FINAL REPORT

AAIU Report No: 2010-002
State File No: IRL00909037
Published: 03/03/10

In accordance with the provisions of SI 205 of 1997, the Chief Inspector of Air Accidents, on 29 May 2009, appointed Mr. Thomas Moloney as the Investigator-in-Charge to carry out a Field Investigation into this Serious Incident and prepare a Report. The sole purpose of this Investigation is the prevention of aviation accidents and incidents. It is not the purpose of the Investigation to apportion blame or liability.

Aircraft Type and Registration:	Boeing 757-28A, C-GTBB
No. and Type of Engines:	2 x Rolls-Royce RB211-535
Aircraft Serial Number:	32447
Year of Manufacture:	2001
Date and Time (UTC[1]):	29 May 2009 @ 01.53 hrs
Location:	Dublin Airport (EIDW)
Type of Flight:	Public Transport
Persons on Board:	Crew - 8 Passengers - 198
Injuries:	Crew - Nil Passengers - Nil
Nature of Damage:	None
Commander's Licence:	Air Transport Pilot Licence (Canada)
Commander's Details:	Male aged 54 years
Commander's Flying Experience:	14,000 hours, of which 1,800 were on type
Notification Source:	Operations Manager, Dublin Air Traffic Control (ATC)
Information Source:	AAIU Field Investigation

SYNOPSIS

The aircraft landed on Runway (RWY) 10 in EIDW in conditions of poor visibility. On roll-out, it passed a ride-on grass mower which was travelling eastwards along the runway approximately 18.5 metres (m) to the right of the centre-line. The driver of the mower was unaware that an aircraft was arriving until he heard it on the runway behind him. Prior to the incident, ATC was informed that all grass-cutting equipment had vacated the field. The Report of the Investigation makes one Safety Recommendation.

[1] Local time = UTC + 1 hour during summertime. All times in this Report are in UTC.

1. FACTUAL INFORMATION

1.1 History of the Flight

The aircraft was operating a passenger charter flight from Sharm-el-Sheikh, Egypt (HESH) to EIDW. On transfer to Dublin ATC Centre, the aircraft was cleared for an Instrument Landing System (ILS) approach to RWY 10. The crew reported to ATC that they were established on the localiser at 01.49:19 hrs and requested the visibility and cloud ceiling. The Air Movements Controller (AMC) in the Tower replied *"Vis of 800 metres now in fog, cloud is broken at one hundred feet and the IRVRs*[2] (Instrumented Runway Visual Ranges) *at the touchdown for one zero is in excess of 1,500 metres, midpoint 1,700 and stop end* (of the runway) *is 1,500"*.

The AMC cleared the aircraft to land at 01.51:13 hrs and the aircraft landed at 01.52:45 hrs. The approach and landing were carried out normally. As the aircraft decelerated along RWY 10, the co-pilot *"noticed a lawnmower too close to the runway edge lighting"* (quotation from the Captain's report). As the aircraft rolled out along the runway, having passed the vehicle, the crew reported to the AMC on the Tower frequency, *"Check…we saw ground equipment right at the runway lights at the edge lighting here"*. The AMC responded *"I don't believe it…they guaranteed me that they were clear of the runway"*. The crew further transmitted *"Could have sworn I saw a man riding a lawnmower"* and *"OK, he was on the right side of the runway although maybe two thousand feet down but it looked like a guy just riding a lone tractor lawnmower"*. The aircraft exited RWY 10 at taxiway E1 and taxied to the parking stand without further incident. The vehicle exited the runway to the right (south) a few seconds after the aircraft had passed it. There were no injuries.

1.2 Ground Operations

1.2.1 General

In the period before the incident, there had been difficulties with grass-cutting operations due to wet weather. The Dublin Airport Authority (DAA) had received reports from pilots earlier in the week of the incident that the Precision Approach Path Indicators (PAPIs[3]) had become obscured by long grass in some areas close to the end of RWY 10. The long-range weather forecast indicated that winds would favour the use of RWY 10 for an extended period. Therefore it was considered a priority to have the grass cut in that particular area. Cutting was also required in the area in front of the RWY 28 localiser which also contains approach lighting. Arrangements had been made between the DAA Airport Duty Manager (ADM) and the ATC Station Manager that grass-cutting operations would take place on the night in question. Cutting close to an active runway during the hours of daylight is highly problematic due to the intensity of aircraft movements.

[2] IRVR is an instrumented means of measuring the Runway Visual Range (RVR), which is the distance that the pilot of an aircraft on the centreline of a runway can see the surface markings or lighting delineating the runway or identifying its centre line.

[3] PAPIs provide visual glide slope guidance to pilots, using a series of lights installed alongside a runway.

The Station Manager had been briefed by the ADM that clearing the grass-cutting equipment away from the aircraft manoeuvring areas[4] could be carried out expeditiously if required.

The ADM had arranged that a DAA supervisor operating a 4-wheel drive vehicle, call-sign "Maintenance 12", would oversee the grass-cutting operations. Maintenance 12 was fitted with two-way communications equipment capable of operating on the relevant ATC Tower and Ground frequencies, so that its driver could communicate as required with the controllers and could also hear communications between ATC and aircraft. It was fitted with a transponder for use with compatible ground surveillance equipment such as the Irish Aviation Authority (IAA) Advanced Surface Movements Guidance and Control System (ASMGCS). Further information on this system is provided in Section 1.5.

Three vehicles were carrying out the grass-cutting operations under the supervision of the driver of Maintenance 12. They were:

(a) A tractor-drawn grass mower operated by a contractor (T1). This vehicle was not fitted with an airfield radio (i.e. ATC frequencies) but the driver had been issued with a hand-held radio by the supervisor, which enabled him to communicate with the supervisor in Maintenance 12 on a discrete DAA maintenance frequency. T1 was equipped with a transponder.

(b) A tractor-drawn forage harvester operated by a DAA employee (T2). This tractor was equipped with an airfield radio, which enabled the operator to listen out on the Tower and Ground ATC frequencies. Communications between the supervisor in Maintenance 12 and this operator were by mobile phone. T2 was equipped with a transponder.

(c) A ride-on grass mower (T3), **(Photo No. 1),** operated by a DAA employee. He had also been issued with a hand-held radio by the supervisor for communication with Maintenance 12 on the discrete DAA frequency. He had no airfield radio equipment and thus he was unable to listen out on the Tower frequencies. T3 was not fitted with a transponder.

