AAIU Report No. 2001/0012
AAIU File No. 2000/0058
Published: 10 Sep 2001

Name of Operator:	Aer Lingus
Manufacturer:	Fokker Aircraft B.V. The Netherlands
Model:	Fokker 50
Registration:	EI-FKD
Nationality:	Irish
Location:	Runway 17, Cork Airport (EICK)
Date and Time (UTC):	29 October 2000, 1619 hrs

Notification

The Operator notified the Air Accident Investigation Unit (AAIU) of this serious incident at 1645 hrs on the 29 October 2000. A member of the AAIU arrived at EICK at 2200 hrs on the same evening and commenced the investigation.

On the 31 October 2000, the AAIU transmitted formal notification of this serious incident to the Netherlands Aviation Safety Board (NASB) and the Irish Aviation Authority (IAA).

Under the provisions of ICAO, Annex 13, (Aircraft Accident and Incident Investigation), the Chief Inspector of Accidents, Mr. Kevin Humphreys appointed Mr. Jurgen Whyte (Operations) Inspector of Accidents/Investigator in Charge, and Mr. John Hughes (Engineering) Inspector of Accidents, to carry out an investigation into the circumstances of this serious incident and to prepare a Report for publication.

SYNOPSIS

The aircraft (EI-FKD) was on a scheduled flight from Dublin (EIDW) to EICK. The en-route segment of the flight was uneventful. A standard ILS approach was flown to runway (RWY) 17 at EICK. Shortly after landing, the aircraft weather-cocked right, into wind and drifted towards the right-hand side of RWY 17/35. The aircraft departed the right-hand side of the paved runway surface approximately 305 metres south of the intersection of both runways and continued on over soft ground for a further 195 metres, before finally coming to a stop. There were no injuries. The aircraft suffered some minor propeller and tyre damage. Some additional damage was caused to the runway infrastructure.

1. FACTUAL INFORMATION

1.1 History of the Flight

The aircraft departed EIDW at 1520 hrs on a scheduled flight to EICK. A total of fifty-one passengers (including one infant) and a crew of four were onboard. The flight crew were on their first flight/sector of the day, having just come off a three-day break from flight duty. The Captain was designated as the pilot flying (PF).

The flight en-route to EICK at Flight Level (FL) 160 was uneventful. On handover from Shannon (EINN) Area to EICK Approach, the PF indicated an initial preference for RWY 25. The flight crew acknowledged the hourly EICK weather at 16.02.45. Some concern was expressed by the flight crew regarding the reported cloud, which was given as "*few at 600ft, broken 3200, and overcast 4500",* and the fact that it was below their published minima for RWY 25. After a brief discussion the PF elected to request RWY 17 on the grounds that it was ILS equipped and had the longer runway. Air Traffic Control (ATC) reported the wind direction at this time as 250/12 kt and the runway condition as "*wet.*"

Data on the Cockpit Voice Recorder (CVR) showed that the flight crew completed a standard approach and landing briefing for RWY 17. After the briefing the F/O, pilot-not flying (PNF), sought clarification with regard to the type of landing the PF was intending to carry out at EICK. The PF informed the PNF that due to the wet conditions, he would carry out a firm 1000ft point centreline landing. There then followed a general discussion between the flight crew regarding the idiosyncrasies of landing at EICK and the landing technique used. Just prior to autopilot disconnect, the PF advised the PNF that he was going to carry out a smooth landing. At 16.14.18 the aircraft called established for RWY 17 and was handed over to EICK Tower. Reporting at 10 miles the aircraft was cleared to land RWY 17, surface wind 260/15 kt.

A stabilized approach was flown using the landing configuration of Flap 25° and a speed of (Vref +10). A final wind check was passed to EI-FKD by ATC at 16.16.28, giving 260/17 kt. The visual landing conditions were that of dusk, in rain, with wipers on. The autopilot was disconnected at a height of approximately 200ft above the threshold. Following the autopilot being disconnected the aircraft drifted slightly to the right and quickly re-established onto the centreline. Shortly thereafter, the aircraft made a smooth landing on the runway (16.18.11).

During discussions with both flight crewmembers, the PF told the investigation that on landing and being aware of the wet runway surface, he decided that he was, "*just going to close the power levers slowly and bring the aircraft to a nice steady stop."* The PF confirmed that both power levers were retarded symmetrically. Nose wheel contact with the runway was made 2 seconds later. The PF then handed over stick control to the PNF, whilst he himself took control of the rudder, the tiller and selected ground idle on the power levers. After the PNF acknowledged "*My stick,"* the PF called *"give me plenty of right* (stick) *there please."*

The PNF complied with this request. Almost immediately after this, and prior to any application of pedal braking, both the PF and the PNF felt the aircraft weathercock right-nose into wind, followed by a drift towards the right-hand side of the runway. The PF stated that, "*it felt like they had been pushed in the back."* The PF called out *"I'm aquaplaning",* three times, while attempting to regain directional control.

Efforts by the PF to regain directional control through inputs of left rudder, left control wheel, full foot pedal braking and reverse thrust failed. The aircraft departed the right-hand side of the paved runway surface at a point approximately 305 metres south of the intersection of RWY 17/35 and RWY 25/07. Both tiller and rudder were selected to full left, and reverse thrust was at approximately 60% as the aircraft departed the runway. On entering the soft ground, the PF recalled that the tiller shot back of its own accord to the central position, and that, "*it was the first time since the initial call of aquaplaning that I felt I had some directional control".* The aircraft continued on for a further 195 metres on a heading of 200° magnetic (M), before finally coming to a halt (16.18.35). The final heading recorded on the aircraft was 205° (M). The distance between the tail of the aircraft and the edge of the runway, including the shoulders was approximately 16 metres, while the distance from the nose of the aircraft to the runway, including the shoulder was approximately 29 metres.

After completing the "ON Ground" Emergency Check List the co-pilot advised EICK Tower that they had just aquaplaned off the runway. This was followed by the Captain making a public address (PA) announcement to the passengers that they should remain in their seats. The co-pilot remained in his seat, to monitor the radios, while the Captain entered the cabin to assess the situation. On confirming that there were no injuries, the Captain pinned the undercarriage and made arrangements for the passengers to be bussed back to the terminal building. Normal disembarkation took place through the front left door.

1.2 Injuries to Persons

Injuries	Crew	Passengers	Others
Fatal	Nil	Nil	Nil
Serious	Nil	Nil	Nil
None	4	51	

1.3 Damage to Aircraft

During its transition across the soft ground, the aircraft's main wheels sank beneath the turf/sub-soil and down towards the prepared hardcore surface. During this transition across the grass, the tips of three blades on the No 2 propeller incurred damage after striking a bird-scaring loud speaker unit. The No 2 engine and its propeller were subsequently removed for repair and shock-load testing. The main tyres suffered a number of cuts and scrapes and as a result were replaced.

1.4 Other Damage

The aircraft damaged a bird-scaring unit during its run off. The four main tyres caused deep rutted tyre groove damage for a distance of 195 metres along the grass verge to the right-hand side of RWY 17/35. Additional vehicle tyre damage was caused to the soft ground in the area of the run-off and a baggage loader belonging to the Operator also broke two runway edge lights, during the recovery of the aircraft.

1.5 Personnel Information

1.5.1

***Commander**:*	Male, aged 33 years.
License:	ATPL
Periodic Check (PC):	23 September 2000
Instrument Rating:	23 September 2000
Medical certificate:	19 June 2000, Class I
Flying experience:	Total flying: 5000 hours
	Total on Type: 500 hours
	Last 90 days: 130 hours
	Last 28 days: 48 hours
	Last 24 hours: 1 hour
Duty Time:	1 hour 45 min
Rest Period:	72 hours

1.5.2

***Co-pilot**:*	Male, aged 26 years.
License:	CPL
Periodic Check (PC):	14 October 2000
Instrument Rating:	14 October 2000
Medical certificate:	4 August 2000 Class I
Flying experience:	Total flying: 1400 hours
	Total on Type: 496 hours
	Last 90 days: 158 hours
	Last 28 days: 31 hours
	Last 24 hours: 1 hour
Duty Time:	1 hour 45 min
Rest Period:	72 hours

1.6 Aircraft Information

1.6.1 The Fokker 50 is a twin-engined, pressurised, high wing aircraft, designed for short and medium haul operations.

1.6.2 Leading Particulars

Registration:	EI-FKD
Manufacturer:	Fokker Aircraft B.V. The Netherlands
Model:	Fokker 50
Serial No:	20181
Year of manufacture:	1990
Engines:	(2) Pratt and Whitney PW 125 B turbo-prop
Propellers:	(2) Dowty Rotol 6 bladed, reversible-pitch, constant speed
Certificate of Registration:	Valid
Certificate of Airworthiness:	Valid

1.6.3 Aircraft Weights

The (MTOW) Maximum Take-Off Weight for the aircraft is 20 820 kg, and the (MLW) Maximum Landing Weight is 19 730 kg.

The actual weight of the aircraft on departure from EIDW was 19 310 kg, while the landing weight at EICK was 18 823 kg. The centre of gravity (C.G.) was within limits at 33 % of mean aerodynamic chord (MAC) at take-off.

1.6.4 Aircraft Maintenance

According to aircraft records all maintenance had been carried out in conformity with regulations and the authorized company maintenance programme.

1.6.5 Aircraft Systems

1.6.5.1 Propeller Control

Propeller pitch is controlled by high-pressure engine oil and counterweights. The pitch ranges from feathered, through zero pitch, to full reverse. Feathering can be initiated automatically or manually.

1.6.5.2 Landing Gear General

The landing gear consists of a forward retracting nose gear and two rearward retracting main gears. Each gear is equipped with a shock absorber and two wheels. The main gear wheels are equipped with brake units. A skid-control system provides optimum braking for all runway conditions.

1.6.5.3 Brakes

The hydraulic brake system is operated by both pilot's brake pedals. Two brake-control valves meter hydraulic pressure to the brakes, thus allowing differential braking. The brake system is equipped with a skid-control system, which modulates the brake pressure.

1.6.5.4 Skid Control General

Individual wheel-brake pressure is continuously and rapidly modulated to guarantee that each wheel has the maximum effective braking force without locking of the wheel. A deceleration of one or more of the wheels will be detected by the skid control box. The relevant skid control valves are signalled to reduce the pressure in accordance with the rate of deceleration. An amber skid control (SKID CTL) light on the Caution Advisory Panel (CAP) comes on when a failure in the skid control box is detected.

1.6.5.5 Locked Wheel Protection

When the speed of a wheel decelerates to a point where the wheel may lock, the relevant brake is fully released to allow the wheel to spin up. Locked wheel protection is inactive at normal taxi speed, i.e. < 17 kts.

1.6.5.6 Touchdown Protection

The locked-wheel protection mode releases all pressure from the brakes in flight with landing gear down, and for a period of seven seconds or 30 kt spin up (which ever is the earlier) after touchdown in case of no wheel spin-up, e.g. due to aquaplaning.

1.6.5.7 Skid Control Test

The skid control system is tested by depressing the SKID CTL TEST button on the test panel. The system is divided into separate circuits for the inboard and outboard wheels. When one or both skid-control-test lights remain on after the button is released, a fault is present. Subsequent to this incident an anti-skid operational Built in Test Equipment (BITE) test was carried out on EI-FKD on the 31 October 2000. The system was found to be serviceable.

