75-1

Department of Transport
Australia

Air Safety Investigation Branch

INCIDENT INVESTIGATION REPORT

Fokker F28-1000
Aircraft VH-FKA,
at Broome Airport,
Western Australia,
on 17 January 1974

Special Investigation Report 75-1

AIR SAFETY INVESTIGATION BRANCH

Incident Investigation Report

MacRobertson Miller Airline Services F-28-1000 Aircraft VH-FKA at Broome Airport, Western Australia, on 17 January 1974

The Secretary to the Department of Transport authorised the investigation of this incident and the publication of this report pursuant to the powers conferred by Air Navigation Regulations 278 and 283 respectively.

Prepared by: Air Safety Investigation Branch

December 1975

AUSTRALIAN GOVERNMENT PUBLISHING SERVICE
CANBERRA 1976

ISBN 0 642 01339 X

Printed by Watson Ferguson & Co., Brisbane

Contents

Note: Metric units are used except for airspeed and wind speed which are given in knots; and for elevation, height and altitude where measurements are given in feet.


VH-FKA
FOKKER F28
MMA

THE INCIDENT

At approximately 0338 hours Western Standard Time (WST) on 17 January 1974, Fokker Fellowship F-28-1000 aircraft, registered VH-FKA, overran Runway 10 during a landing at Broome Airport, Western Australia, and became bogged in soft earth.

The aircraft was engaged in operating a Regular Public Transport flight and was carrying fifty-six passengers. No one was injured and the damage incurred by the aircraft was minor.

1 FACTUAL INFORMATION

1.1 HISTORY OF THE FLIGHT

Fokker Fellowship F-28-1000 aircraft VH-FKA was operated by MacRobertson Miller Airline Services (M.M.A.S.), a division of Ansett Transport Industries (Operations) Pty Ltd. The holder of the certificate of registration for the aircraft was Ansett Airlines of Australia. The aircraft, which was operating under the terms of appropriate air service licences, was engaged on a Regular Public Transport flight (M.M.A.S. Flight 492) from Perth to Darwin with intermediate landings at Port Hedland, Broome, Derby and Kununarra.

The aircraft departed from Perth at 0002 hours and the flight to Port Hedland was uneventful. Subsequently the aircraft departed from Port Hedland at 0240 hours, being flown by the First Officer from the right-hand pilot seat. The estimated time of the aircraft's arrival at Broome was 0322 hours but, en route, whilst cruising at Flight Level 250, the crew diverted from track around one or more thunderstorms.

At 0306 hours the Derby Flight Service Unit (FSU) passed the following 0230 hours Broome aerodrome weather report to VH-FKA: wind from 320 degrees at 8 knots, visibility 5 nautical miles, rain, $\frac{1}{8}$ fracto-stratus cloud, base 1500 feet, 5/8 alto cumulus cloud, base 12 000 feet, 8/8 alto-stratus cloud, base 14 000 feet.

At approximately 0310 hours VH-FKA contacted the M.M.A.S. office at Broome Airport and requested the 0300 hours Broome aerodrome weather report. The M.M.A.S. duty traffic officer then telephoned the Broome Meteorological Office and obtained the following information which he passed to VH-FKA: surface wind from 320 degrees at 8 knots, wind at 1000 feet 275 degrees at 10 knots, visibility 5 nautical miles, rain, $\frac{3}{8}$ fracto-stratus cloud, base 1500 feet, 5/8 alto-cumulus cloud, base 12 000 feet, 8/8 alto-stratus cloud, base 14 000 feet, temperature 25 degrees C, dewpoint 24 degrees C, QNH 1001.

The Captain states that the descent from cruising level was normal but, over the final 30 miles (nautical), as the aircraft approached Broome Airport, elevation 39 feet a.m.s.l., there was a line of thunderstorms lying in a north-west/south-east direction across the flight path which necessitated a diversion from track. Consequently, the aircraft approached Broome on a heading of 300 degrees magnetic. The aircraft, which was still being flown by the First Officer, was descended to the permissible minimum altitude of 800 feet in accordance with the Distance Measuring Equipment (DME) Arrival Procedure; however, as the aircraft was not in visual contact with the ground at the minimum altitude it was then flown back to 2000 feet in preparation for an instrument approach employing the Non-Directional Beacon (NDB) facility. Advice to this effect was passed to the Derby FSU at 0329 hours.

Subsequently visual contact with the ground was achieved when the aircraft was at about 900 feet approaching the aerodrome on a track of 216 degrees magnetic at which time the Captain took over the controls and continued the descent to the minimum

permissible circling altitude of 800 feet. The aircraft was then on the left downwind leg of a circuit approximately in a position to turn onto base leg for a landing on Runway 10. The Captain says that, at about this time, he contacted the M.M.A.S. office on the airport and was advised that the wind was calm. At 0336 hours the First Officer advised the Derby FSU that the aircraft was in the Broome circuit area and that it would report after landing.

Light rain was encountered and the flight crew state that it varied in intensity from light to moderate during this and subsequent manoeuvring in the circuit area. The Captain did not activate his windscreen wiper, but the First Officer's windscreen wiper was operating during the final approach and landing. Rain repellent was not used.

The Captain planned to land on Runway 10 but, during the turn onto final approach, the aircraft overshot the runway alignment and the landing approach was abandoned at a height of 600–700 feet. The left-hand orbit of the airport was then continued and the aircraft was manoeuvred for a landing approach in the reciprocal direction—on Runway 28. Whilst turning onto final approach for this landing the runway lights became partially obscured by low cloud and, on resighting the runway threshold, the Captain judged the aircraft to be too high to effect a landing. Again the landing approach was abandoned at a height of 600–700 feet, the left-hand orbit of the airport was continued, and the aircraft was manoeuvred onto the left downwind leg of a 'bad weather circuit' for Runway 10. The principal elements of this type of circuit are landing gear down, and flaps to 42 degrees when abeam the runway threshold; 32 seconds later commence a turn through base leg onto final approach using a 30 degree bank angle, and an indicated airspeed (IAS) of 130 knots.

During the turn onto this final approach the aircraft again overshot the runway alignment and calculations based on the flight data recorder information (Appendix B) indicate that, some 52 seconds before touchdown, it was 548 metres to the right of runway alignment, approximately 3000 metres from the runway threshold, and at an altitude of about 620 feet. It was flying substantially horizontally and passing from a position below the normal 3 degree approach slope to a position above it. Additionally, it was turning left at an estimated bank angle of 35 degrees.

