Air Accident Investigation Unit Ireland

FACTUAL REPORT

ACCIDENT

Boeing, 737-8AS, EI-DWE & EI-DYA

Taxiway LINK 2/F1, Dublin Airport, Ireland

1 April 2015

An Roinn Iompair Turasóireachta agus Spóirt

Department of Transport, Tourism and Sport

Foreword

This safety investigation is exclusively of a technical nature and the Final Report reflects the determination of the AAIU regarding the circumstances of this occurrence and its probable causes.

In accordance with the provisions of Annex 13[1] to the Convention on International Civil Aviation, Regulation (EU) No 996/2010[2] and Statutory Instrument No. 460 of 2009[3], safety investigations are in no case concerned with apportioning blame or liability. They are independent of, separate from and without prejudice to any judicial or administrative proceedings to apportion blame or liability. The sole objective of this safety investigation and Final Report is the prevention of accidents and incidents.

Accordingly, it is inappropriate that AAIU Reports should be used to assign fault or blame or determine liability, since neither the safety investigation nor the reporting process has been undertaken for that purpose.

Extracts from this Report may be published providing that the source is acknowledged, the material is accurately reproduced and that it is not used in a derogatory or misleading context.

[1] **Annex 13**: International Civil Aviation Organization (ICAO), Annex 13, Aircraft Accident and Incident Investigation.
[2] **Regulation (EU) No 996/2010** of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation.
[3] **Statutory Instrument (SI) No. 460 of 2009**: Air Navigation (Notification and Investigation of Accidents, Serious Incidents and Incidents) Regulations 2009.

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In accordance with Annex 13 to the Convention on International Civil Aviation, Regulation (EU) No 996/2010 and the provisions of SI 460 of 2009, the Chief Inspector of Air Accidents on 1 April 2015, appointed Mr Howard Hughes as the Investigator-in-Charge to carry out an Investigation into this Accident and prepare a Report.

Aircraft Type and Registration:	(1) Boeing, 737-8AS, EI- DWE (2) Boeing, 737-8AS, EI- DYA
No. and Type of Engines:	2 x CFM56-7 on each aircraft
Aircraft Serial Number:	(1) 36074 (2) 33631
Year of Manufacture:	(1) 2007 (2) 2008
Date and Time (UTC[4]):	1 April 2015 @ 06.25 hrs
Location:	Intersection Taxiway LINK 2 and F1, Dublin Airport
Type of Operation:	Commercial Air Transport
Persons on Board:	(1) Crew - 6 Passengers - 170 (2) Crew - 6 Passengers - 88
Injuries:	Crew - Nil Passengers - Nil (On either aircraft)
Nature of Damage:	(1) Substantial damage to starboard elevator (2) Substantial damaged to tip of port winglet
Commanders' Licence:	(1) ATPL[5] issued by the Irish Aviation Authority (IAA) (2) ATPL issued by the IAA
Commanders' Details:	(1) Male, aged 25 years (2) Male, aged 62 years
Commanders' Flying Experience:	(1) 3,744 hours, of which 3,523 were on type (2) 17,044 hours, of which 10,044 were on type
Notification Source:	Dublin Air Traffic Control (ATC)
Information Source:	AAIU Field Investigation, AAIU Report Forms submitted by Flight Crews of both aircraft

[4] **UTC:** Coordinated Universal Time. On the day of the event, local time = UTC + 1 hour.
[5] **ATPL:** Airline Transport Pilot Licence.

SYNOPSIS

A Boeing 737-8AS, registration EI-DWE, was stationary on Taxiway LINK 2 at the entrance to Taxiway F1 awaiting sequenced departure off Runway 28 at Dublin Airport. A second Boeing 737-8AS, registration EI-DYA, which was following EI-DWE, commenced a right turn on LINK 2, towards Taxiway A to hold short of Runway 34, during which the tip of its port winglet struck the starboard elevator of EI-DWE. The winglet of EI-DYA and the elevator of EI-DWE were substantially damaged. There were no injuries.

PREAMBLE

On 7 October 2014, a collision occurred at the same location at EIDW, in which the winglet of a B737-8AS struck the elevator of another B737-8AS. That accident was investigated by the AAIU, and a report was published. The report, AAIU Report No. 2015-019, can be viewed on the AAIU website.

The accident of 1 April 2015 occurred whilst the previous investigation was still on-going. Following publication of AAIU Report 2015-019 a number of safety actions were taken by the parties involved. Therefore, due to the nature of this event, its similarities to the accident on 7 October 2014, and the actions already taken, this Factual Report should be read in conjunction with Report No. 2015-019. Furthermore, Report No. 2015-019 contains a number of Safety Recommendations which are also pertinent to this event.

3

1. FACTUAL INFORMATION

1.1 History of the Flight

At the time of the occurrence Dual Runway Operations were in progress from Runway (RWY) 28 and RWY 34 at Dublin Airport (EIDW) (**See Section 1.5.3**). The prevailing conditions were daylight, with good visibility and no precipitation. A schematic of the airfield areas relevant to the collision is presented at **Figure No. 1** below.

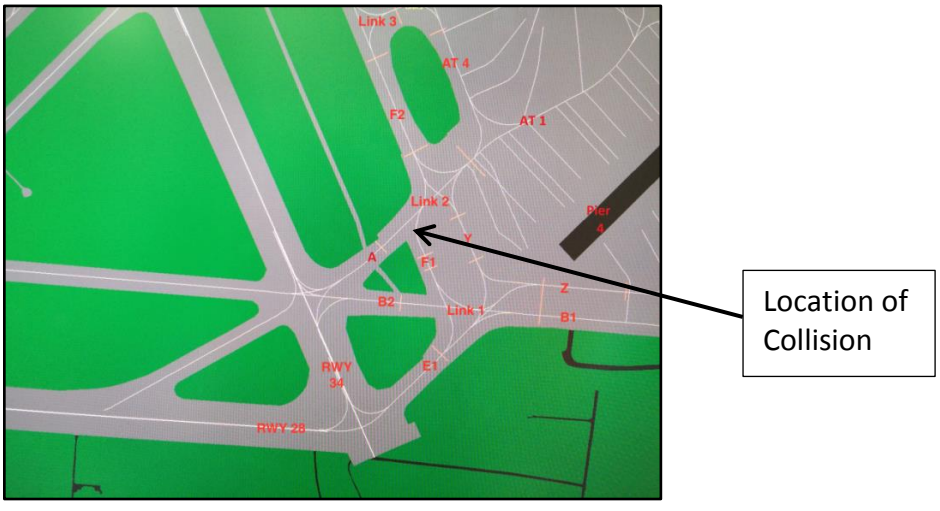

Figure No. 1: Schematic of part of EIDW movement area.

As is normal practice, on both aircraft the Commander was seated in the left-hand pilot's seat and was the handling pilot for taxiing the aircraft.

