Runway overrun by Celtic Airways Fokker F.27, G-ECAT, at Sligo Airport, Ireland, November 2, 2002

Micro-summary: A fast, low non-precision approach by this F.27 resulted in a runway overrun.

Event Date: 2002-11-02 at 1702 UTC

Investigative Body: Air Accident Investigation Unit (AAIU), Ireland

Investigative Body's Web Site: http://www.aaiu.ie/

Cautions:

1. Accident reports can be and sometimes are revised. Be sure to consult the investigative agency for the latest version before basing anything significant on content (e.g., thesis, research, etc).

2. Readers are advised that each report is a glimpse of events at specific points in time. While broad themes permeate the causal events leading up to crashes, and we can learn from those, the specific regulatory and technological environments can and do change. ***Your company's flight operations manual is the final authority as to the safe operation of your aircraft!***

3. Reports may or may not represent reality. Many many non-scientific factors go into an investigation, including the magnitude of the event, the experience of the investigator, the political climate, relationship with the regulatory authority, technological and recovery capabilities, etc. It is recommended that the reader review all reports analytically. Even a "bad" report can be a very useful launching point for learning.

4. Contact us before reproducing or redistributing a report from this anthology. Individual countries have very differing views on copyright! We can advise you on the steps to follow.

FINAL REPORT

AAIU Formal Report No: 2005-015
AAIU File No: 2002/0055
Published: 25 August 2005

Operator:	Celtic Airways
Manufacturer:	Fokker
Model:	F 27 – 500
Nationality:	UK (Callsign ECY 4065)
Registration:	G-ECAT
Location:	Sligo Airport (EISG), Ireland N541648 W0083557
Date/Time (UTC):	2 November 2002 @ 17.02 hrs

SYNOPSIS

The aircr aft was operating a scheduled passenger flight from Dublin to Sligo. The flight departed Dublin Airport (EIDW) at 16.05 hrs and carried out a Non-Directional Beacon/Distance Measuring Equipment (NDB/DME) approach to Runway (RWY) 11 at Sligo Airport. The aircraft, according to the pilots and eyewitnesses, carried out a lower and faster approach than normal, due to gusty wind conditions, and touched down further along the runway than normal i.e. almost halfway down the runway. The aircraft skidded along the runway and off at its end, coming to a halt with the nose section of the aircraft in the sea, with the main wheels resting on the edge of the embankment leading to the sea. The passengers and crew evacuated through the rear portside passenger door, down fire service ladders, and were bussed to the terminal building. There was no aircraft fire or reported injuries. The accident occurred at evening twilight.

NOTIFICATION

The Manager of Sligo Airport notified the Chief Inspector of Air Accidents of this accident at 17.15 hrs on 2 November 2002. An Investigation team consisting of the Chief Inspector of Air Accidents, Mr Kevin Humphreys, Mr Graham Liddy and Mr Jurgen Whyte, Inspectors of Air Accidents, travelled to Sligo Airport and on arrival at 21.45 hrs, immediately began the investigation.

In accordance with the provisions of SI 205 of 1997, the Chief Inspector of Air Accidents, decided to carry out an investigation into the circumstances of this accident and prepare a Formal Report for publication. The Chief Inspector acted as the Investigator in Charge (IIC).

The UK Air Accident Investigation Branch (AAIB), as the State of Registry of the aircraft, was invited to nominate an Accredited Representative to the Investigation, in accordance with International Civil Aviation Organisation (ICAO), Annex 13 provisions.

On the 4 November 2002, the UK AAIB appointed Mr R. Tydeman, Senior Inspector of the Air Accident Investigation Branch of the Department for Transport as the United Kingdom Accredited Representative.

1. FACTUAL INFORMATION

1.1 History of the Flight

The aircraft, a Fokker F 27-500, registration G-ECAT, departed Dublin at 16.05 hrs (local time) for the 4th leg of a Public Service Obligation (PSO) rotation between Sligo in the North West of Ireland and Dublin. The aircraft had earlier departed Sligo for Dublin at 10.00 hrs, returned to Sligo at 12.30 hrs and departed once again for Dublin on time at 14.30 hrs. The Operator held the PSO contract to provide regular air service between Sligo and Dublin and also between Donegal (EIDL) and Dublin. The accident flight was delayed for 10 minutes as the flight to Donegal had been cancelled due to strong crosswinds at Donegal and arrangements had been made to fly these passengers to Sligo and bus them onwards to Donegal.

The en-route segment of this flight was uneventful.

At 16.22 hrs G-ECAT called Sligo on Tower frequency 122.10 Mhz and requested the latest weather conditions for Sligo. The Tower Controller transmitted the 16.30 hrs actual for Sligo, as presented at **Section 1.7 Meteorological Information.**

At 16.50 hrs, the aircraft was handed over from Shannon Control to Sligo Tower, descending to 3,500 ft to the SLG beacon for NDB/DME approach to RWY 11. Sligo Tower then transmitted the Donegal weather, as presented at **Section 1.7 Meteorological Information.**

At 16.53 hrs, the aircraft called overhead the SLG beacon and was cleared by Sligo Tower for the approach.

At 17.00 hrs, G-ECAT reported at the Final Approach Fix (FAF) and was cleared to land by the Tower, giving a wind of 120 degrees 15 kt, gusting 29 kt.

At 17.01 hrs, just prior to landing, G-ECAT was given a wind check of 120 degrees 15 kt, gusting 31 kt.

At 17.02 hrs the aircraft made an initial touchdown at approximately the mid-point of the runway and appeared to a number of witnesses not to immediately decelerate.

The aircraft continued down the runway until it departed the paved surface at the right hand side of the threshold of RWY 29. On seeing the aircraft pass the apron taxiway/runway intersection at an abnormally high speed, the Tower Controller immediately sounded the crash alarm.

The aircraft continued on through a prepared run-off area at the end of the runway, for a further 50 metres, before coming to rest (17.02:30 hrs) with the main wheels embedded in boulders that formed part of an embankment leading down to the sea. The main wheels were approximately one metre short of where the boulders fall away into the sea.

The nose wheel, cockpit and forward section of the fuselage cleared the top of the boulder embankment and the aircraft tilted approximately 15-20 degrees nose down onto the outgoing tide. Full tide was due at 04.00 hrs the following day at a depth of 3.9 meters.

The Tower Controller immediately contacted the Shannon ATC Station Manager advising of the runway excursion and called 999 to request Gardaí, Fire Brigade and Ambulance assistance.