As the aircraft approached runway alignment the speed brakes were deployed to 40 degrees. At this time the aircraft was about 160 feet above the normal 3 degree approach slope and a descent was then initiated which reached a maximum rate of about 2200 feet per minute. The aircraft next passed through the runway alignment from right to left but, at about 18 seconds before touchdown when it was some 610 metres short of the runway threshold, it was virtually on runway alignment at an altitude of 200 feet and it had descended onto the normal 3 degree approach slope. The Captain states that he was 'flying the VASIS' which is designed to indicate a 3 degree approach slope to an aiming point 305 metres inside the runway threshold. Sixteen seconds before touchdown he made a substantial power increase for a few seconds which arrested the rate of descent and which caused the automatic lift dumper circuit to disarm. The First Officer reset the circuit.

The Captain states that the touchdown occurred approximately 300 metres along the runway, that it was firm, and that full extension of the speed brake from 40 degrees was immediately selected. He checked the lift dumper indicators 1 to 2 seconds after touchdown to ensure that the lift dumpers had operated and, at the same time, the aircraft pitched forward onto the nosewheels in accordance with the normal reaction to lift dumper deployment. He states that almost immediately he applied firm braking consistent with a normal landing on this runway and the brake pedal feel and deceleration appeared normal. He did not detect any malfunction of the anti-skid system and believed that he could feel the system operating. The Captain has said that about 305 metres after touchdown, believing that a loss of braking efficiency had

occurred, both he and the First Officer applied maximum brake pedal pressure, at which time the indicated airspeed was 70–80 knots, but this action appeared to have no additional effect on the deceleration of the aircraft. He states that normal deceleration again became noticeable as the aircraft traversed the final 250 metres of the runway.

The First Officer states that the approach and landing were normal. At touchdown, he checked that the lift dumpers had operated and, initially, the deceleration felt normal. He then gained the impression that there was no retardation. Brake pedal pressure felt normal and he was applying maximum brake pedal pressure as the aircraft traversed the final 550 metres of the runway, but this action had no apparent effect in decelerating the aircraft. There was no sudden deceleration at any stage of the landing roll.

One passenger described the touchdown as normal, not hard or smooth. There was a slight pause before braking commenced and this felt normal but after a short period he was not conscious of any braking. Another passenger observed the lift dumpers operate shortly after touchdown: he considered that the touchdown was in the area 460 to 700 metres along the runway. He stated that the brakes were applied and it felt as if the 'pilot was pumping them'—this sensation commenced about 450 metres before the aircraft overran the runway. A third passenger stated that during the landing run, it felt as if the brakes were being pumped and this sensation increased during the landing run.

The aircraft overran the sealed surface of the runway at a speed stated to be similar to a fast taxi speed, and calculated to have been about 32 knots. Examination of the sealed runway surface did not reveal any tyre marks which could be associated with this landing; however, when the aircraft left the sealed surface and entered the overrun area, the nosewheels were 11.9 metres to the right of the centre-line and 10.9 metres from the right-hand edge of the runway. As the aircraft traversed the 45.7 metre long gravel stopway area all the wheels penetrated the surface 13 to 25 millimetres. The disturbance of the gravel along the mainwheel tracks was consistent with the wheels being heavily braked. Over the next 36.6 metres the aircraft traversed soft sodden terrain and then the nose of the aircraft penetrated a picket and wire fence. The nose gear entered a depression and the aircraft came to a stop in an area covered by 150 millimetres of water.

The incident occurred at night.

1.2 INJURIES TO PERSONS

Injuries	Crew	Passengers	Others
Fatal	—	—	—
Serious	—	—	—
Minor/None	4	56	—

1.3 DAMAGE TO AIRCRAFT

Damage was confined to the nosewheel doors, the fuselage mounted taxiing light, and the oxygen access panel.

1.4 OTHER DAMAGE

There was no other significant damage.

1.5 PERSONNEL INFORMATION

Captain George William BEAMISH, aged 51 years, was the pilot in command and he

held a first class airline transport pilot licence which was current until 31 July 1974. His last proficiency check had been successfully completed on 7 December 1973. His licence endorsements authorised him to fly Fokker F-28 aircraft and he held a first class instrument rating endorsed for the appropriate radio navigation aids. His total pilot experience at the time of this incident was 14 670 hours of which 1724 hours had been gained in F-28 aircraft. His total pilot in command experience was 9529 hours. In the 90 days preceding this incident he had flown 185 hours, all in F-28 aircraft. At the time of this incident he had been on duty for 4 hours 38 minutes. Captain Beamish had landed at Broome on many occasions, the most recent landing being on 8 January 1974.

First Officer Frank SCHOLMANN, aged 31 years, held a second class airline transport pilot licence which was current until 30 June 1974. His licence endorsements authorised him to fly Fokker F-28 aircraft and he held a second class instrument rating endorsed for the appropriate radio navigation aids. His total pilot experience at the time of this incident was 4564 hours of which 358 hours had been gained in F-28 aircraft. In the 90 days preceding this incident he had flown 102 hours, all in F-28 aircraft. At the time of the incident he had been on duty for 4 hours 38 minutes.

1.6 AIRCRAFT INFORMATION

1.6.1 History

VH-FKA is a Fokker Fellowship F-28-1000 aircraft which was manufactured in 1970 by the Fokker–VFW International b.v. in the Kingdom of the Netherlands and allotted Serial No. 11021. It had flown a total of 11 007 hours since new. The aircraft was maintained in accordance with the Ansett Airlines of Australia Maintenance System Manual and there was a certificate of airworthiness current for the aircraft which was to remain valid until 8 June 1979 provided that the aircraft continued to be maintained in accordance with the approved maintenance system. Prior to the aircraft's departure from Perth on this night an inspection had been carried out and a maintenance release issued. There was no record of any engineering deficiency which could have been relevant to this incident.

1.6.2 Loading

The maximum permissible gross weight for landing in this aircraft, having regard to structural considerations, was 26 761 kg. It is calculated that the landing weight at Broome was 26 346 kg and that the centre of gravity was within the permissible limits. Having regard to the weight of the aircraft, the use of speed brakes was limited to a 40 degree deployment until touchdown.

The landing performance information available to the crew of VH-FKA, which is based on the F-28 type dry runway certification data factored by 1.92 to cater for variations in airline operating techniques and other factors encountered in service, including wet runway surface, indicated that, in calm conditions, an availability of 1262 metres of runway was required, or 1387 metres if landing with a 7 knot tailwind component. The actual effective operational length available for a landing on Runway 10 was 1527 metres and for a landing on Runway 28 it was 1694 metres.

The target threshold speed computed for the landing at Broome was 119 knots (IAS) with the desired approach speed being 124 knots. Using a normal landing flare technique, touchdown could then have been expected to occur at a speed of 115 knots.