1.6.5.8 Nose Wheel Steering

The nose gear is provided with a hydraulic nose-wheel steering and a cantering system. Two interconnecting tillers, one on each side panel, control the steering control valve mechanically. This valve directs hydraulic pressure to either side of the steering motor allowing up to +/-73º of travel. The cantering mechanism is hydraulically activated when the landing gear is selected up.

1.6.6 Wheels/Tyres

Some hours after the incident, an AAIU investigator inspected the wheels and tyres of the aircraft at Cork airport.

The nose wheels and tyres were found to be in good condition, with the tyre pressure of 50 pounds per square inch (psi) being within the limits of the Daily Inspection Schedule. As both wheels and tyres were deemed serviceable, they remained on the aircraft.

The four main tyres showed signs of some minor cuts and scratches. These cuts and scratches may have been caused during normal ground manoeuvring, but more likely when the aircraft left the runway. The tyre pressures, 83 psi for No 1 tyre, 82 psi for No 2, 83 psi for No 3, and 82 psi for No 4, were within the prescribed limits of the Daily Inspection Schedule. All main tyres were subsequently removed for further analysis.

Three tyres were sent to Goodyear and one to Dunlop for inspection. The following was reported:

Posn	Wheel S/N	Make	Tyre S/N	Cycles	Retread	Remaining Tread Depth
# 1	Jul 89-0506	Goodyear	8049T402	228	R1	61%
# 2	Nov 86-103	Dunlop	97003320	526	R1	7%
# 3	Jul 89-0505	Goodyear	8052T414	220	R2	66%
# 4	Nov 86-109	Goodyear	6197T603	109	R3	68%

No sign of skidding, rubber reversion or aquaplaning was observed on any of the four main tyres. However, in discussions with both manufacturers it was confirmed that it was possible, and in the case of the Fokker 50 probable, for aquaplaning to take place and not leave any physical signs on the tyres.

The 7% remaining tread on No 2 main tyre, equates to all tread grooves worn to less than 1 mm of groove depth. It is considered common practice in industry to have different makes of tyres on aircraft, once the tread pattern remains the same.

The Operators Transit Check for Fokker 50, Chapter 2, Section 1 Page 1, Para 5 (a) Landing Gear (Walk around Inspection) states:

> *"Check tyres for damage and wear, (Maximum allowable to the base of the groove)".*

The Fokker 50 Maintenance Manual Ref 32-41-00, ZZ2-810-A, Page 002, Para E covers, Criteria for Removal of Bias Tyres and states:

> *"(1) Tread wear*
>
> *<u>Home base</u>: Inspect treads visually and check remaining thread. Tyres should be removed when the tread has worn to the base of any groove at any spot.*
>
> *<u>Outside station</u>: As above. However, the tyres can be worn more than prescribed but landings should not exceed 5-7 more landings to prevent tyre-wear into cord body plies. Wear beyond these limits is only allowed in special cases, such as at outside stations, if a wheel change would delay aircraft considerably, or if no tyres were available. However, the tyre must not be worn through to the body plies, both for safety reasons and also for economic reasons, as such tyres cannot be rethreaded."*

1.6.7 Crosswind Limitations

As per the Fokker Aircraft Operating Manual, the maximum demonstrated crosswind component for take-off and landing on a hard dry runway is 33 kt.

The Operator's Operations Manual (Part A, Operating procedures, Table 2) states, "*that the maximum cross wind limitation for take-off and landing for the Fokker 50 on a dry runway is 30 kt*". Wet runway operations are covered under Table 6 of the same section and states, "*that where the braking action declared is good and the co-efficient of Friction Factor is 0.40 or above, the maximum cross wind component is 30 kt with a 10 kt tail wind*".

1.6.8 Dynamic Aquaplaning Speeds

The threshold minimum velocity in knots at which dynamic aquaplaning may occur on a rolling tyre is calculated through use of the formula: Vkts = 9 √ Tyre Pressure (p), where (p) is measured in p.s.i. and if a tyre is not rotating: Vkts = 7.7 √ Tyre Pressure (p).

In the case of Fokker 50 type aircraft, this would equate to 82 kts (tyres rotating) and 71 kts (tyres not rotating) for the main wheel tyres and 63 kts (tyres rotating) and 54 kts (tyres not rotating) for the nose wheel tyres. A brief description of aquaplaning is presented at **Appendix A** to this report.

1.6.8.1 Aquaplaning Training

It was determined that during basic type conversion company pilots are warned of the possibility for the on-set of aquaplaning and briefed on the laid down aircraft operating manual technique for recovery from same. There is no capability on the aircraft simulator to train for the recovery from aquaplaning and no actual aquaplaning recovery training is carried out on the aircraft itself.

1.6.9 Use of reverse thrust

In discussions with the operator it was stated that under normal field operations, ground idle is used to decelerate the aircraft after landing. Reverse thrust might be used during short field operations, but only on rare occasions.

1.7 <u>Meteorological Information</u>

1.7.1 General Situation

A low of 958 hPa was centred just NNW of Scotland and maintained a moist, fresh westerly airflow over Cork Airport. There was a frontal system south of Cork at 50° North.

1.7.2 Short TAF issued 1200 hours for EICK

291200 EICK (Cork) 1322, 21012KT 6000 –RA SCT007 BKN012 TEMPO 1315 2000 RA BKN005 BECMG 1416 25015G30KT 9999 SCT010 BKN030 BECMG 1922 22014G24KT TEMPO 1522 SHRA BKN010 BKN015.

1.7.3 Automatic Terminal Information Service (ATIS) Report 1500 hours EICK;

Information Golf 1500 hours, ILS to Runway 17, Wet, Wind 240/12 kt, visibility 10 km in rain, cloud scattered at 1000, scattered at 4500. Temp/Dew point 7/6 degrees Celsius, 989 hPa. No Sig.

1.7.4 METAR 1600 hours EICK – Transmitted by Cork Approach to EI-FKD

1600 EICK (CORK) Surface wind 250/12 kt, Visibility 8 Km in rain, few at 600 feet, broken 3200, overcast 4500 feet, temp +8, dew point +7, QNH 988 No Sig.

1.7.5 Weather Report for Cork Airport at time of incident

1619 hours	Wind:	(Surface) varying 240-250/12-14 kt, (2000 feet) 280/30 kt
	Visibility:	5 to 10 km
	Cloud:	SCT006 BKN030
	Temp/Dew Point:	08/07 (degrees Celsius)
	MSL Pressure:	989 hPa.

1.7.6 Rainfall - 29 October 2000, Cork Airport.

A total of 25.3 mm of rain fell at Cork Airport on the 29 October 2000, the day of the runway excursion. The duration of rainfall was 12 hours. From 0000 hrs UTC to the time of the runway excursion (1619 hrs), 14.3 mm of rain fell. From 0900 hours to 1619 hrs, continuous rainfall totalling 14 mm was recorded. The maximum rate of rainfall was 8 mm/hr (4.6 mm) at 1300 hours. In the hours after the runway excursion, rainfall was initially very light (0.8 mm over 3 hrs), followed by (2.6 mm) over the next two hours. By the time the AAIU Inspector arrived at the airport (2200 hrs), a total of (3.4 mm) of rain had fallen since the runway excursion. A table of the recorded rainfall for the 29 October 2000 is presented at **Appendix B** to this report.

1.7.7 Rainfall – October 2000, Cork Airport

Cork Airport registered 190% of its normal monthly rainfall average in October. On the day of the runway excursion, a total of 26 % (25.3 mm) of the monthly rainfall fell at the airport, making it the wettest day for the month of October.

1.7.7 Rainfall - Year 2000

Rainfall totals for the year 2000 varied between 843 mm at Dublin Airport and 1768 mm at Valentia. Cork Airport recorded a total of 1142.9 mm or 95% of its normal average.

1.8 Aids to Navigation

ILS to Runway 17 at EICK.

1.9 Communications

Normal communication took place between the aircraft and Air Traffic Control (ATC).

1.10 Aerodrome Information

1.10.1 General

Cork Airport is an International Airport, State owned and operated by Aer Rianta. It is located 3.5 nautical miles South of Cork City at 502 feet AMSL (51°50N 08°29W).

1.10.2 Physical characteristics of Runways

The Airport has two intersecting runways, namely RWY 17/35 and RWY 25/07. A gradient profile of both runways is presented at **Appendix C** to this report.

RWY 17/35 is 2133 metres long, 45 metres wide and is provided with 7.5 metre shoulders. The surface is covered in asphalt and is grooved. This runway has a full east to west crossfall from the RWY 17 threshold, out to 960 metres. Between 960 metres and 1050 metres, it has a moving crown, from 1050 metres to 1800 metres, it has a crown section, from 1800 metres to 1930 metres, it has a moving crown, and from 1930 metres to 2133 metres, it has a full east to west crossfall. A downward slope of approximately 0.75% falls from the 300 metre point of RWY 17, towards a point 350 metres south of the intersection.

RWY 25/07 is 1310 metres long and 45 metres wide. The surface is covered in concrete/asphalt and is grooved at the intersection of both runways. A downward slope of approximately 0.9% falls from the RWY 25 threshold towards the runway intersection.

1.10.3 Overlay of Runway 17/35 at Cork Airport

During 1998/1999 a considerable amount of work was carried out on RWY 17/35. The work consisted of:

- (a) Installation of cable ducting along pavement edges,
- (b) Construction of 7.5 metre wide shoulders on both sides of the runway,
- (c) Construction of a grooved asphalt overlay to the existing runway, and
- (d) Removal and reinstallation of light fittings in the runway and taxiway pavements.

The overlay of RWY 17/35 was completed in the Spring of 1999. The surface friction of the new pavement was enhanced by grooving the asphalt pavement. 5 mm deep x 5 mm wide grooves at 37 mm centres were provided for the full width (45 metres) of the runway.

The grooves were cut at right angles to the centreline, except at the runway intersection, where the grooves were cut at 45º to the centreline, so as to provide surface friction for both runways. The original concrete runway pavement and the asphalt pavement in the 300 metre extension to RWY 17/35 were also grooved.

In early January 2001, additional/deeper grooving was provided over parts of the runway, in particular in the general area of the intersecting runways. The effectiveness of this additional grooving is at present under continuous monitoring in wet weather by the Airport Authority.

1.10.4 Surface Friction Testing

1.10.4.1 The measurement of the friction coefficient (see also Additional Information 1.18) has been found to provide the best basis for determining surface friction conditions. This can be achieved through the use of a continuous friction measuring device e.g. Surface Friction Tester (SFT), using self-wetting features on a clean surface. The Mu values are used to signify a designated friction value representing runway conditions. These values range from 0 to 1, where zero is the lowest friction value and 1 is the maximum value obtainable.

1.10.4.2 Surface Friction Tests Cork Airport

At the time of the incident, Cork Airport did not have an on-site SFT. It is not a requirement of the International Civil Aviation Organization (ICAO) Annex 14 provisions to have a SFT in situ. When surface friction tests are required to be carried out on the runways, a SFT (Skiddometer) is brought in from Dublin Airport.

A surface friction test (Using a Skiddometer from Dublin Airport) was last carried out at Cork Airport on the 14 March 2000. The weather conditions recorded on the day were nil precipitation at any time during the test. However the system has a self-wetting capability (lays down 1 mm of water in front of wheel during the test). Using an average test speed of 55 km/hr, the readings recorded for RWY 17/35 were as follows:

	Runway 17	Runway 35	
Test 1	**Friction**	**Friction**	**Total average**
1st third (A)	0.70	0.70	0.70
2nd third (B)	0.74	0.77	0.75
Last third (C)	0.65	0.66	0.65
Average	0.696	0.71	**0.70**

Test 1: Showed an average friction coefficient for RWY 17/35 of 0.70.

