

Air Accidents Investigation Branch

Department of the Environment, Transport and the Regions

**Report on the accident to Fokker F27-500, G-BNCY
at Guernsey Airport, Channel Islands
on 7 December 1997**

This investigation was carried out in accordance with
The Civil Aviation (Investigation of Air Accidents and Incidents) (Guernsey) Order 1998

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ISBN 0 11 552141 0

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**Department of the Environment, Transport and the Regions
Air Accidents Investigation Branch
DERA Farnborough
Hampshire GU14 6TD**

16 June 1999

*Mr de V. G. Carey
The Bailiff of Guernsey*

Sir,

I have the honour to submit the report by Mr D S Miller, an Inspector of Air Accidents, on the circumstances of the accident to Fokker F27-500, G-BNCY at Guernsey Airport, Channel Islands on 7 December 1997.

I have the honour to be
Sir
Your obedient servant

K P R Smart
Chief Inspector of Air Accidents

Department of the Environment, Transport and the Regions
Air Accidents Investigation Branch
DERA Farnborough
Hampshire GU14 6TD

16 June 1999

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

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GLOSSARY OF ABBREVIATIONS USED IN THIS REPORT

AAIB	-	Air Accidents Investigation Branch (AAIB)
ATIS	-	Automatic Terminal Information Service
ATC	-	Air Traffic Control
CAA	-	Civil Aviation Authority
CAP	-	Civil Aviation Publication
CVR	-	Cockpit Voice Recorder
DH	-	Decision Height
DME	-	Distance Measuring Equipment
DV	-	Direct Vision
FFPS	-	Flight Fine Pitch Stop
GFPS	-	Ground Fine Pitch Stop
GMC	-	Ground Movement Control
HP	-	High Pressure
IAS	-	Indicated Airspeed
ICAO	-	International Civil Aviation Organisation
ILS	-	Instrument Landing System
LDA	-	Landing Distance Available
MATS	-	Manual of Air Traffic Services
mb	-	Millibars
MHz	-	Mega Hertz
MTOW	-	Maximum Takeoff Weight
nm	-	Nautical Miles
PAPI	-	Precision Approach Path Indicator
PCU	-	Propeller Control Unit
PF	-	Pilot Flying
PNF	-	Pilot not flying
TAF	-	Terminal Aerodrome Forecast
TGT	-	Turbine Gas Temperature
TOI	-	Temporary Operating Instruction
TTS	-	Target Threshold Speed
UFDR	-	Universal Flight Data Recorder
VOR	-	VHF Omni Range



Air Accidents Investigation Branch

Aircraft Accident Report No: 4/99

(EW/C97/12/1)

Registered Owner and Operator: Air UK Limited (now known as KLM UK)

Aircraft Type and Registration: Fokker F27 Mark 500, G-BNCY

Nationality: British

Place of Accident: Guernsey Airport, Channel Islands
Latitude: 49°26'N Longitude: 002°36'W

Date and Time: 7 December 1997 at 1818 hrs

All times in this report are UTC

Synopsis

The accident was notified to the Air Accidents Investigation Branch (AAIB) at 1905 hrs on 7 December 1997 and an Inspector's Investigation, conducted under the Civil Aviation (Investigation of Accidents) (Guernsey) Order 1972, began the following day at the request of the Bailiff of Guernsey. The investigation was continued under The Civil Aviation (Investigation of Air Accidents and Incidents) (Guernsey) Order 1998 when the 1972 Order was revoked on 24 August 1998.

The investigation was conducted by Mr D S Miller (Operations), Mr P R Coombs (Engineering) and Ms A Evans (Flight Recorders).

The accident occurred when the aircraft, which was on a scheduled flight from Southampton to Guernsey, overran Runway 27 whilst landing on a wet runway in strong crosswind conditions. Both propellers were reportedly selected to ground fine pitch after touchdown. The commander was not aware that the crosswind component at the time of landing was 34 kt, which was 5 kt above the maximum allowed by the company operations manual. Consequently he had difficulty in maintaining directional control whilst attempting to apply maximum braking. The two pilots and two of the passengers sustained minor injuries as a result of the overrun and subsequent evacuation. The remaining passengers were uninjured. The aircraft sustained substantial damage to the landing gear, the right wing, right engine and propeller.

The investigation identified the following causal factors:

- (i) The commander decided to continue with the landing knowing that touchdown was beyond the normal point.
- (ii) The commander was not aware at touchdown that the crosswind component of the surface wind affecting the aircraft exceeded the Flight Manual limit.
- (iii) The commander could not apply maximum braking to both main landing gear brakes at the same time as maintaining directional control through differential braking and full rudder application.

One safety recommendation was made during the course of the investigation.

1 Factual information

1.1 History of the flight

During his pre-flight preparation the commander noted that the crosswind at Guernsey would need close monitoring throughout the day as it would be close to the aircraft's crosswind limits. The aircraft departed from Guernsey at 1610 hrs for the first sector to Southampton, with the first officer acting as pilot flying (PF). On departure the first officer stated that the aircraft was 'difficult to keep straight' on the runway and moderate turbulence were encountered after takeoff between 500 to 1,000 feet agl but the remainder of the flight was uneventful. After landing at Southampton the commander carried out an external inspection of the aircraft and refuelled it with 800 litres of fuel increasing the total fuel on board to 1,745 kg. This was sufficient for the flight to Guernsey with necessary reserves to divert back to Southampton.

The aircraft departed from Southampton at 1723 hrs, with 50 passengers and 2 kg of freight on board, with the commander as the PF and the first officer as the pilot not flying (PNF).

During the cruise the first officer obtained the latest weather for Guernsey from the Automatic Terminal Information Service (ATIS). This gave the surface wind as 170°/19 gusting to 32 kt, visibility 5 km in rain, cloud scattered at 600 feet, broken at 800 feet, temperature 11°C, dewpoint 9°C, QNH of 1004 mb with turbulence and windshear below 200 feet agl. The commander briefed the first officer that he intended to carryout a 'radar vectored' ILS approach to Runway 27 using 26.5° of flap, instead of the usual 40°, for greater aileron control in the crosswind conditions during the landing. He also intended to add 10 kt to the target threshold speed (TTS).