It should be noted that recordings were made of all ATC communications and were available to the Investigation, as is standard practice. However there was no recording of the communications on the discrete DAA frequency between Maintenance 12 and the grass-cutting operators in T1 and T3. Also, the discrete DAA frequency being used for communications between Maintenance 12 and T1 and T3 could not be heard by ATC. Similarly, the mobile phone communications between Maintenance 12 and T2 were not recorded, nor could they be heard by ATC.

[4] Annex 14 to the Convention on International Civil Aviation defines a manoeuvring area as "That part of an aerodrome to be used for the take-off, landing and taxiing of aircraft, excluding aprons".

Photo No. 1: Ride-on Mower T3

1.2.2 Grass-cutting Activity

Grass-cutting on the airfield commenced at approximately 21.00 hrs in areas remote from the active runway. Following consultation with the DAA air movements office (referred to as the "Pod"), and with the authorisation of ATC, the supervisor in Maintenance 12 commenced cutting operations within the flight strip[5] and along the pavement edge of the active RWY 10 at approximately 23.00 hrs after the level of intensity of air movements had reduced for the night. The supervisor in Maintenance 12 decided to stay in close proximity to the contractor's vehicle T1 due to the contractor's relative lack of familiarity with the airfield, and to use the hand held radios for communications with the DAA operator in the ride-on mower, T3. The procedures adopted on the night required the DAA operator in the tractor equipped with an airfield radio (T2) to listen out on the Tower frequency and to pull back from the flight strip when he heard communications between the Tower and aircraft about to depart or arrive. He would then confirm having done so by mobile phone with the supervisor. On several occasions prior to the incident, ATC directed that the grass-cutting vehicles be pulled back from the runway and taxiways due to aircraft movements, and this was carried out without any issues arising.

RWY 10/28 is 45 m wide with two additional asphalt shoulders, both 7.5 m in width, on either side of the runway. Thus the total width of the paved surface is 60 m. It is designated RWY 10 for aircraft landing from the west and RWY 28 for aircraft landing from the east.

[5] A flight strip is an area including a runway intended to protect an aircraft operating on the runway. No vehicles or other obstructions are permitted within the flight strip during aircraft operations.

Runway lighting is installed in the shoulder areas on each side. It should be noted that when grass-cutting along the edge of the runway, the tractor pulling the cutting equipment travels along the shoulder pavement outside the runway lighting.

The ride-on mower operator, T3, informed the Investigation that he had commenced cutting close to taxiway E2 towards the eastern end of RWY 10/28. His small vehicle was suitable for cutting around lights and runway signage and he gradually made his way westwards in the grass to the North of RWY 10/28 across taxiways E3 through to E7. By 01.40 hrs he was operating in the threshold area of RWY 10, as was T2, the DAA operator with the forage harvester, **(Figure No. 1)**.

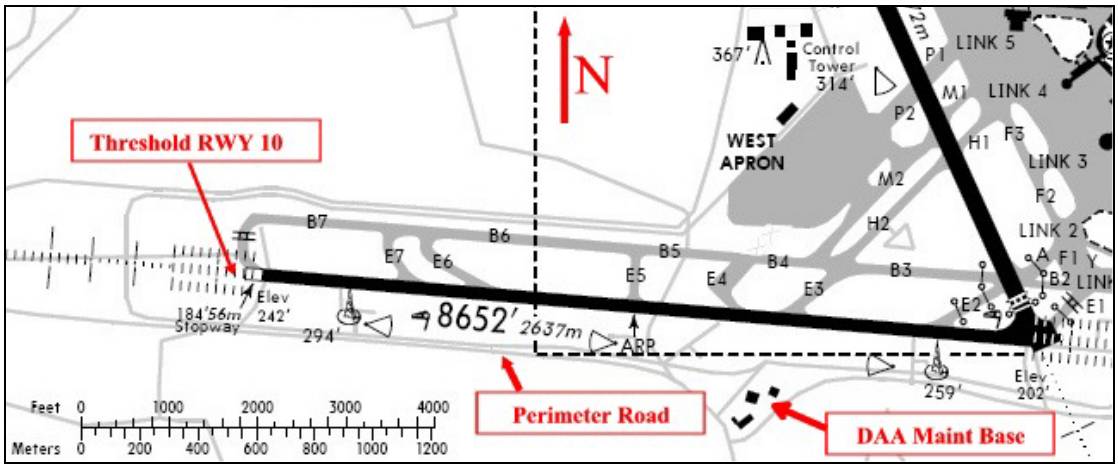

Figure No. 1: Airport Layout – EIDW (Source Jeppesen)

The supervisor in Maintenance 12 had remained close to the contractor's machine T1 and they had been operating in the grass areas close to the threshold of RWY 10 throughout the night. At 01.40 hrs they were operating in the grass area bounded by RWY 10 to the south, taxiway E7 to the east and taxiway B7 to the north and west. During most of the grass-cutting activity, there had been no visual contact between Maintenance 12 and the ride-on mower T3, but the communications between them on the hand-held radios had worked satisfactorily on the occasions when it was necessary to vacate the flight strip to facilitate aircraft movements.

1.2.3 Recordings

Recordings of the communications between ATC and the aircraft C-GTBB and between ATC and the supervisor in Maintenance 12 on Tower frequency 118.600 MHz were available to the Investigation. Also available were recordings of surface movements radar derived data from the ASMGCS. This system was under test and no display unit had been installed in the Control Tower at the time of the incident.

At 01.47:17 hrs the AMC instructed Maintenance 12 to halt the grass-cutting activity due to the decreasing visibility. He transmitted to Maintenance 12 on Tower frequency *"OK I think we're going to have to pack it up"* and *"Yeah, we're down to eight hundred metres and he is giving a tempo now of four hundred metres."*

At 01.47:29 hrs Maintenance 12 replied *"Copied that Tower, starting to clear them now"* to which the AMC replied *"OK report when you're clear of the field please…report when clear of the flight strip and then clear of the field"*. Maintenance 12 acknowledged the instruction.

The supervisor in Maintenance 12 told the Investigation that he had instructed the ride-on mower operator, T3, using the hand-held maintenance radio, to clear the field and to go across the grass onto the southern perimeter road and back to the DAA maintenance base. He also stated that he called the contractor on the hand-held maintenance radio and informed him that they were finishing up. The ride-on mower operator, T3, told the Investigation that the supervisor in Maintenance 12 had instructed him to "*vacate the runway area because low vis was in"*. He stated that he had no idea that an aircraft was due to land. At the time he was told to vacate the runway he had completed his work around taxiway B7 and had just entered RWY10 at its western end on his way towards Maintenance 12, which he could see.