	Runway 17	Runway 35	
Test 2	**Friction**	**Friction**	**Total average**
1st third (A)	0.75	0.72	0.73
2nd third (B)	0.76	0.75	0.75
Last third (C)	0.74	0.74	0.74
Average	0.75	0.73	**0.74**

Test 2: Showed an average friction coefficient for RWY 17/35 of 0.74

Previous to these particular tests, a SAAB Friction Tester from Bonn, Germany, was used to carry out a surface friction test in November 1999. Using the higher average test speed of 90 km/hr for runway 17/35 and 87 km/hr for runway 07/25, the average readings recorded for both runways were as follows:

	Runway 17	**Runway 35**	
	Friction	**Friction**	**Total average**
1st third (A)	0.65	0.60	0.62
2nd third (B)	0.69	0.64	0.66
Last third (C)	0.66	0.63	0.64
Average	0.67	0.62	**0.64**

Test 3 showed an average friction coefficient for RWY 17/35 of 0.64

	Runway 07	**Runway 25**	
	Friction	**Friction**	**Total average**
1st third (A)	0.62	0.57	0.59
2nd third (B)	0.67	0.53	0.60
Last third (C)	0.66	0.56	0.60
Average	0.65	0.55	**0.60**

Test 4 showed an average friction coefficient for RWY 07/25 of 0.60

All these test results are above the minimum levels set by ICAO Annex 14 provisions, for maintenance planning and minimum friction for runway in use. **(Appendix H)**

1.10.5 Assessment of Runway Condition

1.10.5.1 In order to comply with Annex 14 requirements (See Section 1.18 Additional Information), information on the condition of the movement area needs to be provided to the appropriate Aeronautical Information Service (AIS) Units and Air Traffic Service (ATS) Units, to enable those units to provide the necessary information to arriving and departing aircraft. Whenever water is present on a runway, a description of the runway surface conditions on the centre-half of the width of the runway, including the possible assessment of water depth, where applicable, shall be made available.

1.10.5.2 Runway inspections

Members of the Airport Authority's, Police and Fire Service conduct runway inspections at Cork Airport. A minimum of three inspections, are carried out each day, usually on the change of shift at 2400 hours, 0800 hours and 1600 hours respectively. Additional inspections maybe carried out on the request of the ATC.

A standard runway inspection normally entails driving onto the runways and around the airfield perimeter to check for bird activity, taxiway, runway and approach lighting, obstructions and Foreign Object Damage (FOD). Prior to this particular incident, the normal runway inspection did not provide for the assessment of the wet runway condition. The assessment of the wet runway condition would normally be in addition to the routine runway inspection and only carried out on the specific request of ATC.

1.10.5.3 Assessment of Wet Runway Condition (Pre-runway excursion)

There is no record of the Airport Authority's Police and Fire Services carrying out an assessment of the wet runway condition in the hours leading up to the runway excursion (2400-1619 hours). Also, there is no record of a request being made by ATC to the Airport Authority's Police and Fire Services to carry out an assessment of the wet runway condition, or to take water depth readings of the runways.

1.10.5.4 Assessment of Wet Runway Condition (Post-Runway excursion)

The Airport Authority's Police and Fire Services did carry out an assessment of the wet runway condition between 1715 hours and 1800 hours after the runway excursion. Water depth readings of between 1 mm and 1.5 mm were recorded as being present on the runway from the threshold of RWY 17 to the 300 meter point. A depth of 1.5 mm was also recorded present in the area along RWY 17 leading up to the intersection, the general area of the intersection itself and just south of the intersection.

A member of the Investigation team arrived at the airport at 22.00 hrs, approximately 5½ hrs after the incident. The conditions at the time were that of continuous light rain. He proceeded to inspect the site and the aircraft. Measurements were taken of the distance from the intersection of the runways to where the aircraft departed the runway and where it came to a stop.

There were visual patches of standing water in the general area of the intersection, and towards the runway shoulders edge. A tyre mark made by the aircraft as it approached the shoulder of the runway appeared at first sight to be evidence of aquaplaning steaming. However, on closer examination it was discovered that this mark was made by the starboard main tyres, passing through silted water, which was present in the general area of the runway shoulder.

1.10.6 Braking Action

Braking action at Cork Airport is measured by means of a Tapley Meter. Prior to this incident, the last runway braking action test to be carried out by the Airport Authority's, Police and Fire Service was on the 16 February 2000. The weather conditions on the test day indicated: Light snow showers with coverage of 0.5 cm over half of the ground. The readings recorded for RWY 17/35 showed an average braking action of 0.776. It is recognized both by the Airport Authority and the investigation that the Tapley Meter is recommended for use only on compacted snow and/or ice-covered runway surfaces. It is not recommended for operation on wet runway pavement surfaces.

1.10.7 Water Depth Readings

Since this incident, the Airport Authority's Police and Fire Service has provided the AAIU with water depth reading reports for both runways at Cork Airport. Up to 26 March 2001, a total of 163 individual water check reports have been submitted to this investigation, covering 63 separate wet weather days.

The following table shows in percentage terms, the maximum depths recorded to be present on the intersection for a particular reading on each day of the 63 wet days sampled.

Water Depth	**0-1mm**	**1-2mm**	**2-3mm**	**3-4mm**	**4-5mm**	**5-6mm**	**6-7mm**
% Days	41.3%(26)	38%(24)	11.11%(7)	6.4%(4)	0%(0)	1.6%(1)	1.6%(1)

A number of specific examples are considered relevant and are thus outlined below:

5 November 2000: one water depth recording showed 6 mm of standing water present in the general central area, and slightly south of the intersection. This particular day was recorded as the heaviest rainfall day at Cork Airport for the year 2000. (Total day rainfall 43 mm)

30 November 2000: a special observation at 1214 hours stated on the EICK ATIS that…*the runway is covered in water, average depth two millimetres, but seven to eight millimetres at the runways edge.* (Total day rainfall 26.4 mm)

9 December 2000: a water depth of 4 mm was recorded to be present on the intersection. (Total day rainfall 8.5 mm)

10 December 2000: a water depth of 3-4 mm was recorded to be present on the intersection. (Total day rainfall 19.8 mm)

12 December 2000: a water depth of 3-4 mm was recorded to be present on the intersection. (Total day rainfall 16.1 mm)

9 February 2001: a water depth of 3 mm was recorded to be present on the intersection. (Total day rainfall 15.2 mm)

10th February 2001: a water depth of 3 mm was recorded to be present on the intersection. (Total day rainfall 7.4 mm)

6 March 2001: two separate water depth readings, between 6 mm and 7 mm were found to be present on the intersection. (Total day rainfall 27.5 mm)

17 March 2001: a water depth of 3 mm was recorded to be present on the intersection. (Total day rainfall 4.6 mm).

In general, it was found that during or after prolonged and/or heavy precipitation, the rate of surface water run-off on different sections of the runway, but in particular at the general area and slightly south of the intersecting runways, can be delayed. This delay in run-off results in the formation of standing water and/or water patches being present from time to time. It was noted that as the intensity and duration of precipitation increases, so does the likelihood that standing water would form. For the centre half width of the runway the deepest depths were recorded in the general area of and slightly south of the intersection.

The presence of strong easterly or south easterly winds showed a tendency for water to be fed towards and through the intersection from the direction of RWY 25, while a strong westerly or south-westerly wind showed a tendency to impede water run-off at the shoulders of the runway. It was also determined that, in rainfall conditions less severe than that experienced on the day of the runway excursion, water depths were found to be deeper than the depths recorded on the intersection over 1 hour after the event.

1.11 <u>Flight Recorders</u>

1.11.1 Cockpit Voice Recorder (CVR)

The aircraft was equipped with a Fairchild A100A CVR. It was installed in the empennage. The CVR was brought to the AAIB Laboratory in the UK, where a total of 29 minutes of recording was down loaded. The recording covered the majority of the flight and continued up to the point where the flight crew actioned their "On ground" emergency checklist. The CVR was found to have worked as expected, as all communications and other sounds had been recorded satisfactorily. Relevant extracts of the CVR are presented at **(Appendix E)** to this report.

1.11.2 Flight Data Recorder (FDR)

The aircraft was equipped with a Sunstrand P/N 980-4100 FWUS FDR. It was also installed in the empennage. The FDR was brought to the AAIB Laboratory in the UK where it was down loaded. The FDR was found to be in good working order, as all the stated parameters were available to the investigation.

A trace of the relevant parameters of the FDR is presented as **(Appendix F)** to this report. The FDR recording stops approximately 1-2 seconds prior to the aircraft coming to a halt.

1.11.3 FDR and CVR Information

1.11.3.1 Landing – The First 10 seconds

The aircraft first touched the runway with its right main wheel, approximately 110 meters before the end of the touchdown zone, slightly left of centreline, at an indicated airspeed (IAS) of 99 kt, which is equivalent to a groundspeed of 106 kt**.** As the weight of the aircraft came onto the right main wheel, the heading registered 170° (M). The Normal (vertical) G acceleration reached a peak of 1.3G at the first contact and there was a corresponding momentary increase in longitudinal deceleration. The nose of the aircraft pitched down, as the left wing also came down, recording a maximum of 1.2G at the second contact. The IAS decreased slightly from the initial speed to 92 kt, as the air/ground switch indicated "Weight-on-Wheels" (W.O.W.). The ground speed then registered 97.5 kt.

The time recorded was 39 seconds since AP disengagement, indicating an elapsed time of 1 second since first "touch on". The rudder angle at this stage was in the region of 14° left and reduced towards 7° left over the next 2 seconds.

The IAS increased slightly as the aircraft pitched down to bring the nose wheel on. The longitudinal deceleration remained fairly constant at 0.116 G. The control wheel registered 15° to the right (right wing down). This was reduced towards the central position (1° right), as the weight was distributed on to the nose wheel approximately 2 seconds later. The aircraft heading now started to deviate right from 170° (M) towards 176° (M), and more left rudder was applied (13° left). The aircraft steadied on 176° (M) and then decreased left towards 174° (M). When the aircraft was steady on 176° (M), lateral G was recorded to the right. In fact, for the next 9 seconds (11 seconds after W.O.W) the FDR recorded a lateral G, mainly to the right. Approximately 4 seconds after W.O.W, at an IAS of 87 kt, the PF called *"your stick"* to the PNF and the PF continued to steer the aircraft with rudder (10º left). He also went on the nose wheel steering tiller and selected ground idle. The PNF acknowledged *"my stick*" with the control wheel increasing from the near central position towards 29º right. The control column position was 10º nose down. At this point in time, the aircraft was entering the intersection of both runways.

At 5 seconds after W.O.W. (IAS 85 kt), the right low pitch warning light LP 2 (indicating less than + 10° blade angle) came on, with the No 2 engine/propeller torque (TQ 2) bottoming out at 0%. On response to the PF call of, *"give me plenty of right there please,"* the PNF increased the control wheel towards 45° to the right. The left low pitch warning light LP 1 came on approximately 2 seconds after LP 2, with the No 1 engine/propeller torque (TQ 1) bottoming out at +6.7%. For a period of 2 seconds, an asymmetric thrust imbalance of +6.7% ground idle torque, in favour of the No 1 engine/propeller existed (tendency to swing right). Over the next second the heading increased from 174° (M) to 181° (M). The control wheel transitioned from 45º right towards the central position, as the heading increased.

