Final Report

RUNWAY INCURSION BY A VEHICLE IN CHANGI AIRPORT

29 OCTOBER 2020

TIB/AAI/CAS.194

Transport Safety Investigation Bureau
Ministry of Transport
Singapore

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The Transport Safety Investigation Bureau of Singapore

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Table of Contents

GLOSSARY OF ABBREVIATIONS

ADP	Airfield Driving Permit
ADTH	Airside Driving Theory Handbook
AGLCMS	Airfield Ground Lighting Control and Management System
ATC	Air Traffic Control
AWPM	Airside Work Procedure Manual
CAT 1	Category 1
FOD	Foreign object debris
HC	Hotel Charlie
MBD	Microwave barrier detector
OJT	On-the-Job Training
REP	Runway Entry/Exit Point
RT	Radio telephony
SOP	Standard Operating Procedures

SYNOPSIS

On 29 October 2020, a runway incursion involving a maintenance vehicle occurred at Runway 02C/20C of Changi Airport.

The driver of the maintenance vehicle was contacted by Changi Tower on the radio frequency to get ready for wildlife dispersal on the runway. At about 1332LT, the driver of the maintenance vehicle entered the runway after receiving what he thought was a clearance to do so. Upon noticing that the maintenance vehicle had entered the runway, Changi Tower informed the driver of the vehicle that he had not been cleared to enter the runway. The maintenance vehicle then vacated the runway.

There was no aircraft departure or arrival at the time of the occurrence.

The Transport Safety Investigation Bureau classified this occurrence as an incident.

1 FACTUAL INFORMATION

All times used in this report are Singapore Local Time (LT) unless otherwise stated. Singapore Local Time is eight hours ahead of Coordinated Universal Time (UTC).

1.1 Sequence of event

1.1.1 On 29 October 2020 at about 1321LT, the Changi Tower Runway Controller, who was undergoing On-the-Job Training (hereinafter referred to as the OJT Controller) overseen by an OJT Instructor, contacted the driver of a maintenance vehicle with the call-sign Rover 39[1] (hereinafter the driver is referred to as the Driver) on radio frequency 121.9 MHz[2] and instructed him to prepare for wildlife dispersal[3] at 1335LT on Changi Airport Runway 02C/20C.

1.1.2 The Driver acknowledged the instruction from the OJT Controller. At this time, the maintenance vehicle was positioned on a roadway designated as Hotel Charlie (HC) which led to Runway 02C/20C (see **Figure 1**) before a set of drop arm barriers. Apart from the Driver, there was a co-worker in the maintenance vehicle.

[1] The maintenance vehicle belongs to the aerodrome operator. The driver is an employee of a contractor hired by the aerodrome operator to perform airfield maintenance. In addition to conducting wildlife dispersal, the driver can also be deployed for foreign object debris removal, as well as runway inspections.
[2] Frequency 121.9 MHz is used by the ATC for communicating with aircraft on tow and vehicles within the aerodrome.
[3] The Air Traffic Control will initiate a wildlife dispersal whenever there has been a gap of more than 20 minutes without traffic. The OJT Controller had earlier checked the schedule of aircraft movements from the Changi Tower's Pre-Departure Sequence system and the Arrival Management system and ascertained that there would be no aircraft departure nor arrival before 1355LT.