1.1.2 Events immediately after aircraft came to a halt

The Airport Rescue and Fire Fighting Service (ARFFS) were in attendance at the accident site almost immediately after the aircraft came to a halt (See 1.1.3.5). They observed the aircraft in a tilted nose down attitude, with the forward section of the fuselage in the water. The safest point of evacuation for the passengers was deemed to be from the rear portside passenger door. However, the attitude of the aircraft was such that the tail of the aircraft was a considerable height above the ground. The ARFFS, with assistance from the Airport Manager, who arrived on scene from his office in the terminal building, placed a ladder up to this particular exit. The door was opened by the cabin crewmember and she reported no fire or apparent injuries. The ARFFS reported shortly thereafter to the Tower Controller that there was no fire and no injuries to the 36 passengers and 4 crew onboard.

The passengers and crew then exited the aircraft by ladder through the rear portside passenger door. All the passengers were then bussed back to the terminal building where local Health Board personnel checked them for injuries. While none of the passengers or crew complained of any injuries, a number of passengers were distressed by their experience.

At the accident site, the ARFFS secured the area and stabilised the aircraft by attaching winch cables between the aircraft undercarriage legs and the fire tender. Under direction of the Airport Manager, and in consultation with the ARRFS and the engineer, who was a member of Fokker Services BV engaged to provide technical support to the operator, it was decided to remove the baggage (30 bags) from the aircraft as the seawater was encroaching the forward baggage hold. This was completed without incident and all passengers' personal belongings were returned to them. The accident site was then sealed-off by the Gardaí pending the arrival of the AAIU Investigation Team.

On the arrival of the Investigation Team, priority went towards recovery of the flight recorders, and an inspection of the runway, aircraft, and cockpit area. Access to the aircraft was gained through the portside rear door. The seawater at this time had covered the pilot's seats, so the contents of the ships library and other material, was removed by the investigators. In addition, the cockpit parameters and settings were recorded. At the subsequent high tide the seawater reached the first few rows in the passenger cabin.

Interviews were conducted with the Airport Manager, the Tower Controller, the ARFFS, the Flight Crew, the Engineer who was in the cockpit for the flight, the Cabin Crewmember, and a representative of the Operator. Interviews were also subsequently carried out by telephone on all available passengers that had flown on the accident aircraft, as these passengers had left the airport prior to the arrival of the Investigation Team. At 01.00 hrs the Investigation was stood down until 08.00 hrs that morning.

On the 3 November, a specialist recovery crew, under the guidance of the AAIU, recovered the aircraft to the ramp at 17.30 hrs with no further damage. It was noted by the Investigation that seawater corrosion had already begun to form on the main instrument panel and the central console/pedestal.

1.1.3 Witness Observations

1.1.3.1 Flight Crew

The flight was uneventful until the final segment of the approach to RWY 11 at Sligo. The approach according to both pilots, was difficult due to the gusty wind conditions, the wind was varying in direction between 100 degrees and 130 degrees and gusting between 23 and 35 kt.

The pilot flying (PF) told the investigation that large throttle changes were required to maintain airspeed due to the gusty conditions. The aircraft crossed the runway threshold slightly low. The Precision Approach Path Indicators (PAPI's) lights were showing 3 red, 1 white. The PF recalls the airspeed being at target threshold speed of VAT + 15 kt, approximately 120 kt and that the aircraft floated in the gusty conditions touching down further down the runway than ideal. The PF selected (propeller) Ground Fine, however, the required 6 lights indicating that this condition was achieved did not illuminate. The re-selection of Ground Fine resulted in the six lights indication that the propellers were in Ground Fine. At this time the aircraft was well down the runway, past the apron taxiway/runway intersection. The PF initially applied a brake pressure, which he considered was possibly insufficient to slow the aircraft.

As full brake pressure was applied the aircraft began to skid and then it slid the remaining distance of the runway until it departed the paved surface at the right hand side of the threshold of RWY 29 and onto the embankment.

1.1.3.2 Cabin Crew Member (CCM)

The CCM was seated at the rear of the aircraft as it approached Sligo. In her opinion, *the landing did not seem normal and felt that the aircraft bounced a number of times*. As the CCM was not seated beside a window, she was unable to describe the events that occurred outside the aircraft as it travelled down the runway. When the aircraft finally came to rest, the CCM made a PA asking the passengers to remain seated. She recalled a woman screaming, so she went to her attention and advised her to stay seated. Around the same time the engineer, who was travelling in the cockpit jump seat opened the door in the forward partition wall. The CCM asked, "*If it was OK to evacuate"* and the reply from the cockpit was "*Yes, through the rear door*". The CCM returned to the rear of the aircraft, where she opened the left rear door and briefed the incoming fire crews. The CCM then assisted in evacuating the passengers from the aircraft.

1.1.3.3 Air Traffic Tower Controller

The controller said that the aircraft crossed the threshold of the runway, fast and low and appeared not to touchdown until opposite the control tower and on the nose wheel. The aircraft continued down the runway until it slid off the end. During the runway excursion the controller sounded the airport crash alarm and contacted the relevant local authorities.

1.1.3.4 Airport Manager

The airport manager was sitting in his office at the time that G-ECAT was landing. He was very familiar with the sounds associated with an F 27 type aircraft landing and stopping on the runway.

However, in this case, the different sound (*of an aircraft passing further down the runway*) was such that it prompted the manager to leave his office to see what was going on. He ran out to the apron and saw the ARFFS responding down the runway to the east side of the airport. The manager got into his car and drove to the end of RWY 11 where he assisted in the evacuation of the passengers.

1.1.3.5 Airport Rescue and Fire Fighting Service (ARFFS)

As a general airport policy for scheduled operation, the ARFFS pre-position their vehicles at two distinct locations close to the runway.

A fire tender (Rescue 1) was located on the taxiway leading out to the runway. The fire crewmembers onboard observed the aircraft landing approximately three runway edge lights back from the taxiway (180 metres). All onboard the tender realised that the aircraft's passing speed was excessive for that point on the runway and the decision was made to immediately chase after the aircraft. They considered that the aircraft departed the end of the runway at approximately 40 M.P.H., where it suddenly came to a halt at the water's edge.

A rapid intervention vehicle (RIV, Rescue 3) was located on a private road near the threshold of RWY 29. The fire crewmembers onboard observed the aircraft speeding towards the end of the runway. It appeared to be wobbling with no real braking power. It departed the runway end (abeam the position of Rescue 3) at a speed of between 40 and 50 M.P.H. They were convinced that the aircraft would end up in the water, but it came to a rest at the edge of the embankment.

1.1.3.6 Passengers

The majority of the 36 passengers onboard G-ECAT were interviewed by an Inspector of Air Accidents in the days following the runway excursion. In general terms, the accounts given by the passengers were similar in nature.

The approach was described as, *long and bumpy*. The aircraft appeared to land, *very fast and was not slowing down.* Some considered that the aircraft bounced once while others could not recall a bounce. Spray and smoke was seen coming from the left side tyres. The left outer tyre was seen to explode, while the left inner tyre was seen to deflate and rotate around its rim. When the aircraft left the runway a lot of muck and spray was thrown up before the aircraft finally came to a rest at the edge of the water.