At 01.48:40 hrs, two surface targets are visible on the ASMGCS recording, both moving eastwards along RWY 10. These were the DAA operator on the tractor pulling the forage harvester, T2, and the ride-on mower, T3. The forage harvester was at that time moving along the right hand side of the runway, just passing the high-speed exit at taxiway E6. The ride-on mower T3 was very close to the western end of RWY 10, also on the right hand side.

At 01.49:19 hrs, the aircraft C-GTBB called the Tower, established on the ILS localiser, and was cleared for the ILS by the AMC.

At 01.49:39 hrs, the forage harvester T2 exited RWY 10 to the right (south), at a point approximately half way between taxiway E6 and E5. The operator of the forage harvester had heard the aircraft call the Tower on his ATC radio and this prompted him to clear the runway. He subsequently called the supervisor in Maintenance 12 on his mobile phone and confirmed that he was clear of the runway. T3 continued eastwards along the right hand side of RWY 10.

At 01.50:42 hrs, Maintenance 12 reported to the AMC on Tower frequency *"Tower, Maintenance 12 is clear of two eight* (RWY 28) *and holding here on Echo Six* (taxiway E6)*."* The AMC asked Maintenance 12 to confirm that he was on E6. Maintenance 12 responded that he was and that *"when this one lands we'll vacate then"*. In fact, the ASMGCS recording indicates that Maintenance 12 was on taxiway E7 and not E6 at the time of these transmissions. The AMC instructed Maintenance 12 *"OK, can you proceed onto the Bravos"*, i.e. he should move further back from the runway onto the Bravo (B) taxiway which runs parallel to RWY 10/28 to its north. Maintenance 12 responded that he would move towards taxiway B7, which is the furthest west section of taxiway B.

At 01.51:10 hrs, the approaching aircraft, C-GTBB, called by the outer marker and was cleared to land on RWY 10 by the AMC.

At 01.51:45 hrs, the ASMGCS recording shows the targets representing the airborne C-GTBB and the ride-on mower T3 on RWY 10 both becoming highlighted in red, indicating the development of a potential conflict situation.

At this time, C-GTBB was on approximately two miles finals and the ride-on mower T3 had just passed taxiway E6, still moving slowly eastwards along the right side of RWY 10.

At 01.51:49 hrs, the AMC asked Maintenance 12, *"How many pieces of machinery are with you?"* Maintenance 12 responded *"Tower…got machines coming up to me now on Bravo Seven* (taxiway B7) *and the other machines have vacated the field."* A target is visible on the ASMGCS at this time, having cleared off taxiway E7 onto taxiway B7.

At 01.52:45 hrs C-GTBB landed on RWY10. The ASMGCS recording shows that the aircraft passed the ride-on mower T3 at 01.53:00 hrs at a point approximately 150 m west of taxiway E5 at an approximate speed of 96 kts. The mower was moving eastwards along the runway, approximately 4 m to the left of the interface between the runway and its right (southern) shoulder pavement, or approximately 18.5 m to the right of the centreline. The wingspan of a Boeing 757-200 is 38.05 m. The mower T3 continued along RWY 10 for a short distance and its ASMGCS target is seen to disappear off the runway to the right at 01.53:15 hrs.

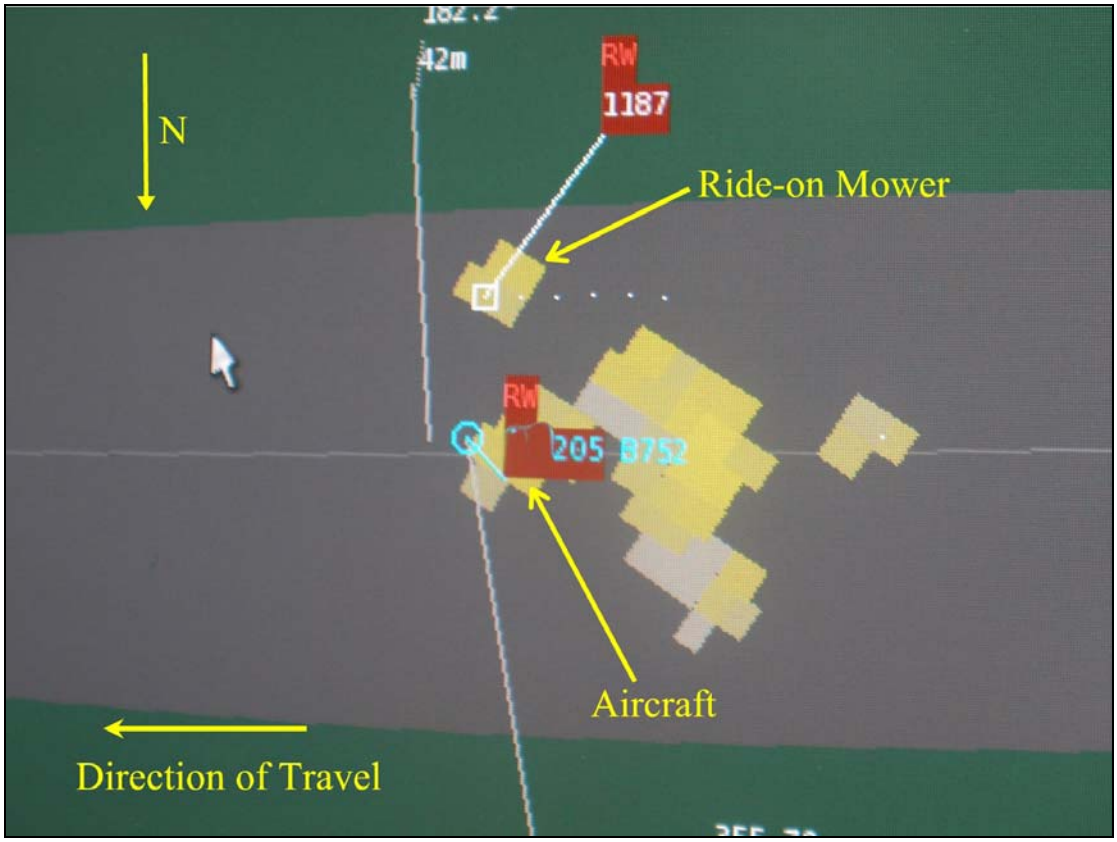

Figure No. 2: ASMGCS Image

Figure No. 2 is an image of the ASMGCS screen at the moment that the aircraft passed by the ride-on mower on RWY 10. The image is oriented with south at the top and thus the direction of travel of the aircraft and the mower is from right to left. The aircraft can be seen on the centreline with the port wing clearly defined.

The starboard wing is not as clearly defined due to shielding by the fuselage from the surface movements radar antenna. The ride-on mower is designated by the label "1187". The labels for both the aircraft and the mower are highlighted in red, indicating a conflict situation.