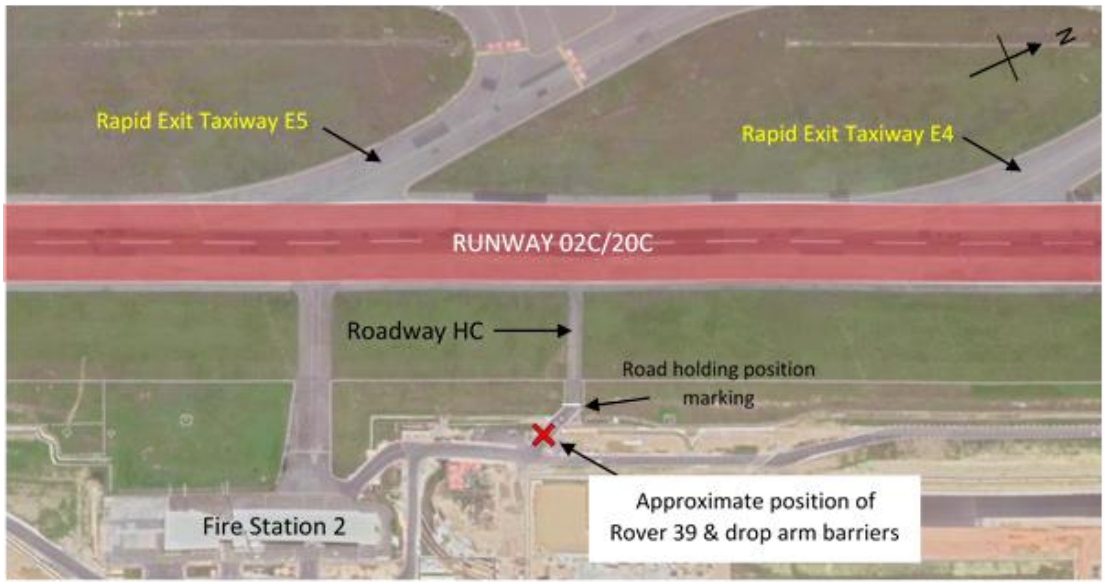
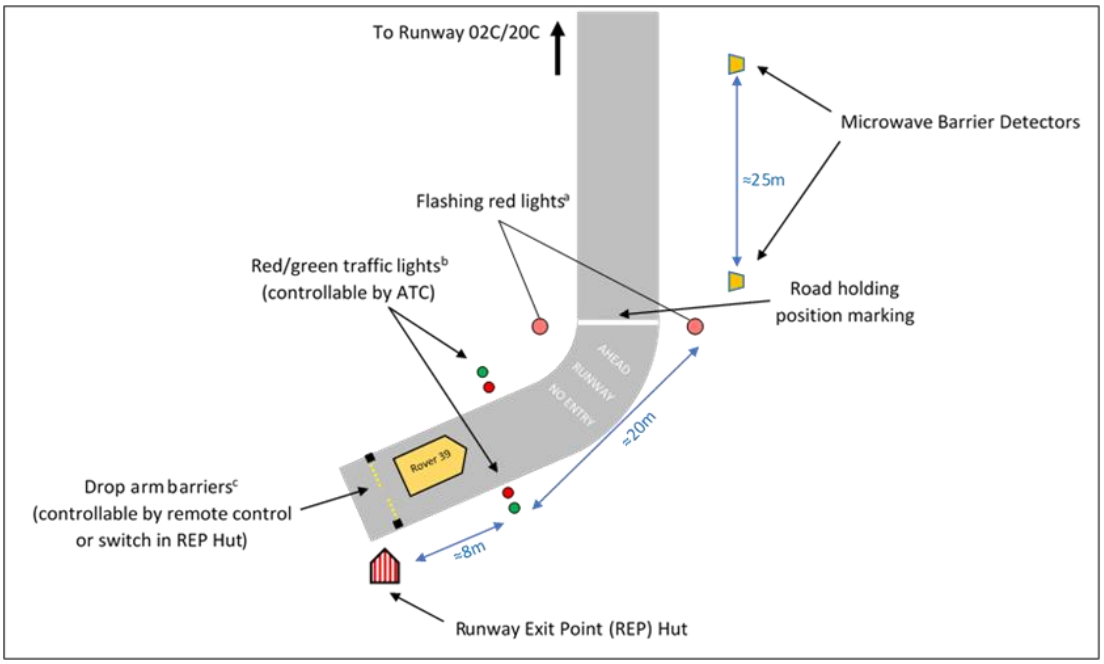


Figure 1: Location of maintenance vehicle and roadway HC.

1.1.3 Shortly after the Driver had acknowledged the OJT Controller's instruction, the co-worker raised the drop arm barriers on roadway HC using a remote control[4]. The Driver then drove onto the roadway and stopped just after passing the drop arm barriers and before a set of red/green traffic lights. The traffic lights are controllable by the Air Traffic Control (ATC) via the Airfield Ground Lighting Control and Management System (AGLCMS) and were indicating red at that time (see **Figure 2**).

[4] According to the contractor's operating procedure, at the time of occurrence, when a maintenance vehicle was ready to enter the runway for wildlife dispersal, either the driver or the co-worker was to raise the drop arm barriers for the vehicle to cross. After that, the vehicle was to stand by at the road holding position. The driver or the co-worker was to ensure that the drop arm barriers were lowered after the maintenance vehicle had crossed the barriers.



[a]The flashing red lights are not controllable by ATC.

