Final Report

RUNWAY INCURSION BY A VEHICLE IN CHANGI AIRPORT

3 JUNE 2022

TIB/AAI/CAS.208

Transport Safety Investigation Bureau
Ministry of Transport
Singapore

18 May 2023

The Transport Safety Investigation Bureau of Singapore

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ABBREVIATIONS

ADP	Airfield Driving Permit
AMA	Aircraft Manoeuvring Area
A-SMGCS	Advanced Surface Movement Guidance and Control System
ARFF	Airport Rescue and Fire Fighting Service
ATC	Air Traffic Control
CET	Changi East Tower
FS	Fire Station
MBD	Microwave Barrier Detector
RWC	Runway Controller
UV	Utility Vehicle

SYNOPSIS

On 3 June 2022, a runway incursion occurred at Runway 3 of Changi Airport involving a utility vehicle (UV) of the Airport Rescue and Fire Fighting Service.

The UV driver intended to drive along Taxiway MY (which is parallel to Runway 3) to return to Fire Station 3. However, the UV driver mistook Taxiway MY1 (which leads to Runway 3) for Taxiway MY and the UV ended up approaching the stop bar lights at the runway holding position on Taxiway MY1. When the UV driver contacted the Changi East Tower to request for permission to use Taxiway MY, the stop bar lights at the runway holding position were turned off by the Runway Controller (RWC). The UV driver drove forward and eventually entered Runway 3. The UV driver then realised that he had entered the runway and he made a U-turn back to Taxiway MY1 and returned to Fire Station 3 via Taxiway MY.

In the meantime, the flight crew of an aircraft that was about to enter the runway for take-off also saw the UV on Runway 3 and alerted the RWC.

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 History of the flight/Sequence of events

1.1.1 On 3 June 2022 at about 2234LT, the driver of a utility vehicle (UV) of the Airport Rescue and Fire Fighting Service (ARFF), with a passenger on board[1], left Fire Station 2 (FS 2) on the western side of Changi Airport for Fire Station 3 (FS 3) on the eastern side of the airport. The UV driver planned to travel on the airport's west perimeter road and north perimeter road, then the service road along the airport's east perimeter fence (hereinafter referred to as the perimeter fence road) to reach Taxiway Y2, and then Taxiway MY to get to FS 3 (see **Figure 1**).

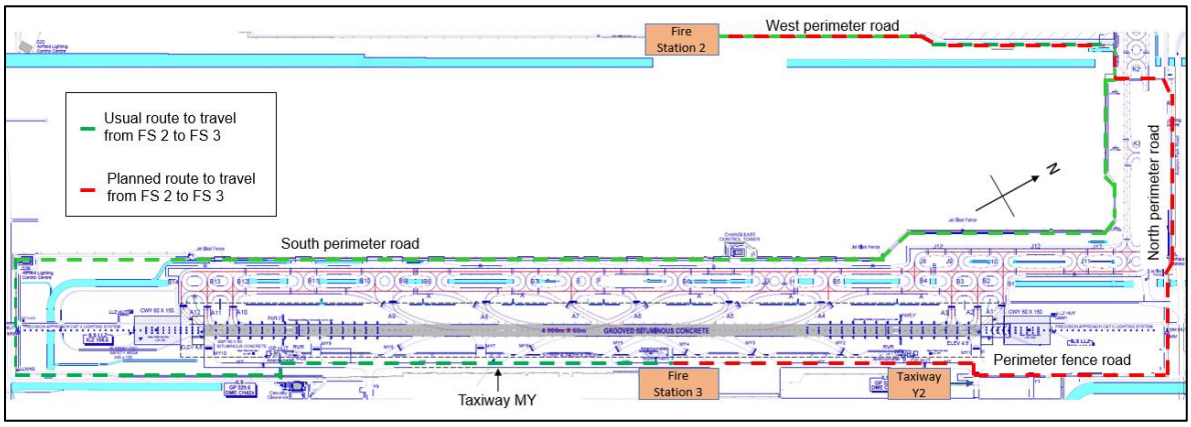

Figure 1: UV's planned route and usual route from FS 2 to FS 3

1.1.2 This route of west perimeter road-north perimeter road-perimeter fence road that the UV driver planned to use was recently opened in February 2022 after the completion of construction works. The UV driver learnt about this alternative route by word-of-mouth from some of his colleagues who had attended some ARFF trials for this routing and the UV driver understood that using this route, from the north perimeter road onwards, would involve the following:

[1] The UV driver and the passengers were qualified drivers of the ARFF and holders of Changi Category (CAT) 1 Airfield Driving Permit (ADP).

(a) A driver shall proceed along the perimeter fence road to Taxiway Y2.

(b) The driver shall contact the Runway Controller (RWC) of the Changi East Tower (CET) via walkie-talkie to request for permission to enter Taxiway Y2 as well as for permission to enter Taxiway MY thereafter[2].