In the final stages of the approach the aircraft experienced a drift angle of 25° to 30° in turbulent conditions. The aircraft was slightly above the prescribed glidepath as it crossed the threshold and the commander stated that when over the runway it was obvious to him that the aircraft would touchdown beyond the normal landing area. He therefore decided to initiate a go-around. Full power was applied and, when established with a positive rate of climb, the landing gear was selected up and the flaps retracted to 16°. The aircraft climbed to 1,500 feet, the flaps were retracted and the crew were given radar vectors for a second ILS approach to Runway 27.

The commander described the second approach as being more stable and on the correct 3° glidepath throughout. The drift angle this time was between 30° and 40° from the inbound track. The crew had correctly calculated the TTS as 96 kt with 40° of flap and 106 kt when using 26.5° of flap. The 40° flap TTS of 96 kt was displayed on the landing data card on the flight deck.

The aircraft was cleared to land by ATC approximately three minutes before the actual touchdown. The surface wind was passed as '180°/18 kt with the runway surface wet'. Nineteen seconds before touchdown ATC transmitted the surface wind as '190°/20 kt'.

The first officer stated that the indicated airspeed (IAS) had been 120 kt 'down the slope' and 110 kt as the aircraft crossed the threshold. The commander stated that the aircraft crossed the threshold, with 26.5° of flap selected, at the correct height with the projected touchdown point in the normal position. Both pilots stated that during the flare, at a height estimated by the commander to be between 10 to 15 feet above the runway, the aircraft appeared to float. The commander reduced the engine torques to zero. The aircraft then continued to descend and touched down, according to the commander, 'a little beyond the normal point, left mainwheel first followed by the right and then the nosewheel'. Several fireman however, who were on standby in their vehicles at the airport fire station, saw the aircraft touch down. They described the touchdown point as being opposite the runway fire access road, ie with 750 metres to 900 metres of runway remaining (see airport plan Appendix 1).

After touchdown the commander selected ground fine pitch on both engines but neither the first officer, the No 1 cabin attendant, who was seated at the rear of the aircraft, nor several of the passengers were aware of the normal aerodynamic braking noise from the propellers. The first officer selected the flaps up and, with the commander having called 'your stick', applied full left (into wind) aileron. It is normal for the PNF to then call '5 lights (indicating that both propellers were in ground fine pitch), TGTs (turbine gas temperatures) stable and flaps travelling'. The first officer can recall seeing five lights but stated that he did not make the normal call. The commander applied full right rudder and braking; applying maximum braking on the right side to keep the aircraft straight. The first officer described the commander as 'standing up in his seat' whilst applying full right rudder.

As the aircraft travelled down the runway it felt to the crew as if it was 'skidding or floating with ineffective brakes'. The first officer did not assist with the braking. Sixteen seconds into the ground roll the aircraft started to turn uncontrollably to the left. Realising that the aircraft would leave the paved surface the commander instructed the first officer to transmit a 'Mayday' message. The aircraft overran the end of the runway and entered the grass to the left of the extended centre-line at a speed estimated by the crew to be 60 kt. It then impacted and crossed a narrow earth bank before stopping in an adjacent field.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	-	-	-
Serious	-	-	-
Minor/None	4	50	

1.3 Damage to aircraft

The aircraft was damaged beyond economic repair.

1.4 Other damage

A hedgerow and earth bank surrounding the airport boundary were disrupted.

1.5 Personnel information

1.5.1	Commander:	Male, aged 50 years
	Licence:	Airline Transport Pilot's Licence
	Instrument rating:	Renewed on 20 May 1997
	Medical:	Class 1 issued on 6 June 1997 and valid until 31 December 1997
	Flying experience:	Total all types: 14,000 hours
		Total on type: 2,865 hours
		Last 90 days: 103 hours

Last 28 days: 17 hours

Duty time: The commander reported for duty at Norwich, at 0915 hrs having had 45 hours free from duty. He then drove to Heathrow to position as a passenger on a scheduled flight to Guernsey in order to operate 4 return sectors from Guernsey to Southampton.

1.5.2 First officer: Male, aged 37 years

Licence: Airline Transport Pilot's Licence

Instrument rating: Renewed on 25 March 1997

Medical: Class 1 issued on 20 January 1997 and valid until 31 January 1998

Flying experience Total all types 2,150 hours

Total on type 320 hours

Last 90 days 75 hours

Last 28 days 25 hours

Duty time: The first officer reported for duty at Stansted at 1045 hrs having had 48 hours free from duty. He travelled by taxi to Heathrow to join the commander for their positioning flight to Guernsey.

1.5.3 No 1 Cabin attendant: Female, aged 24 years

Emergency training: Emergency test and practice completed on 29 November 1997

Evacuation training completed on 23 January 1996 (3 yearly)

Fire and smoke drills completed on 2 November 1995 (3 yearly)

1.5.4 No 2 Cabin attendant: Male, aged N/K

Emergency training: Emergency test and practice completed on 28 May 1997

Evacuation training completed on 19 June 1997 (3 yearly).

Fire and smoke drills completed on 28 May 1997 (3 yearly).

1.6 Aircraft information

1.6.1 General information

Manufacturer:	Fokker VFW NV
Type:	F27 Mark 500
Aircraft Serial No:	10558
Year of Manufacture:	1977
Maximum Authorised Weight:	19,731 kg
Engines:	2 Rolls-Royce Dart R Da 7 Mk 532-7 turbo-prop
Certificate of Registration:	Issued 9 February 1987 by United Kingdom Civil Aviation Authority (UK CAA). Owned by Air UK Limited, Stansted
Certificate of Airworthiness:	Renewed 14 March 1996
Total hours:	44,877
Total landings:	53,639

1.6.2 Aircraft weight and centre of gravity

The aircraft was carrying a crew of 4 (2 pilots and 2 cabin crew), 50 passengers (15 Males; 31 Females; 3 Children; 1 infant) and 704 kg of baggage. The aircraft weight and centre of gravity were calculated by means of a computer generated load sheet. This gave the following information:

Total Traffic Load	4,299 kg	(Including 704 kg of baggage)
Dry Operating Weight	12,942 kg	
Zero Fuel Weight	17,241 kg	(Maximum 17,917 kg)
Take Off Fuel	1,745 kg	
Take Off Weight	18,986 kg	(Maximum 19,334 kg)
Estimated Trip Fuel	590 kg	
Landing Weight	18,396 kg	(Maximum 19,051 kg)

Note: Landing weight estimated at time of first landing

The aircraft was correctly loaded and within the limits of the centre of gravity envelope.