In line with Dual Runway Operations, as part of its departure clearance, each aircraft was allocated a departure runway subject to its departure routing and performance capability. EI-DWE with a planned destination of Zadar Airport, Croatia (LDZD) was allocated RWY 28, and EI-DYA, with a planned destination of Edinburgh (EGPH), was allocated RWY 34.

The stand location of each aircraft, and the push-back sequence, meant that EI-DWE was ahead of EI-DYA when they called for taxi clearance. The controller of EIDW Clearance Delivery Service (CDS) cleared both aircraft to taxi, in sequence, as far as the Central Apron, and to hold short of taxiway (TWY) P1. From TWY P1, both aircraft came under the control of the Surface Movement Controller (SMC), who then cleared them from the Central Apron, via the TWYs F3 and F2 to hold short of TWY LINK 2.

EI-DWE was then cleared by the SMC to cross TWY LINK 2, onto TWY F1, to hold short of TWY LINK 1. The aircraft was stopped with its nose just inside TWY F1, and the parking brake was set.

Once EI-DWE had commenced taxi from TWY F2 onto TWY LINK 2, the SMC instructed EI-DYA to turn right and taxi onto TWY A and to hold short RWY 34. The SMC advised caution concerning wingtip clearance, and the taxi clearance was subject to the aircraft ahead (EI-DWE). As EI-DYA turned right onto LINK 2 and taxied towards TWY A, the leading edge of the port side winglet struck the outer portion of the starboard elevator of the stationary aircraft EI-DWE. Upon realising that physical contact had been made with the other aircraft, the Commander of EI-DYA stopped the aircraft and set the parking brake to assess the situation.

The flight crew of EI-DWE, on sensing movement of their aircraft, initially thought it was as a result of a problem with the left main gear. However, it soon became apparent to them that their aircraft may have been struck by another aircraft. EI-DWE then advised the SMC, *"Ground* […] *we seem to have had contact with that* [aircraft] *that's* […] *holding at alpha".* This transmission may have been partially blocked as the SMC thought it came from EI-DYA, and asked EI-DYA for clarification. EI-DYA confirmed with the SMC that they did make contact with the other aircraft. The SMC instructed all traffic on his frequency to stand-by. He then asked his Air Data Assistant to inform the Emergency Services that a ground collision had taken place. He then proceeded to coordinate the emergency vehicles deploying to the location of the collision.

The Commander of each aircraft briefed the respective cabin crews on the situation and made announcements explaining to the passengers what had happened and directed them to remain seated. The Commander of EI-DYA started the APU[6] in order to supply power to the aircraft systems, and air conditioning for the cabin. He then shut down both aircraft engines.

[6] **APU**: Auxiliary Power Unit; a small turbine engine (usually located in the tail of an aircraft), used to supply electrical and pneumatic power.

As the Commander of EI-DWE was unsure of the extent of the damage to the rear of his aircraft, he decided that it would be prudent not to attempt to start the APU. Initially, EI-DWE remained in position with both engines running and the Commander asked ATC if they could see what damage had occurred. The SMC replied *"I don't have visual at the moment"*, but advised that the rescue services were in attendance and would be in contact with the aircraft shortly. On arrival at the scene, emergency vehicle 'Rescue 2' requested EI-DWE to shut down both engines. The Commander of EI-DWE complied with this request. Without engines or APU to supply electrical power, EI-DWE was left on battery power only. The Commander therefore elected not to deploy the aircraft airstairs[7], and asked for mobile steps to be brought to the aircraft forward Passenger door.

A decision was made to disembark the passengers, and when buses became available the passengers of both aircraft were returned to the departures area. The flight crew and cabin crew of both aircraft remained in their respective aircraft to await arrival of the AAIU.

The airport emergency services provided emergency cover until the aircraft were released by the Investigation (10.30 hrs) following which both aircraft were towed to maintenance hangars 1 and 2.

1.2 On-site Investigation

1.2.1 Position of Aircraft

Two Inspectors of Air Accidents arrived on site approximately one hour after the occurrence.

5

A site survey was carried out, mapping the location of each aircraft as found, post collision. From the measurements taken, the position of the aircraft at time of collision was also determined. A brief description of the location of the aircraft is given in this section. A more detailed description of the location of the aircraft, at impact, and post impact, is given in **Appendix A**.

The first aircraft, EI-DWE, was found in its original parked position on LINK 2 with the nose wheels approximately 3.3 metres (m) short of the northern Intermediate Holding Position Marker (IHPM), delineating the start of TWY F1, with its nose tip protruding slightly into TWY F1 (**Figure No. 2**). The nose wheels were approximately 0.2 m left of the taxiway centreline.

The second aircraft, EI-DYA, was found a short distance (approximately 5 m) from its first point of contact with EI-DWE. The aircraft was positioned over the inbound STOPBAR lights for TWY Alpha/LINK 2 and was approximately 12.2 m short of the IHPM between LINK 2 and TWY Alpha. The nose wheels were approximately 0.7 m to the right of the taxiway centreline (**Figure No. 2**).

[7] The integral passenger steps of the B737, also called 'Airstairs', are electrically operated and the decision to use mobile steps was in order to conserve aircraft battery power.

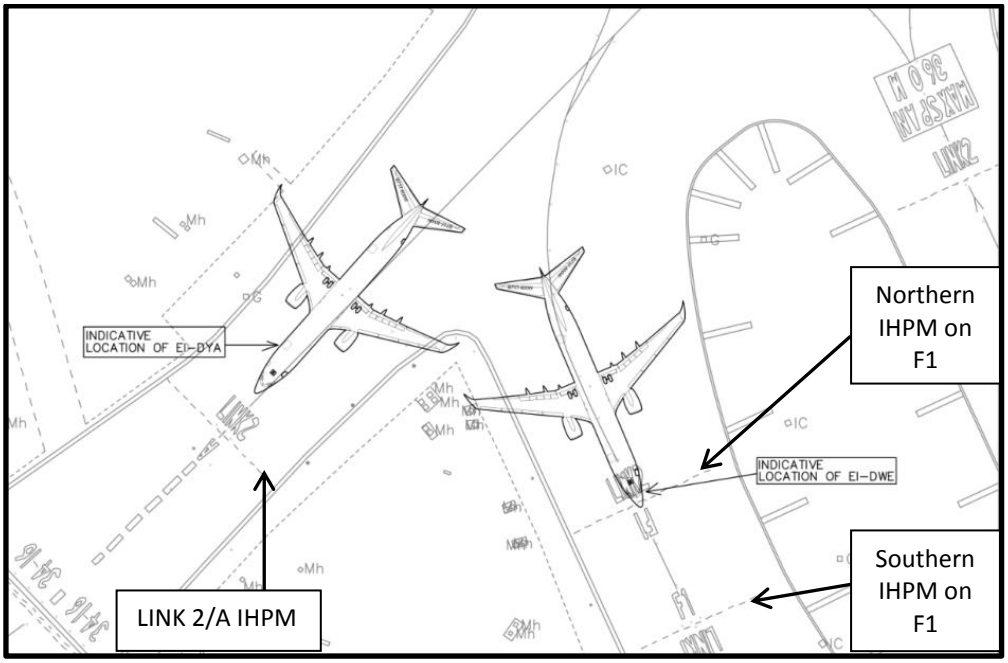

Figure No. 2: Final position of both aircraft, post impact

1.2.2 Injuries

No injuries were reported to the Investigation.