The minimum recorded propeller speeds of 82% occurred simultaneously for both engines at 8 seconds from touchdown and this is taken as the "Ground Idle" point (blade angle of -2°) and point of minimum forward thrust prior to the blades taking up a more negative angle and, consequently, negative thrust.

The torque for both sides then increased, and by 9 seconds after W.O.W, the No 2 engine/propeller torque TQ 2 reached 15% reverse thrust, whilst the No 1 engine/propeller TQ 1 reached 7.6% reverse thrust. This gave an asymmetric thrust imbalance of +7.4% reverse thrust on the right side (right swing). A right lateral acceleration of 0.175G for 1 sec was recorded here. The IAS decreased from 90.4 kt to 75.3 kt, and the ground speed from 95.3 kt to 83.3 kt in the first 10 seconds of the aircraft's roll. Rudder increased from 10º left to 20º left. The PF called that the aircraft was aquaplaning (9 seconds after W.O.W). At this stage the control wheel is recorded transitioning through the central position towards 27º left, with the control column positioned 13º nose down. The control column position was between 13º and 14º nose down, for the remainder of the landing roll out.

1.11.3.2 Landing – The final 15 seconds

The PF called "aquaplaning" for the second time (10.4 sec after W.O.W). Lateral G was recorded to the left for the next 2 seconds as the control wheel goes to 34º left and then to 45º left and rudder was increased to 22º left and then to 25º left. The PF then called "aquaplaning" for the third and final time (11.6 seconds after W.O.W). Heading decreased from 181° (M), (9 seconds after W.O.W.) to 172° (M), (13 seconds after W.O.W) during this time.

Approximately one second earlier (12 seconds after W.O.W.), as lateral G was still showing some movement to the left and heading had briefly steadied at 172° (M), the PF selected reverse thrust on both engines. The No 2 engine/propeller TQ 2 reached a maximum of 60.3% ahead of No 1 engine/propeller TQ 1, which reached a maximum of 54%, giving an asymmetric thrust imbalance of +6.3% torque on TQ 2 at the steady state (right swing).

Thirteen (13) seconds after W.O.W, the lateral G changed from left acting to right acting and remained like that for the remainder of the FDR recording. The heading increased from 172° (M) to 202° (M), and the aircraft decelerates rapidly to a maximum of 0.5G. Control wheel position was recorded at 43° left and rudder at 25° left, just prior to departing the runway. As stated by the PF, nose wheel steering tiller was fully to the left. The IAS reduced from 70 kt to 20 kt (groundspeed 79 kt to 24.7 kt) in 10 seconds. The aircraft came to a halt approximately 25 seconds after W.O.W

1.11.3.3 Track and Heading referenced against Runway centreline

When the aircraft track and heading is referenced against the runway centreline **(Appendix G)**, it can be seen that the aircraft is continuously moving towards the right hand edge of the runway from just after touchdown and the aircraft heading oscillates about the aircraft track. When in the air, an aircraft is allowed to freely rotate about its axes because it is not fixed to any point. If influenced by wind, the heading can vary about the track (drift). On the ground, in particular under dry or non-slippery conditions, the aircraft's undercarriage will restrict lateral movement about the central axis, so heading and track remain the same. Under reduced runway friction or aquaplaning, the aircraft is less restricted in lateral movement and heading can increase or decrease about the aircraft track.

1.11.3.4 Distance Covered during roll.

Using the parameters recorded, the total landing run from W.O.W to the point where the aircraft came to rest can be estimated. During the first 5 seconds, the <u>average</u> longitudinal deceleration of the aircraft from touchdown was 0.089G. The corresponding distance covered was 288 metres and the groundspeed had decreased to 97.5 kt. In the next 5 seconds the deceleration had increased to 0.148G, another 233 metres had been covered bringing the ground speed to 83.3 kt. However, the deceleration then increased to an average of 0.244G and after another 5 seconds the speed was 60 kt and an additional 184 metres had been covered.

The max deceleration of 0.37G then occurred and in 5 seconds the speed was rapidly down to 24.7 kt with a further 109 metres travelled. Finally, the deceleration decreased to 0.32G, allowing the aircraft to come to a stop 25 metres further on. Thus the total rolling distance would have been 839 metres and the time taken from WOW estimated at 25 seconds.

The estimated distance between the aircraft on the grass and the runway intersection was 500 metres. Allowing for a cross-runway width of 45 metres, this figure indicates that the weight came on to the main wheels 294 metres before the commencement of the intersection of the runways.

The aircraft first touched the runway with the right main wheels, 56 metres before W.O.W, followed 1 second later by the left main wheels. W.O.W was recorded slightly left of centreline, and within the final quarter of the declared touchdown zone, 180 metres beyond the middle of the aiming point and approximately 290 metres from the commencement of the intersection of both runways. The nose wheel touched down 2 seconds/107 metres later. It is estimated that the aircraft departed the runway approximately 305 metres from the south end of the intersection, approximately 16-17 seconds after W.O.W. and came to a halt a further 195 metres along the grass approximately 8 seconds later.

1.11.4 Previous Landings EI-FKD

A total of 4 previous landings on the aircraft's FDR were analysed by the investigation. Generally it was found that all these landings were very similar to each other. It was noted that in each case, the Low Propeller Pitch (LP) indication occurs just after activation of the air/ground switch (W.O.W). In addition it was recorded that on each landing, the LP 1 and LP 2 light came on simultaneously and engine torques were well matched with each other, during travel. It should be noted that each light is activated by a micro-switch in the Pitch Control Unit (PCU) through a double contact solenoid when the propeller blades reduce to less than + 10°. One pair of contacts operates the cockpit indication and the other is fed to the flight data acquisition unit (FDAU). Each system left and right is completely separate. It is possible, therefore, to have a small time interval between the right propeller assembly blades reaching +10° and the left set reaching the same angle.

Four of the previous recordings show engine/propeller TQ 2 accelerating ahead of engine/propeller TQ 1 just after torques bottom out at ground idle. In three cases, TQ 2 rises to approximately 15%, while TQ 1 levels at approximately 5%. This indicates that a small amount of reverse thrust was being selected after ground idle. The thrust imbalance of approximately 10% showed no tendency to swing the aircraft to the right.

1.12 Wreckage and Impact Information

Not applicable.

1.13 Medical and pathological information

Not applicable.

1.14 Fire

There was no fire

1.15 Survival Aspects

Not applicable

1.16 Tests and Research

Not applicable

1.17 Organizational and Management Information

1.17.1 Responsibility for the Assessment of Runway Condition

The Airport Authority confirmed to the investigation that matters of operational significance and/or the likelihood of aircraft performance being affected by water on a runway is determined by ATC. ATC request water depth/surface conditions assessment by the Airport Authority.

1.17.2 Purchase of Surface Friction Tester (SFT) Equipment

Prior to this particular incident, the Airport Authority had been assessing a number of different surface friction testers, with the intention of purchasing a suitable type for Cork Airport.

1.17.3 Operational Service of Aircraft

In March of 2001, the Fokker 50 aircraft was withdrawn from operational service with the operator, as part of a planned fleet replacement.

1.18 Additional Information

1.18.1 Runway Friction General

There is general concern over the adequacy of the available friction between the aircraft tyres and the runway surface under certain operating conditions, such as when there is snow, slush, ice or water on the runway. The presence of these contaminants on the runway surface can disrupt the contact between the tyre footprint and the pavement with the result that they can interfere with the development of friction forces. An extract from the ICAO Airport Services Manual with regard to the need for adequate runway friction characteristics and the need to determine runway friction/speed characteristics is presented at **Appendix D** to this report.

1.18.2 ICAO ANNEX 14, Volume 1 Aerodrome Design and Operations

Annex 14 contains Standards and Recommended Practices (Specifications) that prescribe the physical characteristics and obstacle limitation surfaces to be provided for at aerodromes, and certain facilities and technical services normally provided at an aerodrome. The following Annex 14 Standards, Recommended Practices and Guidance Material extracts are presented at **Appendix H** to this report.

1. Condition of the movement area and related facilities (Annex 14 Chapter 2, Section 2.9)
2. Water on a runway (Annex 14, Chapter 2, Section 2.9)
3. Pavements (Annex 14, Chapter 9, Section 9.4)
4. Determination of friction characteristics of wet paved runways (Annex 14, Attachment A (Section 7), Guidance material)

1.18.3 ICAO ANNEX 11 – Air Traffic Services - Flight Information Service (Chapter 4, Para 4.3.8)

4.3.8: ATIS for arriving aircraft

This section of the Annex states the different elements of information that shall be contained in ATIS messages to arriving aircraft. It includes at item *h) significant runway surface condition and if appropriate, braking action.*

1.18.4 AIP Ireland - AD 1. Aerodrome/Heliports – Introduction

Section 6: Friction Measurement (Extract)
The friction of the runway is calibrated periodically by the use of a Surface Friction Tester (SFT) using self-wetting features on a clean surface. Whenever the friction of the runway surface is below 0.40 the runway will be declared to be slippery when wet.

Section 7: Friction Measurement - Other Information
If a runway is affected by standing water not associated with snow, slush or ice at any time during the approach of an aircraft for landing, the depth and location of such standing water, will be notified by the aerodrome authority direct to ATS for transmission to the aircraft. If the duration of the phenomenon is likely to persist and the information requires a wider distribution, a NOTAM will be issued.

1.18.5 Flight Techniques Fokker 50

Section 7 of the Fokker 50 Aircraft Operating Manual (AOM) covers Flight Techniques

7.05.01 Crosswind Landing

- *On final approach maintain runway alignment by crabbing into the wind.*

- *When crossing the threshold, apply rudder to align aircraft with the runway centreline and bank into wind to counteract drift (3 deg – 5 deg bank angle).*

- *After landing, keep straight initially with rudder and counteract the tendency of the upwind wing to lift by decisive use of aileron.*

If reverse is required, apply reverse slowly and symmetrically. If problems with directional control, reduce reverse or select ground idle.

7.09.01 Landing on a wet/slippery runway

When landing on a wet or contaminated runway cannot be avoided, an 'in-the-slot' approach becomes of utmost importance.

A steep, flat or fast approach and a prolonged flare must be avoided. Fly the correct approach and threshold speed and ascertain a firm, positive touchdown at the correct landing point. After touchdown, lower the nose, select ground idle and reverse, and apply brakes. In case no brake response is felt, hydroplaning (aquaplaning) should be expected. Do not use alternate brakes under these circumstances. If directional control cannot be maintained, cancel reverse and use rudder and aileron to regain control.

1.18.6 Thrust Imbalance

In discussions with the aircraft manufacturer, it was determined that there is no limit for an imbalance of thrust while in ground idle, no limit for thrust imbalance during selection of reverse and no limit for reverse thrust imbalance at the steady rate. However, it was stated that with normal rigging errors, thrust imbalance should be less than 10% torque.

2. ANALYSIS

2.1 The Landing

FDR analysis confirms that following an initial gentle bounce the aircraft made a smooth landing at the correct landing speed, slightly left of centreline and within the final quarter of the touchdown zone. W.O.W occurred approximately 180 metres beyond the mid-section of the aiming point and approximately 290 metres back from the commencement of the intersection of both runways. The prevailing landing wind was 250/14 kt.

The landing heading was 170° (M), while the runway heading is 167° (M). At 2 seconds after W.O.W the nose wheel makes contact with the runway. One (1) second prior to this the aircraft heading is recorded as increasing towards 176° M over the next 4 seconds. This coincides with rudder input reducing from 14° left to 7° left and the control wheel decreasing from 15° right wing low, towards the central wheel/wings level position.

