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FINAL REPORT

SERIOUS INCIDENT
to
MD 11
N803DE
at
Dublin Airport

3 February 2002

Notification of Accidents or Incidents should be made on the
24 hour reporting line
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AAIU Report No: 2003/004
AAIU File No: 2002/005
Published: 11 April 2003

Operator:	Delta Airlines
Manufacturer:	McDonald Douglas/Boeing
Model:	MD-11
Nationality:	USA
Registration:	N803DE
Location:	Runway (RWY) 28 Dublin (EIDW), Ireland
Date/Time UTC:	3 February 2002 at about 08.05 hours

NOTIFICATION

The Dublin Airport Manager (DAM) notified the Air Accident Investigation Unit (AAIU) of this serious incident at approximately 08.10 hours on the 3 February 2002. An inspector from the AAIU arrived on scene at 09.00 hours on the same day and commenced the Investigation.

On the 4 February 2002, the AAIU transmitted formal notification of this serious incident to the Irish Aviation Authority (IAA), the Federal Aviation Administration (FAA) and the National Transport Safety Board (NTSB) of the USA, the manufacturer McDonald Douglas/Boeing and the International Civil Aviation Organization (ICAO).

Under the provisions of S.I. No. 205 of 1997 (Air Navigation, Notification and Investigation of Accidents and Incidents, Regulation, 1997) and ICAO, Annex 13, (Aircraft Accident and Incident Investigation), the Chief Inspector of Accidents appointed Mr. Jurgen Whyte, Inspector of Accidents/Investigator-in-Charge (IIC) and Mr. Graham Liddy, Inspector of Accidents, to carry out an Investigation into the circumstances of this serious incident and to prepare a Report.

The NTSB (State of Manufacture/Operator/Registry) appointed Ms L. Ward as the USA Accredited Representative to this Investigation.

The Operator nominated Mr J. Potthast, Specialist-Flight Safety Investigations, as the Operator's Technical Advisor to the USA Accredited Representative to the Investigation. Mr Potthast was subsequently substituted by Mr R. Hicks.

The Manufacturer nominated Mr Stan A. Milkowski, Flight Safety Investigator, as the Manufacturer's Technical Advisor to the USA Accredited Representative to the Investigation. Mr W. Steelhammer also provided manufacturer assistance.

Additional assistance was provided by the Flight Data Departments of both the UK Air Accident Investigation Branch (AAIB) and the NTSB.

SYNOPSIS

During its landing rollout on RWY 28 at EIDW, the MD 11, registered N803DE[1] (Delta 129) started to initially drift towards the right and then slowly to the left-hand side of the runway. Efforts by the Captain, the pilot-flying (PF), to counteract this drift through the application of full right rudder and right tiller failed, and the aircraft departed the paved surface into the prepared graded ground, which was rain soaked. The Captain chose not to evacuate the passengers and crew through the emergency escape slides, preferring instead to wait for outside assistance and disembarkation by mobile stairs. After approximately two hours, passengers and crew commenced disembarkation through the forward right-side (R2) cabin door and down the mobile stairs where they were immediately bussed to the terminal building. There were no reported injuries.

1. FACTUAL INFORMATION

1.1 History of the Flight

The aircraft was on a scheduled public transport flight from Atlanta Georgia (ATL) in the USA, to Dublin Airport (EIDW), with a planned transit to Shannon Airport (EINN) and return to ATL. A total of 3 flight crew, including a Relief First Officer (RFO), 11 flight attendants and 167 passengers were onboard. The departure from ATL at 8.00 (L) and the en-route segment of the flight was uneventful.

At 07.31 hours the flight crew, which at that time, consisted of the Captain (PF) and the RFO, pilot-not-flying (PNF), copied the 07.00 hours landing conditions for RWY 10 at EIDW from the Automatic Terminal Information Service (ATIS), Information "Delta". The Flight Management System (FMS) was configured for RWY 10. (**See Section 1.7.10 Meteorological Information for ATIS "Delta"**)

Approximately three minutes prior to N803DE requesting descent, the First Officer (FO) returned from his rest station in the cabin and took up his position as FO, PNF. The RFO initially re-positioned himself into the left-hand seat, to allow the Captain to take a bathroom break. He updated the FO on the current situation and then, on the Captain's return, the RFO took up position in the relief seat behind the two main cockpit seats.

At 07.35 hours, Shannon Centre cleared N803DE for its descent down to FL150. During the initial descent, the flight crew commenced the approach/landing briefing for RWY 10 at EIDW. As part of this briefing, the Captain set a target/reference speed for final approach Vapp (Flap 50º) of Vref + 5 knots (148 KT). The Captain also initially called for auto-brakes to be set to medium (**MED**) braking. However, after a brief discussion with the RFO, the Captain agreed that auto-braking should be set for minimum (**MIN**).

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[1] This report uses the registration number N-803DE to identify the aircraft. The aircraft's call sign "Delta 129" is used in the reproduced ATC transcripts. In addition all wind direction readings in the report are measured "True". Magnetic variation for Dublin is 6º West.

At 07.39 hours, Shannon Centre issued a Sigmet (Significant Weather Information) on frequency advising that, *"Severe turbulence below FL 90 had been observed North of 53º moving North at 20 KT"*. The RFO relayed this information to the Senior Flight Attendant (SFA), requesting that a cabin announcement be made advising the passengers of the possibility of encountering turbulence and to ensure that all passengers were seated 10 minutes before landing with their seat belts fastened. This was done.

At about 07.44 hours, N803DE was handed over from Shannon Centre to Dublin Area Radar and was cleared via Killiney (KLY) for a landing RWY 28. With the change in runway, the FMS was reconfigured from RWY 10 to RWY 28 and the flight crew commenced an approach/landing briefing for RWY 28. Apart for the procedural requirements for RWY 28, the approach/landing briefing was the same as carried out earlier for RWY 10. The 07.30 hours ATIS Information "Echo" became available about this time, however, there is no record of the flight crew copying this information. (**See Section 1.7.10 Meteorological Information for ATIS "Echo"**)

At about 07.49 hours, Dublin Area Radar advised N803DE of radar vectors for a left turn-in for an Instrument Landing System (ILS) approach, RWY 28. A frequency handover from Dublin Area Radar (129.17 MHz) to Approach Radar (121.1 MHz) took place at about 07.51 hours and at 07.57:51 hours N803DE was recorded crossing the coast outbound with descent clearance down to 2000 feet, QNH 988 (pressure setting to indicate height above mean sea level).

Shortly thereafter, N803DE, which was now configured in "arm approach/land and auto-throttle mode" was vectored left to intercept the localizer at approximately 9 nm final and was requested to report established. Passing (right) through the localizer, N803DE received a radar vector correction to re-establish. The localizer was established at 7 nm Final Approach Fix (FAF). At about 08.01:42 hours approach radar cleared N803DE for the ILS approach, advising that the wind at the field was "*210º at 20 KT gusting to a max of 28 and to change to Tower 118.6 MHz"* [2]. N803DE became fully established at 5 nm and was cleared by the Tower to "*Land 28 with the wind 210º/20 KT"*. The Captain then called for the *"Missed Approach Update"* and on a query from the FO as to whether some speed should be added for turbulence, the Captain requested an additional 5 KT to be added, Vref +10 (Final Target speed 158 KT). Windshield wipers were on, in conditions of light rain.

With N803DE at approximately 3.5 nm to touch down, EIN 154 (a taxying Airbus A320) came on Tower frequency advising that he was holding short RWY 28. Tower acknowledged EIN 154 holding short and on a request from EIN 154 for an update on the wind, tower replied, "*200º now at 22 KT, its been varying between 200 and 210 for the last 20 minutes. But fairly reasonably steady on that"*. EIN 154 was then cleared by ATC *"Behind the MD 11 on finals 28 line-up behind and wait"*.

At about 08.04:10 hours, approximately 1.5 nm to touch down, ATC gave an open transmission wind check (*presumably for N803DE*) of *"210º/20 KT"*.

[2] The relevant sequence of events and ATC transmissions from clearance to land, until just after the aircraft comes to a halt, are reproduced at **Appendix A** to this report.

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Auto-pilot (AP) disconnect occurred about 25 seconds prior to main wheel touch-on, at a radio altitude (RA) height of approximately 362 feet - above ground level (AGL). A short time later, at approximately 08.04:37 hours, the aircraft touched down RWY 28 and in the words of the Captain, "*It was a firm centreline landing, within the touchdown zone*".

Approximately 3 seconds after touchdown, the FO confirmed *"Spoilers out"* and *"Three in reverse"* thereby indicating that the ground spoilers had fully deployed and that the three engines were providing reverse thrust. The Captain then called out that *"……it's slippery",* as the aircraft started drifting initially to the right and then to the left. Inputs from the Captain, consisting of full right rudder and right tiller, failed to arrest the drift to the left and the aircraft departed the paved surface on an indicated heading of approximately 270°, at a point halfway abeam Taxiway E5 and E6[3]. The aircraft continued through the prepared graded ground, which was rain soaked, for a distance of approximately 250 metres before finally coming to a halt at approximately 08.05:13 hours **(See Fig 1)**. The RFO immediately asked the Captain if he required *"Engines off/Auxiliary Power Unit (APU) on"*. The Captain replied, *"Affirmative, tell them to remain seated"* and this action was carried out by the RFO, with the FO calling out the shutdown checks. The subsequent emergency response and disembarkation is covered under **Section 1.15**, **Survival Aspects**.

Fig 1

1.1.1 Witness Observations

1.1.1.1 Senior Flight Attendant (Onboard Leader)

The Senior Flight Attendant (SFA) told the Investigation that the en-route segment of the flight was uneventful. Just prior to descent she received a call from the cockpit (RFO) warning of possible turbulent conditions for the approach and a request that all passengers be seated 10 minutes before landing.

[3] A map of the airport layout/site location of relevant events and witnesses is presented as **Appendix B** to this report.

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At the top of descent all passengers were seated and 5 minutes later at approximately 10,000 feet, all passengers were confirmed to the cockpit as being seated and their seat belts fastened.

The SFA considered from her experience that the approach was normal, but bumpy and that the landing was firm. All appeared normal, until just after she heard the engine noise increase (*reverse thrust*). She felt the aircraft move slowly towards the left side of the runway and depart the paved surface. The transition across the grassy ground was relatively smooth. Due to her seat position she was unable to see out the window. Once the aircraft came to a halt, she noted that some passengers started to get out of their seats. The SFA was then called to the flight deck. **(See Section 1.15, Survival Aspects)**

1.1.1.2 Captain of Aircraft at Holding Point RWY 28

The Captain of EIN 154, who was holding short of RWY 28, informed the Investigation that he observed the MD-11 (*N803DE*) on final approach. While the aircraft rocked/rolled slightly from side to side due to the turbulent conditions, he considered that the approach was stable. As N803DE crossed over the threshold of RWY 28, EIN 154 commenced its taxi for line-up. He observed N803DE make, *"a solid left main/right main touchdown at a point on the runway where he would expect an aircraft of that size to land"*. As EIN 154 lined-up, the Captain saw N803DE drifting slowly to the left side of the runway and then depart the paved surface in a cloud of mud and water spray. EIN 154 vacated the duty runway.

1.1.1.3 Airport Police Officer Taxiway P2

An Airport Police Officer, located beside his vehicle on taxiway P2 observed N803DE as it touched down on RWY 28. The Officer informed the Investigation that just about the same time as the aircraft landed, there was, "*a very sudden severe gust that seemed to come out of nowhere*". The car door of his vehicle slammed, rainwater lifted off the taxiway and his trousers were soaked up to his waist.

1.1.1.4 Tower Controller (118.6 MHz)

The Tower Controller took control of N803DE at approximately 7 nm final and at the outer marker he cleared the aircraft to land on RWY 28 with the wind 210º/20 KT. The Controller informed the Investigation that just prior to N803DE landing, he gave a wind check of 210º/20 KT.

He saw the aircraft land-on and then his attention went to EIN 154 lining-up RWY 28. Almost immediately after this the controller heard a loud "whooshing" sound and felt the Control Tower shake. He looked down at the wind readout display, waited for the gust to register, but it remained at 210º/20 KT. The Controller then took control of GCC 072, which was on finals for RWY 28. On giving the instruction "*GCC072 Good Morning continue approach traffic to depart",* he observed the wind display and called, *"The wind now 210 deg 35 KT gusting up to 42 KT*".

During the initial part of this particular transmission the Controller heard the Ground Controller call out "W*hat's happening to the Delta*?". The Tower Controller looked across towards RWY 28, where he saw N803DE engulfed in a cloud of spray and mud. When the aircraft come to a halt he called *"Delta 129, do you require assistance*?". On receipt of *"Yeah, we're off the runway"* he advised *"OK Sir, Emergency Services on the way"*. As the runway was now blocked the Tower Controller gave the approaching aircraft a go-around and for approximately 4 minutes thereafter provided communications relay for N803DE. At 08.09:38 hours, Tower handed N803DE over to Surface Movements.

1.1.1.5 Ground Controller (Surface Movements 121.8 MHz)

From his tower position, the Ground Controller observed N803DE landing on RWY 28. In his opinion, the landing point looked normal with the aircraft rocking slightly on its mains, as it landed. Just after the landing, the ground controller heard a noise in the tower. He looked at the wind display, but no gust had registered. Looking across again at N803DE, he saw that it was *"Engulfed in a lot of spray"*. He called out *"What's happening to the Delta?"*. On realising that the aircraft had just departed the runway, he immediately called the airport emergency services on the "Red phone" direct line to alert them of the runway excursion. Some moments later, the airfield emergency button (alarm) was also sounded.

1.2 Injuries To Persons

There were no injuries reported to the Investigation

Injuries	**Crew**	**Passengers**	**Others**
Fatal	0	0	0
Serious	0	0	0
Minor	0	0	0
None	14	167	0

1.3 Damage To Aircraft

The initial damage inspection determined that the aircraft was covered in mud splash, in particular on the left side. The flaps and slats were deployed and the thrust reversers were stowed. The nose gear wheels were rotated at near 90º to the right of the aircraft centreline **(See Fig 2)**. The brakes and wheels were embedded with mud. All wheels were still inflated and the brakes were intact.

No 1 and No 3 engine showed evidence of moderate Foreign Object Damage (FOD) ingestion in both the hot and cold sections, and damage was caused to the fan blades. The No 1 engine intake acoustic lining had a 3-inch hole in the (8) o'clock position. There was also evidence of mud around the No 2 engine intake. The left inboard flap fairing was damaged.

Fig 2

1.4 Other Damage

Just prior to departing the paved surface the aircraft demolished a runway edge light. An airport vehicle responding to the emergency demolished a second runway edge light. The landing gear of the aircraft gouged deep tyre paths in the rain soaked grassland for a distance of approximately 250 metres.

A total of 4,450 square metres of prepared graded ground was damaged as a result of, the runway excursion, the emergency response, the disembarkation operation and the subsequent recovery of the aircraft. **(See Section 1.10.6, Aircraft Recovery)**

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1.5 Personnel Information

1.5.1 ***Commander (*Captain*):*** Male, aged 59 years.

Licence:	ATP/USA
Periodic Check (PC):	18 December 2001.
Route Check:	10 January 2002.
Simulator Check:	17 December 2001.
Medical Check:	15 October 2001.

Flying Experience:

Total all types:	7,975 hours
Total all types PI:	1,424 hours
Total on type:	5,642 hours
Total on type PI:	72 hours
Last 90 days:	63.42 hours
Duty Time up to incident:	9.38 hours

1.5.1.1 Experience since September 1987

During the period September 1987 to January 1991 the Captain held the position of First Officer on B-727. From January 1991 until March 1999 he was a First Officer on MD-11. From March 1999 until December 2001 he had command on B-737, and from January 2001 until the day of the runway excursion he held command on the MD-11. The 72 hours command on the MD-11 was uninterrupted.

1.5.2 ***Co-pilot (*First Officer*):*** Male, aged 49 years.

Licence:	ATP/USA
Periodic Check (PC):	31 October 2001.
Route Check:	28 July 2001.
Simulator Check:	30 October 2001.
Medical Check:	04 October 2001.

Flying Experience:

Total all types:	6,043 hours
Total on type:	1,037 hours
Last 90 days:	94 hours
Duty Time up to incident:	9.38 hours

1.5.3 ***Relief (*First Officer*):*** Male, aged 40 years.

Licence:	ATP/USA
Periodic Check (PC):	27 Jan 2002.
Route Check:	07 August 2001.
Simulator Check:	26 January 2002.
Medical Check:	04 December 2001.

Flying Experience:

Total all types:	3,760 hours
Total on type:	321 hours
Last 90 days:	108 hours
Duty Time up to incident:	9.38 hours

1.6 Aircraft Information

1.6.1 General Description

The MD-11 is a modern, large, wide-body tri-jet with a seating capacity on the standard airplane of 285 passengers in a three-class configuration. It is powered by three high-bypass turbofan engines. The aircraft is equipped with a tricycle landing gear with an additional centre-body gear.

The fuselage is divided lengthwise into upper and lower levels. The passenger compartment is located on the upper level. The cargo and accessory compartments are located on the lower level. There are eight passenger doors and three cargo doors. All aircraft compartments are pressurized except for the nose radome, wheel wells, wing centre section and the aft fuselage. The wing contains integral fuel tanks, main leading gear support structure, engine pylons, full span leading edge slats, spoilers, trailing edge ailerons, flaps and winglets. The tail consists of an adjustable horizontal stabilizer with integral fuel tank, right and left two-section elevators, tail-engine pylon, fixed vertical stabilizer, and two-section rudder.

The flight deck is designed for a crew of two and features among other things, six colour cathode ray tubes (CRT)/display units (DU's), digital instrumentation, a dual flight management system, a dual digital automatic flight control system with failsafe capabilities including wind-shear detection and guidance devices. Computerized system controllers perform automated normal, abnormal and emergency checklist duties for the major systems.

1.6.2 Leading particulars

Aircraft Registration:	N803DE.
Aircraft Type:	MD-11.
Manufacture:	McDonald Douglas.
Serial Number:	48474.
Year of Manufacturer:	5 January 1992.
Certificate of Registration:	Valid.
Certificate of Airworthiness:	Valid.
Total airframe hours:	24,332 hours.
Engines:	3 x Pratt &Whitney PW4460.
Maximum Gross Weight Taxi:	628,000 lbs.
Maximum Gross Weight Take-off:	625,500 lbs.
Actual Adjusted Take-off Weight:	510,527.1 lbs.

Centre of gravity at Take-off:	27.2 % Mean Aerodynamic Chord (MAC)
Maximum Landing Weight:	430,000 lbs.
The Computed Landing Weight:	403,000 lbs.
Centre of gravity on Landing:	27.7 % MAC.

1.6.3 Technical Examination

1.6.3.1 General

A technical examination of the aircraft determined that it was fully serviceable prior to the runway excursion. All documentation relating to the aircraft was found to be in order. The aircraft was maintained in accordance with the approved Federal Aviation Administration (FAA) Schedule.

1.6.3.2 Tyre Information

1.6.3.2.1 General

An AAIU Inspector inspected all wheels and tyres in-situ approximately two hours after the runway excursion and also when the aircraft was recovered back to the maintenance stand the following day.

1.6.3.2.2 Main Tyres

The main wheel tyres were found to be in good condition with the tyre pressures and thread within normal range. The depth of the thread on the main tyres was measured. On the right main set, the minimum thread recorded was 2.3 mm and the maximum thread was 10.7 mm, giving an average of 5.2 mm. The left main set thread varied from 4.7 mm to 9.9 mm, giving an average of 6.8 mm. The centre body set measured 3.7 mm on the left and 3.3 mm on the right. Some post runway-excursion damage, in the form of scrapes and cuts, was evident on the majority of the main tyres. There was no visual evidence of skidding or hydroplaning.

1.6.3.2.3 Nose Wheel Tyres

The nose wheel tyres were found to be in good condition with the tyre pressures and thread within normal range. The thread depth of both nose wheel tyres was measured. The left tyre thread was 3.9 mm, while the right tyre thread was 1.4 mm.

Both nose wheel tyres, namely Serial No. 03150727 and 599RX056 were sent to Goodyear Europe for technical examination. The last tyre was manufactured by Bridgestone and rethreaded to R04 by Goodyear Atlanta (US), April 2001. The inspection of the thread surfaces did not reveal any evidence of skidding or hydroplaning. The tyre wear characteristics were considered normal. Both tyres showed cuts and scratches, which were running in an almost radial direction (near right angles to line of thread). The most severe cuts and cracks confirm that the tyres moved sideways over the runway and then over the soft muddy grassland.

1.6.3.3 Electronic Instrument System (EIS) Display

The EIS undercarriage/tyre page was on display in the cockpit following the runway excursion. This page had been selected on the System Display Control Panel (SDCP) by a flight crewmember, after the aircraft came to a halt. It was noted by an AAIU Inspector' that all monitoring of the undercarriage/tyre system was in the green. In addition, the Captain reported that he did not experience any system failures during the landing or rollout phase of the flight.

1.6.4 Aircraft Procedures/Guidance/Limitations

1.6.4.1 MD 11 Pilots Operating Manual (POM)

1.6.4.1.1 Expanded Normal Checklist (*Extract Section 25-230*)

The following crosswind guidelines are applicable to all of the Operator's aircraft for take-off and landing:

Braking Action	Crosswind Limit	Tailwind Limits
Excellent	*Aircraft Limits*	*10 KT*
Normal		
Good		
Fair	*20 KT*	*5 KT*
Poor	*10 KT*	*0 KT*
Nil	*Do Not Operate*	

When multiple reports are present, e.g. "Braking Action Fair to Good", use the lower crosswind value.

1.6.4.1.2 Flap Settings (*Extract 25-233*)

Landing flaps are 35º or 50º, at the Captain's discretion, except that flaps 50º are recommended when:

- *A tailwind exists*
- *The runway is shorter than 8,500 feet*
- *The runway is contaminated.*

1.6.4.1.3 Limitations (*Extract Section 26-3*)

Take-off and Landing	
Crosswind (maximum demonstrated)	*…………………………35 KT*
Tailwind	*…………………………10 KT*
Runway Slope Limit	*…………………………..+/-2º*

1.6.4.1.4 Normal Manoeuvres

On Final (*Extract Page 28-121*)

- *Adjust descent to maintain 300 feet/nm glide path.*

- *At 1,000 feet AGL, and on final, the aircraft must be configured for landing.*
- *Once the aircraft is established on a stabilized approach path both pilots should be aware of the aircraft pitch attitude. The pitch attitude on a 35º flap landing should be approximately 4.5º nose up and for a 50º flap landing pitch attitude will be approximately 3.5º nose up.*
- *Maintain on or above the glide slope until the middle marker (if using an ILS backup).*
- *Refer to AM for VASI types and use.*
- *At 500 feet AGL, initiate a go-around if;*

  - *Airspeed and sink are not stabilized, or*
  - *Runway alignment is not satisfactory.*

- *Intended touchdown point is normally 1,000 feet beyond the approach end of the runway.*
- *If touchdown cannot be accomplished in the first one third of the runway, go-around.*
- *Main gear should cross the threshold at approximately 50 feet.*
- *Landing should be on centreline.*

1.6.4.1.5 All Landings (*Extract Section 28-121*)

After touchdown and main wheel spin up, the PNF will call; either "Spoilers Deployed" or if <u>no</u> spoiler deployment, call; "Spoilers Not Deployed" and deploy spoilers. At 80 knots, smoothly move reverse thrust levers to idle detent by 60 knots. When reverse is no longer needed, move levers to forward idle position.