At 01.53:20 the aircraft crew reported the incident to ATC. Having acknowledged the report, the AMC transmitted to Maintenance 12 *"OK you've still got a man on the field"*. Maintenance 12 responded *"Tower he told me he was clear"*.

1.3 Interviews with Grass-cutting Operatives

The Investigation interviewed the supervisor in Maintenance 12 and the driver of the ride-on mower, T3. The supervisor stated how they had commenced grass-cutting away from the active runway at first and then moved into the area of the flight strip around RWY 10/28 at 23.00 hrs. He recalled advising a time of two minutes for pulling back the equipment from the flight strip. He said that, during the grass-cutting operation, numerous aircraft came in and on each occasion he instructed the two drivers with the hand held radios, T1 and T3, to *"clear the field"* or *"pull back in"*. He did not recall specifically advising that an aircraft was due to arrive or depart at any time.

He stated that when ATC directed a cessation of the grass-cutting, he called the ride-on mower driver T3 on the hand-held maintenance radio and instructed him *"we're told to get off the field, go straight across the grass and onto the perimeter road. I'll see you down at the (DAA maintenance) base"* to which he received the response *"Right, doing that now"*. He stated that it was possible that he had mentioned that low visibility procedures were coming in but he could not be certain.

He stated that his vehicle, Maintenance 12, and the contractor's equipment T1 moved onto taxiway E6 and held there. He had no visual contact with the ride-on mower T3 and he assumed that its driver had cut across the area south of RWY 10 onto the perimeter road, as he had instructed. There were a number of narrow slip roads, a few metres wide, available between the runway and the perimeter road, including one at the end of RWY 10, one at taxiway E7 and one at taxiway E6.

The supervisor got a call on his mobile phone from the other DAA operative T2 to the effect that he was off the field and accordingly the supervisor had advised the Tower that all the equipment was clear of the field. The Tower had instructed him to move back on to taxiway B7 and he did so, along with the contractor.

The supervisor told the Investigation that he was aware of grass-cutting equipment driving along the runway in order to leave the field in the past, but he believed that would not happen if a vehicle had been instructed to vacate. The supervisor was unaware of any written procedures specifically for grass-cutting operations close to the flight strip. There was no procedure, to his knowledge, for vehicles under his supervision to call him when clear of the flight strip. He had heard of cases where drivers had been told in training courses to use the centreline when driving on runways.

The ride-on mower operator, T3, told the Investigation that he had been instructed by the supervisor over the hand-held radio to *"vacate the runway, that low vis was in"*. He had no idea that an aircraft was arriving and he thought he had *"an extra few minutes to vacate the runway"*. He had been moving eastwards along the right hand side of the runway on the inside of the edge lights mounted on the shoulder pavement. The runway lights were on and he thought that the electricians were testing them. He thought that he missed the slip roads leading to the perimeter road due to the fog and the brightness of the runway lighting.

He was reluctant to go onto the grass between the runway and the perimeter road because in places the ground was very soft and he was afraid that his vehicle might get bogged down. His ride-on vehicle had no cab or rotating beacon and it was equipped with headlights on the front and reflectors at the rear. He carried the maintenance radio in one hand and steered the mower with the other. He was not wearing ear-defenders so that he would hear the hand-held radio. The first he knew of the landing aircraft was when he heard a roar behind him on the runway as it braked. He stated that after it passed him to his left, he immediately turned right and exited the runway into the grass.

He stated that it was a common procedure to use the runway and then to turn off onto one of the slip roads, when leaving the field. He also said that in training sessions, he had been told that it was best *"to stick to the centre-line"* on runways and taxiways to avoid becoming lost. However, his own practice was to stay close to the edge lighting.

1.4 Air Traffic Control

The night shift Station Manager, who has overall responsibility for ATC operations during his shift, has a duty period from 21.00 hrs until 07.00 hrs. Two Tower controllers come on duty at 22.00 hrs and are on duty during the night. Normally, they both occupy the Tower for a period with two frequencies in operation. The first is called "Tower" for movements (including vehicular activity) on the active runway (118.600 MHz) and is operated by the AMC. The second is called "Ground" for taxiing aircraft and other vehicular activity clear of the active runway (121.800 MHz) and it is operated by the Surface Movements Controller (SMC). Thereafter, when air traffic reduces to low levels, one controller handles all activity, both air and ground, utilising a single Tower frequency, 118.600 MHz, and he is designated as the AMC. At the time of the incident, there was a single controller in the Tower who was handling both aircraft movements and ground traffic including the grass-cutting operations on the Tower frequency of 118.600 MHz.

The Station Manager, and the AMC who was in the Tower at the time of the incident, both told the Investigation that, while they had been briefed on the grass-cutting activities on the airfield, they were unaware of the number of vehicles involved. The AMC was in communication on the Tower frequency with Maintenance 12, who in turn was communicating with and supervising the grass cutters on a different radio channel, which the AMC could not hear. The AMC informed the Investigation that his understanding was that it would take about one minute to clear the grass-cutting equipment away from the flight strip when ATC so directed.

The AMC informed the Investigation that there was no display unit of the ASMGCS installed in the Tower on the night of this incident, as the system was still under test at that time. On the night of the incident, the AMC had a Surface Movements Radar (SMR) display unit available to him in the Control Tower to assist with his normal visual surveillance of the activity of aircraft and vehicles on the airfield. The SMR has been in use for many years and was known to have areas of limited effectiveness, particularly towards the western end of RWY 10. The Investigation was also told that the SMR displayed a considerable amount of "clutter" along the edges of the runways and taxiways. The SMR display is not recorded.

The AMC informed the Investigation that he made the decision to terminate the grass-cutting operations when the visibility decreased to 800 m. Thus at 01.47:17 hrs he instructed Maintenance 12 to halt the activity and he further instructed him to report clear of the flight strip and then clear of the field. When the AMC received a transmission from Maintenance 12 at 01.50:42 hrs to the effect that Maintenance 12 was clear of RWY 10/28 and holding on taxiway E6, he understood this to mean that all of the grass-cutting equipment under the supervision of Maintenance 12 was clear of the runway. He instructed Maintenance 12 to move back onto the Bravo (B) taxiway and subsequently cleared C-GTBB to land on RWY 10 at 01.51:13 hrs.

The AMC stated to the Investigation that he could not see the western end of RWY 10 due to the poor visibility and that he had no visual contact with any of the grass-cutting equipment by the time he directed that the activity should be halted for the night. He also stated that he was certain that he saw no target representing a vehicle moving along the runway on the SMR display.