(c) On the way to FS 3, there is a holding position on Taxiway MY (hereinafter referred to, for ease of reference in this report, as holding position A (see **Figure 2**)). There are red stop bar lights located at the holding position A[3].

(d) The driver, when seeking permission from the RWC in step (b) to enter Taxiways Y2 and MY, shall also seek the RWC's permission to travel on Taxiway MY to the holding position A.

(e) When approaching the holding position A, the driver shall inform the RWC about this. This is for the RWC to know that the driver will be leaving the RWC's area of responsibility and will be going into a next segment of Taxiway MY which is under the control of another controlling agency. (For ease of reference in this report, the controller of this other controlling agency is hereinafter referred to as Controller B)

(f) After crossing the holding position A, the driver shall establish contact with Controller B to request for permission to continue travelling on Taxiway MY to FS 3.

1.1.3 This was the first time the UV driver used the route as an alternative to his usual route via the west perimeter road, along the airport's inner boundary fence, the southern perimeter road and then Taxiway MY to get to FS 3. He opted to use this alternative route because it was shorter than his usual route. The UV driver and his passenger had not used the perimeter fence road and the roadways in the area around Taxiways Y2/MY before.

1.1.4 The UV driver, after arriving at Taxiway Y2 from the perimeter fence road, contacted the RWC via walkie-talkie to request for permission to enter Taxiway Y2 and then Taxiway MY and travel to the holding position A. The RWC gave the permission. The UV driver turned right from the perimeter fence road onto

[2] Going from the perimeter fence road to Taxiway MY involves turning right from the perimeter fence road onto Taxiway Y2 and, almost immediately, turning left from Taxiway Y2 onto Taxiway MY.

[3] Red stop bar lights are designed to be only visible in one direction. The red stop bar lights at the holding position A are facing south. A driver who is travelling on Taxiway MY from the north (e.g. towards FS 3) will not be able to see the lit red stop bar lights.

Taxiway Y2 but he did not turn left onto Taxiway MY, whose taxiway edge lights were not turned on as no aircraft had been expected to use the taxiway that night. Instead, he travelled on Taxiway Y2 towards a line of red stop bar lights on Taxiway MY1 (see **Figure 2**). (Note: Taxiway MY1 leads to Runway 3 and the red stop bar lights are located at the runway holding position. See paragraph 1.6.1.1.) The UV driver's understanding was that he should look out for the red stop bar lights at the holding position A[4]. He had mistaken the red stop bar lights on Taxiway MY1 for the red stop bar lights at the holding position A. There are markings on the ground and signs on either side of the red stop bar lights at the runway holding position on Taxiway MY1 to indicate that Runway 3 is ahead. However, the recording of the in-vehicle camera showed that the UV driver was checking his handphone on the procedure for communicating with the RWC and that he did not look out for the signs and markings.

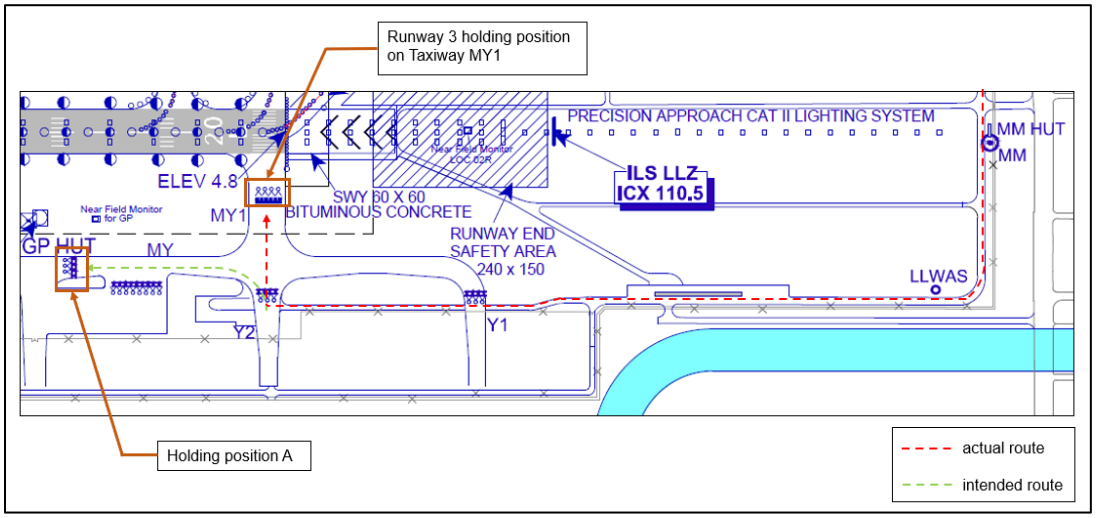

Figure 2: UV driver mistaking Taxiway MY1 for Taxiway MY

1.1.5 While on Taxiway Y2 and approaching the lit red stop bar lights on Taxiway MY1, the UV driver called the RWC to inform the latter that he was approaching the holding position A. Without checking the position of the UV, the RWC

[4] The UV driver was not aware that the directionality of the red stop bar lights at the holding position A was such that he would actually not see any lit stop bar lights at all if he was travelling southward towards FS 3.

turned off the red stop bar lights[5] on Taxiway MY1 and informed the UV driver that the stop bar lights had been turned off.