In general, people were calm. Some got out of their seats to leave the aircraft. However, the cabin attendant shouted at them to remain seated. The majority of the passengers stated, *"that no public address (PA) was made by either the flight crew or the cabin attendant."* Some recalled the cabin attendant making a PA to remain seated.

Almost immediately after the aircraft came to rest, a member of the ARFFS entered the cabin and arranged for the orderly evacuation of the aircraft down a ladder at the rear portside door. Passengers were bussed back to the terminal building where they were provided with refreshments and medical attention, as required. Names and addresses were taken by the airport staff of all the passengers before they departed for home.

1.1.3.7 Passenger Terminal

A man who was collecting his wife from the inbound aircraft was located in the arrivals hall and was looking out towards the runway. He was familiar with scheduled airlines taking off and landing at Sligo. He recalled that he did not see the aircraft until just before it landed.

It touched on the nose (*wheel*) first with its tail in the air just as it passed across from the lounge. The tail dropped and the aircraft went out of view.

1.2 Injuries To Persons

There were no reported injuries to any of the 4 crew and 36 passengers.

Injuries	Crew	Passengers	Others
Fatal	0	0	0
Serious	0	0	0
Minor	0	0	0
None	4	36	

1.3 Damage To Aircraft

The aircraft came to rest at the seawall embankment off the end of RWY 11. Large boulders, which formed part of the embankment, arrested the further travel of the aircraft. However, the nose section of the aircraft came to rest on the out-going tidewater. On initial inspection the aircraft sustained extensive braking damage to the four main wheels and impact damage to the nose wheel. Some damage was caused to the forward underside of the fuselage due to resting contact with the boulders. During the night of the accident the rise and fall of the tide immersed the cockpit and forward section of the cabin. This salt water caused immediate visible corrosion in the cockpit and rendered the airframe a total economic write off.

1.4 Other Damage

A runway centreline approach light, located just off the threshold edge of RWY 29 was demolished. In addition, the prepared ground between the paved surface at the RWY 29 threshold and the embankment was rutted and damaged as a result of the aircraft's transition to its resting point and the subsequent heavy mechanical efforts to recover the aircraft.

1.5 Personnel Information

1.5.1 Pilot Flying:

Personal Details:	Male, aged 48 years
Licence:	UK ATPL
Last Periodic Check:	1/4/2002
Medical Certificate:	Class 1, 18/9/2002

Flying Experience:

Total all types:	5,710	hours
Total all types PI:	3,112	hours
Total on type:	1,176	hours
Total on type PI:	749	hours
Last 90 days:	43	hours
Last 28 days:	14	hours
Last 24 hours:	5	hours

Duty Time:

Duty Time up to incident:	7 hours 32 minutes
Rest period prior to duty:	14 hours 05 minutes

1.5.2 Pilot-non-Flying (Commander)

Personal Details:	Male, aged 61 years
Licence:	UK ATPL
Last Periodic Check:	24/4/2002
Medical Certificate:	Class 1, 9/5/2002

Flying Experience:

Total all types:	20,117	hours
Total all types PI:	16,831	hours
Total on type:	787	hours
Total on type PI:	787	hours
Last 90 days:	111	hours
Last 28 days:	27	hours
Last 24 hours:	5	hours

Duty Time:

Duty Time up to incident:	7 hours 32 minutes
Rest period prior to duty:	14 hours 05 minutes

1.6 Aircraft Information

1.6.1 Leading Particulars

Aircraft type:	F 27 Friendship Mark 500
Manufacturer:	Fokker
Constructor's number:	10672
Year of manufacture:	1986
Certificate of registration:	Issued 14/4/2000
Certificate of airworthiness:	To expire 16/12/2002
Total airframe hours:	27452
Engines:	2 x Rolls-Royce Dart 532-7 Turboprop
Maximum All Up Weight (MAUW):	19,999 kg
Actual Take off weight:	18,854 kg
Maximum authorised landing weight:	19,051 kg
Estimated weight at time of accident:	18,376 Kg
Centre of Gravity limits (At incident weight):	Within Limits

1.6.2 General Information

1.6.2.1 Propeller Ground Fine Pitch (GFP)

The pitch range is from ground fine pitch at zero degrees to fully feathered at 87 degrees; these pitch positions are determined by permanent stops. A positive mechanical pitch stop (flight fine pitch) is provided at approximately 20 degrees, while an additional mechanical pitch stop (flight safety pitch) is provided at 32 degrees. During take-off and flight, the flight pitch stops automatically engage when the propeller pitch increases beyond the stop settings and can be disengaged when withdrawal solenoids in the propeller controller unit are energized. The ground fine pitch stop provides a useful braking effect during the landing run because of the high wind milling drag effect.

The flight fine pitch stop is incorporated to prevent excessive drag in case the propeller tends to fine off towards ground fine pitch during flight. It is hydraulically withdrawn by oil pressure in the third oil line. Oil pressure is admitted only when the flight fine pitch lock withdrawal solenoid in the propeller controller unit is energized. The pitch lock withdrawal solenoids of both propellers are wired in parallel, and can be energized by lifting either one or both rpm control handles from the idle position and pulling them back against spring tension.

1.6.3 Wheel Anti-skid System

Both main undercarriages units are equipped with an anti-skid system. This system releases the brakes on the respective main wheels when a sudden deceleration of the wheels is sensed. This system was tested on both sides after the accident and found to be functioning correctly. It may be noted that this system will not release the brakes, to prevent skidding, if the main wheels touch down with the brakes in the ON position and the wheels not rotating. In this configuration there is no wheel deceleration to be sensed, and consequently the system does not release the brakes.

1.7 Meteorological Information

1.7.1 General

The weather during the day of the accident maintained a strong south-easterly wind with pulses of heavy rain. A very heavy band of rain did pass through the field at 16.00 hrs and this was advised to the flight crew of G-ECAT through the handling agent at Dublin.

1.7.2 Local Area Forecast (LAF) for Sligo

Valid:	02 November 02, 12.00 - 21.00 hrs
Wind:	110 degrees 23 kt gusting 35 kt, Becoming 17.00 - 20.00 hrs 220 degrees 35 kt gusting 50 kt.
Visibility:	5 – 10 KM
Weather:	Rain becoming 17.00 - 20.00 hrs rain showers (SHRA)
Cloud:	Scattered (SCT) 1,000 feet, Broken (BKN) 1,500 feet Tempo 12.00 –18.00 hrs Sct 600 feet BKN 1,000 feet.