1.6.3 Braking system

The aircraft is fitted with differential wheelbrakes which are operated pneumatically by means of conventional toe brake controls positioned on each rudder pedal. Pneumatic pressure is provided by two pumps, one mounted on each engine accessory gearbox. 'Maxaret' anti-skid units acting on each individual brake pack sense locking of the associated wheel and vent its supply pressure to achieve brake release.

The emergency brake system is supplied by pneumatic reservoirs which also receive air under pressure from the pneumatic pumps. The system is operated via a handle accessible to the left seat flight deck crew member. All brake units are supplied together when the handle is operated. The emergency system pressure is routed via separate piping which bypasses 'maxaret' control.

1.6.4 Propeller control system

The aircraft is powered by two Rolls-Royce Dart single shaft turbo-prop engines driving Dowty Rotol propellers. Each propeller is controlled via its individual Propeller Control Unit (PCU). The total operating blade pitch range of this propeller type is from the zero degree setting to the fully feathered (87°) position, all pitch angles being referenced to the 0.7 radius spanwise station. The zero degree setting corresponds with the end of available travel of the main blade operating sleeve, the physical limit being the fixed Ground Fine Pitch Stop (GFPS).

Pitch is limited in flight to a minimum of 20°, by means of a withdrawable Flight Fine Pitch Stop (FFPS). This is provided to prevent excessive drag and possible loss of control which would occur if significantly lower pitch angles were to be reached whilst airborne. Operation on the ground under power, with the blades above the 20° position, would, however, result in overheat damage to the turbine. The FFPS is therefore withdrawn on the ground by crew action to enable the blades to be rotated to angles below 20° (ie into the ground fine range).

Withdrawal of the FFPS during the landing run, by allowing the blades to move into the ground fine range, produces the associated benefit of placing the blades at a negative angle relative to the airflow. This negative aerodynamic angle decreases as the aircraft slows down but initially produces considerable drag, thereby assisting the brakes in stopping the aircraft.

Control of propeller pitch and of FFPS withdrawal function is carried out hydraulically via each PCU. Desired RPM is signalled mechanically by the power levers. The blade pitch is then increased or decreased by varying oil pressures to either side of the main operating piston in response to pilot demanded RPM and achieved RPM detected by the constant speed element of the relevant PCU. Both FFPS can be withdrawn by operation of solenoid valves in each PCU which in turn supply oil under pressure to the third oil line within the corresponding propeller.

Each flight deck power lever can be lifted and moved backwards beyond its normal rearward position. The individual movement of either lever into this range operates micro switches which energise a circuit incorporating both pitch stop operating solenoids in series. In addition, engagement of the gust locks, carried out via a lever accessible to the left seat flight deck crew member, similarly energises both solenoids in series and should result in FFPS withdrawal.

1.7 Meteorological information

1.7.1 Aerodrome forecast

The forecast weather for Guernsey, issued at 1200 hrs on 7 December 1997 in Aerodrome Forecast (TAF) format, was as follows:

071322 17025G40KT 7000 -RA SCT005 BKN025 BECMG 1315 3000 RA
BKN 004 TEMPO 1518 1200 +RA BKN001 BECMG 1819 21022G35KT 5000
NSW

Decode:

Forecast for 7 December 1997 valid from 1300 hrs to 2200 hrs. Surface wind 170°/25 kt gusting to 40 kt with a visibility of 7 km in light rain. Cloud scattered at 500 feet, broken at 2,500 feet and becoming (ie a permanent change to), at an unspecified time between 1300 hrs and 1500 hrs, visibility 3,000 metres in rain with broken cloud at 400 feet. Temporarily (ie a period of temporary fluctuations occurring at any time) between 1500 hrs and 1800 hrs, visibility 1,200 metres in heavy rain with broken cloud at 100 feet; becoming in the period 1800 hrs to 1900 hrs, surface wind 210°/ 22 kt gusting to 35 kt, visibility 5,000 metres with no significant weather).

1.7.2 Rainfall data

Guernsey Airport is equipped with an 'MO Tilting Syphon Rain Gauge' capable of continually recording, on a moving paper graph, rainfall amounts and rates. The record for 7 December 1997 showed no rainfall from 0900 hrs until a period of light rain between 1545 hrs and 1555 hrs. There was then very little rain until a period of moderate rainfall (0.7 mm) between 1635 hrs and 1740 hrs. After this period there was little or no rainfall until two short periods of moderate rain at 0450 hrs and 0710 hrs the following day. The overall rainfall amount measured in the 24 hours up to 0900 hrs on the 8 December 1997 was 1.3 mm.

A report submitted by a pilot of a light twin engined aircraft landing on Runway 27 at 1805 hrs that evening stated that the runway was 'very wet'. He was not aware of the presence of any standing water.

1.7.3 Wind measurement

Guernsey Airport is equipped with the VAISALA Anemometer System which complied with the requirements specified in Civil Aviation Publication (CAP) 573 (replaced in April 1998 by CAP 670). Surface wind data is provided from two anemometers sited on the glidepath aerals adjacent to the respective touchdown points for each runway. There are two display units situated at both the Tower and Ground Movement Control (GMC) positions and a single unit at each of the three Radar positions.

1.7.3.1 Actual wind conditions

Information for both windspeed and direction was recorded from the anemometer sited abeam Runway 27 touchdown point. The recording (see Appendix 2) showed that the average wind direction for the period 1700 hrs to 1900 hrs on the

day of the accident was 170° veering to 180°. At the time of the accident the mean wind direction was 173° with variations between 155° and 190°.

Recorded mean windspeed for the same period was 15 kt at 1700 hrs rising to between 18 kt to 20 kt at 1730 hrs and rising further to a mean speed of 23 kt by 1850 hrs. The recorded mean speed at the time of the accident was 17 kt however the instantaneous wind was recorded as a maximum of 34 kt and a minimum of 19 kt. Gusts of 34 kt lasted for a period of approximately 5 minutes and were the maximum recorded that day.