1.1.6 Upon being informed and seeing that the stop bar lights were turned off, the UV driver proceeded forward, without realising that he was entering the runway. The RWC, after informing the UV driver that the stop bar lights had been turned off, shifted her attention to an aircraft that was travelling on Taxiway A1 (hereinafter referred to as Aircraft C) and gave the flight crew of Aircraft C a take-off clearance.

1.1.7 Right after crossing the red stop bar lights and while still being on Taxiway MY1 but believing that he was on Taxiway MY, the UV driver stopped the UV and contacted Controller B to request for permission to transit along Taxiway MY to FS 3. Controller B acceded to the request[6]. While the UV driver was communicating with Controller B, the RWC tried to contact the UV driver to request him to confirm that the UV was on the runway[7]. The transmission was garbled and the RWC's request was missed by the UV driver. The RWC did not pursue with the UV driver for a response and turned to other tasks.

1.1.8 Also, while the UV driver was pausing on Taxiway MY1 after crossing the stop bar lights and communicating with Controller B for permission to transit along Taxiway MY to FS 3, the stop bar lights came on again automatically[8]. The presence of the UV was detected by the microwave barrier detector (MBD), resulting in the Advanced Surface Movement Guidance and Control System (A-SMGCS) generating a visual alert indicating a runway incursion on the RWC

[5] The investigation team noted from the recording of the Advanced Surface Movement Guidance and Control System (A-MSGCS) that the RWC had moved the cursor on the A-SMGCS control screen to the position of the red stop bar lights on Taxiway MY1 and clicked there to turn off the stop bar lights. The RWC told the investigation team very much later that she thought that the UV was at the stop bar lights at the holding position on Taxiway Y2 and that she might have mistaken the stop bar lights at the runway holding position on Taxiway MY1 as the stop bar lights at the holding position on Taxiway Y2 when the UV driver contacted her. However, the stop bar lights at the holding position on Taxiway Y2 were not in operation and were shown in blue on the A-SMGCS control screen. The RWC knew that when the stop bar lights shown in blue meant that these stop bar lights were not in operation. She could not explain why she needed to turn off the stop bar lights at the holding position on Taxiway Y2 when these lights were not in operation at all.

[6] Controller B did not have line of sight to the holding position A or any equipment that could allow him to know that the UV was at the holding position A. Since the incident, a kind of detection system has been installed to allow Controller B to know if the vehicle requesting for permission to transit along Taxiway MY in the direction of FS 3 is at holding position A.

[7] The RWC could not explain to the investigation team as to what had prompted her to ask the UV driver to confirm that the UV was on the runway.

[8] After the red stop bar lights have turned off, they will come on automatically again after 60 seconds.

and the CET Leader's A-SMGCS control screen[9] (see **Figure 3**).

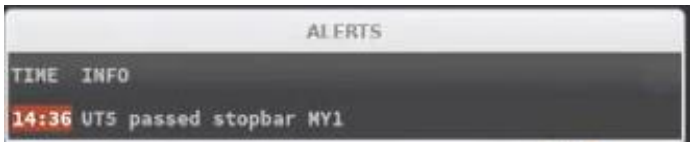

Figure 3: Visual alert when the UV (callsign UT5) was detected by the MBD

1.1.9 The A-SMGCS also generated an aural warning in the form of a "Runway Incursion" annunciation at both the RWC and the CET Leader's control stations. (More on A-SMGCS, aural alarm and visual alert in paragraph 1.6.2). However, both the CET Leader and the RWC told the investigation team that they were not looking at the A-SMGCS screen and did not hear any aural warning.

1.1.10 Around this time, the flight crew of Aircraft C that had been given a take-off clearance by the RWC (see paragraph 1.1.5) asked the latter to confirm the take-off clearance. In response, the RWC asked the flight crew of Aircraft C to ignore the take-off clearance and instructed it to line up and wait. The flight crew acknowledged the RWC's new instruction. When aircraft C was about to enter the runway, the flight crew saw the UV. They stopped the aircraft on Taxiway A1 and alerted the RWC of the presence of the UV on the runway. At about this time, the passenger in the UV suddenly realised that the UV was on the runway and he pointed this out to the UV driver. The UV driver quickly made a U-turn with the aim of exiting the runway.

1.1.11 Upon being alerted by the flight crew of Aircraft C, the RWC looked out of the CET cabin and saw the UV on the runway and tried contacting the UV driver via walkie-talkie but there was no response from the UV driver.