An increase of rudder input from 7° left to 13° left, does arrest the initial increase in heading, as the heading steadies on 176° M, however, the control wheel continues its travel to the wings level position. The control column is positioned 10º nose down.

The handover of stick control occurs just as the aircraft enters the general area of the intersection, slightly right of centreline, on a steady heading of 174° M and at an IAS of 85 kt. This speed is in excess of the known aquaplaning speed of 82 kt for the aircraft. On acknowledgement from the co-pilot of *"My Stick"*, the control wheel increased from wings level to 29° right wheel and on the request by the PF for *"Give me plenty of right there please,"* the co-pilot increased the control wheel to 45° right wing down.

Selection of ground idle by the PF occurred approximately 4 seconds after W.O.W. A 2-second delay occurred between the LP2 light and the LP1 light being activated and this accounts for a thrust imbalance of +6.7% torque in favour of the left engine (right swing).

Eight (8) seconds after W.O.W, just as both propellers have reached ground idle, a sharp increase in heading and lateral G to the right is recorded. Under normal runway conditions, the influence of the actual crosswind component, combined with a slight asymmetric reverse thrust in favour of a right swing, should not have an adverse effect on the directional controllability of the aircraft.

Previous landings on EI-FKD show that even with approximately 10% asymmetric reverse thrust in favour of a right swing, no subsequent swing was recorded. However, in this particular case, the combined effects of surface condition, crosswind and asymmetric thrust became significant. When ground idle was reached, the aircraft swung right and continued its drift right.

The first call by the PF of, *"I'm aquaplaning"* followed this event. The call was observed on the CVR as, both sudden and very definite in nature. As the heading continued to increase, the control wheel decreased from the 45° right towards the central position, and rudder increased to the left. Neither flight crew could recall this control wheel input. However, the investigation considers that this movement may have been caused by a reactive response by the PNF (who had stick control) who sensed the drift to the right or was possibly leaning away from the direction of travel. The movement of the control wheel from the right wing down position towards the wings level position would have reduced the weight on the windward side undercarriage and thus the friction between the tyre and the runway.

The increase of TQ2 to 15% and TQ 1 to 7.6% at 9 seconds after W.O.W records a thrust imbalance of 7.4% reverse thrust in favour of the right side (right swing). This thrust imbalance of 7.4% produced an adverse effect on the aircraft, as lateral G to the right remained almost steady at 0.175 G for over 1 sec, even though heading had steadied briefly on 181° (M). This indicates again that the aircraft was experiencing a drift to the right. With the control wheel now moving towards 25° left and rudder at 20° left, some signs of directional recovery are apparent, as lateral G started to act briefly to the left and heading slowly started to decrease from 181° (M) towards 172° (M).

In fact, when 172° M, was reached, it was the first time during the landing run that the aircraft heading equals the aircraft track (Appendix G at sample 15 seconds). However, at this point in time, the aircraft is well to the right side of the runway and only seconds from departing the paved surface.

The FDR does not have the facility to record pedal braking action. However, the PF confirmed that as part of his attempts to stop the aircraft departing the runway, he applied full pedal braking, but that this action had no decelerating effect on the aircraft at the time.

Under the circumstances in which the PF of EI-FKD found himself in, it is considered understandable that a pilot would select reverse thrust and/or any other means available to him, to ensure the safety of the aircraft.

The general philosophy on use of reverse thrust (as prescribed for in the A.O.M) is that, "*if directional control cannot be maintained, cancel reverse and use rudder and aileron to regain control"*. The reason for this is that when reverse thrust is used, it causes a turbulent airflow around the rudder, thereby rendering it less effective. At or below IAS 60 kt rudder inputs start becoming ineffective and steering control is normally continued through use of the nose wheel steering. The aircraft speed at the time of selection of reverse thrust was IAS 58 kt. It is therefore considered likely that no adverse effect would have been caused to rudder control by the selection of reverse thrust. What is interesting to note is that the IAS of 58 kts at the time of selection of reverse thrust is between the aquaplaning speed of the nose wheel tyres, namely 63 kts (rotating) and 54 kts (not rotating).

As reverse thrust started its travel towards maximum values and with the control wheel positioned 43° to the left, and rudder and tiller fully left, lateral G was recorded as moving from left acting to right acting, followed by a sharp heading increase from 172° (M) to 190° (M) and onwards towards 204° (M). The movement characteristics of the aircraft at this time show that under a reduced coefficient of friction, the combined effects of the crosswind component and a steady state asymmetric thrust imbalance of 6.3% on the right side produced a further swing to the right. The lateral G continued to act to the right as the aircraft left the runway and up to the point where it came to a stop.

The FDR does not have the facility to record movement of the nose wheel tiller steering. However, the PF stated that he had selected full left tiller prior to departing the runway. At such a low speed, the nose wheel steering should have been effective enough to counteract the swing right, but it failed to do so. The nose wheel was therefore most likely in a condition of full aquaplaning as it left the runway.

2.2 Physical Characteristics of runways EICK Airport

The intersecting runways at EICK are at near right angles to each other. The threshold at RWY 25 is at the airfield elevation of 153 metres (502 ft), with the predominant natural gravitational flow towards the intersection of the runway. RWY 17 also has a natural gravitational flow towards the intersection, albeit, slightly less than RWY 25.

It is recognized that in the surface profile of asphalt concrete minor irregularities may occur. It is also a normal design feature to have flat gradients on the intersection of runways. Taking into account this natural gravitational flow, it can be expected that during periods of heavy and/or prolonged precipitation, water will run across the general area of the intersection, in a westerly or south westerly direction. If the gravitational run-off is delayed, for example, due lack of natural drainage or if the run-off is impeded by strong westerly/south-westerly crosswinds, standing water and/or large puddles will form. The irregularities as mentioned, as well as the required flat gradient at the intersection, will contribute to this condition.

2.3 Reporting of runway condition

Taking into account, the annual rainfall for EICK Airport, the fact that over 10 mm of rain fell at EICK in the four hours leading up to this occurrence and in considering the experience gained from previous runway assessments, more awareness should have been shown by ATC and the Airport Authority towards the need to carry out a wet runway surface assessment.

The Airport Authority has confirmed that matters of operational significance and/or the likelihood of aircraft performance being affected by water on a runway are determined by ATC, who request water depth/surface conditions assessment by the Airport Authority.

It is recognized that the Airport Fire Service does have a long standing practice regarding the measurement and reporting of water on the runways at Cork. However, it is clear that the lack of a formalized procedure between ATC and the Airport Authority developed a situation whereby the runway was classified and reported by ATC as "Runway Wet", when no actual assessment of the wet runway condition had been called for, or carried out in the hours leading up to the occurrence and standing water was recorded as being present on the runway over one hour after the runway excursion.

Furthermore, in the Airport Authorities obligation to monitor the condition of the movement area, and the operational status of related facilities, there are many different factors/conditions which can have an operational significance for aircraft, or affect aircraft performance. There is therefore a requirement that suitably qualified persons should monitor and provide information on all aspects of the condition of the movement area on an on-going basis. This information should be kept up to date and changes in the conditions should be reported without delay to the appropriate AIS and ATC units.

Under normal circumstances the wet runway condition recorded over one hour after the runway excursion would have been classified by Annex 14 provisions as, "*Runway Wet*", with *"water patches"* at stated locations.

The classification of *"Runway Wet with water patches"* should not normally preclude operations to or from a runway. What is imperative is that departing or arriving aircraft are made aware of this condition, so that the crew can ascertain whether the condition reported is within the limitations of their aircraft, thereby allowing them the opportunity to consider adjusting their operating technique and/or apply performance corrections.

2.4 Actual runway condition

The true depth of standing water cannot be determined for the exact time of the runway excursion. The post-occurrence water depth readings taken by the Airport Authority's Police and Fire Service, indicated that a minimum of 1.5 mm of standing water was present on parts of the runway, but more significantly, on and slightly south of the intersection of both runways. In layman's terms, 1.5 mm of water would not be considered a significant amount of water. However, in aviation, and particularly under assessment of runway surface condition, it would be considered a sufficient depth of liquid to provide conditions for reduced runway friction and aquaplaning.

The analysis of water depth readings taken from the runway over a period of several weeks after the runway excursion determined that, during or shortly after heavy and/or prolonged precipitation, parts of the runway, in particular, the general area of and slightly south of the intersection, are susceptible to delays in water run-off. This results in formations of standing water occurring from time to time.

2.5 Reporting of Braking Action

The AIS Unit of Cork Airport provides ATIS for departing and arriving aircraft. Under Annex 11 provisions for flight information services, different elements of information are required to be contained in ATIS messages including significant runway surface condition, and if appropriate, braking action.

At the time of this occurrence, the Airport Authority had the capability to provide braking action to the AIS Unit under conditions of ice or snow covered runways. However, no suitable vehicle was in place to determine the wet braking action of a runway when standing water was present or when water depth levels were measured in excess of 1 mm.

Bearing in mind the climatic conditions experienced at Cork Airport and the fact that standing water does form in the general area of the intersection of both runways from time to time, the investigation considers that it would be appropriate for Cork Airport to be in possession of their own Surface Friction Tester (SFT). The Airport Authority should have the capability not only to carry out periodic surface frictions tests, but more importantly be in a position to determine the true wet braking action of the runway under natural conditions, representative of local heavy rain. **(Appendix H)**

2.6 Condition of No 2 tyre

The No 2 main tyre was found to have 7% (less than 1 mm) of tread remaining after the runway excursion. This measurement was within the limits laid down by the aircraft manufacturer and operator's transit check. However, a tyre with this amount of tread would exhibit a reduced resistance to aquaplaning.

2.7 Low Pitch activation/Torque imbalance

The operator removed the damaged No 2 engine/propellers of EI-FKD from the aircraft, the day after the runway excursion. The FDR readout determined that a 2 second delay occurred between LP2 and LP1 coming on, resulting in positive ground idle torque of +6.7% being present on the left side (swing right). In addition, the right hand (No 2) engine/propeller was recorded to be slightly quicker in the reverse position than the left hand (No 1) engine/propeller, thereby causing an asymmetric thrust imbalance on the right side (right swing).

With the No 2 engine/propeller out of service, the investigation was unable to examine the rigging of both engines/propellers (which are factory set) and therefore was not in a position to determine the cause of the 2 second delay between LP2 and LP1 coming on nor the reason for the thrust imbalance, during selection of reverse thrust.

Ground tests carried out by the investigation on a similar type aircraft determined that both the LP1 and LP2 low pitch warning lights come on simultaneously, approximately 1 second after lever retardation from flight idle to ground idle position. Ground idle is achieved approximately 1 second later with the torques seen to bottom out at between +3% and +5%, (+/- 2%).

Four previous FDR readings for EI-FKD recorded both propellers going into low pitch simultaneously, with the torques equally balanced as they decrease to ground idle.

Manipulation of the power levers during the ground test showed that there is limited lever travel available between flight idle and ground idle (approximately 2 inches). When taking into account the actual timed difference (2 seconds) between the two LP lights illuminating, it is considered that it would require a conscious effort on behalf of the PF to induce the non-symmetrical retardation of the power levers. The PF has confirmed to the investigation that the power levers were retarded symmetrically.

With regard to the fact that the right hand (No 2) engine/propeller was recorded to be slightly quicker in the reverse position than the left hand (No 1) engine/propeller, the four previous landings analysed on the FDR show a similar pattern of thrust imbalance (approximately 10% in favour of the No 2 engine/propeller) as a small amount of reverse thrust is applied after ground idle. What is interesting to note is that no adverse effect on directional controllability of the aircraft is recorded on these four landings.