1.7.3.2 Aeronautical Information Circular (AIC) 4/1997

AIC No 4/1997 concerns 'Surface Wind Information at UK Aerodromes'. It states that:

'Surface wind indication systems at Air traffic Control (ATC) units enable controllers to report to aircraft the best practicable information about the surface wind which an aircraft will encounter during takeoff and landing. ICAO Annex 3 (Meteorological Service for International Air Navigation) makes recommendations for the use of averaging wind indication systems to replace traditional display equipment giving instantaneous readings. These recommendations have been accepted by the CAA for immediate implementation at certain ATC units in the UK and, in due course, compliance will be required at all permanent ATC units at UK aerodromes.

When available, the 2 minute averaged wind surface wind is provided to aircraft requesting start-up or taxi clearance and when the current meteorological information is passed to arriving aircraft. Pilots may, as an alternative, request an instantaneous wind. The 2 minute averaged surface wind is used when the surface wind is included in an ATIS recording.

When a pilot requests the instantaneous surface wind at aerodromes where the 2 minute average surface wind is normally used the word 'instant' will be inserted to indicate that the wind being reported is not the 2 minute average. (Although not grammatically correct the word 'Instant' has the advantage of brevity).'

1.7.3.3 Local instructions

The ATC Manager at Guernsey, issued a Temporary Operating Instruction (TOI) No 04/97 on the 3 February 1997, concerning the 'Supply of Meteorological Information to Aircraft'. It stated that the following changes would take place in accordance with guidance material contained in Aeronautical Information Circular (AIC) No 4/1997. Firstly, with effect from 4 February 1997 the surface wind supplied by the Met office on the AIRFAX, for broadcast on the Automated Terminal Information Service (ATIS), would be the 2 minute averaged surface

wind and secondly that when transmitting the instantaneous surface wind (to crews) the word 'INSTANT' would be used instead of instantaneous.

A further TOI (No 6/97) was issued on 5 February 1997 regarding the surface wind information broadcast on the ATIS. It stated that, after consultation with the CAA Safety Regulation Group, the surface wind supplied by the Met Office would be the 2 minute average wind read from the anemometer sited abeam the touchdown point of the runway in use and not the Runway 27 reading which was the preferred site used for all Met information disseminated outside the airport.

1.7.3.4 Manual of Air Traffic Services (MATS) Part 2

The Manual of Air Traffic Services included a section on the reporting of surface wind to aircraft. One sub-section dealt with the display settings to be used on the VAISALA system and stated:

'In all operational positions the Display Mode Select Switch should be set on the Take-Off and Landing (T/L) setting (meeting the ICAO and CAP 573 requirements). This setting displays

- (a) Average Wind Speed – calculated over the previous 2 minutes.
- (b) Maximum and Minimum wind speed – recorded during the previous 10 minutes and displayed only when they differ from the 2 minute average by 10 kt or more.
- (c) Wind Direction – average direction calculated over the previous 2 minute period.
- (d) Wind Direction Variation – displayed when the wind is 5 kt or less or greater than 5 kt and the variation, recorded over the previous 10 minutes, is greater than 60°.'

A further sub-section covered its operational use and stated:

'Only the 2 minute average wind reading is to be passed to aircraft, unless the pilot has requested an 'instantaneous' wind readout or the surface wind condition is 'strong or gusting crosswinds, in excess of a mean of 20 kts, 45° or more from the runway QDM' (extract from section 7-1-2 para 2 (iii)).

In this case the Tower controller may at his/her discretion, pass the instantaneous surface wind reading. The instantaneous surface wind should be available to be passed to pilots on request, particularly those operating aircraft with a MTOW of 5,700 kg or less.'

The Air Navigation Order No 2 1989 (Appendix B – Surface Wind Indication) stated that the CAA had accepted the ICAO recommendations in ICAO Annex 3

and required eventual compliance at all aerodromes. Paragraph 1.4.7 of Appendix B stated that:

‘Variations from the mean wind speed (gusts) during the past 10 minutes shall be reported only when the variation from the mean speed has exceeded 10 kt: such speed variations (gusts) shall be expressed as the maximum and minimum speeds attained.’

1.8 Aids to navigation

1.8.1 Instrument Landing System (ILS)

Runway 27 is equipped with an Instrument Landing System (ILS) with the glideslope set to 3°. The system was last checked prior to the accident by a flight test on 16 September 1997 and was ON and serviceable at the time of the accident. The Distance Measuring Equipment (DME), co-located with the VOR, was also ON and serviceable.

The aerodrome operating minima for an ILS approach includes a Decision Altitude (DA) / Decision Height (DH) of 535 / 200 feet with a minimum visibility of 600 metres.

1.9 Communications

VHF communications between the crew and Guernsey approach (128.65 MHz), and Guernsey tower (119.95 MHz) were satisfactory. Conversation was recorded and a copy tape with injected time signal was provided to the investigation team.

1.10 Airport information

1.10.1 Runway physical characteristics

Runway 09/27 at Guernsey, is 1,463 metres (4,800 feet) in length and 45 metres (147.63 feet) wide and has a QDM of 273°M. The full length is declared as landing distance available (LDA) and the overall slope of Runway 27 is published as being 0.65% down. The runway surface is of asphalt.

1.10.2 Lighting

The runway is equipped with high intensity centreline and 5 bar approach lights, precision approach path indicators (PAPIs) set at 3° and threshold lights with wing bars. At the time of the accident these were selected to 1% intensity. The

runway has elevated high intensity edge lights and high intensity colour coded centreline lights. These were both selected ON to an intensity setting of 3%.

The lighting was checked prior to night flying on the 7 December 1997 and no deficiencies were recorded.

1.10.3 Runway friction

Runway friction classification analysis of Runway 09/27 at Guernsey Airport was carried out, in accordance with CAA guidance material, on 12 February 1998 by the Aircraft Ground Operations Group of Cranfield Aerospace Ltd. The weather was fine and the runway surface remained dry throughout the trial. The results of the analysis are shown in Appendix 3.

1.11 Flight recorders

1.11.1 Flight Data Recorder

The aircraft was fitted with a Sundstrand Universal Flight Data Recorder (UFDR) and a 30 minute Fairchild A100 Cockpit Voice Recorder (CVR). The UFDR was readout by the AAIB and the plot for the landing is shown in Appendix 5. Extracts from the CVR transcript are included. The seven parameters recorded were airspeed, pressure altitude, magnetic heading, normal acceleration, flap, frame counter and the VHF transmission switch.