1.6.3 Defects

The aircraft was not recovered from its overrun position for four days, during which

time the wheel brakes were totally immersed in water for two days. Following recovery of the aircraft it was subjected to an accelerate–stop test, and two landings during a ferry flight, prior to the brakes being removed. On each of these occasions it was noted that the No. 1 wheel brake was cold compared with the other units and apparently not operating.

In the subsequent examination no malfunction was found in the brake system components that would account for the non-functioning of the No. 1 brake assembly. An examination of all the mainwheel tyres for rate of wear indicated that the No. 1 tyre had worn at the rate that could be expected in normal service and thus it is unlikely that there was a long-term malfunction of this brake unit. Examination of the brake pads did not reveal whether or not the No. 1 brake had been operating during the landing at Broome.

The No. 1 wheel brake assembly unit had been overhauled in accordance with the manufacturers' requirements and installed on VH-FKA on 9 November 1973. It had completed 605 landings since that overhaul.

Examination of all the mainwheel tyres installed on VH-FKA at the time of the landing revealed no evidence of tyre deterioration or condition which could be considered consistent with skidding or aquaplaning.

1.7 METEOROLOGICAL INFORMATION

The terminal forecast prepared by the Perth Airport Meteorological Office and issued to the flight crew prior to their departure from Perth predicted, for the expected time of the aircraft's arrival at Broome Airport, that the surface wind would be from 290 degrees at 8 knots, the surface visibility would be 10 nautical miles in rain and rain showers, and there would be $\frac{1}{8}$ cumulo-nimbus cloud at 2000 feet, $\frac{3}{8}$ stratus cloud at 1400 feet, $\frac{3}{8}$ cumulus cloud at 2000 feet, and 7/8 alto-stratus cloud at 12 000 feet. Additionally, it was forecast that, until 0100 hours, there was a 20 per cent probability of thunderstorms.

Copies of the routine aerodrome reports for 0100 hours and 0200 hours, prepared by the Broome Meteorological Office which is located on the Broome Airport, were obtained by the Captain after landing at Port Hedland. The 0200 hours report recorded the surface wind as 300 degrees at 8 knots, visibility 7 nautical miles in rain, and the cloud $\frac{1}{8}$ fracto-stratus at 1500 feet, $\frac{3}{8}$ alto-cumulus at 12 000 feet. The 0100 hour report was essentially the same.

Whilst en route from Port Hedland to Broome the crew received the Broome 0230 hours and 0300 hours routine aerodrome weather reports, as well as information on the wind at 1000 feet as recorded in the 0015 hours radio-sonde flight. These details have already been described in Section 1.1 of this report.

At 0330 hours a 'special' Broome aerodrome weather report was compiled showing the wind from 280 degrees at 8 knots, the surface visibility 2 nautical miles in rain, and the cloud as $\frac{3}{8}$ fracto-stratus at 1500 feet, $\frac{3}{8}$ cumulus at 2000 feet and 8/8 alto-stratus at 10 000 feet. This report was not passed to the aircraft by the Derby FSU as it was not available until about 0336 hours at which time VH-FKA had already reported as being in the circuit area at Broome.

The meteorological observer first saw the aircraft at about the time it was attempting the approach to Runway 28. At that time patches of fracto-stratus cloud were evident in the cloud searchlight beam and there was moderate to heavy rain at the meteorological office. He again saw the aircraft during its landing run on Runway 10 at which time there was moderate rain over the runway.

An anemometer located adjacent to the meteorological office at Broome Airport recorded, at 0338 hours, a mean surface wind velocity of 270 degrees at 7 knots. About

this time the recorded wind direction varied between 240 degrees and 300 degrees, and the recorded wind speed varied between 4 knots and 10 knots.

A pluviograph located adjacent to the meteorological office at Broome Airport recorded that light rain commenced to fall at 1845 hours on 16 January 1974 (i.e. the day prior to this incident) and 7 millimetres were recorded up to 0135 hours on 17 January 1974. Heavy rain then commenced and continued until 0330 hours (8 minutes prior to this incident) during which time a further 52 millimetres were recorded. Another 10 millimetres were recorded over the next two hours following which the rain ceased.

At about 0315 hours a M.M.A.S. traffic officer, in a motor vehicle, conducted a runway inspection to establish that the runway lighting was operating and that the runway was free of obstructions. During the course of the inspection he observed water, estimated to have been from 25 to 60 millimetres in depth, flowing across the runway in a stream about 150 metres wide at a point some 1000 metres east of the Runway 10 threshold. Additionally, he observed water running off the runway surface over its entire length with small areas of water up to 13 millimetres in depth particularly over the eastern 50 per cent of the runway; that is, the lower end. The flow or depth of water did not impede the progress of the vehicle and information concerning its presence and extent was not passed to the aircraft.

1.8 AIDS TO NAVIGATION

Broome Airport is equipped with 200 MHz Distance Measuirng Equipment (DME) and a Non-Directional Beacon (NDB) which permit instrument approaches to be made at night, to a height of 760 feet above the airport elevation. It is then necessary to manoeuvre the aircraft by visual reference to the ground in order to effect a landing.

1.9 COMMUNICATIONS

Communications with the aircraft were normal and were not a factor in this incident.

The Department of Transport does not maintain an aviation communication facility at Broome Airport and aircraft in the vicinity of Broome communicate with the Derby Flight Service Unit (FSU). There is a teleprinter communication channel between the Broome Meteorological Office and the Derby FSU.

MacRobertson Miller Airline Services maintain a VHF transceiver at Broome Airport to permit air/ground communications between company personnel.

1.10 AERODROME INFORMATION

Broome Airport is located at 17° 56′ 46″S 122° 13′ 50″E and has two sealed runways; Runway 01/19 is 1225 metres in length and Runway 10/28 is 1527 metres in length. In addition, there is a stopway 45.7 metres long with a low strength gravel surface beyond the end of Runway 10. This stopway is not considered suitable for normal operations but is available for stopping in an emergency situation even though the surface might be damaged in so doing. The effective operational length for a landing on Runway 10 was 1527 metres; it is aligned 103 degrees magnetic; it is 45 metres wide and is contained within a flight strip 1989 metres long by 150 metres wide. Its elevation at the Runway 10 threshold is 56 feet above mean sea level, and its elevation at the eastern end is 22 feet. The overall slope is 0.7 per cent down whilst the slope over the eastern 915 metres is 0.8 per cent. Standard runway markings—threshold strips, identification number, distance and centre-line markings—in white paint were present on the runway.

An illuminated windsock is located 315 metres west of the Runway 28 threshold

and a non-illuminated windsock is located adjacent to the threshold of Runway 10.