The distance from the Tower to the end of RWY 10 is approximately 1,850 m while the distance from the Tower to RWY 10 at taxiway E5 is approximately 800 m.

The AMC stated that he thought he could see some movement on the SMR display on taxiway E6 and then he was able to see two SMR targets moving from taxiway E7 onto B7. At 01.51:49 hrs, the AMC asked Maintenance 12 to confirm how many pieces of machinery were with him. Maintenance 12 replied *"Got machines coming up to me now on Bravo Seven* (taxiway B7) *and the other machines have vacated the field."*

The AMC stated that he was certain from his communications with Maintenance 12 that the equipment was clear of the airfield and that he was *"incredulous"* when the crew of C-GTBB reported the presence of the equipment on the runway.

The AMC stated to the Investigation that he had never before seen grass-cutting on the airfield at night. He also considered that, with hindsight, this particular grass-cutting operation was not so essential that it needed to be carried out at night, especially when fog was forecast.

On the night in question, Reduced Visibility Operations (RVOs) were not initiated. The ATC Operations Manager informed the Investigation that such operations are more relevant to RWY 16 operations.

The Station Manager's log shows that at 00.02 hrs Low Visibility Procedures (LVPs) were initiated. This was due to a fogbank approaching EIDW from the south. The log noted that at 00.39 hrs all the necessary checks were complete. It further noted that *"However, grass cutters operating near Runway 28 will be removed prior to implementing LVOs* (Low Visibility Operations). *Essential maintenance due PAPIs obscured."*

The Station Manager's log shows that LVPs were implemented at 02.14 hrs and were cancelled at 04.20 hrs as visibility improved.

1.5 ASMGCS

To address the shortcomings of the SMR, the Irish Aviation Authority (IAA) procured an ASMGCS for Dublin Airport. This modern technology system takes data feeds from the original SMR and from the approach radar and also incorporates a multi-lateration system consisting of 23 sensors situated around the airfield. Vehicles operating on the airfield are required to carry transponders and the ASMGCS generates identification labels for all aircraft and vehicles on its display.

Given the under-test status of the ASMGCS on the night of the incident, one week later the IAA and DAA carried out a re-enactment exercise to verify the accuracy of the recorded ASMGCS data. The test area used was on RWY 10 between taxiways E6, E5 and the DAA Maintenance Base, and also on taxiways E6 and B7. The ride-on mower T3 involved in the incident, and two larger vehicles, both equipped with transponders, were used in the exercise.

The exercise showed that T3, which had no transponder, gave an accurate return on the ASMGCS display when moving along the runway pavement 4 m in from the shoulder. However when it was at the runway verge or on the grasslands adjacent to the runway, no return was displayed. These areas are filtered on the ASMGCS to prevent false data being displayed due to moving grass. The transponder-equipped vehicles did show returns at runway verges and on grasslands and were displayed correctly on the ASMGCS. The exercise verified that the ASMGCS recording of the incident was accurate and confirmed that the mower T3 was approximately 4 m inside the right hand shoulder of RWY10 when C-GTBB passed it by.

1.6 DAA Procedures

The DAA published "The Aerodrome Manual for Dublin Airport" in compliance with the IAA's aerodrome licensing requirements. The scope of the manual is to include such information and instructions as are necessary to enable the airport operating staff to perform their duties safely.

The manual includes more than forty Airport Directions, which cover various aspects of airport activity. Airport Direction 20, "Operations on the Manoeuvring Area", has the safety objective of ensuring the safe operation of vehicles on the manoeuvring area. In addition, the Direction is intended to protect the manoeuvring area from unsafe procedures and practices. The version of Airport Direction 20, which was effective on the 29 May 2009, is the DAA document with most relevance to this particular incident.

Paragraph 1, "Control of the manoeuvring area" states that responsibility for the control of the manoeuvring area rests with ATC. It states that *"all vehicles operating on the manoeuvring area must be fitted with radio (R/T) equipment capable of being tuned to frequency 121.800 MHz (ground movements control) and frequency 118.600 MHz (Tower) and must at all times remain in contact with ATC"*. It also states that no vehicle, equipment or person may enter the manoeuvring area without prior permission from ATC.

Paragraph 6.1, "Characteristics of airfield vehicles" states that vehicles operating on the airfield shall be equipped with *"a vehicle-marking designating its call-sign; a yellow flashing anti-collision beacon at least 20 cm in height; airfield radio equipment capable of being tuned to frequencies 121.8 MHz, 118.6 MHz and 119.55 MHz; and operational front and rear lighting"*.

Para 7, "R/T frequency communication" sets out the procedures, which drivers must follow when operating on the manoeuvring area. It states *"Vehicles shall NOT enter the flight strip of a runway without first obtaining permission from ATC. All drivers shall report back to ATC when they have vacated the flight strip of a runway."*

Para 7.1, "R/T procedures for active runways" sets out detailed procedures for entering and vacating an active runway in terms of radio contact between the vehicle driver and ATC Ground and Tower frequencies. It notes as follows *"**Vehicles must not enter an active runway without permission from the ATC Tower**"*.

The version of Airport Direction 20, which was effective on 29 May 2009, contained no specific instructions related to routine grass-cutting operations on the airfield. Additionally, it did not require that vehicles operating on the manoeuvring area be fitted with transponders.

All personnel who work airside at Dublin Airport are required to undergo and pass a DAA airside safety awareness course. In addition, personnel with a requirement to drive airside must undergo specific airside driving training and assessment. All personnel who operate R/T equipment on ATC frequencies on the manoeuvring area are required to undertake training and to successfully complete a classroom test, using standard ICAO Annex 10 approved aeronautical phraseology. They must also undertake a test on the airfield, under the control of an instructor before being allowed to operate on the manoeuvring area. Dublin ATC has recently completed an R/T phraseology manual, which will be incorporated into DAA R/T training to ensure uniform phraseology on the airfield. Airport Direction 5 requires that movement area staff undergo appropriate refresher training every three years or as determined by the DAA.

In accordance with the Dublin Airport Safety Management System (SMS), the DAA carries out formal risk assessments to identify hazards and their associated risks. A risk assessment of grass-cutting was performed on 14 April 2009. The risks that were identified in the assessment were runway/taxiway incursions, collision between cutting equipment and aircraft, and an increase in FOD (foreign object damage). The assessment process included the control measures that were in place to mitigate the identified risks.

These measures were "Training: airside safety awareness, airside driving and escort driving", "Provision of escorts for grass-cutting vehicles and personnel" and "Briefings for staff by Airfield Manager prior to commencement of job". The assessment determined that the risks were reduced to an acceptable level with the implementation of these control measures.