1.6.4.2 MD-11 Pilots Reference Manual (PRM)

1.6.4.2.1 Training Guide - Operational Techniques

1.6.4.2.2 Landing (*Extract 10-7*)

Good landings are the result of good approaches. Brief the approach and landing regarding power control, either manual or auto-throttles, to touchdown. If using manual throttles, ensure that auto-throttles are off no later than 1,000 feet AGL. If planning to use auto-throttles on the approach, plan to do so down to touchdown. The auto-throttles will retard at 50 feet and be at idle by 30 feet. If necessary, the pilot can override or disconnect the throttles at any time.

The pilot flying should keep a hand on the yoke (control column) and the other on the throttles, regardless of whether manual or auto-throttle are used. Auto-throttles and auto-breaks are to be used whenever possible. The use of flap 35º for landing is more fuel-efficient and creates a smaller noise footprint. A helpful technique is to ask the PNF to call 200 feet and 100 feet from the radio altimeters, and adjust your sink rate and drift.

At 1,000 feet AGL, be configured for landing with speed at VAPP (including any wind additives). At 500 feet AGL be on speed with a sink rate of less than 1,000 feet per minute (fpm). Begin removing crosswind crab correction by approximately 200 feet AGL. Be established in a forward slip, aligned with the runway centre line by 100 feet AGL. If the approach is not stabilized below 500 feet, execute a go-around. Pitch attitude and thrust are keys to a good landing and rollout.

1.6.4.2.3 Touchdown (*Extract 10-14*)

After touchdown, monitor ground spoiler deployment and be prepared to counter any pitch-up tendency as spoilers extend. At touchdown continue to fly the aircraft; smoothly and positively fly the nose wheel to the runway.

*Avoid full elevator down input. Pitch up tendency is more pronounced at 50^o flap or aft CG and use of auto brakes will help counter any pitch up tendency. Initiate reverse as soon as practical after main gear touchdown; the FADEC system will not allow the number 2 engine to go above reverse **IDLE** until the nose gear is on the runway even if the reverse lever is in full reverse. After the nose is on the runway, maintain forward pressure on the yoke (control wheel) until 80 KT.*

Spoilers will extend partially with main wheel spin up and fully at nose gear touchdown. If they fail to deploy the PNF should extend them manually after the nose gear is on the runway. No call out is necessary or desirable.

1.6.4.2.4 Rollout (*Extract 10-14*)

*Use steady pressure on the reverse thrust lever to initiate reverse thrust. Pull reverse to maximum, then start reducing, to be at **IDLE** reverse by 60 KT. When all engine rpm's have reduced to ground **IDLE**, move the levers to the **FORWARD** thrust position. Do not go directly from reverse thrust to forward thrust without allowing the engine rpm's to reduce to IDLE, as this will result in unwanted thrust.*

1.6.4.2.5 Rudder Control and Nose Wheel Steering After Touchdown (*Extract 10-14*)

Rudder control is effective down to approximately 40-60 KT. Rudder pedal steering is sufficient for maintaining directional control during the rollout. In a crosswind, use aileron as an aid in maintaining wings level. Do not attempt to use the nose wheel steering tiller until speed is reduced to taxi speed (approximately 25 knots).

1.6.4.2.6 Spoilers (*Extract 10-14,15*)

The MD-11 is equipped with ground spoilers. These are large panels, which open out from the wing upper surface during landing. Their purpose is to reduce the landing roll. This is achieved by:

- *Increasing aerodynamic drag, thereby slowing the aircraft.*
- *Reducing lift created by the wings.*

This increases the percentage of the aircraft weight carried by the main undercarriage, thereby increasing the braking force that can be applied to the main wheels without wheel lock-up (skidding). Both these effects of the ground spoilers are more pronounced at high speed, i.e. immediately after touchdown. The ground spoilers can be deployed manually. However, to hasten their deployment immediately after touchdown, when they are most effective, they can be armed, before landing, to deploy automatically at touchdown.

For the Automatic Ground Spoilers (AGS) deployment to commence on the MD-11, the system must be armed during the approach. When spin-up of the main wheels, as result of ground contact, is detected, the AGS will automatically extend to 30°. Then when compression of the nose strut is detected, which results from the nose wheel coming into contact with the runway, the AGS will deploy to the full 60° position. Once the AGS has been armed, it can only be dis-armed by either:

- *"Knocking down" the spoiler lever in the cockpit from its armed (extended) position. This is a crew action.*

  or

- *Advancing the No. 2 throttle lever 1.05 inches forward of the idle position. This corresponds to the Throttle Resolver Angle (TRA) of 46° to 50°. This is to provide for automatic closure of the ground spoilers in the event of a "go-around" situation.*

Ground spoiler extension places approximately 70% of the airplane weight on the main landing gear, providing excellent brake effectiveness. Ground spoiler deployment causes a nose up pitching moment, but it will also prevent a skip or bounce.

In order to prevent a skip or bounce, spoilers must be armed to extend automatically. Unless spoilers are extended after touchdown, braking effectiveness may be reduced initially since very little weight will be on the wheels and brake application may cause rapid anti-skid cycling. After touchdown, monitor ground spoiler deployment. The PNF should monitor spoiler extension after touchdown so if auto extension fails, the PNF can immediately extend them manually.

1.6.4.2.7 Auto-Brakes (*Extract 10-15*)

*The MD-11 is fitted with an auto-braking system. The purpose of this system is to optimise braking performance and reduce tyre wear. The system on the MD-11 has three settings, **MIN**, **MED**, or **MAX**. The auto-brake deploys 3 seconds after deployment of the ground spoilers, when set to **MIN** or **MED**, or in 1 second when set to **MAX**, when all the following criteria are met:*

- *Autobrake armed at MIN, MED or MAX setting*

- *Brake pedal position < 40° of full travel*

- *Flaps > 28°*

- *No pressure detected by servo valve pressure switches or shut-off valve pressure switches in the Integrated Brake Control Valves (IBCV's)*

- *Both servos pass the continuous electrical integrity test*

- *Anti-skid operative (ON, with no Fail condition)*

- *Ground Spoiler handle position indicates spoiler deployment commanded, either manually or by AGS*

Whenever the brake pedal position is pushed beyond 40° of full travel, the system automatically reverts to manual mode.

It is recommended that auto brakes be set to:

- ***MIN** for normal, dry runway conditions.*
- ***MED** for wet runway conditions.*
- ***MAX** setting should be used on very short runways or when the runway is extremely slippery.*

1.6.4.2.8 Auto-brakes Performance

The following are the auto-brake performance figures for the 3 different settings:

MIN: Braking at 6.5 feet per second per second

MED: Braking at 9.0 feet per second per second

MAX: Braking at full 3,000 pounds per square inch (p.s.i)

1.6.4.2.9 Loss of Direction Control/Reverse Thrust and Crosswind (Extract 10-15)

If the airplane starts to weathervane into the wind, the reverse thrust side force component adds to the crosswind component and drifts the airplane to the downwind side of the runway. To correct back to the centreline, reduce the reverse thrust to reverse idle and it may be necessary to release the brakes.

This will minimize the reverse thrust side force component without the requirement to go through a full reverse actuating cycle. In extreme conditions, it may be necessary to return to forward thrust. Use rudder steering, and differential braking, as required, to prevent over correcting past the runway centre line. When re-established near the centreline, apply maximum braking and reverse thrust consistent with control to stop the aircraft.

1.6.4.3 MD-11 Flight Operations Manual (FOM)

1.6.4.3.1 Evacuation Not Required (Extract 10-1.2)

Anytime a situation occurs that alarms the passengers, the possibility exists of a passenger-initiated evacuation. As soon as the Captain determines that an evacuation is not required, the following PA should be made:

"This is the Captain. Please remain seated with your seat belt fastened"

1.6.4.3.2 Evacuation (Extract 10-1.3)

At the Captain's discretion, an evacuation may be initiated based on the environment created by the non-normal. The Captain may request or be assigned a discrete frequency for ATC/Aircraft Rescue Fire Fighter (ARFF) to assist in planning and handling the non-normal event. ATC and ARFF resources may assist in the evacuation decision-making process by providing information pertaining to conditions outside the aircraft.

1.6.4.3.3 Evacuation Required (Extract 10-1.3)

After a thorough evaluation, if an emergency evacuation is required, make the following announcement when directed by the Emergency Evacuation Checklist:

"This is the Captain. Evacuate. Evacuate".

Some aircraft are equipped with an evacuation signal or horn, which can be used to give the evacuation command. If an engine fire or other condition makes certain exits unusable, state the direction of egress, i.e., "Use left side exits only". Remove all passengers to a point well clear of the aircraft (recommend 300 feet off the nose or the tail), out of range of possible fire or explosion. Do not allow passengers to return to the aircraft.

1.6.4.3.4 Hydroplaning

Section 14 - 7.1 to 7.6 of the Operators FOM **(See Appendix C)** has a dedicated section on Hydroplaning. A review of this material by the Investigation indicates that guidance material in the following areas has been provided for and is adequately addressed in the FOM.

- Dynamic Hydroplaning
- Viscous Hydroplaning
- Reverted Rubber Hydroplaning
- Controllable Physical Factors
- Cockpit Considerations and Techniques

1.6.4.4 Training

1.6.4.4.1 Crosswind landing

Qualification Syllabus – Modules 18, Tail-strike Video (McDonnell Douglas produced) and landing Video (Delta produced). Full Flight Simulator, Modules 18, 19, 21, 22, 23, & 24. Pilots practice visual and instrument approaches to maximum demonstrated crosswind landing limit, 35 knots of direct crosswind.

Continuing Qualification Syllabus – Full Flight Simulator, Modules CQ6, CQ2. Crosswind landings to the maximum demonstrated crosswind landing limit, 35 knots of direct crosswind.

1.7 Meteorological Information

1.7.1 General

Met Éireann, the Irish Meteorological Service provides meteorological information for all Irish Airports.

1.7.2 Terminal Area Forecast (TAF)

1.7.2.1 TAF EIDW 030600Z

030716 08013 KT8000-RA SCT-010 BKN-018 TEMPO 0710 08018G30KT 3000 RA SCT-005 BKN-008 BECMG 0912 21015-KT 9999 NSW BKN-025 TEMPO 1216 24018G30-KT 5000-SHRA BKN-18CB.

1.7.3 Meteorological Reports (METAR's)

1.7.3.1 METARs Issued by Dublin Airport 07.00 (Local) to 08.10 (Local) on 3 Feb 2002

EIDW 030700Z 36008 KT8000-RADZ SCT005 BK010 05/04 987 TEMPO 3000 BKN 003

EIDW 030720Z 34006 KT9999-RA FEW005 SCT015 BK030 05/05 987 TEMPO BKN 015

EIDW030730Z 34008 KT9999-RA FEW005SCT015 BKN030 05/05 987 NOSIG

EIDW030734Z 21012 KT9999-RA FEW005 SCT015 BKN030 06/05 987 NOSIG

EIDW030755Z 22012 KT9999 FEW009 SCT028 BKN200 07/05 988 NOSIG

EIDW030800Z 22020 KT9999-FEW009 SCT028 BKN200 07/05 988 NOSIG

EIDW030810Z 21024 KT9999-RA FEW009 BKN028 BKN035 07/05 988 NOSIG

1.7.4 Weather Pattern in the Days Leading up to the 3 February 2002

The area was influenced by a series of Atlantic fronts and troughs during the two days prior to the day of the runway excursion. Dublin Airport experienced occasional rain and strong Southwest winds for much of the period. Temperatures generally remained above 7° throughout.

1.7.5 Rainfall Amounts in the Period Leading up to Runway Excursion

The rainfall amounts measured at Dublin are presented in table form below. The symbol TR stands for a trace, which is less than 0.1mm.

Date	Period	Rainfall Amount
31 January 2002	0000-0600	Nil
	0600-1200	1.3 mm
	1200-1800	0.8 mm
	1800-0000	Nil
1 February 2002	0000-0600	0.5 mm
	0600-1200	7.6 mm
	1200-1800	1.9 mm
	1800-0000	Nil
2 February 2002	0000-0600	10.0 mm
	0600-1200	0.8 mm
	1200-1800	TR
	1800-0000	Nil
3 February 2002	0000-0600	6.9 mm
	0600-0700	3.8 mm
	0700-0800	0.3 mm
	0800-0900	TR
	0900-1000	0.3 mm

1.7.6 Weather Conditions Prevailing Over Hours leading up to Runway Excursion

General Situation: A shallow depression was centred Southwest of Ireland at 0000 hours on the 3 February 2002 and was forecast to continue to move Eastwards and fill. However, as the depression moved east along the South coast of Ireland it deepened rapidly and changed track to the North as it was positioned off the Southwest coast of Ireland. The low centre continued to move quickly Northwards being centred to the West of Dundalk at 08.00 hours, leaving Dublin in the South Westerly area of the general low circulation (the region of strongest winds). Rain-bands associated with the low moved across the region ahead of the low centre, clearing the Dublin region by around 07.00 hours.

1.7.7 Wind Conditions from 07.00 hours to 08.30 hours on 3 February 2002

At 07.00 hours the low was centred close to Dublin, giving light winds. As the low centre moved further North over the following 1.5 hours there was a marked increase in wind mean speed and gusts – associated with Dublin Airport coming under the influence of the windier South Westerly quadrant of the low circulation. From 07.35 hours the wind had adopted the Southwesterly flow it would maintain for the rest of the morning.

The following table gives an indication of wind speed[4] and direction from 07.00 to 08.30 hours, as taken from the output from the automatic weather station (AWS) at Dublin Airport.

Time	Direction (degrees true)	Speed (knots)
07:50:05	205	15.3
07:51:05	208	13.4
07:52:05	204	13.2
07:53:05	207	13.4
07:54:05	210	14.2
07:55:05	207	12.8
07:56:05	205	16.3
07:57:05	210	20.6
07:58:05	214	19.6
07:59:05	211	19.8
08:00:05	207	21.7
08:01:05	205	21.0
08:02:05	200	21.0
08:03:05	194	22.3
08:04:05	193	21.5
08:05:05	195	26.2
08:06:05	197	29.5
08:07:05	195	26.0
08:08:05	197	24.9
08:09:05	198	23.9
08:10:05	200	23.1
08:11:05	200	25.2
08:12:05	205	23.7
08:13:05	205	21.4

1.7.8 Synopsis of Wind and Weather Conditions Prevailing about the Time of Touchdown.

An intense depression of 987 hPa centred 35 nautical miles Northwest of Dublin Airport maintained a strong South-westerly flow over the area.

Gradient Wind:	23045-50 KT
Surface Wind:	20028-34 gust 43 KT
Temperature:	6.9 degrees Celsius
Dew Point:	4.9 degrees Celsius
MSL Pressure:	990 hPa
Weather:	Light Rain
Visibility:	10 + km
Cloud:	FEW 900 feet, BKN 2300 feet, BKN 3500 feet

[4] Speed and direction readings are 2 minute averages

A detailed pixel-by pixel analysis of the Dublin Airport radar picture[5] for 08.00 and 08.15 hours respectively show that there were isolated and localised radar signals indicating moderate convective precipitation just south of Dublin Airport at the time.

Wind conditions at the time of the incident suggest moderate low-level turbulence would be common, with localised severe turbulence. In fact there was a Significant Weather Information (SIGMET) in operation for the area at the time of the incident.

The content of this SIGMET[6] was as follows:

WSIE31 EIDW 030720
EISN SIGMET 01 VALID 030720/030920 EINN-
SHANNON FIR SEV TURB OBS BLW FL090 N OF 53N MOV AT 20 KTWKN-

1.7.9 Wind Regime at the Time of Landing

An analysis of the wind data available indicates that the maximum 2-minute mean speed that occurred about the time of landing was between 23 and 28 knots. This is particularly shown by the continuous wind traces from the anemograph trace printer[7]. The maximum wind recorded by the automatic weather station (AWS) was 26.2 knots. The mean wind speed around the time of the incident (about 08.04:45 hours) was accompanied by a sudden gust of about 43 KT[7].

1.7.10 ATIS and Pilot Reports

1.7.10.1 ATIS Information "Delta" and "Echo".

Designator	Delta	Echo
Time	0700 (L)	0730 (L)
Runway in use	RWY 10	RWY 28
Type of Approach	ILS	ILS
RWY surface condition	Wet	Wet
Braking action	-------	-------
Holding delay	-------	-------
Transition Level	Moderate turbulence below 9000 feet	7000 feet
Wind	010 degrees 06 knots	250 degrees 03 knots
Visibility	6 km	10 km +
Present weather	Rain and drizzle	Light rain
Cloud	Scattered at 500 feet Broken at 1,000 feet	Few at 500 feet Scattered at 1,500 feet Broken at 3,000 feet

5 Dublin weather radar picture for 08.00 and 08.15 hours are presented at **Appendix D** of this report.
6 Shannon SIGMET advising that severe turbulence below FL 90 had been observed North of 53º moving North at 20 KT and weakening.
7 Main Anemometer continuous wind trace readings are presented at **Appendix E** to this report.

Temperature/Dew point	+5°/+4°	+5°/+5°
QNH	987 hPa	987 hPa
RWY Threshold QFE	RWY 10	RWY 28, 980 hPa
Trend	Visibility 3,000 m Cloud 800 feet	No Significant change

1.7.10.2 Pilot Meteorological Report

The Captain of a local Airbus A320 (EIN 154) who was taxiing for the holding point for departure RWY 28 advised the Investigation that, he had some concern for the prevailing weather, in particular, with regard to shower activity to the south west and the wind conditions, which appeared to have become somewhat stronger than that reported on the ATIS. This concern prompted the Captain to seek further clarification on the wind conditions from ATC. Tower responded, " *200º now at 22 KT, its been varying between 200º and 210º for the last 20 minutes. But fairly reasonably steady on that"*.

1.7.11 Wind Measuring System at Dublin Airport

Met Éireann maintains and uses two anemometers on separate masts at Dublin Airport. One anemometer is the "live" machine, and the other acts as a backup. The anemometers are supplied by a Finnish Company, named Vaisala, a leading provider of meteorological equipment. The anemometer sensors on the mast in the field are linked to a control box (WAT11) at the base of the mast and from there to display units (called WAD21) in the meteorological operation rooms and ATC.

The anemometer display units have been programmed by Vaisala to display wind data to International Civil Aviation Organisation (ICAO) ANNEX 3, Meteorological Service for International Air Navigation, specifications. In particular, the wind output for local (plain language) reports and for the ATC wind display units is the 2-minute average for the mean data, with gusts and directional variations taken over the previous 10-minute period, except where there is a "marked discontinuity" in the wind speed and direction during this 10-minute period.

A marked discontinuity occurs when there is an abrupt and sustained change in wind direction of 30 degrees or more, with a wind speed of 10 knots before or after the change, or a change in wind speed of 10 knots or more, lasting at least 2 minutes[8]. In the event of a marked discontinuity in the 10-minute period, then only data occurring after the discontinuity is taken into account in determining the gust.

The operational anemometer, which was active at the time of the incident, is representative of the touchdown area for RWY 28 and along the runway because of its position and the topography of the area. The output from this anemometer was confirmed by the output from the backup anemometer.

[8] A description of defining average wind and gust is presented at **Appendix F** to this report.

The anemometer systems were specified by Met Éireann to ICAO standards and were certified by Vaisala as complying with these specifications, including the accuracy specifications from ICAO.

The following are the accuracy statistics supplied by Vaisala for the anemometer system at Dublin Airport, and the Operationally Desirable Accuracy of Measurement and Attainable Accuracy Specification of ICAO Annex 3 (Attachment B).

Element	**Accuracy Statistics for Dublin Airport Anemometer System**	**ICAO Operationally Desirable Accuracy of Measurement**	**ICAO Attainable Accuracy Spec**
Wind Speed:	Sensor: ±0.20 KT up to 20 KT ±2% above 20 KT	±1 KT up to 20 KT ±10% above 10 KT	±1 KT up to 20 KT ±5% above 20 KT
Wind Direction:	Sensor (Vane): ±2.8º	±10º	±5º

The anemometers undergo a regular and thorough programme of preventative maintenance by technical staff of Met Éireann. The bearings had been replaced and the system tested within the previous three months of this runway excursion. In addition, simulated winds tests are carried out periodically (about every six months).

1.8 Aids to Navigation

Radar vectors for ILS to RWY 28.

1.9 Communications

Normal communications took place between the aircraft and Dublin Area Radar (129.17 MHz), Approach Radar (121.10 MHz) and Tower Control (118.60 MHz).

Shortly after the aircraft came to a halt, N803DE switched to ground frequency of 121.80 MHz in order that they could open up communications with the airport fire service.

Following a briefing from the Airport Fire Officer-in-charge (AFO) to the flight crew on the exterior condition of the aircraft, communications on frequency 121.80 MHz became difficult due to some "open mic" blocking and the increased level of frequency activity due to the initial closure of the airport. The source of the "open mic" blocking could not be determined.

Two-way communications were also established between the Company Station Engineer and the flight deck through use of the nose wheel bay intercom system.

This system was also used by the AFO in order to keep the flight deck updated on the on-going external situation. In addition, some communications were achieved on frequency 121.6 MHz. A discrete frequency was not formally established at the incident site, because there was no formalized procedure in place at the airport at that time for the use of a discrete frequency.

The Airport Authority did submit a procedure and suggested AIP amendment, to the IAA, in August 2001 for use of a discrete frequency on 121.6 MHz. The main purpose of this frequency was to facilitate immediate and direct communication between the Flight Crew and the Officer-in-Charge of the Airport Fire Service. This would establish the intentions of the Flight Crew in relation to the aircraft evacuation and to enable the Officer-in-Charge of the Airport Fire Service to inform the Flight Crew of the circumstances and conditions outside of the aircraft. It would also minimise congestion on the ground frequency.

In principle the IAA were in agreement with the Airport Authorities initiative. However, they identified a number of administrative issues that had to be resolved, such as the legality of use and potential risk of interference with local navigational aids. Discussions between the Airport Authority and the IAA were on going at the time of this particular runway excursion.