[b]The red/green traffic lights are controllable by ATC and corresponded to their instruction. Red means no approval to enter the runway; green means approval has been given to enter the runway.

[c]The drop arm barriers were controllable using a remote control placed in the maintenance vehicle Rover 39 or a switch located in the REP Hut.

Figure 2: Illustration of vehicle roadway HC (not to scale).

1.1.4 After the Driver moved past the drop arm barriers, the co-worker lowered the drop arm barriers using the remote control. The Driver waited at that position for further instruction from the OJT Controller for wildlife dispersal.

1.1.5 At about 1330LT, the OJT Controller called the Driver again on 121.9 MHz to ascertain his position, to whom the Driver responded that he was on roadway HC. The OJT Controller then instructed the Driver to monitor the radio frequency 118.25 MHz[5]. The Driver switched on another radio set in the maintenance vehicle that was pre-set to frequency 118.25 MHz and lowered the volume of the radio set that was tuned to 121.9 MHz.

1.1.6 At about 1332LT, the Driver called the OJT Controller on 118.25 MHz and reported that he was ready for wildlife dispersal. As the OJT Controller had planned for the Driver to enter the runway only at 1335LT, she gave the

[5] Frequency 118.25 MHz is used by the ATC for communicating with vehicles and aircraft on Runway 02C/20C.

instruction "*Rover 39, Singapore Tower, stand by to enter Runway 20C*" .

1.1.7 The Driver then read back "*39, entering Runway 20C for wildlife dispersal*" and drove towards the runway. According to the co-worker[6], he could not recall the instruction from the OJT Controller, but he could remember the Driver's readback.

1.1.8 According to the Driver, he heard the OJT Controller giving the clearance to enter Runway 20C and so he drove the maintenance vehicle towards the runway. The Driver did not check the colour of the traffic lights before driving towards the runway[7]. At that time, the co-worker was typing messages on his company-issued mobile phone regarding the wildlife dispersal operation which he planned to send out after the operation, and he did not pay attention to the traffic light.

1.1.9 The OJT Controller heard the readback from the Driver that he was entering the runway but did not stop the Driver immediately. She was suspecting that the traffic lights might have somehow turned green, as otherwise she could not think of a reason why the Driver would enter the runway. So, she checked first the AGLCMS control panel and found that the traffic lights were still displaying red.

1.1.10 While the OJT Controller was looking at the AGLCMS control panel, the OJT Instructor prompted her to stop the Driver. The OJT Controller then repeated to the Driver, *"Rover 39, stand by to enter Runway 20C."* This time, the Driver responded, *"39, copied"* but continued to drive towards the runway.

[6]The co-worker was not required to listen to the communication between the OJT Controller and the Driver.

[7] The requirement to obey the traffic lights was not stated in the contractor's procedure. The Driver told the investigation team that although he was trained during his OJT to observe traffic light signal, there were instances when he was conducting ad hoc runway inspection previously and where the traffic lights did not turn green after the ATC had given the clearance to enter a runway. During these instances, the Driver proceeded to enter the runway without waiting for the traffic lights to turn green or checking with the ATC on the colour of the traffic lights. In this incident, as in these past instances, the Driver proceeded to enter the runway without checking the colour of the traffic lights. However, in this incident, the ATC had not given a clearance to the Driver to enter the runway.

1.1.11 Based on the response from the Driver, both the OJT Controller and the OJT Instructor thought that the Driver had understood the instruction and that the Driver would not enter the runway. A moment later, when the OJT Instructor saw that the Driver had entered the runway, she immediately transmitted on 118.25 MHz to tell the Driver that he had only been told to *"stand by to enter Runway 20C".* The Driver acknowledged the transmission and vacated the runway.

1.1.12 There are two microwave barrier detectors (MBDs) installed 25m apart by the aerodrome operator along the roadway HC to detect unauthorised entry into the runway (more on MBD in paragraph 1.5.6). During this incident, the MBD system did not detect the runway incursion during this occurrence. Post-occurrence tests showed that the MBD that was nearer the flashing red lights was affected by the presence of marker boards (see **Figure 3**) erected by the aerodrome operator[8] (see paragraph 1.5.7).