1.2.3 Damage to Aircraft

The tip section of the port side winglet of EI-DYA struck the outer portion of the starboard elevator of EI-DWE, causing substantial damage to the elevator. As EI-DYA continued forward, the tip then sheared from the main part of the winglet once it had reached the hinge point of the elevator of EI-DWE. The underside of the horizontal stabilizer of EI-DWE suffered scuff and scrape marks on its lower surface, as a result of the stub of the winglet remaining in contact with the aircraft structure as EI-DYA continued forward. Both the winglet of EI-DYA and elevator of EI-DWE were subsequently replaced.

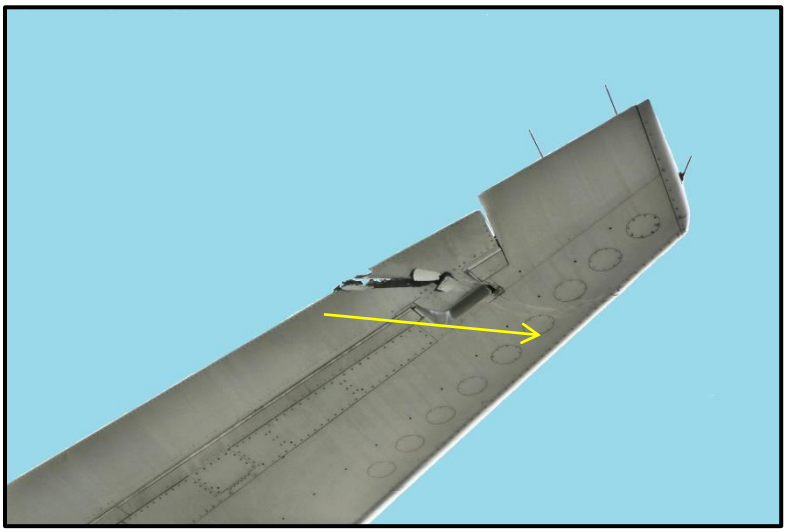

Photo No. 1: Underside of right elevator of EI-DWE showing damage and scuff marks. Arrow indicates direction of travel of EI-DYA's Winglet.

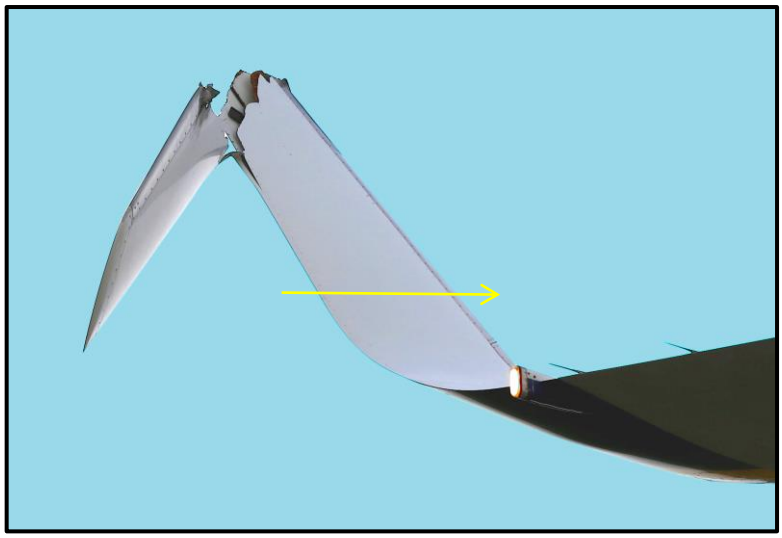

Photo No. 2: Left Winglet of EI-DYA showing damage to top section. Arrow indicates direction of travel.

1.2.4 Meteorology

Weather conditions at the time of the event were reported as:

Surface wind:	260°/18 kts
Visibility:	10 km or more
Cloud:	Few 1200 ft and Broken at 20,000 ft
Environmental:	Daylight conditions. No precipitation.

1.3 Interviews and Reports

1.3.1 General

Shortly after the event, the crew members of each aircraft were interviewed by an AAIU Inspector, on board their respective aircraft.

The Cabin Crew on both aircraft were seated at their take-off positions and therefore did not see the collision. However, when interviewed, they did confirm the post-collision actions and communications made to the cabin by the Flight Crew of their respective aircraft.

The statements from the Co-Pilots confirmed the sequence of events, actions and communications for both aircraft. Therefore, the following sections deal solely with the Commanders' reports/statements for each aircraft, and the statement from the SMC.

1.3.2 Commander of EI-DWE

The aircraft Commander of EI-DWE held a valid ATPL. He was issued with a valid Class 1 medical which carried no endorsements. He stated that he followed ATC clearances, firstly, under control from EIDW Clearance Delivery Service (CDS), to taxi from stand onto TWY F-Outer to hold short of LINK 5. At this point, he told the Investigation, they were transferred to EIDW Surface Movement Controller (SMC), and received onward instructions to taxi along the Foxtrot taxiways and hold short of LINK 2. He stated he was then cleared by the SMC to taxi to F1 and to hold short of LINK 1. He recalled that there was one item of traffic on TWY E1, and one on B1. He informed the Investigation that he taxied onto TWY F1 and brought the aircraft to a stop and set the parking brake, at a position where he could see the dashed yellow line ahead, between TWYs F1 and LINK 1. (Note this is the dashed yellow line, labelled as '*Southern IHPM on F1'*, shown in **Figure No. 2**).

He told the Investigation that he felt a sudden movement, which he initially thought was caused by a problem with the left main landing gear. But discussion with his Co-Pilot, who saw the other aircraft after it had passed behind them, suggested that they had been struck from behind. The Commander of EI-DWE stated that his Co-Pilot informed ATC that they may have had contact with the aircraft behind them. The Commander then made a public address (PA) to the passengers, telling them to remain seated, and that they would receive further information as soon as possible. The Commander asked the Co-Pilot to request a damage report from ATC. The SMC informed EI-DWE that he could not see if there was damage from his position, but that the Emergency Services had been deployed and they would be able to assist. The Commander of EI-DWE stated he elected not to the start the aircraft's APU because of possible damage to the tail area. Consequently, the engines of EI-DWE remained running in order to supply electrical power and air conditioning to the aircraft. However, when the Emergency Services arrived, they requested that EI-DWE shut down its engines, so that they could assess the situation. The Commander of EI-DWE complied with this request.

The Commander reported no injuries to persons on board. The passengers disembarked through the front portside door and mobile steps onto buses, shortly after the occurrence. He and his crew then awaited the arrival of the AAIU.