1.7.3 Actual Reports (METAR's)

1.7.3.1 16.30 hrs Sligo Actual

The Tower Controller passed the following 16.30 hrs Sligo Actual weather conditions to the aircraft as:

Wind: 120 degrees 15 kt gusting 29 kt
Visibility: 3000 - 5000 m in rain
Cloud: Broken at 700 feet overcast at 1000 feet

Temperature: 12 º Celsius

Q.N.H: 983

Runway: RWY 11 NDB/DME Approach

Condition: Wet

1.7.3.2 16.42 hrs Donegal (Finner) Automatic

The Tower Controller passed the following 16.42 hrs Donegal weather conditions to the aircraft as:

Wind: 130 degrees 36 kt
Temp: 13ºC
Dew Point: 10ºC
QNH: 983

1.7.3.3 16.30 hrs Connaught Airport (EIKN) Actual:

Wind: 140 degrees 12 kt
Visibility: 300 meters Rain and Fog (RA FG)
Cloud: BKN 100 feet BKN 300 feet
Tempo 1500 metres SCT 100 feet, BKN 200 feet

1.8 Aids to Navigation

NDB/DME approach to RWY 11 was serviceable

1.9 Communications

Normal communications existed between the Sligo Control Tower and G-ECAT on Frequency 122.100 MHz

1.10 Aerodrome Information

1.10.1 General

Sligo is a coastal airport (11 feet above mean sea level/AMSL), which is located approximately 5 nautical miles (NM) west of the City of Sligo.

RWY 11 is 1,199 metres long and 30 metres wide, with a displaced threshold for landing (30 metres) giving a Landing Distance Available (LDA) of 1,171 metres

The asphalt runway surface is level. The runway is equipped with 3º Precision Approach Path Indicators (PAPI's), which were switched on at the time of G-ECAT's approach. Runway edge lighting is located every 60 metres along the entire length of the runway. No approach lights are located on the approach to RWY 11. However, RWY 11 does have threshold wing bar lighting and runway end lighting.

The NDB/DME approach to RWY 11 requires a 4% gradient to the Missed Approach Point (MAPt) of 520 feet, at 2 nm DME.

1.10.2 Runway Surface Condition

1.10.2.1 General

The Sligo Airport Authority is responsible for the assessment and dissemination of the runway condition and information for flight crews.

1.10.2.2 Runway Friction

The measurement of the friction coefficient (Mu) has been found to provide the best basis for determining surface friction conditions. This can be achieved through the use of a continuous friction-measuring device using self-wetting features on a clean surface. The Mu values are used to signify a designated friction value representing runway conditions. These values range from 0 to 1, where zero is the lowest friction value and 1 is the maximum value obtainable. Whenever the friction of the runway surface is below 0.40 the runway will be declared slippery when wet.

The runway friction coefficient is measured annually by Dublin Airport Fire Service/City of Derry Airport Fire Service using an approved Surface Friction Tester. Results of these tests remain on file at Sligo Airport and the Irish Aviation Authority (IAA).

1.10.2.3 Recent Friction Test

On the 23 July 2002 a runway friction test was carried out in both directions of the single runway at Sligo. RWY 29/11 achieved an average runway friction on its entire length of Mu 0.94. For RWY 11/29 the runway friction was recorded at an average of Mu 0.88 for its entire length. Both these MU values are well above the maintenance planning level of 0.60 and the minimum friction level of 0.50 as laid down in the International Civil Aviation Organisation (ICAO) - Determination of friction characteristics of wet paved runways, Annex 14.

1.10.2.4 Runway Braking Action

Runway braking action is assessed by Sligo Airport through use of a Bowmonk Braking Action Meter when the runway is subject to frost/ice/snow conditions.

1.10.2.5 Reporting of water on runway

Whenever water is present on the runway, a description of the runway surface conditions on the centre half of the width of the runway, including the possible assessment of water depth, where applicable, is made available using the following:

DAMP – the surface shows a change of colour due moisture.
WET – the surface is soaked but there is no standing water.
WATER PATCHES – significant patches of standing water are visible.
FLOODED – extensive standing water is visible.

Prior to G-ECAT's approach, a visual runway inspection by the ARFFS determined that the runway condition was WET. This information was provided to the flight crew of G-ECAT.

1.11 Flight Recorders

1.11.1 General

Upon arrival at the aircraft accident site a member of the AAIU Investigation Team entered the aircraft tail section through an access panel in the rear underside of the fuselage via a caged platform raised by a hydraulic lift and removed both the Cockpit Voice Recorder (CVR) and the Flight Data Recorder (FDR). The CVR and FDR were subsequently sent under AAIU custody to the UK AAIB at Farnborough, for downloading, transcription and analysis.

1.11.2 Cockpit Voice Recorder (CVR)

1.11.2.1 General

The CVR is a Fairchild A100A tape type recorder of 30 minutes duration.

1.11.2.2 Pertinent Information

The PNF called out altitudes of 50 ft, 20 ft. and 10 ft. at intervals of one second. The PF was then instructed to "*keep the right wing down*". Two seconds later the aircraft was heard to touch on.

Three seconds following touchdown, the first of two clicking sounds were heard as the PF attempted to engage ground fine pitch (GFP). Seven seconds after touchdown the PNF instructed the pilot to "brake" and informed him that "some of the lights" had illuminated. After 9 seconds the PNF announced that "all the lights" had come on. There was a further "click" and a further instruction from the PNF to the pilot to "brake" and then a second later, to brake "hard".

The aircraft was then 11 seconds after touchdown. It became apparent from the CVR noises that the crew were experiencing difficulties with the landing. A sound resembling wheel skidding could be heard at 17 seconds. The aircraft is heard apparently leaving the paved surface after 24 seconds and 2 seconds later coming to rest.

As the aircraft comes to a rest the CCM is heard making a PA to the passengers requesting, "*Please remain seated, seat belts fastened until the Captain switches off the seatbelt sign*".

In addition, the CCM is heard at the cockpit door request, "*If it is OK to evacuate*". No other cockpit or CCM PA's were evident on the remaining CVR tape.

1.11.3 Flight Data Recorder (FDR)

1.11.3.1 General

The FDR is a ChecStroke 980-4100-GWUN recorder.

Recordings of magnetic Heading, Flap position, Indicated Airspeed (IAS), VHF key, Normal G and Altitude only were available from the FDR recordings. Plots of these for the relevant part of the flight are shown at **(Appendix A)**.

1.11.3.2 Pertinent Information

The recording of normal acceleration (G forces) at touchdown shows pulses of positive G between + 1.6 and + 1.9 and this confirms the moment of touchdown.

The initial descent of the aircraft was about 10 ft/sec or 600 ft/min. The aircraft floated along the runway surface initially at IAS in excess of 130 kt until touchdown point at which the IAS was recorded at 129 kt **(Appendix B).** The aircraft's deceleration along the runway was in two separate phases.

The initial deceleration, which occurred over the first 12 seconds, was an average of 2.4 ft/sec/sec during which 459 metres (1,505 ft) of the runway was covered. During this first phase the heading of the aircraft remained almost constant at 110º Magnetic (M).