Following the serious incident, another risk assessment of grass-cutting was carried out on 24 June 2009. In this case, the risk of incursions was assessed as being "unacceptable" with the control measures that had been in place. In order to reduce the risk level to acceptable, eight new control measures were introduced with immediate effect. These measures are detailed in paragraph 1.9 hereunder.

1.7 Reduced and Low Visibility Procedures

An IAA document titled "Procedures for Reduced and Low Visibility Operations at Dublin Airport" sets out the ATC and associated procedures to be followed during periods of reduced or low visibility. The DAA has an equivalent manual, Airport Direction 16, "Procedures for Reduced and Low Visibility Operations".

The IAA document states that procedures for Reduced Visibility Operations (RVOs) shall be initiated when the IRVR or Met Visibility falls below 1,500 m, or when the AMC or Surface Movements Controller (SMC) loses visual contact with any part of the manoeuvring area or restricted apron taxiway. During RVOs, work essential to safety is permitted. Construction work and non-essential maintenance may take place on the manoeuvring area or the restricted apron taxiway with the approval of the ATC Station Manager.

The document states that LVPs shall be initiated by the Station Manager if visibility is 1,000 m or less and forecast to deteriorate significantly, or the cloud ceiling is 300 ft or less. LVPs shall be enforced when the IRVR is 550 m or less (or if the IRVR is unserviceable when the Met Visibility is 800 m or less) and/or the cloud ceiling is 200 ft or less. Initiation of LVPs is the preparation of the various requirements that need to be in place when LVPs are enforced. LVPs require, inter alia, that appropriate lighting and power supply systems (including standby generators) are serviceable, that essential IRVR and anemometer equipment and displays are serviceable, and that the manoeuvring area is clear of all obstructions such as machinery, maintenance vehicles, contractors, etc.

The activation of the stand-by electrical generator by the AMC is a key part of the enforcement of LVPs. The IAA Procedures Manual states that the status of the back-up electrical generator shall not be altered while there is an aircraft on approach. The AMC told the Investigation that at the time that the visibility decreased to 800 m and he instructed that the grass-cutting operations be terminated, he was unable to immediately enforce LVPs due to the fact that the grass-cutting equipment would require a period of time to clear the field and also that C-GTBB was by then on the base leg of its approach.

1.8 Meteorological Information

Met Éireann were requested to provide an aftercast of the meteorological conditions for the time of the incident. Their weather report is as follows:

Meteorological Situation:	High pressure dominated the incident area leaving Dublin airport in a generally southeasterly, moist, flow.
Wind:	Surface: 130° 08 kts 2,000 feet: 190° 15-20 kts
Visibility:	0100 hrs: 6 km 0130 hrs: 1,200 m 0200 hrs: 500 m
Weather:	FOG
Cloud:	0100 hrs: Few 200 ft 0130 hrs: Bkn 100 ft 0200 hrs: Bkn 100 ft
Surface Temp/Dew Point:	11°C/11°C
MSL Pressure:	1030 hPa
Freezing Level:	Circa 6,000 ft
Additional information:	TAF for EIDW issued at 282300: TAF EIDW 282300Z 2900/2924 16007KT 9999 SCT030 TEMPO 2900/2909 3000 BR BKN007 PROB30 TEMPO 2903/2908 0800 FG BKN001 PROB30 TEMPO 2909/2913 BKN012 BECMG 2910/2912 12013KT=

The Terminal Area Forecast (TAF) for EIDW issued at 23.00 hrs on 28 May 2009 shown above as Additional Information may be decoded as follows: - 29 May from 00.00 hrs until 24.00 hrs, wind 160° at 07 kts, visibility greater than 10 km, cloud scattered 3,000 ft. Temporarily 29 May 00.00 hrs until 09.00 hrs visibility 3,000 m, mist, cloud broken 700 ft. Probability 30% temporarily 29 May 03.00 hrs until 08.00 hrs, visibility 800 m, fog, cloud broken 100 ft. Probability 30% temporarily from 29 May 09.00 hrs until 13.00 hrs, cloud broken 1,200 ft becoming 29 May 10.00 hrs until 12.00 hrs, wind 120° at 13 kts.

The aftercast shows that the observed visibility was 6 km at 01.00 hrs, 1,200 m at 01.30 hrs and 500 m at 02.00 hrs. Cloud was recorded as 'Few' at 200 ft at 01.00 hrs, and 'Broken' at 100 ft at 01.30 hrs and 02.00 hrs.

1.9 Actions Since the Serious Incident

The AAIU published a Preliminary Report into this Serious Incident on 30 June 2009. This Report was issued to interested parties on 22 June 2009. The Report contained an Interim Safety Recommendation, SR 11 of 2009, which stated *"The Dublin Airport Authority (DAA) should ensure that all vehicles, which are required to operate on or in close proximity to active runways should be equipped with airband VHF radios capable of being selected to ground control and tower frequencies, and also with flashing yellow light beacons and transponders compatible with the ASMGCS system".*

The DAA responded as follows:- *"We have already implemented the Interim Safety Recommendation SR 11 of 2009 and confirm that all vehicles which are required to operate on or in close proximity to active runways are equipped with airband VHF radios capable of selecting ground control and tower frequencies and also with yellow lights and transponders compatible with the ASMGCS".*

Following the incident, the DAA immediately withdrew the ride-on mower T3 and replaced it with a larger unit with a cab, equipped with a flashing beacon, an airfield radio capable of operating on the relevant ATC frequencies, and a transponder.

As stated in paragraph 1.6 above, the DAA introduced eight new control measures in June 2009 to reduce the risk of incursions during grass-cutting to an acceptable level. These measures were:

(1) An ADM Permit system for grass-cutting at night.
(2) Installation of transponders in all vehicles.
(3) A safety briefing to be given by the driver of the lead vehicle before commencement of any grass-cutting operations.
(4) All vehicles to be equipped with radio equipment capable of receiving and transmitting on 121.8 and 118.6 MHz (Ground and Tower ATC frequencies).
(5) Maintenance radios to be installed in all vehicles for transmitting and receiving on fixed (non-ATC) frequencies.
(6) Revision of grass-cutting procedures in Airport Direction 20.
(7) All airside vehicles to have a yellow flashing beacon while operating on the manoeuvring area.
(8) The introduction of a new training course specifically for those involved in grass-cutting.