ICAO Annex 14 provisions recommend the use of a discrete frequency at airports (**See Section 1.18.1.3.4, Communications and Alerting Systems**).

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1.10 Aerodrome Information

1.10.1 General

Dublin Airport (EIDW) coordinate position N 5325.17 W00616.12 is an International Airport, State-owned and operated by Aer Rianta (Irish Airport Authority) under licence from the Irish Aviation Authority (IAA). It is located 5.3 nm north of the city of Dublin at 242 feet above mean sea level (AMSL).

1.10.2 Physical characteristic of runways

The airport has a number of runways, including RWY 10/28, RWY 16/34, RWY 11/29.

RWY 10/28 (the incident runway) was officially opened on 21 June 1989 and is the main runway at the airport. RWY 28 is suitable for Category II and Category IIIA operations, while RWY 10 is suitable for Category II operations. It measures 2,637 metres in length and 45 metres in width. The surface is made of brush micro texture concrete and is brushed in a direction perpendicular to the centre line of the runway.

1.10.3 Surface Friction/Tests/Runway Condition

1.10.3.1 General

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

1.10.3.1.1 Defining the Runway Surface Condition

The International Civil Aviation Organisation (ICAO) and the European Joint Aviation Authority (JAA) define the runway surface condition. These definitions are provided at **Appendix G** to this report.

1.10.3.1.2 Surface Friction/Braking Action Dublin Airport

At Dublin Airport, surface friction and braking action on runways is normally measured by means of a Skidometer (SKD). The friction of the runway surface is calibrated periodically by use of the SKD using self-wetting features on a clean surface. In the event of the SKD being out of service, braking action is measured by the means of a Griptester (GT) or a Tapley.

1.10.3.1.3 Surface Friction Tests

Prior to this particular occurrence (17 January 2002), the Airport Fire Service carried out a runway surface friction test on RWY 28/10 (Using SKD). The results were as follows:

1st Third RWY	2nd Third RWY	3rd Third RWY	Overall Average
Mu 0.88	Mu 0.82	Mu 0.85	Mu 0.85

A runway surface friction test (Using SKD) was also carried out on RWY 10/28 prior to its re-opening at 19.02 hrs on the 4 February 2002. This particular test was partly done in heavy rain and wet conditions. The results were as follows:

1st Third RWY	2nd Third RWY	3rd Third RWY	Overall Average
Mu 0.88	Mu 0.82	Mu 0.81.5	Mu 0.83

1.10.3.1.4 Runway Rubber Deposits

A survey of the runway friction monitoring records determined that runway rubber deposits were last removed from RWY 28 on the 12 and 13 November 2001.

1.10.3.1.5 Runway Surface Inspection, Pre-Runway Excursion

A runway surface inspection was carried out by a member of the Airport Fire Service on RWY 28/10 at 07.30 hours on 3 February 2002, approximately one half-hour prior to N803DE's arrival. The runway was reported as "Wet".

1.10.3.1.6 Previous Aircraft Landing

The last aircraft to land on RWY 28, prior to the runway excursion was a Continental Airlines (Flt CO-25) 757-200, registration N17133 from Newark (USA). It landed at 07.32 hours without incident or comment on the runway condition.

1.10.3.1.7 Runway Surface Inspection - Post Runway Excursion

Approximately one hour after the runway excursion an AAIU Inspector carried out a visual runway surface inspection along RWY 28/10 in an airport vehicle. The runway was observed as generally wet and tending towards the condition of damp. Some small puddles were observed periodically, however, there was no evidence of any standing water.

When the runway was fully dry an additional inspection was carried out in order to determine the condition of the rubber deposits. The rubber deposits while evident in the general area of the touchdown point were not considered in any way excessive.

1.10.4 Tyre Marks on Runway/Graded Surface

Examination of the runway surface showed clear evidence of main wheel, body wheel and nose wheel tyre marks from the aircraft. These marks were characteristic of a "pressure washing" effect that occurs when water is trapped under a tyre and squeezed out under pressure as the tyre moves along the surface. They were not characteristic of reverted-rubber hydroplaning[9].

The track of the aircraft could be traced from its point of departure from the paved surface, back east along the runway for approximately 895 metres. This point is located just east of the junction of Taxiway E3. From that point on (east), the wheel marks were obscured by a mass of other aircraft tyre marks on the runway.

The first visible tyre marks showed the aircraft to be running about 3 metres South (left) of the centre-line, and then gradually arcing to the left to the point where the aircraft departed the paved surface. For the majority of the ground rollout, the main centre-body tyre print could be clearly identified on the runway surface. However, approximately 120 metres prior to departing the runway's edge, the tyre print from the left side of the main body undercarriage tyres was masked by a tyre scrub mark.

[9] Reverted rubber hydroplaning 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 then produces a pressure under the tyre causing it to lift off the ground. The effect also leaves a distinct white mark on the runway surface.

This effect was most likely caused by the nose-wheel tyres coming in contact with the runway surface in their near fully right deflected position. This condition remained until the aircraft came to a halt.

The extreme left main gear departed the hard surface 249.8 metres before the final stopping point of the nose wheel (as measured along the runway axis). The extreme right main exited the hard surface 145.7 metres before the same return point. This indicates that the aircraft departed the runway on a track 5.8º left of the runway heading. The wheel marks then continued to arc to the left, until the aircraft came to rest on a heading of 263º.

The aircraft came to rest, with its tail 17.1 metres from the edge of the hard shoulder (24.6 m from the runway edge marking) and the nose 38.3 metres from the edge of the hard shoulder (45.8 m from the runway edge markings). The aircraft was angled 20¼º to the left of the runway heading.

1.10.5 Airport/Runway Closure

The airport was closed immediately after the runway excursion (08.05 hours) and remained closed for a total of 47 minutes. It re-opened using RWY 16/34 at 08.52 hours. RWY 28 remained closed for a total of 35 hours, opening at 19.02 hours on the following day, 4 February.

1.10.6 Aircraft Recovery

The AAIU formally handed the incident site over to the Airport Authority at 11.30 hours on the day of the runway excursion. As it happened, the Airport Authority Services Manager-Airfield (SMAF) was at the incident site, having reported earlier to the airport on an unrelated matter. In preparation for the recovery operation, he arranged for the callout of a team of operatives and began making arrangements for the recovery operation.

To recover the aircraft, a temporary roadway had to be laid aft of the aircraft. This roadway, made up of 1,200 tons of hardcore gravel, followed the path left by the aircraft tyres when it departed the runway. The process of construction necessitated the removal of the dislodged soil and the drainage of accumulated water that had gathered in the tyre tracks. Topsoil was also removed and the roadway was constructed. The aircraft was de-fuelled of 8 tons of fuel. Tugs were then attached to the aircraft and it was pulled backwards with the assistance of a digger back onto the paved surface of the runway. The aircraft was back on the runway at 06.50 hours on the 4 February 2002 and positioned on to a stand by 07.55 hours. No damage was caused to the aircraft during the recovery.

1.10.7 Airport Grassland

Grasslands are managed at Dublin Airport on the "long grass" principle, which in effect requires grass length to be maintained at approximately 225 mm in height to deter known problem bird species. While it does create a slight undulating surface, it has been shown conclusively that the long grass policy has substantially reduced the bird hazard risk at Dublin Airport. Therefore, grassland damage or destruction will increase the bird hazard.

All damaged grasslands require to be repaired as quickly as possible, as quick repair will prevent the gathering of hazardous bird species. Repairs can involve lifting up of the floor of the divot or tyre track, levelling it, followed by re-seeding or back filling with top soil and re-seeding or the laying of pre-grown grass sod. Due to the extensive nature of the grassland damage following the runway excursion, the Airport Authority laid tarmac in order to secure the area of FOD. However, in time it is intended to lay grass sod on the affected area, as this is considered to be the most practical and efficient method of repair.

1.11 Flight Recorders

1.11.1 Cockpit Voice Recorder (CVR)

1.11.1.1 General

The aircraft was equipped with a Fairchild Model FA 2100 Cockpit Voice Recorder (CVR) with a continuous loop tape of two-hour duration. The CVR was brought to the Air Accident Investigation Branch (AAIB) Laboratory in the UK, where the full total of two hours of recording was downloaded. The general quality of the recording was good, with a total of 1 hour 43 minutes of recording available prior to the aircraft coming to a halt and 18 minutes available after the engines were shut down and the APU was switched on.

1.11.1.2 Warnings

No wind-sheer or Ground Proximity Warning System (GPWS) alerts were activated or recorded on the CVR.

1.11.1.3 Relevant Extracts

The following CVR extracts are considered relevant to this Investigation.

Time	Elapse Time	Remark	By whom
About 08.04.37	+0:0 Sec	Aircraft touch-on	
About 08.04:48	*+0:11 Sec*	*"…..it's slippery"*	Captain
About 08.04:50	*+0:13 Sec*	*"Let it go"*	PNF
About 08.04:52	*+0:15 Sec*	*"You got to get the tiller"*	RFO
About 08.04:55	*+0:18 Sec*	*"I do"*	Captain
About 08.05:04	+0:27 Sec	Aircraft departs runway	
About 08.05:13	+0:36 Sec	Aircraft comes to halt	
		"Engines Off/APU On".	RFO
		"Affirmative,- Tell them to remain seated".	Captain

1.11.2 Digital Flight Data Recorder (DFDR)

1.11.2.1 General

The aircraft was equipped with a Lockheed Aircraft Service Company Model 209 F DFDR. The DFDR was brought to the AAIB Laboratory in the UK for downloading. A copy of the downloaded parameters was also sent to both the Boeing Company and the NTSB for their observations on the data.

It was noted that on several points of the downloaded data, the data appeared to drop out of the normal operating ranges. These data dropouts represent bad data points and therefore were not used for analysis. In addition, tiller/nose wheel steering was not recorded as a DFDR parameter.

1.11.2.2 Review of data[10]

- The approach speed was 150 KT ± 10 KT.

- The vertical acceleration at touchdown was approximately 1.5G, at an airspeed of approximately 145 KT. The airplane heading at touchdown indicated 277 º. The runway heading is 281º.

- The ground spoilers[11] deployed to 30º at touchdown and extended to 60º approximately three seconds after touchdown. The spoilers remained at 60º for approximately 30 seconds.

- Approximately 3 seconds after touchdown, the elevator was deflected to approximately 20º airplane nose down (AND) and remained there for about 3 seconds. The deflection then decreased to approximately 4º AND at about 120 KT. This is an indication that the control column was at or near its neutral position, since the Longitudinal Stability Augmentation System (LSAS) automatically applies 3º AND elevator deflection at main wheel spin up, and another 1º when the spoilers are extended more than 10º.

- Approximately 4 seconds after touchdown, the right brake pressure started to increase to an indicated 611 psi about 20 seconds after touchdown. It decreased to its indicated pre-landing pressure approximately 24 seconds after touchdown. The left brake pressure indicated no increase from the pre-landing level during the entire landing. The maximum brake pressure for each side is 3,000 psi. Brake pressure is sampled once every 4 seconds.

- About 8 seconds after touchdown, all four ailerons flared to approximately their neutral position and remained there for the remainder of the rollout. The outboard ailerons automatically droop 4º trailing edge down during landing, while the inboard ailerons automatically flare to zero degrees.

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[10] A trace of the relevant DFDR plots is presented as **Appendix H** to this report.
[11] If armed before touchdown, the ground spoilers automatically deploy to 30º when the main wheels spin up to 80 KT and automatically extend to their full deflection of 60º after the nose gear is compressed.

- The airplane heading at touchdown indicated 277º (4º to the left of the runway heading). After touchdown, the airplane slowly turned to the right, reaching an indicated heading of 284º approximately 8 seconds after touchdown. Then the airplane heading turned back to the left, eventually reaching a heading of 263º about 30 seconds after touchdown (indicating 18º to the left of the runway centreline).

- During the approach the rudder indicated deflections of plus or minus 5º. The rudder indicated 5º Airplane Nose Right (ANR) approximately 7 seconds before touchdown and increased to 10º ANR by touchdown. After touchdown rudder deflection briefly returned to 0º and then 10 seconds after touchdown appeared to go to full ANR for most of the remainder of the rollout.

- All 3 thrust-reversers started to deploy about 3 seconds after touchdown. The thrust-reversers were fully deployed by about 7 seconds after touchdown and remained fully deployed for approximately 10 seconds. All 3 thrust-reversers were then cancelled/stowed.

- Lateral G recorded that about 7 seconds after touchdown there was forces acting to the right followed by forces acting to the left.

- The aircraft departed the paved surface at a ground speed of approximately 35 KT.

1.11.2.3 Auto-brake data

The flight crew confirmed to the Investigation that the auto-brake was set to (MIN). The DFDR does not record the auto-brake selection as a parameter.

If the auto-brake was on (which the Investigation considers was the case), the absence of brake pressure recorded from the brake system 2 would indicate that the left pressure transducer was inoperative or out of calibration, because on auto-brake command brake pressure application, Brake System 1 and 2 ramp up pressure equally. The integrated brake control valves do not have the ability to apply differential braking in the auto-brake mode.

Each of the two brake systems supplies pressure to all brakes independently of the other. Brake pressure is recorded by two pressure transducers: The right pressure transducer records pressure applied by Brake System 1, and the left pressure transducer records pressure applied by Brake System 2. During an auto-brake application the right and left pressure transducers do not record the brake pressure applied to the right versus that applied to the left brakes as an indication of differential braking, but rather provide the pressure applied symmetrically to all brakes by Brake System 1 and Brake System 2, respectively. The fact that the pressure transducers are plumbed into the right and left brake lines is not important when considering an auto-brake application.

The 611 p.s.i. brake pressure recorded by the right pressure transducer during the landing roll is consistent with the 5.4 degrees of pedal travel recorded by the right pedal position transmitter. Meanwhile, the left brake pedal position transmitter recorded no pedal travel before or during the landing, which is consistent with the brake pressure recorded by the left pressure transducer.

1.12 Wreckage and Impact Information

Not a factor

1.13 Medical and Pathological Information

Not applicable.

1.14 Fire

There was no fire. Dublin Airport has an aerodrome Category 9 capability for rescue and fire fighting. This category covers aircraft with an overall length of 61 meters up to but not including 76 metres and a maximum fuselage width of 7 metres.

1.15 Survival Aspects

1.15.1 General

This section of the report details the survival aspects of the runway excursion and in particular:

- The events immediately after the aircraft comes to a halt;
- The preparation for disembarkation;
- The disembarkation of passengers, and;
- The reception of the passengers at the terminal building.

Correspondence and communications from a number of passengers who were aboard N803DE were received at the AAIU. In brief, it can be said that passengers, in general, reported experiencing high levels of apprehension and anxiety during the period prior to disembarkation. Their principle concerns were that of fire, the general lack of information being relayed to them with regard to the on-going situation and the delay in commencing the disembarkation. Some passengers complained that the fire emergency services response was slow. Passengers seated on the right side of the aircraft were fortunate enough to witness at first hand the activities of the emergency response services. However, for those passengers seated on the left side (with windows blackened by mud spray) or those passengers seated on the right side that had no external views, the anxiety levels were considerably higher.

1.15.2 Events immediately after the aircraft came to a halt

1.15.2.1 Flight Deck /Cabin

The aircraft came to a halt at about 08.05:13 hours, with the RFO calling out, *"Engines Off/APU On"*.

The Captain responded *"Affirmative,- Tell them to remain seated"*. The FO commenced the shutdown checks. The Tower controller, in seeing that the aircraft had departed the runway, called on frequency, "*Delta 129,* (N803DE)*, do you require assistance?"*. N803DE responded, *"Yeah, we're off the runway",* to which Tower replied, *"OK Sir, Emergency Services on the way"*.

With all Cabin Flight Attendants (CFA's) remaining seated at their stations, the SFA reported to the flight deck and was briefed by the RFO that the passengers should remain seated and to standby. On returning to the cabin the SFA made contact with the CFA's on the cabin interphone system (CIS) and advised, "*That the aircraft had gone off the runway, to remain seated and standby for further"*. One CFA requested that the Captain be informed that the wings and engines were covered in mud. The SFA returned to the flight deck to advise the flight crew that all passengers were seated and that a CFA had reported that the wings and the engines were covered in mud. In addition, the SFA suggested to the Captain that a Public Address (PA) should be made to inform the passengers of the current situation.

At about 08.09:16 hours (+4 minutes 04 seconds after the aircraft came to a halt) the Captain made a PA advising the passengers of the current situation. He requested that the passengers remain seated and that it would take some time for the ground services to get a stairs into place.

At about 08.09:37 hours (+4:25), N803DE switched from tower to ground frequency.

At about 08.10:58 hours (+5:46), the Airport Fire Service Officer (AFO) reported by radio to the flight deck on the general situation outside the aircraft and the condition of the aircraft.

At about 08.14:01 hours (+8:49), the SFA returned once again to the flight deck and suggested to the Captain that a further PA be made to the passengers, as it appeared that they were becoming restless.

At about 08.14:27 hours (+9:15), the Captain made a second PA, and updated the passengers on the on-going disembarkation efforts outside the aircraft.

At about 08.16:35 (+11:23), the SFA called to the flight deck to determine if the passengers could use their mobile phones. The Captain advised, *"Not at this time, there is too much going on outside, they should wait until they get inside the terminal building"*.

At about 08.17:33 hours (+12:21), the SFA made a PA advising the passengers that, *"Use of mobile phones at this time is prohibited, as we do not want to interfere with the communications between the flight deck and the ground crews outside the aircraft. If you wish to use the rest rooms you may, but please limit your movements to that"*.

At about 08.18:26 hours (+13:14), the Captain made a third PA update on the disembarkation efforts.

At about 08.23:14 hours (+18:02), the CVR tape ends. However, in discussions with the SFA, it was determined that, the Captain gave a number of additional PA updates during the on-going wait for disembarkation.

1.15.2.2 External to the aircraft

1.15.2.2.1 Emergency Response - Airside

The red phone direct line system was activated by the Tower at about 08.05 hours, just as N803DE commenced its transition across the graded ground. The alarm was received in the Watchroom by the Watchroom Controller. The message stated that an aircraft had gone into the grass left side of RWY 28. ATC did not provide a verbal categorisation of the aircraft emergency to the Watchroom Controller at that time.

An immediate attendance of all First Line[12] appliances was made with a routing direct to the incident site via Taxiway P2 and E4. No hold-ups occurred en-route.

Analysis of the surface movement radar tape by the AAIU (IIC), confirmed that the fire service response from just prior to the aircraft coming to a halt, to the time that the vehicles were standing by the stricken aircraft, was less than two (2) minutes.

Rescue 2 and 4 were immediately positioned on the hard standing at the front of the aircraft (Zone 1), and Rescue 3 and 7 were positioned at the tail of the aircraft on the hard standing (Zone 2). Fire lines were run-out fore and aft of the aircraft and fire fighters on the branches (end of fire lines/hoses) donned breathing apparatus (BA's). Additional vehicles were located at Zone 3, a hard standing northeast of the aircraft.

The initial observations by the AFO was that the aircraft was positioned in the grass to the left of the runway between taxiways E5 and E6 at an angle of approximately 20º to the runway. The undercarriage appeared intact with the nose wheel positioned to the right at near right angles to the centreline of the aircraft.

The three aircraft engines were in the shut down condition, with the reversers stowed and the APU operating. All flaps were fully extended.

There was no evidence of fire or fuel leaks. The main undercarriage was emitting what appeared to be smoke, but on closer examination it was found that the hot wheel brakes were generating steam after entering the wet grass and earth. There was no apparent structural damage to the aircraft.

On completion of his external inspection, the AFO made contact with the cockpit and gave a briefing to the flight crew (Ground Frequency 121.8 MHz) on the external condition of the aircraft and the positioning of the fire services in attendance.

[12] (1) Rapid Intervention Vehicle, (2) Rapid Intervention Foam Tender Vehicles, and (1) Foam Crash Truck.

As it was his belief that difficulty would be experienced in gaining access to the aircraft over the graded ground, the AFO made contact with his Watchroom and requested a mobile stairs, buses, an engineer and equipment to access soft terrain.

At about 08.18 hours the Dublin City Fire Brigade[13] arrived on-scene and was briefed by the AFO. Their appliances[14] were positioned upwind of the aircraft and remained on standby. Members of An Garda Siochana (The Irish Police Force) 'H' District, Santry Station were also in attendance. In addition, the Airport Fire Service Second Line[15] Turn Out from the Terminal building arrived on scene at about 08.21 hours giving a Category 8 response. Category 9 was available on request.

At about 08.06 hours the Airport Authority Operations Room advised the Airport Authority Airside Management Unit (AMU) that an aircraft had departed the runway. The AMU responded immediately by requesting the Handling Agent to arrange for four buses, one tug and an engineer to meet at Stand 17 and to be prepared to be escorted to the incident site. At about 08.25 hours the vehicles and personnel were in position at Stand 17 and shortly thereafter they were escorted in convoy across the airfield to the runway excursion site.

1.15.2.2.2 Emergency Response – Terminal

At about 08.06 hours the Airport Fire Service Watchroom Controller complied with the Initial Response Action (call-out procedures) of the Emergency Response Directive and contacted, among others, the Airport Authority Operations Room, advising that an aircraft had departed the runway. At that time no specific classification was made by ATS with regard to the type of emergency and the emergency response required from the Airport Authority – Terminal Side.

Contemporaneous to this, personnel located in the POD (Stand Allocation Office) saw that an aircraft had departed the main runway and immediately contacted the Duty Airport Manager (DAM) who was located in the main terminal building. The DAM went to the Operations Room to determine the response required.

As a classification had not been assigned, and bearing in mind that a large commercial transport aircraft had departed the runway, the DAM classified the response as **Distress** with a **Full Emergency Response**. At about 08.08 hours the Operations Assistant, who was located in the Duty Office, commenced the call-out procedure using the **Aircraft Distress** and **Red Alert**.

[13] The Airport Emergency Response Directive No 3 requires that the Local Authority Fire and Medical Services and the Garda Siochana are called out to any turn-out of the Airport Fire Service.
[14] (3) Water Tenders, (1) Emergency Tender and (2) Ambulances.
[15] (2) Foam Crash Tenders, (1) Water Tanker, (1) Ambulance, (1) Airport Fire Service Tractor and (1) Mobile Incident Control Unit.

A Customer Services Agent employed by the Operator was awaiting the imminent arrival of N803DE at Gate B 26 when she observed the landing Company aircraft depart the main runway. The Agent immediately contacted the Operator's Station Manager at home and also called the two remaining Company Service Agents. Within a short time the Operator's four Company personnel were located in the terminal building, concentrating all their efforts on the needs of both the incoming and out going passengers. However, as a result of this, the Operator's local emergency response plan was not activated or followed, the Operator's Operation Control Centre (OCC) in Atlanta was not notified until a significant period after the runway excursion and the Operator's office at the airport remained mainly unmanned throughout the event.