After the initial 459 metres was covered the aircraft commenced the second phase of the landing run, at the start of which the heading abruptly changed to 120º M momentarily and then turned at a constant rate of 5º/sec during the final run to reach 70º M before the aircraft finally came to rest. During this part of the landing the recording of altitude varied considerably. This recording combined with the heading and normal acceleration (G forces oscillate between + 1.8 and - 0.3) indicates vertical, lateral and horizontal forces, which resulted in a very complex motion of the aircraft.

The point at which these forces return to normal were found to coincide with the point at which the heading ceased turning and this was taken as the point where the aircraft came to rest. The final deceleration was in the region of 8 ft/sec/sec and existed for 294 metres (967 ft). The total landing roll therefore, was 753 metres (2470 ft). The position at which the aircraft came to rest was measured as 50.5 metres from the runway pavement. This would indicate that the aircraft touched down about 460 metres from the threshold of RWY 11 **(Appendix C).**

1.12 Wreckage and Impact Information

It was noted that both propellers had suffered light tip damage, consistent with the propellers making ground contact as the aircraft's nose sank.

The underside of the aircraft suffered extensive puncture damage, which was consistent with the nose sinking, thereby bringing the underside into contact with the stone embankment. When the aircraft came to rest, the nose wheel was not in ground contact.

1.13 Medical Information

Nil

1.14 Fire

There was no fire

1.15 Survival Aspects

The aircraft came to rest as illustrated in **(Appendix D).** This type of aircraft is not fitted with evacuation slides because of the doorsill height. It can be seen that, evacuation of the aircraft through the front exit was impossible, as it was submerged and would require passengers to enter the seawater and clamber up the embankment. Evacuation through the rear exit was also difficult due to the tilting of the aircraft nose down thereby dramatically increasing the doorsill height above the ground.

Rescue services therefore had to improvise with ladders and cradles to evacuate the passengers. This was carried out very effectively and efficiently by the Airport Rescue and Fire Fighting Service. Had there been injuries on board or indeed had the aircraft not been halted by the main wheels contacting the boulders the outcome would have been far more serious.

1.16 Tests and Research

Because of the high speed recorded at touch down, the aircraft's airspeed indication system and the FDR were tested after the accident. In both cases, the systems were found to be recording airspeed accurately.

Three main wheel tyres were found to have deflated and showed signs of rotating on their wheel rims after deflation. These were both tyres on the port side and the starboard inner tyre. The starboard outer remained inflated. All four tyres were removed for further examination. The results of this examination showed that the starboard outer type was worn down to almost its limits, and did not show any indication of skidding or aquaplaning. All the other three tyres showed a distinct skid mark, where the tyre material had been worn significantly, to such an extent that the tyre pressure caused the remaining material to suffer the classical X type of burst failure **(Appendix E)**, thereby deflating the tyre. None of these three tyres showed any indication of aquaplaning.

1.17 Organisational and Management Information

1.17.1 Operator's History

This Operator was originally carrying out flights between Waterford, a city in the South East of Ireland and Lydd in the UK, and had only commenced operations with F 27 aircraft in late 2000. The original Air Operator Certificate (AOC) holder operated Britten Norman Trislanders. The new company, Euroceltic, applied for a new UK AOC and eventually having suffered various setbacks, began operating the Waterford Luton route in February 2001. G-ECAT, the accident aircraft began operating the route from April 2001. Business on the route increased, the company began a route expansion process and in October 2001 commenced a Liverpool-Luton service. Yields proved low on these routes and in January 2002 a Waterford businessman became the majority shareholder in Euroceltic. The route network contracted to nine services per week on the Waterford-Luton route, with charters/services at weekends.

In trying to expand its route network and in commencing operations with its F 27 the Operator encountered the problems which are daily headaches for an established operator but are considerable setbacks for an ab initio undertaking. These included difficulty in securing the necessary maintenance back up for public transport aircraft of this type, crew training and work up. Various technical problems occurred, including engine failures on both its aircraft G-ECAH in January 2001 and G-ECAT in January 2002.

With no reserve aircraft this necessitated wet leasing various Fokker F 50 and ATR 42 aircraft to maintain the services. G-ECAT was also removed from service for 3 weeks, following damage to the aircraft electrical system, which was caused by a faulty ground power unit (GPU).

The Operator told the Investigation that it was their intention to replace its F 27s with F 50s and to acquire an Irish AOC.

In the meantime, it continued operating the F 27s on the PSO routes and leased aircraft to fulfil its other contractual obligations. Following the accident to G-ECAT, the Operator continued for a short time on the PSO routes with leased F 50s, but the Company finally ceased operations in January 2003.

1.17.2 Public Service Obligations (PSO)

In July 2002, Euroceltic tendered for the provision of Public Service Obligations (PSO) on the routes from Carrickfinn (Donegal), Sligo, Connaught, Galway and Kerry airports to Dublin and were awarded the Sligo and Carrickfinn services. Public Services Obligation routes are service provided by States under Council Regulation EEC No. 2408/92 of 23 July 1992.

Article 4 states, inter alia "*A Member State, following consultations with the other Member States concerned and after having informed the Commission and air carriers operating on the route, may impose a public service obligation in respect of scheduled air services to an airport serving a peripheral or development region in its territory or on a thin route to any regional airport in its territory, any such route being considered vital for the economic development of the region in which the airport is located, to the extent necessary to ensure on that route the adequate provision of scheduled air services satisfying fixed standards of continuity, regularity, capacity and pricing, which standards air carriers would not assume if they were solely considering their commercial interest.*

The Commission shall publish the existence of this public service obligation in the Official Journal of the European Communities".

In Ireland, the Programme for Government provides for the continued support of regional airports and regional air access, in general. In pursuit of this policy, the Department of Transport administers the Essential Air Service Programme (EASP). The programme was introduced in 1995 against a backdrop of a sharp fall-off in traffic at the regional airports in the early 1990's. Under the programme, public service obligations (PSO) have been imposed on six regional air routes, in accordance with the relevant EU Regulation for PSO Air Services i.e. EU Council Regulation 2408/92.

The EU Regulation allows Member States to impose a PSO on 'thin' regional air routes to improve accessibility and encourage the growth of both industry and tourism related activities, where air carriers are not prepared to provide services on a commercial basis.

One Operator currently provide air services, under PSO contract with the Department of Transport, on routes linking Dublin with the regional airports in Kerry, Galway, Knock, Sligo and Donegal. Another Operator services the Derry/Dublin route.

The maximum amount of subvention for each contract year is decided at the competition stage and is written into the contract. The actual amount of subvention payable each month/quarter is calculated with reference to the actual losses incurred for the period plus a 'profit' element, subject to the maximum amount agreed in the contract. The total cost of the subvention amounts to approximately €20m per year.

The routes awarded to Euroceltic had been previously serviced by an Operator using ATR 42 aircraft. The Board of Sligo Airport expressed concern over the selection of Euroceltic for the Sligo Dublin route quoting the perceived limitations of the F 27.