1.1.12 After U-turning from the runway and before exiting the runway, the UV stopped before the runway holding position marking. The UV driver contacted the RWC four times[10] via walkie-talkie to seek permission to cross the runway holding

[9] The MBD's detection function is always in operation whether the associated red stop lights are turned on or not. However, the A-SMGCS will be ready to generate a runway incursion alert only when the associated red stop bar lights are turned on.

[10] The RWC was giving holding instructions to another aircraft when the aircraft got transferred from ground control position to runway control position.

position marking[11]. The RWC responded to the fourth call by the UV driver and instructed him to vacate the runway immediately. The UV driver then crossed the runway holding position marking and turned right onto Taxiway MY. At the holding position A, he obtained the necessary permission to go beyond the holding position A to reach FS 3.

1.1.13 The UV had dwelled on the runway for about one minute.

1.2 Injuries to persons

1.2.1 There was no injury to any person.

1.3 Personnel information

1.3.1 Runway Controller (RWC)

Age	33 years old
ATCO license validity	31 July 2024
Ratings	Changi Tower and Seletar Tower
Total experience	7 years as ATC Controller
Experience in position manned	5 years at Changi Tower
Duty time in last 48 hours	0 hour
Rest period in last 48 hours	48 hours

1.3.2 CET Leader

Age	53
ATCO licence validity	30 September 2022
Ratings	Changi Tower and Seletar Tower
Total experience	28 years as ATC Controller
Experience in position manned	1 year 2 months
Duty time in last 48 hours	0 hour
Rest period in last 48 hours	48 hours

[11] There is no requirement for a driver to seek permission to cross the runway holding position marking when exiting the runway, as the stop bar lights are facing away from the runway. The RWC also does not need to turn off the stop bar lights for the UV to exit the runway.

1.3.3 UV Driver

Age	30 years old
Changi Category 1 Airfield Driving Permit (CAT 1 ADP)	Since 2018
Time on duty	4.5 hours
Duty time in last 48 hours	14 hours 44 mins
Rest period in last 48 hours	33 hours 16 mins

1.3.4 UV Passenger

Age	33 years old
Changi Category 1 Airfield Driving Permit (CAT 1 ADP)	Since 2015
Time on duty	4.5 hours
Duty time in last 48 hours	13 hours 39 mins
Rest period in last 48 hours	34 hours 21 mins

1.4 Meteorological information

1.4.1 According to the weather reports at 2230h and 2300h, visibility was 10,000m. There was no precipitation at the time of the incident.

1.5 Communications

1.5.1 The walkie-talkies of the UV driver and the RWC were tested after the incident. The transmission using the walkie-talkies was clear.

1.6 Aerodrome information

1.6.1 Lightings and ground markings

1.6.1.1 All taxiways leading to a runway have each a holding position for aircraft and vehicles. To prevent unauthorised entry to Runway 3, the following visual aids are installed at the runway holding position of Taxiway MY1 (see **Figure 4**) to remind flight crews and vehicle drivers that they need permission before moving beyond the holding point to enter the runway:

(a) Red stop bar lights embedded on the ground[12] across the runway holding position

(b) Location signs and runway guard lights on both sides of the taxiway

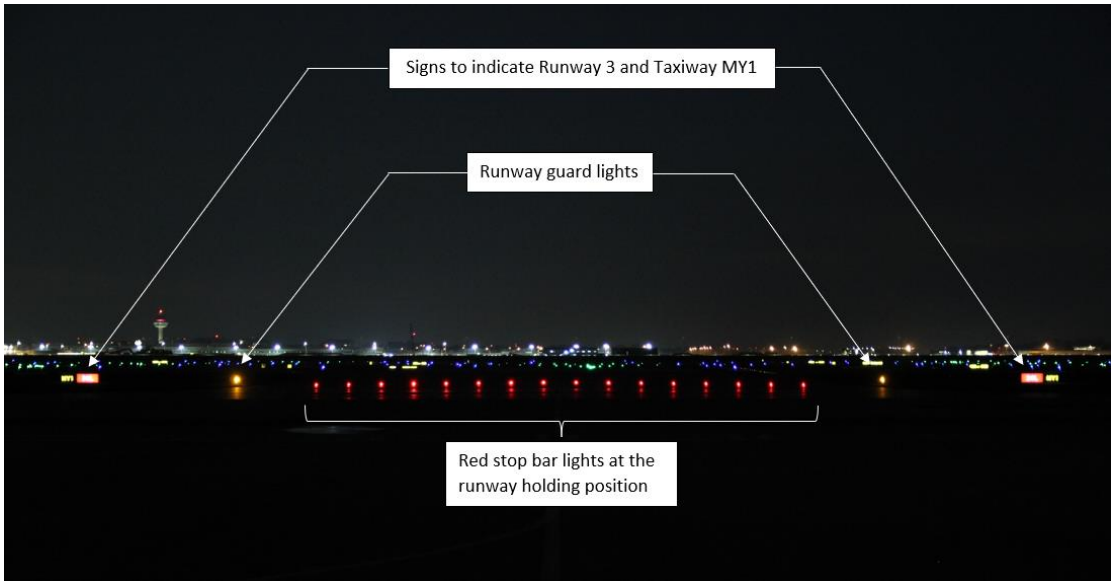

Figure 4: Lightings and signs at Taxiway MY1 runway holding position

1.6.1.2 There are also ground markings to indicate that the runway is ahead of the runway holding position (see **Figure 5**):