Runways 10 and 28 are equipped with standard omni-directional fixed intensity, runway edge lighting. T-VASIS systems are installed on Runways 10 and 28 to provide visual approach slope guidance to landing aircraft. The Runway 10 system is positioned at the aiming point 305 metres inside the threshold and it delineates an approach slope of 3 degrees. It was operating for the arrival of VH-FKA but the light intensity setting is unknown.

Due to the unavailability of suitable equipment it was not possible to measure the co-efficient of friction of the runway surface at the time of the on-site investigation of this incident. Subsequently, however, Mu meter tests were undertaken and these indicated that under wet conditions, not flooded, braking at 40–60 mph was 'good' and at 80 mph it was 'in the upper half of the medium range'. The runway was last resealed in 1968 using an aggregate of river sand 2–5 millimetres in size. The aggregate is worn some 15–20 per cent over the centre 15 metres of the runway width. It has a central crown with an average cross fall of approximately 1.0 per cent but the runway slope is not uniform and consequently water would not flow freely to the sides of the runway at all places. The runway exhibits wheel track surface deformation and this, coupled with the runway longitudinal slope, could cause water to accumulate and flow downhill along the tracks.

There were heavy deposits of rubber over the touchdown areas 305–460 metres inside the respective thresholds for Runways 10 and 28, but no significant build-up of rubber was evident.

1.11 FLIGHT RECORDERS

The aircraft was equipped with a United Data Control 542B Flight Data Recorder which records the aircraft's pressure altitude, indicated airspeed, heading and vertical acceleration against a time base by means of engravings made on a stainless steel tape.

The section of the foil which recorded the movements of the aircraft during the 22 minutes prior to completion of this landing has been examined. At Appendix A there is a representation of the flight data record for the final 60 seconds. The flight data recorder information indicates that the aircraft crossed the runway threshold at an altitude of approximately 140 feet, that is a wheel height of about 80 feet, and it then followed a descent path slightly above but parallel to the normal 3 degree approach slope. Throughout the approach the flight data recorder reflects an indicated airspeed varying about 130 knots, but there was an excursion to 139 knots 45 seconds before touchdown. The recorded indicated airspeed over the runway threshold was 131 knots which decreased to 115 knots at touchdown.

Performance specifications for this type of recorder do not prescribe any standards of accuracy for speed below 100 knots but, nevertheless, it is of interest that, after touchdown, the recording indicated a steady deceleration to an indicated airspeed of 11 knots at a time 25 seconds after touchdown. All visible stylus strikes in the airspeed trace were read out and plotted, then a line of best fit based on inspection was drawn through these points. In respect of the vertical acceleration trace, the characteristic change from long-term to short-term excursions at touchdown was evident as was the positive excursion at touchdown. A further excursion defines the point at which the aircraft came to rest. The time interval between touchdown and stop was 30.6 seconds.

The aircraft was also equipped with a Collins 652-C1 Cockpit Voice Recorder which, for the last 30 minutes of recorder operation, provides a record of all radio communications between the aircraft and ground stations as well as audible speech and other sounds heard in the cockpit. When cockpit audio recorders were first installed in Australian airline aircraft, the Australian Federation of Air Pilots (AFAP) insisted

that the information they contained should not be used in the investigation of air safety incidents or of any accident which the flight crew survived. In the interests of having this source of information available on other occasions, the then Department of Civil Aviation agreed to this demand for the time being. Accordingly, the evidence contained in the cockpit audio record for VH-FKA has not become available for use in this investigation.

1.12 WRECKAGE AND IMPACT INFORMATION

Not relevant to this investigation.

1.13 MEDICAL AND PATHOLOGICAL INFORMATION

Examination of the flight crew activities prior to and during this flight indicated that fatigue should not have been a factor.

1.14 FIRE

There was no fire.

1.15 SURVIVAL ASPECTS

None of the crew nor the passengers sustained injury. The forces involved were not such as to introduce any question of survival. Emergency evacuation of the occupants was deemed by the Captain to be unwarranted and was not undertaken.

1.16 TESTS AND RESEARCH

1.16.1 Wheel assemblies

All the components associated with the wheel assemblies and brake systems of the aircraft were functionally tested and no significant fault was found. It was determined, however, that the wheel speed transducer signals were generally 3 per cent lower than the minimum permitted at component overhaul. The condition is consistent with their time in service and would have increased the delay in the automatic operation of the lift dumper by only 0.06 seconds. Additionally, and in association with another minor fault found, it would have resulted in the locked wheel prevention circuit ceasing to operate at a wheel speed of about 12 knots instead of 11 knots. The condition would have had no effect on the operation of the basic anti-skid system which responds to the rate of voltage change rather than to absolute voltage.

It is significant that the basic anti-skid control circuits for each of the four main wheels are independent of each other. The locked wheel prevention circuit is a back-up system in that it fully dumps brake pressure to a 'locked wheel' should such an event occur; it is an auxiliary circuit whereby the speed signals from Number 1 and Number 4 wheels are compared, and likewise the speed signals from Number 2 and Number 3 wheels. Whenever the wheel speed of one of a pair falls below 11 knots whilst the other is above 19 knots brake pressure to the slower wheel is fully dumped. When the wheel speeds of both wheels in a pair are less than 19 knots, braking without anti-skid or locked wheel protection is available.

The condition of the tyres fitted to the aircraft was satisfactory. Number 1 tyre had completed 129 landings and had an average of 4 mm of tread remaining; Number 2 tyre had completed 2 landings and had an average of 9 mm of tread; Number 3 tyre had

completed 179 landings and had an average of 3 mm, while Number 4 tyre had completed 51 landings and had an average of 7 mm of tread remaining. Arising from the linking of the locked wheel prevention circuits, in each case wheel speed signals associated with a new tread were being compared with those associated with an older tread.

1.16.2 Landing performance

The manufacturer, Fokker–VFW International b.v., was asked to provide performance information related to the landing of VH-FKA at Broome. The company advised that, based on their tests conducted on a wet well-soaked runway with no significant standing water and a mean tyre tread of 5.2 mm, the distance from touchdown to stop, assuming maximum braking with all wheel brakes operative, speed brakes fully extended, lift dumpers armed and operative, and 42 degrees of flap, would be 667.5 metres under the following conditions:

Landing weight	26 023 kg
Touchdown airspeed	115 knots IAS (117.5 knots CAS)
Air temperature	25°C
Airport elevation	39 feet
Tailwind component	7 knots
Runway slope	0.8% down

This calculation is based on the engines being at idle thrust and the speed brakes being fully extended at the time of touchdown, lift dumper extension commencing 0.2 seconds after touchdown and being completed in one second; full brake pressure being applied and being effective one to two seconds after touchdown and some back pressure on the control column to increase the load on the main wheels.