1.3.3 Commander of EI-DYA

The Commander of EI-DYA held a valid ATPL. He was issued with a valid Class 1 medical which carried one endorsement, requiring the use of Corrective Lenses for near vision. There was no endorsement for distance vision.

The Commander informed the Investigation that the duty was the second one of '*a block of earlies'* and that he was well rested and fit for duty. He stated that push back was normal, and that weather and visibility were ok. He told the Investigation that he was '*number two, behind the other aircraft',* (EI-DWE) and that he followed it to TWY F2 under ATC clearance. Shortly after EI-DWE was cleared to TWY F1, he stated that he was cleared to taxi via TWY LINK 2, to TWY A, to hold short of RWY 34. He was aware of the aircraft ahead on TWY F1. He also stated that he was instructed to taxi towards TWY A *'when sufficient clearance was available'*.

He saw the other aircraft stopped ahead at F1 and stated that he brought his aircraft to a halt during the turn onto taxiway LINK 2. He said he then looked at his wing tip through the left rear cockpit window, to judge what clearance was required, and considered that there was sufficient room. The Commander informed the Investigation that as he taxied past EI-DWE his gaze was directed forward so as not to breach the RWY 34 holding point. As he continued taxi towards TWY A, he felt a jolt and said to his Co-Pilot that their aircraft had hit the other aircraft. He set the parking brake and tried to advise ATC. However, his first transmission may have been partially blocked as he heard EI-DWE calling to inform ATC that they may have had contact with the other aircraft behind. ATC called EI-DYA, and the Commander confirmed that they had made contact with EI-DWE. A PA was made to the passengers to advise them what had happened, and to remain seated. The Commander instructed the Cabin Crew to keep the aircraft doors closed and the escape slides armed until further instructed, and to ensure the passengers remain seated.

The APU was started, and the engines were shut down. The Commander stated that the emergency services checked both aircraft on arrival and reported to the Flight Crew of each aircraft. Once buses arrived at the aircraft, the passengers deplaned using the airstairs. The Commander confirmed that there were no injuries to persons on board. He and his crew then awaited the arrival of the AAIU.

1.3.4 Surface Movements Controller (SMC)

The SMC, who had a valid licence, was on an overtime duty. He stated he was well rested and fit for duty. The event occurred approximately one hour after he commenced duty.

When describing the operations leading up to the event the SMC stated that he considered it *'had been moderately busy'*, with normal traffic levels for that time of day.

He stated that the two aircraft involved had been handed over to him by the CDS at LINK 5/P1 and he had cleared them both along the Foxtrot TWYs to F2, to hold short of LINK 2.

He then cleared EI-DWE to taxi to F1 to hold short LINK 1, as there was traffic on TWY E1. Once he observed that EI-DWE was moving, he cleared EI-DYA to taxi onto LINK 2, TWY A, to hold short of RWY 34. The SMC stated that this was a conditional clearance, and he cautioned EI-DYA about wing tip clearance, and the presence of the aircraft ahead. He stated that issuing a conditional clearance was now a requirement under an instruction issued in December 2014, following a previous ground collision that year (see **Section 1.6.2**).

The SMC stated that on each occasion that he gave a clearance he first made visual contact with the aircraft or vehicle. However, he noted that the distance from the control tower to the location of the accident was approximately 1 km, and therefore he could not provide visual separation between aircraft. He also stated that the ASMGCS[8], which gives controllers pertinent information about aircraft on the ground, including position and speed, was only used by controllers to give gross separation and not absolute separation of aircraft.

[8] **ASMGCS:** Advanced Surface Movement Guidance and Control System.

The SMC became aware of the collision when the flight crew of EI-DWE reported on frequency that they may have had contact with the aircraft on TWY A. This was confirmed to him by the flight crew of the other aircraft (EI-DYA). He then instructed all aircraft on his frequency to stand by. He briefed the CDS and AMC[9] controllers on the situation, and told his Air Data Assistant to call the Emergency Services to inform them that a ground collision had occurred on TWY A.

The first emergency vehicle to report on frequency was Rescue 2, and the SMC gave it clearance and instructions to proceed to the location of the collision, along with the other emergency vehicles that had deployed in response to the event. The SMC stated that in accordance with procedures, in the absence of a report of reduced cover from the Fire Service, full Category-9 Fire Cover[10] was deemed to be available throughout the event, and therefore aircraft movements at EIDW could continue.

1.4 Aircraft Recorders

After the occurrence, the Flight Data Recorder (FDR) and the Cockpit Voice Recorder (CVR) on each aircraft were preserved by the Flight Crew. All four recorders were subsequently impounded by the Investigation and were successfully downloaded at the AAIU facilities.

The data from the FDRs and CVRs confirmed the version of events, as provided to the Investigation by the Flight Crew of both aircraft, and the SMC.

The FDR for EI-DWE confirmed that the aircraft was stationary, with the parking brake set at the time of impact.

The FDR data from EI-DYA was examined in detail from the time the aircraft left TWY F2, until it came to a stop on TWY LINK 2 after the accident. The data shows that the aircraft moved forward onto LINK 2 at 7 kts, and commenced a right turn towards TWY A. Before the turn towards TWY A was completed, the aircraft came to a halt on a magnetic heading of 225^0. The aircraft remained stationary in this position for 9 seconds before continuing towards TWY A. Prior to the collision the aircraft was recorded as taxiing at a groundspeed of 6 kts.

1.5 Aerodrome Information

1.5.1 Control Tower

The control tower, in which both the CDS and the SMC were located, is approximately 1 km northwest of LINK 2 where the collision took place.

1.5.2 Taxiway F1

At the time of the occurrence, TWY F1 was a short taxiway, connecting TWYs LINK 2 to LINK 1. It was not aligned with TWY F2, its centreline being approximately 43 m southwest of that of TWY F2. TWY Y ran parallel to, and approximately 71 m northeast of TWY F1.

[9] **AMC**: Air Movements Controller, also known as 'Tower'.
[10] The Fire Category number is the minimum required to continue flight operations at an Airport based on the largest aircraft size expected to operate into the airport.

It was bounded at both ends by an IHPM, one between TWYs F1 and LINK 1, and one between TWYs F1 and LINK 2. TWY F1 was 20 m in length. Any aircraft with a fuselage length greater than 20 m would overhang the limits of TWY F1. This Investigation and the previous Investigation, found that pilots from a number of operators often stopped their aircraft some distance back from the IHPM between TWY F1 and LINK 1 in order to keep the IHPM in full view and to ensure their aircraft did not infringe taxiway LINK 1 ahead. Consequently, the rear of their aircraft may protrude significantly into LINK 2.

1.5.3 Dual Runway Operations

In order to maximise aircraft movements during early morning operations at EIDW, when RWY 28 is active, departures may also take place from RWY 34 for medium and light wake turbulence category aircraft on routes to the East, North East, North West and West. Aircraft on routes to the South, South West and South East can depart from RWY 28. When both RWYs 28 and 34 are in use, this is known as Dual Runway Operations.