The DAA published an amended Airport Direction 20 on 4 August 2009, which includes detailed procedures for grass-cutting operations. Paragraph 9 of the Direction requires that all grass-cutting vehicles shall be equipped with an amber flashing beacon, a transponder, a VHF radio capable of receiving and transmitting on frequencies 118.6, 119.55 and 121.8 MHz and a maintenance radio for communication between vehicles. There is a requirement for detailed briefings between the ADM and the driver of the supervisory vehicle and between the ADM and the ATC Station Manager. At night, the ADM is required to issue a permit to the driver of the supervisory vehicle. There is a requirement that, prior to commencement of grass-cutting, there will be a safety briefing for all staff involved and that radios are tested and operating.

All drivers involved are required to maintain a listening watch on the relevant ATC frequency and are directed not to depend solely on the lead driver for situational awareness. It is also a requirement that drivers of all vehicles report to the driver of the lead vehicle, using the maintenance radio, that they have vacated a runway or taxiway and the driver of the lead vehicle must also visually verify that all vehicles are clear of runways and/or taxiways prior to reporting all vehicles are clear to ATC. The use of mobile phones has been prohibited as a means of communication between drivers when engaged in grass-cutting operations on the manoeuvring area.

Paragraph 10 of Airport Direction 20 sets out similar procedures for grass-cutting in restricted ILS areas and paragraph 11 directs that *"It is a mandatory requirement that each vehicle, with the exception of aircraft tugs, operating on the manoeuvring area is equipped with a transponder"*.

The IAA published an Air Traffic Services (ATS) Operations Notice on 7 August 2009, "Procedures for Grass-cutting on the Airfield", to reflect the changes made in Airport Direction 20.

The IAA placed an ASMGCS display unit in the Control Tower as an uncommissioned aid to controllers on the day following the incident, although the system remained on test.

The ASMGCS became fully operational on 27 October 2009. Two display units were installed in the Tower, one at the AMC position and one at the SMC position. Two additional displays were located in the Area Control Centre, one at the approach radar position and one at the Station Manager's desk.

2. ANALYSIS

2.1 The Incident

The grass-cutting operation was carried out by three pieces of equipment along with a supervisory vehicle, Maintenance 12. While Maintenance 12 was equipped with the appropriate radio transceiver equipment operating on ATC frequencies, two of the other vehicles (the contractor's tractor T1 and the ride-on mower T3) had no ATC communications capability. The operator of the third machine, the DAA tractor T2, had the facility to listen out on the ATC frequencies. The supervisor remained in close physical proximity to the contractor's vehicle throughout the operation but the ride-on mower T3 operated remotely, with communications relating to clearing the flight strip being provided by a hand-held radio operating on a discrete maintenance frequency. The system had worked satisfactorily during the period prior to the halting of grass-cutting operations.

When the AMC instructed the supervisor in Maintenance 12 to halt proceedings due to the deterioration in visibility to 800 m, it is likely that the supervisor passed on a similar message to the ride-on mower driver, i.e. to the effect that the grass-cutting was to be terminated due to low visibility. The mower driver assumed that the visibility was the sole reason for the termination, and that he was therefore safe to use the runway as a route back towards the DAA maintenance base.

He also made an assumption that the runway lighting was on because the electricians were testing it. As he had no facility to listen out on the Tower frequency, and since he received no further air traffic information from the supervisor, he had no knowledge of the developing situation.

The supervisor told the Investigation that he had instructed the ride-on mower driver T3 to get off the field by going straight across the grass to the perimeter road. The mower driver's recall of the message was that he had been instructed to vacate the runway as low visibility procedures were coming in. However, he did not vacate the runway but remained on it for a period of approximately five minutes. It was his intention to exit the runway at one of the slip roads that link the runway with the perimeter road, as he was uncomfortable with taking his small vehicle across the soft grassy areas. But it is likely that he was unable to see the slip roads due to the intensity of the runway lighting in the low visibility. However, his decision to travel along the runway inside the lights, which are mounted on the runway asphalt shoulder, would have hindered his ability to see the unlit slip roads which met the shoulder pavement approximately 11.5 m to his right.

The supervisor transmitted a message to ATC at 01.50:42 hrs that *"Maintenance 12 is clear of* (runway) *28 and holding here on Echo Six* (taxiway E6)*"*. The AMC asked him to confirm he was on taxiway E6 to which Maintenance 12 responded, *"Affirm ground, when this one lands we'll vacate then"*. The AMC asked him to move back towards the Bravo (B) taxiways and the supervisor responded that they would move towards taxiway B7.

By that time, the supervisor had received a mobile phone call from the DAA operator in T2 confirming that he was clear of the runway. The supervisor was also aware that an aircraft was on final approach to RWY 10. He assumed that the ride-on mower, T3, was clear of the runway since he had instructed him to vacate some two minutes earlier. However, he had not received any radio communication to confirm that the mower had vacated, nor had he visually confirmed that T3 was clear of RWY 10. But in effect, his message to the AMC was a confirmation that all of the vehicles under his supervision were clear of the runway.

The AMC made the reasonable interpretation that the supervisor's message at 01.50:42 hrs meant that all of the vehicles were clear. He subsequently cleared C-GTBB to land. He would not have done so if he had any doubts about the runway being clear.

Subsequent to issuing the landing clearance, the AMC asked how many pieces of machinery were with Maintenance 12. The supervisor in Maintenance 12 responded *"got machines coming up to me now on Bravo Seven* (taxiway B7) *and the other machines have vacated the field"*. While this answer was vague in terms of the question asked, in any case the AMC was unaware of the number of grass-cutting machines that had been active that night. However the principal effect of the exchange was to reinforce the fact that the supervisor was certain that all of the machines were clear and he so informed the AMC.

The final exchange between the AMC and Maintenance 12 was after C-GTBB had landed and the crew reported seeing a man on a lawnmower. The AMC transmitted *"You've still got a man on the field"* to which Maintenance 12 responded, *"Tower, he told me he was clear"*. However the Investigation is of the opinion that it is unlikely that the driver of the mower T3 passed such a message to Maintenance 12, since he had not vacated the runway prior to the landing.

The ASMGCS recording indicated that the ride-on mower was travelling eastwards along RWY 10 approximately 18.5 m to the right of the centreline. The wingspan of the Boeing 757 is 38.05 m. Therefore, since the ASMGCS recording shows the aircraft rolling out along the centre-line of the runway, it is reasonable to conclude that the starboard wing-tip of the aircraft passed over the mower.

Given the poor visibility at the time of the landing, allied to the lack of a rotating beacon or rear lighting on the ride-on mower, the crew of C-GTBB would not have been in a position to take avoiding action to avert a potential collision.

