-in-command's responsibilities are the fuel requirement and the refuelling requirement, in conjunction with the co-pilot. He is also responsible for an assessment of the weather "where necessary".

The co-pilot has primary responsibility for flight planning and the OM issues guidance that this includes obtaining the full and most recent meteorological forecast and completing fuel calculations, recommending the route and advising on departure fuel and en-route fuel requirements.

There is no evidence that a telephone or fax briefing was sought from the Meteorological Service immediately prior to departure, so the 18:00 - 24:00 hrs Local Area Forecast was presumably used as the available weather information. Neither is there any record of an attempt to contact Shannon ATC or Cork ATC for a weather update during the mission.

In the OM Section 1.1 paragraph 6, the Manual states "it is essential that the weather be checked at each of the relevant locations, i.e. en-route, rescue point, recovery point and alternates." An alternate is an Airport or landing site other than the intended arrival point. It also states that, "it is unlikely that the Dauphin's endurance will allow for a diversion to an alternate." The OM states that, "it is therefore essential that the recovery airfield forecast is above minimum for ETA plus one hour, if an IFR transit is planned."

In Section 2.1 paragraph 3 "*IF*(R) *Approach*" the OM states that the Dauphin is certified for Category 1 precision approach, i.e. "*ILS with a decision height not lower than 200 feet and a Runway Visual Range (RVR) of 500 metres*". The LAF was therefore forecasting highly marginal conditions given the prediction of local visibility of 500 metres after 20:00 hrs, and cloudbase "*locally broken 200 feet later*". The 200 feet in the LAF is referenced to sea-level.

The OM does state in Section 2.2 paragraph 1.k that take-off minima are at Aircraft Commander's discretion for SAR operations.

1.18.2 Letter Regarding Avionic Obsolescence and Support

A document written by an Air Corps Engineer Officer to his superiors dated 25 January 1999 was brought to the attention of the investigation. The text of this document is as follows :-

"***REF Dauphin Avionics***

Sir,

1. Over the last 4 years all possible efforts have been made by Avionics Squadron to deal with problems of obsolescence and support issues for major Avionic components on the Dauphin Aircraft (i.e. EFIS 10 System (inc. Screens, Symbol Generators, RCP's) and Radar RT's,). The EFIS and Radar systems on this Aircraft are very much late 70's \early 80's technology which have been superseded by rapid changes in technology and new equipment designs since then. It should be noted that the design of the Dauphin was finalised in 1982. The net result of this is that we have systems on the Aircraft which are out of production and are no longer fully supported by the manufacturer. It is impossible to locally retrofit newer versions of these components due to the compatibility problems resulting from the unique fit of the aircraft i.e. the mix of digital and analogue equipment.

2. I have had many contacts with Allied Signal and ECF in relation to these issues since 1995 and some limited successes have been achieved in obtaining support from Allied Signal in relation to spares and supply of 'Loaner' units. However, the core issue of having a policy to either upgrade the Avionics on the Aircraft during the next 'C' and 'G' checks or replacing the aircraft must

be addressed. If not, then it will be impossible to maintain Avionic support in the medium term.

3. Prior to Christmas last year we had a situation where 1 Dauphin was missing vital Avionic components for a period of time due to this issue. This scenario is likely to happen on a more frequent basis due to the increasing difficulty with maintaining support as the aircraft get older and our spares situation depletes further. It will also mean that our ability to support a Waterford detachment this year will be difficult.

4. *I am bringing these issues to your attention because of the serious implications they may have. I also recommend that these matters be addressed as a matter of urgency due to the lead time involved in any resolution*."

The investigation discussed the letter with the officer concerned. He stressed that when component(s) were missing from an aircraft, this meant that the aircraft was grounded, and became unavailable for operations and training. The letter was written to highlight to senior management the absolute requirement to either carry out a major upgrade to the Dauphin fleet at the next major inspections which are due to commence in 2001, or to replace the fleet with a more modern aircraft type.

Non-action on the issue would inevitably mean more down-time for the Dauphin fleet with a consequent reduction of the ability of the Air Corps to meet its operational and training requirements. The officer who wrote the document also stated that certain articles in the media had totally misinterpreted the content, context and tone of his letter. He stated that he was not warning of "flight dangers" but simply highlighting an engineering support issue.

1.18.3 Experience with West Coast Operations

During this investigation, the shortcomings of the Dauphin as a SAR platform in the Irish Atlantic coast theatre have been expressed to the investigating team by many past and present Air Corps SAR aircrew. Shortcomings expressed, included the lack of available power, inadequate auto-hover capability when operating in typical North Atlantic sea-states, lack of endurance and low casualty carrying capacity. These shortcomings were formally communicated to Air Corps higher authority in 1991. The aircraft manufacturer attempted to resolve/relieve the auto-hover problem by modifying the sea-swell filters in the AFCS. In addition the Operating Unit, when offered a choice by the manufacturers, between increased payload or increased engine torque limits, selected the latter in an attempt to solve some of these problems. However, current SAR practitioners have expressed the view that these problems still exist.

1.18.4 Casualty Vessel

Details of the casualty vessel were received from the crew of the Helvick Inshore Lifeboat. There were five persons on board, four adults and a child. They had set out on a fishing trip at about 8 pm local time in a 15-foot fibreglass boat with a small cabin. When the fog rolled in they became completely lost.

The boat was equipped with a VHF Marine radio but no-one on board could use it until instructed how to do so by MRCC over a mobile phone. The boat was also equipped with a depth finder and a compass. The vessel had only two life-jackets for five persons, no bow rope and no anchor. When the vessel was located the child was very seasick and was getting very cold.

1.18.5 Lifeboat GPS installation

The Inshore Lifeboat's operational navigation system was a GPS satellite navigation system. Electrical power for the Lifeboat is provided by four batteries which are charged by an engine driven electrical generator. Because of the slow speed of the lifeboat, whilst towing the casualty vessel, engine revolutions were low and due to the level of electrical loading on the batteries, they may have been running down. The GPS became unreliable, probably as a result of voltage drop, and the lifeboat crew requested DH248 to provide navigational assistance.

1.18.6 Waterford Airport Approach Lighting Anomalies

During the course of this investigation the Irish Aviation Authority were informed of the anomalies in the airfield lighting control systems and they carried out an inspection of the facilities on 29 July 1999. Since that time indications have been provided in the Control Tower of the correct operation of the various regulators for the airfield lighting.

1.18.7 Standby Fuel Load

On arrival at Waterford Airport on the morning of 01 July 1999 the Detachment Commander set a standard fuel load for the detachment of 600 kg. This figure would be the fuel quantity to which the technical crew would refuel the aircraft following each operational or training flight while it was based at Waterford.

A standard fuel load is set by all Detachment Commanders on arrival at a SAR base for each detachment. The principal criterion is that the most frequent flying carried out during a detachment is SAR training, i.e. Trans-downs, winching with a training vessel or on "opportunity decks", etc.

Dauphin crews require to come to the hover over the training boat at a typical maximum weight of 3,800 to 3,900 kg. This allows a degree of reserve power to be available in the critical hover phase of flight.

As the training flights usually have short transits of perhaps ten or fifteen minutes, the Detachment Commander chooses a standard fuel load which is considerably less than the maximum load possible to ensure that he will arrive at his training location at an aircraft weight he is comfortable with. This also eliminates any requirement to jettison fuel on routine training missions.

Standard fuel loads of 500 to 600 kg are typically set for SAR detachments. If the aircraft is required for a SAR mission, the Detachment Commander then makes a decision on the fuel load based on the merits of the particular mission, taking into account factors such as distance away from base, weather, likely

winching scenario, i.e. how many casualties, requirement to refuel en-route, etc.

Detachment Commanders who were operational in the early 1990's in Finner have stated that the practice at that time was to ensure maximum possible fuel up-lift prior to departure on night SAR missions, and to jettison fuel if necessary. However this policy appears to have been revised in the intervening years.

1.18.8 Rear Crew Composition

The rear crew comprised a winch operator and a winchman, both trained in aviation and paramedical disciplines. These personnel are recruited internally within the Defence Forces, and are appointed as SAR crew only after successful completion of a highly specialised and demanding selection and training course. Among their many functions they assist the flying crew during certain approach and landing procedures, for example when landing in confined areas. They also call out pre and post Trans-down checks for the flying crew. The expression "*eyes-out*" refers to an operating configuration in which the rear sliding doors are locked in the open position and reports from the rear crew are used to augment the flying crew's all round visibility.

It is understood that hand-held Night Vision Goggles (NVGs) for the use of the rear crew were part of DH248's SAR kit. It is not known if they were in use on the night of the mission. Given the weather conditions, it is probable that NVGs would have been of no use to the rear crew during the coastal approach. This is because NVGs use ambient light such as starlight to provide night vision. However, given the prevailing conditions of night fog, it is most unlikely that the NVGs would have been effective.

1.18.9 Simulator Training

The unique nature of the 365 Fi variant Dauphin means that no representative simulation environment is available for training purposes. This limits the availability of training environments for simulated emergency procedures. Air Corps Dauphin crews utilise a Super Puma Mk 1, level D, simulator located in Switzerland. Crews undergo simulator training once per year. This training comprises six hours of emergency procedure and Crew Resource Management training including a simulated night SAR exercise. Simulator training supervision is provided by Air Corps instructors who themselves underwent an initial simulator course in 1998. Whilst all simulated emergencies are dealt with according to 365 Fi checklists, it should be noted that there are several differences between the Super Puma Mk 1 simulator and the 365 Fi aircraft. These differences include the facts that the simulator AFCS Coupler is three axis (versus four axis for the 365 Fi), the simulator cockpit is analogue (versus EFIS for the 365 Fi), and handling characteristics differ between the two types.

1.19 Useful or Effective Investigation Techniques

1.19.1 Acoustic Analysis

The Dauphin, as already noted, was not fitted with a CVR. Consequently the acoustic analysis carried out for the investigation by the UK AAIB, was confined to analysing background noise recorded on DH248's radio transmissions. The scope of this analysis was necessarily constrained by the fact that, whilst a CVR captures 'raw' noise, radio transmissions are made via a microphone system which is designed to minimise the levels of background noise. As a result the only acoustic analysis possible was essentially empirical/subjective in nature.

1.19.2 Reconstruction Flight

A reconstruction flight was carried out some time after the accident. This flight closely followed all the known parameters of the accident flight. One of the purposes of the flight was to validate the theoretical fuel analysis, which had been carried out using published AFM figures. The flight showed that the analysis was representative of actual fuel consumption encountered.

During the reconstruction flight a Trans-down to 100 feet followed by a Coupled Groundspeed approach to the beach, along the likely flight path of DH248 (as per the Coastal Approach Plate) was flown. The wind in the Tramore Bay area, according to the Nadir computer, was 206^{o} at 6 kts, though at the Waterford Airport Control Tower the wind was reported as being more Westerly.

As the aircraft approached the beach the Radar picture became unusable for navigation, as expected, at a distance of approximately 0.2 nm from the beach. Just after this the Doppler went into Memory mode. This was caused by environmental affects degrading the Doppler signal returns from the sea surface. Consequently the selected Coupler mode of Groundspeed was degraded and the aircraft started to drift to the left. The flying crew were alerted by standard warning displays in the cockpit and the handling pilot was forced, for safety reasons, to immediately initiate a manual go-around. As the aircraft turned right back out to sea the Doppler came out of Memory mode and full Coupler functionality was restored.

A second 100 feet Groundspeed mode approach was made to the beach with the same results.

A simulated cloudbreak procedure to 200 feet was flown and in this case the Doppler did not go into Memory mode.

During all three manoeuvres the handling pilot had been briefed to carry out a standard manual go-around procedure with a right turn back out to sea. In all cases the go-around flight path passed directly overhead DH248's impact point.

During the reconstruction flight, no VHF communications were possible with either Shannon or Cork Air Traffic Control Centres, whilst loitering at 500 feet at the search area.

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2. ANALYSIS

2.1 General

The first point that must be made in analysing the possible causes of this accident is that the crew of DH248 departed from Waterford Airport on the evening of July 1 1999 with the intention of saving life. The nature of Search and Rescue missions is entirely different from normal civil and most other military flying. SAR missions are, by their nature, ad-hoc and highly varied.

The majority of SAR missions are required in adverse meteorological conditions and at the outer ranges of the capabilities of man and machine. Crews faced with a SAR call-out in adverse conditions, must carry out an assessment of the risks involved, known and estimated, and reach a balanced judgement, all within tight time constraints. The attendant pressures have no equivalent in the vast majority of other types of flying.

This analysis is in two parts. The first part examines the circumstances of the accident, including flight planning and the various landfall recovery strategies available to the crew of DH248, and examines the direct/active causes of the accident.

The second part of the analysis discusses the systemic causes of the accident, including the pressures on the crew of a search-and-rescue (SAR) helicopter, the command and control aspects of SAR operations against a background of the particular operating characteristics of the Dauphin helicopter and the infrastructure in place to assist the crew of the Waterford 24 hour SAR service.

2.2 Planning for the SAR Mission

2.2.1 Fuel Planning

The initial call from MRCC came to the Detachment Commander at the crew accommodation in Dunmore East at 21:02 hrs. Having got the seven members of the crew together, they set out in the minibus on the drive in to the airport. En-route the Detachment Commander took a second call from MRCC on his mobile phone, the initial purpose of which was to stand down the mission as MRCC had by now established VHF Marine communications with the casualty vessel and as they (MRCC) felt that the weather, in nautical terms of sea-state and wind, was "*good*". However, as the conversation continued, in a discussion of the weather and the proximity of the search location to base, it was decided to continue with the mission. (See Annex C).

On arrival at the Airport the senior technician asked the Detachment Commander whether he was happy with the 600 kg of fuel in DH248. The Detachment Commander, in consultation with the co-pilot, stated that he was happy and that no further refuelling was required. At that stage DH248 could have taken a further 200 Kg of fuel to bring it up to maximum take off weight.

However there are several credible reasons why the Detachment Commander decided that 600 Kg of fuel was sufficient.

Firstly the search area was very close to base, less than 20 nautical miles away, about ten minutes flying time. The estimated duration of the mission was entered as *"1.00 hr"* on the Air Corps Flying Detail signed by the Detachment Commander, which suggests a relatively short mission was anticipated. With the take-off fuel of 600 Kgs an additional 1 hour 20 minutes to 1 hour 30 minutes flying time was available above the estimated mission time of 1 hour. The phone call from MRCC as the crew drove in to the airport saying that VHF Marine communications had been established with the casualty vessel and that they (MRCC) were happy to stand down the mission probably re-inforced the concept of a short mission.

Another consideration for the crew would have been the fact that Waterford Airport had a precision landing aid in its Category One ILS along with DME at the airfield. The SAR base which the crew were used to at Finner Camp is not ILS equipped. It is also clear from the afternoon briefing that the Detachment Commander was highly aware of the 45 minute call out time. In the event DH248 was airborne in 40 minutes from the initial call. He may have felt that further re-fuelling, in addition to the first night towing of the Dauphin out of the Waterford hangar, could have caused a potential delay.

It can also be considered that in every SAR scenario there is always a possibility of a requirement to winch. Prior to departure from Waterford, the Detachment Commander was aware that a young child was on board the casualty vessel, and that he was very seasick.

A Dauphin crew will normally plan to come to the hover over a casualty vessel at a weight of 3,800 to 3,900 kg. This allows a degree of reserve power to be available in the critical hover phase of flight. This is especially true for the night of the accident when the small size of the vessel combined with poor visibility and relatively calm conditions required that a greater power reserve was available. Given the start-up weight of 3919 Kg, the short transit to the search area would allow the Dauphin to arrive overhead the casualty vessel at an approximate weight of 3,800 Kg, which Dauphin Pilots would regard as highly desirable.

The technical problems and anomalies experienced with the fuel jettison system as detailed in **Appendix B.1.1** and the potential delay associated with fuel transfer required by the AFM following jettison have tended to make Dauphin crews favour departure with a lighter fuel load instead of departing with maximum fuel and jettisoning prior to winching, for close-in missions.

However, what appears not to have been taken into account in the fuel planning was a potential need for maximum possible endurance to allow for an extended search task, while retaining enough fuel for a recovery to a location where the weather was forecast to be better than that prevailing at Waterford.

2.2.2 Weather Planning

The Dauphin crew had access to the routine forecasts supplied by Met Eireann to the SAR Operations Room and to Waterford Airport. The most relevant of these was the 16:00 hrs Local Area Forecast (LAF) faxed to the Airport at 16:46 hrs and valid from 18:00 to 24:00 hrs on 01 July. This LAF was not faxed to the Air Corps offices at Waterford but would have been available to the pilots in the Airport Operations Room, which they visited prior to departure.

There is no recorded evidence indicating that the pilots of DH248 sought any further information from Met Eireann immediately prior to the SAR mission. Therefore, it seems highly probable that the crew based their decision to launch the SAR mission on the weather predicted in the 18:00 - 24:00 hour LAF, and on their own observation of the weather conditions on the drive in and at the Airport as they prepared for the mission.

The crew may have decided that the 18:00 - 24:00 hour LAF was as accurate a forecast as would be available for Waterford Airport given that there is no resident Meteorological Observer there.

MRCC provides weather forecasts for commercial operator S-61 SAR missions as part of their SOPs. IMES management have stated that this practice had ceased for Air Corps SAR missions some years ago, at the instigation of the Air Corps. Neither IMES management nor Air Corps management are able to say why, when or by whom this was done. It may have been because of the installation of an automatic weather reporting facility at the Air Corps SAR base in Finner. No such facility was in place at Waterford. The restoration of this MRCC provision of weather forecasts for Air Corps SAR missions flown from bases other than Baldonnel (where there is a 24-hour Met presence) or Finner would clearly be of benefit to Air Corps crews.

In the OM Section 1.1 paragraph 6, the Manual states that it is essential the weather be checked at each of the relevant locations, i.e. en-route, rescue point, recovery point and alternates. It also states that it is unlikely that the Dauphin's endurance will allow for a diversion to an alternate and that it is therefore essential that the recovery airfield forecast is above minimum for ETA plus one hour, if an IFR transit is planned.

However, with the exception of the discussions with IMES concerning the conditions at the rescue location, the LAF and the crew's own observations prior to and during the mission, the flight crew do not appear to have carried out these weather checks.

The LAF forecast for Waterford predicted visibility of 500 metres locally after 20:00 hrs, local fog later and a cloudbase of locally broken 200 feet later. This cloudbase is referenced to mean sea level and would therefore indicate a locally broken cloudbase of under 100 feet at the Airport.

In Section 2.1 paragraph 3 "IF Approach" the OM states that "*the Dauphin is certified for Category 1 precision approach, i.e. ILS with a decision height not lower than 200 feet and a Runway Visual Range (RVR) of 500 metres*". The Jeppesen publication of JAA Minimums for Waterford Airport indicates a

required runway visual range of 1000 m for an ILS/DME approach to RWY 21. The LAF was therefore forecasting highly marginal conditions for a recovery to Waterford Airport.

The OM does state in Section 2.2 paragraph 1.k that take-off minima are at the Aircraft Commander's discretion for SAR operations. However, it is undoubtedly the wisest course of action to make direct contact with Met Eireann and to receive the most up-to-date weather briefing from them, including the forecast for alternates in the event of a possibility of not being able to land at the planned destination.

However there is no evidence that the crew had carried out any detailed pre-flight planning towards the eventuality of diversion to another Airport and it is clear that at all times their intention was to recover either to Waterford Airport or to a landing site close by the Airport. It is noted that the OM states that "*it is unlikely that the Dauphin's endurance will allow for diversion to an alternate*", and furthermore operational experience in the Finner theatre would re-inforce this thinking.

2.3. The Operational Flight

2.3.1 The SAR Mission

DH248, or Rescue 111 its designated call sign, was airborne at 21:42 hrs, and routed to the search area. The casualty vessel was located by the Helvick Inshore Lifeboat at 21:58 hrs, and was taken under tow. DH248 was requested by MRCC to continue to the position of the casualty vessel and to monitor the situation for a while. This was at 22:00 hrs.

At 22:19 hrs the Waterford Airport Control Tower made a radio check call to DH248, and the P2 replied that they would be lodged there for another fifteen minutes. Just after that, at 22:20 hrs, the Helvick Inshore Lifeboat reported a problem with its GPS navigational system and requested navigational guidance from DH248. The Dauphin crew assisted the Lifeboat with its navigation by passing information to its crew concerning steering and 'distance to go' to its base at Helvick pier.

One hour into the mission at 22:41 hrs, the Dauphin crew called Waterford Tower for an update of the weather at the Airport and they were told that it was "*staying the same*". This was the first weather-related communication made with the Airport since the Dauphin departed. At 22:50 hrs the Tower informed the Dauphin crew that the weather at Waterford was *"deteriorating slightly"* and that they *"could barely see the runway which is a distance of 300 metres from the Tower".* Approximately two minutes after receiving this message, the Dauphin crew requested from MRCC, and received, permission to leave the operational area to attempt to recover to Waterford Airport.

What is of significance here is the amount of time spent 'on task' in relation to the total fuel available. The Dauphin departed from Waterford with a fuel load of 600 kg on board. Assuming an estimated average fuel consumption rate of 250 kgs/hour this would give an endurance, on departing the search area to return

to base, of 1 hour 12 minutes. The Nadir flight management system would have provided the crew with constant updates of their fuel state and of their endurance. However the recovery phase of the flight was necessarily constrained by the length of time spent 'on task'.

2.3.2 The ILS approaches at Waterford

The ability of an aircraft and its crew to perform Instrument Landing System (ILS) approaches to a runway is determined by several factors, including ground equipment installed at the airport, the airborne equipment installed on the aircraft/helicopter, the training and currency of its crew and also factors such as the terrain on the approach flight path, approach, runway and touchdown zone lighting and ground surveys.

At Waterford Airport the ILS on RWY 21 is classified as Category 1 with a published Decision Height (DH) of 310 feet above the runway (422 feet above sea-level).

The pilots were familiar with the published ILS procedure, since Waterford Airport is regularly used by the Air Corps for training purposes. This training, though normally carried out in simulated IF conditions, 'under the hood', is usually done in favourable weather conditions and in daylight. In such a training context, the necessity to adhere to published minimums would be paramount. It seems probable therefore that on the first ILS approach the crew descended to the DH of 310 feet above the runway and made the decision to go around because they had no visual references to continue a descent to the runway.

Analysis of the geometry (as schematically outlined in **Annex M**) of the ILS approach to RWY 21 shows that at the published decision height of 310 feet an aircraft is at a distance of 741 metres line-of-sight from the first element of the approach lighting. Given the estimated visibility of 500 metres at the time of the go around from the first ILS approach, the crew could not have made any sighting of the approach lighting from the DH point and would have been obliged to go around.

They then attempted a second ILS approach, which also resulted in a go around. A key factor here is whether on the second ILS approach the crew made their go around decision at the published DH of 310 feet or whether they pushed down through this height in an attempt to see the runway lights. What is clear is that the crew did not make the visual reference required to continue for a landing from this approach. Also the personnel in the Control Tower which is itself 50 feet high could at all times see the closest runway lights, a horizontal distance of 300 metres.

Even if the crew had decided to push the second ILS approach down to 250 feet, below the published limits, they would still have been over 400 metres, line-of-sight, from the first element of the approach lighting at their new DH.

The published, and trained for, procedure is that "*if Decision Altitude (Height)/ Minimum Decision Altitude (Height) DA(H)/MDA(H) is reached and no 'Runway in Sight' call has been made*, *then the flying pilot will initiate the Missed Approach Procedure*" , ref OM, Section 2.1, Para 3, Note 1.

The visibility estimates given by the personnel in the Tower were estimates of ground-level visibility in fog. It is noted that the LAF quotes broken cloud at 200 feet later i.e. broken cloud at 88 feet above the runway. Thus it may be that, due to the additional effects of low cloud, the visibility experienced by the crew during the ILS approaches was significantly worse than that observed on the airfield at the same time.

2.3.3 70/70 ILS Approach.

The Dauphin has the technical capability to perform a fully automatic coupled ILS approach down to 70 feet at which height it will level off and fly along the localiser above the centreline of the runway at a speed of 70 knots. This is known as a 70/70 approach. However the AS365Fi Dauphin is certificated by the French airworthiness authorities for Category 1 approaches only. It is not certificated for the 70/70 approach.

It is probable that if the crew had carried out a 70/70 approach on either ILS that they would have made visual contact with the runway lighting, given that the personnel in the tower maintained some degree of horizontal visual contact with the runway lighting at all times.

Dauphin crews do not train as a matter of course in the 70/70 ILS procedure. However, it does appear that in the past this procedure was trained for more regularly by crews. There are several reasons for this. The main reason was the initial location of the Dauphin SAR detachment at Shannon Airport, where there was opportunity and good reason for its practice. The very high turnover of Dauphin crews between 1996 and 1998 as outlined in paragraph 1.17.12 has meant that the emphasis in training has been on SAR procedures, such as winching and Trans-downs and also on ab-initio training. Also the 70/70 approach does not work at Connacht Regional Airport which is the closest ILS-equipped airport to the SAR base at Finner Camp, due to the nature of the terrain on the approach. Bad weather recoveries into Finner are flown by entirely different techniques referred to as "coastal approaches", since it is not ILS-equipped.

It is likely that the crew considered that the aircraft fuel state had not reached a sufficiently critical point to warrant attempting the 70/70 approach on the second ILS, and that their best option at that stage was to attempt a more normal and practised ILS approach followed by a decision to go-around for a coastal approach.

2.3.4 Possible descent below 70 feet on a coupled ILS Approach

Although it is thought unlikely that DH248 descended to 70 feet on its second ILS approach, for completeness, the scenario whereby such an approach was attempted but visual cues were still not available to the crew at 70 feet is analysed here.

In the event that the crew did allow the Dauphin to continue on the ILS all the way down to 70 feet above the runway using the full capability of the 4-axis coupled approach, then on arrival at that height there is no further flight director glideslope guidance below 70 feet. This is due to the software configuration of

the coupler and autopilot. If, at 70 feet, the crew had not got adequate visual reference to continue down, an attempt to use the automatic coupler to descend lower than 70 feet and to slow down into the hover would require the pilot to de-select the coupler ILS modes and to select the coupler hover and hover-height modes instead, see **Appendix B.2.2.1**.

While this is physically achievable, it is not trained for by Dauphin crews and it would mean that the aircraft would be travelling at considerable speed (up to 70 kts) at 70 feet above the runway with no visual reference and with no flight director guidance for several seconds, a scenario which would be highly dangerous and unacceptable to pilots. A crew finding themselves in this situation would be professionally inclined to overshoot the ILS, to transit to an over-water location, and to use the SAR Modes of the AFCS Coupler. These modes include Trans-down to the hover which will can bring the helicopter to an automatic hover at heights down to a minimum of 40 feet over the sea. These are procedures in which Dauphin crews are highly trained.

It should also be noted that the Trans-down and Hover modes of the Coupler are SAR modes and are designed to be used only over the sea. Furthermore autohover is only available down to a minimum height of 40 feet, below which it is necessary for the pilot to take manual control and use external visual references. The concept of bringing the helicopter to the hover over land at very low height in Instrument Meteorological Conditions (IMC) following an ILS approach without any external references such as sight of the ground or runway lighting, is impractical.

The elevation of RWY 21 at Waterford is published as 112 feet, so that all heights such as DH are referenced to this. The DH of 310 feet is actually 422 feet above sea level. Even if the crew decided to try a lower descent on the second approach, say to 200 feet above the runway, they would still be at 312 feet above sea level. In the context of being unable to gain sufficient visual cues to achieve a landing from two ILS approaches, and taking into account the operational culture, training and experience of the crew, the advantages from their point of view, of abandoning the ILS and trying a let-down over the open sea, where there are no obstructions and where the automatic systems will allow a considerably lower descent, are clear.

2.3.5 ILS Timings

The portions of the Shannon radar recordings which tracked DH248 indicate that standard ILS patterns were flown on both approaches. Reports from the witnesses who came forward are also consistent with two standard-pattern ILS approaches to RWY 21.

As the Dauphin returned to Waterford from the search area to attempt the first ILS approach, they called "*just inside six miles*" at 23:00 hrs. At 23:06:17 they called *"just coming up to the turn for inbound"* i.e. a 14 nm transit overhead Waterford Airport in 6 mins 17 secs, or a ground speed of 134 knots approx. This concurs with the Shannon radar evidence which showed the Dauphin at various times between 23:01:32 and 23:03:20 at ground speeds between 132 and 148 knots, heading Northeast and turning towards the ILS.