Additionally, Fokker–VFW estimated that if one wheel brake assembly was inoperative then only 75 per cent of the total braking force would be available and the stopping distance from touchdown, for the same conditions, would be 795.5 metres.

2 ANALYSIS

2.1 METEOROLOGICAL ASPECTS

The general weather conditions encountered during the descent at Broome and the subsequent manoeuvring for the landing approach, with the exception of the cloud base, were essentially as forecast prior to the departure of the aircraft from Perth, and as reported in the weather observations passed to the crew during the flight to Broome. The actual cloud base encountered was about 900 feet, or some 600 feet lower than that predicted and reported.

The wind velocity was forecast to be 290 degrees at 8 knots and the four weather reports received by the crew, for the two-hour period prior to the landing, confirmed the forecast. The surface wind velocity at the time of the landing was 270 degrees at 7 knots, and so the action of the Captain in landing downwind on Runway 10 has to be examined.

It is apparent that the aircraft's arrival at Broome coincided with the passage of a weather disturbance and under such circumstances it is not unusual for the wind direction or speed to vary for a period from the predominant wind pattern. It is improbable that the flight crew could have sighted the illuminated windsock during their pre-landing manoeuvring of the aircraft and the Captain states that, when the aircraft became visual, he made a request to M.M.A.S. on the Company frequency for the wind velocity. He states he was advised it was calm, and his subsequent decisions and actions were based in part on that information. The M.M.A.S. employee

concerned had a recollection of such a request, and his recollection of the timing of the request in relation to the aircraft's movements is not inconsistent with the Captain's statement, but he says that he telephoned the meteorological officer for the wind information which, on receipt, was transmitted to the aircraft. The meteorological officer had no recollection of such a request, but he had previously provided the complete 0300 hour weather observation to M.M.A.S. on request and that gave the surface wind was 320 degrees at 8 knots. The wind velocity at about the time the aircraft became visual was similar to that reported in the 0300 hour observation. Thus, it has not been possible to determine whether or not the Captain received advice that the wind was calm. Of course, if there was such a transmission to the aircraft it would have been recorded on the cockpit recorder which was not available to the investigation.

There is no specific operational limitation to landing an F-28 aircraft with a tailwind component of up to 10 knots, and it might be significant that neither the forecast surface wind nor any of the reports received in the aircraft whilst en route to Broome describe a surface windspeed in excess of 10 knots. For the conditions pertaining at the time of the landing, including the 7 knot tailwind component, the required runway availability was 1387 metres which was 140 metres less than the actual runway length available. Thus, in isolation, the existing wind velocity did not preclude VH-FKA from landing on Runway 10.

2.2 THE RUNWAY

The fact that 52 millimetres of rain fell at Broome aerodrome during the two hours preceding the landing was not conveyed to the crew, but the four weather reports passed to them each described reduced visibility in rain and were indicative of consistent moderate to heavy rain. A few minutes prior to the crew obtaining visual contact with the ground however, and during the subsequent in-flight manoeuvring of the aircraft, the rain intensity became light and as the results of the ground inspection were not passed to the flight crew they were not aware of the depth of water on the runway. Nevertheless, from the information available to them it was obvious that the landing would have to be carried out on a runway which was, at least, thoroughly wet.

The general condition of Runway 10 at Broome, including its surface characteristics, was not abnormal but generally consistent with its life in service. Although the runway surface for at least the first 1000 metres of Runway 10 tended to retain water to a depth of 5 to 13 millimetres, thus providing conditions suitable for dynamic aquaplaning, other evidence leads to the conclusion that aquaplaning did not occur in this landing.

For some days prior to this incident Broome Airport had been subjected to heavy rain associated with cyclonic conditions. In this period the ground had become saturated and it is apparent that the further heavy rainfall which occurred shortly before this incident caused a higher than normal surface run-off which was beyond the immediate capacity of the surface drainage system.

The landing distance required to be available for this approach and landing contained a factor to accommodate variations in runway slope from 0 to 1.0 per cent. Therefore there was no requirement for the flight crew to have given the average slope of 0.7 per cent down specific consideration, particularly as the distance required was 140 metres less than the actual runway length available. Thus, in isolation, the downhill slope did not preclude VH-FKA from landing on Runway 10.

2.3 THE APPROACH AND TOUCHDOWN

Although the cloud base encountered by VH-FKA on arrival at Broome was lower

than forecast or reported, it still permitted an instrument approach to be made to the minimum circling altitude at night of 800 feet, 761 feet above the aerodrome elevation, and for the approach to be continued below that height by visual reference. It seems that the first approach was abandoned because of an error in positioning the aircraft and the second, because of temporary loss of visual reference to the runway, arising from the presence of a small area of lower cloud. Both of these approaches were discontinued prior to significant descent below the minimum permissible circling altitude.

The third and final approach, initially, was unstable in that the aircraft overshot runway alignment and in attempting to regain it the aircraft again crossed the extended centre-line of the runway but to a lesser extent. At the same time, the aircraft reached a position substantially above the 3 degree approach slope as indicated by the T-VASIS and a rate of descent of 2200 feet per minute was established in order to correct this situation. This rate of descent was over-corrected and the aircraft proceeded again, but to a lesser extent, above the 3 degree approach slope. In this connection it is noteworthy that the M.M.A.S. operating procedures state that rates of descent must not exceed 1000 feet per minute when the aircraft is below 1500 feet above terrain.

Over the final 10 seconds of flight prior to touchdown, the approach was stable in the sense that the aircraft was aligned with the runway centre-line and was descending at a 3 degree approach angle, albeit to an aiming point displaced further into the runway. During this final stage of the third approach, it is also significant that the indicated airspeed was some 7 knots higher than the desired approach speed and this was not corrected as the aircraft approached the runway threshold.

As the aircraft crossed the runway threshold the wheel height was 80 feet, the indicated airspeed was 12 knots higher than the desired threshold speed and, as a result, the total energy of the aircraft was some 25 per cent higher than would be expected in a normal approach. Beyond the runway threshold, the approach was continued in a stable fashion and it resulted in the aircraft touching down at the desired indicated airspeed of 115 knots but at a point some 633 metres beyond the runway threshold.

The evidence of the flight crew was that the aircraft touched down some 300 metres beyond the runway threshold. The evidence obtained from passengers indicated that the touchdown point was somewhere between 460 and 700 metres beyond the runway threshold. The computed touchdown point of 633 metres beyond the runway threshold has been determined from the flight data recorder evidence and is considered to be reliable. The touchdown was identified on the vertical acceleration trace and the time from touchdown to stop occupied 30.6 seconds. From the indicated airspeed trace in this period, corrected for a 7 knot tailwind component, the ground distance traversed by VH-FKA was computed at frequent intervals and the touchdown point determined by applying this to the known stopping point of the aircraft.