1.18 Additional Information

1.18.1 Non-Precision Approaches

Sligo Airport is located on the North West coast of Ireland and essentially is a balanced field. It provides little protection by way of an overrun area at the end of the runway, before an aircraft, failing to stop on the runway, enters the sea. A balanced field in general terms means that if a take off has to be aborted the aircraft must be brought to a halt on the remaining runway.

The instrument flight approaches to the airport are non-precision approaches. Such approaches provide no glide slope guidance to the pilots and essentially it is left to the pilot to maintain a virtual glide path roughly corresponding to 300 ft per mile for each mile of the approach.

Research by the USA Flight Safety Foundation has shown that non-precision approaches are six times more likely to lead to an approach and landing incident than a precision approach. An additional problem for older generation aircraft such as the F 27, which do not have a flight management and guidance system, results in all non-precision approaches being flown manually, rather than coupled to the autopilot. This may increase workload particularly in adverse weather conditions.

1.18.2 Additional Crew Information

Euroceltic held a UK Air Operators Certificate (AOC) and operated UK registered aircraft, therefore, operational and technical surveillance of this company was carried out by the UK Civil Aviation Authority (CAA). A month prior to the accident, following an audit by the CAA, the company imposed an operational limitation on the captain of G-ECAT requiring that he only fly left hand seat under supervision. This requirement was fulfilled on the accident flight, as the supervising pilot was the chief pilot of the company, and a qualified line-training captain.

1.19 Useful or Effective Investigation Techniques

Nil.

2. ANALYSIS

2.1 The Landing

Interviews with the pilots, discussion with the witnesses, analysis of the CVR and FDR, indicate that the aircraft was low and fast on the final phase of the approach. This led to the aircraft landing further down the runway than normal or recommended. The PF, was the former Chief Pilot of the Operator and was under the supervision of the PNF who was the new Chief Pilot and a qualified training captain. It is clear from the CVR that the approach was difficult and the PNF was using an instructor tone and coaching the PF.

Whilst the meteorological conditions were difficult they were well within the limits for the type of approach and there was very little crosswind component.

The PF told the investigation that considerable thrust adjustments were required, however, the aircraft obviously touched on nose first and, according to a witness, wheel barrowed for some time. The PF said that his initial braking was probably insufficient.

The Investigation believes that two conditions influenced this. Firstly, the PF was obviously aware from the PAPI's (showing 1 white 3 red as opposed to 2 white 2 red) that he was low and in a shallower approach than normal, but also fast and deep. The landing was initially on the nose wheel with minimum contact of the main wheels. The failure to achieve Ground Fine Pitch (GFP) on the first attempt may have distracted or interrupted the normal landing sequence of flaring, selecting reverse or GFP, and applying the wheel brakes. Secondly, when full wheel braking was applied without the necessary spin up of the wheels, then the obvious outcome was locked wheels and subsequent deflation and destruction of the tyres. This combination of events made it impossible for the aircraft to be brought to a halt on the remaining runway.

The layout of the airfield with the sea at both ends limits the amount of overrun available to an aircraft leaving the end of the runway and in this case the nose section of the aircraft actually entered the water.

2.2 Tyre Deflation

The failure of three burst tyres is consistent with the aircraft landing with the wheels not rotating. The probable scenario is that the brakes were heavily applied either when the aircraft was airborne during a bounce, or when it had touched on with only the nose wheel in ground contact.

When the main wheels subsequently came into contact with the runway, the locked tyres were worn away quickly. As noted in 1.6.3 above, the anti-skid would not have released the brakes in such circumstances

When sufficient material was eroded, the tyres material was insufficient to resist the internal inflation pressure, and, the tyre burst at this point. This failure mode was noted on all three failed tyres. Once each tyre had burst and deflated, it rotated on its rim, thereby negating any braking affect.

The non-failure of the starboard outer tyre may have been a result of the port wing being low at touchdown due to the crosswind effect, poor braking effect on this particular wheel, or a combination of such factors.

The absence of aquaplaning indications on any of the tyres showed that the runway conditions were not conducive to aquaplaning at the time of the landing, and that there was no significant standing water on the runway during the landing.

3. CONCLUSIONS

(a) Findings

3.1 The aircraft held a valid Certificate of Airworthiness (COA).

3.2 The crew were properly licensed to carry out the flight

3.3 The aircraft was fully serviceable with no defects and was suitable for the routes serviced by the Operator.

3.4 The Pilot Flying (PF) was restricted by the company to operate under supervision.

3.5 The weather conditions, in particular the crosswind component, were well inside the weather limitations permitted for this aircraft.

3.6 The Airport Rescue and Fire Fighting Service (ARFFS) performed their tasks with considerable improvisation and efficiency.

3.7 The final resting position of the aircraft made passenger evacuation very difficult and the actual evacuation was carried out without mishap.

3.8 The inter-service cooperation and teamwork by the ARFFS, the Local Authority Fire Service, An Garda Síochána and the Recovery Crew, led to an efficient recovery of the aircraft from its final resting place.

3.9 The availability of a Precision Approach System at Sligo Airport may have prevented this overrun.

3.10 The Cabin Crew Member (CCM) carried out her duties during the post crash scenario and evacuation with total professionalism.

3.11 Sligo Airport staff and management assisted shocked and upset passengers with due consideration and courtesy.

3.12 The Operator was undergoing a considerable change both in the type of aircraft being used and the nature of services it was providing.

3.13 The Operator was under the supervision of one Aviation Authority - the UK Civil Aviation Authority (CAA), whilst operating in the State of another Aviation Authority - the Irish Aviation Authority (IAA).

3.14 The Operator was a relatively new entrant to Air Operations with only seventeen months experience with the Fokker F 27.

(b) Causes

Primary Cause

The probable cause of this accident was a fast, low approach, leading to the aircraft landing late, beyond the normal touch down point, thereby making it impossible to stop the aircraft on the remaining runway available.

Contributory Cause

1 The lack of an adequate overrun area before an aircraft, failing to stop on the runway, enters the sea.

2. The lack of experience of the Operator in scheduled air operations.

3. The changing operational management structure and uncertain nature of the direction of the company with regard to aircraft type and network development.