The crew subsequently called *"two point five miles out"* some 5 mins 51 secs after the 23:06:17 transmission, and reported having overshot a further 2 mins 29 secs later, total time between calls 8 mins 20 secs.

Allowing one and a half minutes for the turn onto finals, the first ILS approach was flown from the 8.0 DME point to the 2.5 DME point in 4 mins 21 secs, i.e., an average ground speed of 76 knots approximately and an average airspeed, given a 10 knot headwind, of 86 knots approximately. The total time for the first ILS was 6 mins 50 secs, if 1½ minutes are allowed for the turn inbound.

The latter two calls indicated a ground speed of at least 60 knots, depending on the exact moment at which the crew reported having gone around, and thus an airspeed of approximately 70 knots taking the windspeed into account in the final phase of the approach. This airspeed is consistent with an ILS in difficult meteorological circumstances. The lower airspeed provides for a lower rate of descent and also for more time approaching the DH in which to make a decision to continue down or to go-around.

On the second ILS approach, the crew called *"turning finals"* at 23:18:35. The Tower called DH248 at 23:27:24, 8 mins 49 secs later as it was "*going away*". The second ILS approach appears to have taken approximately two minutes longer that the first one. This means that the second ILS was even slower than the first one and it could also suggest that the crew may have descended through the DH of 310 feet in an attempt to make adequate visual reference with the runway lights.

For the reasons stated in **Appendix B.2.2.1**, ILS approaches are flown at speeds between 70 and 125 knots.

2.3.6 In summary, DH248 attempted two unsuccessful ILS approaches. It is probable that the first approach was terminated at the published DH of 310 feet above the runway, some 741 metres line of sight distance from the first element of the approach lighting. Given that the second approach was slower, it is possible that the crew may have descended through the published DH in an attempt to become visual with the runway. However it is unlikely that they allowed the helicopter to descend all the way down to 70 feet over the runway since they never became visual or were never themselves seen by witnesses at or near to the Airport, including the personnel in the Tower at 50 feet elevation who, at all times, maintained horizontal visual contact with the runway lights 300 metres away.

The ILS/NDB/DME chart for RWY 21 at Waterford Airport is attached at **Annex G**.

2.4 Approach Techniques

2.4.1 The Coastal Approach

Prior to the detachment to Waterford, most experience in IMC recovery had been gained at Finner where there are no precision approach aids available. Crews were therefore well accustomed to the coastal approach techniques

when recovering to base in poor weather. The situation at Waterford was different in that precision approach aids were available. The crew of DH248 therefore logically used the ILS for their initial approaches.

Following the two unsuccessful ILS approaches to RWY 21 at Waterford, the crew decided to *"go round for a coastal approach"*. This message was passed at 23:27:24. Six minutes later the Dauphin crew inquired if the weather at Waterford Airport was improving. When told that it was not they stated that they were descending in the bay and that they were going to do a coastal approach in to Tramore - *"we may land in Tramore"*.

The most likely scenario of what took place in that six minutes is that DH248 climbed to a safe altitude and headed south over Tramore bay. At a ground speed of 90 knots, six minutes flying would have brought the Dauphin to a point 9 nm South of the airport.

Initially at 23:27 hrs the crew may have been planning to make a coastal approach all the way in to the Airport which would have been a repeat of the poor visibility approach they had carried out in the afternoon training flight. At 23:33 hrs they inquired if the weather at the Airport was improving and were told that it was not. They then made a decision to make a coastal approach in to Tramore with the intent of landing somewhere in the bay area. The message to the Coastal Radio Station at 23:35 hrs stated *" we're doing an approach to Tramore Bay this time and if we can get down we're going to land in the bay area somewhere".* This transmission would have been made by the winch operator prior to "opening up" the right hand rear sliding door to attempt to make visual surface contact.

It is considered likely that the coastal approach to Tramore was an improvised variation on the coastal approach to Waterford Airport. The coastal approach chart for the Airport, which had been developed within No 3 Sp Wing, had an 'initial point' at 7 nautical miles (nm) DME from the Airport on an inbound heading of 028º magnetic. A reconstructed representation of this chart is attached at **Annexes I and J**. The chart was developed to allow the approach to be initiated well clear of the high ground South of Tramore town and also Brownstown Head which is on the eastern side of Tramore Bay. The coastal approach would then bring the Dauphin over the East central part of Tramore Bay to the Airport. However this track would bring an aircraft over some of the highest sand dunes on Tramore beach.

A waypoint at 3 nm DME on the 028º inbound heading would have acted as an "anchor" waypoint about 1 km off the beach. This waypoint is shown on the portion of chart recovered from the wreckage and is likely to have been pre-programmed in the Nadir navigation computer. The crew were then faced with a decision as to the best method of making an approach to Tramore bay with the intention of finding a safe place to land.

Tramore beach is 4 km approximately from Waterford Airport and is 100 feet approximately lower than Waterford Airport. No meteorological observation was available to the crew at Tramore beach and observations made at the airport may not have been representative of conditions prevailing at the beach at the same time. Indeed when the senior Air Corps technician arrived at the beach

after the accident he described conditions there as significantly worse than those prevailing at the Airport.

2.4.2 Options for descending in the bay and approaching the coast

Essentially there were three options available to the crew:

1) Trans-down with navigation to ground speed or hover

2) Trans-down without navigation to ground speed or hover

3) Cloud break/bad visibility let down to a chosen minimum decision height (MDH)

2.4.2.1 Trans-down with Navigation (also known as guided Trans-down)

In this scenario the helicopter, having been given a target fix from an over-flight or joystick fix, will position itself for an into-wind let down and transition to groundspeed/hover. Taking into account the prevailing wind conditions at Tramore Bay on the night in question, 200º/10 kts (as per the Met Eireann Aftercast), it is clear that for the crew to carry out a guided Trans-down and to finish somewhere close to the shoreline, they would have had to over fly terrain at some stage in the circuit pattern, or in the let-down to the hover. This is a normally prohibited manoeuvre. Trans-down with Navigation is designed for use over water and is only reliable if carried out in that environment. It is considered unlikely that the crew would have attempted it.

Alternatively they could have done a guided Trans-down well out to sea which would not have necessitated overflying land. In this case however the final part of the procedure as the aircraft approached the hover into wind would have been facing South away from the coast and therefore with no radar guidance as to the relative location of Tramore Bay. At this point the shoreline would have been behind the helicopter, and it would not have been displayed to the crew on the radar screen because of the design of the 120º forward looking radar. To recover the aircraft from this position to the beach would have required prolonged groundspeed flight in a rearward direction without any radar guidance. Radar guidance would only have been possible if the aircraft was turned into a downwind position. Such a turn in the hover, at night and at a very low hover height following a Trans-down would have been neither safe nor practical. There would have been a clear pressure on the crew to approach the shore in a direction that allowed the radar screen to display the coast-line, especially given the IMC conditions encountered in the ILS approaches and thereafter.

2.4.2.2 Trans-down without Navigation (also known as an unguided Trans-down)

When letting down to a point near a shore-line, crews would normally require an into-wind approach and maximum use of the forward looking radar for navigation, i.e. forward flight towards the beach. If insufficient sea room is available to carry out a guided Trans-down, or if the wind direction is such that it does not allow for good radar coverage of the target, then an unguided Trans-

down is a further option. The main advantage of an unguided Trans-down is that the crew can initiate the Trans-down on the heading of their choice.

The main disadvantage is that the selected heading may not allow for an into-wind or near into-wind approach to ground speed/hover. A further disadvantage is that such a Trans-down is not managed by any automatic navigation input and the final hover position is not definitively computed and displayed to the pilot.

The distance from the initiation of the Trans-down to the final hover point is dependent on several factors including the initial height departed from, the hover height flown to, the initial airspeed prior to initiation of the manoeuvre, as well as the wind direction and speed. As there is no cockpit display of the final hover point the initiation point for the unguided Trans-down is a matter of judgement. Discussions with several pilots very familiar with the Dauphin suggested that a down-wind unguided Trans-down would be a very uncomfortable manoeuvre.

The Dauphin does not behave particularly well at low speed when the nose is out of wind. Even at low weight, handling while transitioning to the hover and in the hover is difficult with high nose pitch-up attitude necessitating high power settings, along with a tendency to fish-tail and drift. It is also a manoeuvre which is not practised frequently for the above reasons. Even though there was dense fog on the night of the accident, there was still a significant on-shore breeze of 10 knots approximately.

However given that the crew had not become visual during the two ILS approaches to Waterford Airport, it is possible that they would have attempted an unguided Trans-down towards Tramore beach. This would have had the potential to bring them down to a lower hover height, possibly 80 to 100 feet, and slow ground speed over the surface of the sea, while maintaining a good radar picture of the coastline, and at the same time moving towards an area where a landing could be attempted. During such a manoeuvre the rear sliding doors would be locked in the open position and the rear crew would be "eyes-out" in an attempt to gain visual cues during the approach. The major disadvantage of the manoeuvre would have been the significant tailwind of approximately 10 kts, resulting in poor aircraft stability.

If such an unguided downwind Trans-down had been completed by the crew of DH248, then the very nearest that they could have approached the beach without acquiring visual cues would have been 0.2 nautical miles (nm), refer to **Appendix B.3**. Beyond that point the radar becomes incapable of displaying the shoreline. If at that point the crew were still unable to become visual, than an immediate go-around to a safe altitude would have been their only option. Go-around is a frequently practised manoeuvre, although not in downwind conditions. The P1 manually uncouples the automatic systems, applies power and initiates a positive rate of climb, simultaneously selecting a 5º nose down attitude. The P2 confirms the rate of climb and monitors the instruments. As the aircraft climbs through a pre-briefed height, it is normal for the P2, who is not flying, to set his Radio Altimeter bug to this height to provide a degree of protection against an inadvertent descent. Once the aircraft is stabilised and coupled at a safe height and course, the P1 then normally sets his bug to the

pre-briefed height. The rear crew close up the sliding doors during the procedure.

It is possible that the crew of DH248 carried out such a manoeuvre. Given the severity of the fog later reported on the beach, it is highly likely that visual cues would not have been attainable at 0.2 nm offshore. Having failed to attain the necessary visual cues the pilot would have followed his pre-briefed go-around procedure. The position of the impact point to the east (right) of the inbound track as on the coastal approach plate suggests that the handling pilot made a right turn during or following the go-around. The positions of both bugs at 160 ft (P1) and 150 ft (P2) indicate strongly that at least the bugged height was attained during the go-around.

At some point after this, and during the right turn, the aircraft may have descended through the bugged height and struck the sand dune. Analysis at the scene indicates that a standard go-around and right turn from the inbound course of the coastal approach is consistent with both the position and direction of the impact. Finally, the evidence that the right hand rear sliding door was in transit, i.e. in the process of being opened or closed, is significant. Normal procedures involve the rear doors being locked in position, either open or closed. They are never kept in an intermediate position for more than a few seconds during opening or closing. It is very possible that the right hand rear sliding door was in the process of being closed during the go-around when the accident occurred.

2.4.2.3 Cloudbreak Procedure

Their third option was a cloud-break/bad visibility letdown using the cruise-height mode of the coupler.

This method is a standard and practised procedure for let down over the ocean at night or in IMC. The aircraft transits out over the sea to a clear area as confirmed on the radar. It then commences a descent using airspeed hold, heading mode and either vertical speed mode (500 feet/minute) or cruise height, to 1000 feet above sea level, and below that using airspeed hold, heading mode and cruise height.

The cruise height rotary knob on the Coupler is used to automatically descend the helicopter down to a pre-selected Minimum Descent Height (MDH) set on the Coupler. Automatic fly-up protection is provided by setting the radio altimeter bug at a height just below the desired MDH. This method has got certain advantages over the Trans-down modes described above.

Firstly it is possible to descend to a relatively low height over the sea (minimum 100 feet) without committing to a Trans-down to the hover. Airspeed, and consequently stability, can be maintained, which is important in a downwind scenario. There is height protection through the fly up facility and there is the facility to initiate a controlled climb up from the MDH to a higher height using the Coupler cruise height knob. Use of cruise height over terrain is not a normal procedure.

There are indications to suggest that the crew made the decision to attempt a cloud-break type of coastal approach, rather than a guided or unguided Trans-down. Firstly they had carried out a very similar procedure during the afternoon training flight, when they had recovered back through Tramore Bay and over the beach at 200 feet above sea level. They may well have felt that the conditions out over the sea might have been similar to what they had encountered earlier, close to Helvick Head, when they had made visual contact with the Inshore Lifeboat at least once. Furthermore the cloud-break type of approach would have been more comfortable, from the handling pilot's perspective, than an out-of-wind unguided trans-down.

At 23:33 it is estimated that approximately 30 minutes of fuel remained so there would still have been an opportunity to try a further procedure, e.g. a Trans-down to a lower hover height above the sea, if the cloud-break procedure was unsuccessful. In addition, the setting of the P1's radio altimeter bug at 160 feet and the P2's bug at 150 feet are consistent with a coastal approach height of 200 feet.

During such a procedure it is normal practice that the rear crew would be ''eyes out'' with the rear sliding doors open attempting to make visual contact with the sea or the beach. The pilots would have been aided by the anchor waypoint at 3 miles DME from the Airport, as shown on the approach chart recovered from the wreckage, available to them on the EFIS screens for guidance.

2.4.3 Final Descent

There is not enough evidence to support a definitive statement of what happened in the final portion of the flight.

The landing gear was in the landing configuration at impact. The starboard rear sliding door was found to be open and probably in the process of being closed, at the moment of impact. The port rear sliding door was closed. This suggests that the rear crew had been "eyes-out" attempting to gain visual cues during the approach and were in the process of closing up the doors at impact. This suggests that the approach had been terminated, and that a manual go-round away from land and back out to sea from either an unguided Trans-down or a cloudbreak procedure was in progress. Also the winch operator did not reply to a call from MRCC at 23:38:30. However the non-voice transmission from DH248 on Waterford Tower frequency was after this at 23:39:27. It is probable that the winch operator did not reply because he was fully occupied in his attempt to make or maintain visual contact with the surface.

It seems likely that, whilst making a right turn through 130º the Dauphin descended through the bugged height and impacted with the sand-dune. The filament analysis of the DH bulb in the P1 radio altimeter indicated that it was illuminated at impact.

A reconstruction flight involving three manual go-around manoeuvres from the point of Radar picture loss, showed that go-arounds with a right turn back out to sea invariably brought the aircraft directly overhead DH248's impact point.

The reconstruction flight also showed that in wind conditions reasonably similar to those encountered by DH248 on the night of the accident, as the aircraft approached the beach, the Doppler went into Memory mode for environmental reasons i.e. degraded sea surface returns. This occurred immediately after the Radar picture loss, and the handling pilot was forced, for safety reasons, to initiate a manual go-around.

In the absence of a Cockpit Voice Recorder or Flight Data Recorder the events that transpired during the final moments of the flight can not be definitively determined. The investigation has considered three possible scenarios as to why the aircraft descended below the radio altimeter bugged height:

1) One possibility is that the crew got some visual cues and attempted to remain visual through a deliberate manual descent below the bugged height

2) It cannot be ruled out that some type of distraction in the cockpit contributed to the descent below the bugged height.

3) It is also possible that having taken over manual control in the right turn and as the Dauphin came over the beach and dunes, that the handling pilot became momentarily disoriented and the Dauphin descended into the dunes.

2.5 Weather

2.5.1 Weather during the SAR Mission

There was no weather-related communication between the Dauphin crew and the Control Tower until one hour into the mission at 22:41 hrs. This suggests that the crew were not unduly concerned about the weather conditions at the Airport. When they did request an update on the weather at 22:41 hrs, "*has it improved or dis-improved*" the reply of *"Negative, she's staying the same*" was probably interpreted by the crew as meaning that the visibility was still as it was one hour earlier when they departed in twilight. At 22:51 hrs, the Tower reported *"weather deteriorating slightly here"* to the Dauphin crew, who responded *"Can you see the lights of Tramore at all?"* It may well be that as the Dauphin departed from Waterford Airport en-route to the SAR area, they may have seen Tramore as they overflew it since fog can have very different visibility characteristics in the horizontal axis as opposed to the vertical axis.

However as Tramore town is 4 km from the Airport, this suggests that the crew had, at 22:51 hrs, a false picture of the visibility at the Airport. They were then told that the visibility was about *"300 metres",* as the personnel in the Tower could only just see the runway at that point. Three minutes later, the Dauphin departed the search area for Waterford Airport, saying to MRCC that the conditions at Waterford were deteriorating and that they wanted to get in before the Airport closed, i.e. while it would still be possible to land there.

During the search at Helvick Head, the crew had become visual with the Inshore Lifeboat at least once at 22:42 hrs. Also the query at 22:51 hrs to the

lifeboat as to whether they could see the lights of Helvick Head infers that the crew of DH248 up at 500 feet could see those lights one mile away. So it is likely that improving visibility conditions at the search area led the crew into a belief that they would not have a problem getting into the Airport using the ILS.

One further Airport visibility report was passed by Waterford Tower to the crew of DH248 at 23:14 hrs, *stating "about five hundred metres"*. This was just following the first unsuccessful ILS. The visibility during the ILS approaches was later described by those personnel in the Tower as being rolling fog, with one, two or three of the runway edge lights intermittently visible.

2.5.2 Visibility at Tramore Beach

It is evident that conditions at Tramore Beach, in the immediate aftermath of the accident, were extremely poor, with visibility of 10 - 20 metres and no lighting references. Indeed, if the crew were using the Dauphin's external lighting to try to illuminate the shoreline or the beach, it is likely that a large proportion of the light-beam would be reflected back, causing even greater difficulties with external visibility.

It can be concluded that, when the Dauphin crew attempted to make an approach to the Tramore Bay area, they failed to gain adequate visual reference to find a safe point at which to land. As has been stated earlier it is essential to have the necessary visual cues to effect a safe landing. At heights below 40 feet the automatic systems of the Dauphin are not available and it is necessary for the crew to make a manual landing in all cases.

2.5.3 Weather Reporting

The personnel who were in communications with the Dauphin from the Tower were the technicians who were supporting the maintenance of the helicopter on detachment. They had no training in, or experience of meteorological observation. These technicians unwittingly found themselves, through no fault of their own, placed in a situation outside their training and experience.

They were joined in the Control Tower at 21:55 hrs by the Airport Manager who is a formerly qualified AFISO. While he assisted in meteorological observations and visibility assessment, his understanding was that the Air Corps technician was running the Tower service and that he, the Airport Manager, did not have a particular role there. Therefore he did not assume the direct role of communication with the helicopter. His presence in the Tower was not made known to the Dauphin crew, nor did the crew enquire as to the presence of a local operator.

It is possible that, had an experienced local ATCO/AFISO with meteorological observation rating been on duty, then an earlier communication about the poor visibility and low cloudbase or indeed a recommendation to divert from Waterford may have been forthcoming. It is noteworthy that during the afternoon training flight, a local Waterford ATCO was proactive in his reporting to DH248 of a deterioration of the local cloudbase as the helicopter approached Waterford Airport.

2.5.4 Weather at Potential Alternate Airports

For completeness, the weather conditions forecast and actually reported for potential alternates are analysed here. As already stated there is no recorded evidence to indicate that the crew sought or obtained, prior to or during the mission, any of the weather information mentioned hereunder. The relevant weather data is attached at **Appendix C**.

The Significant Weather Chart for 0000 hrs on 02 July 99 shows a freezing level between Flight Level 120 (12,000 feet) and Flight Level 100 (10,000 feet). Moderate, locally severe ice is forecast above Flight Level 110 (11,000 feet). The Dauphin would require no more than 5000 feet for an IFR diversion anywhere in the country and therefore would not have been constrained by icing conditions on the night.

The same chart also forecasts isolated embedded cumulonimbus (Cb) cloud over Ireland. It would have been essential for the Dauphin to avoid these clouds due to the possibilities of icing, and severe turbulence. Though icing was not a limiting factor on the night, the presence of these clouds would have been a negative factor in considering a high level diversion. Nevertheless, the Dauphin's weather radar can show up Cb cloud and allow the crew to avoid them. Given that the Cbs were forecast as only isolated and not occasional or frequent, a high level diversion can be considered a potentially feasible, if not ideal, option on the night in question. Encountering Cbs in transit requires diversion from direct track flight and would lengthen the transit duration and increase the fuel requirement.

Casement Aerodrome, Baldonnel

TAFs for the period indicate cloud as low as 300 ft and visibility down to 3000 m at times. These conditions were reflected in the Station METAR at 2100 hrs. As the cloudbase is forecast to be below the 400 feet above ground level required for a VOR/DME approach, the TAFs indicate that Baldonnel was not a feasible alternate at the planning stage of the mission. In the event the actual weather at Baldonnel was better than that forecast. The actual Baldonnel weather was obtained by one of the technicians and after the second ILS approach the crew of DH 248 were advised that Baldonnel was open but they replied "don't have the juice".

Dublin Airport

TAFs for the period of the mission indicate cloud as low as 300 ft and visibility as low as 3000 m. The Station METAR for 2200 hrs shows cloud worse than forecast, at 200 ft, which was also reported at 2300 hrs and 0000 hrs. Given that a 200 ft ceiling is the minimum required for a Category 1 ILS, these conditions could be considered as limiting and would effectively rule out Dublin as a planned alternate at the time of launch.

Cork Airport

Fog was forecast for Cork for the period of the mission in the relevant TAFS.

Visibility as low as 200 m with vertical visibility of 100 ft are forecast in the 22-07 TAF. The conditions are reported by the Station METARs to be in line with the forecast for the entire period of the SAR mission. Cork Airport was not an option as an alternate due to weather.

Shannon Airport

The least favourable weather for the period of the mission was given by the 16-01 TAF with visibility of 3000 m and cloud at 300 ft forecast temporarily between 2000 and 0100 hrs. The Station METARS indicate weather better than the forecast as prevailing during the mission. Winds remained light, visibility was above 10 km, and the lowest cloud reported was at 900 ft in the 2100 and 2200 hrs Station METARS. At 2300 hrs, and later at 0000 hrs, the lowest cloud was at 1300 ft .

At no stage is the weather, either forecast or reported, below limits for an ILS and hence Shannon was a suitable alternate on the night.

It must be borne in mind that IFR alternate planning is seldom operationally possible in Dauphin SAR operations due to the limited endurance and range of the aircraft, and the prevalence of icing conditions at IFR cruising levels. However, on this mission it would have been possible to so plan given the proximity of the SAR location, and the availability of Shannon Airport as a suitable alternate.

2.6 Mission Fuel Analysis

2.6.1 Fuel Data

DH248 departed from Waterford Airport with 600 kg of fuel on board.

An analysis of the fuel usage on the flight has been carried out using the fuel flow figures set out in the Aircraft Flight Manual charts in Section 5.2 Additional Performance Data.

Table as per fuel analysis graphs

Time (mins)	Phase	Start Weight (Kg)	Fuel Burn (Kg per hour)	Fuel Used (Kg)	Fuel Remaining (Kg)	End Weight (Kg)
5	Start up and Taxi	3,919	270	22.5	577.5	3,896.5
18	Transit to Helvick	3,896.5	270	81	496.5	3,815.5
54	Loiter at Helvick	3,815.5	220	198	298.5	3,617.5
13.5	Return from Search Area	3,617.5	270	61	237.5	3,556.5
7	1st ILS	3,556.5	220	26	211.5	3,530.5
4	Overshoot	3,530.5	270	18	193.5	3,512.5
8.5	2nd ILS	3,512.5	220	31	162.5	3,481.5
13	2nd Overshoot and Coastal Approach	3,481.5	250	54	108.5	3,427.5

N.B. Since no Flight Data Recorder was installed on DH248, the above fuel-burn figures and consequent analysis can not be regarded as definitive.

Notes :-

(a) Fuel usage on the outbound leg is estimated at an IAS of 130 kts

(b) Loiter fuel is estimated at an altitude of 500 ft (as per communication with Coastal Radio Station) and at an IAS of 80 kts. This is based on experience and common practice, but a definite speed and altitude during the loiter is not known

(c) Similarly, the exact parameters of the fuel burn during and following the unsuccessful approaches are not definitively known.

From the analysis it can be estimated that, following the second ILS approach, there was approximately 160 kg of fuel remaining. At the time of impact, there was an estimated 108 kg of fuel remaining. This would have allowed for an additional 25 to 30 minutes endurance to dry fuel tanks.

The intense fire, which occurred after the crash, indicates that a significant volume of fuel remained on the aircraft at the moment of impact. Also during the examination of the wreckage on-site and the clear-up operation, which followed, there was evidence of considerable fuel soakage into the sandy terrain.

A reconstruction flight was performed in another Dauphin from Waterford, which carefully followed the known flight parameters of the SAR mission. The theoretical fuel analysis was shown to be representative by the reconstruction flight and after two hours three minutes of the reconstruction flight the fuel remaining was 92 kg.

2.6.2 Diversion Fuel Requirement

Notwithstanding the fact that there is no evidence that the crew planned for a possible diversion to an alternate, for the sake of completeness the fuel requirements for transit to their most viable alternate Airport are considered here.

As per the analysis in para 2.5.3 above, the most viable weather alternate Airport available was Shannon. The OM stipulates, for normal operations, that final reserve fuel for IFR missions is 45 minutes at best range speed, and for VFR missions 20 minutes of fuel at best range speed. These equate to fuel quantities of approximately 187.5 kgs and 83 kgs respectively.

It is considered that the VFR final reserve of 83 kgs is the minimum desirable fuel remaining on landing that a Dauphin pilot would require before committing to an emergency IFR diversion. If the crew perceived themselves to be in an absolute emergency situation they might conceivably commit to an emergency transit to arrive with 50 kgs (i.e. 12 minutes endurance) of fuel remaining.

Unforeseeable en-route events such as a need to circumnavigate Cbs, adverse winds aloft or deterioration in the weather at the destination could adversely affect the transit fuel requirement.

It is estimated that 150 kgs of fuel would have been required for a transit from Waterford to Shannon, a distance of 73 nm. Allowing for an emergency reserve of 50 kgs this means that once the aircraft fuel quantity went below 200 kgs, i.e. at the end of the first ILS approach, the crew had no viable diversion option.

The crew were informed at 23:34 hrs, following completion of the second ILS approach, that Baldonnel was open if required. Required fuel figures for diversion to Baldonnel are similar to those for Shannon, and thus the Baldonnel diversion option was non-viable following completion of the first ILS approach.

2.7 The Aircraft and Systems

2.7.1 General

No evidence was found in any of the components or systems that were recovered in reasonably intact condition, that there was any pre-existing defect or malfunction that could have related to the accident. In particular, the engines, main gearbox and other transmission components were stripped and examined and found to have been operating normally at impact.

Using the land survey results, and interpolating the dune surface profile prior to impact, a sectional view of the dune, corresponding to the aircraft's longitudinal axis, was produced. Comparison of this sectional view with a side-elevation of a Dauphin in flight suggests that first ground impact was made with the aircraft nose wheel. Allowing for variation in the pre-impact interpolated surface profile it may be that the radome struck the ground first followed immediately by the nose undercarriage. However given the fact that the radome is not structurally significant, the first significant ground impact with the aircraft structure was probably made by the nose wheel, which sheared off as a result.

Evaluation of the tail rotor pitch angle indicates that the helicopter was flying at a speed of 60 to 80 kts at impact, if an assumption is made of balanced flight. The analysis carried out by the Cranfield Impact Centre also suggests that the impact speed was at the "lower end of the suggested speed range" which was 50 - 125 knots. Empirical analysis by experienced investigators in the UK AAIB concur that an impact speed of 60 kts to 80 kts is consistent with the wreckage pattern observed.

None of the radio transmissions made from the aircraft make any reference to technical problems. The fact that an experienced Dauphin technician and an avionic technician were in direct communications with the aircraft throughout the mission suggests that any such problem might well be mentioned over the radio.

The senior detachment technician was on the Tower veranda during the two unsuccessful ILS approaches and he noted nothing unusual in terms of engine or rotor noise.

The AAIB analysis of the final carrier-only transmission from DH248 at 23:39:27 confirmed that the transmission was from DH 248. There were two elements to the final transmission, a 'whoosh' noise and then the blade noise. It was not possible to confirm the source of the initial 'whoosh' noise, even under AAIB analysis. The blade noise revealed no abnormalities from the main rotor. The analysis did reveal the presence of a characteristic switch 'bump' on all recordings from DH 248, including the final transmission. This switch 'bump' indicates that the transmission ended normally i.e. by release of the transmission switch, rather than by a power interruption on impact.