During Dual Runway Operations, aircraft using RWY 34 are expected to depart from the intersection with TWY ALPHA without a back-track. Aircraft unable to comply with this limitation will depart from RWY 28. Dual Runway Operations are subject to suitable meteorological conditions and ASMGCS serviceability.

1.6 Regulations

1.6.1 Irish Rules of the Air

In line with all other EU Member States, Ireland has introduced the Single European Rules of the Air (SERA) legislation (EU 923/2012). The legislation came into effect on Thursday, 4th December 2014. SERA definitions include the following:

*30. '**air traffic control service'** means a service provided for the purpose of:*
(a) preventing collisions:
(1) between aircraft; and
(2) on the manoeuvring area between aircraft and obstructions; and
(b) expediting and maintaining an orderly flow of air traffic;

*131. '**traffic avoidance advice'** means an advice provided by an air traffic services unit specifying manoeuvres to assist a pilot to avoid a collision;*

Section 3 of SERA *'General rules and collision avoidance',* chapter 2 *'Avoidance of collisions',* SERA.3201 states

> *"Nothing in this Regulation shall relieve the pilot-in-command of an aircraft from the responsibility of taking such action, including collision avoidance manoeuvres based on resolution advisories provided by ACAS equipment, as will best avert collision".*

Rule SERA.3205, *'Proximity'*, goes on to state:

"An aircraft shall not be operated in such proximity to other aircraft as to create a collision hazard".

Section 7 of the regulations, *'Air Traffic Services'*, under rule SERA.7001, *'General – Objectives of the air traffic services'* states:

The objectives of the air traffic services shall be to:
(a) prevent collisions between aircraft;
(b) prevent collisions between aircraft on the manoeuvring area and obstructions on that area;
(c) expedite and maintain an orderly flow of air traffic;
(d) provide advice and information useful for the safe and efficient conduct of flights;

1.6.2 Aeronautical Information Publication (AIP) Ireland

Section 2.20 of the AIP, which is published by the IAA, gives specific information to Pilots and Controllers in relation to operating at Dublin Airport. This section includes guidance and requirements when taxiing in the vicinity of TWY F1.

Following the previous ground collision in October 2014, a subgroup of the DAOPG[11] was set up to review taxiing operations at EIDW. The subgroup proposed the introduction of additional instructions to be issued to pilots when taxiing in a queuing scenario[12]. The proposed changes were approved by the IAA-SRD. Pending publication of the revised instructions in the AIP, EIDW Air Traffic Services (ATS) received the amended text as AON[13] 084-14, which came into effect on 22 December 2014.

Amongst the suggested changes to AIP 2.20 included in AON No. 084-14, was the addition of text to the restrictions pertaining to TWY F1. The additional text included the requirement for controllers to issue a caution to pilots with respect to wing tip clearance and traffic ahead, when taxiing between TWY A and LINK 2 / TWY F2 or vice versa, when a queuing scenario was in place. The additional text, as it pertains to TWY F1, is shown in **Appendix B.**

1.7 Human Factors

1.7.1 View of Wingtip from Cockpit

The subject event occurred at the same taxiway location and involved the same aircraft type as the accident referred to in AAIU Report No. 2015-019.

The Investigation notes that the research conducted as part of the investigation into the accident of October 2014 identified that that there are a number of factors that compromise the human eye's ability to accurately determine the clearance between objects at distances greater than 6 m. These factors are reproduced in **Appendix C.** The report also states:

[11] **DAOPG**: Dublin Airport Operations Planning Group
[12] A queuing scenario is in place when traffic is using TWY A for RWY 34, and TWY E1 for RWY 28
[13] **AON**: ATS Operations Notice

Specific to judging distances, when viewing objects, the eye tends to be drawn to angular changes, edges and corners which help the observer define the outline of an object and gauge its orientation and distance. The eye is also drawn to areas of high contrast or colour change. Specific to the wingtip structure in this occurrence, as the surface presented to the pilot does not project at a sharp angle from the wing, but evolves from a blended curve into an upright structure, it presents further difficulties in terms of depth perception. Furthermore, the eye may be drawn to wing features with relief/contrast, such as the navigation light and extended leading edge slats, which are up to 1.5 m closer to the pilot than the winglet tip.

Additionally, the upright portion of the winglet angles outwards from the wing, and is swept back from the pilot's view, compounding the difficulty. The fact that the other aircraft was presented to the Commander at an obtuse angle would have further complicated his ability to judge separation accurately.

1.7.2 Other Taxiing Scenarios

The Investigation also notes that flight crew are frequently required to taxi their aircraft in close proximity to other aircraft and objects on airport ramp areas designed for aircraft parking. On these occasions the aircraft are either under the guidance of marshalling personnel, or the area in which the aircraft is manoeuvring is marked with guidance lines and signage; all of which assist the pilot in determining if his/her aircraft is clear of other obstructions.

1.8 Safety Actions

1.8.1 Safety Actions Taken Following 7 October 2014 Accident

Following the accident in the same taxiway location on 7 October 2014 the following action was taken:

1. A subgroup of DAOPG was established to review taxiway safety in the vicinity of TWYs A, B2, F1, F2, Y and Z.

2. Following this review, the IAA-SRD[14] approved the issuing of AON No. 084-14 which instructed ATC controllers to issue caution advice to pilots in relation to traffic ahead and wingtip clearance, when taxiing aircraft in a "Queuing Scenario".

3. The Operator circulated information to its pilots through a number of channels highlighting the potential of wingtip related events.

[14] **IAA-SRD**: Irish Aviation Authority – Safety Regulation Division

1.8.2 Safety Actions Taken Following this Accident

Notwithstanding the safety actions taken following the previous event, this accident occurred in the same location at EIDW. Subsequently, the following safety actions took place:

1. The IAA-SRD issued a directive withdrawing TWYs A and B2 from service. (This action restricted Dual Runway Operations at EIDW to a single common taxiway access to both runways via TWY E1). This was a temporary action pending a review of taxiway operations.

2. Following on from 1 above, the subgroup of the DAOPG continued to review all aspects of operations in the vicinity of TWYs A and B2 and proposed additional measures required to facilitate safe operations. The review established that maintaining situational awareness for pilots should be a priority in future amendments. A number of options to achieve this were evaluated, and a final action list produced. The list of actions required by the various responsible parties, to highlight wingtip clearance to pilots, is included as a table in **Appendix D**. The review group recommended the reopening of TWYs A and B2. Permission to reopen these taxiways was issued by the IAA-SRD on 26 June 2015, and operations on the taxiways commenced on 1 July 2015.