One of the premises on which the runway length required to be available is based is that the aircraft will cross the runway threshold at a wheel height of 50 feet and at a speed equal to 1.3 times the power-off stalling speed (1.3 Vs), plus a tolerance for gust effect if necessary. This will produce a touchdown in the zone 305–457 metres beyond the threshold. In this incident VH-FKA overflew the normal touchdown zone by 176 metres, but it did touch down at the correct speed. As the landing distance available was only 140 metres in excess of that required to be available then, if all other tolerances were utilised to their maximum limits, it could be expected that VH-FKA would overrun the available distance by 36 metres. Nevertheless, having due regard to the degree of accuracy which can be attributed to such calculations, it is considered that the touchdown point alone was not an exclusive factor.

Whilst the available evidence is not such as to allow a firm determination of the factors which led to the landing approach initially being unstable, and subsequently

too high and too fast, it seems likely that, at least, part of the problem was that the aircraft was experiencing a tailwind component of up to 10 knots and this was not recognised or compensated for by the flight crew. The earlier difficulties in positioning the aircraft for an approach to Runway 10, together with the fact that information concerning the surface wind conditions had been provided a number of times—and such a wind had been recorded at 1000 feet and advised to the flight crew, should have alerted them to the need for particular care in establishing a stable and correct approach to this wet runway.

2.4 LANDING ROLL PERFORMANCE

From the point of touchdown, there were 893 metres of sealed runway still remaining and there were 975.5 metres to the point where the aircraft came to rest. On the basis of established braking performance on a wet well-soaked runway with no standing water, using optimum techniques, Fokker–VFW International b.v. computed—having regard to all the other known factors relevant to the landing of VH-FKA at Broome—that the aircraft could have been brought to a stop on the runway with a ground roll of 667.5 metres. VH-FKA exceeded this distance by 308 metres.

An examination of the gradient of the rolling speed calculated from the indicated airspeed trace on the flight data recorder revealed that sustained and fairly uniform braking with a deceleration of 2.19 m/sec^2 (7.2 ft/sec^2) was achieved from 3 seconds after touchdown until at least 25 seconds after touchdown, and was probably achieved over the remaining 5.6 seconds until the aircraft came to rest. The indicated airspeed trace still showed a positive value after the aircraft had come to rest; this was probably due to instrument lag during the latter 5.6 seconds when air pressure operating the stylus was small. When the indicated airspeeds below 30 knots are corrected for this lag the aircraft rolling speed deceleration becomes almost constant for the total landing roll.

An examination of 100 landings selected at random from the same VH-FKA flight data recorder foil revealed that the arithmetic mean of those ground decelerations was 2.29 m/sec^2 (7.5 ft/sec^2). At no given time during the landing roll did the incident flight record a speed more than 6 knots above the mean speed at the relevant time in the landings examined. The examination did not proceed to determine the runways used, the conditions pertaining, or whether maximum or heavy braking was being attempted. Nevertheless, it is evident that there was no significant variance during this incident with the deceleration previously achieved by the aircraft over a period of time under various conditions and circumstances.

Since the rate of deceleration was sustained and basically uniform throughout the landing roll, and was close to that normally achieved in this aircraft, it is considered that a condition of total dynamic aquaplaning did not occur. This conclusion is supported by the fact that the aircraft tyres exhibited no evidence that they had been subjected to aquaplaning, nor were marks characteristic of aquaplaning found on the runway.

The braking performance established by Fokker–VFW International b.v. aircraft type certification utilised optimum techniques applicable to aircraft type certification. Such techniques are not followed nor recommended in airline operation. Thus, in comparing performance capacity with performance achieved on this occasion it is necessary to examine the difference between certification techniques and those followed in this particular incident. Firstly, the certification data is based on full lift dumper extension being effective one second after touchdown. It has been found, and the Fokker–VFW Company so advise, that when landing on wet runways full lift dumper extension might not occur until 2 to 3 seconds after touchdown because of a

slow wheel spin-up. In this incident, however, the evidence suggests that the extension was normal and effective 1 to 2 seconds after touchdown.

The certification data is based also on maximum braking being applied and effective 1 to 2 seconds after touchdown. Normal airline procedure is that braking is applied some 3 seconds after touchdown and, initially, it will be light braking being increased as required. The evidence in this incident indicates that braking was applied about 3 seconds after touchdown. The crew evidence also indicates that, whilst firm braking was applied initially, maximum braking was not sought until they became concerned that the aircraft might not stop within the confines of the runway. Additionally, it is possible that the brake pedal pressure was released momentarily, as a test, when the Captain first doubted whether or not the brakes were operating normally.

The certification technique also involves the use of elevator to place maximum possible weight on the mainwheels whilst braking. This is not a normal airline practice and the effectiveness of this technique in reducing landing roll is difficult to quantify—it may not be great. Nevertheless, it must be regarded as another potential factor in evaluating the difference between certification data and the stopping distance achieved in this incident.

It is also noteworthy that Fokker–VFW recommend that tyres which have a groove depth of less than 50 per cent of the 'as new' depth be replaced for wet season operations. Their wet runway certification data was obtained using tyres which conformed to that recommendation. Two of the main wheel tyres installed on VH-FKA at the time of this incident were relatively new but the other two main wheel tyres had average tread depths of 45 per cent and 33 per cent of the 'as new' tread depth.

The Fokker–VFW wet runway certification tests were conducted on a wet well-soaked runway with no significant standing water. In this incident, however, there was, without any doubt, standing water on the runway, in some areas up to 13 millimetres in depth. Even without aquaplaning it must be expected that such a difference in the 'lubrication' of the runway would reduce the co-efficient of friction being achieved between the tyres and the runway surface and, hence, lengthen the stopping distance of the aircraft.

These are at least some of the factors which go towards explaining why the deceleration achieved by VH-FKA during this landing at Broome was 2.19 m/sec^2 (7.2 ft/sec^2) whereas the wet runway deceleration achieved during the manufacturer's certification tests was 3.2 m/sec^2 (10.5 ft/sec^2).

Finally, there is the possibility that the No. 1 wheel brake unit was inoperative during the landing roll at Broome. If this was so, then the computed distance required from touchdown to stop, based on the Fokker–VFW certification technique, is 795.5 metres and the computed deceleration would be 2.68 m/sec^2 (8.8 ft/sec^2). Nevertheless, the landing roll of VH-FKA exceeded this distance by 180 metres.