An RTÉ video tape filmed on the morning of the accident was made available to the investigation. It shows that systems such as engine indications, radar, EFIS, radio altimeter and flight instruments were operating normally.

There were three Maintenance Deferred Items (MDIs) noted on the Technical Log in the days prior to the 1st July. Two bulbs on the Coupler Control Panel had failed and had not been replaced. These were the two right hand bulbs shown as item 4 in **Annex N**. These bulbs do not affect the performance of the Coupler. The specific modes selected on the Coupler are displayed on the Control Panel itself and also on both Pilots' EFIS screens, thus providing the pilots with a clear indication of the Coupler modes being armed or engaged. The caption bulb for the Landing Light on the Instrument Panel was inoperative but the Landing Light itself was serviceable. The Collins Communications System had been reported as being of "very poor quality". This relates to the No. 1 communications transceiver normally used by the P2. On the tape recordings of both Waterford Airport and the Coastal Radio Station communications, the quality of all transmissions is good and there was no difficulty in communications in either case.

The Detachment Commander would have been fully familiar with these defects and found them to be acceptable, as he had flown the aircraft on each of the three days before the 1st July and three times on the 1st July prior to the SAR mission without comment to his technical crew. He had also specifically requested DH248 be made available for the first SAR detachment to Waterford as he felt that it was flying particularly well.

It is felt that these three MDIs were insignificant in terms of the acceptance of the mission and were not a factor in the accident.

2.7.2 Bulb Analysis

The filament of the P1 Alarm Light bulb, which was recovered, is distorted in such a way as to indicate that it was hot, i.e. illuminated, when subjected to violent shock. In tests of the characteristics of the bulb, it has been shown that the filament is hot 20 milliseconds (ms) after initial triggering. At a speed of 70 kts, this time interval equates to a displacement of 0.72 m.

As noted in para 1.12.5 there are over twenty individual indicated conditions, related to critical aircraft systems, which can give rise to the illumination of the Alarm Light. Wiring for all of these warning indications is routed through a junction box located in the Radome at the nose of the aircraft. As noted in para 2.7, it is likely that the initial ground impact was made by the nose of the

aircraft. The impact loading would have caused severe disruption to both these critical aircraft systems and their associated warning indication wiring. Such disruption, early in the impact sequence, may have illuminated the Alarm Light.

Disconnection of the autopilot, by depressing a button on either pilot's cyclic stick, will cause the Alarm Light to illuminate. Inadvertent disconnection could have occurred early in the impact sequence.

It cannot be ruled out that the Alarm Light had illuminated prior to the initial impact, thus indicating a systems failure or warning condition to the crew. However, no evidence was found that indicated any pre-existing malfunction in any of the components which were recovered and examined, including the two engines, main gearbox, main servocontrols or landing gear.

The Alarm Light illuminates for low fuel level in the feeder tank, when there is only five minutes flying time on two engines remaining. However, given the fuel analysis in para 2.6, along with the evidence of fuel ignition at the point of initial impact, this is considered to be highly unlikely.

Finally, the Alarm Lights are two very bright flashing red lights directly in both pilots' field of vision. It is an instinctive reaction to cancel them immediately by pressing either one when the reason for their illumination has been identified on the Caution Advisory Panel, especially at night. This suggests that the lights may have illuminated in the accident sequence.

The condition of the P1 Limit Light filament suggests that it was hot, i.e. ON, at impact. It is possible that a last moment large movement of the cyclic, as an attempted terrain avoidance measure, by one of the crew on seeing the ground could have illuminated the light. It is also possible that the Limit light illuminated during the impact sequence due to the abnormal loads being imposed on the aircraft.

The P1 Radio Altimeter Decision Height (DH) Bulb condition indicated that it was ON at impact. This would have illuminated when the aircraft passed through the bugged height on the Radio Altimeter.

The Coupler Collective Axis Active Indicator Light being apparently on does not, on its own, give enough information to come to a conclusion. The light could indicate that the Collective Flight Director Mode was active or that the Collective Axis was fully coupled to the Autopilot. But without any information on Mode Selection on the Coupler Control Panel, which was not recovered, a conclusion cannot be reached. The remaining Coupler Lights being off indicated that there had been no Coupler failure or manual over-riding of the Coupler in the seconds before the impact.

The fact that bulbs may have been illuminated at impact indicates that the aircraft electrical system was operational at impact.

2.7.3 Voice and Data Recorders

The fact that a Cockpit Voice Recorder (CVR) was not fitted, nor was it required to be, limited the investigation in that it was not possible to determine the

strategies developed by the crew as the mission progressed. Similarly the absence of a Digital Flight Data Recorder (DFDR) meant that it was not possible to determine the exact flight-path of the aircraft in the final stages of the flight, nor the performance of the various installed systems.

Cockpit Voice Recorders, which are required by legislation on many civil public transport aircraft, are an invaluable tool for analysing accidents and thereby enabling regulatory agencies to formulate preventative measures. A recording can provide records of radio communications, crew intercommunications and, particularly in helicopters, aircraft mechanical noises. JAR-OPS-3, which is the European legislation governing civil helicopter operations, requires CVRs to be installed on newly registered helicopters of weights greater than 3120 kg. There are now small and lightweight CVRs available on the market, which are relatively simple to retrofit onto existing aircraft.

Similarly DFDRs are invaluable in recording parameters such as aircraft attitudes, speeds, engine data, flight control settings, systems performance, etc. While DFDRs are more complex and expensive to retrofit onto existing aircraft than CVRs, there are lightweight and small combined DFDRs/CVRs available, which are suitable for installation on new aircraft.

Health and Usage Monitoring Systems (HUMS) are fitted to certain helicopters and have proved useful in other investigations. Air Corps helicopters are not fitted with HUMS, nor are they required to be so fitted.

2.8 Human Factors

It is timely to examine the human pressures, which the Waterford SAR crew found themselves subject to on 1st July 1999. These pressures may have been felt either consciously or subconsciously.

It was the first day of a new and important Air Corps SAR mission, which was highlighted by media attention and the presence of GOC Air Corps for the inauguration.

The Detachment Commander's briefing to his crew in the early afternoon, as reported by the technicians who were present, stressed the importance of the mission and the need to be alert and responsive to any call-out, by day or night. It is clear from this briefing that he required that the conduct of the detachment should be above reproach from any quarter.

There was a pressure on the crew to carry out an in-theatre training flight on the first day of operations due to a lack of a prior work up at Waterford.

On-site “suitable accommodation”, with rest facilities, as defined in the O.M. (an Air Corps stated requirement for 24-hour SAR) was not available at the Airport and the crew accommodation was in three self-catering holiday homes at Dunmore East. It was the Detachment Commander's first time to use this kind of accommodation whilst on a detachment. The additional requirement of self-catering may have introduced another distraction into their already busy schedule.

The absence of a local Air Traffic Controller or Aerodrome Flight Information Services Officer after normal Airport opening hours obliged the Detachment Commander to detail one of his aircraft technicians to carry out this role. This was another unforeseen and unnecessary distraction.

Once the call out was initiated by MRCC, the loss of 15 to 20 minutes drive in time to the Airport, added to the pressures on the crew to meet the 45 minute call-out time.

The Detachment Commander mentioned in conversation with MRCC during the drive in, that the weather was "pretty poor". However he made the decision to go ahead with the mission. This was an understandable decision as, by its very nature, SAR operations are conducted with the acceptance of greater risk than most other operations.

The motto of SAR Squadron is "Go Mairidís Beo" (That others might live) and this philosophy influences the decisions and actions of all SAR crews. A decision to go, even in the most marginal of conditions, will almost always be made on the basis that lives are at risk and that a rescue will, at the very least, be attempted. The fact that, prior to departure, the crew were made aware that a sick child was on board the casualty vessel would have further increased the pressures on them to respond.

Initially, the crew anticipated an operation of one hour's duration. However, on-scene demands extended the operation, even as the weather deteriorated back at the Airport. Once they learned of this deterioration they immediately departed from the SAR location back to base, where they carried out two unsuccessful ILS approaches. All these activities reduced their fuel quantity to the extent that they could not divert to an alternative airport.

It is probable that the reduction in fuel remaining, combined with the extreme meteorological conditions, which were unlikely to have been encountered previously by the crew, would have led to serious pressures on the crew in their attempt to make a safe landfall in a hostile environment. By this stage their options were severely limited.

2.9 SAR Equipment

When the weight data set out in para 1.6.3 for DH248 is analysed, it is evident that the aircraft could never take-off, in accordance with its certification, with more than 800 kg of fuel on-board in the given SAR configuration. The AFM gives the total capacity of the fuel tanks on the aircraft as 915 Kg. The figure of 180 Kg of SAR kit, which excludes the winch, is taken on every SAR mission. This would appear to be high, given the limited payload available on the SAR Dauphin. The carrying of this amount of SAR kit on every mission puts a restriction on either the amount of fuel that can be uplifted, or the number of survivors/persons that can be carried, or both.

It is noteworthy that the weight of SAR equipment carried in the Dauphin has grown by over 50 % since 1990.

2.10 Tasking

SAR detachments in the Air Corps are self-detailing i.e. a detachment commander authorises himself and his crew to fly on a specific mission. Consequently the decision to proceed with the Waterford SAR mission requested by IMES was the Detachment Commander's alone. As stated above in para 1.18.1.2, the SOP for SAR missions had evolved to a situation where the "approval" required from Group Operations had become a "for information" message, and effectively no separate, objective assessment or approval system was/is in place for SAR launch decisions.

In this case, the Detachment Commander may have considered that he was under pressure to accept the tasking, firstly because of the possible danger to life and also because of the prestigious nature of the new mission, which only on the morning of the accident had been highlighted by the media and inaugurated by the GOC. Furthermore, the Detachment Commander had briefed his crew on the need for performance to be beyond reproach in the face of what he considered to be a possibly sceptical tasking agency.

Also, before departure, he had become aware that a "*very seasick*" young child was on the casualty vessel. All these combined factors must have persuaded him to accept the mission, when a more objective analysis and greater theatre familiarity may have led him to pay closer attention to the fact that the weather conditions required a meticulous and cautious attention to fuel planning. This included an assessment of the maximum time available to spend on-task against the time required for a safe recovery plan in view of the marginal weather conditions at Waterford Airport.

2.11 Crew Currency

Neither of the two pilots met the strict requirements of Air Corps Flying Order (ACFO) No. 25 on the day of the accident in respect of night Trans-down.

With regard to night flying, there is a practical difficulty during the months of May to August, when daylight can extend until quite close to midnight, in performing a Trans-down by night on each detachment (as required by the ACFO). Training so late at night could have a negative effect on the crew's ability to respond to an early morning SAR mission. Therefore it has become the accepted practice within No. 3 Support Wing that training for night Trans-downs at Finner during the Summer is not carried out. Often crews will compensate by carrying out simulated (under the hood) day trans-downs/emergencies on at least one flying detail per SAR detachment.

The crew of DH248 had together flown a 2½ hour IF training detail at Connacht Airport in mid-May, which included precision approaches. The P1 had also completed his simulator checks in late May. ACFO No. 25 makes no reference to simulator training time for SAR currency rating purposes.

It is considered that non-compliance with the ACFO was not, of itself, a causal factor. On their final approach into Tramore Bay, the crew encountered

conditions, which they were highly unlikely to have previously experienced and for which no representative method of training is available.

2.12 Systemic Analysis

2.12.1 Infrastructural Deficiencies

When the SAR service at Waterford was announced by the Minister of State at DOMNR in December 1997 a DoD/Air Corps working group set out infrastructural requirements at Waterford which needed to be in place by 01 July 1999 in order that the 24 hour Dauphin SAR service should go ahead. An on-site accommodation block on the Finner model was a stated requirement. The Dept. of Marine and Natural Resources agreed to fund the construction of a dedicated SAR operations and accommodation block and they employed the Office of Public Works to advance the project. However, due to a series of delays and setbacks, which centred around the provision of a new hangar and the siting of the two buildings, this block was not built and the crew was accommodated in holiday homes in Dunmore East, five miles from the Airport.

It was realised several months before 01 July 1999 that this would be the situation and the Air Corps accepted the alternative accommodation arrangements as a temporary solution. A consequence of the alternative arrangements was that, although rest facilities were provided for Detachment members at the Airport, these did not extend to the provision of “Suitable Accommodation” as defined in the Dauphin O.M. Chapter 8.2, paragraph 3. The OM advises that rest periods, including sleep, if possible, should be availed of by SAR crews during the 0900 hrs to 1700 hrs period. This advice is intended to assist crews in obviating possible fatigue effects, which could impair performance, but in the absence of “Suitable Accommodation” it could not be complied with.

However, the maximum response time of 45 minutes by night, agreed to by the Air Corps, was the same as that for Finner Camp where the crews live on-site. In the Waterford case, although the planned transit time was twelve minutes, there was a lost time of 15 to 20 minutes during which the crew responded to the call-out, drove to the Airport in semi-darkness, opened it up and prepared for the mission.

DH248 was airborne within 40 minutes of the initial call and it is known that the Detachment Commander was very aware of the 45 minute response time. It may be that the reduced time available for flight planning at Waterford in comparison to the normal experience at Finner was a factor in the absence of any telephone briefing with Met Eireann at Shannon or any other meteorological station.

Furthermore, at Finner, there is an automatic on-site weather station, together with a computer terminal, linked to the Met Eireann Aeronautical Weather database, which provides immediate and detailed weather information on request. No such facility had been sought or installed for the Waterford operation.

It would have been unreasonable for the Air Corps to refuse to proceed with the detachment on the basis of the alternative accommodation, especially in the light of the perceived advantages of operating out of an Airport. However, there should have been a comprehensive review of the night response times, the possible fatigue implications, and the assumed advantages of the Airport as an operating base.

It is noted that in 1997 the Air Corps Finner detachment re-located, within 24 hrs, to Carrickfinn Airport, Co. Donegal, due to storm damage to the Finner facility. Crews in Carrickfinn lived remotely from the base in a hotel, operated after-hours with communications provided by an aircraft maintenance technician, and did not have access to their normal weather reporting facility.

2.12.2 ATC/Meteorological Reporting

With regards to an Air Traffic Control requirement at Waterford, Air Corps management had identified this need prior to the commencement of the Waterford Alouette detachment in July 1998. OC No 3 Support Wing had re-iterated the need for this, especially on an outside normal Airport opening hours basis, in November 1998 and the Department of Defence had written to Waterford Airport management in January 1999 stating the requirement. However, sanction for the expenditure of public funds on a call-out allowance was not given until 25 June 1999 and, in any event, management and staff at Waterford Airport had not reached agreement on the proposed call-out allowance by 1 July 1999.

Waterford Airport Company have informed the investigation that they intended to meet the Air Corps requirement for ATC services by means of either qualified Air Traffic Control Officers (ATCOs) or qualified Aerodrome Flight Information Service Officers (AFISOs).

Air Corps management and DoD officials directly involved have stated that they saw it as a matter of fact that local ATC services outside normal opening hours would be available to support the SAR mission.

The only option open to the Detachment Commander was to detail one of his technical crew to operate the Tower, if the 24 hour SAR operation was to continue after darkness on 1 July 1999. This was unsatisfactory. It meant that a technician with absolutely no ATC/AFISO or meteorological training, or local knowledge, was placed in the role of having to provide Control Tower services including meteorological data to the crew of DH248.

While he performed this role to the best of his ability, and in a manner, which gave the Airport Manager no cause for concern or intervention, there can be little doubt that a qualified ATCO/Meteorological Observer with local knowledge would have been a more satisfactory situation.

A written Service Level Agreement between the Air Corps/DoD and the Waterford Regional Airport, which spelled out clearly the level and nature of services to be provided would have been the professional approach in this regard.

2.12.3 Work-up Period

The absence of a Service Level Agreement or any updated guidance material specifically for the 24 hour Dauphin detachment at Waterford Airport meant that the Detachment Commander had no formal direction regarding the level of services and infrastructure he should expect/demand at Waterford Airport on the first day of 24 hour operations. An Operational Order and a set of Standard Operating Procedures were issued and promulgated in June 1998 for the start-up of the Alouette detachment on 1 July 1998, but they had not been revised to take account of the 24 hour nature of the Dauphin operation.

The infrastructural deficiencies, including the lack of local ATC/AFISO support, which have been identified would have become clear had a work-up period been employed. It may well be that given a number of weeks of operational training in-theatre, different land-fall techniques and landing sites around the coast would have been known to and trained for by crews. As pointed out in the analysis of the coastal approach to Tramore, what appears to have been attempted was an improvised variation of a coastal approach to the Airport along a QDM of 028^{o}. This track would bring an aircraft over the dunes at a point where they are relatively high.

Expertise in the use of, and familiarity with the limitations of Waterford's ILS could have been developed during a work-up period. The feasibility of using other Airports as potential weather alternates would also have become clear. Although the Alouette III operation had been ongoing for a year and indeed the P2 had himself been an Alouette Detachment Commander on nine occasions, this type of flying cannot be equated to an IFR recovery to the Airport in thick fog at night.

The absence of an in-theatre work-up period adversely impacted on the ability of the crew to carry out the Waterford 24 hour SAR tasking generally, and the 1 July 1999 mission specifically.

2.12.4 Loss of Dauphin Experience in the Air Corps

The loss of twelve Dauphin pilots to the civil sector between 1996-1998 combined with the additional taskings of the GASU and Waterford detachment in the same time-frame had placed a severe strain on Air Corps resources. The fact that it is invariably pilots with ten or more year’s experience who retire means that the Air Corps is constantly trying to "catch up" in terms of experience.

A typical Dauphin crew in 1997 could have had a P1 with 1,500 - 2,000 hours on type and a co-pilot with 600 hours on type. Those levels have inevitably been pushed right down, with P1s now being SAR rated at around 600 hours on type and co-pilots going directly onto Dauphin from helicopter conversion courses.

The crew of DH248 had over 5,000 flying hours between them, which in Air Corps terms is a highly experienced crew. However, on Dauphin specifically, the combined flying hours of just under 1,200 is considerably less than the typical crew of two years earlier.

In terms of Dauphin night flying experience, the P1's experience of 138 hours and the P2's experience of 59 hours are considered to be low.

Furthermore, this loss of experience means that there is no cadre of experienced Dauphin commanders who have left the Operational Unit but who are still available in the Air Corps to provide a degree of independent audit of standards, experience levels, etc.

The rate of loss of experience, 17,000 Dauphin hours over three years, is considerably greater than the rate at which experience can be achieved, given available Dauphin hours, now further reduced by the loss of DH248. The average annual flying rate of 350 hours per aircraft per annum equates to 700 pilot hours per aircraft per annum or a total availability of 2,800 pilot hours per year for the fleet of four aircraft.

An insidious side-effect of the rate of experience loss is that the highly desirable culture of fostering/mentoring which is a useful adjunct to a pilot's skill development has been severely eroded.

The loss of experience allied to the expansion in Wing taskings has resulted in a situation where all middle management personnel i.e. Squadron Commanders are highly involved in rostered flying duties away from Baldonnel. This means that everyday administrative taskings and the over-seeing of Squadron activities by the Squadron Commander can be compromised. Furthermore the rate of change of No. 3 Support Wing Unit Commander during the period 1997-1999, did not contribute to a stable and continuous management flow.

This loss of experience is a very difficult problem to solve and requires assistance in finding solutions from outside the Air Corps. It is a problem which is affecting many military air arms at present. If the State requires the Air Corps to be able to provide a level of service which is directly comparable with that provided by the civil sector, then it is essential that systems must be put in place which will attract experienced personnel to remain in the Air Corps rather than inevitably moving on to other sectors. This is not a new problem. It was highlighted by the Gleeson Commission of 1990, which recommended a maximum time frame of 5 years to resolve the problem.

2.12.5 Dauphin Multi-Roles

The Air Corps Dauphins are tasked to perform multiple roles. These include:

- Search and Rescue (Land and Sea)
- VIP Transport
- Air Ambulance
- Training (Conversion and Role)
- Army Co-operation
- Naval Co-operation
- Aid To Civil Power.

All of the above are competing activities in terms of usage of aircraft hours. Hours are limited due to a number of reasons including spares shortages previously mentioned and key technical personnel shortages.

In practice, VIP Transport can take precedence over the training role and, in effect training hours may receive low priority in face of the above operational requirements. This is an ongoing Service dilemma regarding the competition between operational and training needs. This situation contrasts with that pertaining to the civil SAR operators who are tasked with a single SAR role. Also the GASU helicopter, which is operated by No 3 Support Wing is a totally focused single role operation.

The problem of limited flying hours was exacerbated by the requirement for an increase in the number of SAR rated Dauphin pilots necessary to cater for the Waterford SAR mission. There was a consequent need for an increase in the number of ab-initio pilot training hours along with increased continuity training requirements.

In summary, the available Dauphin hours are insufficient to meet the requirements of the multiple roles, along with the need for ab-initio training, directly resulting from personnel loss, along with the standing recurrency training requirement.

2.12.6 SAR detachment crew rosters

Air Corps SAR rosters provide for crews, based at Baldonnel, being detached for 3 or 4 days to Finner or Waterford. Much SAR continuity training is actually carried out by crews, whilst on detachment. Situations can arise whereby the continuity training cannot be achieved due to unsuitable weather, low aircraft hours available, or mission requirements. In such circumstances individual pilots may find that they are unable to comply strictly with the requirements of ACFO No. 25.

Three or four day duty periods, during which a crew are required to remain in an advanced state of readiness, have inherent fatigue risks associated with them. The OM attempts to minimise these risks by giving guidance on rest periods whilst on duty.

2.12.7 Fatigue

As is evident, the detachment complement had a very busy schedule on 01 July 1999. This was compounded by the fact that it was the launch date for the new service with the attendant photocalls for the press and the arrival during the morning of GOC Air Corps. Both an RTÉ publicity flight and a training flight incorporating a reconnaissance of the local hospital were carried out, together with the relevant flight briefings and debriefings, all of which took additional time. The Detachment Commander also gathered the entire detachment for a briefing at 13:00 hrs during which he had to deal with the problem of no ATC/AFISO services being available after 16:00 hrs. When they left the airport at 16:15 hrs, they routed via the shops to their accommodation where they then had to prepare their own meals in a "self-catering" arrangement.

By the time of the callout at 21:02 hrs, the crew's Flight Duty Period (FDP) was 14 hrs 02 mins. At the time of the accident, the FDP was 16 hrs 40 mins. To put these figures in perspective, the maximum allowable FDP as per the Dauphin OM for general operations is 12 hours. The crew had a 4 hour break at their accommodation before callout. Technically this would allow the extension of the FDP to 14 hours, although given the need to self cater it is questionable whether these 4 hours can be considered as a true break. By the time of the callout, the crew were at the end of their maximum allowable FDP for general operations. By the time of the accident they were over 3 hours beyond that figure.

The nature of the No. 3 Support Wing detached roster system, which puts crews on 24 hour standby for periods of up to 96 hours, is incompatible with these criteria. Indeed it is unique in the SAR sphere, as civil contractors operate a 24 hour shift system. In light of this the OM offers guidance on the sort of daily routine to be followed by crews to minimise fatigue. This incorporates possible sleep/rest periods in both the morning, afternoon and evening to be availed of by SAR crews as "integral part of each days duty". Additionally, it is based on the Finner system where crews live on base, in “Suitable Accommodation” as per the O.M. definition, and where they may retire to the comfort of their own rooms during the day to rest when necessary. The Waterford aircrew spent the day at the Airport and did not have this facility. They were also involved in the formalities of launch day, meeting VIPs, dealing with the press, conducting a training flight, and troubleshooting problems such as after-hours Control Tower services.

Medical studies have shown that response times in vigilance and sustained attention tasks are degraded by up to 7% after 16 hours of continuous wakefulness. It is noted that these studies do not take account of the significant additional pressures, over and above continual wakefulness, which the crew were subject to on 1 July 1999.

Concerns regarding fatigue-impaired performance are not restricted to aircrew and extend also to technical detachment members.

In summary, the Waterford aircrew were tasked with a mission at a time when, in non SAR Detachment circumstances, they would have been outside their FDP. Additionally they were unable to avail of rest as outlined by the OM. Therefore it could be considered that fatigue was a contributory factor in both the planning, launch decision and execution of the mission on 01 - 02 July 1999.

2.12.8 Flight Safety Organisation

At the time of the accident there was neither an established nor an effective flight safety organisation in the Air Corps. The deficiencies in the Air Corps flight safety organisation had been identified by the Price Waterhouse Report of February 1998. The Report recommended that the appointment of a full time Air Corps Flight Safety Officer was essential. At the time of the accident this had not been done.

It is considered essential that a Flight Safety Office be established immediately, independent of the Operational Units, with a direct line to GOC Air Corps and with the remit of ensuring that a degree of independent audit of flight safety issues and operational standards is available to the GOC.

The concept of setting up a new operation, such as a 24-hour SAR base at Waterford, solely by the Operational Unit, is flawed. The Unit is very much under pressure to achieve dates, provide crews, set up infrastructure and deal with all other related issues, in addition to their normal responsibilities. The availability of an independent assessment when setting up such a new operation, coming purely from a flight safety viewpoint, is vital because issues that could be overlooked under operational pressures can be assessed and reviewed from a more detached point of view. In the case of the Waterford detachment, an independent audit prior to 1 July 1999, was likely to have identified the infrastructural deficiencies which have been discussed in this report.

The loss of Dauphin experience, the expressed concerns of crews regarding the limitations of the Dauphin to carry out certain SAR taskings especially on the Northwest coast, and multi-roling in the face of a shortage of Dauphin flying hours are cause for concern. They make this an opportune time for the Air Corps to request a comprehensive flight safety operational audit of its Dauphin SAR operation in particular, and its flying operations generally, by an organisation which carries out similar military aviation roles. A suitable organisation, with a demonstrated understanding of military air culture, should be contracted to carry out such an audit. This audit would provide independent, highly constructive and professional review and advice on the Air Corps Dauphin SAR operation, and on flying operations generally. The results of such an audit would form the foundation for the new Air Safety Office in the Air Corps.

2.12.9 Mission Following

There was no formal or effective mission following infrastructure within the Air Corps, or elsewhere, on the night of the mission. The highly fluid nature of SAR missions coupled with dangers of crews becoming absorbed by the demands of their mission means that experienced, proactive, informed mission following personnel could assist crews by providing accurate and timely meteorological information, suggesting possible recovery options and objectively evaluating the evolving SAR scenario.

2.12.10 Experience with West Coast Operations

Several shortcomings of the Dauphin as a SAR platform for use in the Atlantic theatre generally, and the Northwest coast specifically, were brought to the attention of the investigation by SAR practitioners past and present.

The investigation studied the matter and any shortcomings relevant to this accident have been considered in the above Analysis. Notwithstanding this, it is felt that a further review of these shortcomings should be undertaken at another forum, in the interests of flight safety.

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3. CONCLUSIONS

(a) Findings

Immediate Findings

1. The aircraft was properly maintained in accordance with Air Corps Technical Orders and the manufacturer's Maintenance Manuals.

2. Post-accident examination of the wreckage revealed no aircraft defect or failure which could have caused the accident. However much of the aircraft was destroyed in the impact and subsequent fire and was therefore not amenable to meaningful examination.

3. The destruction of the aircraft was caused by ground impact and a post-crash fire.

4. Indications are that the recovered P1 Alarm Light bulb was "ON". No evidence was found to indicate any systems failure which might have illuminated this bulb. It is plausible that the reason for the illumination relates to the aircraft impact sequence.

5. There were some minor Maintenance Deferred Items (MDIs) notated on the Technical Log in the days prior to the accident. The P1 was aware of these minor MDIs, from the Technical Log, when he accepted the aircraft. Given crew familiarity with the defects, it is unlikely that these MDIs contributed to the accident.

6. The pilots were properly rated in accordance with Air Corps Flying Orders with the exception that neither pilot had completed a night Trans-down during each of their Finner detachments in the previous month as per ACFO No. 25. Both had current Night SAR ratings and Green Instrument ratings.

7. There is a practical difficulty in maintaining compliance with the strict terms of ACFO No. 25 during the summer months. It has become the accepted practice within No. 3 Support Wing that training for night Trans-downs is not carried out on each Finner detachment during the Summer.