At about 08.20 hours the DAM overheard on the Airport Police frequency that there were no injuries and that the runway excursion had been classified as an Aircraft Emergency. The DAM then advised the Operations Assistant to downgrade the **Aircraft Distress** call-out to the **Aircraft Emergency** call-out.

1.15.3 Preparation for disembarkation

The final resting position of the aircraft determined that a distance of 35 metres of terrain had to be traversed by ground personnel in order to gain access to a suitable door for passenger disembarkation. On arrival of the handling agents mobile stairs[16] (about 08.35 hours) the Airport Fire Service tractor was initially used to tow the stairs up to the forward right side door (R2). This attempt failed as the tyres of the stairs sank into the soft ground. The Operator then sought assistance from the Airport Authority for the disembarkation of the passengers and the subsequent recovery of the aircraft back to a hard standing.

The AFO told the Investigation that, during the initial attempt and throughout the on-going effort to gain access to the aircraft, he endeavoured to remain in contact with the cockpit.

Initial communications were opened on Ground Frequency 121.8 MHz. When this particular frequency became blocked, he opened communications on frequency 121.6 MHz. On the arrival of the Operator's Company Engineer, the AFO made use of the plug-in intercom system at the nose of the aircraft. He also provided several messages to the Company Engineer who relayed details to the cockpit.

A temporary roadway (Track-way matting)[17] was transported out to the site in rolled sections from the airfield maintenance base, where it was stored as part of the Airport Authorities recovery equipment. The small sized vehicle used to carry these sections necessitated additional trips to and from the maintenance base. Some loading and off loading problems were also experienced. When the temporary roadway was in place, a tractor was initially used to pull the stairs along the matting. However, due to the undulating condition of the overlaid surface and the low ground clearance between the mobile stairs and the matting, further difficulties were experienced in getting the stairs up to the aircraft.

[16] The mobile stairs was of conventional type designed for use on hard standing only.

[17] Ribbed strips of heavy-duty rubber formed into coiled lengths of interlocking matting 4.4 metres wide by 5 metres long. Total length available 70 metres.

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In the end, the stairs was manhandled into position by the ground personnel and was secured to the aircraft with ropes attached to the nose wheel strut assembly. Access to the R2 door was achieved approximately 2 hours (about 10.00 hours) after the aircraft came to a halt **(See Fig 3)**.

1.15.4 Disembarkation

Disembarkation of the passengers and the crew commenced at approximately 10.05 hours through the R2 door and down the mobile stairs to the waiting buses. Both the Operator's Station Manager and one Company Agent were present for the passenger disembarkation and subsequent bus transfer. The passengers were bussed (about 10.29 hours) to Stand 34 (Gate B 26), where they were met by representatives from the Handling Agent and the Airport Authority.

Fig 3

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1.15.5 Reception at Terminal Building

On arrival at the terminal building the passengers were escorted to Passport Control for immigration processing and then through the airport terminal building on to the mezzanine level of the departures hall. Passenger's names and addresses were taken in order that their baggage could be forwarded to them when recovered from the aircraft. In addition, the Operator made arrangements to book hotels and re-book flights for the passengers.

The Meeters and Greeters[18] (approx 20) were re-united with the passengers in the mezzanine where the Airport Authority made refreshments available.

1.15.6 Emergency Planning/Exercises

The Airport Authority is responsible for complying with the ICAO provisions of Annex 14 Aerodromes, in particular with regard to Emergency Planning **(See Section 1.18 Additional Information)**.

The last full major emergency exercise to take place at the airport was on the 30 March 1999. An emergency exercise was planned for the 7 November 2001. However, the events of September 11 necessitated that the exercise be postponed until 12 December 2001. The 12 December exercise was subsequently cancelled due to the fact that the host airline was unable to provide the required resources. The IAA allowed a derogation on the exercise until the following year, with the proviso that a Table Top exercise be carried out in the interim.

A Table Top exercise was carried out at the airport on the 9 January 2002.

The Airport Authority held two safety seminars at Dublin Airport in March 2002, in order to re-familiarise all agencies with the Emergency Plans.

A full emergency exercise was held at Dublin Airport on the 3 December 2002.

Dublin Airport does have an active Emergency Planning Group, which meets several times per year in order to co-ordinate Emergency Plans and Procedures between the Airport Authority, the emergency agencies (internal and external) and the airlines/operators. These Emergency Planning Group Meetings are generally well attended by the emergency agencies, however, it is noticeable that a number of airlines regularly fail to attend.

1.16 Tests and Research

Nil

[18] Meeters and Greeters is a term used to describe family and friends who come to the airport to drop off or collect passengers.

1.17 <u>Organizational and Management Information</u>

1.17.1 The Airport Authority

1.17.1.1 General

The Airport Authority – Terminal Management Team advised the Investigation that the DAM of the day experienced some initial communication problems with the Operator and the Handling Agent. The DAM was unable to make initial contact with the Operator's Office in order to determine if they had put their own emergency response plan into action to deal with the crisis.

It was stated that a Terminal Services Officer (TSO) was put in position at the Airport Information Desk shortly after the runway excursion and remained there for a considerable time before a representative from the Operator arrived.

Initial difficulties were experienced in contacting the Handling Agent. However, this was resolved when the DAM made contact with the Handling Agent Station Manager at his home at 08.30 hours, approximately 20 minutes after the runway excursion.

1.17.1.2 Airport Authority Manuals/Directive

The Airport Authority at Dublin Airport has developed a number of manuals and directives pertaining to emergency response.

The three principle publications are: the Dublin Airport Emergency Response Directive No 3 (October 2001), the Disabled Aircraft Recovery Planning Manual and the Wildlife Management Planning Manual 2000.

1.17.1.2.1 Dublin Airport Emergency Response Directive No 3

1.17.1.2.2 General

The Dublin Airport Emergency Response Plan, which is incorporated in the Dublin Airport Directive No 3, October 2001 was in force at the time of the runway excursion. A revision/update of the Directive commenced in January 2002 and a new Directive No 3 was published in December 2002.

In General Section (1) the Directive outlines the types of emergencies covered and the response to deal with such situations. The Procedures Section (2–9) gives details of the Procedures, Standing Orders involved and the call-out lists. It is stated that the Directive will be supplemented by local procedures from each area. Specific extracts are reproduced at **Appendix I** to this report.

1.17.1.3 Disabled Aircraft Recovery Planning Manual

1.17.1.3.1 General

The Disabled Aircraft Recovery Planning Manual of February 2000 was in force at the time of the runway excursion.

1.17.1.3.2 Relevant Extract

The following **(Chapter 1, page 4 Extract)** is considered relevant to this Investigation:

Airlines operating from Dublin Airport are responsible for ensuring that adequate planning in respect of resources, equipment and spares are available, to ensure a rapid response to an incident which may require the removal of a disabled aircraft. A plan, which details response and the persons responsible for implementing it, shall be made available to Aer Rianta.

It shall be the responsibility of each airline, to ensure that adequate essential spares, including jacks and spare wheels, are available to ensure the most expeditious removal of an aircraft, if it becomes disabled on a runway or taxiway.

Aircraft operators are responsible for the removal of disabled aircraft. Aircraft, which have become disabled on a runway or within the flight strip of a runway or on a taxiway, must be removed within a reasonable period. If an operator is unable to effect removal within a reasonable period, the Airport Authority may undertake any necessary action and any cost incurred shall be recouped from the aircraft owner or operator.

1.17.2 The Operator

The Operator operates a once daily scheduled flight from Atlanta to Ireland. Flights alternate through Dublin Airport and Shannon Airport. A total of 4 staff, including (1) Company Station Manager and 3 Company Service Agents are employed full-time by the Operator at Dublin Airport. Under normal circumstances 2 staff members would be present for the arrival/departure of the aircraft.

A handling contract is in place with a local Handling Agent in order to supplement staff numbers Terminal Side when required and to provide normal ground-handling Airside. The Handling Agent is also contracted to provide additional staff to assist in an emergency response. The Operator also has a contract with a local Maintenance Company, which provides technical support, maintenance and assistance for removal of disabled aircraft.

The Operator has in place a world wide Emergency Operations Manual, which is supplemented by a Local Emergency Response Action Plan for Dublin Airport. The plan includes a checklist for immediate actions.

In the event of a major accident/occurrence, the first task in the process of notification by the Operator's staff at Dublin Airport is to contact the Flight Operations Centre in Atlanta. The Flight Operations Centre will contact all other parties at Headquarters, as well as the Operations Control Centres of any marketing partners of the victim flight. The Operator's Station Manager/Deputy is then required to commence the notification process for those people/organisations identified in the local organisation plan.

As part of the Operator's overall emergency response plan, an emergency response go-team (located in London, UK) will be activated on receipt of the initial call and plan to be located on-site at Dublin or Shannon within approximately two hours.

In discussions with the Operator's Station Manager, there was some concern expressed regarding the lack of information that was provided by the Airport Authority during the unfolding events in the terminal. It was also felt that the mezzanine area, in which the passengers were assembled with the Meeters and Greeters, was a very public area and not a particularly suitable location.

1.17.3 The Handling Agent

The Handling Agent is contracted by the Operator to provide normal ground handling for Airside/Terminal Side. The Handling Agent is also contracted to provide additional staff to assist in non-normal situations. On the day of the runway excursion, the handling agent provided an assortment of vehicles for the airside and assigned additional staff members to assist the Operator on the terminal side. The responsibility of how these additional staff members are utilised, lies with the Operator.

1.18 <u>Additional Information</u>

1.18.1 The International Civil Aviation Organization (ICAO)

1.18.1.1 General

ICAO, Annex 3 provides International Standards and Recommended Practices (SARP's) for Meteorological Service for International Air Navigation, while Annex 14, Volume 1, provides SARP's for Aerodrome Design and Operations.

1.18.1.2 Annex 3, Meteorological Service for International Air Navigation, (Chapter 4) – Meteorological Observations and Reports

1.18.1.2.1 Observing and Reporting Surface Wind

Relevant extracts with regard to observing and reporting wind is provided at **Appendix J** to this report.

1.18.1.3 Annex 14, Aerodromes, Volume 1, Aerodrome Design and Operation, (Chapter 9) - Emergency and Other Services

1.18.1.3.1 Aerodrome Emergency Planning (Section 9.1).

Extracts regarding aerodrome emergency planning is provided at **Appendix J** to this report. Relevant sections include:

(a) Emergency Operations Centre and Command Post
(b) Response time
(c) Communications and Alerting Systems
(d) Disabled Aircraft Removal

1.18.1.4 ICAO Airport Services Manual Part 7, Airport Emergency Planning

Extracts regarding airport emergency planning are provided at **Appendix J** to this report. Relevant sections include:

(a) Care of Ambulatory Survivors
(b) Care of Fatalities
(c) Airport Emergency Exercises
(d) Airport Medical Care Facilities (Medical Clinic and/or First-aid Room) - Appendix 3

1.18.2 Maximum Demonstrated/Computed Crosswind[19]

1.18.2.1 Maximum Demonstrated Crosswind

Maximum demonstrated crosswind, published in the performance section of an approved Airplane Flight Manual (AFM), is the maximum crosswind component that has been encountered and documented during certification flight tests or subsequently. The wind value is recorded during a period bracketing the touchdown time (typically from 100 ft above airfield elevation down to taxi speed).

For some aircraft models, if a significant gust could be recorded during this period, a demonstrated gust value is also published in the AFM.

The maximum demonstrated crosswind:

- Is not an operating limitation;
- Does not necessarily reflect the aircraft maximum crosswind capability; and,
- Generally applies to a steady wind.

The majority of operators have published and implemented reduced crosswind limits for operation on contaminated runway. The crosswind limits published by operators for a dry or wet runway and for a runway contaminated with standing water, slush, snow or ice, often are lower (by typically 5-10 KT) than the demonstrated values.

1.18.2.2 Maximum Crosswind

The maximum computed crosswind reflects the computed design capability of the aircraft in terms of:

- Rudder authority;
- Roll control authority; and,
- Wheel cornering capability.

[19] Material reproduced from publication "Getting to grips with Approach and Landing Accident Reduction", with kind permission of the Flight Safety Foundation.

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2 ANALYSIS

2.1 Meteorological Information

The synoptic weather situation in the hours leading up to the runway excursion showed a shallow depression centred southwest of Ireland. As the depression moved east along the south coast, it deepened rapidly and changed track to the north. The low continued to move quickly northwards being centred to the west of Dundalk (about 30 nm north of Dublin) at 08.00 hours. This left the area of Dublin Airport in the southwesterly area of the general low circulation or the region of the strongest winds.

The wind profile at Dublin Airport is averaged over the last 2-minute period to provide ATIS or ATC reported average wind. The wind profile is also observed over the last 10-minute period, the maximum or minimum wind value recorded during this period defines the gust value (except when a marked discontinuity, as defined in 1.7.11, has occurred in the 10-minute period). The extreme (maximum and minimum) values recorded over the 10-minute period (or after a marked discontinuity) are compared to the 2-minute average value. If an extreme value varies from the 2-minute mean by 10 KT or more then the displays will show the maximum and minimum values in addition to the 2-minute average.

The plain language report issued by the meteorological office only contains the maximum value and then only if it is 10 KT greater than the 2-minute average (except when a marked discontinuity, as defined in 1.7.11, has occurred in the 10-minute period).

ATIS Information, namely "*Information Delta/07.00 hours*" and "*Information Echo/ 07.30 hours*", which was made available to N803DE, reflected the prevailing meteorological conditions at their respective reporting times.

The first actual notification of wind conditions for N803DE occurred on hand-over from EIDW Radar to EIDW Tower. Radar advised, at about 08.01: 42 hours, "*wind at the field 210º at 20 KT gusting to a max of 28 KT*. This particular wind check was the current 2-minute wind profile on display to the controller at that time, with a maximum peak wind value recorded over the previous 10 minutes.

Under ICAO Annex 3 provisions, the wind is considered gusty only if the 10-minute minimum and maximum value varies from the 2-minute average by 10 KT or more (but again taking account of the marked discontinuity defined in 1.7.11).

The "clearance to land" wind of, "*210º/20 KT* and the open transmission wind check (*210º/20 KT*) given approximately 1.5 nm from touch-on, was the 2-minute wind profile at that time. No gust (exceeding 10 KT of the 2-minute average wind) was recorded.

The average wind and gust values displayed to the controller are refreshed every 10 seconds.

In this particular case, the maximum value was observed during the last 2-minute period, therefore, the gust became part of the average wind. As wind direction and speed are sampled every second, a marked discontinuity was observed and the gust was recorded on the tower display approximately 10 seconds later.

The sudden gust of 43 KT occurred just after N803DE landed and is clearly recorded on the anemograph trace. The tower controller advises the approaching GCC 072 just prior to N803DE departing the runway, "*wind now just 210°/35 KT gusting up to 42 KT*".

All of the ATC reported wind conditions were consistent with the anemograph traces at the time of recording. The winds recorded by the AWS over the same time period were slightly different. This can be explained by the different sampling rates of the AWS compared to the anemograph trace and the tower display.

The situation, as it developed that morning, presented significant forecasting problems. In the first instance, the numerical models had failed to pick up the depth and track of the depression that caused the sudden strong winds at Dublin Airport. In these circumstances, the track and speed of the movement of the depression, and the associated winds were difficult to forecast. In addition, the precise position of the low centre and its speed and direction of movement (and consequently the associated wind speed and direction) were difficult to determine from the data available.

The increase in the mean wind speed just after N803DE landed was accompanied by a gust of about 43 KT. A detailed pixel-by-pixel analysis of the Dublin Airport radar picture for 08.00 hours shows that there were isolated and localised radar signals indicating moderate convective precipitation just south of Dublin Airport at the time. However, there could have been more active cells present, which would not have been picked up by the radar. Whilst the number of such cells would have been small, the downdraft from one of these cells could account for the sharp increase in wind speed experienced at the time of the incident, especially when accompanied by the pre-existing low-level mechanical turbulence associated with the steep pressure gradient. This is the most likely explanation for the gust event.

In relation to the EIDW Terminal Area Forecast (TAF) 030600Z, the change of wind occurred earlier than predicted in the TAF, but was caused by the forecasting problems referred to above. The wind speed did not differ significantly (as defined by Annex 3 Provisions) from the forecast through the period in question.

Airports with complex topography can benefit from the use of multiple anemometers. However, this is not the case for Dublin Airport, as the topography is not considered complex and the location of the main anemometer is representative of the prevailing wind conditions at the touchdown point for RWY 28. Under the meteorological conditions described in this report, it is considered that there would seldom be a clear pre-warning for the occurrence of sudden gusts. The deployment of multiple anemometers would not have guaranteed that the gust would have been detected earlier.

In the opinion of the Investigation, the meteorological facilities, including their recording/display, at Dublin Airport on the day of the runway excursion were and presently are in full compliance with the ICAO provisions of Annex 3. In addition, the reporting of the prevailing wind conditions by ATC to N803DE, were representative of the displayed wind. The report does not support any safety recommendations with regard to Meteorological Information.

2.2 Runway Surface Condition

The runway condition was reported as "wet" for the landing. Rainfall amounts in the 8-hour period leading up to the event totalled 11 mm, with the majority (6.9 mm) falling during the 00.00 to 06.00 hours period on the 3 February 2002. Only 0.3 mm fell in the hour prior to N803DE landing. These rainfall amounts are not considered significant in terms of daily winter rainfall.

An inspection of the runway surface condition by the IIC approximately one hour after the runway excursion determined that the surface was generally wet and tending towards the condition of damp. Some small puddles were observed periodically. However there was no evidence of any standing water. Rubber deposits identified at the touchdown point were not considered excessive.

The Mu average value of 0.85 for RWY 28/10 (pre-excursion, dated 17 January 2002) and the Mu average value of 0.83 (post excursion, dated 4 February 2002) for the same runway are well above the maintenance planning level of 0.60 and the minimum friction level of 0.50 as laid down by ICAO, Annex 14, Attachment A (Section 7) Guidance material - Determination of friction characteristics of wet paved runways.

The runway condition of "wet" was correctly reported. No braking action information was provided to N803DE nor was it requested. Under the prevailing conditions, the runway braking action for the landing N803DE was "good" and therefore not a contributing factor to the runway excursion.

2.3 The Runway Excursion

Under the prevailing weather conditions, the approach was considered stable from 7 nm to the touchdown point. The reported landing wind conditions of 210º/20 KT was well within the Operator's stated crosswind limitation of 35 KT. The aircraft landed firmly, on speed, on centreline and within the touchdown zone. The aircraft heading on landing was 277º, while the runway heading was 281º. This indicates that the aircraft was not completely de-crabbed on landing. However, had the wind conditions remained constant at 210º/20 KT, it is considered most likely, that the landing rollout would have continued to a satisfactory conclusion.

In the event, just after touchdown the aircraft slowly turned to the right, reaching an indicated heading of 284º approximately 8 seconds after touchdown. During these 8 seconds both the spoilers and reverse thrust had fully deployed.

In addition, approximately 3 seconds after touchdown, the elevator was deflected to about 20º airplane nose down (AND) and remained in that condition for a further 3 seconds. The control column deflection then decreased to its near neutral position at a speed of about 120 KT. In about the same time all four ailerons flared to approximately their neutral position and remained there for the remainder of the rollout. The Pilot's Reference Manual recommends maintaining forward pressure on the control column until 80 KT and also that in crosswind conditions, aileron should be used as an aid to maintaining wings level on the ground.

Rudder increased to 10º airplane nose right (ANR) on touchdown and then rudder deflection is seen to briefly return to 0º.

At approximately 8 seconds after touchdown, and at a ground speed of about 116 KT, the aircraft was struck by a sudden and violent gust from the left side. The recorded gust of 43 KT was approximately 23 KT above the reported landing wind conditions. This gust would have created a tendency for the aircraft to initially drift downwind (right) and then yaw into wind and move airplane nose left (ANL).

This unexpected gust occurred at a time when the aircraft was at its most vulnerable. Spoilers and reverse thrust had fully deployed, the aircraft was decelerating and transitioning from a speed where rudder authority would be fully effective to maintain directional control, to a point where rudder authority becomes less effective as speed decreases and at which point differential braking would be required to maintain directional control.

At 10 seconds after touchdown, rudder was moved from its 0º position, to full (100%) ANR and it remained in this position for the remainder of the rollout. This was clearly an attempt by the pilot flying to counteract the movement to left. However, the yaw to the left could not be contained. This indicates that the nose wheel was at its limit of adhesion. The only further corrective inputs available to the pilot at that time would have been to cancel reverse thrust and attempt differential braking.

As speed decreased, the rudder efficiency decreased and was further affected by the airflow disruption created in the wake of the engine reverse flow. Selecting reverse idle cancels the effects of reverse thrust and thus further assists in regaining directional control. Reverse thrust was cancelled approximately 10 seconds after it had fully deployed or about 10 seconds before the aircraft departs the runway.

The 611 p.s.i. brake pressure recorded by the right pressure transducer during the landing roll is consistent with the 5.4º of pedal travel recorded by the right pedal position transmitter. Meanwhile, the left brake pedal position transmitter recorded no pedal travel before or during the landing, which is consistent with the brake pressure recorded by the left pressure transducer.

As 5.4º of pedal travel is near the auto-brake disarming switch point, it cannot be conclusively determined that the auto-brake did not disarm and revert to manual mode due to pedal position during the landing rollout.

However, when considering all the available data, the Investigation is of the opinion that auto-brake was most likely disarmed by pedal movement and that the recorded brake pressures would indicate that manual differential braking occurred during the landing. It is, however, noted that the braking pressure of 611 p.s.i. achieved on the right side was well below the maximum available braking pressure of 3,000 p.s.i.

Tiller and nose wheel steering position is not recorded on the DFDR. However, in the analysis of the CVR, runway tyre marks and the nose wheel tyres themselves, it is clear that nose wheel steering was used shortly after the un-commanded yaw towards the left. Use of nose wheel steering above taxi speed (25 Knots) may result in slipping or skidding of the nose wheels, which can result in the loss of nose wheel cornering forces and thus directional control. While the input of right nose wheel steering was not the contributor to the loss of directional control, its use at the time, mitigated against re-establishing directional control.

The aircraft heading was seen drifting slowly back to the left. Directional control was lost, and the aircraft departed the paved surface at a ground speed of about 35 KT. The approximate time from loss of directional control or application of full right rudder to departing the paved surface was 17 seconds.

2.4 The Emergency Response

The analysis of the Emergency Response will be conducted under three specific areas, namely:

Emergency Response - Inside the aircraft
Emergency Response - Airside
Emergency Response - Terminal

2.4.1 Emergency Response - Inside the aircraft

The aircraft came to a halt after a relatively gentle transition across the graded ground. On arrival of the SFA on the flight deck, the RFO briefed her on the situation, advising, "*to remain seated and standby for further*". This message was relayed by the SFA to the CFA's on the cabin interphone.