4. SAFETY RECOMMENDATIONS

The following Safety Recommendations were made during the course of the investigation:

4.1 Sligo Airport should consider the installation of an Instrument Landing System. **(SR 11 of 2005)**

4.2 Sligo Airport in conjunction with the IAA should improve the over run area of RWY 11. **(SR 12 of 2005)**

Response SR 12 of 2005

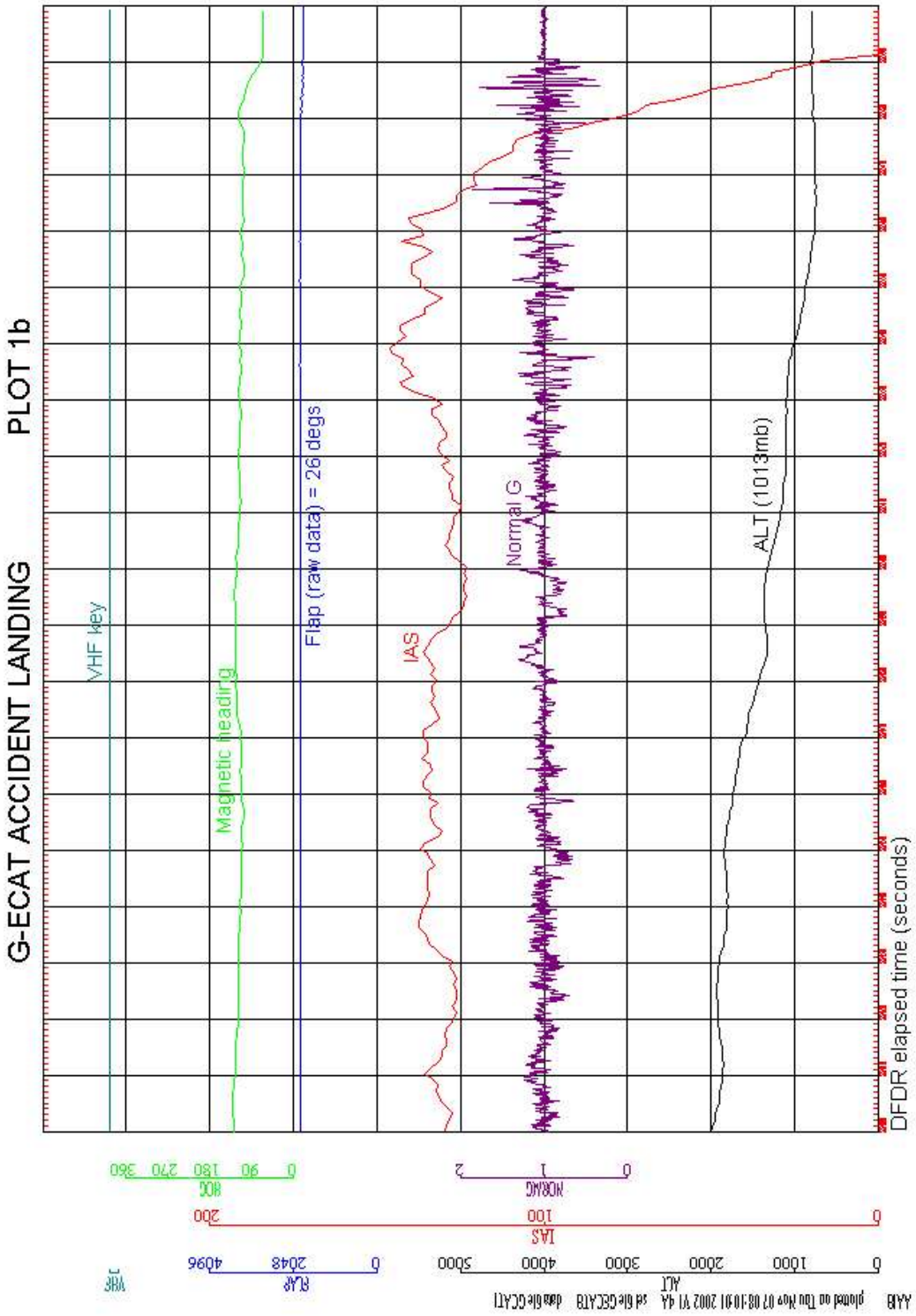
The IAA is not in a position to provide or assist in the provision of a runway end safety area at Sligo Airport. It has advised the licensee of Sligo Airport to provide same and is aware that the Airport has commissioned a design and anticipates applying for planning permission.

4.3 The Department of Transport should ensure that appropriate aviation technical support is available to any committee or panel awarding PSO air routes. **(SR 13 of 2005)**