8. The pilots were medically fit to carry out the flight. There were no adverse pathological findings.

9. The reason for the SAR mission was that a small boat, with four adults and a seasick child on board, was missing off Dungarvan in thick fog. The boat skipper was unable to use his Marine Band radio but made initial contact with the Irish Marine Emergency Service (IMES) on a mobile phone. IMES immediately tasked the Helvick Inshore Lifeboat and the Waterford-based Dauphin to search for the vessel and, shortly afterwards, the larger radar-equipped Ballycotton Lifeboat was also tasked.

10. The mission was initially tasked directly to the Detachment Commander at the crew accommodation in Dunmore East by the Marine Rescue Co-ordination Centre (MRCC) of IMES. It was subsequently stood down by MRCC to the Detachment Commander on his mobile phone while the crew were en-route to Waterford Airport. Following further discussions between the Detachment Commander and MRCC the mission was re-activated.

11. The final decision to proceed with the mission was that of the Detachment Commander. The mission was advised to the Group Duty Officer (GDO) in Baldonnel, by one of the detachment technicians. The GDO had no executive role in the launching of the mission.

12. The pressures on the Detachment Commander to accept the mission were very high. The main pressure came from the fact that lives were potentially at risk and that the crew were aware before departure that a "*very seasick*" child was on the missing vessel. The fact that it was the first day of the new 24-hour SAR service, that it had been highlighted by the media that day and that it was very important for the Air Corps to be seen to make a success of the new service, all increased the pressures on the crew to respond positively to the tasking.

13. At the time of the decision to launch the crew flight duty period was 14 hrs 30 mins and at the time of the accident it was 16 hrs 40 mins. Due to the fact that it was the first day of the 24 hour operational mission, this duty period was uncharacteristically busy. A medical study suggests that the crew's judgement may have been adversely affected by their accumulated fatigue.

14. The fuel endurance and number of persons on board were not passed by the crew of DH248 to MRCC, nor were they requested by MRCC.

15. No flight plan was filed for the mission. Notification of the mission was not passed to the Aviation Rescue Co-ordination Centre (ARCC) Shannon by either MRCC (as per their own SOPs) or by the SAR crew at Waterford, as the mission commenced. Consequently Shannon Air Traffic Control Centre was unaware of the mission until they were informed that the aircraft was overdue.

16. It appears that the most up-to-date meteorological information availed of by the crew of DH248 was the Local Area Forecast (LAF) for Waterford Regional Airport valid from 18:00 to 24:00 hrs which was faxed to the Airport at 16:46 hrs by Met Eireann.

17. There is no recorded evidence to show that the crew sought or obtained any further meteorological briefing from Met Eireann immediately prior to the mission.

18. The 18:00-24:00 hrs LAF quoted a forecast visibility of 3 - 8 km, locally 500 metres after 20:00 hrs with local fog later. The cloud forecast was scattered 300 feet, overcast 500 feet by 20:00 hrs, locally broken 200 feet later. This final figure is equivalent to a possible cloudbase of less than 100

feet at the Airport. The forecast predicted that '*locally*' the cloudbase could be below the published Decision Height (310 feet) for an ILS approach to RWY 21 at Waterford.

19. The visibility conditions at Waterford Airport when DH248 departed were described by the Air Corps technician who was in the Control Tower as being 1000 metres approximately. He estimated this from his view of the runway lighting down to the 03 end of the runway. Another technician who was on the ramp as the Dauphin departed also estimated that the visibility was 1000 metres. However the Airport Fire Officer estimated that the visibility was only 100 to 150 metres when he carried out a pre-departure runway inspection.

20. In accordance with the OM, take-off minima for SAR missions are at the Aircraft Commander's discretion.

21. The Detachment Commander decided to leave the fuel load for the SAR mission at 600 kg, which was his pre-determined standard fuel load while the helicopter was on standby. It is likely that he made this decision based primarily on the proximity of the search area to the SAR base. The decision was reflected in the estimated one hour duration of the mission as notated by him on the Flying Detail. He would also have been aware of a possible requirement to winch with a consequent need to arrive overhead the casualty vessel at a desirable weight of 3800-3900 kg.

22. A fuel load of up to 800 kg could have been taken, which would have brought the aircraft up to its maximum take-off weight.

23. There was no licensed Air Traffic Control Operator (ATCO) or Aerodrome Flight Information Service Operator (AFISO) on duty in Waterford Airport Control Tower during the mission.

24. In the absence of an ATCO or AFISO, the communications function from Waterford Tower during the SAR mission was performed by an Air Corps technician who had no training or qualifications in ATC/AFISO, Control Tower procedures or meteorological observation.

25. The Airport Manager, a formerly qualified AFISO, did come into the Tower after the departure, having been phoned by the SAR crew. He remained there throughout the mission. He assisted with visibility assessments for the Air Corps technician but he did not act in the capacity of ATCO or AFISO.

26. Subsequent to take-off on the mission, there was no communication concerning weather conditions between the crew of DH248 and Waterford Control Tower until one hour's flying had elapsed. The implication is that the crew were not particularly concerned about the weather conditions at Waterford Airport.

27. The Helvick Inshore Lifeboat located the casualty vessel at 21:58 hrs, as the Dauphin was arriving into the search area. At 22:00 hrs MRCC

requested DH248 to route to the lifeboat's position and to monitor the situation for a while.

28. At 22:20 hrs the Helvick Inshore Lifeboat requested navigational assistance from DH248 as its GPS navigation system was having problems. The Dauphin flew search patterns to overhead the lifeboat and assisted with steering information to Helvick Head.

29. After one flight hour had elapsed at 22.41 hrs, the crew of DH248 called Waterford Tower for an update on the weather. They were informed that the weather was *"staying the same"*. This probably led the crew to believe that conditions at Waterford Airport were the same at that time as they had been at the time of departure.

30. At 22:42 hrs, DH248 passed overhead the Helvick Inshore Lifeboat and reported that they had sighted the lifeboat.

31. At 22:51 hrs, Waterford Tower called DH248 to advise them that the weather was "*deteriorating slightly here*". The crew of DH248 inquired as to whether they could see the lights of Tramore from the Tower (a distance of 4 km). The reply was *"Negative, we can just about hardly see the runway which is a distance of 300 metres from the Tower"*. This suggests that, at this time, the crew of DH248 had a false impression of the conditions at the Airport.

32. At 22:51:40 hrs, DH248 asked the Helvick Inshore lifeboat if they had the lights of Helvick Head in sight. The answer was negative.

33. At 22:53:30 hrs, DH248 requested permission from MRCC to return to Waterford Airport as conditions there were deteriorating. At 22:54 hrs, DH248 was released by MRCC and took up a heading for the Airport.

34. DH248 carried out two ILS approaches to RWY 21 at Waterford from neither of which a landing was achieved. On each of these approaches the helicopter was heard but not seen by the personnel in the Control Tower. In addition several people living in close proximity to the Airport heard the helicopter flying overhead at low level, but could not see it.

35. At the point in space where an aircraft carrying out an ILS approach to RWY 21 reaches the published Decision Height (DH) of 310 feet, the line-of sight distance to the first element of the approach lighting is 741 metres.

36. At the time of the go-around from the first ILS approach, a horizontal visibility estimate of 500 metres, as assessed from the Control Tower, was passed to the aircraft.

37. The OM directs that if DH is reached and the “runway in sight” call has not been made, then the flying pilot will initiate the Missed Approach Procedure.

38. At about the time of the conclusion of the first ILS approach (23:14 hrs) DH248's remaining fuel became too low to allow for a safe IFR diversion to Shannon, which was a viable weather alternate for the mission. This also applies to a diversion to Baldonnel.

39. The Dauphin has a capability, which is not certificated by the French airworthiness authorities but which is described in the Aircraft Flight Manual, to descend automatically to 70 feet radio height over a runway on a fully coupled ILS approach. At the time of the accident this capability was not being trained for regularly. It is described as a "for demonstration" technique in the Dauphin Operations Manual.

40. It is considered unlikely that the aircraft descended to 70 feet on either ILS approach.

41. The absence of regular training for, and approval to carry out (in emergency situations) 70/70 ILS approaches, which are within the technical capabilities of the Dauphin, deprived the crew of the use of the full capabilities of their aircraft when attempting to land at Waterford Airport.

42. The airfield lighting at Waterford Airport had a known problem, which caused a half pattern of the RWY 21 approach lighting to trip out on occasion. On the date of the accident, there was no indication of this fault condition in the Control Tower at Waterford. On discovering this, the matter was immediately advised by the investigation to the Irish Aviation Authority. Consequently a positive indication of the correct operation of the approach lighting is now in place in the Control Tower.

43. It is possible that a half pattern of the RWY 21 approach lighting was inoperative during the two ILS approaches.

44. At 23:27 hrs, DH248 advised Waterford Tower that they had overshot (the second ILS) and were going *"to go-around for a coastal approach"*.

45. At 23:28 hrs, the Control Tower switched the approach lighting over from RWY 21 to RWY 03, to aid a possible approach from the South.

46. At 23:33 hrs, DH248 inquired if the weather at the Airport was improving. The Tower replied negative. DH248 advised the Tower that they were descending in the bay and that they were going to do a coastal approach in to Tramore and that they may land in Tramore.

47. At 23:34 hrs, Waterford Tower advised DH248 that Baldonnel was open. DH248 replied *"Roger, don't have the juice"*. Analysis of the estimated fuel consumption suggests that at this time the aircraft had approximately 30 minutes fuel remaining at an economy cruise power setting.

48. At 23:35:25 hrs, DH248 advised MRCC through Rosslare Radio that they were doing an approach to Tramore Bay at that time and that if they could

get down they were going to land in the bay area somewhere. This was the final voice transmission made from DH248.

49. There is no definite evidence of the flight path followed by the helicopter between the final voice transmission and the impact.

50. The lowest height above the surface that the Dauphin Automatic Flight Control System can provide automatic hover height hold is 40 feet (in Hoverheight mode). Therefore it is always necessary for the handling pilot to take manual control of the helicopter below 40 feet. Thus it is always the case that landing of a Dauphin is a manual procedure.

51. In order to effect a safe landing the handling pilot must obtain adequate visual cues.

52. The evidence available suggests that the crew attempted either a cloudbreak procedure to a Minimum Descent Height (MDH) of 200 feet, similar to an approach made during the afternoon training flight, or an unguided Trans-down followed by a Ground speed approach towards the beach. Failure to obtain adequate visual cues from either of these procedures would have resulted in a go-around manoeuvre.

53. It is likely that a manual go-round followed by a turn to the right and back out to sea was being undertaken when the Dauphin descended through the MDH and impacted with the sand dune.

54. Examination of the wreckage indicated that the landing gear was down and locked, and that the right hand side rear-crew sliding door was open and probably being closed at the moment of impact. The closing of the door suggests that a go-around was being carried out.

55. At 23:38:30 hrs, MRCC called DH248 but there was no reply. This indicates that the Winch Operator was engaged on other, more important duties. It is likely that he was concentrating on attempting to make visual contact with the surface i.e. rear crew sliding doors locked open and 'eyes-out' mode.

56. At 23:39:27 hrs, there was a short burst of carrier-only transmission on Waterford Tower frequency, later confirmed as being from DH248. The end of the transmission was normal, i.e. it was not caused by a power interruption as might occur on impact. There was no voice on this transmission.

57. There were two elements to the final transmission, a 'whoosh' noise and then the blade noise. It was not possible to confirm the source of the initial 'whoosh' noise, even under AAIB analysis. The blade noise revealed no abnormalities from the main rotor.

58. The accident occurred shortly after this final transmission.

59. The accident occurred at night in conditions of extremely poor visibility.

60. It is estimated from wreckage analysis that the impact speed was between 60 knots and 80 knots.

61. It is estimated that approximately 108 kgs of fuel were remaining at the time of impact.

62. There was no Mayday or emergency call made from DH248 prior to the accident. This suggests that the crew did not believe they had exhausted all of their options and that they were not experiencing any problems with the aircraft or its systems.

63. The fact that no Cockpit Voice Recorder or Flight Data Recorder were installed on DH 248 limited the investigation of the accident.

Systemic Findings

64. The Air Corps dispatched a SAR Dauphin helicopter and crew to Waterford Airport on 01 July 1999, as planned.

65. While an Operational Order and Standard Operating Procedures had been issued by the Air Corps for the commencement of the daylight only Alouette SAR operation at Waterford, there was no updated guidance material provided to crews for the start-up of the 24 hour Waterford Dauphin detachment. Neither was a Service Level Agreement in place between the Department of Defence/Air Corps/IMES and Waterford Airport.

66. The Air Corps requested certain facilities be provided on day one of the 24 hour Dauphin operation, through the Department of Defence. These included an on-site accommodation block, local Air Traffic Control and Crash Rescue Services outside normal Airport opening hours.

67. The on-site accommodation block was not provided prior to the detachment commencing. Overnight accommodation was provided for the SAR crew in self-catering holiday homes at Dunmore East, five miles from the SAR base. Although accommodation, including offices and a rest room, was provided to SAR crews at the Airport, this did not extend to the provision of “suitable accommodation” as defined in the Dauphin Operations Manual.

68. Local Air Traffic Control or Aerodrome Flight Information Services Officer services were not provided after duty hours on 01 July 1999 due to the absence of a financial agreement on call-out allowances between Airport management and staff. Air Corps senior management have stated, subsequent to the accident, that they were unaware that this matter had not been resolved. Department of Defence officials who were dealing directly with the Waterford deployment, have stated that they saw it as a matter of fact that after-hours local ATC services would be provided.

69. The Detachment Commander, on learning of the absence of local ATC/AFISO cover outside normal opening hours, instructed a member of his technical support team, an aircraft maintenance technician, to go to the Control Tower and to obtain a briefing on the operation of the communications and the airfield lighting during the afternoon of 01 July 1999.

70. The technician who received this briefing and who carried out the communications function with DH248 during the mission had no formal training in ATC/AFISO, Control Tower or meteorological procedures whatsoever and had never before been in Waterford Airport.

71. No specialist weather briefing equipment was provided by the Air Corps at the SAR base at Waterford, as is provided at Finner SAR base.

72. The Detachment Commander gave a thorough briefing during the afternoon to his complete crew, where he emphasised the importance of an effective and efficient response to any call-out, as this was the first 24-hour SAR detachment to Waterford. He was particularly concerned about meeting the 45-minute to airborne response time for night call-out.

73. The 45-minute response time did not take adequate account of the drive in time between Dunmore East and the Airport (15 to 20 minutes on the night in question). Under normal circumstances the planned transit time was twelve minutes. The majority of the SAR crew's previous night SAR experience had been in Finner Camp, Co. Donegal, where they lived on-site, and were subject to the same 45-minute response time.

74. Twelve Dauphin Pilots, of whom ten were SAR rated Aircraft Commanders, retired from the Air Corps between 1996 and 1998. The total flying time of these personnel was over 37,000 flying hours, of which almost 17,000 hours were on Dauphin.

75. The loss of experience has had the inevitable effect of reducing significantly the experience levels of both Dauphin commanders and co-pilots.

76. The loss of experience, allied to the expanded tasking of the Unit, has resulted in a stretching of the management resources.

77. An indicator of the stretching of management resources is the fact that in the period 1997 to 1999, the appointment of Officer Commanding No.3 Support Wing was held by five different officers (of Lt. Colonel and Commandant ranks) and the appointment of Officer Commanding SAR Squadron was held by four different officers of Commandant rank.

78. The available Dauphin flying hours, which average out at 350 to 400 hours per aircraft per annum, are insufficient to meet the requirements of the multiple operational taskings (multi-roles) along with the ab-initio and continuity training needs, especially in the light of the loss of experience.

79. The low level of flying hours is due primarily to the poor availability of obsolescent avionic spare parts and the non-availability of key technical personnel.

80. Air Corps Dauphin crews carry out annual simulator training in emergency procedures on a Super Puma Mk 1 helicopter simulator. This simulator is not fully representative of the 365 Fi aircraft, nor indeed is there any representative simulator available.

81. At the time of the accident there was no formal or effective flight safety organisation within the Air Corps, other than a non-executive and part-time flight safety committee. The Price Waterhouse Report of February 1998 recommended that a senior position in ACHQ should be dedicated full-time to a "proactive aviation safety programme".

82. Within the Air Corps, there is no system of independent audit of Operating Unit standards, experience and procedures. In relation to Waterford specifically, there was no independent audit of the proposed new operation.

83. There was a degree of confusion at MRCC regarding certain aviation-related aspects of the search for the missing helicopter. These were the endurance of the helicopter and the precise location of Waterford Airport.

84. Members of the rescue services who arrived on-scene in the hours following the accident, including the IMES teams, the Gardaí and the Fire Service were not properly equipped to deal with the hazards posed by the accident site.

85. The AS365Fi Dauphin, as certified, cannot take-off with a full load of fuel (915 kg), the full SAR kit as currently configured, and a SAR crew of four, as the maximum all-up weight would be exceeded.

86. The SAR kit as currently configured weighs 180 kg. Given the limited payload of the Dauphin, this weight is considered to be excessive.

87. Several Dauphin SAR practitioners, past and present, brought to the attention of the investigation, shortcomings of the aircraft when operating in severe Atlantic weather conditions. These included lack of available power in the hover, inadequate performance of the auto-hover system, lack of endurance and low casualty carrying capacity.

88. The Omega navigation system, which was part of the original aircraft specification and certification, was withdrawn from service by the US authorities in 1997. In anticipation of this, the Air Corps fitted a stand-alone GPS satellite navigation system to the Dauphin fleet.

89. There is confusion and concern in the Air Corps surrounding the capabilities, reliability and functionality of the AS365Fi fuel jettison system.

(b) Causes

Active Causes

1. The primary cause of the accident was collision with a sand dune during or following a probable go-around after an unsuccessful coastal approach to Tramore beach at night in extremely poor visibility.

2. The coastal approach was unsuccessful and it is likely that the aircraft carried out a manual go-around and turned right onto a heading of 130^{o} with the intention of going back out to sea. At some point during this manoeuvre the aircraft descended through the bugged height and impacted with the dune. The reason(s) for this descent cannot be fully determined but the investigation has considered that the probable reasons for this descent are either (a) deliberate manual descent following acquisition of visual cues, (b) distraction occurring in the cockpit or (c) momentary pilot disorientation in a manual turn.

Contributory Causes

3. The probable weather conditions prevailing in Tramore Bay at the time of the coastal approach made a successful landing there virtually impossible, due to the absence of visual references essential for landing.

4. The pressures on the Detachment Commander to accept the mission were very high and included the fact that lives were potentially at risk.

5. The Detachment Commander decided to launch although the applicable weather forecast for Waterford Airport, the Local Area Forecast valid from 18:00 to 24:00 hrs, predicted that “locally” the cloudbase could be below the published Decision Height for an ILS approach to RWY 21.

6. There is no recorded evidence that the pilots sought or obtained any meteorological briefings or updates, for Waterford Airport or elsewhere, immediately prior to, or during the first hour of, the mission. Thus no consideration appears to have been given to flight planning for diversion to an alternate airport. This left the pilots with no option other than the coastal approach, after they had unsuccessfully attempted two ILS approaches at Waterford Airport.

7. The pilots' decision to depart from Waterford Airport with 600 Kgs of fuel, when 800 Kgs could have been carried, limited the options open to them in their attempts to make a safe landing, given the meteorological conditions on the night. The pilots' options to uplift additional fuel prior to departure were restricted by a possible requirement to winch, the anomalies associated with the fuel jettison system and the weight of the SAR kit.

8. The extension of the mission, as precipitated by the malfunctioning of the Inshore Lifeboat's GPS navigation system, to a duration significantly longer than that anticipated by the pilots prior to departure meant that their recovery options became limited. However the pilots did not express any

concern about remaining on station to either the Lifeboat or to IMES, prior to their request to IMES to return to base.

Systemic Causes

9. The lack of an in-theatre work-up period meant that operational expertise and procedures for Dauphin poor visibility/night ILS approaches to Waterford Airport, for SAR mission recoveries, had not been fully developed. This expertise would have included awareness of the implications of the high Decision Height, the long line-of-sight distance from the DH point to the Approach Lighting and the abbreviated Approach Lighting.

10. The lack of an in-theatre work-up period meant that standard approaches to previously reconnoitred suitable local landing sites other than Waterford Airport had not been fully developed.

11. The lack of an in-theatre work-up period meant that infrastructural deficiencies, including the absence of local ATC/AFISO services, remained undetected at the commencement of 24 hour SAR operations at Waterford Airport.

12. The lack of an independent audit of operational readiness meant that infrastructural deficiencies, including the absence of local ATC/AFISO services, remained undetected at the commencement of 24 hour SAR operations.

13. The lack of an on-site accommodation block meant that of the 45 minute response time, 15 to 20 minutes were required to travel in and open up the airport thus reducing the time available to the crew for flight planning. This became a particular issue because the mission was the first night mission, on the first day of 24 hour SAR operations, at Waterford Airport.

14. The Detachment Commander's authorisation to dispatch at his "discretion", as per the Operations Manual, contained no safe-guard requiring independent consultation if conditions were marginal.

15. Crew fatigue is considered to have been a contributory cause of the accident. Factors which could have induced crew fatigue include the long FDP on 01 July 1999, the unusually busy nature of the day, and the non-availability of suitable on-site rest facilities including bedrooms at Waterford Airport, as defined in the Dauphin Operations Manual. This meant that the crew were not able to avail of rest/sleep periods as recommended in the Operations Manual. This situation was compounded by the need to self-cater at the off-site accommodation.

16. The absence of a qualified and licensed Air Traffic Control Officer or Aerodrome Flight Information Services Officer eroded the safety net available to the crew during their mission particularly in relation to the provision of meteorological information.

17. The lack of an effective, supportive and proactive Air Corps mission-following facility deprived the crew of a variety of mission-related inputs, which might have better informed their decision-making process.

4. SAFETY RECOMMENDATIONS

It is recommended that:

4.1. The Department of Defence should establish, as a matter of urgency, a full-time fully-resourced Air Safety Office in the Air Corps, to be headed up by a Flying Officer of Lieutenant Colonel rank. This issue has already been the subject of a similar recommendation in the February 1998 Price Waterhouse Report. **(SR 11 of 2000)**

4.2. Due to the historical absence of an established flight safety organisation within the Air Corps, the Department of Defence should commission, on behalf of the Air Corps, an independent Air Operations Safety Audit, by an agency with a proven track record of expertise in Military Aviation. The results of this audit will form the foundation for the new Air Safety Office. **(SR 12 of 2000)**

4.3 The Air Safety Office should, as part of its duties, carry out independent audit of all new Air Corps operations and also of all aspects of simulator training. **(SR 13 of 2000)**

4.4 GOC Air Corps should request and obtain the necessary legislative changes to ensure that findings and recommendations related to flight safety, arising from military Courts of Inquiry, are promulgated and acted upon within the Air Corps. **(SR 14 of 2000)**

4.5 GOC Air Corps should institute an immediate review of the fuel uplift policy and the use of alternate airports, for Dauphin SAR missions. **(SR 15 of 2000)**

4.6 GOC Air Corps should institute an immediate review of the weight of SAR kit carried on-board Dauphin Aircraft. **(SR 16 of 2000)**

4.7 GOC Air Corps should institute an immediate review of the launch procedure and authority for SAR missions. **(SR 17 of 2000)**

4.8 GOC Air Corps should institute an immediate review of the roster system used for Air Corps SAR detachments. **(SR 18 of 2000)**

4.9 GOC Air Corps should institute an immediate review of the provision of weather information for SAR missions, to include use of MRCC resources. **(SR 19 of 2000)**

4.10 GOC Air Corps should institute an immediate review of the use and practice of 70/70 ILS approaches for Dauphin aircraft. **(SR 20 of 2000)**

4.11 GOC Air Corps should institute an immediate review of ACFO 25 to consider the achievability and necessity of the currency requirements contained therein and to consider incorporating the utilisation of simulator training. **(SR 21 of 2000)**

4.12 GOC Air Corps should institute an immediate review of mission-following for Air Corps missions. **(SR 22 of 2000)**

4.13 GOC Air Corps should institute an immediate review of the operational use and technical performance of, and the guidance material available for the fuel jettison system. **(SR 23 of 2000)**

4.14 The emergency services including Fire Service (including Regional Airport firecrews), Garda Siochana, IMES Coastal Teams, Mountain Rescue Teams and RNLI Lifeboat crews should be made fully aware of, and trained to deal with, the potential hazards to rescue personnel associated with sites of serious aircraft accidents. **(SR 24 of 2000)**

4.15 A formal Service Level Agreement should be put in place between the Air Corps and the Irish Coast Guard defining the precise responsibilities and deliverables of both parties. **(SR 25 of 2000)**

4.16 For future SAR bases at Airports/Aerodromes, a Service Level Agreement between the operator and the Airport authorities should be put in place before operations are commenced. This should clearly identify the level of support services to be provided. **(SR 26 of 2000)**

4.17 GOC Air Corps should retrofit modern lightweight cockpit voice recorders (CVRs) into all existing operational aircraft. **(SR 27 of 2000)**

4.18 GOC Air Corps should install, as standard equipment, CVRs and Digital Flight Data Recorders (DFDRs) on all new operational aircraft to be procured. **(SR 28 of 2000)**

4.19 GOC Air Corps should review the feasibility of restoration of the functionality and certification status of the Dauphin fleet, equivalent to those prevailing at time of delivery, given the levels of equipment obsolescence being experienced. **(SR 29 of 2000)**

4.20 GOC Air Corps should review the shortcomings of the Dauphin as an SAR platform operating in the Northwest theatre, as expressed to the investigation by past and present SAR practitioners. **(SR 30 of 2000)**

4.21 The Department of the Marine and Natural Resources should review the aviation expertise and training requirements for personnel involved in the tasking of SAR air assets. **(SR 31 of 2000)**

4.22 The Department of the Marine and Natural Resources should conduct an investigation into the maritime circumstances, which gave rise to the mission and also to the prolonging of the mission. **(SR 32 of 2000)**

4.23 GOC Air Corps should review all relevant issues including operational and maintenance practices and spares support issues to maximise Dauphin flying-hour availability and revise as appropriate operational and training priorities for usage of available Dauphin flying hours. **(SR 33 of 2000)**

4.24 The loss of Dauphin experience identified in this report has been recognised and reported on previously by others. However it has not been successfully dealt with to date. The Department of Defence should urgently develop

personnel management strategies, which adequately address this issue. **(SR 34 of 2000)**

4.25 The relevant operators should ensure that future new, or significantly changed, SAR operations, are the subject of a work-up period prior to the commencement of full operations. **(SR 35 of 2000)**

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APPENDICES A,B,C

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Appendix A

Pilots' Experience Profile

P1 - Experience Profile

The P1 commenced his "Wings Course" flight training in June 1989 and he was awarded his Pilot's Wings in July 1990, following a flying course of 201 hrs 25 mins on SF260 Marchetti and CM170 Fouga Magister aircraft. He was awarded his first "White" Instrument rating during the Wings course in February 1990.

Following five months in Gormanston flying Cessna FR172H and -K aircraft, he was posted to No. 3 Support Wing in January 1991 and commenced helicopter conversion on SA342L Gazelle and thereafter onto Alouette III helicopters. He received his type rating on Alouette in September 1991 and he then became an operational pilot on type flying missions including Army Co-operation, Garda (Police) Co-operation, border detachments at Finner and Monaghan, Air Ambulance and SAR.

Between July and December 1994 he completed an Instructor's Course flying SF260 Marchetti and he was awarded a Grade II Instructor's Rating in December 1994. He then returned to No. 3 Support Wing to fly Alouette III operationally and he was awarded his Instructor's Rating on Alouette and Gazelle in June 1995. After that he mixed instructing pilots converting onto rotary-wing with operational flying on Alouette and Gazelle. He commenced his conversion training onto Dauphin in June 1996 at which point he had a total flying time of 1,650 hours approximately. He received his White Instrument Rating on Dauphin in June 1996 and his P2 night SAR rating in October 1996. After that he commenced operational SAR flying on Dauphin including Finner detachments.

While a P2 on Dauphin, he also continued Alouette and Gazelle flying. On 20 April 1998 he received his Dauphin P1 night SAR rating and thereafter he commenced Finner detachments as Detachment Commander. He completed twenty detachments to Finner as Detachment Commander between May 1998 and June 1999. He received his Green Instrument Rating on Dauphin in October 1998 and his Instructor's Rating Grade I on Dauphin in August 1998.