(a) Runway holding position markings and mandatory instruction markings on the ground across the taxiway

(b) Enhanced taxiway centreline marking

[12] During normal runway operations, the red stop bar lights are turned on and remain on to remind flight crews and vehicle drivers not to enter the runway even if clearance had been given by the Air Traffic Control (ATC). The ATC will turn off the stop bar lights to allow aircraft or vehicles to enter the runway. The stop bar lights will come on again automatically after 60 seconds.

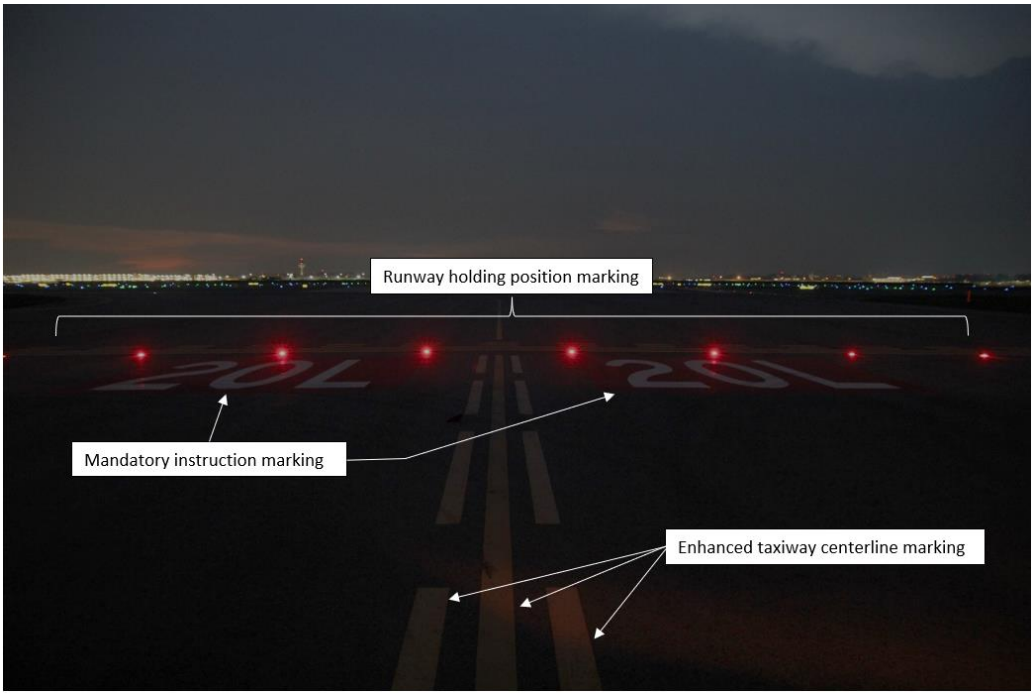

Figure 5: Ground markings at the runway holding position

1.6.1.3 The investigation team visited Taxiway MY1 and established that the location signs, the runway guard lights and the stop bar lights, when lit, can be seen by a vehicle driver as he or she approaches the red stop bar lights.

1.6.2 Advanced Surface Movement Guidance and Control System (A-SMGCS)

1.6.2.1 The A-SMGCS is to augment, for the ATC controllers, visual observation of traffic on the aircraft manoeuvring area and to provide surveillance of traffic on those parts of the manoeuvring area which cannot be seen from the control towers.

1.6.2.2 There are two control positions at the CET: Ground and Runway. There is also one CET Leader position. Each position has an A-SMGCS terminal which comprises a control screen, a speaker, a keyboard and a mouse. The A-SMGCS presents traffic information on the control screens and can generate an aural alarm and a visual alert when there is a runway incursion:

(a) Aural alarm is in the form of an audio message of “Runway Incursion, Runway 3”, played through built-in speakers connected to the system. The aural alarm is programmed to sound only once.

(b) Visual alert is in the form of a text message on A-SMGCS control screens, and stays displayed for five minutes, unless it has been acknowledged by the controller within the five minutes.

1.6.2.3 Ground and Runway control positions have different areas of responsibility and a controller at the Ground or Runway control position will only receive aural alarms and visual alerts pertaining to the controller's area of responsibility. A controller at the Leader position will receive aural alarms and visual alerts for the whole aerodrome. As such, only the RWC and the CET Leader received alerts for this runway incursion occurrence. The controller at the Ground position did not receive any aural or visual alert.