The aircraft touched down at an indicated airspeed of 105 kt, identified from the normal acceleration peak of 1.47g. Eight seconds later, at an IAS of 83 kt, the aircraft began to turn to the left; its heading decreasing from the runway heading of 273° to 263°. Seven seconds later the aircraft turned further to the left onto 260°. Seventeen seconds after touchdown, with the aircraft speed below 30 kt IAS some large excursions in normal acceleration were recorded. This probably occurred during the final transition of the aircraft off the runway and over the bank. These lasted for some eight seconds, until the aircraft came to rest and the peak values recorded were -0.46g and +2.34g. The aircraft stopped on a heading of 263°.

1.11.2 Cockpit voice recorder

Engine power was not recorded by the UFDR but engine low pressure compressor frequencies were identified on the area microphone track of the CVR. The aircraft manufacturer stated that the 15 vanes on the LP compressor will create a 2.5 to 2.6 KHz tone at engine speeds of between 10,000 and 10,400 RPM. Minimum constant speeding RPM during approach is 11,000, but when the aircraft is decelerating during the landing flare the flight fine pitch stop in the propeller will cause the engine/propeller to under-speed, which is considered acceptable down to 8,000 RPM. Engine power is not affected when ground fine pitch is selected, because the engine remains at idle.

The engine frequencies during the landing flare reduced from 2.6 KHz (10,400 RPM) to below 2 KHz (8,000 RPM). There was a small difference of about 4 seconds in the timing at which each engine/propeller under-spun, although it was not possible to determine which engine reduced first. The selection of ground fine pitch could not be identified.

1.11.3 Landing distance calculations

The landing reference speed for flaps 26.5 was 106 kt; this is the speed at which the aircraft should be at the screen height of 50 feet. In the case of this accident the aircraft touched down at 105 kt IAS.

The aircraft manufacturer provided details for the calculation of the stopping distance. For the following conditions the distance to stop was calculated:

Aircraft Weight:	18,081 kg (39,914 lb) (estimated accident weight)
Flap setting;	26.5°
Touchdown speed:	105 kt IAS
Runway slope:	0.65% downhill
Runway condition:	wet
Temperature:	+9°C
Pressure Altitude:	+600 feet
Wind speed:	180/25 to 35 kt on Runway 27 (zero headwind)
Propeller:	flight fine

Distance to stop:	653 metres (2,141 feet) (dry runway, flight fine pitch)
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523 metres (1,713 feet)
(dry runway, ground fine pitch)

815 metres (2,676 feet)
(wet runway, flight fine pitch)

653 metres (2,141 feet)
(wet runway, ground fine pitch)

The figures are calculated for dry runways and assume that full braking is applied after touchdown. For wet runways the scheduled landing distance is increased by 15% (approximately 25% increase in the stopping distance). This factor is obtained for the Airworthiness Requirements and does not have to represent the actual wet runway situation.

Tests with propellers in ground fine pitch showed that the deceleration increased by 20%, and this factor has been used to derive the stopping distance figures for ground fine pitch. Normal procedure is to select ground fine pitch after touchdown.

The aircraft touched down with approximately 750 metres to 900 metres of the runway remaining. From the calculations the distance to stop on a wet runway would be 653 to 815 metres, however this figure contains no margins to allow for operational conditions, such as actual runway friction and the amount of braking used by the pilot.

The Flight Manual landing distance for flap 26.5° was 1,188 metres (3,900 feet). This distance represents the dry runway landing distance from 50 feet screen height to standstill and factored by 1.67 as a safety margin.

1.12 Wreckage and impact information

1.12.1 Accident sequence

The aircraft came to rest in a field outside the airport boundary. Wheel-tracks visible on the runway and more distinctly on the over-run area showed that the aircraft was beginning a turn to the left whilst sliding to the right before it departed from the end of the paved surface, still positioned laterally within the width of the runway. Once on the grass, the turning and lateral sliding continued until the aircraft encountered a narrow earth bank, striking it obliquely.

At this point the left landing gear leg passed through the bank without damage. The nose landing gear leg separated on impact with the bank and the right propeller struck hedging, fencing posts and wire on top of the bank. The right landing gear leg then struck the bank and collapsed rearwards. The aircraft passed over the bank and fell onto the ground outside the airport perimeter, rolling rapidly to the right as a result of the left landing gear contacting the ground whilst there was an absence of corresponding support from the collapsed right landing gear. The right wingtip struck the ground causing the wing box structure to fail in bending approximately ten feet inboard of the tip.

The left propeller, which was undamaged, was found in the feathered position whilst the damaged right unit had blades at a variety of pitch angles.

The markings on the runway suggested initially that changing amounts of braking may have been occurring; as the aircraft was sliding laterally at the time, however, these indications were considered to be unreliable.

1.12.2 Examination of the aircraft on site

The fuselage had telescoped by approximately 1.3 cm at a point close to the aft edge of the forward door. In addition to the damage evident to the outboard right wing box structure, the alignment of the right engine nacelle was disturbed as indicated by extensive skin wrinkling aft of the fire-wall.

Damage had occurred to the underside of the forward fuselage and to a point on the underside of the rear fuselage, in the region of the tailplane, apparently caused when the rear of the aircraft descended onto the earth bank. The right propeller had extensive damage to all four blades, no consistent pitch angle being evident.

Examination of the flaps showed that the aircraft came to rest with them in the up position.

1.12.3 Testing on site

The emergency brake system pressure gauges indicated maximum when first examined, although the wire 'tell-tale' on the selector handle was broken. A compressor was connected to the main brake pneumatic system. The left unit functioned correctly when the foot pedals were operated, whilst compressed air flowed freely from a pipe in the right nacelle area which had fractured as a result of the damage occurring when the associated leg collapsed. After inserting a section

of piping to bridge the damaged area, it was possible to function the right unit in a similar way.

The two condition levers were found in the fully aft 'Manual Feather' position. The levers were initially re-selected to the 'run' position. The batteries were re-connected to the electrical system and the feathering pumps used to provide oil pressure for blade pitch control. The internal operating piston and one blade of the damaged right propeller were found below the flight fine pitch stop (FFPS) position.

The manual feather positions were selected on the condition levers and the internal mechanism within the right propeller responded, driving the only connected blade towards feather. It was then found that both propellers could be returned to positions below the FFPS by normal aft movement of the power levers into the ground fine (GFPS) position, although all movements of the right propeller were accompanied by abnormal mechanical noises from within the hub.