P2 - Experience Profile

The P2 commenced his "Wings Course" flight training in July 1990 and he was awarded his Pilot's Wings in June 1991, following a flying course of 204 hrs 35 mins on SF260 Marchetti and CM170 Fouga Magister aircraft. He was awarded his first "White" Instrument Rating during the Wings course in April 1991.

Following a period in Gormanston between July 1991 and November 1992 flying Cessna FR172H and -K aircraft, he was posted to No. 3 Support Wing in November 1992 and commenced helicopter conversion on SA342L Gazelle and thereafter onto Alouette III helicopters. He received his type rating on Alouette in May 1993 and he then became an operational pilot on type flying missions including Army Co-operation, Garda (Police) Co-operation, border detachments at Finner and Monaghan, Air Ambulance and SAR.

Between January and May 1995 he completed an Instructor's Course on SF260 Marchetti aircraft. He returned to No. 3 Support Wing in June 1995 and resumed operational flying on Alouette III. He was awarded his Instructor's Rating Grade II on Gazelle in October 1995 and on Alouette III in April 1996. After that he mixed instructing pilots on both Rotary types with operational flying on Alouette and Gazelle. He received his Green Instrument Rating on Gazelle in January 1998.

He commenced his conversion training onto Dauphin in December 1997, and received his White Instrument Rating on type in February 1998 and his P2 night SAR rating in June 1998. He was awarded his Green Instrument Rating on Dauphin in March 1999. Up to the date of the accident he continued to fly operationally on both Alouette and Dauphin. He completed eighteen detachments to Finner as Dauphin P2 between May 1998 and June 1999. He also completed nine detachments to Waterford as Alouette 111 Detachment Commander (daylight only) between July 1998 and June 1999.

Appendix B

Aircraft Systems

B.1 Fuel System

Fuel is contained in two independent fuel tank groups with a combined fuel capacity of 1158 litres (915 kg). The fuel tank group supplying the port engine comprises three tanks with a combined total capacity of 573 litres (453 kg). The fuel tank group supplying the starboard engine comprises two tanks with a combined total capacity of 585 litres (462 kg). There are individual gravity refuelling receptacles for the two tank groups and a separate single pressure re-fuelling receptacle. A fuel transfer system based on a two-way transfer pump can draw fuel from either tank group into the other one at a rate of approx. 300 litres/hr. There is also a fuel jettison system which, according to the Aircraft Flight Manual (AFM), "*is designed to dump fuel overboard in order to lighten the aircraft in an emergency*" (see B.1.1 below).

Each tank group is equipped with two booster pumps and two jet pumps which continuously fill a feeder tank from which fuel is fed through a filter to the relevant engine. A red FUEL.Q warning light on the Fuel Management Panel and on the Master Warning Panel indicates a drop in the fuel level in the feeder tank, equivalent to approximately 5 minutes endurance remaining on two engines. This warning also illuminates the red Alarm Light.

Fuel quantity is displayed to the crew on an indicator located in the centre of the instrument panel. There are two needles, one for each tank group. The indicator reads in kg (X 100).

A Fueltron computer is installed on the aircraft. This indicates the instantaneous fuel flows for both engines. Before flight the crew enter the fuel quantity manually and during the flight the fuel quantity remaining or the endurance remaining is displayed on the Fueltron.

The Nadir flight management computer also contains a fuel management page. The crew enter the fuel quantity into the system before departure and the Nadir displays the remaining fuel quantity. A reserve quantity can be entered at pilot's discretion which, when reached, will activate the fuel warning alarms in the cockpit including a fuel alarm on the Electronic Flight Instrumentation System (EFIS). The standard reserve quantity used is 150 kgs. Reaching this reserve does not cause the Red Alarm Light to illuminate. Table 1 below shows all fuel quantity related warnings.

The Nadir has another facility which tells crews the estimated fuel remaining on arrival at particular destinations. During the flight they can select this facility and they will be informed how much fuel is required to fly to any selected destination and how much fuel will remain in the tanks on arrival. The system does not take account of changing wind conditions that might be encountered en-route.

The fuel consumption rate is dependent on power setting, aircraft weight, pressure altitude and Outside Air Temperature (OAT). The Operations Manual (OM) gives a planning figure of 300 kg/hour but this is fairly high and an average figure of 250

kg/hour is more realistic. If the helicopter is loitering at low speed in a search pattern then the fuel burn may be as low as 220 kg/hour.

Fuel quantity on dispatch is assessed on a mission by mission basis. The Detachment Commander at Waterford decided on a standby fuel load of 600 kg . On its final flight DH248 departed from Waterford with 600 kg of fuel i.e. the standby fuel load.

Dauphin Fuel Warnings - Relating to Quantity Remaining

Warning	Location	Colour	Meaning
Fuel Comp	EFIS, Nadir Computer	Amber	Fuel remaining on landing at the destination currently selected on the Nadir flight management system, will be below the programmed reserve
Alt Fuel	EFIS, Nadir Computer	Amber	Fuel remaining on landing at the alternate currently selected on the Nadir flight management system will be below the programmed reserve
FUEL	EFIS, Nadir Computer	Red	Actual fuel on board is now below the programmed reserve. (this does not illuminate the ALARM light)
FUEL.Q	Fuel Management Panel (One for each fuel group), Caution Advisory Panel	Red	Indicates a drop in the level of the feeder tank. This can be caused by:- a. Failure of either jet pump or the valve in the bottom of the feeder tank b. Running a fuel group very low. In this case the light would mean sufficient fuel remaining for 5 minutes twin-engine flight or 4 minutes single-engine flight, from that particular fuel group. The FUEL. Q light illuminates the ALARM light

Table 1

B.1.1 Fuel Jettison System

According to the AFM, the Dauphin has a fuel jettison system which can be used to lighten the aircraft quickly "*in an emergency*". There is a Jettison Valve for each of the two tank groups. The AFM states in Section 9.6 that the "*complete fuel load*" can be jettisoned in approximately six minutes, i.e. an average rate of 150 kg/min approximately.

Following a valve failure in the open position during a training flight in February 1987, Air Corps Group HQ (as the relevant regulatory body) issued a series of recommendations concerning fuel jettison:

- sequential jettisoning, i.e. one group at a time
- the possibility of valve failure should be taken into account in the planning of missions which may involve fuel jettison
- fuel jettison should only be used when essential rather than as a routine procedure
- in offshore missions, fuel jettison should be done from one group only, followed by rebalancing of the tanks by fuel transfer.

A new maintenance requirement was introduced requiring the checking of the correct operation of the fuel-jettison valves every 50 hours.

In October 1993, DH244 was overhauled at the manufacturer's facilities in France. Jettison tests were done as part of the acceptance tests and it was found that the right hand Group jettison stopped at the AFM minimum of 91 kg, but the left hand Group jettison continued below the AFM minimum of 79 kg. This led to an AFM amendment to Section 9.6. para 3.3.3. dated 93-46 for partial fuel jettison in flight. This restricts fuel jettison to the right hand Group only. Following right Group jettison the AFM requires balancing of the Fuel Tank Groups using the Transfer Pump.

The AFM also notes "To obviate the risk of valve closing failure, partial fuel dumping shall not be performed unless the fuel quantity available in the left hand Group is sufficient to ensure return to base with only one engine operating, should the case occur".

On 10 September 1996, DH244 (not the accident helicopter), when operating on the LE Eithne, an Irish Naval Service vessel, suffered a failure in a partially open position of the right hand Group Jettison Valve in flight. The Dauphin recovered to the LE Eithne and after landing, the Technical Crew, while troubleshooting, opened the left hand Group Valve. It too failed in an open position.

Following this incident fuel jettison checks were carried out on the Dauphin fleet to establish minimum remaining fuel quantity following simulated double fuel-jettison valve failure in the open position. DH248's log books show that the fuel remaining in the left hand Fuel Group was "*80 Lts*" i.e. 64 Kgs approx., and that the fuel remaining in the right hand tank group was "*110 Lts"* i.e. 88 Kgs approximately, giving a total remaining fuel quantity of "*190 Lts*" i.e. 152 Kgs approximately.

It is part of Air Corps Standard Operating Procedures (SOPs) that fuel transfer is not carried out during Trans-down to the hover or in the hover. The Winch-operator calls pre Trans-down checks to the pilots and these checks include "No

Fuel Transfer". This is to prevent any possibility of a Fuel Group being drained through fuel transfer in the hover.

It is also common practice that both Fuel Groups are balanced following jettison and prior to winching. Again this practice is in accordance with the AFM fuel tank group balancing requirement and its purpose is to prevent the possibility of the engine being fuelled from the right hand Fuel Group (used for jettison) running down through fuel starvation.

In a situation where 200 kg of fuel is jettisoned from the right hand fuel group then this would mean that 100 kg (125 litres approx.) of fuel would have to be transferred from the left hand group into the right hand group prior to winching. At a transfer rate of 300 litres/hr, this would take approximately 25 minutes.

B.2 Automatic Flight Control System (AFCS)

The AFCS consists of a 3-axis Autopilot and a 4-axis Coupler. The Coupler is the module which enables the higher order modes such as Transition Down, Hover Height, etc. to be engaged. In normal operation the autopilot is always engaged. During manual handling by crews, the aircraft is flown through the Autopilot, using a facility known as "*transparency*".

The Autopilot operates in pitch, roll and yaw. Each axis is controlled by two mutually monitored lanes, which also ensure fail passive operation. It can maintain the helicopter attitude and heading at pilot-selected reference values. It also incorporates a fly-through manual override control and an attitude reference modification system called "beep-trim".

The Coupler operates on the pitch, roll, yaw and collective axes and has seventeen operating modes including Trans-down, Trans-Up, Hover Height, Hover (zero groundspeed acquire and hold), Groundspeed acquire and hold, Localiser acquire and track, Glideslope acquire and track, Airspeed acquire and hold, Vertical Speed acquire and hold, and Coupling to the navigation system.

B.2.1 The Coupler Control Unit

The Coupler Control Unit is illustrated in the diagram shown at **Annex N**.
The four push-buttons marked "4" on this diagram are the Coupler and Flight Director function buttons on the cyclic and collective axes. These buttons must initially be depressed by the crew, and subsequently the specific modes available on the Coupler such as Trans-down, Hover Height, etc. can be selected by depressing the appropriate button (numbers 8 - 22 in the diagram). If the Flight Director (F/D) buttons are selected then Flight Director commands are displayed on the EFIS screens, which the pilot follows using manual control. If the Coupler (CPL) buttons are selected then the system automatically follows the commands through the AFCS.

Note: To prevent pilot overload, only one of the axes can be selected in F/D mode at any time, if neither cyclic nor collective axis is selected as coupled.

When the pilot selects an axis "on" using either the Coupled or Flight Director push-button, then an annunciator light illuminates on the instrument panel in front of each pilot. When a specific mode such as Trans-down is selected, then captions on the top of the Electronic Attitude Director Indicator appear to show the pilots what mode each axis is operating in.

The two rotary knobs (numbers 7 and 23) allow the pilot to select his chosen Cruise Height or Hover Height respectively.

B.2.2 Instrument Landing System (ILS)

The AS365Fi Dauphin is certificated by the French Airworthiness Authorities for Category One ILS approaches only. These are generally down to a minimum Decision Height (DH) of 200 feet above the runway although airport facilities may mean that a particular Category One approach has a higher DH, for example Waterford Airport has a DH of 310 feet above the runway. The published DH is the lowest height to which a crew may legally descend without making a decision to continue for a landing, having achieved visual references, or to go around.

In the Dauphin the ILS approach can be flown in a number of different ways. It can be flown manually through the autopilot using the localiser and glideslope raw data displayed on the Electronic Flight Instrumentation System (EFIS) screens. Alternatively it can be flown manually through the autopilot using the flight director command bars displayed on the EFIS and which are generated using the Coupler. The approach can also be flown 3-axis coupled in which case the pitch axis tracks the glideslope, the roll axis tracks the localiser and the pilot manually controls the airspeed using the collective. The ILS approach can also be flown fully automatically using the full 4-axis capabilities of the Coupler. In an operational scenario it is normal practice to fly an ILS Approach in a fully coupled, 4-axis, Automatic mode.

B.2.2.1 The 70/70 Approach.

When a full 4-axis coupled ILS approach is set up by the crew the AS365Fi has the uncertificated demonstrated capability to intercept, capture and track the localiser and glideslope down to 70 feet radio altimeter height over the runway at a typical airspeed of 70 knots. The Aircraft Flight Manual (AFM) states of this capability, "When the radio altitude is equal to 100 feet, the system switches onto the radio altitude height which should bring the aircraft to 70 ft in level flight on completion of the approach phase" (section 9.22, para 4.3.4). Also the Dauphin Operations Manual (OM) states that the technique is "for demonstration purposes only" (Chapter 2, Section 2.1, paragraph 5). Air Corps crews do not routinely train on the 70/70 technique as a low visibility approach and landing technique. Between 1989 and 1991, when an SAR Dauphin was based at Shannon Airport, significant 70/70 approach proficiency was developed by crews using the Shannon ILS. Following the 1991 move to Finner, most Dauphin ILS training was conducted at Connacht Regional Airport, where local topography is incompatible

with the 70/70 approach. This led to much less practice of the 70/70 Approach with consequent lessening of confidence and proficiency in this technique.

In a typical 4-axis coupled ILS approach, during the initial stages as the helicopter flies to intercept the ILS, the coupler collective axis will be in altitude hold mode with glideslope armed, the roll axis will be in heading or nav mode with localiser armed, and the pitch axis will be in airspeed hold mode.

As the helicopter intercepts the localiser, the roll axis will automatically capture and track the localiser and as the helicopter intercepts the glideslope the collective axis will automatically capture and track the glideslope. The pilot can modify the airspeed on the approach using a switch (beep-trim) on the cyclic stick. Normally a coupled ILS is flown at an airspeed of 100 kts but it can be flown up to 125 kts or down to 70 kts. Below 70 kts the helicopter becomes less stable and it becomes more difficult to track the localiser.

The Coupler software is programmed to allow a minimum height over the runway of 70 feet. The helicopter automatically levels out at this radio altitude and continues at the pre-set speed along the RWY centreline. No Flight Director guidance is available below 70 feet in ILS mode. To descend lower than 70 feet and to enter the hover from such an ILS approach would require the crew to change the configurations of the EFIS Display Control Panel from VOR/ILS navigation mode (VL1/VL2) to Nadir navigation mode (RNAV). The crew would have to select Hovermeter on the EFIS. Also the AFCS Coupler modes would have to be changed from settings LOC (localiser) and G/S (glideslope) to H-HT (hover height) and HOV (hover)/G.SPD (Ground Speed) in order to allow a change from ILS mode to hover and hover height mode. (See next paragraph for a description of these modes). This would mean that the crew would be without flight director guidance and couplings for a number of seconds while at 70 feet above the runway at an airspeed of up to 70 knots. The crew would also lose azimuth guidance, i.e. localiser, during this time. Such a procedure is highly dangerous and is not trained for.

While the AFCS will carry out the approach automatically to 70 feet, the Air Corps Dauphin Operations Manual states at Section 2.1 para 3 that "*the Dauphin is certified for Category 1 precision approach i.e. ILS with a Decision Height* (DH) *not lower than 200 feet and RVR of 500 meters".*

The OM gives a detailed description of the Approach procedure as follows:

"a.The final approach will be flown with the flying pilot fully on instruments and the non-flying pilot monitoring the approach, but devoting sufficient attention outside the cockpit to be able to identify the approach and/or runway lights when they become visible. When approaching DH the non-flying pilot's attention should be largely outside the cockpit. The flying pilot should plan the approach as if he would be required to go-around and will be fully briefed of the Missed Approach Procedures. The aircraft will be in the LDG (landing) configuration by the outer marker (undercarriage down and landing lights on).

b.The approach will be continued beyond the DH only when the non-flying pilot has called "runway in sight" and the aircraft is correctly positioned for landing, at which time the flying pilot will look outside the cockpit for visual cues to landing. No pilot may continue his approach below his decision height unless at least one of the following visual references for the intended landing point is distinctly visible and identifiable to the pilot.

(1)Elements of the approach light system
(2)The threshold
(3)The threshold markings
(4)The threshold lights
(5)Threshold identification lights
(6)The visual approach slope indicator
(7)The touchdown zone or touchdown zone markings
(8)The touchdown zone lights
(9)Elements of the runway lights".

B.2.3 SAR Modes

The AFCS incorporates several Search and Rescue (SAR) modes:- hover hold mode, hover-height mode, groundspeed mode, cruise height mode, Trans-down mode (with navigation and without navigation), Trans-up mode. These modes are described in Section 4.4 of the AFM.

B.2.3.1 Hover Hold

In this mode the AFCS will maintain the aircraft at longitudinal and lateral Doppler speeds (Vx and Vy) equal to zero. Vx is the forward/rearward speed of the aircraft. Vy is the left/right speed of the aircraft. The pilot can move the cyclic stick against the trim loads and when he releases the stick, the aircraft will return to Vx and Vy equal to zero. To engage hover mode, both the cyclic and collective channels of the coupler must be selected.

There is a "Hover Beep" function available to the pilot by means of a 4-way switch located on top of the cyclic stick, which can be used to vary Vx and Vy speeds, without having to move the cyclic, up to the following maximum values:

10 kt forward
7 kt to the right or left
5 kt aft.

When the switch is released, Vx and Vy speeds gradually return to zero.

B.2.3.2 Hover Height Mode

In this mode the AFCS acquires and holds, through the collective channel, a hover height derived from the aircraft's radio altimeter. The height can be selected between a minimum of 40 feet up to a maximum of 300 feet using a rotary knob on the Coupler control panel. In this mode, the pilots should also set

the DH bug on the radio altimeters to a setting below the selected hover height, e.g. for a hover height of 80 feet, the bug could be set at 60 feet.

This gives "fly-up" protection to the aircraft, whereby, if for any reason the aircraft descends through the DH bug setting then the coupler will automatically fly the helicopter up by immediately raising the collective lever. (See **Appendix B paragraph B.2.3.9**).

The lowest height at which any Coupler collective modes are operational is 40 feet. To bring the aircraft below 40 feet the pilot must use manual handling.

Hover and hover-height modes are used together to automatically maintain a hover (Vx , Vy = 0) at a given radio height over the sea.

B.2.3.3 Groundspeed Mode

In this mode the pilot can utilise the pitch and roll axes of the AFCS to acquire and hold a selected groundspeed, i.e. speed over the ground/sea, up to the following maximum values:

50 kt forward
20 kt to the right or left
10 kt aft.

The commanded groundspeed can be selected by moving the cyclic stick against the trim loads or by actuating the 4-way switch on top of the cyclic without pressure on the cyclic. The ground speed vector (Vx, Vy) is displayed as a magenta coloured circle on the EFIS screen display on the instrument panel. Groundspeed mode and hover-height mode can be used together to automatically acquire and hold a selected speed within the given limits at a given radio-height over the sea.

This is the mode normally used to bring the aircraft to a low speed over the sea. The pilot will normally intervene during the Trans-down and engage Groundspeed mode.

B.2.3.4 Cruise-height Mode

In this AFCS mode, the pilot can automatically acquire and hold a radio altitude between 100 and 2,500 feet by selecting the desired cruise-height on a rotary knob on the Coupler control panel. This mode can only be engaged when both the cyclic and collective channels of the coupler are selected. It is designed for altitude hold when the aircraft is in cruising flight over the sea. Fly-up protection operates as per Hover-height mode.

B.2.3.5 Trans-down Mode

This AFCS mode enables the helicopter to transition from level cruising flight down to an automatic hover at a height between 40 and 300 feet as selected on the rotary knob on the coupler control panel. The transition can be carried out

with or without coupling to the aircraft navigation modes. Trans-down is designed for use over the sea. Flight over land during a transdown is likely to cause the procedure to fail.

B.2.3.6 Trans-down with Navigation (Guided Trans-down).

In this mode the pilot enters a mark point into the navigation system either by overflying the point and fixing it into the Nadir navigation computer as the helicopter passes directly overhead, or the mark point can be entered by using a joystick controlled cursor point on the radar screen.

The Nadir computer calculates a pattern and automatically flies the helicopter around the pattern to bring it into an automatic hover at the selected radio height (between 40 and 300 feet) heading into wind, at a distance of approximately 100 metres short of the target mark point. At the end of the transition down to the hover, the AFCS will be in Hover-height mode using the collective axis and roll axis of the Coupler.

This procedure is the standard Air Corps procedure for achieving an automatic hover in the Dauphin helicopter, and is typically used in achieving a hover in Instrument Meteorological Conditions (IMC) or at night. It is fully described in the AFM at section 9.22, para 4.4.5 and in the OM at Section 1.4.

The OM states that "Trans-down with Nav utilises the AFCS and Flight Management System to its full potential. It is normally used when sufficient manoeuvring room is available, to allow a full circuit to Trans-down to be flown, clear of obstructions". Trans-down with Nav is trained for routinely and would be regarded as the preferred method of bringing the Dauphin to an automatic hover at the lowest possible height over the water, minimum 40 feet.

Note:in this mode the system will not accept anything other than an *into-wind* let-down and transition to the hover. Normal practice is for the pilot to interrupt the Trans-down and engage Groundspeed mode to transition to low speed flight over the sea before acquiring Hover-height.

B.2.3.7 Trans-down Without Navigation (Unguided Trans-down)

In this mode the AFCS Coupler controls an automatic transition from cruising flight down to the hover, but in this mode without any input from the Nadir navigation computer. The pilot sets up the helicopter on the heading he wishes to maintain during the Trans-down. When he selects Trans-down on the AFCS Coupler control panel, the aircraft immediately commences a descent to the pre-selected hover height while maintaining the same heading as at the moment of mode selection. To Trans-down in a downwind situation, only an unguided Trans-down can be used. Low speed Dauphin handling is significantly more difficult in downwind situations. Even at low aircraft weights, handling while transitioning to the hover and in the hover, is difficult with high nose pitch-up attitude necessitating high power settings, along with a tendency to fish-tail and drift. This imposes a significantly higher pilot workload than would be experienced in an into wind situation.

The OM states that "Trans-down without Nav is normally utilised when obstructions in the rescue area prevent an automatic pre-Trans-down circuit being flown with Nav. This will arise when the rescue point is close to land and where the wind direction will result in automatic Trans-down with Nav being flown over land". The OM also states (Section 1.4. para 12.c.) that "in cases where the approach distance is drastically reduced, i.e. proximity to shore and on-shore winds, the aircraft should be descended to its lowest safe cruise height and the airspeed reduced to 60 kts to minimise the Trans-down distance required".

B.2.3.8 Trans-up Mode

In this mode the AFCS facilitates an automatic transition up to a cruising altitude from hover flight. The helicopter climbs at an indicated airspeed of 75 kts and it levels off and holds a cruise height between 100 and 2,500 feet as selected on the rotary knob on the Coupler control panel.

Note: All of the above SAR modes were designed and optimised for use over the sea. These modes employ the radio altimeter input for height measurement. Radio altimeter "spiking", i.e. rapidly changing indications due to topography beneath the aircraft, is far less likely over sea than over land.

B.2.3.9 Fly-up mode

This is an automatic safety mode which is active when the following three conditions are met:

a Collective channel is coupled

b Coupler mode Hover Height or Cruise Height is active

c The radio altitude is less than either of the bugged heights selected on the pilot's and co-pilot's radio altimeter indicators

If the three conditions are met then Fly-Up is automatically engaged resulting in:

a The radio altimeter DH light illuminating

b An aural warning tone sounds in the crew headsets

c The Fly-Up lights illuminate on the instrument panel

d A Fly-Up command signal is sent to move the collective pitch control to full high pitch.

Fly-Up mode can only be disabled by manually counteracting the collective lever loads. Failure to counteract the collective lever loads will result in the aircraft being overtorqued.

Note that below the minimum hover-height of 40 feet, there is no automatic height acquire or hold facility with the Dauphin Coupler, i.e. below 40 feet manual intervention by the pilot(s) is required and therefore there is no automatic fly-up protection.

B.2.3.10 Go-around Procedure

During or at the conclusion of certain procedures such as an ILS approach or Trans-down, the pilots may elect to carry out a go-around procedure, also known as an overshoot. The purpose of the go-around is to terminate the particular procedure, such as a Trans-down, and to re-establish stabilised flight at a safe height and on a safe course.

The normal manual go-around procedure is that the handling pilot uncouples the automatic systems, applies power and initiates a positive rate of climb, simultaneously selecting a 5º nose down attitude. The non-handling pilot confirms the rate of climb and monitors the instruments. As the aircraft climbs through a pre-briefed height, it is normal for the non-handling pilot to set his Radio Altimeter bug to this height to provide a degree of protection against an inadvertent descent. Once the aircraft is stabilised and coupled at a safe height and course, the handling pilot then normally sets his bug to this height. If the procedure being terminated requires the rear sliding doors to be open, then the rear crew close up during the go-around. Manual go-around is a frequently practised manoeuvre, following into-wind Trans-down procedures. Therefore pilots are very familiar with go-arounds into wind, but are much less so with downwind go-arounds.

Two modes of automatic go-around are available on the aircraft. The first, known as Trans-up is described above at para **B.2.3.8**, and is used in conjunction with the Coupler SAR modes. The second, called emergency go-around mode in the AFM, is controlled by a button on the collective pitch lever and used to terminate an instrument approach, such as an ILS.

B.3 Radar System

The AS365Fi is equipped with a Bendix 1500 Radar which incorporates both weather and search modes. Radar data is displayed to the crew on the large central EFIS screen, item 27 in **Annex P**, and it can also be displayed on the smaller Electronic Horizontal Situation Indicator (EHSI) screens, item 24 in **Annex P**, in front of each pilot. A different range may be selected on the larger central screen from the range selected on the two smaller screens if the pilots require this. The radar on the Dauphin is a 120º forward-looking system with a nose-mounted antenna. There are two weather modes of operation, called weather and weather-alert, and three search (SRCH) modes. The search modes are used to identify targets on the surface and also for coastal mapping. The system is not designed or suited to mapping of terrain features over land.

SRCH 1 mode is used on short ranges 0.5, 1, 2, 5 and 10 nautical miles (nm) and selects a 0.1 microsecond pulse-width and a pulse repetition frequency (PRF) of 800 Hz. It incorporates a Fast Time Constant (FTC) which allows a degree of sea

clutter rejection. Above 10 nm range the pulse width is 2.35 microseconds with a PRF of 200 Hz. SRCH 2 is similar to SRCH 1 but has no FTC feature. SRCH 3 uses a 2.35 microsecond pulse with a PRF of 200 Hz at all ranges. A search gain potentiometer allows the pilot to control the gain of the system in the three SRCH modes. The other control is antenna tilt which allows the radar antenna to be tilted through $\pm$ 15º. The shortest range available on the radar is 0.5 nm with a range spacing of 0.1 nm. There is a facility whereby two different ranges can be simultaneously selected on different screens should the crew require this. Should one of these ranges be greater than 10 nm and the other be 10 nm or less, then the update rate of the radar picture is halved on each screen.

The P2 is the Dauphin radar operator using the larger central screen. The P1 will normally set his EHSI set up in Sector mode with radar overlay, if he wishes to see radar data.

There are two control panels associated with the radar, the Radar Control Panel (RCP) and the Joystick/Checklist Control Panel.

The RCP is used to select weather (Wx) or search modes, to control the radar range on the central screen, to overlay navigation data, to adjust the gain and to tilt the antenna up or down.

The joystick control panel allows the crew to move a cursor around the radar screen and then to fix it over a target of interest, e.g. a vessel or a headland. This target position can then be transmitted to the Nadir navigation computer and stored as an auxiliary waypoint.

There has been considerable discussion with Dauphin crews about radar performance. This varies from aircraft to aircraft and it is also dependent on the skill and experience of the operator. The general feeling is that the coastal mapping performance of the radar is good and accurate at ranges greater than 0.5 nm. However, at ranges less than that it becomes difficult to maintain a good picture and that at ranges less than 0.2 nm (300 metres approximately) it is no longer possible to derive useful navigational information from the radar picture.

B.4 Navigation System

The AS365Fi is fitted with a Nadir Mk 2 navigation computer, normally operated by the P2, which provides navigation information to the crew from up to three independent sources. The principal navigation source is Doppler radar. In addition, VOR/DME navigation can be processed through the Nadir. In the event of loss of signal from a navigation source, the system continues to compute the aircraft's position, based on the last known position from the source, and updated by Dead Reckoning (DR), using true airspeed (TAS) and aircraft heading. Normally there is only one navigation source available, i.e. Doppler, as VOR/DME is often not available due to the low altitudes at which Dauphins operate.