1.7 Recorded Information

1.7.1 The A-SMGCS and relevant ATC recordings were made available to the investigation team:

(a) The recording of the A-SMGCS visual display showed that there was a STOPBAR visual alert (see **Figure 6**) and alert message triggered by the UV when it passed the runway holding position at Taxiway MY 1 (see **Figure 3**). According to the RWC, she did not notice the visual alert and alert message.

(b) CET cabin ambient recordings registered a corresponding aural warning[13] for the runway incursion by the UV.

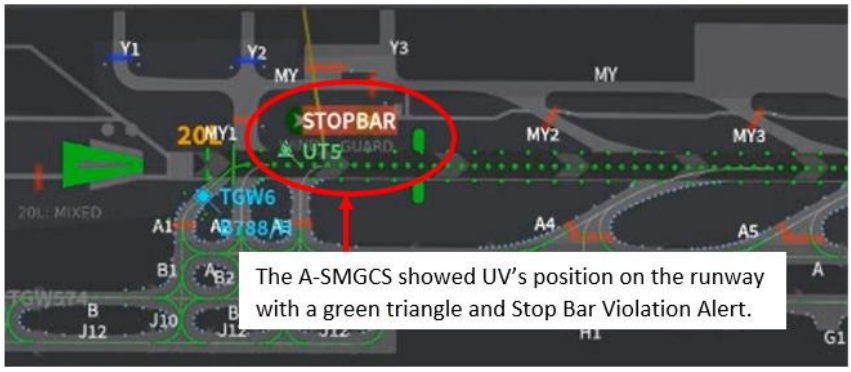

Figure 6: The A-SMGCS display at 22:46:13LT

[13] In the opinion of the investigation team, the "Runway Incursion" annunciation is rather soft and lacks forcefulness.

1.8 Additional information

1.8.1 Category 1 Airfield Driving Permit (CAT 1 ADP)

1.8.1.1 Both the UV driver and the passenger held valid CAT 1 ADP. To obtain a CAT 1 ADP, an individual must meet the requirements set by the aerodrome operator, including a satisfactory completion of the Airfield Rules and Regulations course and a practical test, both conducted by the aerodrome operator. Drivers may use any usable route in the aerodrome so long as they comply with the airfield rules and regulations.

1.8.1.2 Based on aerodrome operator's requirements on airfield driving, all radiotelephony (RT) should be performed by the CAT 1 ADP driver and only the driver is allowed to operate the RT set to communicate with the Changi Tower for all matters while driving on the Aircraft Manoeuvring Area (AMA). The passenger is not allowed to assist the driver in the communication task.

1.8.1.3 The ARFF regularly organises familiarisation exercises and tests, in both night and day conditions, to familiarise its drivers of the AMA and other locations in the aerodrome before assigning them for driving duty. ARFF drivers may consult the aerodrome map available in all ARFF vehicles to familiarise themselves with the intended route before drive-off. ARFF drivers operating out of FS 3 are also subjected to annual refresher training.

1.8.2 SOP for issuing take-off clearance

1.8.2.1 ATC controllers are required to scan the runway before any movement into or out of the runway. In particular, when giving take-off or landing instructions, controllers are required to scan the full length of the runway to ascertain whether the runway is occupied. When in doubt, they are expected to double-check using the A-SMGCS.

1.8.3 If, after the issuance of a take-off or landing clearance, the ATC controller becomes aware of a runway incursion or of an imminent runway incursion that can affect the safety of an aircraft taking off or landing, the ATC controller concerned is expected to take appropriate actions such as cancelling the take-off clearance and informing the departing aircraft of the runway incursion and the location of the intruding entity.

2 ANALYSIS

The runway incursion is a result of the UV entering the runway after the RWC turned off the red stop bar lights at the runway holding position on Taxiway MY1. The investigation looked into the following:

(a) The UV driver's preparation for the travel from FS 2 to FS 3

(b) Additional resource for drivers

(c) The RWC's actions

(d) The alert system of the A-SMGCS

2.1 The UV driver's preparation for the travel from FS 2 to FS 3

2.1.1 As mentioned in Footnote 2 in paragraph 1.1.2(b), going from the perimeter fence road to Taxiway MY involved turning right from the perimeter fence road onto Taxiway Y2 and, almost immediately, turning left from Taxiway Y2 onto Taxiway MY. However, it was the first time the UV driver took this route and he was not familiar with the roadways around the area of Taxiways Y2/MY. He did not immediately turn left onto Taxiway MY after entering Taxiway Y2. Instead, he went straight from Taxiway Y2 towards Taxiway MY1.

2.1.2 The UV driver knew that, on the way to FS 3, he needed to stop at the holding position A which was co-located with red stop bar lights. He was expecting to see red stop bar lights at holding position A. However, he was not aware that the red stop bar lights were facing south and that he would not see any lit red stop bar lights if he was travelling on Taxiway MY from the north (i.e. towards FS 3). Had he been aware, he would not have needed to look out for the red stop bar lights at the holding position A and would have realised that he was not on the right track when he saw the red stop bar lights at the runway holding position on Taxiway MY1.