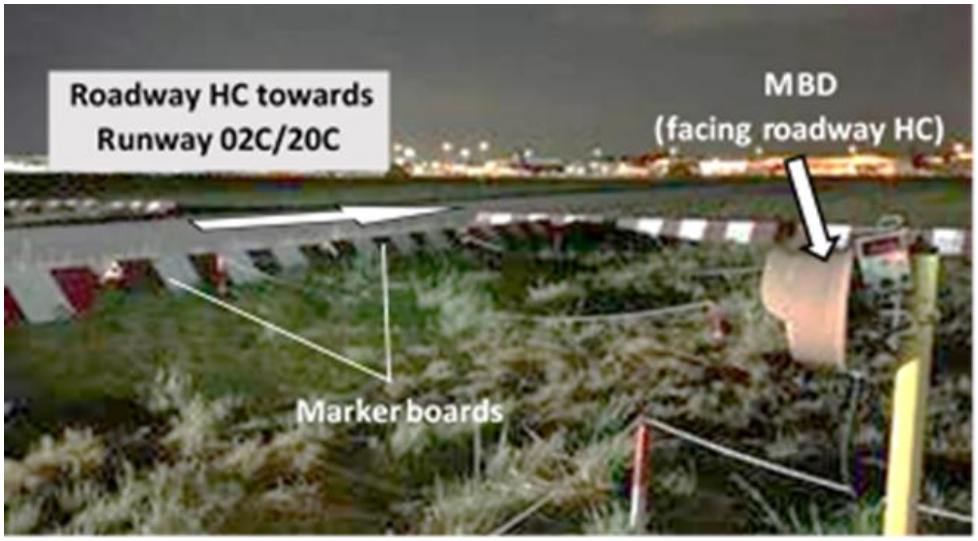


Figure 3: Position of marker boards during the incident.

1.2 Injuries to persons

1.2.1 There was no injury to any person.

[8] The marker boards were used by the aerodrome operator to cordon off the construction site next to roadway HC and to prevent construction personnel and equipment from straying out of the construction site.

1.3 Personnel information

1.3.1 Driver

Working experience	• 4 years as maintenance vehicle driver in Changi Aerodrome
Changi Category 1 Airfield Driving Permit (CAT 1 ADP)	Since 2012

1.3.2 OJT Controller

Working experience	• Passed the Changi Aerodrome simulator training • Had been undergoing OJT since September 2020
Valid ATC rating	No[9]

1.3.3 OJT Instructor

Working experience	• Obtained Changi Aerodrome rating on 3 November 2006 • Has been an OJT Instructor since 2009[10]
Valid ATC rating	Yes

1.4 Meteorological information

1.4.1 The incident occurred in daylight and there was no precipitation.

1.5 Aerodrome information

The following safety features are installed at roadway HC as defences to prevent and detect runway incursions:

- Road holding position
- Lighting systems

[9] To obtain a valid ATC rating, a controller on probation is required to undergo the OJT in a live traffic condition under the supervision of an instructor.
[10] The OJT Instructor had a 2-year non-controller job posting in 2015-2017.

- Drop arm barriers
- Microwave barrier detectors

1.5.1 Road holding position

1.5.1.1 A road holding position, marked by a white line across the road, is established about 124m away from the centreline of Runway 02C/20C. All vehicles have to stop before this white line prior to clearance being given to enter the runway.

1.5.2 Lighting systems

1.5.2.1 There are two lighting systems installed on roadway HC:

(a) Two flashing red lights, one at each side of the road holding position. They are meant to indicate the point of entry to the runway and are not controllable by the ATC; and

(b) Two sets of red/green traffic lights, one at each side of the road, located approximately 20m before the road holding position marking. The red/green traffic lights are controllable by the ATC.

1.5.3 Flashing red lights

According to the aerodrome regulatory authority, the flashing red lights are regarded as the road holding position lights required by the regulation, whereas the traffic lights were installed to provide additional visual indication to vehicle drivers using roadway HC.

1.5.4 Red/green traffic lights

The traffic lights were installed by the aerodrome operator and are controlled by the ATC using the AGLCMS control panel in the Control Tower. The colour of the lights indicated on the AGLCMS control panel corresponds to that of the traffic lights on the ground. The traffic lights are red by default to indicate to a driver that he does not have clearance from the ATC to enter the runway. Upon giving clearance to the driver to enter a runway, the ATC will switch the traffic lights to green. If the traffic lights' colour is not consistent with the ATC's clearance, a driver should verify the clearance instruction with the ATC before

proceeding to the runway, to avoid runway incursions.