The right pitot static pipe system had remained intact in the area of the structural damage to that wing. Both left and right pitot-static systems were subjected to standard pressure /leak testing; the UFDR connections were blanked since that unit had been removed, thereby opening pitot-static connections. Both airspeed indicators were found to register within the prescribed limits

The rear passenger door was not free to slide rearwards when tested unless its upper section was positioned outboard. This was the result of the angle at which the aircraft had come to rest (ie inclined to starboard). This allowed the upper part of the door to rest against the inside of the housing into which it slides rather than to rest in its normal position. Further testing of the door however revealed no evidence of unlatching (opening) difficulties.

1.12.4 Component examination

The No 1 (left) propeller was undamaged by the impact and was not subjected to examination beyond the functional testing carried out in situ on the aircraft. The No 2 (right) propeller was partly stripped to establish its pitch position at the time of its impact, together with the condition of the pitch stop. It was determined from the condition of the main internal sleeve that the unit was at or within a few degrees of the GFPS when the blades suffered damage. Absence of damage on the FFPS hardware confirmed that the propeller had not been driven by impact forcibly through that stop.

Both left and right PCUs were subjected to rig testing with particular emphasis on repeated electrical operation of the FFPS solenoids and hence the third oil line pressure control. No defects were found within these units.

Strip examination of the No 2 engine revealed that the turbine shaft had failed in torsion, whilst the turbine presented no corresponding evidence of overheating.

The tyres were examined and no evidence was observed of operation having occurred with wheels locked. The maxaret units were also functionally tested and found to operate correctly. The brake units were serviceable.

1.13 Medical and pathological information

The commander suffered a slight injury to one of his ankles and the first officer injured his back. A passenger suffered from a slight back injury and one passenger injured her head during the evacuation.

1.14 Fire

There was no fire.

1.15 Survival aspects

1.15.1 Aircraft doors and emergency exits

The aircraft is equipped with a main passenger door, situated on the rear left side; two emergency exit windows, one on either side of the main passenger cabin beneath the wings and four windows from the rear; and an emergency door situated in the toilet compartment at the rear right side. The crew emergency exits are designated as the cargo/crew entrance door on the forward left side and the first officer's sliding window on the flight deck.

During take off and landing the No 1 cabin attendant sits by the left rear door in the rear 'jump seat' and the No 2 cabin attendant sits by the front left 'cargo' door in the front 'jump seat'.

1.15.2 The evacuation

The aircraft came to rest inclined on its right side. The commander called for the full fire drill and the first officer selected both HP cocks to feather, fired extinguishers into both engines and opened his direct vision (DV) window ready for an evacuation. The commander spoke, via the intercom, to the No 1 cabin

attendant seated at the rear of the cabin, and instructed her to 'evacuate the passengers via the port side as there was fuel on the starboard side'.

In the passenger cabin were two cabin crew members, 46 adults, three children, and one baby. Three of the children were travelling unaccompanied.

The No 1 cabin attendant attempted to open the left rear door but could not turn the door handle sufficiently. She asked a passenger seated in the last row to help but he could not open it either. She then moved forward into the cabin and saw the passengers leaving the aircraft via the under-wing emergency exit windows. They appeared to be having some difficulty so she shouted "legs then body" in an attempt to advise them on how they should exit. She then grabbed the two unaccompanied children seated in row 12. As she did so the commander broadcast over the PA to evacuate via the rear toilet compartment door. The No 1 opened this door, jettisoned it outboard, exited the aircraft and moved the door clear. The unaccompanied children and a substantial number of the passengers followed her. Once clear of the aircraft the passengers were directed around the tail to congregate on the aircraft's left side. When the No 2 who had been shepherding the passengers to the exit reached the door he, along with the No 1 who had re-entered the aircraft, walked back along the cabin to check that the aircraft was clear of passengers. By this time a fireman had opened the rear left door from outside and entered the aircraft. The two cabin attendants then walked to the rear of the aircraft, exited via the toilet compartment door, and joined the passengers.

It was determined that 18 of the passengers exited the aircraft via the toilet compartment exit at the rear of the aircraft on the right side. Seven passengers exited via the left under-wing emergency window exit and 10 passengers via the right under-wing exit. It was not possible to determine the exits used by the remaining 14 passengers. The baby was carried out via the right under-wing exit.

With all the passengers clear the No 2 carried out a 'head count' while the No 1 checked the passengers for injuries. One female passenger had injured her head during the evacuation. The No 1, along with a fireman, then collected survival blankets from a nearby fire vehicle and returned to distribute them amongst the passengers who by this time were gathered near to the earth bank on ground sloping up from the aircraft. Although most of the passengers were given the silver foil blankets they found the packaging difficult to open and the blankets almost impossible to wrap around themselves because of the strong wind.

The first officer attempted to stand up in order to exit the aircraft but found it difficult because of a back injury. The commander suggested that the first officer

remain seated while he attempted to open the cargo door (situated on the left side behind the flight deck). This attempt and a further attempt by the first officer failed. As there was no sign of fire or immediate danger, the first officer sat down in one of the passenger seats to await assistance.

Approximately 15 to 20 minutes later two taxis, fortuitously parked on a taxi rank outside the airport, were commandeered and escorted to the crash site to complement the ambulances and police cars ferrying the passengers to the terminal. The airport did not have any passenger coaches.

Several of the passengers were suffering from shock and cold. The three unaccompanied children, again in the care of the No 1, were transferred into the care of fire service personnel for transfer to the terminal. The No 1 returned to the aircraft to assist with a stretcher provided for the first officer. She, together with a fireman, attempted to unlock the cargo door to ease the first officer's egress. This door took 10 minutes to free as the airframe around the door had been distorted and one of the door locking pins had to be cut to release it. The reason for the initial difficulty in opening the aft passenger door could not be established.

1.16 Tests and research

None.

1.17 Organisational and management information

The Airport Director, who reports to the Chief Executive Officer of the States Board of Administration, is in charge of the day-to-day operation of the airport. Working for him are five senior managers: The Deputy Airport Director; Manager Air Traffic Control; Chief Telecommunications Officer; Chief Airport Fire Officer; and the Senior Meteorological Observer.

The Air Traffic Control Manager's responsibilities and duties are defined by the Board of Administration. In essence he has responsibilities for the effective provision of Air Traffic Services at Guernsey and Alderney Airports. He is specifically responsible for the preparation of the Airport Manual and Emergency orders specific to ATC. Likewise the Chief Fire Officer is responsible for the production and maintenance of the 'Airport Fire Service Emergency Manual'. Both these manuals were used as a basis for the airport's emergency response at the time of the accident.