2.1.3 There were markings on the ground and signs on either side of the red stop bar lights at the runway holding position on Taxiway MY1 to indicate that Runway 3 was ahead. However, the UV driver did not look out for them as he was busy

checking his handphone on the procedure for communicating with the RWC[14] and missed all the signs indicating that the runway is ahead.

2.1.4 The UV driver's mental picture was that he was expecting to see red stop bar lights at the holding position A, thus his attention was most probably drawn to red stop bar lights at the runway holding position on Taxiway MY1. In addition, the RWC's turning off the red stop lights on Taxiway MY1 (after she was informed by the UV driver that he was approaching the holding position A) probably reinforced the UV driver's perception that he was at the holding position A.

2.1.5 Taxiway MY's taxiway edge lights were not turned on at the time of the incident. One might argue that, had the edge lights been turned on, the UV driver could have been alerted that he should turn left onto Taxiway MY. However, given that the UV driver's fixation on the red stop lights at the runway holding position on Taxiway MY1 and that he was busy checking his handphone on the procedure for communicating with the RWC, it is by no means certain that the UV driver would notice Taxiway MY's taxiway edge lights even if they were on[15].

2.1.6 In short, the UV driver lost situational awareness. He did not prepare adequately for using roadways in an unfamiliar area. He was also not familiar with the communication procedures with the RWC and needed to refer to his handphone. This resulted in his missing the visual cues. There is room for improvement for the ARFF to ensure that its drivers are familiar with the system of roadways when traveling in the AMA.

2.2 Additional resource for drivers

2.2.1 Where more than one person is involved in an endeavour, it is not uncommon to consider the people involved as a crew or a team and to consider their interaction in a framework of crew resource management (CRM). The areas of application of CRM practice have over the years extended from the cockpit, where pilots interact, to the entire aircraft cabin, where flight crew and cabin

[14] As it was his first time using this route and as he knew he had to communicate with the RWC, the UV driver had prepared a script on his handphone on the procedure for communicating with the RWC. For the usual route via the west perimeter road (i.e. along the airport's inner boundary fence, the southern perimeter road and then Taxiway MY to get to FS 3), there is no need to communicate with the RWC.

[15] The aerodrome operator has since the incident arranged for Taxiway MY's taxiway edge lights to be turned on at night whether or not there will be any expected aircraft movement on the taxiway.

crew interact, to control towers, where ATC controllers interact, etc.

2.2.2 At the time of this runway incursion, the aerodrome operator's driving rules only allowed the drivers to operate the radiotelephony set. The investigation team believes that the passenger, who was also a holder of CAT 1 ADP, was a qualified and useful resource to the UV driver for communicating with ATC. Using this resource would allow the UV driver to better focus on the task of navigating on the aerodrome and maintaining situation awareness visually.

2.2.3 Thus, from a CRM point of view, it seems that there is merit in allowing a passenger who holds CAT 1 ADP to share a driver's workload in communicating with ATC.

2.3 The RWC's actions

2.3.1 The investigation team could not understand why the RWC turned off the red stop bar lights at the runway holding position on Taxiway MY1. At the beginning of the investigation, the RWC could not offer an explanation. It was only very much later that the RWC explained that she had thought that the UV was at the stop bar lights at the holding position on Taxiway Y2 and that she might have mistaken the stop bar lights at the runway holding position on Taxiway MY1 as the stop bar lights at the holding position on Taxiway Y2 when the UV driver contacted her. Still, the RWC could not explain why she needed to turn off the stop bar lights at the holding position on Taxiway Y2 when these lights were not in operation at all.

2.3.2 Another action on the part of the RWC that the investigation team could not understand was that, as mentioned in paragraph 1.1.6, when she tried to contact the UV driver to request him to confirm if the UV was on the runway. The RWC could not explain what had prompted her to do that. If she had any premonition that the UV had entered the runway, she could have verified this through the A-SMGCS. In this occurrence, the transmission was garbled, the UV driver did not receive the RWC's request, and the RWC did not pursue with the UV driver for a response and turned to other tasks. The RWC could not explain why she did not pursue with the UV driver for a response.

2.3.3 The standard operating procedures required the RWC to check the runway occupancy before issuing any take-off instruction to an aircraft. However, the RWC gave a take-off clearance to an aircraft after she turned off the red stop

bar lights for the UV driver to cross the runway holding position at Taxiway MY1. Had she scanned the runway by looking outside the cabin or had she double-checked using the A-SMGCS, she would have noticed the UV on the runway and would not have given the take-off clearance to the aircraft. The RWC could not explain her action for not following the standard operating procedures.

2.3.4 The investigation team had difficulty understanding the RWC's actions. It seemed that the RWC might not have been paying attention to her tasks.