Approximately 4 minutes after the aircraft came to a halt, the Captain made a PA advising the passengers on the current situation. A number of update PA's were made by both the Captain and the SFA during the period awaiting disembarkation.

Correspondence received at the AAIU indicated that a number of passengers expressed concerns regarding the possibility of fire, the lack of activity by the cabin crew in the cabin and the lack of information being provided.

A number of important issues arise out of this phase of events and will be discussed under the following specific headings:

- Decision not to carry out an emergency evacuation.
- Response by the cabin crew in the cabin.
- Information provided to passengers.

2.4.1.1 Decision not to carry out an emergency evacuation

No fire warnings were observed or activated on the flight deck during the entire sequence of the runway excursion and subsequent attempt to disembark passengers. Additionally, the Airport Fire Service was in attendance 2 minutes after the aircraft came to a halt and commenced a detailed visual inspection of the exterior of the aircraft. Approximately 6 minutes after coming to a halt, the AFO reported by radio to the flight deck on the general condition of the aircraft and on the situation outside. No external fire was observed by the AFO. The AFO did advise the Investigation that, if fire had been present at anytime, or if he had any doubt regarding the aircraft's external condition, he would have "*demanded that the aircraft be evacuated immediately*". In consideration of the following points:

- The departure off the runway and subsequent transition across the graded ground was expressed as "relatively smooth";
- No internal or external fire warnings were observed or reported to the flight deck;
- No aircraft structural damage was observed or reported to the flight deck;
- The outside prevailing conditions were that of rain and strong crosswinds;
- The terrain was that of long grass and soft ground;
- The Captain being initially unaware that ground disembarkation would be such a protracted affair;
- The risk of injury to passengers, in particular the elderly, is high when evacuating down slides from a large transport aircraft, and,
- The possibility of the slides being blown over the top of the aircraft due to the strong wind gusts;

the Investigation is of the opinion that the Captain's decision not to initiate an evacuation using the emergency slides, was justified and correct. While the delay in disembarkation is fully recognised, the wait for the mobile stairs did allowed for an orderly egress of the passengers, free from injury.

2.4.1.2 Response by the cabin crew in the cabin

All CFA's were in their nominated positions when the aircraft came to a halt. Emergency operating procedures require that cabin crew remain at their stations until otherwise directed. In particular, cabin crew stationed at emergency exits are required to remain in that position in order that they are immediately available to initiate an evacuation, if so be required. In following the correct procedures, some of passengers' perception of the CFA's lack of activity throughout the disembarkation effort, did generate anxiety amongst the passengers.

The main doors remained closed during the entire attempt to gain access to the aircraft. For emergency slides to operate, the slides must be armed when the door is closed. Under normal disembarkation, the slide must be de-armed before the door can be opened. If a main door is open and there is a need to initiate an immediate emergency evacuation using the slides, the opened door would have to be closed, the slides re-armed and the door re-opened again, for the slide to deploy automatically. The requirement for the Captain to have immediate availability of the emergency evacuation slides is self-explanatory. Two over-wing exists were opened in the later stages of the disembarkation effort, in order to supply fresh air to the cabin.

2.4.1.3 Information provided to passengers

Immediately after the aircraft came to a halt, the flight crew commenced their emergency checklist shutdown drills. The call of, "*tell them to remain seated*" by the Captain to the RFO may be considered as a holding PA, in order that the flight crew can complete their checks and allow time to evaluate the situation. The RFO did advise the SFA of the situation, and in turn the SFA advised the cabin crew. However, the passengers remained un-informed of their well being for approximately 4 minutes after the aircraft came to a halt, when at the request of the SFA, the Captain made his first PA. A delay of 4 minutes for the first PA appears under the circumstances to be excessive. An earlier PA would undoubtedly have clarified the situation to some degree and would have contributed greatly to reducing the passenger anxiety levels. The Investigation considers that, barring some time needed to evaluate the situation, the Captain should make a PA to the passengers at the earliest opportunity.

In examination of the CVR and in discussions with the flight crew and CFA, the indications are that in general the crew provided update information to the passengers when it became available. The difficulty for the crew was that they were entirely dependent on the effort of the ground personnel outside the aircraft and nobody was in a position to confirm when the stairs would be put in place.

2.4.2 Emergency Services Response - Airside

Analysis of the surface movement radar confirms that the Airport's First Line Fire Service was in attendance at the aircraft within two minutes of the crash alarm being sounded.

In addition, the Dublin City Fire Brigade and the Gardaí from "H" District Santry arrived on-site within 13 minutes of the aircraft coming to a halt. The airport's second-line fire service was in attendance 8 minutes later.

Concerns expressed by some passengers regarding a poor response by the Airport Fire Services are unfounded. It is understandable that some passengers will suffer a degree of trauma during and after an event such as a runway excursion. Many of the passengers were unsighted and unable to see the emergency response, which was taking place outside the aircraft.

The delay in disembarkation of approximately 2 hours and the perceived inactivity inside the cabin would have increased passenger anxiety levels, which ultimately can effect people's judgement of time and the accounts of events that take place at the time.

The Investigation is satisfied that the Airport Fire Service Emergency response time was well within the provisions laid down by ICAO's Annex 14 and considers that the Airport Fire Service and Civil Emergency Services responded in a professional, timely and efficient manner.

2.4.2.1 Use of Discrete Frequency

Communications between the flight deck, ATC and the airport fire service were maintained throughout the emergency response. However, the Investigation is of the opinion that in order to fully comply with Annex 14 provisions relating to Communications and Alerting System (Chapter 9.2.31), all Irish International Airports should have a formalised procedure in place for the use of an emergency discrete frequency. The AAIU Interim Safety Recommendation SR 7 of 2002 - 18 Feb 2002 was issued for attention of the IAA. The IAA's response to this Interim Safety Recommendation is presented at Section 4.1 of this report. In May 2002 the formalized use of a discrete emergency frequency was implemented at all three Irish State Airports.

In review of the ICAO Annex 14 wording at 9.2.31 regarding Communications and Alerting System, it is recommended that ICAO include the wording "*a disabled aircraft*" in the recommendation, in order that a disabled aircraft is included in the linking of the discrete frequency with the fire station, the control tower, any other fire stations on the aerodrome and the rescue and fire fighting vehicles.

2.4.3 The Airside Emergency Support Response

The Airside Management Unit initiated their emergency response plan immediately on receipt of the information that an aircraft had departed the main runway. Approximately 20 minutes after the aircraft came to a halt, various vehicles were escorted in convoy across the airfield to the runway excursion site. The Investigation is of the opinion that the response was of a timely and professional manner.

2.4.3.1 Gaining Access to the Aircraft

ICAO Annex 14 provisions provide at Chapter 9.3 recommendations regarding planning for disable aircraft removal. In addition, guidance material on removal of a disabled aircraft, including recovery equipment, is given in the Airport Services Manual, Part 5.

The Dublin Airport Disabled Aircraft Recovery Planning Manual (February 2000) was examined by this Investigation. The plan complied with the requirements of the ICAO Annex 14 provision.

Whilst the nearest access point to the aircraft (Door R2) was less than 35 metres from the paved surface, the open ground to be traversed created a significant challenge to the Airport Ground Personnel. Conventional mobile stairs proved unsuitable because of poor ground clearance and the undulating ground conditions.

The laying of track-way matting (normally used for recovery of disabled aircraft) proved in the end to be an essential item of equipment for gaining access to the aircraft.

The vehicle in which the matting was transported proved unsuitable in size, and thus necessitated additional trips to and from the airport maintenance yard.

Every effort was made by the Airport Ground Personnel to expedite the disembarkation.

However, the delay of 2 hours did cause some uncertainty, discomfort and distress among a large number of passengers. In a commitment of care to the passengers, such a delay is considered unacceptable. The AAIU Interim Safety Recommendation SR 8 of 2002 – 18 February 2002 was thus issued.

In light of experience gained by the Airport Authority during the disembarkation and recovery operation of the 3 February 2002, the Airside Services and Facilities Department, Dublin Airport conducted a review of their Disabled Aircraft Recovery Planning Manual and published a new amended version in April 2002. In particular, a section entitled "*Disembarking Passengers*" was included, whereby an aircraft has departed the paved surface and where it is not possible to bring in conventional mobile stairs directly to the aircraft due to soft ground.

The ICAO Annex 14 provisions fail to include requirements for gaining access to a disabled aircraft where, for any reason, emergency slides are not deployed. The Investigation recommends that ICAO review Annex 14 provisions and related guidance material for gaining access to a disabled aircraft.

In April 2002 the Airport Authority Services Manager – Airfield, specified a tender for supply and delivery of a flatbed trailer. The flatbed is required to carry a payload of 30 tons and will allow both the storage and carriage of all the track-way matting (approximately 70 metres) in a single load.

The flatbed trailer has since been delivered to Dublin Airport (October 2002) and is now fully operational.

2.4.4 The Terminal Emergency Support Response

The Duty Airport Manager (DAM) was made aware of the runway excursion almost immediately after it occurred. As per the Emergency Response Directive No. 3, the DAM is responsible for the co-ordination and direction of the support response for aircraft accidents and incidents.

Directive No. 3 also provides that ATC are responsible for categorising the occurrence to the Airport Fire Service Watchroom so that the appropriate emergency response can be initiated.

The direct line emergency call and the sounding of the airfield emergency button by ATC, provided a categorisation of **"Aircraft Emergency Situation"**, for the Airport Fire Service, who responded with a First Line turnout (Phase I - Immediate Response).

Some hesitation was noted by the Investigation in relation to ATC providing a "Verbal Categorization" of the occurrence to the Watchroom. In turn, this created some difficulty for the DAM with regard to determining his level of response for the Terminal (Phase 2 – Support Response).

In reviewing these events, the Investigation is of the opinion that Directive No. 3's instruction for ATC to provide categorisation of an occurrence for Phase II of the emergency response is somewhat flawed. The degree of workload experienced by ATC personnel during an aircraft distress or emergency is invariably high. In addition, all relevant information may not be available to ATC at the time, in order for them to make an accurate judgement on the categorisation for Phase II. This is particularly the case where the final resting position of the aircraft is not known or is out of view of the control tower.

While ATC can provide vital information for the categorisation of the occurrence for Phase II, a more appropriate and informed source would be the AFO/On-Scene-Commander.

In the absence of clear verbal categorisation of the occurrence, the DAM declared and instructed that the Terminal Phase II Support Response was to be for **"Aircraft in Distress"**, necessitating a **"Full Emergency Response"**.

Considering that a large wide body passenger aircraft had departed the paved surface, and bearing in mind that the category of response could and subsequently was downgraded, the DAM's initiative was both appropriate and correct.

Directive No 3 (2001) provides at Para 3.2, Phase 2 – Emergency Support Response, that the DAM will be responsible for coordinating the Emergency Support Response and, in the case of aircraft accidents, will liaise with the Airline or Handling Agent who will put their own emergency response plan into action to deal with the crisis.

When the Company Services Agent observed the company aircraft depart the runway, she immediately alerted, by phone, the remaining 3 staff members, including the Company Station Manager. All efforts by these staff members (with support from the ground handling company) were then centred on providing assistance to the passengers and then to the Meeters and Greeters. However, as a result of these activities, the Operators Emergency Response Plan was not activated, the Operators Control Centre in Atlanta was not advised of the runway excursion until approximately 45 minutes after the event and the Operators Office at the airport remained mainly unmanned throughout the event. Initially, lines of communication between the DAM and the Operator would appear to have been difficult to establish.

In addition, some misunderstanding existed with regard to where the Operator or Handling Agent should go to rendezvous (RV) with the Airport Authority in order to handle the Meeters and Greeters. The Investigation does recognise that the RV Point was clearly stated in the Directive No 3 (2001) and was manned by the Airport Authority almost immediately after the runway excursion.

The Operator has an Emergency Operations Manual and Local Emergency Response Plan available to its staff at Dublin Airport. The plan includes, in the form of a checklist, a process of notification and immediate actions to initiate in an emergency response. The local plan, however, does not provide information for staff with regard to the classification or categorization of an event, nor does it provide guidance as to when the plan should be activated and to what degree.

While the commitment of care by the Operator's staff to passengers is commendable, the Investigation considers that priority should have been given towards manning the office and activating the emergency response checklist. This may have resolved the initial communications and RV problems experienced.

Carrying out the analysis of the Phase II Emergency Support Response for this particular event provided the opportunity for the Investigation to review and comment on the Annex 14 provisions for Chapter 9, Emergency and Other Services and the Airport Authority planning procedures and facilities available for a major accident.

It is noted that the responsibility for the reception of passengers from an accident/incident aircraft and more importantly the facilities for the reception of these passengers and Meeters and Greeters is not provided for under ICAO's Annex 14 provisions.

The Investigation is of the opinion that ICAO, in addition to recommending at Chapter 9 - Emergency and Other Services, the provision of a fixed emergency operations centre and a mobile command post, this document should also specify in broad terms the need for the Airport Operator or Authority to provide and nominate fixed facilities for the care of passengers and Meeters and Greeters during an aircraft accident or emergency situation.

Recognising that no passengers were injured during this particular runway excursion, it should be noted that there was, and always will be, a potential for an airport to experience an accident that would bring forth large numbers of fatalities and injuries.

Dublin Airport has experienced phenomenal growth in the past decade. Passenger numbers are increasing by approximately 1 million per year. The current passenger numbers for 2002 are running at 14.2 million per annum and this is expected to rise to 20 million over the next 5 years.

This expansion not only presents a significant challenge to the Airport Authority with regard to providing facilities for aircraft and passengers but it also affects established emergency planning procedures and facilities related to these plans.

On examination of the Airport Authority Emergency Response Directive No. 3 (2001) it is clear that the Directive had become out-dated in certain areas and, in general, lacked detail.

Directive No. 3 was in the process of being updated prior to 3 February 2002, and an amended draft version was submitted to the Investigation (8 July 2002) for comment.

In general, the amended version is a significant improvement on the previous edition, providing far greater detail and clarity. The Investigation does, however, have comments regarding some of the stated accommodation facilities provided at the airport for the Emergency Support Response.

2.4.4.1 Emergency Operations Centre

Directive No. 3 (2001) identifies the Operations and Duty Office of the Airport Authority as the Emergency Operations Centre. The Investigation considers this location to be wholly inadequate for an Emergency Operations Centre, as it lacks available meeting/working space, and a comprehensive communication and administrative suite.

A room previously made available for security situations has since been provided as an emergency operations centre. Known as the Airport Emergency Coordination Centre (AECC), it is located in the North Terminal.

In the event of a full emergency response requirement, the room can be set up to accommodate approximately 20 essential personnel who will be tasked to coordinate the emergency response. While this room is an improvement on the original Operations and Duty Office, the Investigation has concern that, the room is not available or set up on immediate standby, and the present communications/administrative suite is considered inadequate to cope with a large scale emergency response.

2.4.4.2 Survivors Reception

Directive No. 3 (2001) allocates the North Terminal as the Survivors Reception – where the uninjured and casualties who have not been brought directly to hospital can be treated. This facility is equipped with oxygen supply points and procedures, as laid down in Directive No 3, require that stretcher beds/medical supplies are set up automatically by staff once an aircraft distress is declared.

The Airport Fire Service can augment the capacity of the survivors' reception area to 142 person/beds through the use of two inflatable tents. However, mindful that the average passenger transport aircraft can carry between 100-200 passengers, large transport jets, in excess of 350 passengers and the planned transporters over 600, the Investigation considers that the capacity of the North Terminal, as a fixed structure survivors' reception, would be restrictive in the event of a major occurrence at Dublin Airport. Additional Survivor Reception accommodation should be sourced and identified in the amended Directive. In addition, the close proximity of the survivors' reception to the AECC would be a concern, in particular with regard to crowd control and security.

2.4.4.3 Meeters and Greeters

Due to the on-going building extension of the main terminal building, the assigned location for Meeters and Greeter, “Noel’s Bistro”, as identified in Directive No 3 (2001) was no longer in existence at the time of the runway excursion. The passengers were therefore walked through the main terminal building to an area known as, “The Mezzanine”. The Mezzanine is located on a large balcony overlooking the Main Departures Hall.

The Investigation is of the opinion that this particular location was too public an area and did not provide sufficient privacy for the passengers and Meeters/Greeters during reconciliation.

The draft amended Directive (2002) does specify several areas for Meeters and Greeters to be brought to. The selection of these areas should take into account

- Location - not a public area;
- Access - easily accessible;
- Availability - at short notice;
- Capacity - for large numbers; and,
- Views - of the airport-Airside should be restricted.

2.4.4.4 Reconciliation Centre

After a major aircraft accident, the outcome for Meeters/Greeters/Family and Friends during reconciliation of the passengers will vary greatly. Some will be reconciled with uninjured passengers/minor injury passengers and others will be directed towards hospitals where the more seriously injured passengers will have been taken. For others, they will be confronted with the loss of loved ones and may even be required to assist in body identification. The range of emotions during the reconciliation process will be complex, therefore the selection of such a site must be chosen with a high degree of sensitivity. The reconciliation centre should not be co-located with the Meeters and Greeters area.

2.4.4.5 Temporary Morgue

Directive No 3 (2001 & 2002) identifies Hangar No 1 as a suitable location for use as a Temporary Morgue. This particular Hangar is a heavy maintenance repair facility. Availability of this facility as a Temporary Morgue will depend on what stage of inspection an aircraft is on, at any particular time. The Investigation considers it appropriate that the Airport Authority source an additional suitable location for use as a Temporary Morgue to cover the event that the first location is unavailable and identify this in Directive No 3.

On foot of these general comments, it is recommended that the Airport Authority carry out a review of their nominated emergency response facilities at Dublin Airport, in order to ensure that their availability and suitability is adequate to deal with large numbers of people following a major accident at the airport.

2.4.5 Airport Medical Care Facilities (Medical Clinic and/or First-aid Room)

An examination of the facilities at Dublin Airport determined that no medical care facility is currently in operation at the airport. Until recently, a major airline did provide a medical centre at the airport, with the Airport Authority contributing to the running costs. However, this airline is no longer in a position to provide this service. Bearing in mind that:

- Dublin Airport has a working population of over 12,500 people;
- Over 14 million passengers per annum are passing through the terminal;
- An untold number of Meeters and Greeters are present in the terminal building at any one time; and,
- In consideration of the specifications as laid out in the Airport Services Manual, Part 7 Airport Emergency Planning - Airport Medical Care Facilities,

the Investigation considers that a medical centre should be available and in operation at Dublin Airport.

2.5 Prepared Graded Ground

The prepared graded ground adjacent to the runway proved highly effective in decelerating the aircraft, keeping it upright and minimizing the damage to the undercarriage and the aircraft itself.

2.6 Aircraft Recovery

Recovery of the aircraft from its final resting position back to a hard standing was a major operation for the Airport Authority. The operation itself was conducted in both an efficient and professional manner. The fact that the aircraft was recovered without sustaining further damage is commendable.

2.7 Discussion

2.7.1 The Runway Excursion

The philosophy of training by the Operator, and as per the majority of airlines, is to teach flight crews, "not to lose directional control", as opposed to "regaining directional control". Flight simulators play a crucial role in the training and rating of airline pilots. However, these simulators are programmed to fly within the certified limitations of the particular aircraft chosen and within the limitations set down by the operator themselves. If, for example, the landing conditions are outside the operator's stated landing limitations, the flight crew are obliged to either hold until conditions come within the limitations, or divert to a more suitable location.

To reproduce extreme conditions, such as a gust in excess of the maximum crosswind limitation during the landing roll, is difficult, if not near impossible on a simulator. Therefore, flight crews are not generally practiced at recovering from loss of directional control and have to rely on the theoretical guidance provided by the operator. Crosswind landings require the flying pilot to efficiently balance all the forces that are acting on the aircraft during the landing rollout.

Any sudden unbalancing of forces, such as those imposed by crosswind gusts, will make it more difficult to assure the desired directional control and the pilot will have to respond with a combination of flight controls, wheel braking and reverse thrust, as available. The greater the unbalancing of forces that result from crosswind gusts, the greater the effort the pilot will have to make to balance those forces and keep the aircraft tracking straight on the runway.

Having just completed a long haul flight from Atlanta, the pilot was prepared for a landing that, under the reported prevailing conditions, should have been routine. Without warning, the aircraft's direction of travel was influenced by a violent gust from the left, which caused the aircraft to initially drift to the right and then yaw to the left. A critical hindsight review of the data available during the landing rollout, suggests, that if more effort had been put towards:

- Maintaining positive forward pressure on the control column – in order to keep the nose wheels fully loaded;
- Maintaining left into wind aileron control – in order to prevent the into wind wing lifting and to counteract the weathervane effect;
- Not using tiller/nose wheel steering at speeds higher than taxing speeds, and;
- Selecting (MED) auto-braking for wet conditions – to increase rate of deceleration and thus risk of exposure,

the final outcome may have been different. However, with the dynamics involved, this could never be conclusively proven. The pilot had no practice for the unfolding events and the dynamics were such that he only had a very short time and space to attempt to resolve the situation. Any number of pilots faced with the same situation most likely would have had the same outcome. In brief, the upset was a sudden and violent event, which happened to catch an aircraft and flight crew at the worst possible moment in time.

2.7.2 The Emergency Support Response

This particular event thankfully did not bring forth casualties or injuries. However, it does serve as a reminder that there is always a potential for disaster to strike at an airport such as Dublin. When disaster strikes, it invariably happens at the worst possible time. The immediate repercussions are not just for the victim airline or the emergency services. The domino effect ensures that the vast majority of employees, passengers and meeters/greeters will in some way be affected and involved, particularly, if the airport is closed for a significant period of time.

It goes without saying that key personnel employed throughout the entire airport should be familiar with their own emergency support response plans and that of the Airport Authority. In particular, airlines operating limited staff at foreign bases will require additional assistance from other bodies. To be effective, the personnel supplied need to be aware of the emergency plans of the particular operator and of the Airport Authority. In addition, these people need to be trained. There is a need at Dublin for some airlines to establish mutual cooperative support for each other in the event of a major emergency crisis. The Airport Authority should seek ways to develop and nurture this mutual cooperation amongst airlines and the airlines should be supportive of the initiative.

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3. CONCLUSIONS

(a) Findings

The runway excursion

1 The crew were properly qualified, licensed and rested in accordance with USA FAA Regulations, to undertake this flight.

2. The aircraft had a valid Certificate of Airworthiness and had been maintained in accordance with an appropriate and approved schedule.

3. No evidence was found of any technical problem on the aircraft, or its systems prior to the aircraft departing the paved runway surface.

4. The auto-braking system was originally set at medium (MED). However, after a brief discussion between the PF and the RFO, auto-brake minimum (MIN) was set for the landing. The Operators Pilots Reference Manual (PRM) recommends the setting of auto-brake to (MED) for wet runway conditions.