Study of the 'Airport Emergency Procedures', published to co-ordinate the responses of both the airport and Island emergency services, showed that they

were drawn-up in November 1983 and amended in January 1985. Since then they had fallen into disuse and as such no current definitive Airport Disaster Plan existed.

The 'landside' section of the airport (ie the passenger handling and terminal control) is the responsibility of the Terminal Duty Officer who, in the event of an emergency, is responsible to the Management Duty Officer. The airport management team did not however include an individual specifically responsible for 'airside' safety.

In March 1999 the States of Guernsey Board of Administration advertised, in the aviation press, for an 'Airport Operations Manager' for the 'safe and efficient operation of the Airport's airside areas in accordance with the provisions of the Aerodrome Licence and regulatory legislation'.

1.18 Additional information

None.

2 Analysis

2.1 General

The commander and first officer were both aware of the general conditions to be expected for their return to Guernsey. They were both properly qualified and adequately experienced for the flight. The aircraft, which was free from defects, was calculated to be 970 kg below its maximum landing weight at the time of the accident. At this weight the distance required for the aircraft to stop was within the estimated 900 metres of runway remaining from touchdown but it failed to stop in the distance available. After successfully evacuating the aircraft, passengers and crew experienced a 15 to 20 minute delay before they were afforded shelter within nearby airport buildings. During this delay inadequate environmental protection for the survivors was provided.

This analysis considers the crew procedures, the condition of the runway, the meteorological environment and its reporting at the time of landing, the performance and the braking effectiveness of the aircraft and the post evacuation passenger handling.

2.2 Aircraft handling and performance

During the approach the aircraft was flown with 26.5° of flap. This reduced flap setting was to give the commander more control in the strong crosswind conditions. The target threshold speed (TTS) for 40° of flap was correctly calculated to be 96 kt and this figure was written down by the crew and displayed in the flight deck. A TTS of 106 kt, however, was used to cater for the 26.5° flap landing. Airspeed fluctuations between 119 kt and 102 kt were recorded during the later stages of the approach. These were to be expected in the prevailing conditions. At touchdown the UFDR recorded a speed of 105 kt consistent with that calculated. The first approach had been terminated by the commander when he realised that the aircraft would touch down 'beyond the normal position' and again on this subsequent approach the aircraft floated and appeared 'reluctant to descend'. The commander however decided to continue with the landing by reducing the engine torques to zero.

After landing the first officer, in accordance with the standard operating procedures, retracted the flaps to reduce the lift generated by the wings and hence increase the weight on the wheels. He also recalls seeing indications on the flight deck confirming that both propellers had been selected by the commander to ground fine pitch. He was required to verbally confirm the engine and flap status during this phase of the landing but overlooked this call. This omission however

had no material effect on events. Analysis of the CVR could not identify the selection of ground fine pitch.

There is no doubt that the commander had extreme difficulty in maintaining directional control of the aircraft when it was on the runway. He did not know that the crosswind was at or above the limit of controllability.

In order to maintain the runway heading he not only had to apply full rudder but also full right braking. His effort was such that 'he appeared to be standing up in his seat'. It is not possible to determine the amount of braking applied to the left brakes, if any. With full rudder deflection and full right brake applied it would have been almost impossible for him to apply any significant braking to the left brakes without loss of directional control. Therefore the total amount of braking applied could only have been marginally more than half of that available.

When it became apparent to the commander that the aircraft would overrun the paved surface he instructed the first officer to transmit a 'Mayday' call to the tower. At the time the commander was not aware of the reasons why the aircraft was not stopping. It could have been that the brakes were not functioning correctly and therefore he had the option of asking the first officer to apply his brakes as well. In exercising this option however the first officer could have exacerbated the directional control problems being experienced by the commander. It is considered therefore that although this option was available the benefit of such action would have been outweighed by the difficulty in coordinating the braking effort from both pilots thus creating even more directional control problems for the commander.

The aircraft touched down with no more than 900 metres of runway remaining. The landing distance required, in the aircraft's landing configuration and in the prevailing conditions, was 815 metres with flight fine pitch selected on the propellers and 653 metres with ground fine pitch selected. The aircraft did not stop in the distance available and departed the paved surface at a speed of 30 kt. In the absence of any systems malfunctions the degradation in stopping performance must primarily be as a result of inadequate braking.

Neither the first officer, the No 1 cabin attendant, nor several of the passengers were aware of the normal aerodynamic braking noise from the propellers. Therefore, though less significantly, a possible delay in propellers achieving ground fine pitch and the possibility of some standing water being present on the runway towards the end of the landing run, may have had an effect.

2.3 Aircraft systems

No evidence was found of any mechanical or electrical defect which could have contributed to the aircraft failing to stop in the distance required. The failed turbine shaft in the No 2 engine suggests that the corresponding power lever may have been slightly above the idle position at impact. The propeller pitch position and absence of damage to the FFPS however confirms that the engine was at a power well below that required to raise the pitch out of the ground fine range.

2.4 Wind reporting

The commander and first officer were aware that the windspeed and direction at Guernsey would need close monitoring throughout the day. They were also aware that the company operations manual crosswind limit for the F27 is 29 kt.

The forecast predicted that the surface wind would be 170°/25 kt with gusts to 40 kt becoming 210°/22 kt with gusts to 35 kt in the period 1800 hrs to 1900 hrs. In other words the crosswind component was predicted to be gusting outside the aircraft's limit.

The ATIS information, obtained by the first officer prior to the approach, gave the surface wind as 170°/19 kt gusting to 32 kt. This was the 2 minute average wind broadcast in accordance with the guidance material contained in AIC No 4/1997.

The Manual of Air Traffic Services (MATS) Part 2 states that only the 2 minute average wind is to be passed to aircraft unless the pilot has requested an 'instantaneous' wind or the surface wind condition is 'strong or gusting crosswinds, in excess of a mean of 20 kt, 45° or more from the runway heading.' The commander did not request the instantaneous wind and, with the mean wind speed at the time of touchdown of 17 kt, the tower controller was not obliged, under his own discretion, to volunteer the instantaneous wind. The controller did however pass the surface wind of 190°/20 kt to the aircraft some 19 seconds before touchdown.