2.4 The warning system of the A-SMGCS

2.4.1 The A-SMGCS presents traffic information on the CET Leader and the RWC's control screens and can generate an aural alarm (which sounds only once) and a visual alert when there is a runway incursion occurrence. The CET Leader and the RWC failed to notice the visual warning. The Leader was being briefed by the previous shift leader for shift handover and was not looking at his control screen. The RWC could not explain why she did not see the visual warning alert.

2.4.2 The CET Leader and the RWC also failed to notice the aural warning in the form of an annunciation of "Runway Incursion, Runway 3". As mentioned in Footnote 13 in paragraph 1.7.1, the annunciation appeared rather soft and lacked forcefulness.

2.4.3 Thus, the A-SMGCS warning system seemed to have limited effectiveness in alerting the RWC and the CET Leader of a runway incursion occurrence. It would be desirable to have a more distinct annunciation of "Runway Incursion" or to have a repetitive annunciation to ensure that a runway incursion occurrence will not be missed.

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 runway incursion was a result of the UV entering the runway after the RWC turned off the red stop bar lights at the runway holding position on Taxiway MY1.

3.2 The UV driver lost situational awareness. He was not familiar with the roadways around the aircraft manoeuvring area at Taxiways Y2/MY. He did not prepare adequately for using roadways in an unfamiliar area.

3.3 There are markings on the ground and signs on either side of the red stop bar lights at the runway holding position on Taxiway MY1 to indicate that Runway 3 is ahead. However, the UV driver did not look out for the signage as he was referring to his handphone on the communication script with the RWC. This shows that he did not prepare himself adequately before embarking the journey from FS 2 to FS 3 using a new route.

3.4 The aerodrome operator's driving rules only allow the driver to operate the radiotelephony set in the vehicles even though a passenger who is also a holder of CAT 1 ADP is a qualified and useful resource to the driver for communicating with ATC.

3.5 The investigation team could not understand the RWC's actions in turning off the red stop bar lights at the runway holding position on Taxiway MY1, in trying to contact the UV driver to request him to confirm if the UV was on the runway, and in not pursuing a response from the UV driver. It seems as though she was not paying attention to her tasks of scanning the runway through the cabin window and of correlating the view with the traffic information displayed in the A-SMGCS. The RWC also did not follow the standard operating procedures to

scan the entire length of the runway before issuing take-off clearance to an aircraft.

3.6 The A-SMGCS generated both aural warning and visual alert message for the runway incursion occurrence. However, the warning system seemed to have limited effectiveness in alerting the RWC and the CET Leader.

4 SAFETY ACTIONS

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

4.1 The ATC service provider has taken the following actions:

(a) Conducted a safety briefing to all its controllers in June 2022, with discussion focusing on the following:

- Prevention of runway incursion;
- Actions to be taken in the event a runway incursion;
- Scanning the A-SMGCS display with a view to enhancing their situational awareness in night conditions; and
- Correlating the “out-of-window” view with the A-SMGCS display.

(b) Conducted simulator training sessions for all its aerodrome controllers in June and July 2022 covering runway incursion scenarios to refresh and enhance their ability to handle runway incursion occurrences.

(c) Increased the volume of the aural alarm at the CET Leader's position and at supervisory positions in other air traffic control cabins. (However, the ATC service provider has not deemed it necessary to increase the volume of the aural alarm at other air traffic controller’s positions as it prefers to limit the shock effect of the aural alarm to the CET Leader and supervisory personnel.)

4.2 The ARFF provider has taken the following actions:

(a) Conducted training in June and July 2022 for all its drivers to refresh and enhance their ability to recognise signs and markings within the AMA.

(b) Imposed additional measures to control movement to and from FS 3:

- To only use established routes and to report any intended deviations;
- To use standard radiotelephony in communication between ARFF drivers and the ARFF Watch Room prior to any vehicular movements; and
- To require the ARFF Watch Room to monitor on the Watch Room’s traffic movement display screen the movements of all ARFF vehicles

in the AMA.

(c) Installed on all ARFF vehicles operating in the aerodrome a device that will alert the ARFF drivers when their vehicles are near the runway.

4.3 The aerodrome operator has taken the following actions:

(a) Conducted a safety briefing to all its CAT 1 ADP drivers in June 2022 on the occurrence and refreshed them on safe driving in the AMA.

(b) Published an airside safety notice about the occurrence and to highlight the importance of route planning and maintenance of situation awareness while driving in the aerodrome.

5 SAFETY RECOMMENDATIONS

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 ATC service provider review its A-SMGCS alert system for the aural warning annunciation of “Runway Incursion” to be more noticeable and repetitive. [TSIB RA-2023-008]

5.2 The ATC service provider review its A-SMGCS alert system for the runway incursion’s aural and visual alerts to disappear only after being acknowledged by the user. [TSIB RA-2023-009]

5.3 The aerodrome operator consider allowing a passenger who holds a CAT 1 ADP to share a driver’s radiotelephony workload for better resource management. [TSIB RA-2023-010]