3. The Operator advised the Investigation that the following actions were also carried out:

    - *Information pertaining to Ground Collisions (G COL) included in all presentations by Base Captains to ATC Units at their respective bases, including details of this particular event.*
    - *G COL presentation (Ground damage during taxi with the introduction of winglets) to be part of Annual Roadshow rolled out across all bases commencing April 2015.*
    - *The Operators risk model on G COL was updated following this occurrence, including escalation factor during night time operations with glare from lighting equipment.*
    - *Safety Bulletin published on pilot crew dock highlighting a brief synopsis of the occurrence.*
    - *Safety Office published de-identified base investigation and made available to all staff.*
    - *Memo issued re 'Wingtips – Caution when parking'.*

4. The Airport Authority commenced a program of works in the area of TWY's F2 and F1. This included the realignment of these taxiways and the addition of signage warning pilots of wingtip clearance. Work was completed on 18 August 2015 (see **Appendix E**).

In addition to the safety actions taken in **Sections 1.8.1** and **1.8.2**, the Airport Authority also informed the Investigation of the following planned actions:

- Implementation of the AAIU recommendation to undertake a critical review of the taxiway system is currently being scoped and will commence later in 2016 (AAIU Safety Recommendation IRLD2015017 refers).

- The campus taxiway re-designation plan is to be implemented as part of the apron and taxiway upgrade projects in the course of the next three years (AAIU Safety Recommendation IRLD2012005 refers).

2. AAIU COMMENT

2.1 Responsibility of ATC and Pilot in Command

An ATC service, whilst providing an expeditious flow of traffic, must do so in a manner that prevents collisions between aircraft and obstructions. However, the Investigation notes that collision avoidance is ultimately the responsibility of the aircraft commander.

In this case, ATC gave clear instructions relating to traffic ahead of EI-DYA, and issued a caution regarding wingtip clearance. This was acknowledged by the Flight Crew of EI-DYA. These instructions were in line with the procedures outlined AON No. 084-14.

The Investigation notes that the Commander of EI-DYA brought his aircraft to a halt as he manoeuvred onto LINK 2, in order to assess the clearance between his aircraft and the aircraft ahead. Believing that sufficient clearance was available, the Commander commenced taxi towards TWY A.

2.2 Assessment of Wingtip Clearance

As outlined in **Section 1.7.2**, pilots are frequently required to operate their aircraft in close proximity to other aircraft during parking manoeuvres. Generally, these manoeuvres are conducted under the guidance of marshalling staff and/or ramp markings. Consequently, it is possible that frequent exposure to close quarter manoeuvring such as this may generate a level of overconfidence amongst pilots leading them to believe that they can judge wingtip clearance accurately.

The investigation into the October 2014 accident identified that, physiologically, it is not possible for the human eye to accurately judge absolute distances greater than 6 m. Furthermore, relative distance between objects is difficult to judge unless certain criteria relating to 'Relative Size', 'Overlapping', and 'Moving Parallax' are satisfied (see **Appendix C**). Specific to the winglets on this aircraft type, the investigation into the October 2014 accident also noted that the winglets evolve from the wing in a blended curve and are angled outward from the wing, and swept back from the pilot's view. These factors may further contribute to difficulties in accurately judging wingtip clearance.

Therefore, regardless of experience, there is a risk that pilots, in attempting to judge the distance between their aircraft and other objects when manoeuvring at close quarters, without additional guidance, may lose separation, resulting in collision.

2.3 Improvement Works to Taxiway F1

At the time of this accident and the accident of October 2014, TWYs F2 and F1 were not aligned. Consequently, an aircraft stopped at the entrance to TWY F1, would have presented its tail to approaching aircraft on LINK 2, at an obtuse angle, possibly contributing to the visual impression that there was sufficient room to manoeuvre behind it. In addition to the non-alignment of TWYs F2 and F1, the location of TWY Y just to the northeast of TWY F1 added a level of complexity to this portion of the movement area of EIDW. The complexity of this area has been the subject of previous AAIU reports and Safety Recommendations.

The Investigation notes the Airport Authority's realignment of TWYs F2 and F1, and the removal of TWY Y. This should reduce the complexity of the taxiways in this area of the airport. The Investigation further notes the addition of signage in the area warning pilots to be mindful of wingtip clearance.

Appendix A
Location of Aircraft at collision and post collision

The first aircraft, EI-DWE, was found in its original parked position on LINK 2 with the nose wheels approximately 3.3 m aft of the northern Intermediate Holding Position Marker (IHPM), delineating the start of TWY F1 and with its nose tip protruding slightly into TWY F-1 (**Figure No. 3**). The nose wheel(s) were approximately 0.2 m left of the taxiway centreline. The left hand main wheels were approximately 3.3 m to the left side of the taxiway centreline, and the right hand main wheels were approximately 1.1 m to the right of the centreline as the aircraft tracked to complete the turn onto the centreline.

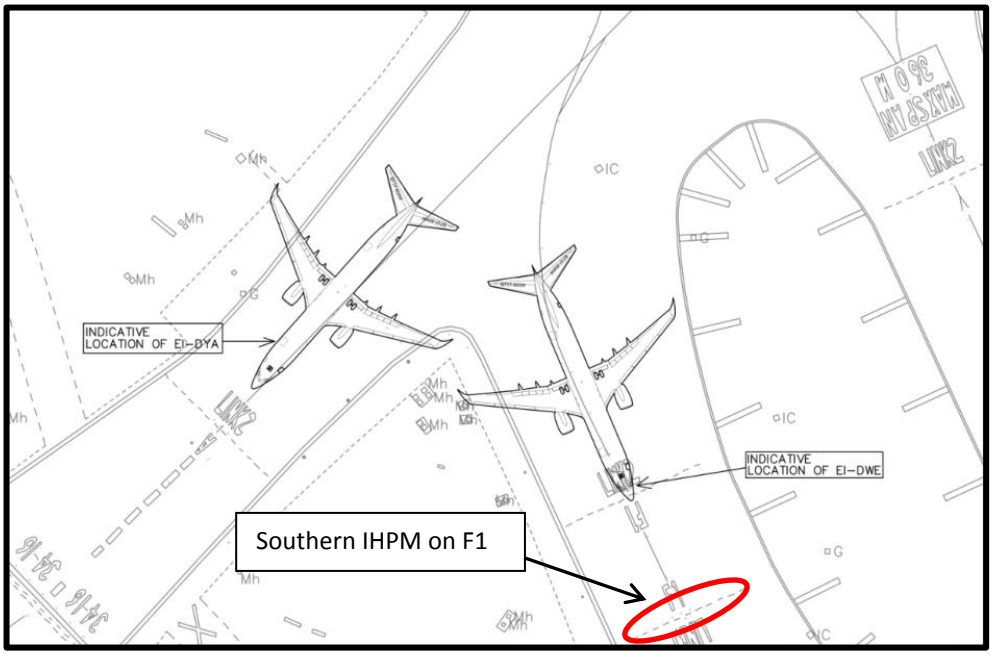

Figure No. 3: Approximate final position of both aircraft post collision

The second aircraft, EI-DYA, was found a short distance (approximately 5 m) from its first point of contact with EI-DWE. The aircraft was positioned over the inbound STOPBAR lights for TWY Alpha/LINK 2 and was approximately 12.2 m short of the marked demarcation line between LINK 2 and TWY Alpha. The nose wheel(s) were approximately 0.7 m to the right of the taxiway centreline. The right hand main wheels were approximately 4 m to the right of the taxiway centreline, whereas the left hand main wheels were approximately 0.5 m to the left of the centreline.