2.5 SUMMARY

In considering the factors which might have caused VH-FKA to overrun the runway, it is necessary to look first at the derivation of the runway length required to be available. It is derived basically from the demonstrated distance travelled from a threshold wheel height of 50 feet at 1.3 Vs to stop on a dry runway, using operating techniques allowable in this type of demonstration. The distance established in this way is then factored by 1.92 to allow for airline operating techniques, for scatter in performance and operating conditions, as well as to provide an adequate safety buffer. The factor of 1.92 does not include a specific allowance for wet runway operations, but it does include a 15 per cent reserve factor which largely contemplates the wet runway operation.

Experience has shown that a 1.92 factoring of the demonstrated dry runway threshold to stop distance normally provides an adequate safety margin for F-28 airline operations. In this incident, however, the safety buffer was eroded by an accumulation of factors each requiring additional runway length. Each of the factors involved placed the aircraft near the maximum limit of the safety margins allowed. If the effect of one brake being inoperative is introduced then VH-FKA came to rest only 94.5 metres beyond the landing distance which would have been required to be available. In particular, although the basic data for the wet runway stopping performance was obtained by Fokker–VFW from actual tests conducted on a wet runway, it is not possible to reliably compare the degree of wetness of the test runway with that pertaining at Broome at the time of this incident. Similarly, it is not possible to accurately compare the surface of the test runway with that of the Broome runway.

Although it has not been possible to determine precisely the extent of the effect of each variation from an optimum procedure in relation to additional runway distance, it is significant that the rate of deceleration achieved by VH-FKA was uniform, and in excess of that attributable to aerodynamic drag which would have been the major decelerating component if total dynamic aquaplaning had been experienced. It is considered that VH-FKA exceeded the landing distance required to be available, by 222 metres, because of the cumulative erosion of the safety factors applied to the pertinent aspects of landing performance, such erosion possibly being compounded by one of the four wheel brakes being inoperative during the landing. A major factor in the initiation of the chain of events was that the pilot-in-command persisted with the landing from an unstable approach.

3 CONCLUSIONS

1. The flight crew involved in this incident were appropriately qualified and licensed.

2. There was a current certificate of airworthiness for the aircraft. There is some evidence that the No. 1 wheel brake system might not have been operating during the landing roll, but otherwise no defect was found which could have contributed to the incident.

3. The aircraft was loaded within safe limits.

4. The weather at Broome Airport at the time of the incident was essentially as predicted and reported by the Bureau of Meteorology except that the cloud base of about 900 feet was lower. The wind direction and speed at the time of the landing were 270 degrees (True) and 7 knots, representing a 7 knot tailwind component during the landing.

5. Some 8 minutes prior to the landing the rain intensity decreased to light or moderate. During the 2 hours preceding the landing, 52 millimetres of rain fell and the depth of water on Runway 10 at the time of landing is estimated to have varied from 5 to 13 millimetres. At about 1000 metres beyond the landing threshold there was a stream of water about 150 metres wide and probably in excess of 25 millimetres in depth flowing across the runway.

6. The runway used for landing was 1527 metres in length with a downslope of 0.7 per cent. The landing distance required to be available in the conditions was 1387 metres and the aircraft overran the sealed runway by 82.3 metres.

7. The landing was made at night with approach slope guidance being provided by a T-VASIS set at 3 degrees.

8. Following one missed descent approach due to low cloud, and two missed landing approaches due to unsatisfactory positioning on final approach, a third

landing approach was not stabilised and this resulted in the aircraft crossing the runway threshold at an indicated airspeed of 131 knots at a height of 80 feet instead of the desired speed of 119 knots at a height of 50 feet.

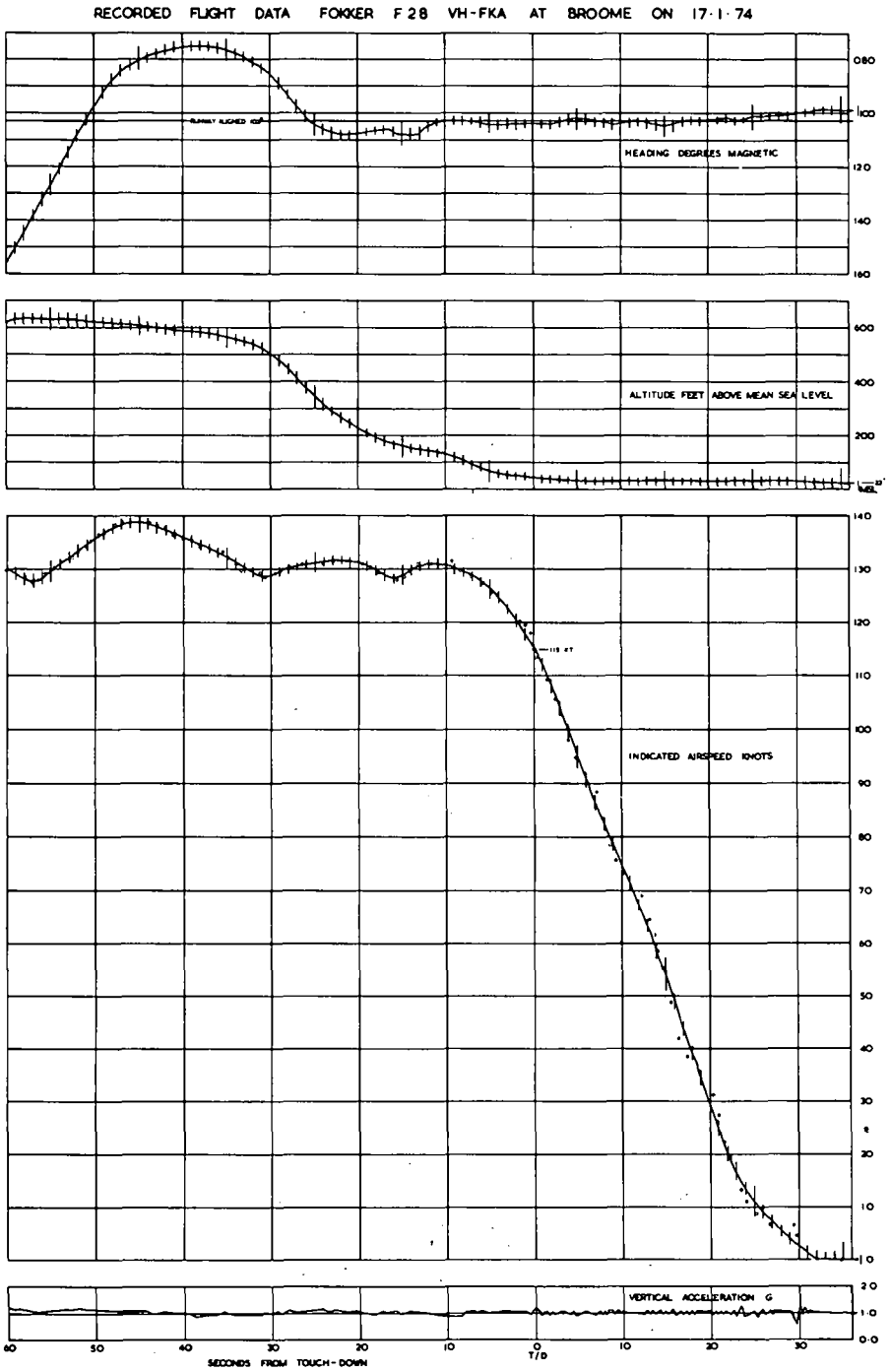
9. The aircraft landed at approximately the normal touchdown speed, but at a point about 633 metres beyond the runway threshold instead of within the normal touchdown zone which extends from 305 to 457 metres beyond the threshold.