5. The approach reference speed of Vapp 153 KT was confirmed to be within one knot of the Vref for the calculated landing weight.

6. Under the prevailing weather conditions the approach was considered stable from 7 nm down to the touchdown point.

7. The ATC reported landing wind of 210º/ 20 KT was correctly recorded and displayed at the time of N803DE's landing.

8. The runway condition was correctly reported as "Wet" for the landing. A post runway excursion inspection of the runway surface and an analysis of the runway friction tests indicate that no significant standing water was present and the braking action was good.

9. The aircraft touched down firmly within the landing touchdown zone, on the centreline and at an airspeed of approximately 145 KT.

10. The aircraft heading on touchdown was 277º. The runway heading is 281º.

11. Nose wheel contact was made approximately 2-3 seconds after main wheel touchdown. The spoilers and reverse thrust deployed and functioned as per their specification.

12. Approximately 3 seconds after nose wheel contact the elevator deflection decrease from 20º aircraft nose down to at or near its neutral position.

13. About 8 seconds after touchdown, all four ailerons flared to approximately their neutral position and remained there for the remainder of the rollout.

14. At about 10 seconds after touchdown and with spoilers and reverse thrust fully deployed, the aircraft was subjected to a sudden and violent gust of wind from the left, which was approximately 23 KT above the reported landing wind of 210º/20 KT. This particular gust was unforeseeable and unexpected.

15. The aircraft initially drifted downwind to the right and then yawed to the left.

16 The pilot could not contain the yaw rate to the left, indicating that the nose wheels were beyond the limit of their adhesion. The lack of a sustained forward pressure on the control column during the rollout would have the effect of unloading the nose wheel tyres, thereby contributing to a reduction in the tyre friction forces.

17. The combination of CVR analysis, the identified nose-wheel cuts/scratches and the runway tyre prints, indicate that the tiller and nose-wheel were deflected to their fully right position shortly after the un-commanded yaw to the right and this condition remained until the aircraft came to a halt. The Operators PRM recommends not to use nose wheel steering tiller until airspeed is reduced to taxi speed (approximately 25 knots).

18. An examination of the nose-wheel and main wheels revealed no evidence of skidding or hydroplaning.

19. The aircraft departed the left side of the runway at a ground speed of approximately 35 KT

20. The meteorological facilities, including recording/display at Dublin Airport are in full compliance with the ICAO Annex 3 provisions.

The Emergency Response

21. The Airport Fire Service was in attendance at the stricken aircraft within 2 minutes of the crash alarm being sounded. Both the Airport Fire Service and the Civil Emergency Services responded in a professional, timely and efficient manner.

22. A period of 4 minutes elapsed from the time that the aircraft came to a halt until the Captain made his first PA to the passengers.

23. The Captain's decision not to carry out an emergency evacuation using the emergency slides was, in the opinion of the Investigation, correct.

24. At the time of the runway excursion, no formalised procedure was in place at Dublin Airport for the operation and use of an emergency discrete frequency.

25. Dublin Airport was closed for a total of 47 minutes as a result of the runway excursion. RWY 28, the main runway, was closed for approximately 35 hours.

26. The air-side initial emergency response to the incident site was conducted in a timely and professional manner. However, due to difficulties experienced in gaining access to the aircraft, the disembarkation of passengers did not occur until approximately 2 hours after the aircraft came to a halt.

27. The International Civil Aviation Authority does not provide provisions in Annex 14 for disembarkation from an aircraft that has been involved in a runway excursion and where, for any reason, the emergency evacuation slides are not used.

28. An examination of the Airport Authority Emergency Response Directive No. 3 (2001) by the Investigation determined that it lacked detail and required updating.

29. While recognising the Operator's commitment and duty of care to the passengers, the Operator's Staff at Dublin Airport failed to correctly activate and manage their emergency response plan.

30. The nominated Emergency Operations Centre in place at Dublin Airport at the time of this event was inadequate for its purpose.

31. The newly allocated Airport Authority Coordination Centre (AECC) is not available on immediate standby and is not appropriately equipped to cope with a major airline accident at Dublin Airport.

32. A review of the Airport Authority Emergency Support Response accommodation facilities indicate that, in the event of a major accident at Dublin Airport, some of the nominated facilities may not be immediately available, suitably located/equipped or fully adequate to cope with large numbers of people.

33. There is no medical centre available at Dublin Airport.

(b) Cause

The cause of the runway excursion was that the aircraft was subjected to an unexpected and sudden wind gust during the initial stages of the landing rollout, inducing a rate of yaw to the left, which could not be controlled by the pilot flying.

4. SAFETY RECOMMENDATIONS

The following safety recommendations were made during the course of the Investigation.

4.1 SR 7 of 2002 was originally issued as an Interim Safety Recommendation on the 18 February 2002. It reads:

"The Irish Aviation Authority should ensure that airports in the State, formalize a procedure, whereby airport fire services are allocated a discrete emergency working frequency in order that they can maintain continuous communications with the crew of a disabled aircraft". **(SR 7 of 2002)**

The IAA's response to this Interim Safety Recommendation, was as follows:

The Authority agrees objectively with this recommendation but is still examining the issue of enforcing it as such. Prior to the subject event, the Authority, acting on behalf of the ODTR (which is in fact the agency with the authority to allocate such frequencies at the present time) had requested and provided the frequency of 121.6 MHz to the crash rescue services at Dublin Airport as a dedicated ground frequency for crash rescue purposes. It is, therefore certainly possible to enable such a frequency, at least at the State Airports. Since the above incident, in the light of the recommendation, the same frequency has been allocated to Cork and Shannon Airports. The Authority will include a reference to this frequency in the aerodrome licensing procedures and will endeavour to establish a procedure for its use when required. It is not proposed at this time to further extend the allocation of this frequency to other airports, in view of their limited traffic.

4.2 SR 8 of 2002 was originally issued as an Interim Safety Recommendation on the 18 February 2002. It reads:

"The Irish Aviation Authority should ensure that airports in the State, review the adequacy of their procedures and equipment for the disembarkation of passengers and crew from an aircraft, which departs the paved surface and is unable, for any reason, to use the emergency evacuation slides or airstairs". **(SR 8 of 2002)**

The IAA's response to this Interim Safety Recommendation, was as follows:

The Authority has also researched the second recommendatwhich it objectively agrees, but finds that it falls within the scope of facilitation at airports rather than under a safety remit. As such the Authority is in a position only to recommend compliance by aerodrome operators, which it will do. It should be pointed out that crash rescue vehicles at aerodromes are required to carry access ladders to cater for a situation where an evacuation slide fails to deploy in the event of an emergency evacuation. The Authority will verify that such equipment is indeed available at airports under its licensing remit.

In light of the IAA response, the Investigation considers that this safety recommendation is more appropriate for action by the Airport Authority. The Investigation does recognise that the responsibility for disembarkation of passengers from an aircraft presently lies with the airline/handling agent.

The Airport Authority has, in its Disabled Aircraft Recovery Planning Manual, already taken suitable remedial action, therefore, no further action is required.

4.3 The International Civil Aviation Organisation should consider providing provisions in Annex 14 and related guidance material for gaining access to a disabled aircraft where, for any reason, the emergency slides are not deployed. **(SR 5 of 2003)**

4.4 The Airport Authority should consider amending Directive No. 3 in order that the Duty Airport Manager (DAM), following consultation with the AFO/On-Scene-Commander will categorize the level of emergency support response required following an occurrence. **(SR 6 of 2003)**

4.5 The Airport Authority should carry out a review of all the accommodation facilities required for emergency support response at Dublin Airport. **(SR 7 of 2003)**

4.6 The Operator should reiterate to their Flight Crews the need to comply with the Flight Operations Manual (FOM), in particular with regard to evacuation procedures and the PA announcements to be made immediately following an emergency situation. **(SR 8 of 2003)**

4.7 The Operator should conduct an audit on its Irish Stations in order to confirm the compatibility of their emergency plan with that of the Airport Authority and the appointed Handling Agent. **(SR 9 of 2003)**

4.8 The Operator should ensure that, foreign-based station staff, are fully aware of their responsibilities and functionality of their Local Emergency Response action plans. **(SR 10 of 2003)**

4.9 The International Civil Aviation Organisation should consider amending the provisions of Annex 14, Chapter 9, Emergency and Other Services, Para 9.2.31, Communication and Alerting System, to include the term "*disabled aircraft*", when linking the discrete frequency with the fire station, the control tower, any other fire stations on the aerodrome and the rescue and fire fighting vehicles. **(SR 11 of 2003)**

4.10 The International Civil Aviation Organisation should consider amending the provisions of Annex 14, Chapter 9, Emergency and Other Services, to include, in broad terms, the need for the Airport Operator/Authority to provide and nominate fixed facilities for the care of passengers and meeters/greeters during an aircraft accident or emergency situation. **(SR 12 of 2003)**

Appendix A

Air Traffic Control Transcript/Sequence of Events

Time	Station	Event	Transmission/Remarks
About 8.02:26	Tower	Transmission ATC/Delta	Delta 129 Good Morning to you cleared land 28. The wind 210 degrees 20 knots
About 8.02:32	Delta	Transmission Delta/ATC	Delta 129
About 8.02:38	EIN 154	Transmission Shamrock/ATC	Tower good morning Shamrock 154 holding short 28
About 8.02:39	Tower	Transmission ATC/Shamrock	Shamrock 154 Good Morning to you hold short 28
About 8.02:45	EIN 154	Transmission Shamrock/ATC	Wilco 154
About 8.03:11	EIN 154	Transmission Shamrock/ATC	Shamrock 154 What's the wind at present?
About 8.03:13	Tower	Transmission ATC/Shamrock	200 degrees now at 22 knots. It's been varying between 200 and 210 for the last 20 minutes. But fairly reasonably steady on that.
About 8.03:20	EIN 154	Transmission Shamrock/ATC	Thank you
About 8.03:25	Tower	Transmission ATC/Shamrock	Shamrock 154 Behind the MD 11 on Finals 28 line up behind and wait
About 8.03:28	EIN 154	Transmission Shamrock/ATC	Behind the landing Line up and wait Shamrock 154
About 8.04:10	Tower	Open Transmission ATC (*presumably for Delta 129)*	210 degrees 20 knots
About 8.04:12		Auto pilot disconnect	362 Feet Radio Altitude
About 8.04:37		Touchdown Spoilers deploy	30º
About 8.04:40		Spoilers fully deployed	60º
About 8.04.40		Reversers deploy	
About 8.04:44		Reversers fully deployed	
About 8.04:45	Anemo meter	Gust of 43 KT	Print out Anemograph Trace Appendix E
About 8.04:50	GCC 072	Transmission Continental/ATC	Dublin Tower GCC 072 is 2 miles to the marker ILS Full Stop.

About 8.04:53	Tower	Transmission ATC	GCC 072 Good Morning to you, continue approach traffic to depart. The wind now just 210 degrees 35 knots gusting up to 42 knots.
About 8.04:54		Reversers stowed	
About 8.05:04		Aircraft departs paved surface	
About 8.05:09	Tower	Transmission ATC/Delta	Delta 129 (N 803DE), do you require assistance?.
About 8.05:11	Delta	Transmission Delta/ATC	Yeah, we're off the runway.
About 8.05:12	Tower	Transmission ATC/Delta	OK Sir, Emergency Services on the way.
About 8.05:13		Aircraft comes to halt	
About 8.05:14	Delta	Transmission Delta/ATC	Roger.
About 8.05:16	Tower	Transmission ATC/Continental	GCC072 Cleared Go Around Runway 28. Climb straight ahead 3000 feet Runway is blocked with disabled aircraft.
About 8.05:23	GCC072	Transmission Continental/ATC	072 going around runway heading till 3000 feet.
About 8.05:28	Tower	Transmission ATC/Continental	Correct. The surface wind, 210 degrees 34 knots.
About 8.07:12	Rescue Services	Emergency services in attendance at aircraft	1 min 59 seconds from aircraft coming to halt.

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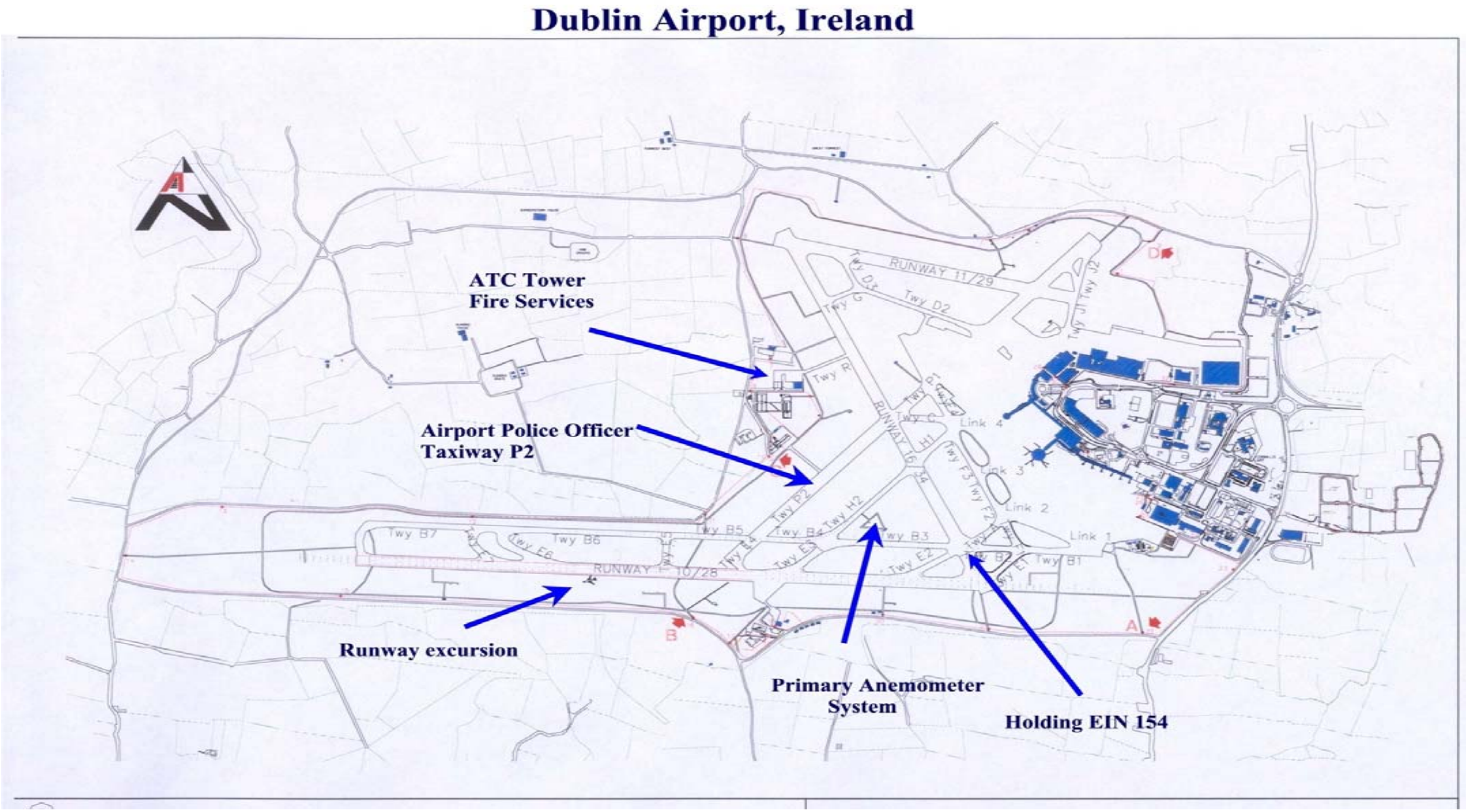
Appendix B


Dublin Airport, Ireland
ATC Tower
Fire Services
Airport Police Officer
Taxiway P2
Runway excursion
Primary Anemometer
System
Holding EIN 154
RUNWAY 11/29
RUNWAY 10/28
RUNWAY 16/34
Twy R
Twy G
Twy D2
Twy C
Twy P2
Twy H2
Twy H1
Twy B7
Twy B6
Twy B5
Twy B4
Twy B3
Twy B1
Twy E2
Twy F2
Link 1
Link 2
Link 3
Link 4
A
B
D

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Appendix C

Hydroplaning

General

Scientific reports on hydroplaning cite water depth, speed, tire tread depth, runway surface texture, tire inflation pressure, effective weight, and landing gear arrangement as contributing factors.

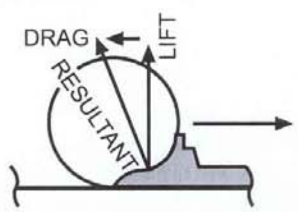
Experts generally agree that there are three types of hydroplaning: dynamic (or hydrodynamic), viscous, and steam (or reverted rubber). It is to be noted that these may be indistinguishable from the cockpit. All three types can seriously degrade the braking effectiveness and directional capability of the aircraft tires.

Dynamic Hydroplaning

This type of hydroplaning is a function of high speeds and can occur only when the runway surface is critically flooded. The critical depth of water (or slush) can vary from .1 to .4 inches, depending on tire and surface condition.

In the case where an aircraft is accelerating on a water-covered runway, partial hydroplaning begins as the moving tires contact and displace the stationary water. The resulting change in momentum of the water creates hydrodynamic pressures that react on the runway and tire surfaces.

The resultant force forms a fluid "wedge" which, to some degree, separates the tire from the runway and decreases the footprint area available for braking action. At some higher speed the hydrodynamic lift developed under the tire equals that part of the aircraft weight being supported by the tire, so that the tire is lifted completely off the runway surface.



The critical ground speed at which the latter occurs is termed the "tire hydroplaning speed" (Vp). Partial hydroplaning is occurring at speeds below Vp, total hydroplaning at speeds at or above Vp.

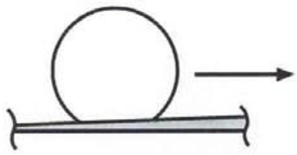
Additionally, as the tire accelerates, the center of hydrodynamic pressure shifts increasingly forward of the axel center line, creating a wheel spindown moment.

At the same time, the friction-induced spin-up moment is decreasing with decreased footprint area until, at some vehicle speed, the wheel will begin to slow down and stop. This can occur before hydroplaning commences and at this point the effectiveness of wheel braking is lost. The small residual footprint disappears at VP along with all tire-to-surface friction and cornering effects.

Of additional concern in the takeoff regime is the effect of fluid displacement drag. Where a runway is heavily flooded with water or slush, this drag factor increases with speed, peaking near Vp. This can result in greatly increased takeoff distances, and is the main reason for the "1/2 inch rule."

Some discussion is in order on the subject of total hydroplaning speed (Vp), which is defined as the speed at which the tire is lifted completely off the surface. The most preponderant opinion is that this speed in knots may be approximately by the formula $Vp = 9\sqrt{p}$, Where p is the tire inflation pressure. If this thesis is accepted as true, then most aircraft will find themselves in a total hydroplaning condition at the high-speed end of the takeoff and landing operations (if fluid is above the critical depth). Other respected opinion holds that this formula is oversimplified and that the total hydroplaning condition is never reached within the normal groundspeed envelope. The argument is academic, however, since effective footprint area will be minimal at speeds approaching Vp on flooded runways.

For the decelerating or landing condition where hydroplaning occurs, the effects will be the same as in acceleration, but in inverse order. Experiments have shown that, in deceleration from a hydroplaning condition, a tire will spin up at a slower ground speed than that required for spin-down in an accelerating condition. This suggests that dynamic hydroplaning may be more serious for landings and aborted takeoffs than for takeoffs because of the greater speed range of potential exposure.



The question may arise whether fluid displacement drag may help in slowing an aircraft in hydroplaning conditions. This parameter will be helpful at speeds close to Vp, but the effect drops sharply at higher or lower speeds.

It should be noted that, while hydroplaning is the most serious condition, some degradation in braking and cornering effectiveness begins with partial hydroplaning at speeds well below Vp. From this point, adverse effects increase as a function of the square of the ground speed.

Viscous Hydroplaning

Even slight amounts of precipitation, such as heavy dew, can result in this type of hydroplaning. Loss of traction can occur at relatively low speeds because of the inability of the tires to penetrate a very thin but tenacious fluid film on a smooth pavement surface. The requirements for viscous hydroplaning are:

- A very smooth or smooth-acting runway surface.
- A thin film of water or other contaminant; film thickness required is estimated to be less than 0.01 inches.

Exposure to viscous hydroplaning is thus greatest on an abnormally smooth runway, or one that has become heavily coated with rubber from landings and wheel spin-up. Complete separation of tire and surface can occur at groundspeeds at least 35 percent less than the speeds required for total dynamic hydroplaning. The effects, however, can be equally hazardous.

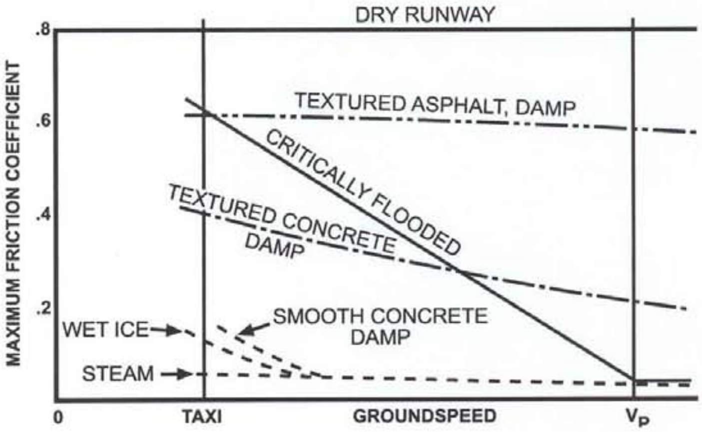
Steam Hydroplaning (Reverted Rubber)

This type of hydroplaning is associated with wet runway conditions where the tire is allowed to remain locked up for a period of time. The longer the tire remains stationary, the more total heat is dissipated in the footprint area, converting the water to superheated stream. Steam pressures then lift the tire from the runway surface.

Temperatures up to 500°F can be generated in this process, which tends to explain the observed damage to tire structure. The tire shows a patch of rubber that looks like it has been heated to the melting point and then reverted to the uncured state: hence the term "reverted rubber." It has been suggested that this melted rubber may form a seal, trapping the steam in the footprint area, while some sources maintain that steam can be generated, without a seal, at a rate sufficient to sustain hydroplaning. The high-pressure steam also tends to explain the white (steam-cleaned) marks on the pavement, characteristic of steam hydroplaning.

Since one of the requirements of steam hydroplaning is a high temperature in the footprint, this is more likely to occur on damp to moderately wet pavement rather than in heavy water where a lower tire friction is experienced. In this process, friction coefficients are similar to total hydroplaning conditions. Most important is the fact that steam effect can persist to extremely low groundspeeds, measured in some cases to be below 20 knots.