Discussions with the aircraft manufacturer determined that there is no limit on imbalance of torque during the selection, transition or maximum steady state of reverse thrust. It was stated by the manufacturer that normal rigging errors should be less than 10 %. Torque fluctuations on take-off or approach are limited to +/- 2%.

2.8 Landing Technique

Section 1.18.5 of this report describes the Flight Techniques for Fokker 50 aircraft operating in crosswind/wet runway conditions.

The aircraft made initial contact with the runway, right main wheel first, followed 1 second later by the left main wheel. W.O.W was recorded to have occurred within the final quarter of the touch down zone, approximately 290 meters from the commencement of the intersection of both runways. Prior to nose wheel touch-on, the rudder is positioned 14° left, reducing towards 7° left, while the control wheel is selected 15 ° right.

As the weight comes on the nose wheel (2 seconds after W.O.W.) rudder increases again from 7° left towards 13° left and over the next 2 seconds the control wheel reduces from 15° right towards 1° right. Moving the control wheel towards and to the central position during the initial stages of a crosswind landing would have a tendency to allow the wing to lift on the windward side, thereby reducing the tyre/runway friction characteristics on that side. Without decisive use of left rudder, the crosswind component can influence the aircraft by pushing the fin downwind (to the left) and swing the nose right. Heading increases from 170° (M) to 176° (M) over the same period.

In addition, the control column position is recorded as being 10º nose down, just after the nose wheel makes contact with the runway, and increases to between 13º and 14º nose down after the three calls of *"I am aquaplaning"*. As the control column position has an effect on the weight on the nosegear and thus on the nosewheel tyre cornering forces, it is considered, that more decisive forward pressure on the control column, throughout the landing run and particularly just prior to and during the heading and track diversions, may have improved the nosewheel tyre/runway friction characteristics.

2.9 Discussion

It is clear that a combination of a number of factors contributed to EI-FKD departing the runway at EICK.

When the aircraft track and heading are referenced against the runway centreline **(Appendix G)**, the aircraft is seen to be continuously moving towards the right hand edge of the runway from just after touchdown and the heading oscillates about the track. This is a clear indication that the aircraft is suffering from a lack of traction with the runway surface. The cause of this lack of traction is considered to have resulted from a combination of the wet runway, crosswind, landing roll out technique used by the PF and the presence of standing water in the general area of the intersection of both runways.

More decisive use of left rudder, right control wheel and forward pressure on the control wheel column, during the early stages of the landing run, might have stopped the initial increase in heading and the subsequent drift to the right. When full rudder was selected to the left (Appendix G at sample 15 seconds), the aircraft turned to the left and stopped the drift to the right. Lateral G is recorded to be acting to the left for approximately 2 seconds and track and heading is aligned for the first time during the landing run. The aircraft's heading never aligned with the runway centreline.

Ground idle was selected approximately 4 seconds after W.O.W. FDR analysis of 4 previous landings on EI-FKD show ground idle being selected immediately after W.O.W.

More prompt selection of ground idle would have decelerated the aircraft more quickly, thereby reducing its susceptibility to the influence of crosswind component and the possibility of aquaplaning.

Conditions of reduced coefficient of friction between the aircraft tyres and the runway, due to the presence of standing water, the state and circumstances in which the aircraft transitioned through the intersection, combined with the on-set of ground idle, with its recorded asymmetric thrust imbalance and the crosswind component, all contributed to the initial swing and drift to the right. Corrective actions by the PF in the form of full left rudder did show a positive response. However, with little runway manoeuvring space remaining, and with the nose wheel in a condition of aquaplaning, the selection of full reverse thrust, with its recorded asymmetric thrust imbalance swung the aircraft further right as it departed the paved surface.

It is considered likely that the PF of EI-FKD would have adjusted his landing technique and/or applied performance corrections, if a true and accurate assessment of the wet runway condition had been reported by ATC to the approaching aircraft. As it was, the runway condition was reported as *"Runway wet"*, when in fact no actual wet runway assessment had been requested by ATC or carried out in the hours prior to the arrival of EI-FKD.

If the PF had carried out the landing as originally briefed for (as per the stated crosswind/wet runway landing technique), it is possible that directional controllability of the aircraft may not have been so adversely affected, as it transitioned through the intersection.

3. CONCLUSIONS

3.1 (Findings)

3.1.1 The aircraft had a valid certificate of Airworthiness and had been maintained in accordance with an approved schedule.

3.1.2 The aircraft landing weight and centre of gravity were within the prescribed limitations.

3.1.3 Both flight crew were medically fit, fully rested and licensed in accordance with IAA Regulations to undertake this flight.

3.1.4 Initially, the crew expressed a preference for RWY 25, however, due to the prevailing conditions, they elected to carry out an ILS approach to RWY 17. The surface wind given at the time of the approach to RWY 17 was reported by ATC as 260/15 kts, whilst the surface wind on landing was reported as 250/14 kts. These conditions were well within the crosswind limitations, as set out in the Operators Operating Manual for landing on a wet runway.

3.1.5 Both the EICK ATIS and ATC reported the runway surface condition to EI-FKD as being *"Runway wet"*, however, no assessment of the actual wet runway condition had been called for by ATC, or indeed carried out at the airport in the hours leading up to the runway excursion.

3.1.6 The flight crew of EI-FKD, were not made aware of the true runway surface condition prior to landing.

3.1.7 The PF initially briefed for a firm, 1000 ft point, centreline landing, and then, just prior to autopilot disconnection, advised the co-pilot that he would carry out a smooth landing.

3.1.8 The aircraft landed within the touchdown zone at the correct speed, slightly right of centreline on a heading of 170° (M). The runway heading is 167° (M). A subsequent drift to the right was not adequately counteracted by the PF.

3.1.9 More decisive use of left rudder, right control wheel and forward pressure on the control column on the initial part of the landing run might have reduced the first increase in heading and drift to the right.

3.1.10 The landing technique used by the PF was not consistent with the wet runway/crosswind landing guidelines as laid down in the A.O.M.

3.1.11 Travelling through the runway intersection, the aircraft was right of centreline, on a steady heading of 174° M and at an IAS of 85 kt, which was above the dynamic aquaplaning speed of the aircraft.

3.1.12 The aircraft aquaplaned in the general area of the runway intersection.

3.1.13 Under a condition of aquaplaning the combination of the aircraft speed, it's off centreline track, the delayed selection of ground idle, the asymmetric ground idle imbalance and the crosswind component, all contributed to the initial swing and drift to the right.

3.1.14 Under normal circumstances the influence of the actual crosswind component, combined with a slight asymmetric thrust imbalance, would not have had an adverse effect on the directional controllability of an aircraft operating on a wet runway.

3.1.15 The un-commanded swing of the aircraft to the right, in spite of control inputs by the PF, indicate a critical reduction of friction between the aircraft tyres, in particular, the nose wheel and the runway.

3.1.16 A sufficient amount of standing water was present in the general area of the intersection to reduce the coefficient of friction between the tyres and the runway

3.1.17 The loss of directional control caused the aircraft to drift into the right shoulder of the runway, where deeper standing water was present, thereby exacerbating the loss of friction.

3.1.18 In a final effort to stop the aircraft departing the runway the PF selected full reverse thrust.

3.1.19 Entering the area of the shoulders, the combined effects of the crosswind component and the on-set of full reverse thrust with its asymmetric thrust imbalance recorded an adverse effect on the directional controllability of the aircraft, as it swung sharply right again and continued its drift right.

3.1.20 The nose wheel tyres were most likely in a condition of dynamic aquaplaning as the aircraft departed the paved surface.

3.1.21 There was no formalized procedure in place at EICK Airport for the assessment of the wet runway surface condition. Over 10 mm of continuous rain fell at EICK Airport in the four hours leading up to the runway excursion.

3.1.22 A subsequent survey of the wet runway condition at Cork, found that during or after periods of heavy and/or prolonged precipitation a delay in water run-off can occur. This results in the formation of standing water, in particular, in the general area and slightly south of the intersection. Strong westerly/southwesterly winds contribute to this condition.

3.1.23 In conditions less severe than those recorded on the day, greater depths of standing water have been found to exist on the intersection. It is therefore possible that depths greater than 1.5mm were present on the runway as EI-FKD landed.

3.1.24 At the time of the runway excursion, the Airport Authority at Cork Airport did not have suitable equipment in place to determine the true wet braking action of the runway surface under natural conditions, representative of local heavy rain.

3.2 (Causes)

Directional control of the aircraft was lost as a result of aquaplaning, which was induced by the presence of standing water in the general area of the intersection.

The lack of a formalized procedure at Cork Airport to detect and report the presence of standing water on the runway.

Use of a landing roll out technique, which was inappropriate for crosswind, wet runway conditions.

4. SAFETY RECOMMENDATIONS

The following safety recommendations are made arising out of this investigation:

4.1 The Airport Authority at EICK should formalise a procedure for the assessment of runway surface condition in order that this information can be made available to the appropriate aviation services. **(SR 10 of 2001)**

SR 10 of 2001 was originally issued as an interim safety recommendation on the 16 February 2001. The Airport Authority has advised the AAIU that since 27 January 2001, a formal procedure for assessing runway surface condition has been put in place at EICK Airport.

4.2 The Airport Authority at EICK should purchase, as planned, a Surface Friction Tester (SFT) with self-wetting features. **(SR 11 of 2001)**

SR 11 of 2001 was originally issued as an interim safety recommendation on the 16 February 2001. The Airport Manager at EICK, has since advised the AAIU that a new SFT will be delivered to the airport in mid September of this year.

4.3 The Airport Authority should continue to monitor the effectiveness of the additional grooving put in place in the general area of the intersecting runways at EICK Airport. If the susceptibility to the presence of standing water at the intersection persists, a NOTAM should be issued and corrective maintenance action should be taken as necessary. **(SR 25 of 2001)**

4.4 The IAA should ensure that all State and licensed airports in Ireland have in place a formalized procedure for the assessment of runway surface condition. **(SR 26 of 2001)**

APPENDIX A

Information on aquaplaning

General

Tyre/ground friction produces large forces that are essential both for maintaining directional control and stopping the aircraft. The presence of water on the runway surface disrupts the contact between the tyre footprint and the pavement and interferes with the development of friction forces. This is because water cannot be completely squeezed out between the tyre and the runway and as a result there is only partial contact with the runway and the tyre. There is consequently a marked reduction in the forces opposing relative motion of the tyre and runway, because the remainder of the contacts are between tyre and water. To obtain a high coefficient of friction on a wet or water covered runway, it is therefore necessary for the intervening water film to be displaced or broken through during the time each element of the tyre is in contact with the runway. As the speed rises the time of contact is reduced and there is less time for the process to be completed, thus friction coefficients on wet surfaces tend to fall as the speed is raised. Surface grooving will enhance the friction qualities of a runway. However, if the body of water is lying above the highest point of the groove, any advantage gained in friction qualities will be lost.

One of the factors of most concern in these conditions is the aquaplaning phenomenon whereby the tyres of the aircraft are to a large extent separated from the runway surface by a thin fluid film. Under these conditions, the friction coefficient becomes negligible and the wheel braking and wheel steering are virtually ineffective. In addition, the aircraft becomes vulnerable to influences from external forces such as wind, asymmetric thrust and to a lesser degree internal forces such as control inputs.