1.5.5 Drop arm barriers

1.5.5.1 A set of two drop arm barriers (see **Figure 4**) was installed by the aerodrome operator about 8m before the traffic lights.

Figure 4: Drop arm barriers (for illustration).

1.5.5.2 There were two methods for raising the barriers:

(a) Using a switch installed in the Runway Entry/Exit Point (REP) Hut (see Figure 2) located next to the drop arm barriers

(i) The switch is “interlocked” with the traffic lights system, meaning that the switch can only be effectuated when the traffic lights are green.

(ii) Thus, for a vehicle waiting behind the drop arm barriers to enter the runway, the ATC’s clearance has first to be obtained and the traffic lights turned to green by the ATC, before the switch can be used to raise the drop arm barriers.

(b) Using a remote control

(i) Using a remote control obviated the need for maintenance personnel to alight from their vehicles to go into the REP Hut to operate the switch as described in (a) above. The raising of the barriers using the remote control is independent of the red/green traffic lights system.

(ii) The aerodrome operator allowed its contractors who carried out airfield maintenance and wildlife dispersal to use the remote control in order to expedite the performance of these operations, as the primary purpose of these drop arm barriers was to prevent vehicle users who were not familiar with the aerodrome layout (e.g. construction vehicles working in the vicinity) from straying into the runway via roadway HC.

1.5.5.3 The drop arm barriers are meant for construction contractors who are working in the vicinity but who are not necessarily familiar with the aerodrome layout, to prevent them (including their drivers) from straying unknowingly into the runway. They are not meant for personnel working on the airside who should be familiar with the aerodrome layout (e.g. the aerodrome's contractors performing airfield maintenance and wildlife dispersal).

1.5.5.4 As the owner of the traffic lights and the drop arm barriers, the aerodrome operator integrated the drop arm barriers system to the traffic lights system. Technically, the drop arm barriers serve only the aerodrome operator's needs and the ATC does not need to know about the interlocking arrangement as the prevention of vehicular incursion into the runway relies on the ATC issuing a clearance and turning the traffic lights green.

1.5.6 Microwave barrier detectors (MBD)

1.5.6.1 There are two MBDs installed along roadway HC, one a short distance after the flashing red lights, the other about 25m away from the first and towards the runway. For the MBD[11] system at roadway HC to give a visual and aural alert to the ATC if there is an unauthorised entry of vehicle into the runway during runway operations, the MBD that is nearer the flashing red lights must detect the vehicle crossing.

1.5.6.2 The MBD system is linked to the traffic lights system on roadway HC. Should the MBD detect a vehicle crossing the road holding position when the traffic

[11] MBD systems are also installed at taxiways leading into runways to detect unauthorised aircraft entry.

lights are red, a visual and aural alert will be presented to the ATC on the AGLCMS.

1.5.6.3 In this incident, there was no visual and aural alert on the AGLCMS when the Driver entered Runway 20C.

1.5.6.4 The MBD system is inspected every six months. The last inspection prior to the incident was carried out on 23 July 2020. The MBD was found to be working then.

1.5.7 Tests conducted on the MBD

1.5.7.1 Following the incident, the aerodrome operator conducted tests to determine how the marker boards would affect the MBD's detection capability. The results were:

(a) The MBD could detect a runway incursion by a large vehicle.

(b) The detection capability of the MBD was intermittent in the case of a small vehicle the size of Rover 39.

1.5.7.2 The six-monthly inspections of the MBD mentioned in paragraph 1.5.6.4 involved marker boards and vehicles larger than Rover 39, and there were no reports of intermittent detection during the inspections.

1.5.7.3 According to the MBD manufacturer's technical manual, stationary objects within the MBD detection zone could affect the MBD's detection capability. The aerodrome operator has a copy of the MBD manual but did not refer to it to identify the risk when placing the marker boards. The marker boards were installed in 2017 and the MBD system was deemed satisfactory by subsequent six-monthly inspections.

1.6 Medical and pathological information

1.6.1 The OJT Controller and the OJT Instructor underwent a medical check following the occurrence. There was no evidence of any medical/toxicological factors that could affect the performance of the OJT Controller and the OJT Instructor.

1.6.2 The Driver and his co-worker did not undergo a medical check. Such a medical

check was not required by the contractor nor the aerodrome operator.