The key to preventive measures in this case is the avoidance of wheel lockup and the resulting skid. It follows, therefore, that steam hydroplaning cannot occur if antiskid devices are operating properly and there is no residual drag in wheel bearings or brakes.



Controllable Physical Factors

Having discussed the conditions which cause hydroplaning, we may now describe measures to control the conditions.

Tires

Inflation Pressure

Considering the formula for total dynamic hydroplaning $Vp = 9\sqrt{p}$, it would appear that an infinitely high inflation pressure could remove the threat of hydroplaning in the normal speed envelope. There is, though, only a small practical range of inflation pressures available.

Tread Design

Adequate tread designs tend to increase the groundspeed required for hydroplaning, while also increasing the minimum fluid depth required. Radically grooved tires tend to improve substantially the traction on a critically flooded surface, even when the fluid depth is greater than the tire tread depth. This design provides a low-pressure escape route for water and steam. Slippery runway performance is a prime consideration in Delta's selection of tread design.

Landing Gear

In tandem-wheel landing gear arrangements, the patch clearing action of the front tire tends to reduce the fluid depth for the rear tire, increasing its traction capabilities.

Runways

Pavement Crown

A good crown can inhibit hydroplaning conditions by draining water off rapidly. Slush conditions are not as readily drained.

Surface Texture

A rough or open textured surface can inhibit viscous hydroplaning by puncturing the thin fluid film with sharp asperities. It may also increase the minimum fluid depth for dynamic hydroplaning.

Pavement Grooves

Lateral grooving of runways is believed to be the most effective physical means of avoiding hydroplaning conditions. The pumping action of tires and grooves removes fluid rapidly from the footprint area. The grooves may also suppress formation of a viscous film, and the sharp edges may skim off melted rubber.

Cockpit Considerations and Techniques

A pilot's best weapons against the problem of slippery runways are the knowledge of weather, runway conditions and the capability of planning ahead.

Weather

Snow, slush, or ice will create hazards. Heavy rain showers or continuous rain should raise the question of critically flooded runways. A heavy dew or drizzle on a smooth runway creates ideal conditions for viscous hydroplaning.

Runway Conditions

Smooth runways, or runways with heavy rubber deposits should be treated as very slippery under any moisture conditions. Care should be exercised when turning or taxiing on areas of rubber deposits, as near the ends of a runway. A runway with heavy puddling at the rollout end will not be as hazardous as one with standing water on the approach end.

Technique

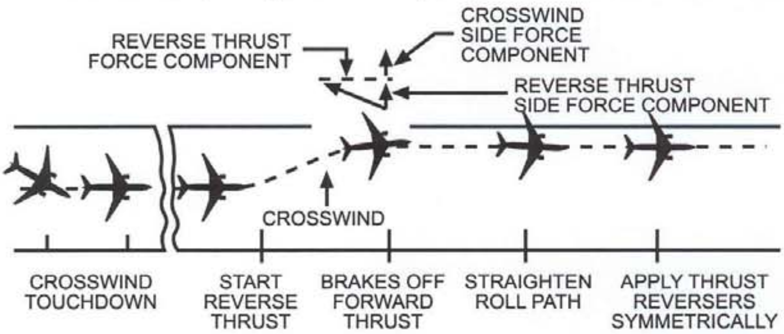
If serious slippery runway conditions are known to exist, holding to allow water drainoff or diversion to an acceptable alternate should be considered. If a landing must be made on a very wet or slippery runway, appropriate operational techniques should be employed.

- Use minimum safe touchdown speed.
- Make early runway contact and early nosewheel contact to get maximum directional capability. A firm landing is better than a "grease job," which may induce hydroplaning in marginal conditions.
- Make early use of spoilers for better wheel spin-up acceleration and to remove lift from the wings.
- Make early use of maximum allowable reverse thrust, which is most effective at the higher speeds.
- Use autobrakes if installed.
- Make early use of wheel brakes, applied at a smooth, steady rate up to maximum braking. Do not "jump" on brakes.
- Land on centerline and track straight down the runway.

Caution should be used to avoid asymmetric application of reverse thrust or brakes with the obvious directional hazards.

Since Vp is a function of groundspeed, a landing directly into the wind will decrease the exposure to hydroplaning. The worst landing condition is one where slippery runway conditions prevail with a crosswind. Besides the hazard of the crosswind side force component, there is the side force component of reverse thrust, which will compound the wind drift if the airplane is allowed to weathercock. The addition of these two forces may cause an aircraft to drift off the side of the runway under low friction conditions. Preventive measures can lengthen landing distance by causing less than optimum handling of reverse thrust. Also, a crosswind blowing up the transverse slope of a runway could create a lateral difference in water depth, possibly resulting in hydroplaning on one side and, thus, asymmetric directional control.

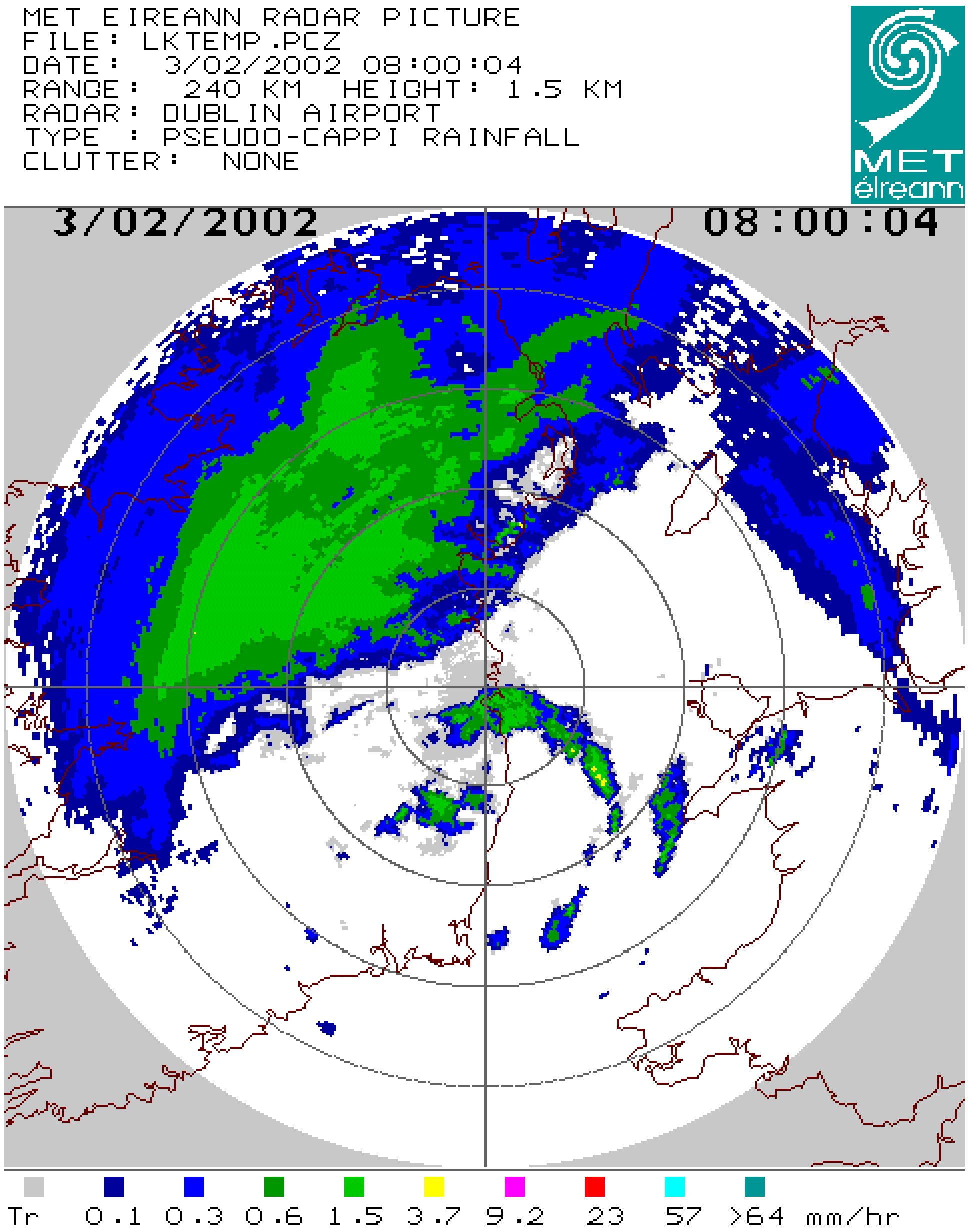
The airplane centerline should be aligned with the runway at touchdown (wing-down method) and initial directional control maintained aerodynamically. If the airplane weathercocks and drifts sidewise during reversing, return all engines to low power forward thrust, straighten aircraft path, then resume reverse thrust.



It has been shown that any runway other than a dry runway can cause loss of traction through a wide range of speeds. General considerations and techniques have been reviewed, with emphasis on the anticipation of conditions and planning the proper action.

For maximum crosswind limits on a contaminated runway, *refer to the AOM.*

APPENDIX D(a)


MET EIREANN RADAR PICTURE
FILE: LKTEMP.PCZ
DATE: 3/02/2002 08:00:04
RANGE: 240 KM HEIGHT: 1.5 KM
RADAR: DUBLIN AIRPORT
TYPE : PSEUDO-CAPPI RAINFALL
CLUTTER: NONE
MET éireann
3/02/2002
08:00:04
Tr 0.1 0.3 0.6 1.5 3.7 9.2 23 57 >64 mm/hr

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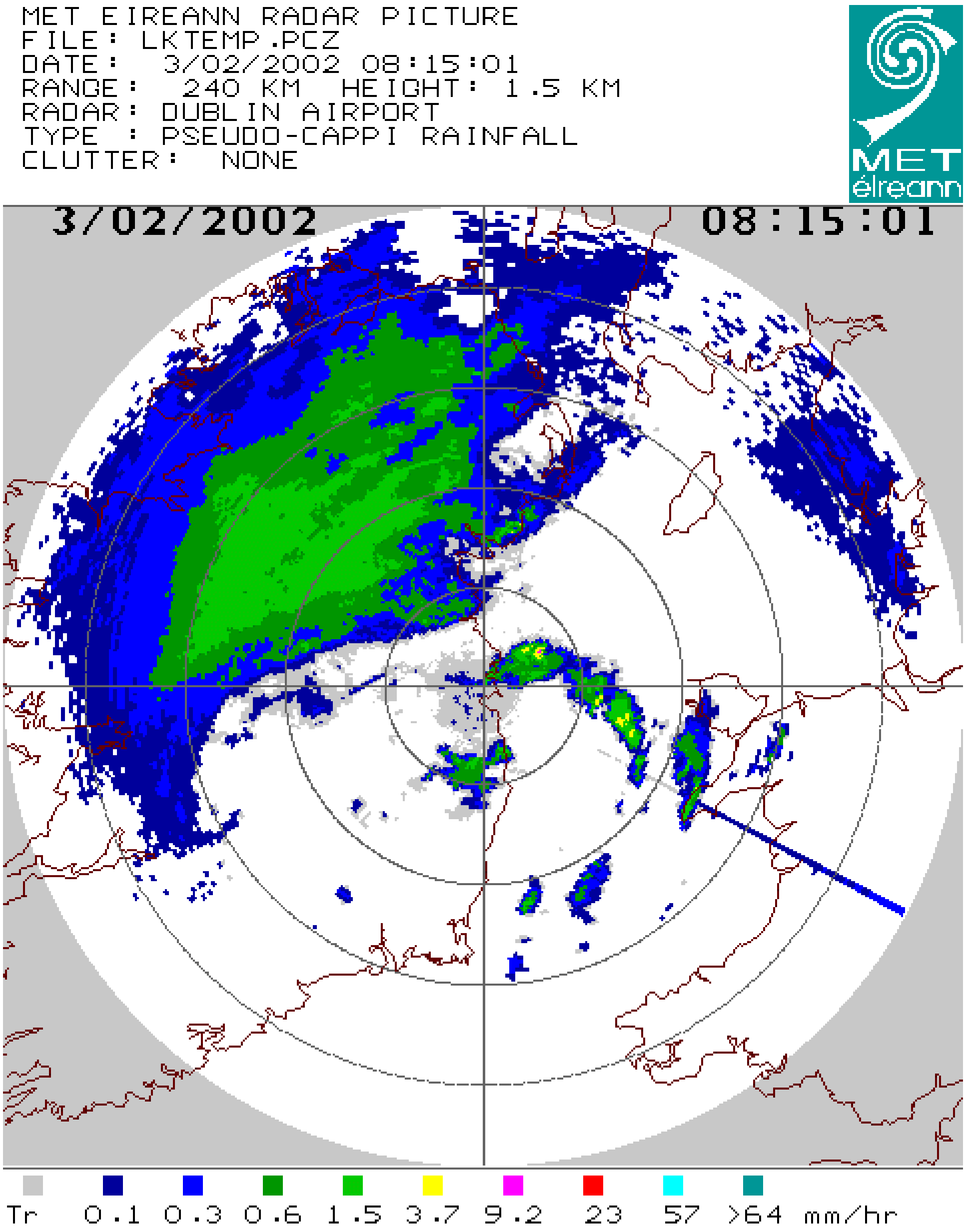
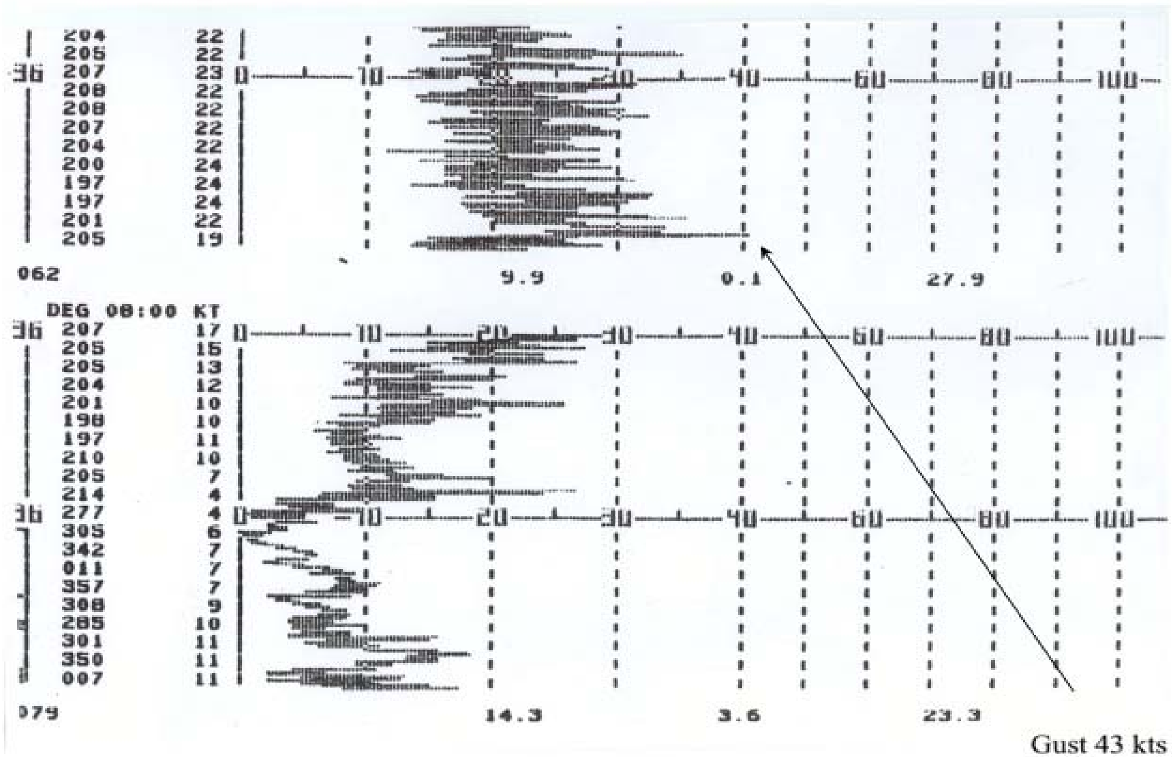
APPENDIX D(b)


MET EIREANN RADAR PICTURE
FILE: LKTEMP.PCZ
DATE: 3/02/2002 08:15:01
RANGE: 240 KM HEIGHT: 1.5 KM
RADAR: DUBLIN AIRPORT
TYPE : PSEUDO-CAPPI RAINFALL
CLUTTER: NONE
MET éireann
3/02/2002
08:15:01
Tr 0.1 0.3 0.6 1.5 3.7 9.2 23 57 >64 mm/hr

Appendix E



Gust 43 kts at about
08.04:45-50 hours

Main Anemometer Trace
Dublin Airport 3 February 2002

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Appendix F

Defining Average-Wind and Gust[19]

Wind direction and velocity are sampled every second.

The wind profile is averaged over the last 2-minute period to provide the ATIS or tower reported average-wind. The average wind is available to the controller on a display terminal. The wind profile is also observed over the last 10-minute period, the maximum (peak) wind value recorded during this period defines the gust value.

ICAO considers that wind is gusty only if the 10-minute peak value exceeds the 2-minute average-wind by 10 KT or more, however gust values lower than 10 KT are often provided by airport weather services.

Figure 1 below shows a 10-minute wind profile featuring:

- A 2-minute average wind of 15 KT; and,
- A 10-minute gust of 10 KT (i.e., a 25 KT peak wind velocity during the 10-minute period).

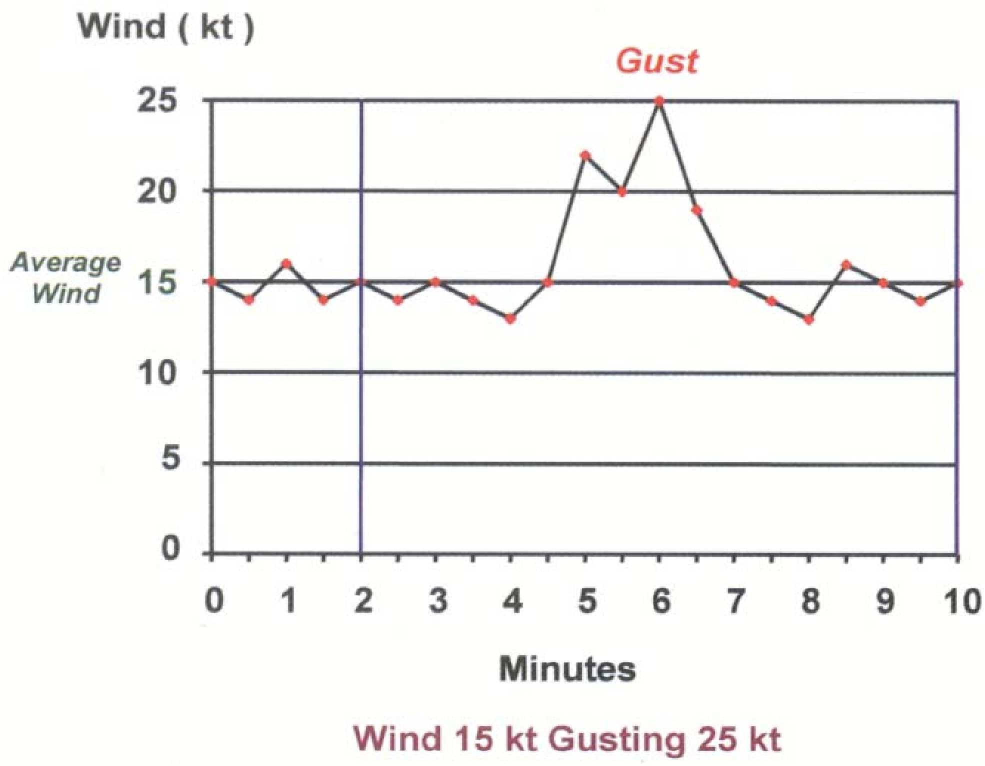

Figure 1

[19] Material reproduced from publication "Getting to grips with Approach and Landing Accident Reduction", with kind permission of Airbus Industrie and the Flight Safety Foundation.

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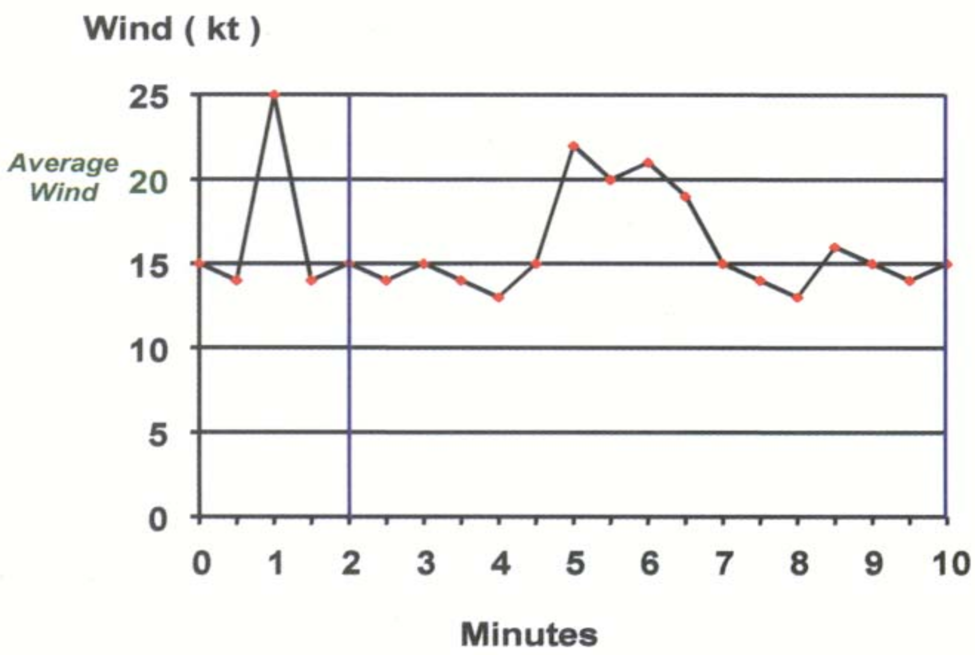
If the wind peak value is observed during the last 2-minute period, the gust becomes part of the average wind, as illustrated by Figure 2.



Wind 20 kt Gusting 25 kt (*)

Figure 2

(*) : or no reference to gust if the 5-kt gust is not accounted for.

Average-wind and gust values displayed to the controller are refreshed every minute. The 2-minute average-wind and the 10-minute gust are used by ATC for:

- ATIS messages;
- Wind information on Ground, Tower, Approach and Information frequencies.

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METAR observation messages include a 10-minute average-wind and the 10-minute gust, as illustrated by Figure 3 (XXX is the wind direction, referenced to the true north).