10. There was no evidence that total dynamic aquaplaning had occurred during the landing roll. The rate of deceleration was sustained and basically uniform throughout the landing roll; however deceleration was adversely affected by the depth of water on the runway.

4 CAUSE

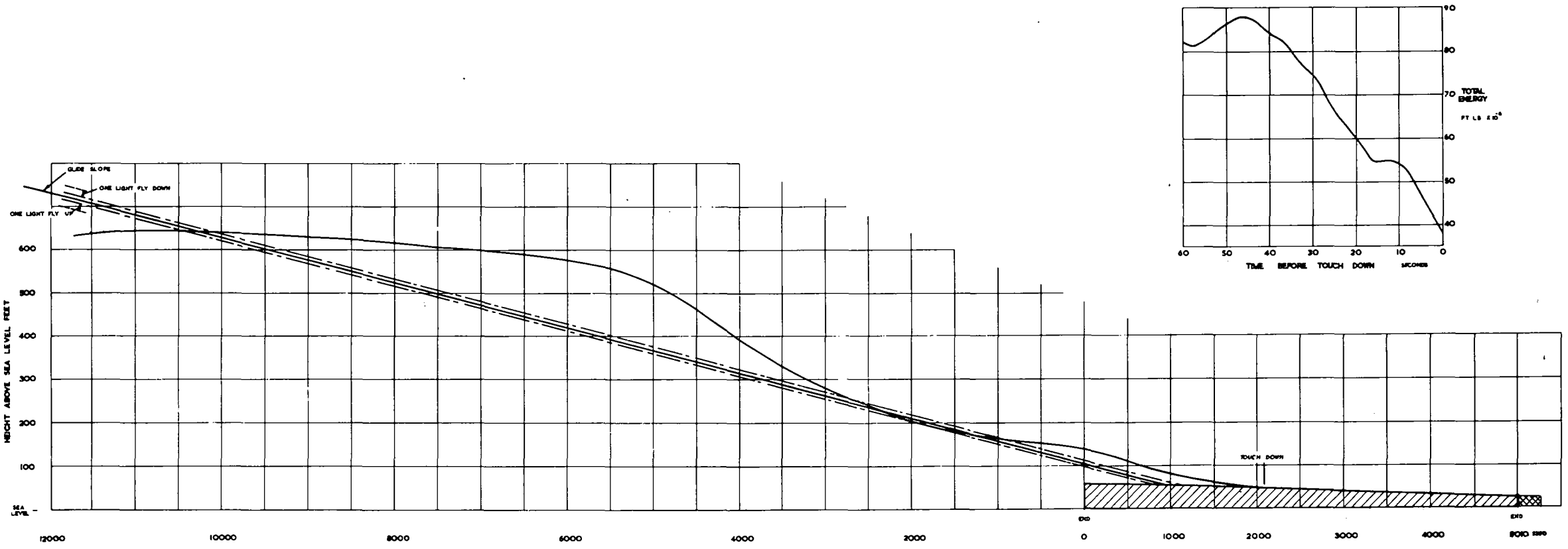
The probable cause of the incident was that the pilot persisted with a landing from an unstable approach in adverse circumstances, some known to him, others not known, which seriously eroded the safety factors associated with the landing phase.

APPENDIX A

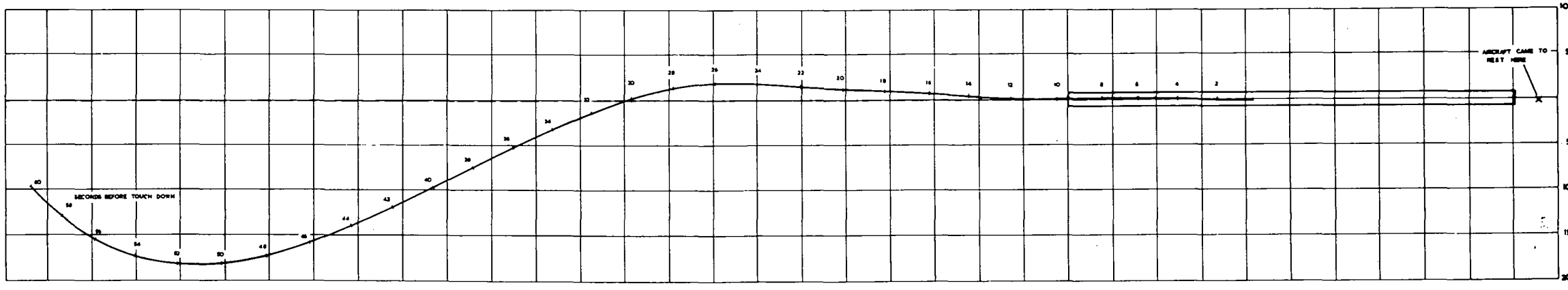

RECORDED FLIGHT DATA FOKKER F 28 VH-FKA AT BROOME ON 17·1·74
HEADING DEGREES MAGNETIC
080
100
120
140
160
ALTITUDE FEET ABOVE MEAN SEA LEVEL
600
400
200
INDICATED AIRSPEED KNOTS
140
130
120
110
100
90
80
70
60
50
40
30
20
10
VERTICAL ACCELERATION G
2·0
1·0
0·0
60
50
40
30
20
10
0
T/D
10
20
30
SECONDS FROM TOUCH-DOWN

APPENDIX B

FLIGHT PATH DERIVED
FROM RECORDED FLIGHT DATA
F28 VH-FKA BROOME 17 - 1 - 74



DISTANCE — FEET



RM 75/30502 Cat. No. 76 6514 1