When an aircraft is subject to a crosswind component, the large exposed area of the tail fin acts like a sail. The wind attempts to push the tail downwind which if successful will swing the nose towards the wind. Under dry runway conditions, the frictional forces between the runway and the tyres restrict and work against this side force. Under wet runway conditions, if the frictional forces are reduced to such a degree that aquaplaning occurs, there is no restricting force (tyre traction) to stop the aircraft swinging into wind.

Viscous aquaplaning

Loss of tyre braking and cornering ability during operations on damp or wet runways is predominantly attributed to viscous aquaplaning. The conditions are ripe for viscous aquaplaning to occur when relatively thin films of water reduce the coefficient of friction between the tyre and the runway. In most simple terms, it makes the runway slippery. Viscous is the technical term used to describe the normal slipperiness or lubricating action of the water.

Dynamic Aquaplaning

Dynamic aquaplaning is the condition where the force that a liquid produces under a tyre is sufficient to raise the tyre completely off the ground, which reduces the friction available for steering and braking. Dynamic aquaplaning may be thought of as a greater degree of viscous aquaplaning.

Reverted rubber

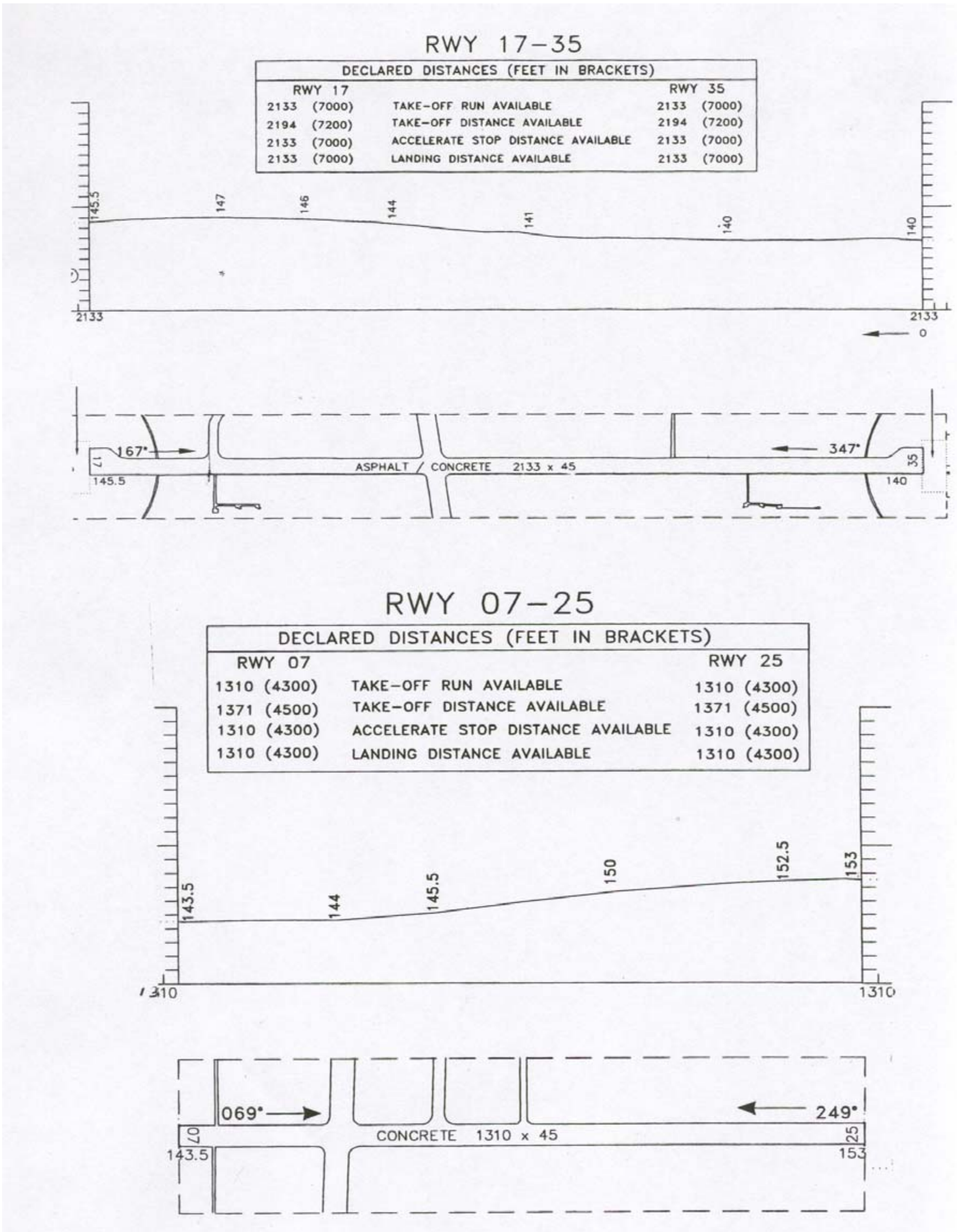
Reverted rubber aquaplaning occurs when a locked tyre skids along a surface. The energy created is transposed onto the rubber causing it to melt and form a bond with the runway. This bond seals in the liquid to the point of creating steam. This steam the produces a pressure under the tyre causing it to lift off the ground.

APPENDIX B

Record of rainfall, wind and temp/dew point, for the period 0000 UTC to 2400 UTC on the 29th October 2000.

Hour/Half Hour	Rain Fall	Wind	Temp/Dew Pt
0100	Nil	N/A	N/A
0200	0.1mm	N/A	N/A
0300	Nil	N/A	N/A
0400	Trace (Tr)	N/A	N/A
0500	Nil	N/A	N/A
0600	0.1mm	N/A	N/A
0700	Nil	N/A	N/A
0800	Nil	N/A	N/A
0900	0.4mm	N/A	N/A
1000	2.3mm	N/A	N/A
1100	1.1mm	N/A	N/A
1200	1.6 mm	210/10	6.8/6.1
1300	4.6 mm	270/03	7/6.6
1400	1.9 mm	270/10	6.9/6
1500	0.1 mm	240/11	7.2/6.1
1600	1.6 mm	230/08	7.5/7.3
1700	1.0mm	N/A	N/A
1800	Tr	N/A	N/A
1900	0.2mm	N/A	N/A
2000	0.1mm	N/A	N/A
2100	1.3mm	N/A	N/A
2200	1.3mm	N/A	N/A
2300	2.8mm	N/A	N/A
2400	4.8mm	N/A	N/A

APPENDIX C


RWY 17–35
DECLARED DISTANCES (FEET IN BRACKETS)
RWY 17
RWY 35
2133 (7000) TAKE-OFF RUN AVAILABLE 2133 (7000)
2194 (7200) TAKE-OFF DISTANCE AVAILABLE 2194 (7200)
2133 (7000) ACCELERATE STOP DISTANCE AVAILABLE 2133 (7000)
2133 (7000) LANDING DISTANCE AVAILABLE 2133 (7000)
145.5
147
146
144
141
140
140
2133
2133
0
167°
347°
17
35
ASPHALT / CONCRETE 2133 x 45
145.5
140
RWY 07–25
DECLARED DISTANCES (FEET IN BRACKETS)
RWY 07
RWY 25
1310 (4300) TAKE-OFF RUN AVAILABLE 1310 (4300)
1371 (4500) TAKE-OFF DISTANCE AVAILABLE 1371 (4500)
1310 (4300) ACCELERATE STOP DISTANCE AVAILABLE 1310 (4300)
1310 (4300) LANDING DISTANCE AVAILABLE 1310 (4300)
143.5
144
145.5
150
152.5
153
1310
1310
069°
249°
07
25
CONCRETE 1310 x 45
143.5
153

APPENDIX D

Extract from the Airport Services Manual (Friction Characteristics)

Adequate runway friction characteristics are needed for three distinct purposes:

a) Deceleration of the aircraft after landing or rejected take-off;

b) Maintenance of directional control during the ground roll on take-off or landing, in particular in the presence of crosswind, asymmetric engine power or technical malfunction; and

c) Wheel spin-up at touchdown.

To alleviate potential problems caused by inadequate runway surface friction there is a need to provide for the provision of adequate runway surface friction at all times, under all environmental conditions.

Runway surface friction/speed characteristics need to be determined under the following circumstances:

a) The dry runway case, where only infrequent measurements may be needed in order to assess surface texture, wear and restoration requirements;

b) The wet runway case where only periodical measurements of the runway surface friction characteristics are required to determine that they are above the maintenance planning level and/or minimum acceptable level;

c) The presence of a significant depth of water on the runway, in which case the need for determination of the aquaplaning tendency must be recognized;

d) The slippery runway under unusual conditions, where additional measurements should be made when such conditions occur;

e) The snow, slush or ice covered runway in which there is a requirement for current and adequate assessment of the friction conditions of the runway surface; and

f) The presence of a significant depth and horizontal extent of slush, wet snow (and even dry snow) on the runway, in which the need to allow for contaminant drag must be recognized.

The friction of a wet paved runway should be measured to;

a) Verify the friction characteristics of new or resurfaced paved runways when wet;

b) Assess periodically the slipperiness of paved runways when wet;

c) Determine the effect on friction when the drainage characteristics are poor; and

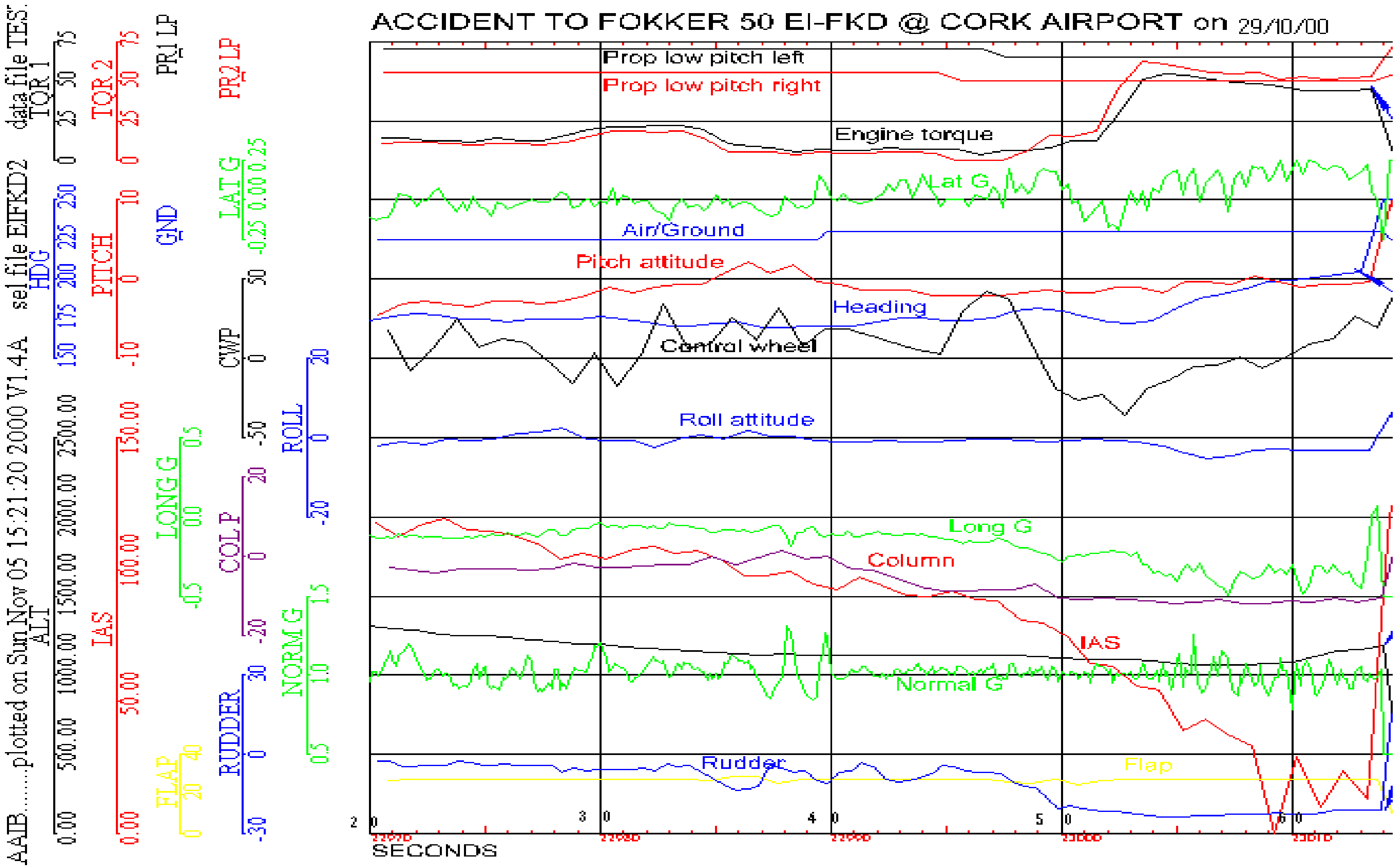
d) Determine the friction of paved runways that become slippery under unusual conditions.