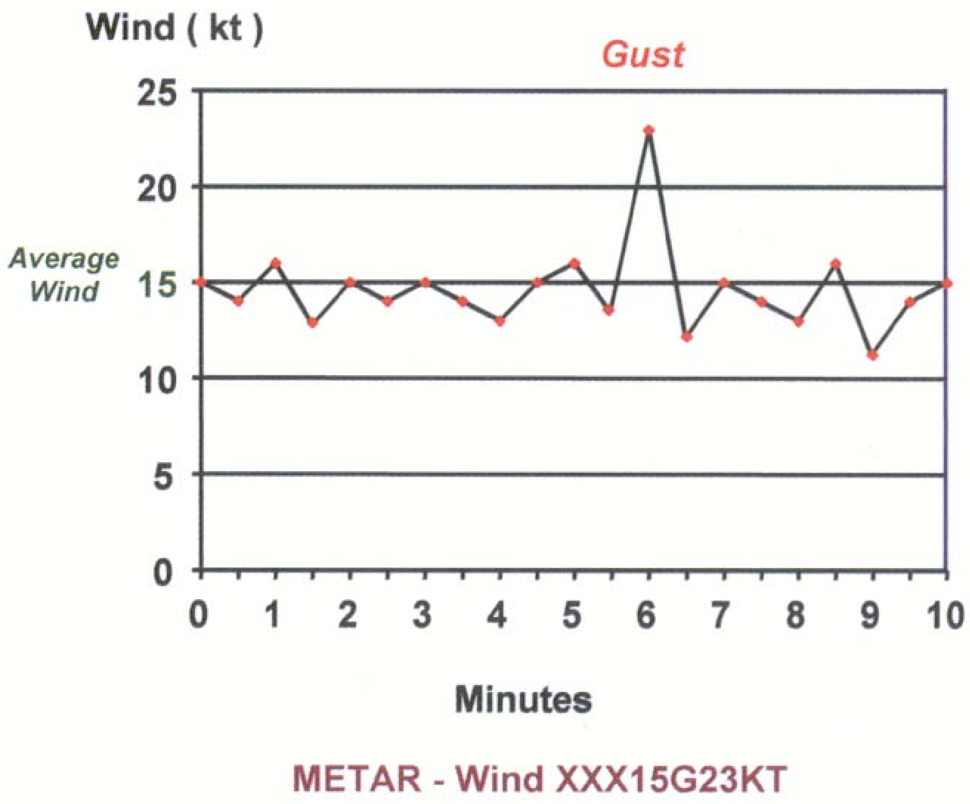

Figure 3

In summary

The METAR wind is a 10-minute-average wind.
The ATIS or tower average wind is a 2-minute-average wind.
The ATIS or tower gust is the peak value during the last 10-minute period.
The ATIS message is updated only if the wind direction changes by more than 30-degrees of if the wind velocity changes by more than 5-KT over a 5-minute time period.

Appendix G

Defining the Runway Surface Condition

The International Civil Aviation Organisation (ICAO)

ICAO Annex 14 Aerodrome Design and Operations, Volume 1, Chapter 2 Para 2.9.4, defines the runway surface condition as follows:

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.

The European Joint Aviation Authority (JAA)

The JAA defines runway condition as follows:

Dry Runway:

A dry runway is "one that is neither wet nor contaminated. This "includes paved runways that have been specially prepared with grooved or porous pavement and maintained to retain an effectively dry braking action, even when moisture is present".

Damp Runway:

A runway is considered damp "when the surface is not dry, but when moisture on the surface does not give a shiny appearance".

Wet Runway:

A runway is considered to be wet "when the surface is covered with water, or equivalent, not exceeding 3 mm – or when there is sufficient moisture on the runway surface to cause it to appear reflective (shiny) – but without significant areas of standing water".

Contaminated Runway:

A runway is considered to be contaminated, "when more than 25% of the runway surface (whether in isolated areas or not) – within the required length and width being used – is covered by either:

- *Standing water, more than 3 mm deep;*
- *Slush (i.e., water saturated with snow) or loose snow, equivalent to 3 mm – or more – of water;*
- *Snow which has been compressed into a solid mass which resists further compression and will hold together or break into lumps if packed up (i.e., compacted snow); or,*
- ***Ice, including wet ice contaminant (runway friction coefficient 0.05 or below)".***

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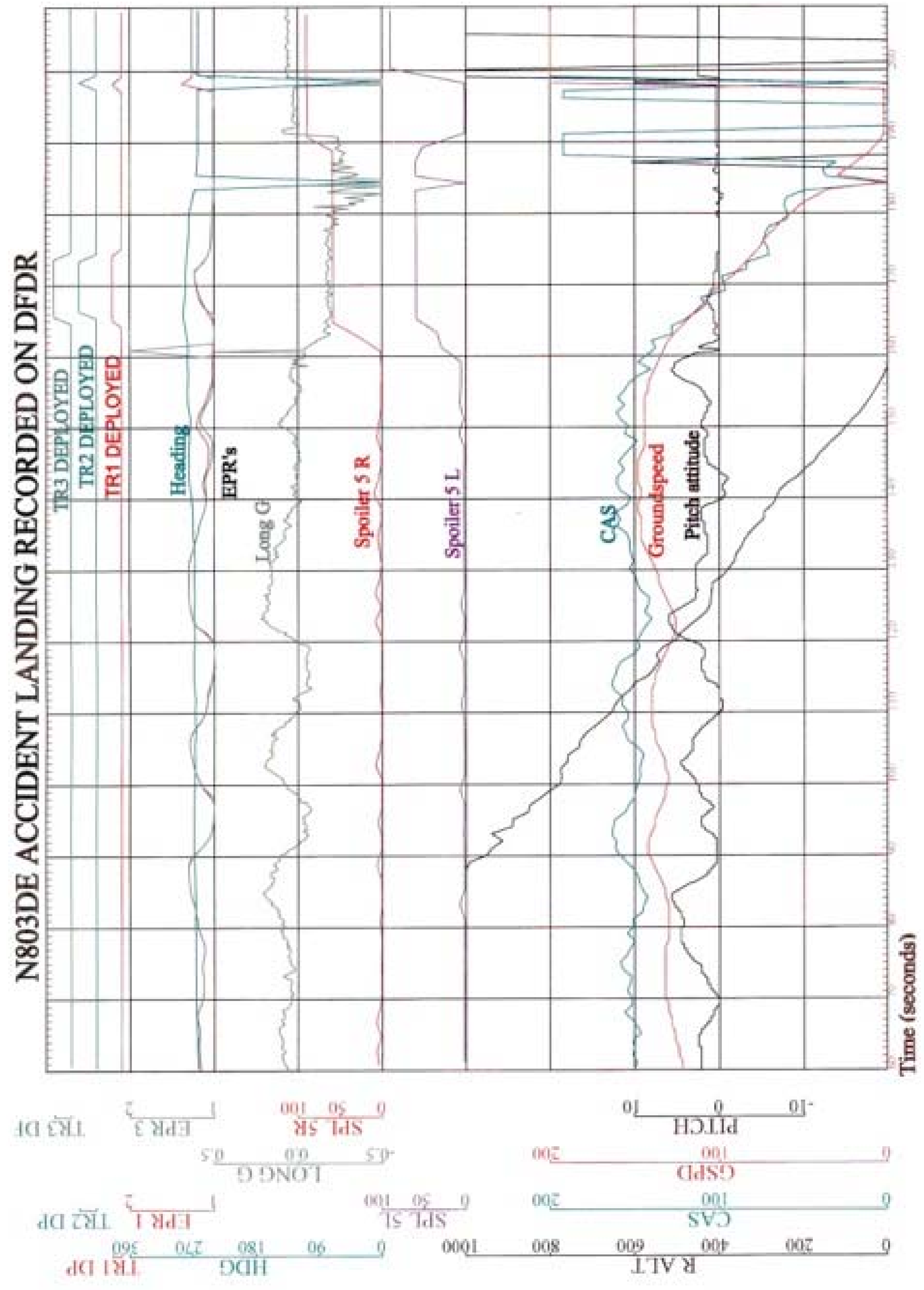
N803DE ACCIDENT LANDING RECORDED ON DFDR
TR3 DEPLOYED
TR2 DEPLOYED
TR1 DEPLOYED
Heading
EPR's
Long G
Spoiler 5 R
Spoiler 5 L
CAS
Groundspeed
Pitch attitude
Time (seconds)
TR3 DP
EPR 3
SPL 5R
PITCH
LONG G
GSPD
TR2 DP
EPR 1
SPL 5L
CAS
TR1 DP
HDG
R ALT

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Appendix I

Airport Authority Emergency Response Directive No 3 (Chapter 2, Extract)

The following specific extracts from this Directive are considered relevant to this Investigation:

Types of Emergencies

2.1. Emergencies involving Aircraft.

The aircraft Commander or ATS will decide which category applies.

AIRCRAFT IN DISTRESS

- *Where an accident has occurred, is about to occur or is considered to be unavoidable.*

AIRCRAFT EMERGENCY

- *When the operating efficiency of an aircraft is seriously impaired and the possibility of an accident is considered to exist.*

AIRCRAFT ALERT

- *Where the operating efficiency of an aircraft is impaired, but not to the extent that an accident is considered likely.*
- *Where the norms of safety and standards have been contravened but will not have serious consequence.*

Emergency Response (Chapter 3, Extract)

The response to an Emergency is dictated by:

- *Number of people involved*
- *Extent of casualties and injuries or potential casualties and injuries*
- *Damage or potential damage to property and/or infrastructure*

Discretion must be used at all times regarding the scale of the response and, if time allows all major decisions should be taken in consultation.

The response can be categorised as:

- *Full Scale Response*
- *Full Standby Response*
- *Alert Response*

3.1. Full Emergency Response

The following is a description of a full emergency response, which typically has three phases:

- *Immediate Response*
- *Support Response*
- *Crisis Management and Recovery*

3.1.1. Immediate Response (Extract)

Phase 1, Para 3.1.1 deals mainly with the fire and rescue services response.

At Para 3.1.6, the Directive makes reference to an Emergency Operations Centre:

In situations involving aircraft accidents or emergencies, the Operations and Duty Offices will be used as the Emergency Operations Centre, to coordinate the Support Response and to handle communications to and from the Incident Control Unit (Mobile Unit at site). A senior representative of the airline/handling agent involved may go to the Emergency Operations Centre, from where transport to the Incident Control Unit will be arranged, if applicable.

3.2. Phase 2, Support Response (Extract)

The DAM will be responsible for coordinating the Support Response and, in the case of aircraft accidents, will liaise with the airline or handling agent who will put their own emergency response plan into action to deal with the crisis.

The following facilities will be put in place:

3.2.1. Survivor Reception (North Terminal)

This is where casualties, who have not been brought directly to hospital, and survivors are brought. Medical aid will be given and personal details will be noted. Staff from the cleaning Section will set up the area according to local procedures.

3.2.2. Meeters and Greeters

As soon as possible, a representative of the airline or handling agent will go to the Information Desk, in order to handle the Meeters and Greeters.

*Persons meeting the flight will be assembled there and escorted to the Meeters and Greeters area where they will be given information on the situation and their details will be taken. Noel's Bistro will be set up for this purpose and may be supplemented by Meeters and Greeters and Reconciliation facilities at the (*Name withheld*) Hotel at Dublin Airport if the scale of the accident/incident demands and/or on the direction of the DAM, the Garda Síochána or the airline representative.*

3.2.3. Reconciliation

*As survivors are matched up with friends and family, they may be reconciled in either the Execair facility, adjacent to the North Terminal or in the (*Name withheld*) Hotel at Dublin Airport.*

3.2.4. Temporary Morgue

If necessary the DAM will arrange for a temporary morgue (Hanger 1) or other facilities as required and/or dictated by the State Pathologist to be set up. The Airfield Operatives will assist in setting up this area, according to local procedures.

Appendix J

The International Civil Aviation Organization (ICAO)

Annex 3, Meteorological Service for International Air Navigation, Chapter 4, Meteorological Observations and Reports - Extract

4.5 - Observing and Reporting Surface Wind

4.5.1 Recommendation. – *The mean direction and the mean speed of the surface wind should be measured, as well as significant variations of the wind direction and speed. Since, in practice, the surface wind cannot be measured directly on the runway, surface wind observations for take-off and landing should be the best practicable indication of the winds, which an aircraft will encounter during take-off and landing.*

4.5.5 Recommendation. – *The averaging period for wind observations should be:*

a) 10 minutes for reports in METAR/SPECI code forms, except that when the 10-minute period includes a marked discontinuity in the wind direction and/or speed, only data occurring since the discontinuity should be used obtaining mean values, hence the time interval in these circumstances should be correspondingly reduced, and
b) 2 minutes for local routine and special reports and for wind indicators in air traffic services units

Note. – A marked discontinuity occurs when there is an abrupt and sustained change in wind direction of 30º or more, with a wind speed of 10 KT before or after the change, or a change in wind speed of 10 KT or more, lasting at least 2 minutes.

4.5.6 Recommendation. – *In local routine and special reports, variations in the wind direction should be given if the local variation is 60º or more; such directional variations should be expressed as the two extreme directions between which the wind has varied during the past 10 minutes. Variations from the mean wind speed (gusts) during the past 10 minutes should be reported only when the variation from the mean speed is 10 KT or more; such speed variations (gusts) should be expressed as the maximum and minimum speeds attained.*

When the 10-minute period includes a marked discontinuity in the wind direction and/or speed, only variations in direction and speed occurring since the discontinuity should be reported. The variations in direction and speed should be derived:

a) for non-automated systems from the wind direction and speed indicators or from the anemograph recorder trace if available; and/or
***b)** for automated systems from the actual measured values of wind direction and speed, and not from the 2-minute and 10-minute running averages required under* **4.5.5.**

Annex 14, Aerodromes, Volume 1, Aerodrome Design and Operation, Chapter 9, Emergency and Other Services - Extract

Aerodrome Emergency Planning (Section 9.1).

General

Introductory Note*.- Aerodrome emergency planning is the process of preparing an aerodrome to cope with an emergency occurring at the aerodrome or in its vicinity. The objective of aerodrome emergency planning is to minimize the effects of an emergency, particularly, in respect of saving lives and maintaining aircraft operations. The aerodrome emergency plan sets forth the procedures for coordinating the response of different aerodrome agencies (or services) and of those agencies in the surrounding community that could be of assistance in responding to the emergency. Guidance material to assist the appropriate authority in establishing aerodrome emergency planning is given in the* Airport Services Manual, Part 7.

9.1.1 An aerodrome plan shall be established at an aerodrome, commensurate with the aircraft operations and other activities conducted at the aerodrome.

9.1.2 The aerodrome emergency plan shall provide for the coordination of the actions to be taken in an emergency occurring at an aerodrome or in its vicinity.

Note:- Examples of emergencies are: aircraft emergencies, sabotage including bomb threats, unlawfully seized aircraft, dangerous goods occurrences, building fires and natural disasters.

9.1.3 The plan shall coordinate the response or participation of all existing agencies, which, in the opinion of their appropriate authority, could be of assistance in responding to an emergency.

Note:- Examples of agencies are:

- *On the aerodrome: air traffic control unit, rescue and fire fighting services, aerodrome administration, medical and ambulance services, aircraft operators, security services, and police;*

- *Off the aerodrome: fire departments, police, medical and ambulance services,*
hospitals, military, and harbour patrol or coast guard.

9.1.4 Recommendation.– *The plan should provide for cooperation and coordination with the rescue coordination centre, as necessary.*

9.1.5 Recommendation.– *The aerodrome emergency plan document should include at least the following:*

(a) types of emergencies planned for;

(b) *agencies involved in the plan;*
(c) *responsibility and role of each agency, the emergency operations centre and the command post, for each type of emergency;*
(d) *information on names and telephone numbers of offices or people to be contacted in the case of a particular emergency; and*
(e) *a grid map of the aerodrome and its immediate vicinity.*

9.1.6 *The plan shall observe Human Factors principles to ensure optimum response by all existing agencies participating in emergency operations.*

Note:– Guidance material on Human Factors principles can be found in the Human Factors Training Manual.

Emergency Operations Centre and Command Post -Extract

9.1.7 Recommendation. – *A fixed emergency operations centre and mobile command post should be available for use during an emergency.*

9.1.8 Recommendation. – *The emergency operations centre should be a part of the aerodrome facilities and should be responsible for the overall coordination and general direction of the response to an emergency.*

9.1.9 Recommendation. – *A person should be assigned to assume control of the emergency operations centre and, when appropriate, another person in the command post.*

Response Time - Extract

9.2.21 (Standard). - *The operational objective of the rescue and fire fighting service shall be to achieve a response time not exceeding three minutes to any point of each operational runway, in optimum visibility and surface conditions.*

9.2.22 Recommendation. - *The operational objective of the rescue and fire fighting service shall be to achieve a response time not exceeding two minutes to any point of each operational runway, in optimum visibility and surface conditions.*

Communications and Alerting Systems - Extract

9.2.31 Recommendation. – *A discrete communications system should be provided linking a fire station with the control tower, any other fire station on the aerodrome and the rescue and fire fighting vehicles.*

Disabled Aircraft Removal -Extract

9.3.1 Recommendation. – *A plan for the removal of an aircraft disabled on, or adjacent to, the movement area should be established for an aerodrome, and a coordinator designated to implement the plan, when necessary.*

9.3.2 Recommendation. – *The disabled aircraft removal plan should be based on the characteristics of the aircraft that may normally be expected to operate at the aerodrome, and include among other things:*

a) a list of equipment and personnel on, or in the vicinity of, the aerodrome which would be available for such purpose: and
b) arrangements for the rapid receipt of aircraft recovery equipment kits available from other aerodromes.

ICAO Airport Services Manual Part 7, Airport Emergency Planning

Care of Ambulatory Survivors, Chapter 10 - Extract

10.1 General

10.1.1 *The Airport Authority, aircraft operator (where involved), or other pre-designated agency selected for the purpose is responsible to:*

(a) select the most suitable holding area for the particular emergency from those pre-designated in the airport emergency plan;
(b) provide for the transportation of the uninjured from the accident site to the designated holding area;
(c) arrange for doctor(s), nurse(s) or teams qualified in first aid to examine and treat the supposedly uninjured, especially for nervous traumatism (shock) and/or smoke inhalation, where pertinent;
(d) furnish a full passenger and crew manifest for accountability purposes;
(e) interview the uninjured and record their names, addresses, phone numbers, and where they can be reached for the next 72 hours;
(f) notify relatives or next of kin where deemed necessary;
(g) co-ordinate efforts with the designated international relief agency (Red Cross, etc); and
(h) prevent interference by unauthorized persons or those not officially connected with the operation in progress.

10.1.2 *Pre-arrangement should be made for the immediate transportation by bus or other suitable transport of the "walking injured" ambulatory from the accident site to the designated holding area. This plan should be implemented automatically following notification of the emergency. A nurse or a person trained in first aid should accompany these people to the holding area.*

10.1.3 *Each and every passenger and crewmember should be examined for nervous traumatism (shock) and smoke inhalation. Cold or inclement weather may require additional provisions for their protection and comfort.*

10.1.4 *Occupants departing an aircraft using evacuation slides may be barefoot or without proper wearing apparel. Where the aircraft accident occurred in water or a marshy area, these people may be wet and uncomfortable.*

10.1.5 *These problems should be anticipated by having supplies of clothing, footwear, and blankets readily available. It may be necessary to establish a special holding area, which can supply warmth and clothing to prevent hypothermia, and be used for examination purposes, before these persons are transported to the designated ambulatory holding area.*

Care of Fatalities, Chapter 11 - Extract

11.1.8 *Accidents, which result in a large number of fatalities, will overload normal morgue facilities. In areas where delay or temperature may contribute to the deterioration of tissue, refrigerated storage should be made available. This may be provided either by a permanently located cooler or refrigerated semi-trailers. The area for post-mortem examination should be located near the refrigerated storage and be arranged to provide a high level of security. This should be suitable working area with electricity and running water, large enough for initial body sorting*

11.1.9 *The morgue should be isolated and in an area remote from places where relatives or the general public have access.*

Airport Emergency Exercises, Chapter 13 - Extract

13.1.1 *The purpose of an airport emergency exercise is to ensure the adequacy of the following:*

31. *response of all personnel involved:*
32. *emergency plans and procedures; and*
33. *emergency equipment and communications*

13.1.2 *It is therefore important for the plan to contain procedures requiring that the airport emergency plan be tested. This test should correct as many deficiencies as possible and familiarize all personnel and agencies concerned with the airport environment, the other agencies and their role in the emergency plan.*

13.2.1 *There are three methods of testing the airport emergency plan:*

(a) Full-scale exercises;
(b) Partial exercises; and
(c) Tabletop exercises.

13.2.2 *These tests shall be conducted on the following schedule:*

Full-scale: At least once every two years;

Partial: At least once each year that a full-scale exercise is not held or as required to maintain proficiency;

Tabletop: At least once each six months, except during that six-month period when a full-scale exercise is held.

Airport Medical Care Facilities (Medical Clinic and/or First-aid Room) Appendix 3 - Extract

28. *General factors influencing need. There are many general factors, which influence the need for an airport first-aid room or an airport medical clinic. Factors to be taken into consideration include:*

 a) *the number of passengers served annually and the number of employees based on the airport;*

 b) *the industrial activity on the airport property and in the surrounding community;*

 c) *the distance from adequate medical facilities; and*

 d) *mutual aid medical services agreements.*

29. *Generally, it may be recommended that an airport medical clinic be available when the airport employee's number 1000 or more and that a first-aid room be available at every airport. The airport medical care or first-aid room personnel and facilities should be integrated with the airport emergency plan.*

30. *The airport medical clinic, in addition to providing emergency medical care to the airport population, may extend emergency care to communities surrounding the airport, if these communities have no emergency facilities of their own.*

31. *The airport medical clinic may be included in the community emergency services organization and planning. In the event of a large-scale non-airport local emergency, the airport medical clinic may function as the co-ordination site for direction of incoming medical assistance.*

32. *Location of airport medical care facilities. The facilities should be readily accessible to the airport terminal building, to the general public and to emergency transportation equipment (i.e. ambulances, helicopters, etc.) Site selection should avoid the problem of having to move injured persons through congested areas of the airport terminal building, while providing access to the facility by emergency vehicles by a route that as far as is feasible can bypass normal public access roadways to and from the airport. This suggests that the medical care facility be located so that access can be gained from the Airside of the airport terminal building as this provides control over unauthorized vehicles interfering with emergency equipment*

33. *Airport medical care facility personnel. The number of trained personnel and degree of expertise needed by each individual, will depend on the particular airport's requirements. The staff of the airport medical clinic should form the nucleus for the medical services planning for the airport emergency plan (and be responsible for implementation of the medical portion of the plan). It is recommended that the airport first-aid room be staffed with at least highly qualified first-aid personnel.*

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