The aircraft as originally specified and delivered included an Omega navigation system. This system was developed and operated under the sponsorship of the United States Navy. It employed eight Very Low Frequency (VLF) radio

transmitters and gave global coverage. When Omega was operational, the Omega navigation system was also an input to the Nadir computer. However, Omega was withdrawn from use by the US Navy in 1997. In anticipation of its withdrawal, the Air Corps, between 1993 and 1996, had a stand-alone satellite navigation Trimble 2100T Global Positioning System (GPS) receiver installed. This was a stand-alone system i.e. not integrated with any of the other aircraft systems. The unit fitted to DH248 was destroyed in the accident and it was not possible to recover any navigation data from its memory. The specified accuracy of the GPS system is 100 metres, with 95% confidence i.e. the user can be confident that 95% of the time the position displayed on the GPS is within a 100 metre radius of his actual position.

Crews use present position data from the GPS to manually update the Nadir present position. Normally this is done every 15 minutes or more frequently if the Doppler position is found to have a significant error by comparison with known land features or the reported GPS position. The procedure is to synchronise both systems with a simultaneous keystroke and then enter the GPS reported position into the Nadir using a keypad. It is also done at the entry point into an SAR scenario.

The Nadir provides navigation data to the crew through its own Control and Display Unit (CDU) and through the five Electronic Flight Information System (EFIS) screens. It is also interfaced with the AFCS to provide the navigational data for all the flight control functions available with that system.

Control and data entry of the Nadir navigation computer is carried out by the crew through the console-mounted CDU using alphanumeric and fixed label keys. Among the control functions available for aircraft navigation are:

- entry of navigation parameters (waypoints, initial position, etc)
- nav mode selection (Doppler, VOR/DME)
- nav type selection (FROM-TO, Direct-to, etc)
- search pattern selection

It provides display functions including:

- navigation parameters (present position, groundspeed, heading, wind, etc)
- waypoint and route characteristics
- search pattern characteristics
- VOR/DME station data
- manual resetting of Doppler position

In calm sea conditions or over certain very flat types of terrain, the Doppler may go into memory mode because of degraded signal returns. The Doppler control

panel incorporates a land/calm sea/rough sea selection depending on the terrain or sea-state being overflown.

A Hover lock selector is provided which momentarily inhibits the "calm sea" selection if the Doppler goes into Memory mode, and this allows the radar to lock onto the sea surface which is being agitated by the rotor downwash. This selection must be immediately disengaged as soon as the system comes out of Memory mode and it is not effective in Cruiseheight or high Hover-height modes.

In memory mode, performance of functions such as autohover can be significantly degraded. During a reconstruction flight flown in similar wind conditions to those on the night of the accident, it was found that the Doppler went into memory mode on two separate downwind Trans-down approaches towards Tramore beach along what is believed to have been the track followed by DH248. On each occasion it was necessary for the handling pilot to initiate the manual go-around procedure due to the degradation of Doppler returns and consequent degradation of Coupler performance.

B.4.1 Waypoint Management

The Nadir navigation computer can maintain up to 140 waypoints (i.e. designated navigation fixed or moving positions on the earth's surface)

- 50 VOR/DME stations
- 50 characteristic waypoints, e.g. useful fixed positions such as headlands, road junctions, landing sites, etc.
- 20 auxiliary waypoints which can be defined on a particular flight using geographic co-ordinates (latitude/longitude) or with respect to another fixed waypoint, or relative to a designated position
- 20 moving waypoints which are additionally defined by their velocity vector.

There is a facility by which an auxiliary waypoint can be designated in the Nadir from the weather radar joystick. The joystick is used to overlay a cursor on a particular target shown on the radar screen e.g. a headland or vessel. By means of a keyboard procedure the target latitude and longitude can be entered into the Nadir navigation databank as an auxiliary waypoint. This procedure is frequently used in the Trans-down with Nav procedure described in **B.2.3.6**.

The primary navigation sensor is the Doppler radar. This equipment is essential to provide the required navigational data for correct operation of all the SAR modes of the AFCS such as Trans-down and automatic hover. The Doppler radar uses Doppler frequency shift techniques to compute the longitudinal and transverse groundspeed components of the aircraft, and by integrating the groundspeed vector it computes the present position at all times (given an initial position before the aircraft starts moving). Indicative Doppler accuracy figures are published, to hovermeters, 2% or 0.4 kts, and to Autopilot, 5% Vx or 0.4 kts and 5% Vy or 0.4 kts.

The Doppler position can be updated at any time by the crew. This would normally be done:

a every 15 minutes by manually inputting the GPS position (more frequently if necessary)

b by overflying a known point and updating latitude and longitude through a keyboard procedure.

c by Joysticking a known point, followed by a keypad procedure.

B.5 Electronic Flight Instrumentation System (EFIS)

Attached at **Annex P** is a schematic of the Instrument Panel layout.

The primary flight instrument displays for the crew consist of a Bendix EFIS 10 system including four cathode ray tube display units, mounted in vertical pairs in front of each pilot. The upper display unit in each case is normally used as an Electronic Attitude Director Indicator (EADI), item 19 in **Annex P**, providing artificial horizon information required to fly the aircraft. The lower displays known as Electronic Horizontal Situation Indicators (EHSI), item 24, can be used in a number of different modes depending on pilot selection including

- horizontal situation indicator (HSI) which is effectively a compass display used to navigate the aircraft
- sector mode which is a sector of the HSI forward of the aircraft
- sector plus radar mode on which a radar display can be overlaid on the sector mode
- hovermeter mode which displays all the data needed for hover including aircraft groundspeed Vx and Vy bars, ground speed tendency circle (the magenta circle) as controlled by the crew, radio altitude, heading, wind velocity, target position and selected hover height. If a target had been designated using the radar joystick, then this target would be displayed relative to the helicopter position. If hovermeter is engaged on the EFIS whilst V/L mode is selected on the Display Control Panel (DCP) then a "Check Nav" warning is displayed because these two selections are incompatible.

The four EFIS screens are controlled from the DCP located in the console between the pilots. There are twelve momentary-contact push buttons, six for each pilot, to enable the different modes to be selected. There are also two rotary knobs, one for each pilot, which enable the pilot to select his desired navigation source for display on his respective EHSI. These include RNAV position when the required displays come from the Nadir Computer, e.g. in Doppler navigation modes such as Trans-down, hover height, etc. Another selection is VL1 and VL2

which is used to display VOR (VHF Omni-range) and ILS data on the screens. Switching between these modes causes a momentary loss of navigational data on the screens while the system resets itself.

There is also a larger Display Unit, item 27 in **Annex P**, mounted in the centre of the Instrument Panel which is used to display radar information. Navigation data can be overlaid on the radar modes including waypoints and routes.

B.6 Radio Altimeter System.

The AS365Fi is fitted with two radio altimeter transceivers, either one of which can be active at any time dependent on pilot selection. The radio altitude of the aircraft is displayed on two radio altimeter instruments, one in front of each pilot. These instruments provide an accurate display of the altitude of the aircraft from ground level up to 2500 feet. In addition a digital display of radio altitude is provided on the EADI screen in front of each pilot. A DH Index or bug is incorporated on the two radio altimeter instruments. This index would be set by the pilots at a safety height below the height required to be flown at by the crew.

For example, a crew wishing to hover at 100 feet might set the index at 80 feet. If the aircraft passes through the safety height for any reason then the crew would get an aural warning in their headsets and a red warning light on the instrument. If the aircraft was four-axis coupled and in one of the particular SAR modes such as Cruise Height or Hover Height then the Fly Up mode would be automatically activated (see **Appendix B.2.3.9**).

B.7 Hydraulic Systems

The AS 365 Fi has four separate hydraulic systems, two primary systems which supply the flying control servo-units, an auxiliary hydraulic system powering the landing gear extension and retraction and the wheel brakes, and an emergency hydraulic system which permits emergency extension of the landing gear in the event of auxiliary hydraulic system failure.

B.7.1 Hydraulic System Alarm Activations

There are several hydraulic system malfunctions which can cause red alarm lights to illuminate on the Caution Advisory Panel (CAP) and will illuminate the master Alarm light. These are a pressure drop below 10 Bars in either of the primary hydraulic systems, overpressure in the auxiliary hydraulic system or a fluid level below 2 litres in the right hand primary system reservoir.

Appendix C

TERMINAL AREA FORECASTS FOR POTENTIAL ALTERNATES 01/02 JULY 1999

EIDW (Dublin Airport)

01/1500 Z 011601 120/06 KT 9999 SCT010 BKN015 TEMPO 1619 -DZ BKN010 BECMG 1921 5000 -RADZ SCT005 BKN010 TEMPO 2101 3000 BKN004=

01/1800 Z 011904 120/07 KT 6000 -RADZ SCT005 BKN008 OVC012 BECMG 1922 150/06 KT TEMPO 1904 3000 SCT003 BKN005=

01/2100 Z 012207 150/06 KT 7000 SCT005 BKN008 OVC012 TEMPO 2207 3000 -RADZ SCT003 BKN005=

EIME (Baldonnel)

01/1500 Z 011601 110/05 KT 9999 SCT010 BKN015 TEMPO 1619 5000 -DZ BKN010 BECMG 1921 5000 -RADZ SCT005 BKN010 TEMPO 2101 3000 BKN004

01/1800 Z 011904 130/06 KT 8000 SCT010 BKN015 OVC020 TEMPO 1904 4000 -RADZ BKN006 OVC010 BECMG 1921 170/06 KT

01/2100 Z 012207 180/07 KT 8000 SCT008 BKN010 OVC015 TEMPO 2207 4000 -RADZ SCT003 BKN006 OVC010

EICK (Cork)

01/1705 Z 011701 170/08 KT 0800 FG -DZ BKN001 OVC002 TEMPO 1801 0200 OVC001 BECMG 2022 200/10 KT=

01/1800 Z 011904 200/10 KT 0200 FG OVC001=

01/2100 Z 012207 200/10 KT 0200 FG VV001=

EINN (Shannon)

01/1500 Z 011601 VRB03 KT 9999 -RA SCT010 BKN015 TEMPO 1601 5000 RA SCT005 BKN010 TEMPO 2001 3000 DZ SCT003 OVC005=

01/1800 Z 011904 170/06 KT 6000 BR SCT008 BKN012 OVC020 TEMPO 1904 3000 DZ BKN005 OVC008=

01/2100 Z 012207 180/07 KT 8000 SCT008 BKN015 OVC020 TEMPO 2207 4000 -DZ BKN006 OVC010=

METARS FOR 01/02 JULY 1999

EIDW (Dublin Airport)

01/2000 Z 120/07 KT 5000 -RA BKN003 OVC008 13/13 Q1013

01/2100 Z 130/06 KT 7000 -RA SCT004 OVC015 13/12 1013 MSL=

01/2200 Z 130/05 KT 4000 -DZ BKN002 BKN006 OVC020 13/13 1012 MSL=

01/2300 Z 130/04 KT 4000 -DZ BKN002 BKN010 OVC020 13/13 1012 MSL=

02/0000 Z 110/03 KT 4000 -DZ BKN002 OVC006 13/13 1012 MSL=

EIME (Baldonnel)

01/2000 Z 070/03 KT 2500 -RADZ SCT003 BKN012 OVC020 14/14

01/2100 Z 080/03 KT 2000 -RA SCT003 BKN014 OVC040 14/14 1012 MSL=

01/2200 Z 090/04 KT 3000 -RA SCT004 OVC014 15/14 1012 MSL=

01/2300 Z 030/03 KT 4000 SCT010 BKN015 OVC023 15/15 1012 MSL RERA=

02/0000 Z 240/05 KT 9999 -RA FEW010 SCT015 BKN022 16/15 1012 MSL=

EICK (Cork)

01/2000 Z 200/06 KT 0200 FG VV001 15/15 Q1013

01/2100 Z 210/08 KT 0200 FG VV001 15/15 1013 MSL=

01/2200 Z 200/07 KT 0300 FG VV001 15/15 1013 MSL=

01/2300 Z 190/06 KT 0400 FG VV001 15/15 1013 MSL=

02/0000 Z 170/04 KT 0300 -RADZ VV001 14/14 1013 MSL=

EINN (Shannon)

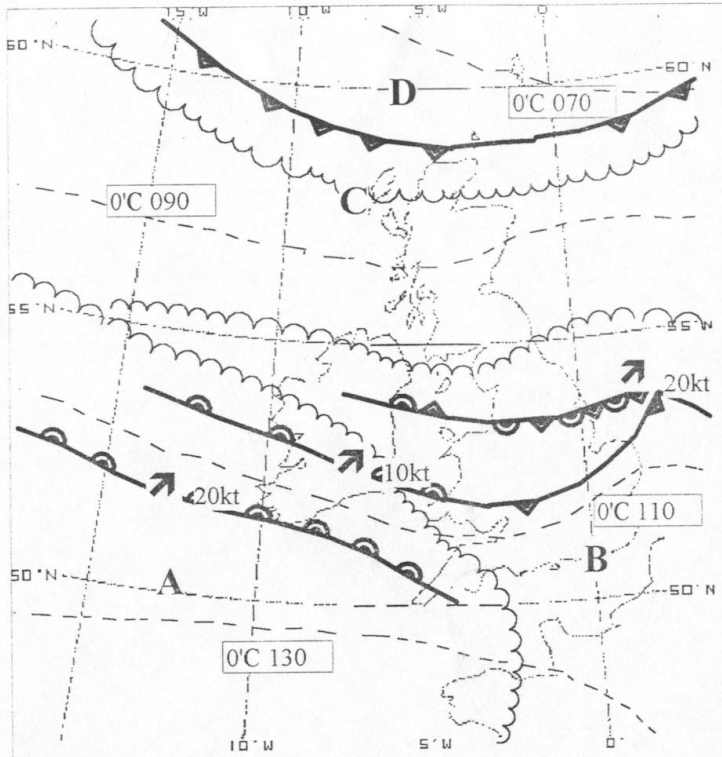
01/2000 Z 210/05 KT 9999 SCT013 BKN016 BKN022 17/17 Q1011

01/2100 Z 180/04 KT 9999 FEW009 OVC016 17/16 1011 MSL=

01/2200 Z 170/04 KT 9999 FEW009 SCT016 BKN023 17/16 1011 MSL=

01/2300 Z 160/07 KT 9999 FEW013 BKN045 17/15 1011 MSL=

02/0000 Z 150/05 KT 9999 FEW013 BKN045 16/15 1011 MSL=



Area	Visibility	Weather	Cloud, Icing, Turbulence
A loc	1500-6km 0300	-radz/ra fg	bkn/ovc lyrs 003-008/xxx bkn/ovc st 001 isol embd cb 015/xxx mod ocnl sev ice 110/xxx
B loc	5-10km 0300	br/-radz fg esp in marcot	bkn/ovc lyrs 005-015/080-180 bkn st 001-003 ocnl mod ice 110/180
C loc	10+km 5-8km	-shra shra	sct/bkn 020-030 /060-090 ocnl bkn stcb 010/150
D ocnl	10+km 5km	-ra/-shra shra	bkn/ovc lyrs 010-020/150/xxx bkn st cb 007/150 ocnl mod ice 080/150-190

REMARKS

Sea Surface Temps Irish Coastal Waters
13/14c

MET éireann

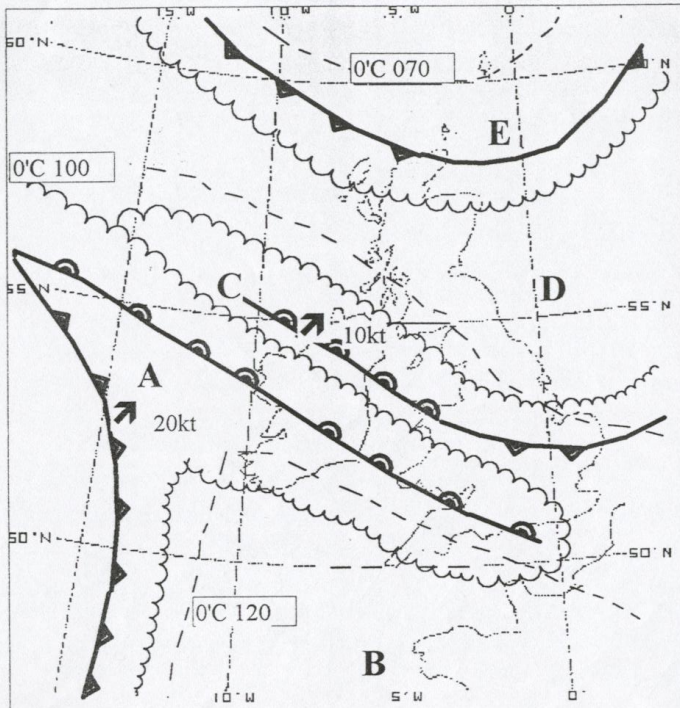
Central Aviation Office
Shannon
Significant Weather Chart
Below FL200
Valid for 1800 UTC 01/07/1999

Issued At 1100 UTC 01/07/1999

Notes:

1. **Pressure -hPa**
2. **Speed -KNOTS**
3. **Vis:-Metres up to 5000M, KM above 5000M**
4. **Heights in hundreds of feet AMSL, below 5000ft; Flight Levels above 5000 feet**
5. **TS and CB imply MOD/SEV TURB and ICING**
6. **ALL TIMES UTC**

Shannon May 1999



Area	Visibility	Weather	Cloud, Icing, Turbulence
A ocnl	1500m-6km 0300m	-radz/ra fg	bkn/ovc lyrs 003-010/xxx bkn/ovc st 001-003 isol embd cb 015/xxx mod ocnl sev ice 110/xxx
B loc	3000m-8km 0300m	br/-dz fg	sct/bkn st 003-010/050-090 bkn/ovc st 001-003
C loc	5-9km 0300m	-radz fg esp in marcot	bkn/ovc lyrs 005-010/080-150 bkn st 001-003 loc mod ice 110/150
D loc	10+km 5-8km	-shra/br	sct/bkn 020-030/050-090 bkn st 007-010
E ocnl	10+km 5-8km	-shra shra	bkn/ovc lyrs 010-020/150-xxx bkn st cb 007/015 ocnl mod ice 080/150-190

REMARKS

Sea Surface Temps Irish Coastal Waters
13-14c

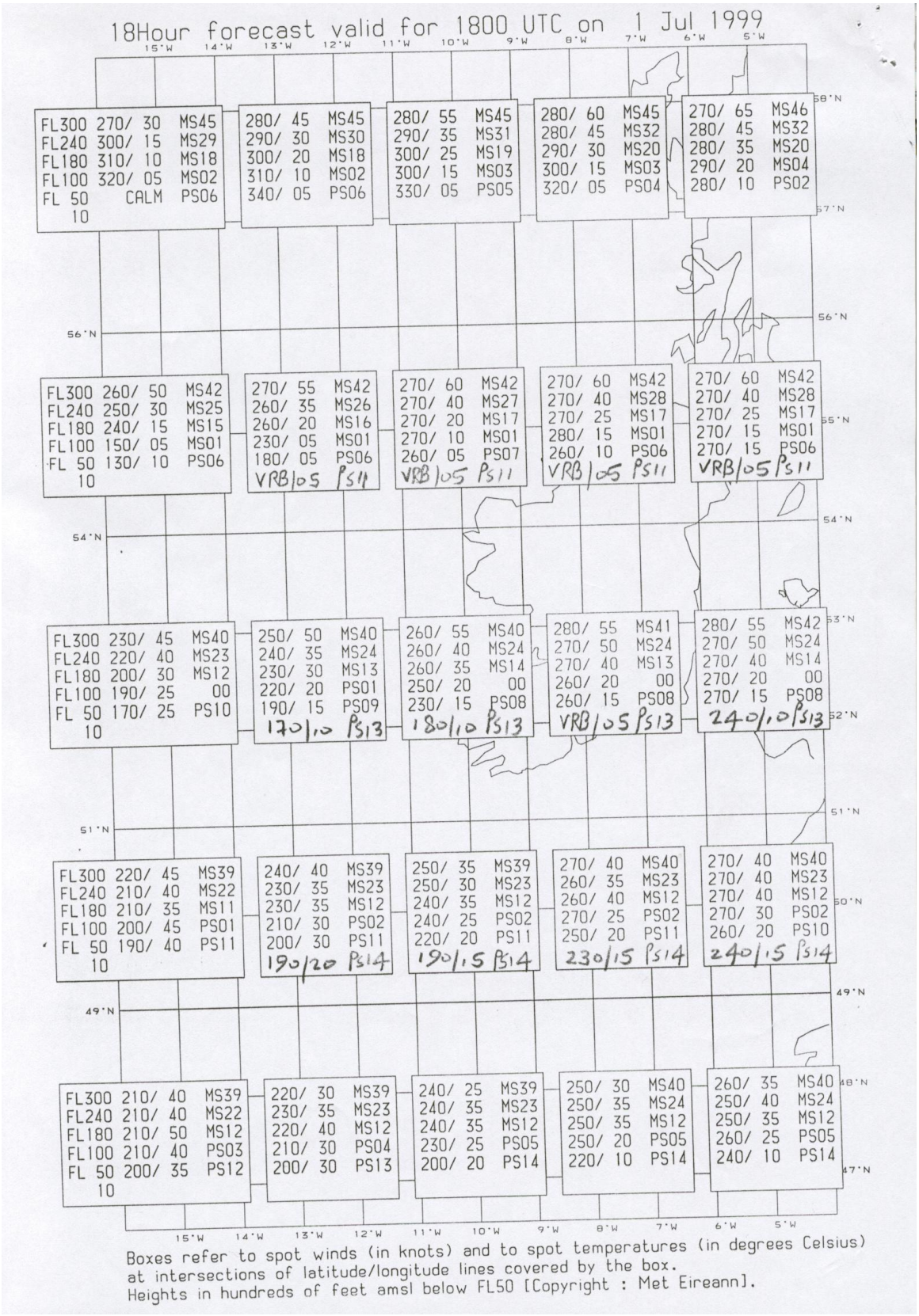
MET éireann

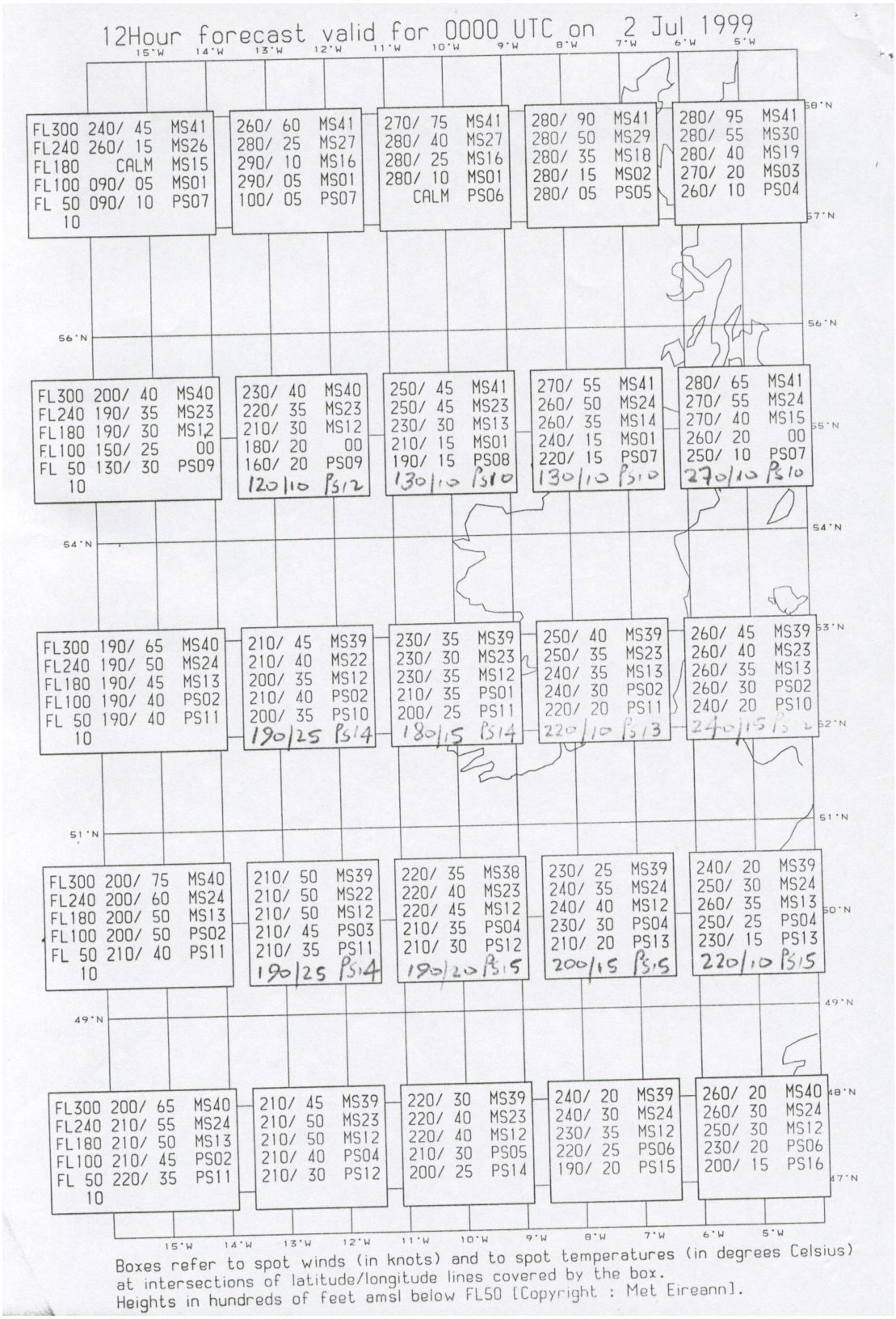
Central Aviation Office
Shannon
Significant Weather Chart
Below FL200
Valid for 0000 UTC 02/07/1999

Issued At 1700 UTC 01/07/1999

Notes:
1. Pressure -hPa
2. Speed -KNOTS
3. Vis:-Metres up to 5000M, KM above 5000M
4. Heights in hundreds of feet AMSL, below 5000ft; Flight Levels above 5000 feet
5. TS and CB imply MOD/SEV TURB and ICING
6. ALL TIMES UTC

Shannon May 1999


18Hour forecast valid for 1800 UTC on 1 Jul 1999
15°W 14°W 13°W 12°W 11°W 10°W 9°W 8°W 7°W 6°W 5°W
58°N
57°N
56°N
55°N
54°N
53°N
52°N
51°N
50°N
49°N
48°N
47°N
FL300 270/ 30 MS45
FL240 300/ 15 MS29
FL180 310/ 10 MS18
FL100 320/ 05 MS02
FL 50 CALM PS06
10
280/ 45 MS45
290/ 30 MS30
300/ 20 MS18
310/ 10 MS02
340/ 05 PS06
280/ 55 MS45
290/ 35 MS31
300/ 25 MS19
300/ 15 MS03
330/ 05 PS05
280/ 60 MS45
280/ 45 MS32
290/ 30 MS20
300/ 15 MS03
320/ 05 PS04
270/ 65 MS46
280/ 45 MS32
280/ 35 MS20
290/ 20 MS04
280/ 10 PS02
FL300 260/ 50 MS42
FL240 250/ 30 MS25
FL180 240/ 15 MS15
FL100 150/ 05 MS01
FL 50 130/ 10 PS06
10
270/ 55 MS42
260/ 35 MS26
260/ 20 MS16
230/ 05 MS01
180/ 05 PS06
VRB/05 PS11
270/ 60 MS42
270/ 40 MS27
270/ 20 MS17
270/ 10 MS01
260/ 05 PS07
VRB/05 PS11
270/ 60 MS42
270/ 40 MS28
270/ 25 MS17
280/ 15 MS01
260/ 10 PS06
VRB/05 PS11
270/ 60 MS42
270/ 40 MS28
270/ 25 MS17
270/ 15 MS01
270/ 15 PS06
VRB/05 PS11
FL300 230/ 45 MS40
FL240 220/ 40 MS23
FL180 200/ 30 MS12
FL100 190/ 25 00
FL 50 170/ 25 PS10
10
250/ 50 MS40
240/ 35 MS24
230/ 30 MS13
220/ 20 PS01
190/ 15 PS09
170/10 PS13
260/ 55 MS40
260/ 40 MS24
260/ 35 MS14
250/ 20 00
230/ 15 PS08
180/10 PS13
280/ 55 MS41
270/ 50 MS24
270/ 40 MS13
260/ 20 00
260/ 15 PS08
VRB/05 PS13
280/ 55 MS42
270/ 50 MS24
270/ 40 MS14
270/ 20 00
270/ 15 PS08
240/10 PS13
FL300 220/ 45 MS39
FL240 210/ 40 MS22
FL180 210/ 35 MS11
FL100 200/ 45 PS01
FL 50 190/ 40 PS11
10
240/ 40 MS39
230/ 35 MS23
230/ 35 MS12
210/ 30 PS02
200/ 30 PS11
190/20 PS14
250/ 35 MS39
250/ 30 MS23
240/ 35 MS12
240/ 25 PS02
220/ 20 PS11
190/15 PS14
270/ 40 MS40
260/ 35 MS23
260/ 40 MS12
270/ 25 PS02
250/ 20 PS11
230/15 PS14
270/ 40 MS40
270/ 40 MS23
270/ 40 MS12
270/ 30 PS02
260/ 20 PS10
240/15 PS14
FL300 210/ 40 MS39
FL240 210/ 40 MS22
FL180 210/ 50 MS12
FL100 210/ 40 PS03
FL 50 200/ 35 PS12
10
220/ 30 MS39
230/ 35 MS23
220/ 40 MS12
210/ 30 PS04
200/ 30 PS13
240/ 25 MS39
240/ 35 MS23
240/ 35 MS12
230/ 25 PS05
200/ 20 PS14
250/ 30 MS40
250/ 35 MS24
250/ 35 MS12
250/ 20 PS05
220/ 10 PS14
260/ 35 MS40
250/ 40 MS24
250/ 35 MS12
260/ 25 PS05
240/ 10 PS14
Boxes refer to spot winds (in knots) and to spot temperatures (in degrees Celsius)
at intersections of latitude/longitude lines covered by the box.
Heights in hundreds of feet amsl below FL50 [Copyright : Met Eireann].