The commander thus made his assessment of the wind condition based on information that was only 19 seconds old. Justifiably he was satisfied that the conditions were acceptable for landing. It was therefore unfortunate and unpredictable that the crosswind component at the time of touchdown, measured by the anemometer, was gusting outside the aircraft's limits.

2.5 Runway condition

The average Friction Classification readings for Guernsey's runway were just above the maintenance planning requirements of the NOTAL 2/904 guidance material. The friction monitoring runs gave no indication of significant low friction areas caused by standing water. Measurements on the day of the accident showed that there had been a period of moderate rainfall from 1635 hrs to 1740 hrs in which 0.7 mm of rain fell but there had been no measured rainfall from then until 1818 hrs, the time of the accident.

Pooling of surface water brought about by the strong southerly wind, preventing natural drainage, could have been a possibility. Reports from a pilot landing his aircraft some 13 minutes before the accident, and after the period of moderate rain, suggested that although the runway was very wet there was no standing water. The point at which this aircraft turned off the runway however could not be determined. It is therefore possible that the pilot did not experience or see the condition of the entire length of the runway. The possibility of a degree of standing water at the end of Runway 27 therefore cannot be ruled out. Reduced braking action brought about by a poor runway surface however is unlikely to have contributed to the accident.

2.6 Fire and rescue service response

The Airport Fire Service (AFS), who were on a weather standby, reacted to the emergency immediately. Firemen, on standby in their vehicles at the time of the landing, heard the 'Mayday' transmitted by the first officer and were driving to attend even before the crash alarm was sounded. The procedures followed were in compliance with those published in the AFS Emergency Manual.

2.7 Evacuation

The passengers and the two cabin crew members vacated the aircraft in a timely manner via the right rear emergency door and both under-wing emergency exits. The cause for the restriction to the opening of the rear left passenger could not be determined. The cabin crew performed their duties in a professional manner and ensured that all the passengers cabin were clear of the aircraft before they attended to them outside the aircraft.

2.8 Survival

After the evacuation the passengers assembled in a corner of the field clear of the aircraft. The cabin crew carried out a head count as soon as possible and then

assessed whether there had been any injuries. The conditions outside the aircraft were uncomfortable with cold temperatures exacerbated by a strong wind.

The airport was not equipped with any suitable airside passenger coaches hence the recovery of the passengers to a place of shelter was via ambulance, police car and local taxi. This recovery was somewhat delayed and as a result many of the passengers complained of the cold and were issued with 'foil type' survival blankets. These were stored in packaging that was difficult to open with cold hands. Furthermore, the blankets when used became torn and disrupted in the strong wind. The passengers were eventually transported to a terminal reception area after a delay of some 15 to 20 minutes.

2.9 Airport emergency planning

Both ATC and the AFS carried out procedures during the emergency that were laid down in their respective emergency manuals. The Airport Disaster Plan, a document co-ordinating the effort of both the airport services and those of the island, had become obsolete. This situation was apparent within a few days after the accident. On the 22 December 1997, as part of the investigation, it was recommended to the Bailiff of Guernsey that:

‘The Airport Director should produce, issue and be responsible for the maintenance of an Airport Disaster Plan that defines the policy, procedures and areas of responsibility of those airport and Island services identified as being required to react in the event of an airport disaster.’
[Recommendation 97-71]

In response the Bailiff of Guernsey forwarded the recommendation to the President of the States Board of Administration for expeditious consideration.

As a result a Contingency Planning Manual for Guernsey Airport, prepared in consultation with the Island of Guernsey's Emergency Services, has been issued to all organisations at the airport, including the airlines and handling agents. Other organisations elsewhere on the Island which may become involved in the event of an aircraft incident or accident have also been issued with a copy. A further copy of the Contingency Plan is now also held by the Civil Aviation Authority's Safety Regulation Group.

Furthermore the Airport Authority has now circulated, to the relevant bodies, a Contingency Planning Manual for Alderney Airport and Aerodrome Manuals for both Guernsey and Alderney.

3 Conclusions

(a) Findings

- (i) The flight crew were properly licensed, rested and medically fit to conduct the flight.
- (ii) The aircraft had a valid Certificate of Airworthiness and Maintenance.
- (iii) The aircraft was calculated to be 970 kg below the maximum authorised landing weight for Runway 27, and was loaded correctly.
- (iv) The commander did not request 'instantaneous' wind information from ATC prior to touchdown as he had been passed the windspeed and direction only 19 seconds earlier. Thus his decision to land was based on wind conditions that were acceptable.
- (v) Friction testing of the runway showed that the runway surface condition was not a factor in this accident.
- (vi) The aircraft's wheelbraking and both propeller pitch control systems were operating satisfactorily.
- (vii) The aircraft required 653 metres of runway within which to stop with maximum braking and ground fine pitch selected on both propellers. Although the initial touchdown on Runway 27 was made with 750 metres to 900 metres of runway remaining and ground fine pitch reportedly selected after touchdown the aircraft failed to stop.
- (viii) The commander had extreme difficulty in maintaining directional control during the rollout phase and could not apply maximum braking to both main landing gear brakes.
- (ix) The commander could not have known the local wind conditions affecting the aircraft at the time of touchdown.

- (x) The commander, realising that the aircraft would overrun the paved surface, and not knowing whether his brakes were fully effective, had the option of asking the first officer to apply his brakes as well. This option however could have exacerbated the directional control problems being experienced by the commander.
- (xi) There were inadequate resources available at the airport to provide protection a timely transportation of the survivors to a place of shelter.

(b) Causal factors

The investigation identified the following causal factors:

- (i) The commander decided to continue with the landing knowing that touchdown was beyond the normal point.
- (ii) The commander was not aware at touchdown that the crosswind component of the surface wind affecting the aircraft exceeded the Flight Manual limit.
- (iii) The commander could not apply maximum braking to both main landing gear brakes at the same time as maintaining directional control through differential braking and full rudder application.

4 Safety recommendations

The following safety recommendations were made during the course of this investigation:

- 4.1 The Airport Director should produce, issue and be responsible for the maintenance of an Airport Disaster Plan that defines the policy, procedures and areas of responsibility of those airport and Island services identified as being required to react in the event of an airport disaster.

[Safety recommendation No 97-71 made 22 December 1997]

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June 1999