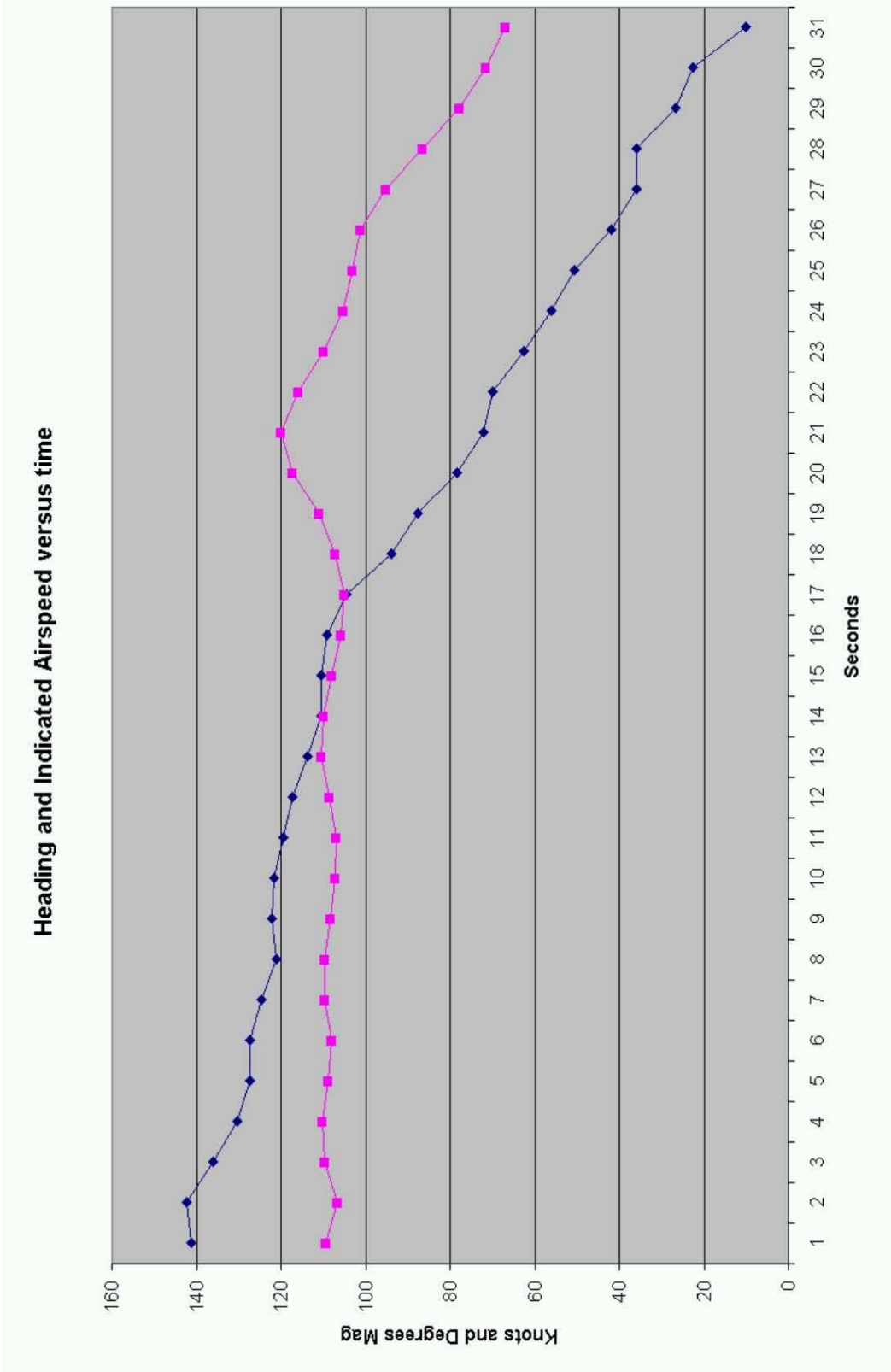
Response SR 13 of 2005

The Department of Transport has implemented Safety Recommendation SR 13 of 2005.

APPENDIX A

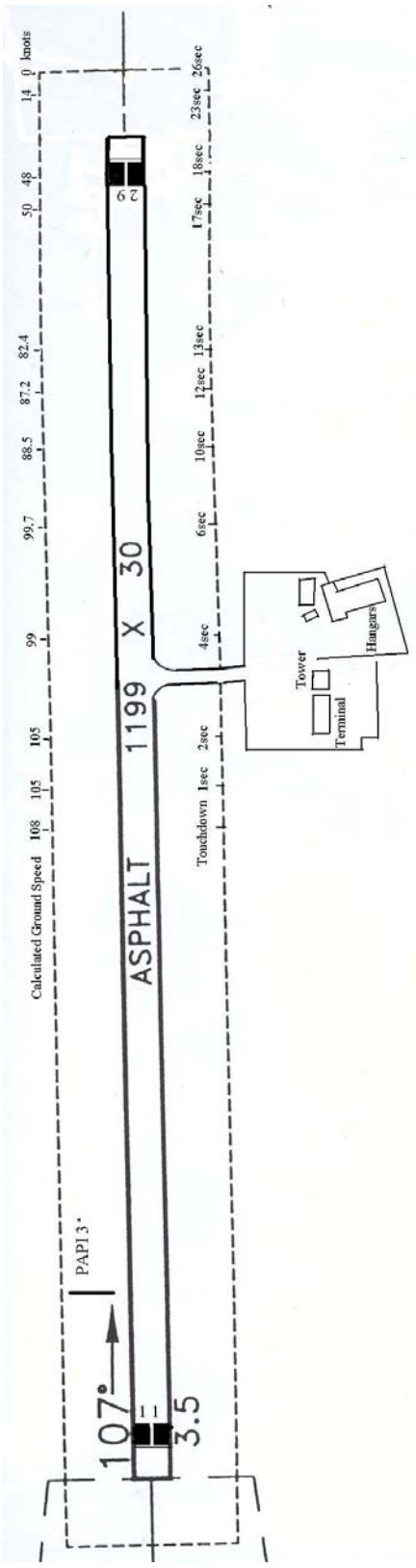

G-ECAT ACCIDENT LANDING
PLOT 1b
VHF key
Magnetic heading
Flap (raw data) = 26 degs
IAS
Normal G
ALT (1013mb)
DFDR elapsed time (seconds)

APPENDIX B


Heading and Indicated Airspeed versus time
Knots and Degrees Mag
Seconds
160
140
120
100
80
60
40
20
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

FINAL REPORT

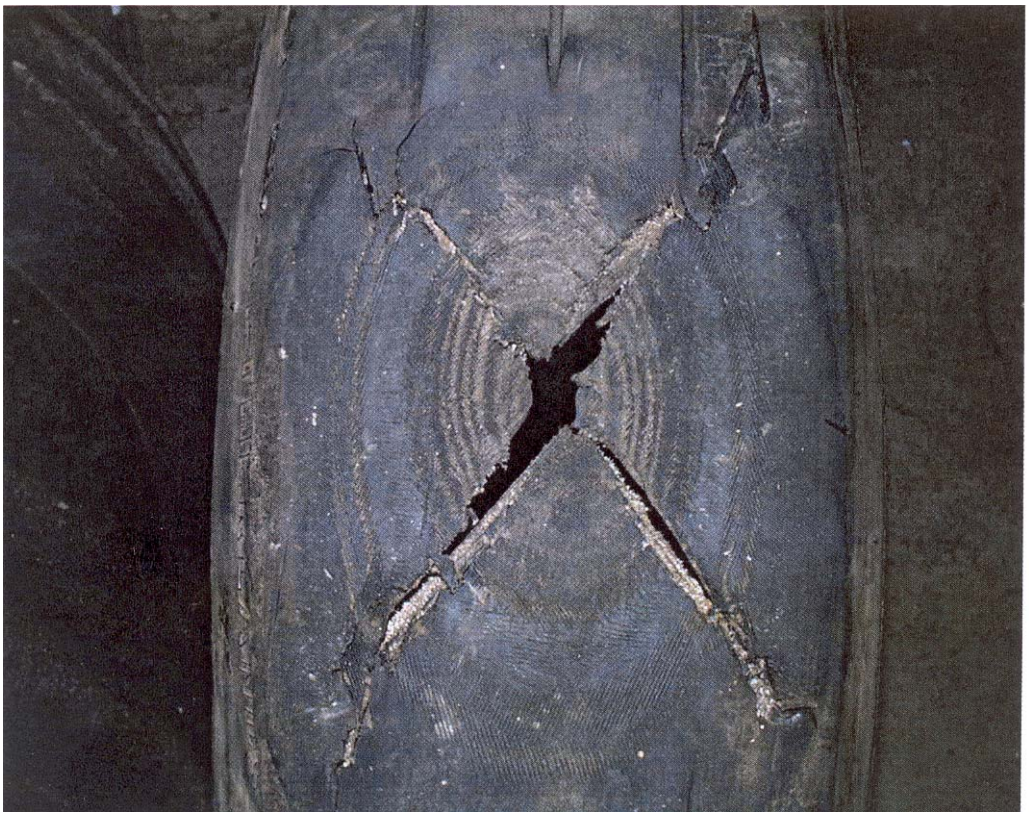
APPENDIX C



APPENDIX D

Final resting position of G-ECAT at half-tide mark.

APPENDIX E



The tread shows a skid mark, 90º counter-clockwise from the serial number. In the skid mark all individual tread and carcass plies show up as oval rings. In the centre of these ovals there is an 'X' break visible. Next to the skid damage there are oval wear marks visible