12Hour forecast valid for 0000 UTC on 2 Jul 1999
FL300 240/ 45 MS41
FL240 260/ 15 MS26
FL180 CALM MS15
FL100 090/ 05 MS01
FL 50 090/ 10 PS07
10
260/ 60 MS41
280/ 25 MS27
290/ 10 MS16
290/ 05 MS01
100/ 05 PS07
270/ 75 MS41
280/ 40 MS27
280/ 25 MS16
280/ 10 MS01
CALM PS06
280/ 90 MS41
280/ 50 MS29
280/ 35 MS18
280/ 15 MS02
280/ 05 PS05
280/ 95 MS41
280/ 55 MS30
280/ 40 MS19
270/ 20 MS03
260/ 10 PS04
FL300 200/ 40 MS40
FL240 190/ 35 MS23
FL180 190/ 30 MS12
FL100 150/ 25 00
FL 50 130/ 30 PS09
10
230/ 40 MS40
220/ 35 MS23
210/ 30 MS12
180/ 20 00
160/ 20 PS09
120/10 PS12
250/ 45 MS41
250/ 45 MS23
230/ 30 MS13
210/ 15 MS01
190/ 15 PS08
130/10 PS10
270/ 55 MS41
260/ 50 MS24
260/ 35 MS14
240/ 15 MS01
220/ 15 PS07
130/10 PS10
280/ 65 MS41
270/ 55 MS24
270/ 40 MS15
260/ 20 00
250/ 10 PS07
270/10 PS10
FL300 190/ 65 MS40
FL240 190/ 50 MS24
FL180 190/ 45 MS13
FL100 190/ 40 PS02
FL 50 190/ 40 PS11
10
210/ 45 MS39
210/ 40 MS22
200/ 35 MS12
210/ 40 PS02
200/ 35 PS10
190/25 PS14
230/ 35 MS39
230/ 30 MS23
230/ 35 MS12
210/ 35 PS01
200/ 25 PS11
180/15 PS14
250/ 40 MS39
250/ 35 MS23
240/ 35 MS13
240/ 30 PS02
220/ 20 PS11
220/10 PS13
260/ 45 MS39
260/ 40 MS23
260/ 35 MS13
260/ 30 PS02
240/ 20 PS10
240/15 PS12
FL300 200/ 75 MS40
FL240 200/ 60 MS24
FL180 200/ 50 MS13
FL100 200/ 50 PS02
FL 50 210/ 40 PS11
10
210/ 50 MS39
210/ 50 MS22
210/ 50 MS12
210/ 45 PS03
210/ 35 PS11
190/25 PS14
220/ 35 MS38
220/ 40 MS23
220/ 45 MS12
210/ 35 PS04
210/ 30 PS12
190/20 PS15
230/ 25 MS39
240/ 35 MS24
240/ 40 MS12
230/ 30 PS04
210/ 20 PS13
200/15 PS15
240/ 20 MS39
250/ 30 MS24
260/ 35 MS13
250/ 25 PS04
230/ 15 PS13
220/10 PS15
FL300 200/ 65 MS40
FL240 210/ 55 MS24
FL180 210/ 50 MS13
FL100 210/ 45 PS02
FL 50 220/ 35 PS11
10
210/ 45 MS39
210/ 50 MS23
210/ 50 MS12
210/ 40 PS04
210/ 30 PS12
220/ 30 MS39
220/ 40 MS23
220/ 40 MS12
210/ 30 PS05
200/ 25 PS14
240/ 20 MS39
240/ 30 MS24
230/ 35 MS12
220/ 25 PS06
190/ 20 PS15
260/ 20 MS40
260/ 30 MS24
250/ 30 MS12
230/ 20 PS06
200/ 15 PS16
58°N
57°N
56°N
55°N
54°N
53°N
52°N
51°N
50°N
49°N
48°N
47°N
15°W
14°W
13°W
12°W
11°W
10°W
9°W
8°W
7°W
6°W
5°W
Boxes refer to spot winds (in knots) and to spot temperatures (in degrees Celsius)
at intersections of latitude/longitude lines covered by the box.
Heights in hundreds of feet amsl below FL50 [Copyright : Met Eireann].

ANNEXES
A to P

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ANNEX A
Templemore
Freshford
Urlingford
THURLES
KILKENNY
Tullow
Muine Bheag
(Bagenalstown)
Bunclody
Borris
Kiltealy
Killenaule
Callan
R. Nore
Thomastown
Graiguenamanagh
R. Suir
R. Slaney
R. Barrow
R. Bann
Cashel
Mullinahone
ENNISCORTHY
Fethard
Caher
CARRICK-ON-SUIR
Mullinavat
NEW ROSS
CLONMEL
COMERAGH MTS.
MONAVULLAGH MTS.
Clogheen
Wellington Bridge
Bridgetown
WATERFORD
AIRPORT
Kilmacthomas
Fethard
Baginbun Head
BALLYTEIGE BAY
Kilmore Quay
Tramore
Dunmore East
Cappoquin
Lismore
Tallow
Dunabrattin Head
TRAMORE BAY
WATERFORD HARBR
Hook Head
Saltee Islands
DUNGARVAN
Ballyvoyle Head
DUNGARVAN HARB
Helvick Head
52°
YOUGHAL
Ardmore Head
YOUGHAL BAY
Knockadoon Head
Capel Island
BALLYCOTTON BAY
SCALE 1:500000
E
A
N

Annex A

Initial Phone Call MRCC - SAR Waterford.

Det Cmd denotes the Detachment Commander.

Time UTC	Station	Transcript
21:02:20	Det Cmd	SAR Waterford (on answering the phone).
	MRCC	Hello there. MRCC Dublin here. We have a job for your shiny new Dauphin.
	Det Cmd	Very good. I had a feeling you'd call us out on our first night.
	MRCC	There you go. That's the size of it yeah. The information we have is this fellow is on a mobile phone actually, he doesn't have VHF at all. Down off Dungarvan area and he's lost. He says he's in .. He's in bad vis is he (to colleague) (no vis, nothing at all) Yeah apparently, there's very very bad visibility. We're calling out the Helvick Inshore Lifeboat.
	Det Cmd	Right.
	MRCC	But it doesn't, it won't have radar. Its only an Inshore Lifeboat.
	Det Cmd	OK.
	MRCC	So he's off the Black Rock near Dungarvan. I don't think we know much more about it to be quite honest.
	Det Cmd	Black Rock. OK em we'll head out to the Airport so and we'll get started up.
	MRCC	That'd be grand yeah, you can give us a call.
	Det Cmd	You can give us more info on Rosslare Radio.
	MRCC	Yeah, the Helvick Lifeboat will be on his way out anyway by then.
	Det Cmd	Have you any information on the size of the vessel or anything like that?
	MRCC	Do we have anything on the size of the boat (to colleague) Its a boat called the ... fifteen foot yellow ... is it inflatable? (to colleague), it has an outboard motor of some sort. I'll tell you what, the best thing to do is if you go into Waterford and give us a buzz from there we should have more information at that stage.
	Det Cmd	No problem.
21:03:40	MRCC	Bye.

Conversation between Detachment Commander (Det Cmd) and MRCC on Detachment Commander's mobile phone while en-route from accommodation to Waterford Airport by mini-bus.

1. Det Cmd denotes the Detachment Commander.

2. (Int) denotes internal communications in MRCC Control Room

Time UTC	Station	Transcript
21.08.40	MRCC (Int)	We'll cancel the helicopter, will we? Will you be able to phone them, phone the Airport? We made communication with them, we can cancel them.
21.09.15	Det Cmd	SAR Waterford (on answering the phone)
	MRCC	Hello SAR Waterford. It's MRCC here in Dublin. Ah you can stand down. We have established comms with this guy, we've talked him into putting on the radio and getting it up, he can read us and we can read him now so you can stand down, we don't require you.
	Det Cmd	OK, he knows where he is, does he?
	MRCC	He doesn't but at least we have comms with him you know.
	Det Cmd	Right.
	MRCC	So I think he's OK, the weather is good and ah the lifeboat's out there or will be out shortly, you know.
	Det Cmd	OK, it's pretty poor weather here now at the moment.
	MRCC	Yeah, it's very bad visibility, ah just a sec, just one moment, just one moment.
	MRCC (Int)	Will I stand him down?
	MRCC (Int)	The helicopter? Well if they want to go for a bit of practice, things like that, we don't mind.
	MRCC (Int)	Are we tasking him or are we not?....(unintelligible)
	MRCC (Int)	Are they at the Airport?
	MRCC	Where are you at the moment by the way?
	Det Cmd	We're on the road out to the Airport.
	MRCC	You're on the road out to the Airport, yeah?
	Det Cmd	Yeah.
	MRCC	Just a second, just one moment.
	MRCC	The lifeboat hasn't launched yet you know ... let them go, let them

	(Int)	go.
	MRCC	Ah OK sure. You might as well go then if you're en-route you know.
	Det Cmd	Yeah.
	MRCC (Int)	To get down there to Dungarvan wouldn't take that long anyway.
	MRCC	It won't take you very long to get down there anyway?
	Det Cmd	No, no
	MRCC	Its just am...
	Det Cmd	fifteen minutes
	MRCC	Yeah, OK then that's fine. You can talk to us on 16 then when you get there.
	Det Cmd	OK
	MRCC	We're just more hopeful now seeing we have comms with him you know.
	Det Cmd	Yeah, well, can't take a chance anyway.
	MRCC	No just the weather is bad or not bad, visibility is bad but...
	Det Cmd	Yeah, yeah
	Det Cmd	OK, talk to you shortly, bye.
	MRCC	OK then

Third Phone Call SAR Waterford to MRCC.

Det Cmd denotes the Detachment Commander.

Time UTC	Station	Transcript
21:29:50	MRCC	Irish Marine Emergency Service (on answering the phone).
	Det Cmd	Good evening, SAR Waterford here. We're just about to launch, just seeing if you've any update on the situation in Dungarvan.
	MRCC	Yeah. The situation is that Helvick Lifeboat is on scene but he cannot find the vessel. Now the em ...
	Det Cmd	You have comms with him yeah?
	MRCC	We have comms with him. We're talking to him on a mobile phone.
	Det Cmd	OK.
	MRCC	He's heading into the weather to try and keep the boat stable because he's got a young child on there who's very seasick.
	Det Cmd	OK.
	MRCC	So if you could head to the area maybe .. you would have a radar that would pick him up would you?
	Det Cmd	We should have ... how big is the vessel?
	MRCC	Its a fifteen foot with a small cabin on it.
	Det Cmd	OK yeah we may get a radar return, its very (unintelligible).
	MRCC	Right. In the meantime we're trying to get Ballycotton we might try and get them on scene as well because they would have a radar.
	Det Cmd	Does he have any flares or anything like that he could launch?
	MRCC	Yeah just hang on a sec ...
21:31:00	MRCC	(Internal) .. that's the helicopter, he's just taking off ... does your man have flares? No he has nothing only the mobile. Now at the moment they can hear a boat but the visibility is so bad ... am ... I'd say get on the way, we can always call you back.
	Det Cmd	Yeah we can launch a flare ourselves anyway if needs be.
	MRCC	Oh right, right.
	Det Cmd	Right, we'll talk to you when you're airborne.
	MRCC	OK thanks for that, bye now.

Transcript from Waterford Tower Frequency 129.85 MHz between 21:35 and 23:45 UTC on the 1st July 1999

Time UTC	Station	Transcript
21.41.38	Tower	Rescue One one ... tower
	DH248	One eleven ... go ahead.
	Tower	Yeah, your QNH is one zero one four, wind is reading at two twenty at eleven knots .... Over.
	DH248	Two twenty at eleven, one zero one four is copied ... One One One.
22.19.45	Tower	Rescue one one, Tower, radio check, Over.
	DH248	Tower, rescue one eleven, is at two miles Southeast of Helvick, the local lifeboat has the casualties under tow. We're going to be lodged in here for about another fifteen minutes.
	Tower	Roger that.
22.41.18	DH248	Er Tower from one eleven.
	DH248	Waterford Tower from rescue one eleven.
	Tower	One eleven, go ahead, strength five.
	DH248	Strength five me also, could I just check any update on the weather, has it improved, or disimproved.
	Tower	Er negative, she's staying the same. From what I can see from here out to the lights. QNH is still one zero one four and the wind is down to about seven knots at two ... two twenty at seven knots. Over.
	DH248	Copied.
22.50.53	Tower	Rescue one one Tower, radio check. Over.
	DH248	Tower, one eleven, reading you strength five, go ahead.
	Tower	Yeah, just to inform you, weather deteriorating slightly here. Just to let you know. Over.
	DH248	Roger, copied that er ... can you see the lights of Tramore at all?
	Tower	Negative, we can just about hardly see the runway which is a distance of 300 metres from the Tower, Over.
	DH248	Roger, copied that, er listening out.
23.00.00	DH248	Tower, one one eleven, we're just inside six miles, check QNH please.
	Tower	Roger that one eleven, reading you strength five, QNH is one zero one four, wind is two ten at eight knots, Over.
	DH248	Two ten at eight knots, one zero one four. We're just six miles this side of the field. We're going to route overhead er out to eight miles and back in for an ILS to two one. Confirm all the lights are on for two one.

	Tower	Roger that. Full lights. Full illumination two one. ILS operational, Over.
23.00.28	DH	Copy. Call you finals.
23.06.17	DH248	And Tower, er one eleven now is just coming up the turn for inbound. Check surface wind please.
	Tower	Roger Tower reading you strength five, wind two twenty at nine. Over.
	DH248	Two two zero at nine. Copied one eleven.
23.12.08	DH248	Tower, one eleven is er two point five miles out.
	Tower	Roger, two point five miles, strength five, wind two twenty at eight, over.
23.14.37	DH248	Tower, one eleven, we overshot that approach, we're going to go around for one more.
	Tower	Roger that, strength five.
	DH248	As a matter of interest er, could you see us at all.
	Tower	No, we had (technician name) out on the ramp just keeping an eye for you er, he couldn't see you actually er visibility is about five hundred metres. Over.
	DH248	Copied.
23.15.19	Tower	Er did you get the runway lights there OK?
	DH248	Negative.
	Tower	Er Roger that, we'll try to assist with a higher beam light maybe from the Tower. I don't know how bright it's going to be, Over.
	DH248	If the lights are up full, that's the best you can do.
23.18.35	DH248	Er Tower, one eleven is just turning on finals again. Check surface wind and QNH please.
	Tower	Roger, one one, QNH still at one zero one four, wind two twenty at eight, Over.
	DH248	Two two zero at eight knots. Copied one one zero.
23.27.24	Tower	Rescue one one, Tower
	DH248	Tower Roger one one, rescue one eleven, we've overshot. We're going to go around for a coastal approach.
	Tower	Roger that. We couldn't see you coming in again but could hear you going away just as I called you. Over.
23.28.15	Tower	One eleven Tower message over.
	DH248	Go ahead
	Tower	Yeah, do you want me to change the approach lights now for zero three, over?

	DH248	Yes please.
	Tower	Roger that ... full beam at zero three, over.
23.33.25	DH248	Er Tower from one eleven, just confirm is the weather improving
	Tower	Negative on the weather improving here. QNH same, wind er two ten at eight, over.
	DH248	That's copied er we're just er in a left er we're descending here now in the bay and we are going to do a coastal approach in to Tramore. We may land in Tramore.
	Tower	Roger that Tower.
23.34.04	Tower	One eleven, message, over.
	DH248	Go ahead.
	Tower	Just for your information, we have been on to Bal Tower and the weather there is fine to get in there if all need be, over.
23.34.13	DH248	Roger, don't have the juice.
23.39.27		Short noise on tape confirmed from DH248 (no voice).

Notes:

1. The runway at Waterford is 21/03.
2. Runway dimensions are 1433 m X 30 m.
3. ILS serves runway 21. (ILS/DME/NDB)
4. NDB/DME serves runway 03.
5. Runway centreline is 300 m from the Tower.
6. Airfield lighting is high intensity elevated runway edge, threshold and stop bar. High intensity approach lighting out to 705 m on RWY 21 and 360 m on RWY 03. High intensity PAPIs on both approaches and white flashing aerodrome beacon.

Communications between MRCC and DH248

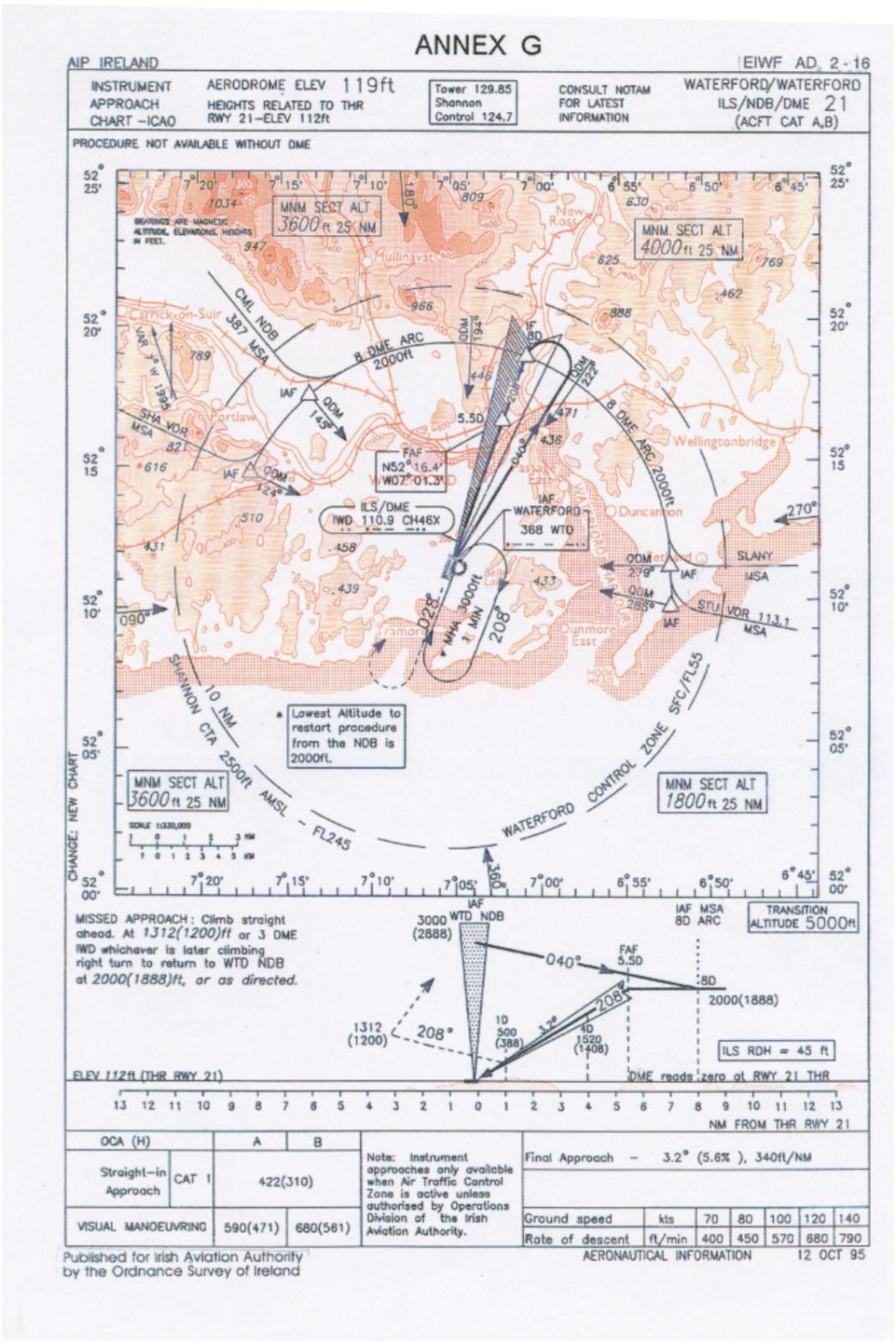
Time UTC	Station	Transcript
21:45:40	DH248	Rosslare Radio, this is Rescue One One One. Channel sixteen. How do you read?
	MRCC	Rescue One One One, Rosslare Radio loud and clear over.
	DH248	Rosslare Radio, Rescue One Eleven here just out of Waterford this time routing to the search area. Have you any information for us.
	MRCC	Rescue One One One, Rosslare Radio. Standby.
	MRCC	Rescue One One One, Rosslare Radio.
	DH248	Rosslare Radio, One One One, go ahead.
	MRCC	Rescue One One One, Rosslare Radio proceed to position Five Two Zero Four North Zero Zero Seven Three One West. Carrickapaine Rock, Carrickapaine Rock at the entrance to Dungarvan Harbour, over.
21:47:00	DH248	Rosslare Radio, One One One here, can you just give me that co-ordinate again please, over.
	MRCC	Rescue One One One, Rosslare Radio, co-ordinate again is Five Two Zero Four North Zero Zero Seven Three One West. It's Carrickapaine Rock, it's at the entrance to Dungarvan Harbour, over.
21:48:40	DH248	Rosslare Radio, Rescue One Eleven, we should be at that search area in approximately Five minutes, over.
21:49:00	MRCC	Rescue One Eleven, Rosslare Radio.
	DH248	Rosslare Radio, this is Rescue One Eleven, go ahead, over.
	MRCC	Yes, em, Helvick Lifeboat reckons the boat is closer to this position Five Two Zero Four point Five and Zero Zero Seven Two Nine decimal Seven. He seems to be closer to the following position Five Two Zero Four point Five and Seven Twenty Nine point Seven. Standby please, standby
21:52:00	MRCC	Rescue One Eleven, Minehead Radio.
	DH248	Minehead Radio, Rescue One Eleven, go ahead, over.
	MRCC	Rescue One Eleven would you change to Channel Six Seven please and standby.
	DH248	Roger, going to Six Seven.
21:53:10	DH248	Minehead Radio, Rescue One Eleven on Channel Six Seven, over.
	MRCC	Yes. Rescue One Eleven, Minehead Radio. Rescue One Eleven, Rosslare Radio go ahead.
	DH248	Ah, Rescue One Eleven. This is Rescue One Eleven here on Channel Six Seven, were you looking for me, over?
21:53:40	MRCC	Ah no. Ah we'd just like to advise you that Ballycotton Lifeboat is

		also making his way to the area and we have now Helvick Lifeboat have been setting off white flares to assist in the search and we've told them to desist from firing the flares now as you are arriving, over.
	DH248	Rescue One Eleven, OK that's copied, thank you for that, over.
21:58:00	Helvick Lifeboat	Minehead Radio, this is Helvick Lifeboat. We have located the casualty and his position now is Fifty Two Zero Four Two Nine Four North Zero Zero Seven Two Nine Zero Eight West, over. We're going to check the Tow-line now, standby please.
21:59:30	MRCC	Rescue One Eleven, Rosslare Radio.
	DH248	Rosslare Radio, One Eleven here, go ahead.
22:00:00	MRCC	Just to update you on the position. Apparently Helvick Lifeboat has now located the casualty at the following position Five Two Zero Four decimal Two Nine and Zero Zero Seven Two Nine decimal Zero Eight and he is taking him in tow. Ah if the visibility is satisfactory there we'd like you to continue to that position and maybe just monitor it for a while.
	DH248	Roger ah, just going to run that position by you ah Five Two Zero Four decimal Two Nine, Zero Zero Seven Two Nine decimal Zero Eight is that correct, over?
	MRCC	Yes that's correct that Five Two Zero Four, OK, that's correct.
	DH248	Rosslare Radio, One Eleven here. Roger we're going to route to that position. We're going to maintain Five hundred feet overhead the target area. We're still in a lot of cloud, a lot of fog here. We'll remain overhead and if they get into trouble at any stage, we'll, we will descend to the scene, over.
22:00:40	MRCC	Rescue One Eleven, Rosslare Radio. That's excellent, thank you very much indeed for that.
22:04:20	DH248	Minehead Radio, this is Rescue One One One, could we get that updated position please, over.
22:04:30	MRCC	Rescue One One One, Minehead Radio, the update position is 54 correction 5204.195 North 00729.123 West, over.
	DH248	Rosslare Radio, Rescue One One One, that's all copied, over.
22:17:00	DH248	Rosslare Radio, this is Rescue One One One, comms check, over.
	MRCC	Rescue One One One, Minehead Radio, loud and clear.
	DH248	Minehead Radio, Rescue One One One, loud and clear also, overhead Helvick Head this time, all ops normal.
	MRCC	That's fine, thank you very much.
22:20:25	Helvick Lifeboat	Rescue One One One, this is Helvick Lifeboat, Sixteen

	DH248	Helvick Lifeboat, this is Rescue One One One, Channel Sixteen, go ahead.
	Helvick Lifeboat	Rescue One One One, you just flew above us there now, did you see us, over
	DH248	Negative, over, negative.
	Helvick Lifeboat	Fine, em, we're just wondering what course you are steering at this moment for Helvick Pier, we just want to verify it with our GPS, over, our signal is not that good, over.
22:21:10	DH248	Helvick Lifeboat, this is Rescue One One One, we're going to come around again and fly overhead and we'll give you headings from there, over.
	Helvick Lifeboat	Fine Rescue One One One, our position is 5203.8 730.1 and we have a course for Two Twenty for Helvick Pier but our signal is not that great. We just want to make sure that that is correct, over.
22:22:00	DH248	Helvick Lifeboat, this is Rescue One One One, can you give me that position again over, please
	Helvick Lifeboat	Yes, Rescue One One, this is Helvick Lifeboat, 5203.821 North, 00730187 West, over.
	DH248	Helvick Lifeboat, Rescue One One One, that's all copied, we're going to come around and we'll try to give you a heading from there.
	Helvick Lifeboat	That's fine Rescue One One One, our heading at the moment is Two Three Zero, Two Three Zero, over.
	DH248	Rescue One One One, that's copied.
22:24:00	DH248	Helvick Lifeboat, this is Rescue One One One, Channel Sixteen, over
	Helvick Lifeboat	Go ahead Rescue One One One.
	DH248	Helvick Lifeboat, this is Rescue One One One, can you get onto us please as soon as we've passed overhead can you contact us, over.
	Helvick Lifeboat	Will do, will do.
22:24:40	Helvick Lifeboat	One Eleven, you're just over us now, over.
	DH248	Helvick Lifeboat, this is Rescue One Eleven, you're heading for Helvick Head would be Two Four Zero, over.
	Helvick Lifeboat	OK Rescue One Eleven, that's fine, we have that copied.
22:38:10	Helvick Lifeboat	Rescue One One One, Helvick Lifeboat.