APPENDIX E

The following extract from the CVR/FDR is reproduced below and is considered relevant as it covers the period from Weight-on-Wheels (WOW), to the initiation of the "On Ground" Emergency checklist.

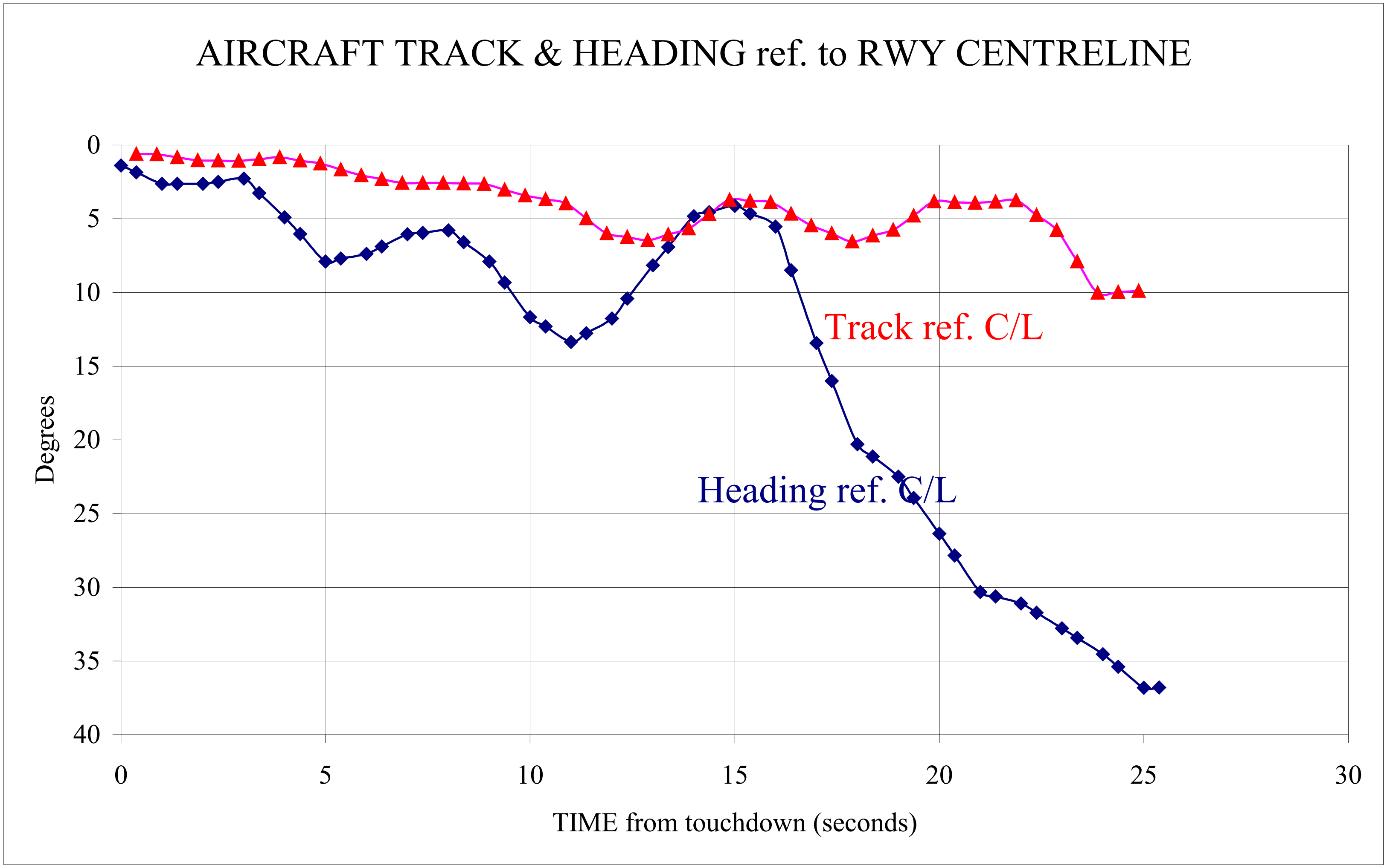
P1/P2	Voice/sound/occurrence	Remarks	Elapse Time
	Weight on wheels (WOW) Mains	*FDR*	*16.18.11 +00.00 sec*
	Sound - Weight on nose wheel	*Background CVR*	*+02.32 sec*
PF	*Your stick*		*+03.54 sec*
PNF	*My stick*		*+04.12 sec*
	LP 2 On	*FDR*	*+05.29 sec*
PF	*Give me plenty of right there please*		*+05.52 sec*
	LP 1 On	*FDR*	*+07.21 sec*
PF	*I'm aqua planing*		*+09.04 sec*
PF	*Aqua planing*		*+10.37sec*
	Sound - reverse thrust coming on. *Increase in engine torque*	*Background CVR* *FDR*	*+11.03 sec*
PF	*I'm aqua planing*		*+11.62 sec*
PF	*Stop everything*		*+12 51 sec*
	Expletive deleted		*+16.57 sec*
	Sound - rough ground	*Background CVR*	*+16.84 sec*
	Aircraft comes to halt		*+25.00sec*
PF	*On ground emergency check list Initiated*	*CVR*	*+25.10 sec*

APPENDIX F



ACCIDENT TO FOKKER 50 EI-FKD @ CORK AIRPORT on 29/10/00
AAIB.........plotted on Sun Nov 05 15:21:20 2000 V1.4A sel file EIFKD2 data file TEST
Prop low pitch left
Prop low pitch right
Engine torque
Lat G
Air/Ground
Pitch attitude
Heading
Control wheel
Roll attitude
Long G
Column
IAS
Normal G
Rudder
Flap
SECONDS
TQR 1
TQR 2
PR1 LP
PR2 LP
HDG
PITCH
GND
LAT G
CWP
ROLL
ALT
IAS
LONG G
COL P
NORM G
FLAP
RUDDER

APPENDIX G



AIRCRAFT TRACK & HEADING ref. to RWY CENTRELINE
Degrees
0
5
10
15
20
25
30
35
40
0
5
10
15
20
25
30
TIME from touchdown (seconds)
Track ref. C/L
Heading ref. C/L

APPENDIX H

Extracts from the Annex 14, Vol 1, Aerodrome Design and Operations

Condition of the movement area and related facilities (Annex 14 Chapter 2, Section 2.9)

2.9.1 Information on the condition of the movement area and the operational status of related facilities shall be provided to the appropriate aeronautical information service units, and similar information of operational significance to the air traffic service units, to enable those units to provide the necessary information to the arriving and departing aircraft. The information shall be kept up to date and the changes in conditions reported without delay.

2.9.2 The condition of the movement area and the operational status of related facilities shall be monitored and reports on the matters of operational significance or affecting aircraft performance given, particularly in respect of the following:

a) Construction or maintenance work;
b) Rough or broken surfaces on a runway, a taxiway or an apron;
c) Snow, slush or ice on a runway, a taxiway or apron;
d) Water on a runway, a taxiway or an apron
e) Snow banks or drifts adjacent to a runway, a taxiway or an apron;
f) Anti-icing or de-icing liquid chemicals on a runway or a taxiway;
g) Other temporary hazards, including parked aircraft;
h) Failure or irregular operation of part or all of the aerodrome visual aids; and
i) Failure of the normal or secondary power supply.

2.9.3 Recommendation.- *To facilitate compliance with 2.9.1 and 2.9.2 inspections of the movement area should be carried out each day at least one where the code number is 1 or 2 and at least twice where the code number is 3 or 4*

Water on a runway (Annex 14, Chapter 2, Section 2.9)

2.9.4 Recommendation.- *Whenever water is present on a runway, a description of the runway surface conditions on the centre half of the width of the runway, including the possible assessment of water depth, where applicable, should be made available using the following terms:*

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

2.9.5 Information that a runway or portion thereof may be slippery when wet shall be made available.

2.9.6 A runway or portion thereof shall be determined as being slippery when wet when the measurements specified in 9.4.5 show that the runway surface friction characteristics as measured by a continuous friction measuring device are below the minimum friction level specified by the State.

Pavements (Annex 14, Chapter 9, Section 9.4)

9.4.4 R*ecommendation.- The surface of a runway should be maintained in a condition such as to preclude formation of harmful irregularities*

9.4.5 Measurements of the friction characteristics of a runway surface shall be made periodically with a continuous friction-measuring device using self-wetting features.

9.4.6 *Recommendation.- When there is reason to believe that the drainage characteristics of a runway, or a portions thereof are poor due to slopes or depressions, then the runway friction characteristics should be assessed under natural or simulated conditions that are representative of local rain and corrective maintenance action should be taken as necessary.*

Determination of friction characteristics of wet paved runways (Annex 14, Attachment A (Section 7), Guidance material)

7.4 For uniformity and to permit comparison with other runways, friction tests of existing, new or re-surfaced runways should be made with a continuous friction measuring device provided with a smooth tread tire. The device should have the capability of using self-wetting features to enable measurements of the friction characteristics of the surface to be made at a water depth of at least 1 mm.

7.5 When it is suspected that the friction characteristics of a runway may be reduced because of poor drainage owing to inadequate slopes or depressions, then an additional test should be made. But this time under natural conditions representative of local rain.

7.6 This test differs from the previous one in that water depths in poorly cleared areas are normally greater in a local rain condition.

Test results are thus more apt to identify problem areas having low friction values that could induce aquaplaning than the previous tests. If circumstances do not permit tests to be conducted during natural conditions representative of rain than this condition may be simulated. The following table is a part extract from Annex 14, Attachment A, Para 7.9 and provides guidance on establishing the design objectives for new runway surfaces, maintenance planning and minimum friction levels for runway surfaces in use. It is noted that the values are average values representative of the runway or significant portion thereof. As a result it is considered desirable to test the friction characteristics of a paved surface at more than one speed.

Test Equipment	Test Speed (km/h)	Test water depth	Design objective for new service	Maintenance Planning level	Minimum Friction Level
Surface Friction Tester Vehicle/ Skiddometer	65 95	1.0 1.0	0.82 0.74	0.60 0.47	0.50 0.34