Figure No. 4 depicts, for indicative purposes only, the approximate position of both aircraft at the time of collision.

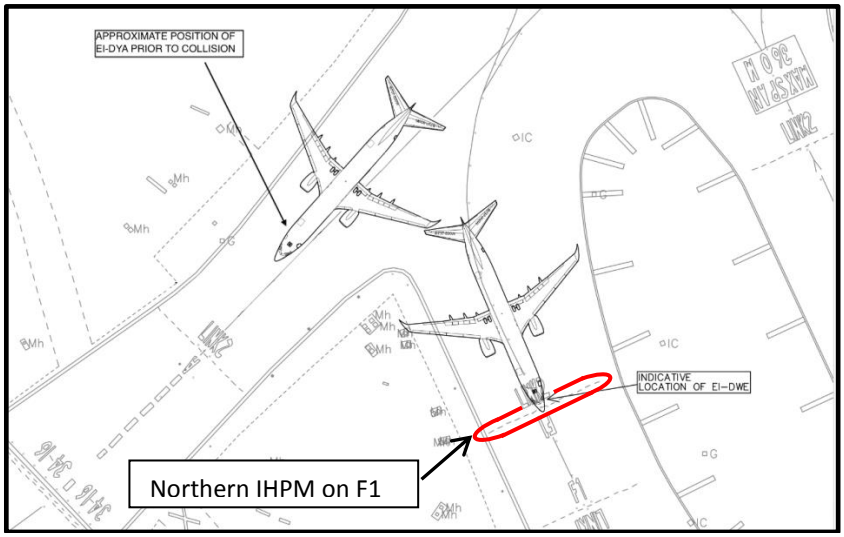

Figure No. 4: Approximate position of both aircraft at collision

Figure No. 5 shows the disposition of EI-DWE relative to TWY LINK 2. The centreline of the aircraft was at an angle of 70° to the southern edge of TWY LINK 2. Consequently, the tip of the left-hand elevator was just over 19 m beyond the taxiway centreline of LINK 2. This placed the elevator approximately 7.3 m beyond the southern edge of TWY LINK 2. This would have been sufficient for a B737-8AS to pass. Due to the geometry of the empennage, the tip of the right-hand elevator was approximately 13.5 m beyond the centreline, and therefore only approximately 1.7 m beyond the southern edge of TWY LINK 2. This would not have been sufficient for a B737-8AS to pass.

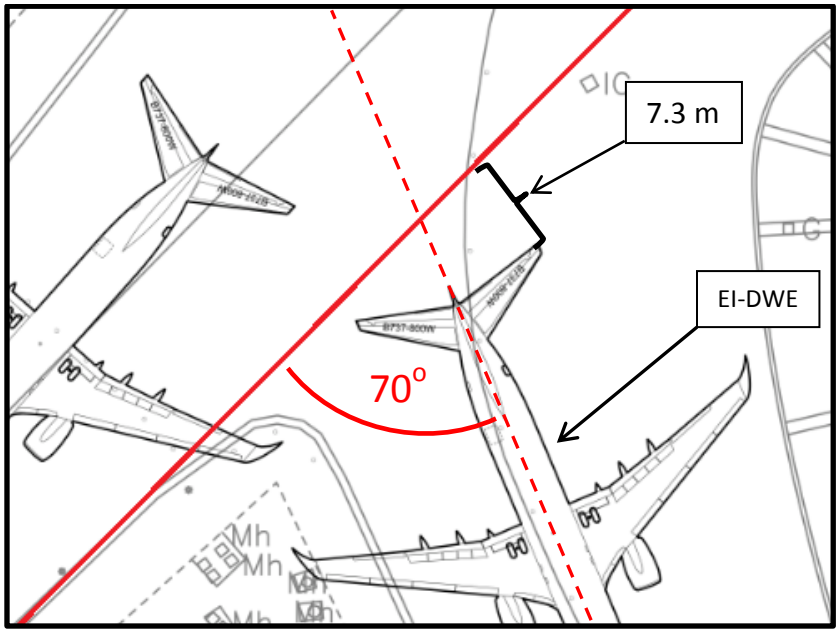

Figure No. 5: Geometry of Empennage of EI-DWE relative to TWY A

Appendix B
AON 084-14

ATS Operations Notice (AON) No. 084-14

Following the previous ground collision in the TWY LINK 2/F1 area in October 2014, which was the subject of AAIU Report No. 2015-019, a subgroup of the DAOPG involving the IAA, DAA, and airlines was established to clarify and refine the AIP section *'EIDW AD 2.20'* (see also **Section 1.6.2**). It was envisaged that this review would take a number of months, but in the interim a change to this AIP section, approved by the IAA-SRD was issued to EIDW Air Traffic Services. It took the form of AON No. 084-14 and came into effect on the 22 December 2014.

Amongst the changes was the requirement for Air Traffic Services to issue cautions with respect to wingtip clearance and traffic ahead. When and where the issuing of a caution should apply was published as additional text to the table in AIP EIDW 2.20 section 1.3 'Taxiing Restrictions'. An extract of the amended table, showing the additional text pertaining to TWY F1 is shown below and highlighted in yellow.

Location	AIP RESTRICTION	FREE-FLOWING SITUATION	QUEUING SCENARIO DIFFERENCE
TWY F1	Aircraft travelling towards LINK 1 / TWY B1 / TWY E1 holding on TWY F1	Aircraft movement not permitted between TWY A and LINK 2/ TWY F2 or vice versa	Caution must be issued to pilots when taxiing between TWY A and LINK 2 / TWY F2 or vice versa
TWY F1	Aircraft travelling towards LINK 2 / TWY F2 holding on TWY F1	Aircraft movement not permitted between TWYs B1 and B2 or vice versa or between TWY E1 and TWY B1 / TWY Y / TWY Z or vice versa	Caution must be issued to pilots when taxiing between TWYs B1 and B2 or vice versa or between TWY E1 and TWY B1 / TWY Y / TWY Z or vice versa

Table No. 1: Extract from AON 084-14

Appendix C
Human Factors - Depth Perception

Humans gauge depth and distance by obtaining visual cues from the observed environment and then interpreting these cues to form a judgement of distance. The sources of visual cues can be divided into binocular and monocular.

With binocular vision, because the eyes are 50-60 mm apart, they each receive a different image of the same object on their respective retina. As each eye moves and focuses on the object, the brain uses a combination of the muscle tone of lens accommodation and eyeball convergence to obtain an indication of depth. The merging of the images from each eye and changes in muscle tone are used to form a three-dimensional picture of the environment.