1.7 Additional Information

1.7.1 Airside operations requirements

1.7.1.1 The aerodrome operator has an Airside Work Procedure Manual (AWPM) to document the airside work procedures. The aerodrome operator also requires airside personnel who operate vehicles on the runway to undergo mandatory training with a view to obtaining the CAT 1 ADP. The Category 1 Airside Driving Theory Handbook (CAT 1 ADTH) is the main reference for the training.

1.7.1.2 There were no procedures in the ADTH nor in the AWPM that dealt with what airside personnel should do when they encountered a red/green traffic light[12].

1.7.1.3 The contractor that was hired by the aerodrome operator to perform airfield maintenance had in 2016 developed an operating procedure for its maintenance vehicle drivers pertaining to entry into the runway for foreign object debris (FOD) removal and wildlife dispersal[13]. The operating procedure was based on the AWPM requirements. The aerodrome operator did not require the operating procedure to be submitted for review. The operating procedure, which was referred to by the Driver in this incident, was not updated by the contractor, after traffic lights were introduced into the airside in 2017, to include guidelines for its personnel to deal with requirements associated with the traffic lights.

1.7.2 Previous incident involving improper use of radio telephony (RT) phraseology

1.7.2.1 The TSIB investigated a runway incursion incident on 3 October 2013 where a maintenance vehicle entered the runway without clearance from the ATC. In that incident the ATC had transmitted *"… proceed for Runway 2, prepare to enter Runway 2 to pick up a bird carcass"* prior to the maintenance vehicle's

[12] The CAT 1 ADTH, AWPM and the operating procedure of the contractor included reminders to all vehicle drivers in the aerodrome to never cross a red stop bar light, but there was no reference to stopping at a red traffic light. The procedure as regards traffic lights was mentioned during CAT 1 ADP theory training in the context of runway closure. There was no similar procedure mentioned in the context of ad hoc runway inspections or wildlife dispersal.

[13] The operating procedure was initially designed for FOD removal. When wildlife dispersal was implemented in 2020, the same operating procedure was adopted for the portion on entry into the runway. Although the procedure for wildlife dispersal itself was different from FOD removal, the contractor did not revise the operating procedure to include the process specific to wildlife dispersal.

entering the runway.

1.7.2.2 The investigation found that the phrase *"…enter Runway 2"* could result in a miscommunication when, for example, the transmission was truncated or intermittent. The investigation also found that an improper readback by the driver of the maintenance vehicle was not challenged by the ATC and the opportunity to stop the maintenance vehicle from entering the runway was missed.

1.7.2.3 The investigation highlighted the importance of using proper RT phraseology and challenging an improper readback.

1.7.2.4 Following the investigation, the ATC reminded its controllers to always end the instruction specifically with *"Hold short of …"* when there was no intention to allow a vehicle to enter the runway immediately.

2 ANALYSIS

The runway incursion would probably not have happened if:

(a) the OJT Controller and the Driver had adhered to RT phraseology and proper readback; or

(b) the Driver had checked that the traffic lights were still indicating red and sought clarification about the ATC clearance to enter the runway; or

(c) Rover 39 had stayed behind the drop arm barriers until the ATC clearance to enter Runway 02C/20C had been given.

The investigation looked into the following issues:

(a) Communication between the OJT Controller and the Driver

(b) Interlocking of drop arm barriers and red/green traffic lights

(c) The Driver's non-adherence to the traffic light rules

(d) MBD detection of runway incursion

(e) Co-worker as a support to the Driver

(f) Requirement of medical examination

2.1 Communication between the OJT Controller and the Driver

2.1.1 There were two instances where RT phraseology and the practice of proper readback were not adhered to:

(a) At about 1332LT, the Driver called the OJT Controller to report that he was ready for wildlife dispersal. The OJT Controller gave the instruction "*…stand by to enter Runway 20C*". The Driver read back *"…entering Runway 20C…*".

(b) Later, the OJT Controller was asked by the OJT Instructor to repeat her instruction to the Driver. The OJT Controller repeated her instruction to the Driver, "*…stand by to enter Runway 20C*". The Driver just responded with "*39*, *copied*".

2.1.2 In both instances, the OJT Controller's instruction contained the phrase *"enter Runway 20C"*. Such a phrase in an instruction that is not a clearance to enter the runway immediately can create miscommunication, as shown in this incident and in the incident on 13 October 2013 (see paragraph 1.7.2).