	DH248	Helvick Lifeboat, Rescue One One One, go ahead.
	Helvick Lifeboat	At this stage you're just North of us there now, our position is 5203.5 007315099, you are just North of us now, over.
	DH248	Helvick Lifeboat, Rescue One One One, just give me that position again please.
	Helvick Lifeboat	5203.5 North 00731.11 West, over.
	DH248	Helvick Lifeboat, this is Rescue One One One, that's all copied, thank you, over.
22:39:20	DH248	Rosslare Radio, this is Rescue One One One, comms check, over.
	MRCC	Rescue One One One, Rosslare Radio.
	DH248	Rosslare Radio, Rescue One One One here, just by Helvick Head this time, all ops normal.
	MRCC	Rescue One One One, Rosslare Radio, all copied.
22:42:25	Helvick Lifeboat	Rescue One One One, you're just above us now, over.
	DH248	Helvick Lifeboat, this is Rescue One One One, we have you in sight there, you've got about a mile to run, over.
	Helvick Lifeboat	Thank you very much.
22:51:40	DH248	Helvick Lifeboat, this is Rescue One One One, over.
	Helvick Lifeboat	Go ahead One One One
	DH248	Can you tell me, can you see the lights of Helvick Head at this time, over
	Helvick Lifeboat	Negative on that, over.
	DH248	One Eleven, that's copied, over.
22:53:30	DH248	Rosslare Radio, this is Rescue One One One, over.
	MRCC	One Eleven, Rosslare Radio.
	MRCC	One Eleven, Rosslare Radio.
	DH248	Rosslare Radio, this is Rescue One Eleven, we're looking for permission to route towards Waterford Airport at this time, the conditions there are deteriorating, we'd like to get in before they close, over.
	MRCC	Rescue One Eleven, Rosslare Radio, just stand by.
22:54:00	MRCC	Rescue One Eleven, Rosslare Radio, you can be released and thank you for your help and your co-operation, over.
	DH248	Rosslare, this is Rescue One Eleven, that's all copied thank you, we're taking up a heading now for Waterford Airport, over.

	MRCC	Rescue One Eleven, Rosslare Radio, out.
22:54:20	Helvick Lifeboat	Rescue One Eleven, Helvick Lifeboat, Sixteen.
	DH248	Helvick Lifeboat, this is Rescue One Eleven on Channel Sixteen, over.
	Helvick Lifeboat	Rescue One Eleven, this is Helvick Lifeboat, thanks for your assistance, have a safe passage home now, over.
	DH248	Roger, thank you for that, safe passage yourself, over.
	Helvick Lifeboat	Good night now.
23:11:40	DH248	Rosslare Radio, this is Rescue One Eleven, Channel Sixteen, over.
	MRCC	Rescue One Eleven, Rosslare Radio, yes, go ahead please.
	DH248	Roger, we're just approaching Waterford Airport at this time, letting down now, we'll be on the ground refuelling and contactable by land link, over. Thank you for listening out, over.
	MRCC	Rescue One Eleven, Rosslare Radio, that's all copied, thank you very much indeed, we'll update you on the situation there at Dungarvan on the land line, OK, thank you.
	DH248	Roger.
23:35:25	DH248	Rosslare Radio, this is Rescue One Eleven, over.
	MRCC	Rescue One Eleven, Rosslare Radio.
23:35:50	DH248	Rosslare Radio, this is Rescue One Eleven, we've had to overshoot Waterford Airport due to weather, we can't get in, we're doing an approach to Tramore Bay this time and if we can get down we're going to land in the Bay area somewhere, over.
	MRCC	Rescue One Eleven, Rosslare Radio, that's all copied, keep us updated please.
	DH248	Roger, will do.
23:38:28	MRCC	Rescue One Eleven, Rosslare Radio, (no response).


ANNEX G
AIP IRELAND
EIWF AD 2-16
INSTRUMENT APPROACH CHART –ICAO
AERODROME ELEV 119ft
HEIGHTS RELATED TO THR
RWY 21–ELEV 112ft
Tower 129.85
Shannon Control 124.7
CONSULT NOTAM FOR LATEST INFORMATION
WATERFORD/WATERFORD
ILS/NDB/DME 21
(ACFT CAT A,B)
PROCEDURE NOT AVAILABLE WITHOUT DME
MNM SECT ALT 3600ft 25 NM
MNM SECT ALT 4000ft 25 NM
MNM SECT ALT 3600ft 25 NM
MNM SECT ALT 1800ft 25 NM
CML NDB 387 MSA
8 DME ARC 2000ft
IAF
FAF N52°16.4' W007°01.3'
ILS/DME IWD 110.9 CH46X
IAF WATERFORD 368 WTD
SHA VOR MSA
STU VOR 113.1 MSA
SLANY MSA
Lowest Altitude to restart procedure from the NDB is 2000ft.
SHANNON CTA 2500ft AMSL – FL245
10 NM
WATERFORD CONTROL ZONE SFC/FL55
MISSED APPROACH: Climb straight ahead. At 1312(1200)ft or 3 DME IWD whichever is later climbing right turn to return to WTD NDB at 2000(1888)ft, or as directed.
IAF WTD NDB
3000 (2888)
FAF 5.5D
8D
2000(1888)
1312 (1200)
208°
1D 500 (388)
4D 1520 (1408)
IAF MSA 8D ARC
TRANSITION ALTITUDE 5000ft
ILS RDH = 45 ft
ELEV 112ft (THR RWY 21)
DME reads zero at RWY 21 THR
NM FROM THR RWY 21
OCA (H) A B
Straight-in Approach CAT I 422(310)
VISUAL MANOEUVRING 590(471) 680(561)
Note: Instrument approaches only available when Air Traffic Control Zone is active unless authorised by Operations Division of the Irish Aviation Authority.
Final Approach – 3.2° (5.6%), 340ft/NM
Ground speed kts 70 80 100 120 140
Rate of descent ft/min 400 450 570 680 790
Published for Irish Aviation Authority by the Ordnance Survey of Ireland
AERONAUTICAL INFORMATION 12 OCT 95

Annex G

EIWF (10-9X) 12 DEC 97

JEPPESEN

JAA MINIMUMS

WATERFORD, IRELAND

WATERFORD

STRAIGHT-IN RWY		A	B	C	D
03	NDB DME	**530' (444')**	**530' (444')**		
		R1300m	**R1400m**	NOT	NOT
	ALS out	R1500m	R1500m	APPLICABLE	APPLICABLE
21	ILSDME	**422' (310')**	**422' (310')**		
		R1000m	**R1000m**	NOT	NOT
	ALS out	R1200m	R1200m	APPLICABLE	APPLICABLE
	LOC	**540' (428')**	**540' (428')**		
		R1300m	**R1400m**	NOT	NOT
	ALS out	R1500m	R1500m	APPLICABLE	APPLICABLE

CIRCLE-TO-LAND	100 KT	135 KT	180 KT	205 KT
	590' (471')	**800' (681')**	NOT	NOT
	V1500m	V1600m	APPLICABLE	APPLICABLE

Take-off **RWY 03, 21**

	Low Visibility Procedure in Force		
	RCLM (Day only) or RL	RL	NIL (Day only)
A B	250m	400m	500m
C D	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE

CHANGES: New Page.

Annex H


ANNEX I
NDB WTD
RWY 03/21
IMPACT SITE
3 NM
QDM 028° WTD
N 52°08.4'
W 07°06.9'
TRAMORE
Trá Mhór
Tramore Bay
Cuan Thrá Mhór
Tramore Strand
An Trá Mhór
Back Strand
An Cheiltra
Waterford Airport
Summerville
Brownstown Head
Great Newtown Head
Beenlea Head
An Bhinn Liath
Brazen Head
Rinnashark Harbour
Cuan Rinn na Searc
Tramore Burrow
SCALE 1 : 50,000

Annex I


ANNEX J
KILKENNY
WATERFORD
Port Láirge
NEW ROSS
Ross Mhic Thriúin
RWY 03/21
NDB WTD
3 NM
4 NM
5 NM
6 NM
7 NM
8 NM
10 NM
QDM 028° WTD
CELTIC SEA
HOOK HEAD
Rinn Duáin
Dunabrattin Head
HARBOUR
SCALE 1 : 250,000

Annex J

Visual Transcript of Radar Tape 1st July 1999
Reference R111 Vicinity of Waterford Aerodrome

Time UTC	Transcript
23:01:32	Squawk A 0060 - ALT 21 A Ground Speed 141 - 138 - 137 commencing overhead Waterford heading Northeast
23:02:00	A 0060 ALT 21 A Ground Speed 148
23:02:10	Signal Lost
23:02:18	A 0060 ALT Ground Speed 145
23:02:41	A 0060 ALT 21 A Ground Speed 136
23:03:20	A 0060 ALT 21 A Ground Speed 132 (Outbound heading Northeast)
23:05:07	Signal Lost (5 miles Northeast Waterford)
23:15:56	A 0060 ALT 16 A Ground Speed 94 - 101 (Overhead Waterford)
23:15:56	A 0060 ALT 16 A Ground Speed 126
23:17:40	A 0060 ALT 21 A Ground Speed 140 (Heading Northeast)
23:18:11	Signal Lost in turn back

Notes:Observation continued until 23:41:00

Annex K

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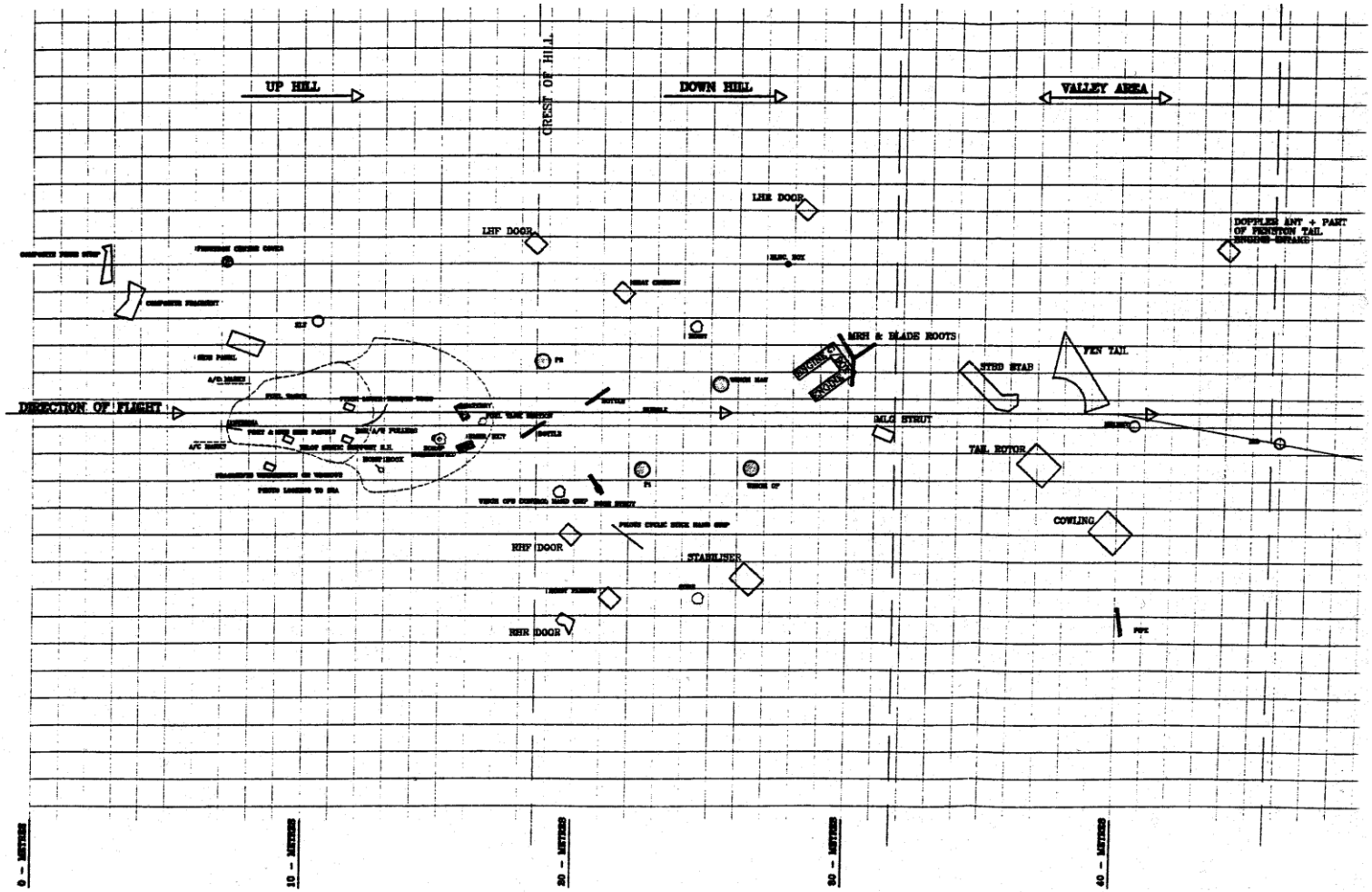
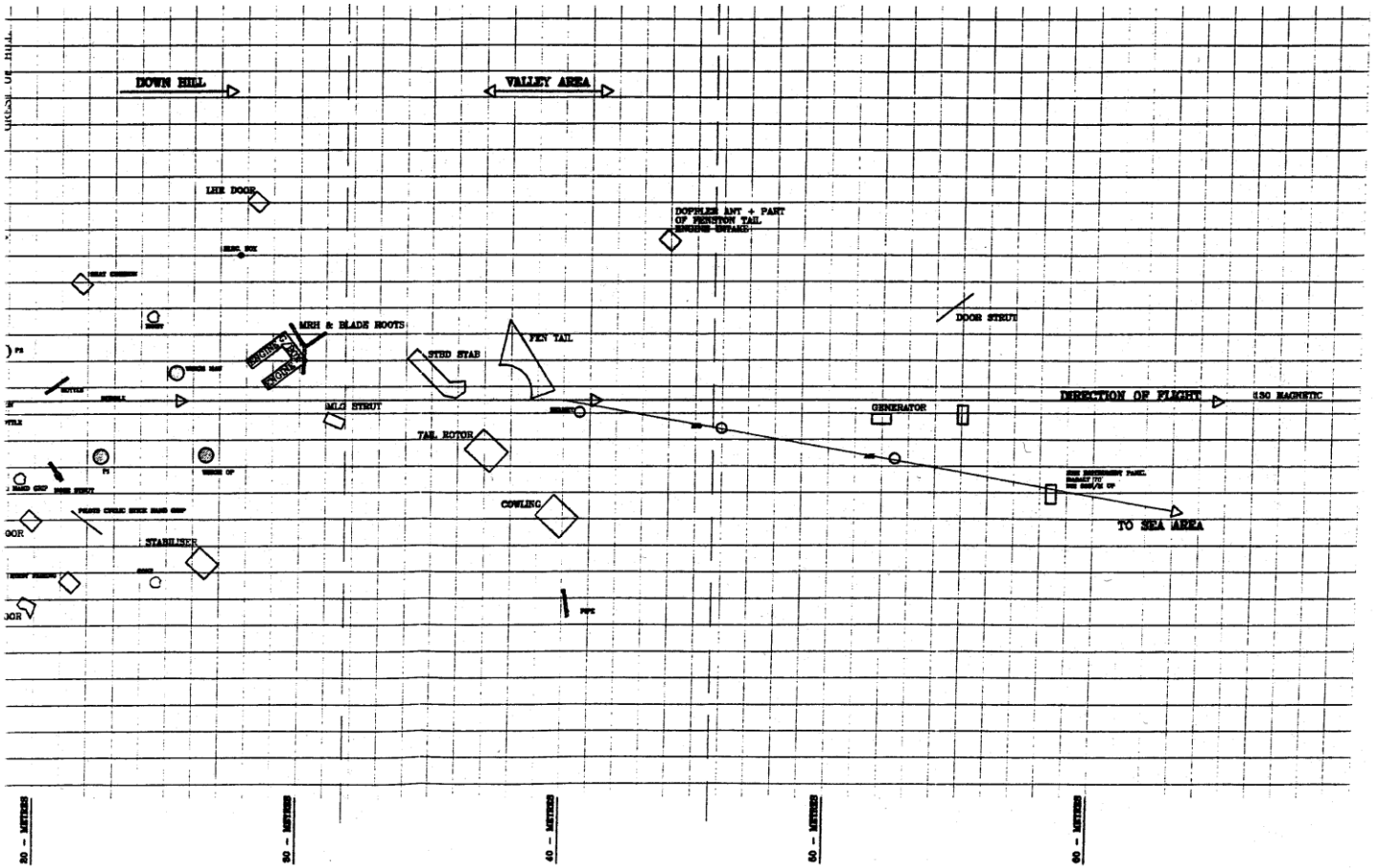
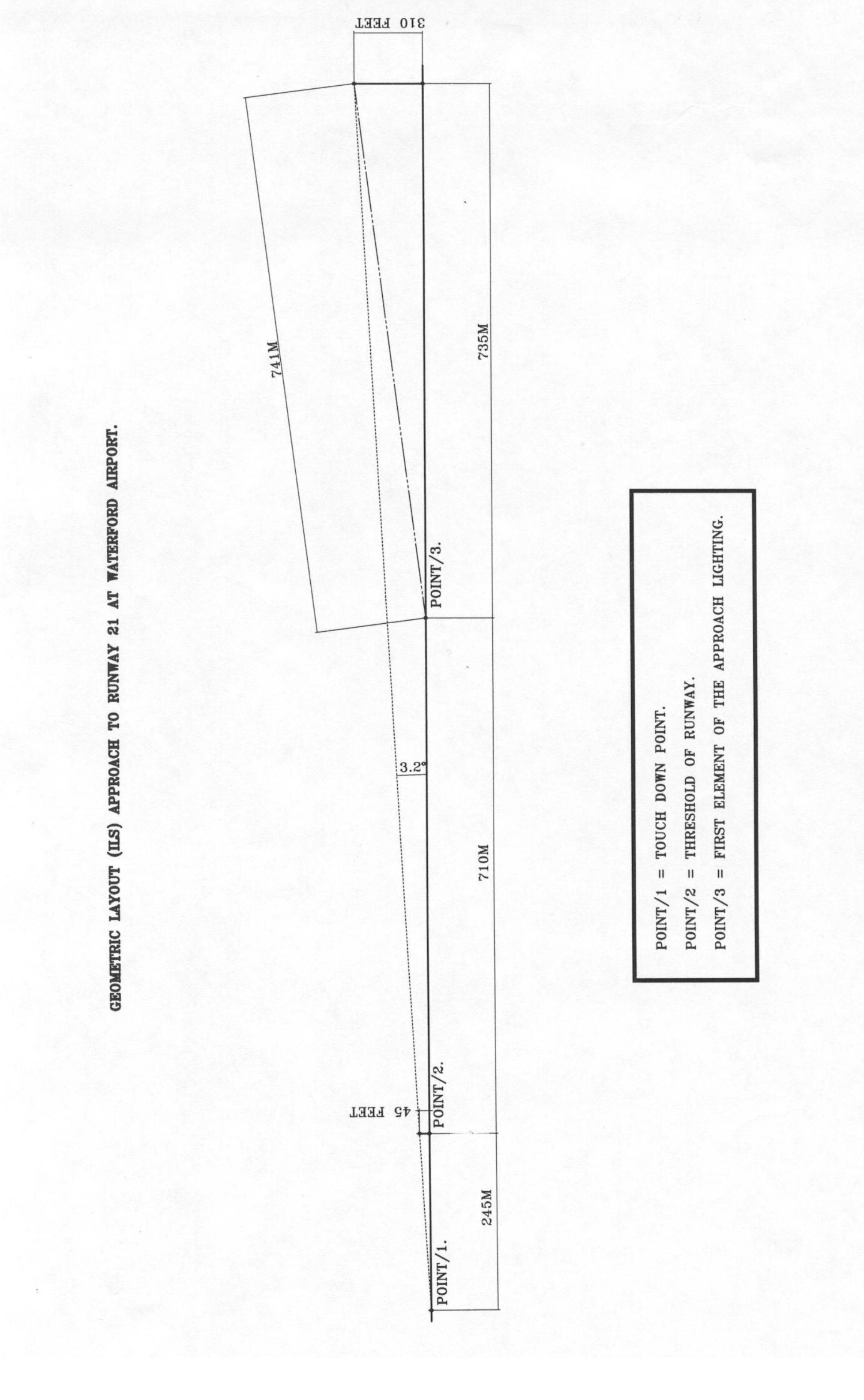
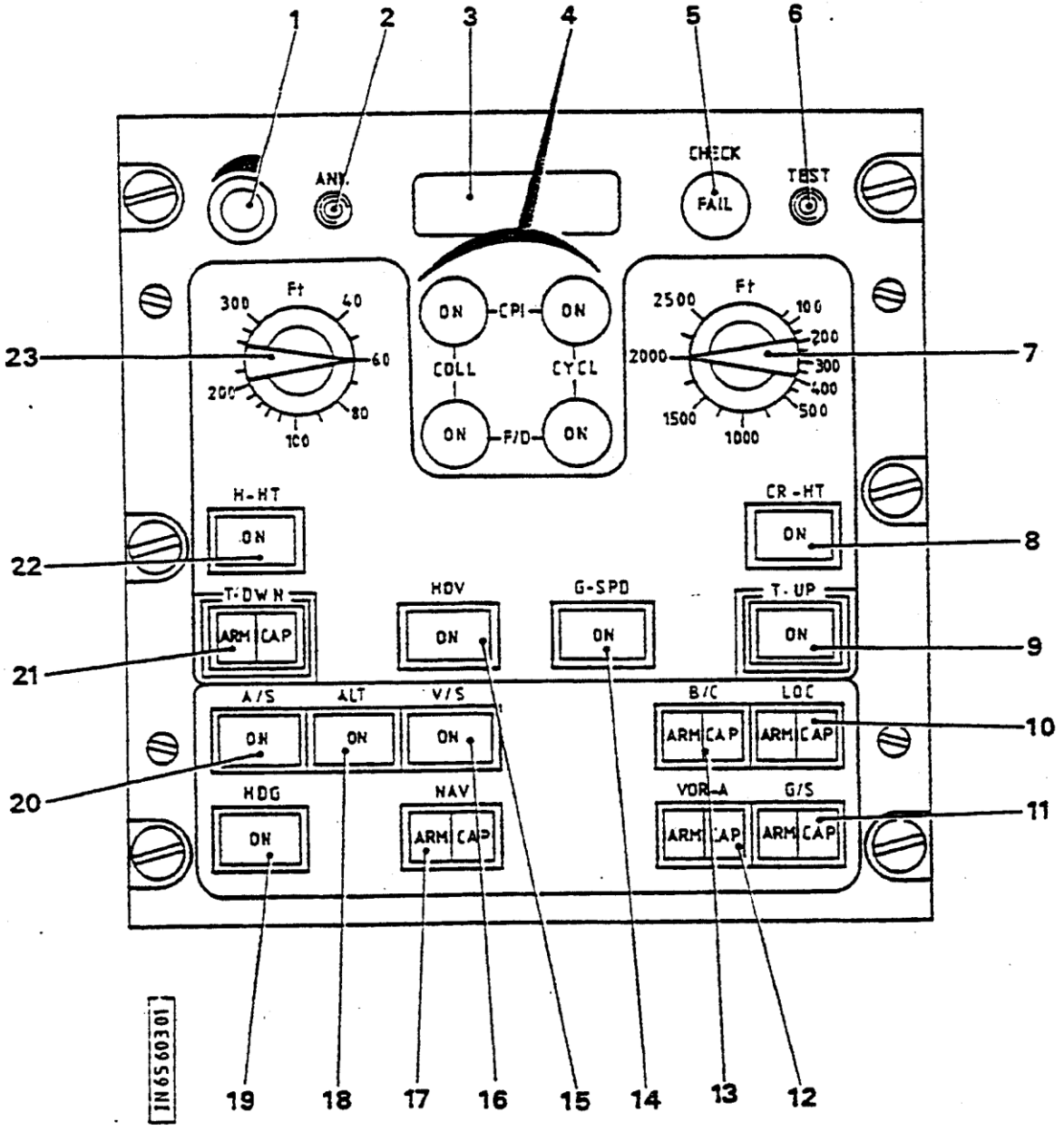


GENERAL AREA DIAGRAM.


DOWN HILL
VALLEY AREA
LHR DOOR
DOPPLER ANT + PART OF PENTON TAIL
ENGINE EXHAUST
MRH & BLADE HOOTS
STBD STAB
PEN TAIL
DOOR STRUT
DIRECTION OF FLIGHT
330 MAGNETIC
MLG STRUT
GENERATOR
TAIL ROTOR
COWLING
STABILISER
TO SEA AREA
20 - METRES
30 - METRES
40 - METRES
50 - METRES
60 - METRES


GEOMETRIC LAYOUT (ILS) APPROACH TO RUNWAY 21 AT WATERFORD AIRPORT.
310 FEET
741M
735M
POINT/3.
3.2°
710M
POINT/2.
45 FEET
245M
POINT/1.
POINT/1 = TOUCH DOWN POINT.
POINT/2 = THRESHOLD OF RUNWAY.
POINT/3 = FIRST ELEMENT OF THE APPROACH LIGHTING.

Annex M

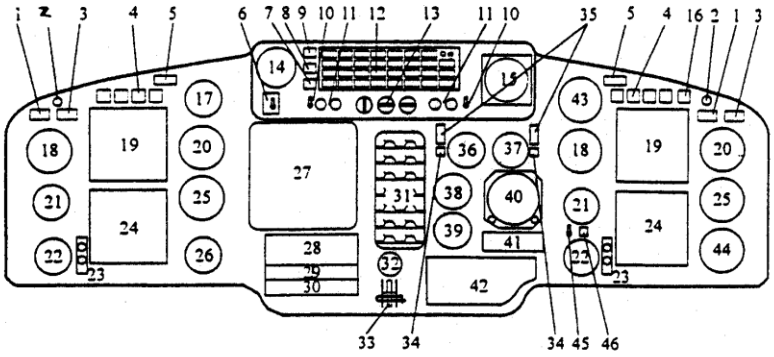


Annex N Page 1

KEY TO COUPLER CONTROL UNIT

1. Lighting dimmer switch
2. ANN light lighting test pushbutton
3. Alphanumerical display window
4. Coupler and flight director function engagement pushbuttons on the cyclic and collective axes
5. Alphanumerical display control CHECK pushbutton
6. Pre-flight TEST sequence engagement pushbutton
7. Radio altitude display potentiometer for CR.HT and T.UP modes
8. Cruise-Height mode engagement annunciator
9. T.UP Mode engagement annunciator
10. Localizer mode engagement annunciator
11. Glide-slope engagement annunciator
12. VOR Approach mode engagement annunciator
13. Localizer reverse tracking mode engagement annunciator
14. Groundspeed mode engagement annunciator
15. Hover mode engagement annunciator
16. Vertical speed mode engagement annunciator
17. Navigation modes engagement annunciator
18. Barometric altitude hold mode engagement annunciator
19. Selected heading hold mode engagement annunciator
20. Airspeed hold mode engagement annunciator
21. T.DWN mode engagement annunciator
22. Radio altitude hold mode engagement annunciator
23. Radio altitude display potentiometer for T.DWN and H.HT modes

2 INSTRUMENT PANEL



KEY

1. ALARM light
2. TCA GPS light
3. LIMIT light
4. AFCS coupler annunciator lights
5. L/Gear light
6. Autom. check list switch
7. Ice light
8. Deicing FAULT TEST light
9. Deicing control
10. FIRE-FAIL light
11. Fire extinguisher controls
12. Caution advisory panel
13. AFCS galvanometers
14. Icing indicator
15. Standby artificial horizon indicator
16. Harpoon light
17. Rotor rpm indicator
18. Airspeed indicator
19. EADI
20. Radio-altimeter indicator
21. Torquemeter indicator
22. Clock
23. EADI-EHSI brightness control
24. EHSI
25. Vertical speed indicator
26. Altimeter
27. Radar
28. Radar control unit
29. Radar joystick and check list panel
30. Doppler radar control unit
31. 14 indicators array
32. Landing gear indicator
33. Landing gear control switch
34. SCP lights
35. POWER LOSS lights
36. Engine 1 rpm indicator
37. Engine 2 rpm indicator
38. Dual fuel quantity indicator
39. Fuel quantity indicator
40. RMI
41. DME indicator
42. Electrical control panel
43. Triple rpm indicator (NR, NF1,NF2)
44. Altimeter encoder
45. CG2 selector
46. DME light