2.2 ATC Aspects

The visibility had reduced to 800 m by the time that the AMC instructed that the grass-cutting should be stood down. Therefore the AMC could not have seen the grass-cutting vehicles' lights as they were all operating in the vicinity of the end of RWY 10, more than 1,500 m away from the Tower. The ride-on mower came closer to the Tower as it travelled east along RWY10 but would still have been approximately 900 m from the Tower at the time C-GTBB landed. The AMC was using the SMR as an aid and he thought he could see some movement on taxiway E6 and subsequently he was able to see the two vehicles on taxiway E7. However, analysis of the targets seen on the ASMGCS recording indicates that the movement seen on E6 was a false return, and that Maintenance 12 and the contractor's equipment were actually on E7. The AMC stated that he was certain that he had seen no SMR target on the runway prior to C-GTBB landing.

Had the ASMGCS been in operation in the Tower on the night of the incident, it is likely that the AMC would have been alerted to the developing potential conflict situation on the runway and would have averted it. However it was still under test at the time. The IAA placed a display unit in the Tower on the following day as an uncommissioned aid to AMCs and SMCs and the system was fully commissioned in October 2009.

The much improved surface surveillance performance and conflict alerting facilities of the ASMGCS, combined with the mandatory requirements for compatible transponders on all vehicles, will greatly assist controllers in the prevention of incidents similar to the one described in this Report.

LVPs were initiated and all the necessary checks were completed more than one hour before C-GTBB landed, but they were not enforced until after the landing. A requirement of LVPs is that the manoeuvring area is clear of all obstructions such as machinery, plant, maintenance vehicles, contractors, etc. Thus, enforcement of LVPs would have meant a cessation of grass-cutting.

The aftercast shows that the recorded cloudbase was "Broken" at 100 ft at 01.30 hrs. IAA Procedures require the enforcement of LVPs when the IRVR is 550 m or less and/or the cloud ceiling is 200 ft or less. Thus, although the visibility was well above LVP requirements at 01.30 hrs, strict adherence to the Procedures in respect of cloud ceiling would have seen LVPs enforced earlier than what actually transpired.

2.3 DAA Procedures

Airport Direction 20 stated that no vehicle should enter the manoeuvring area without prior permission from ATC. It also stated that all vehicles operating on the manoeuvring area must be fitted with radio equipment capable of being tuned to the Tower frequencies. Two of the vehicles involved in the grass-cutting operation were not so equipped. The two DAA operatives driving T2 and T3 both drove along the runway on their way back towards the DAA Maintenance Base following the ATC instruction to stand down the grass-cutting. T2 left the runway after its driver heard the approaching aircraft on his ATC radio, whereas the ride-on mower driver in T3 had no such facility and remained on the runway. If his vehicle had been equipped with an ATC radio, then it is likely that he would have heard the approaching aircraft and would also have exited the runway.

Airport Direction 20 included no specific instructions for grass-cutting operations. While it may be argued that grass-cutting operations imply some sort of "blanket clearance" to operate within the flight strip, subject to ATC direction, the Investigation considers that the use of an active runway as a vehicular road is poor practice. The fact that two DAA operated vehicles used the runway as a route to vacate the airfield suggests that this was not an isolated occasion.

The two DAA personnel interviewed by the Investigation said that in training sessions they had been advised to drive on the centreline on runways and taxiways. Fortunately, on the night of the incident, this was not the case. Again, the Investigation considers that use of the centreline is not good practice.

The driver of Maintenance 12 used some non-standard R/T phraseology on the ATC frequency during the incident. The Investigation notes that Dublin ATC has recently produced an R/T phraseology manual which the DAA intends to incorporate into its training. Also in this context, the Investigation considers that attention should be drawn to ICAO Doc 9870 AN/463 "Manual on the Prevention of Runway Incursions" and in particular to paragraph 4.2 therein, "Communications".

The Investigation also notes that refresher training every three years is a requirement for all personnel employed in the movement area. However, given the circumstances of this incident along with the lessons learned, the Investigation considers that an interval of three years is excessive for those personnel who currently operate vehicles on the manoeuvring area.

Accordingly, the Investigation makes a Safety Recommendation to the DAA, that it should review the content and periodicity of its training for operatives who are involved in driving vehicles on the manoeuvring area.

The supervisor and the drive-on mower operator both told the Investigation that they were unaware of any specific written procedures related to grass-cutting. This has been addressed in the latest revision of Airport Direction 20. This revision also directs that vehicles may not operate on the manoeuvring area without a correctly operating transponder.

The Investigation is satisfied that the actions carried out by the DAA subsequent to the incident, particularly the detailed review and revision of Airport Direction 20, address the deficiencies in the Direction which have been identified in this Report.

3. CONCLUSIONS

(a) Findings

1. The aircraft's wingtip passed over the ride-on mower during the roll-out after touchdown on RWY 10.

2. The AMC and the aircraft's crew were unaware that a vehicle was travelling along the runway as the aircraft was landing.

3. The ride-on mower was equipped with inadequate radio communications equipment and inadequate lighting, and it did not conform to the requirements of Airport Direction 20.

4. The operator of the ride-on mower was unaware that an aircraft was approaching RWY 10.

5. This lack of situational awareness resulted in him not vacating the runway in the most expeditious manner.

6. The grass-cutting supervisor did not positively determine that all the vehicles under his control were clear of the runway before he advised ATC that the runway was clear.

7. At the time of the incident, there were significant deficiencies in Airport Direction 20.

8. The SMR system that was available to the AMC failed to detect the ride-on mower on RWY 10 due to its limited ground surveillance capability.

9. The Investigation identified deficiencies in the training of DAA personnel involved in this incident.

(b) Probable Cause

The failure of the driver of the ride-on mower T3 to vacate the runway after he had been instructed to do so.

(c) Contributory Causes

1. The assumption by the supervisor in Maintenance 12 that the driver of T3 had vacated the runway, even though he had received no confirmatory transmission from T3 nor had he visually confirmed that the runway was clear.

2. The absence of a communication from the supervisor to the driver of T3 that an aircraft was approaching.

3. The use of grass-cutting vehicles that were not equipped in accordance with the requirements of Airport Direction 20.

4. The lack of a capability to listen out on the Tower frequency, which reduced the situational awareness of the driver of the ride-on mower.

5. The lack of specific procedures related to routine grass-cutting in the Airport Manual.

6. The poor visibility combined with the limited performance of the SMR restricted the AMC's capability of intervening in the developing situation.

4. SAFETY RECOMMENDATION

It is recommended that:

1. The DAA should review their training programmes, including the frequency of refresher training, for all operatives who are required to drive on the manoeuvring area. Reference to ICAO Doc 9870 AN/463 "Manual on the Prevention of Runway Incursions" should be included in all such training programmes. **IRLD2010002**

- END -