2.1.3 CAT 1 ADP holders are trained on RT. However, the Driver's readback of "*Copied*" in response to the OJT Controller's repeated instruction was not in accordance with standard RT practice and it was not clear from such a response whether the OJT Controller's message was fully or correctly understood. Neither the OJT Controller nor the OJT Instructor requested for a proper readback.

2.1.4 This incident shows that adherence to RT phraseology and proper readback is key to prevent miscommunication.

2.2 Interlocking of drop arm barriers and traffic lights

2.2.1 To its credit, the aerodrome operator installed the drop arm barriers with a view to preventing its construction personnel and vehicles from straying unknowingly into the runway. The use of the barriers-raising switch in the REP Hut, which is interlocked with the traffic lights system, is meant to ensure that the drop arm barriers could not be raised without the ATC first having given a clearance to enter the runway and turned the traffic lights to green.

2.2.2 This interlocking strategy to prevent unauthorised entry into the runway is effective so long as vehicles are made to wait behind the drop arm barriers until the ATC issued the clearance to enter the runway and turned the traffic lights to green. However, the aerodrome operator's practice of allowing its contractors carrying out airfield maintenance and wildlife dispersal to raise the drop arm barriers via a remote control negated this strategy. While the aerodrome operator did not mean to apply this strategy to this category of contractors, who were deemed to be more familiar with the aerodrome's operational environment, this incident showed that this category of contractors did not necessarily perform better than the construction personnel in terms of adherence to driving safety. It might be desirable to have the strategy applied across the board to all personnel.

2.3 The Driver's non-adherence to the traffic light rules

2.3.1 After receiving what he thought was a clearance from the ATC to enter the runway, the Driver proceeded to enter the runway without checking the colour of the traffic lights.

2.3.2 Although the Driver was trained on traffic light rules, he had assumed that it would be all right to enter the runway even if the traffic lights were red and not consistent with the ATC clearance given. According to the Driver, there were past instances when he was conducting ad hoc runway inspections in which he did not wait for the traffic lights to turn green after the ATC had given the clearance to enter a runway. In this incident, as in these past instances, the Driver proceeded to enter the runway without checking the colour of the traffic lights.

2.3.3 The requirement to follow the traffic lights was not stated in the contractor's operating procedure. Although it is arguable whether such an obvious requirement needs to be explicitly stated in any operating procedure, it cannot be over-emphasised that airside drivers should pay attention to traffic lights and should obtain clarification from the ATC whenever the traffic lights colour is not consistent with the ATC clearance.

2.4 MBD detection of runway incursion

2.4.1 In this incident, the MBD did not detect the runway incursion by the Driver and did not trigger an alert on the AGLCMS. Its detection capability was compromised by marker boards that were placed in front of the MBD.

2.4.2 The MBD manufacturer's technical manual included guidance on site preparation for the placement of MBD and warned that stationary objects within the MBD detection zone could affect the MBD's detection capability. Had the aerodrome operator referred to the manufacturer's guidance, it is unlikely that the marker boards would have been placed in front of the MBD.

2.5 Co-worker as a support to the Driver

2.5.1 The co-worker was preparing messages for their report on the wildlife inspection on his mobile phone and did not pay attention to the radio communication nor notice the colour of the traffic lights when the Driver was

entering the runway.

2.5.2 The co-worker could have been a valuable resource to help ensure safe operations. The investigation team noted that the co-worker was not required to assist the Driver in listening to RT and monitoring the traffic lights prior to entering the runway. Had the co-worker been listening to the RT and monitoring the traffic lights, he could have alerted the Driver of the inconsistency between the traffic lights colour and the ATC's instruction. The miscommunication could have then been detected and the incident avoided.

2.6 Requirement for Medical Examination

2.6.1 The aerodrome operator did not require the Driver to undergo a medical and toxicological examination after an incident. Although the investigation did not suspect that the Driver was impaired when operating the vehicle, it would have been desirable for a medical or toxicological examination to be carried out. Such examination can help rule out the possibility that persons involved in an occurrence, while operating vehicles, are impaired by any effect from any consumption of medicine, drugs or alcohol.

3 CONCLUSIONS

From the information gathered, the following findings are made. These findings should not be read as apportioning blame or liability to any particular organisation or individual.

3.1 The OJT Controller and the Driver used non-standard RT in their communication with each other.

3.2 The Driver entered the runway after hearing what he thought was a clearance from ATC. He did not check the colour of the traffic lights which were showing red at that time.

3.3 The MBD did not trigger an alert to warn the ATC of the runway incursion because its detection capability was compromised by the presence of marker boards in front of the MBD.