This process is known as Stereopsis. However, it is less useful when objects are far away because the images on the retina become more similar with increasing distance. Ernsting's Aviation Medicine states: *"The brain considers optical infinity to be anything more than 6 m away from the observer, and so accommodation and eyeball convergence are limited to within a 6 m range".* It goes on to say "*Binocular cues of stereopsis mediate the perception of relative distance, i.e. one object is in front or behind another, at distances of up to about 60 m but are only of value for the perception of the absolute distance of objects that are about 10 m or less away from the observer*". For stereopsis to work, both eyes must have an un-obscured view.

There are a number of monocular cues including:

- Relative Size: The relative size of an object projected on the retina. For this to be a useful cue requires the knowledge of the size of the object from previous experience. Then the brain can gauge the distance based on the size of the object on the retina.

- Overlapping: A more distant object will appear partially hidden by a nearer object.

- Moving Parallax: When the head is moved from side to side, objects that are close appear to move more rapidly than objects that are further away. A similar effect occurs when an observer views objects from a moving vehicle.

"Overlapping" and "Moving Parallax", when used in conjunction, can give a good indication of the relative positions of two objects, but motion is required, and the objects being judged must be one behind the other for this technique to be effective.

Appendix D
DAOPG Safety Case Parameters to Highlight Wingtip Clearance Awareness to Pilots

Item	Actions	Responsible Parties
New Signage	New signage is required on the airfield in the area at F2 and A warning flight crew of wingtip clearance in the area.	daa
ATIS Broadcast	The EIDW ATIS broadcast would be amended to include a caution re wingtip clearance in the area.	ATC
Enhanced Hotspot communication	Ground Taxi charts for Dublin (AIP and associated Jeppessen and Lido publications) would be amended to highlight areas where particular care by flight crew re wingtip clearance is required.	daa/Base Carriers
Airline SOPS	Communications with airline operators at Dublin on apron and procedure change would be required including Base Carriers to issue enhanced SOPs	Base Carriers
Safety Campaign	Run Safety Poster Campaign focussing on Wingtip collision hazard	daa
Wingtip Clearance responsibility	Reinforce that Wingtip responsibility is the responsibility of the Pilot and that Wingtip clearance is not assured with ATC clearances or if taxiing on the yellow line	Base Carriers
AIP	Application of existing AIP restrictions as outlined in Table 1.3.	All
TWY Alpha	Restricted for dual runway operations and for base carriers only.	daa/ATC
TWYB2	TWY B2 to operate for In bound operations only and to remain closed during dual runway operation	daa/ATC

Table No. 2: Actions required to highlight wingtip clearance to pilots

Appendix E
Taxiway F1 Realignment

Figure No. 6, below, is an extract from EIDW Aircraft Parking/Docking Chart published in the Irish Integrated Aeronautical Information Package dated 12 November 2015, showing new location of taxiway F1. Text pertaining to Hotspot HS1 includes warnings on wingtip clearance.

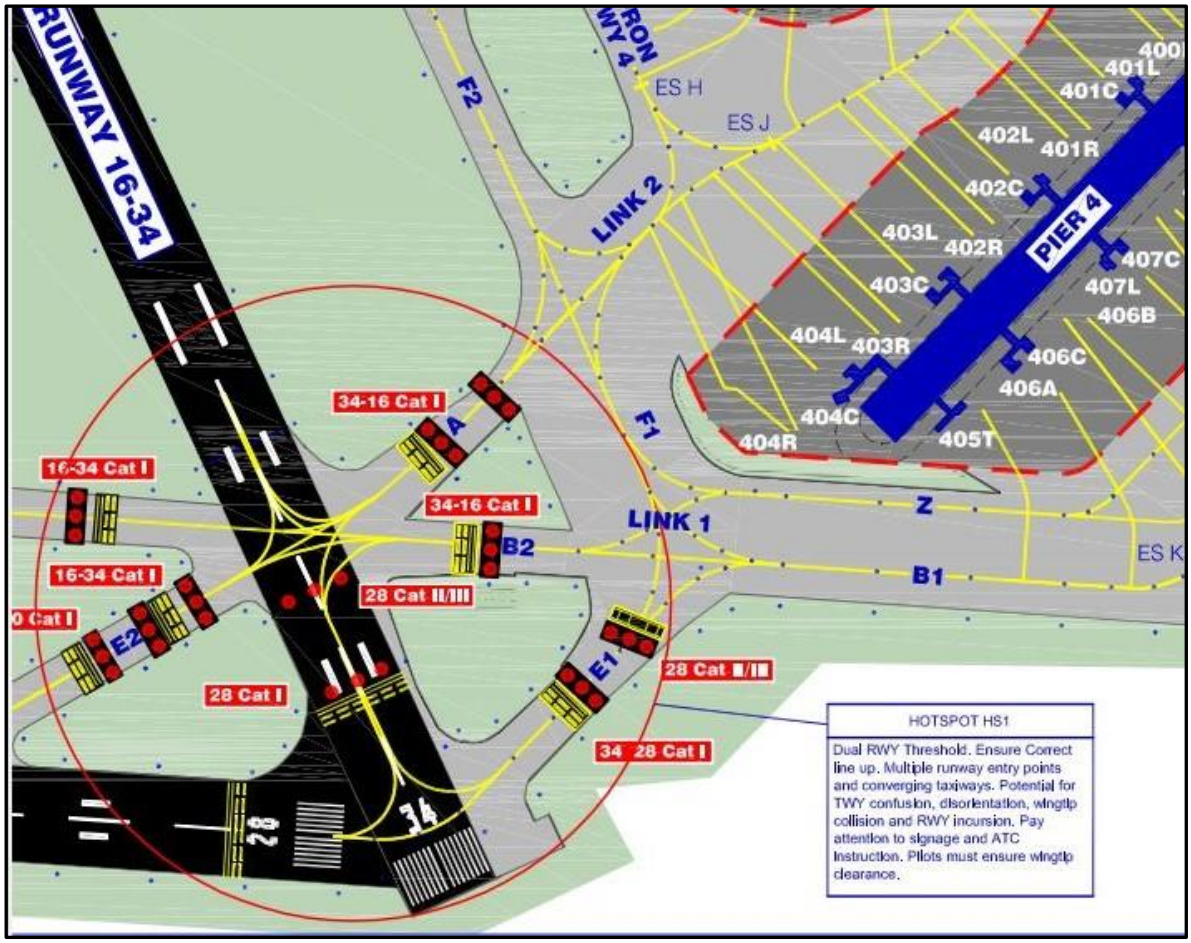

Figure No. 6: IAIP Chart showing realignment of TWYs F1 and F2

- END -

In accordance with Annex 13 to the Convention on International Civil Aviation, Regulation (EU) No. 996/2010, and Statutory Instrument No. 460 of 2009, Air Navigation (Notification and Investigation of Accidents, Serious Incidents and Incidents) Regulation, 2009, the sole purpose of this investigation is to prevent aviation accidents and serious incidents. It is not the purpose of any such investigation and the associated investigation report to apportion blame or liability.

A safety recommendation shall in no case create a presumption of blame or liability for an occurrence.

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