3.4 The aerodrome operator did not refer the MBD manufacturer's technical manual for guidance before placing the marker boards in front of the MBD.

3.5 The aerodrome operator had allowed the use of a remote control to raise the drop arm barriers and had allowed its airfield maintenance contractor's vehicles to wait in the area between the drop arm barriers and the traffic lights. This negated its safety strategy of interlocking the drop arm barriers and traffic lights.

3.6 While the investigation team did not suspect that the Driver was impaired during the incident, it would be desirable for personnel to under medical examination at the aftermath of an incident to rule out any possibility impairment due to medicine, drugs and alcohol.

4 SAFETY ACTIONS

Arising from discussions with the investigation team, the organisation has taken the following safety action.

Safety action in the aftermath of the incident

4.1 Immediately following the incident, the aerodrome operator issued a circular on 17 November 2020 to remind all drivers accessing the runway via a roadway that they could only enter the runway when the following conditions were met:

(a) The ATC has issued verbal clearance; and

(b) The traffic lights are turned to green;

and that they were not to cross red traffic lights even if ATC clearance had been given.

Radio telephony communication

4.2 To ensure compliance with standard RT phraseology, the aerodrome operator has:

(a) reviewed all its document and removed the non-standard phraseology word *"Copied"* from all relevant documents;

(b) conducted a one-off safety briefing to all CAT 1 ADP drivers on RT phraseology; and

(c) begun conducting checks on RT communications between Tower and CAT 1 ADP drivers on operations relating to runway entries/exits and route clearances.

4.3 The air traffic service provider has briefed all tower controllers on lesson learnt from this incident. In particular, it reminded the controllers that:

(a) the phrase *"…enter Runway…"* should be omitted from an instruction where there is no intention of clearing a vehicle into the runway;

(b) the correct RT is just *"Stand by"* when there is no clearance to enter the runway and the intention is to ask the driver to wait for further instruction; and

(c) to use RT such as *"Negative, negative*" when the controller believes that the driver has misunderstood an instruction.

Microwave Barrier Detectors (MBDs)

4.4 To ensure the effectiveness of the MBDs in the aerodrome, the aerodrome operator has:

(a) Moved the marker boards and checked that marker boards elsewhere are not blocking the MBD (see **Figure 5**);

Figure 5: New marker boards positioned at roadway HC behind MBD.

(b) required its officers to conduct visual checks during runway maintenance to ensure there is no obstruction in front of MBDs;

(c) included MBD in the list of items to be inspected by its construction safety inspectors; and

(d) revised the testing methodology in the MBD to include walk test in addition to the existing vehicle test.

Ad hoc runway entry and exit procedure

4.5 The aerodrome operator has stopped the practice of letting its airfield maintenance contractors use the remote control to raise the drop arm barriers. Henceforth, maintenance vehicles wishing to enter the runway will need to first obtain a clearance from the ATC and wait for the ATC to turn the traffic lights to green. Both the driver and the co-worker are required to ascertain that the traffic lights are green before the co-worker activates the switch in the REP Hut to raise the drop arm barriers.

4.6 In addition, the aerodrome operator requires the co-worker to have CAT 1 ADP licence. Both the driver and the co-worker are to ascertain that they have received clearance from ATC before entering the runway.

Oversight on contractors working at aircraft manoeuvring areas

4.7 The aerodrome operator has included a new requirement for all contractors working in the airside to submit their operating procedures that can have an impact on the safety of the aerodrome's aircraft manoeuvring areas. Works will only be allowed to commence after the aerodrome operator is satisfied that the operating procedure comply with its requirements.

Documentation of procedures

4.8 The aerodrome operator revised its AWPM on 25 November 2020 to incorporate the new process as described in paragraph 4.5 above. The aerodrome operator ensured that the airfield maintenance contractor had incorporated the new procedure in its operating procedure.

4.9 The aerodrome operator has amended the CAT 1 ADTH to make it clear that at roadways equipped with traffic lights, "Drivers shall not enter the runway when the traffic lights are red."

5 SAFETY RECOMMENDATION

A safety recommendation is for the purpose of preventive action and shall in no case create a presumption of blame or liability.

It is recommended that:

5.1 The aerodrome operator require airside workers who are involved in an aerodrome incident be sent for a medical/toxicological examination as soon as is practicable. [TSIB RA-2021-002]