

# **Final Report**

## **RUNWAY INCURSION BY A CRANE VEHICLE AT CHANGI AIRPORT**

**24 OCTOBER 2021**

TIB/AAI/CAS.201

Transport Safety Investigation Bureau  
Ministry of Transport  
Singapore

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## **GLOSSARY OF ABBREVIATIONS**

ATC	Air Traffic Control
A-SMGCS	Advanced-Surface Movement Guidance and Control System
CAA	Civil Aviation Authority
CET	Changi East Tower
LT	Local Time
REP	Runway Entry/Exit Point
REPO	Runway Entry/Exit Point Officer
REP SO	REP Support Officer
RESA	Runway End Safety Area
AOS	Airport Operational and Safety Requirements

## **SYNOPSIS**

On 24 October 2021 at about 1100LT, a runway incursion involving a crane vehicle occurred at Changi Airport Runway 3.

Runway 3 was earlier closed for maintenance and a contractor team had used the closed runway as a transit path for driving its crane vehicle to a worksite located outside of the runway. Runway 3 was to reopen to facilitate an aircraft arrival and the contractor team was supposed to remain at their worksite during that time. However, the contractor team left the worksite with its crane vehicle and entered the runway when the runway was reopened.

The arrival aircraft was 23 minutes away from Runway 3 when the contractor team entered the runway. The crane vehicle was spotted and was duly escorted away from the runway before the aircraft arrived.

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

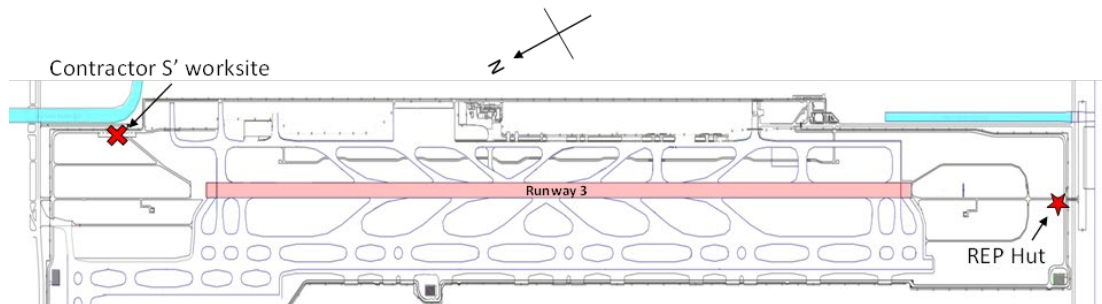
# 1 FACTUAL INFORMATION

All times used in this report are Singapore Local Time (LT) unless otherwise stated.

## 1.1 Sequence of event

1.1.1 On 24 October 2021, Runway 02R/20L (Runway 3) was closed from 1000LT to 2300LT for maintenance work. Access to the runway for maintenance work was via a roadway at the southern end of the runway. The entrance to the roadway was designated as the Runway Entry/Exit Point (REP). The REP Hut (see **Figure 1**) was sited there and an employee from the aerodrome operator was appointed as the REP Officer (REPO)<sup>1</sup>. The REPO was to station at the REP Hut to oversee and control the movement of vehicles accessing the runway for maintenance works.

1.1.2 There was an obstacle lights installation work (not a part of the runway maintenance work) on a building located more than 500m beyond the northern end of Runway 3 (see **Figure 1**) outside the runway strip<sup>2</sup> and runway end safety area<sup>3</sup> (RESA). The work was being carried out by a contractor, Contractor S, on behalf of another Contractor, Contractor A.



**Figure 1:** Diagram showing REP Hut, Contractor S' worksite and Runway 3.

1.1.3 The REPO arrived at the REP Hut at about 0935LT. She had earlier received an email from her management informing her that the runway would need to

<sup>1</sup> The REPO's responsibility included communicating with the Air Traffic Control using radio and making sure all vehicles exit the runway before it reopens.

<sup>2</sup> The runway strip is an area including the runway (and stopway, if provided) which is intended to reduce the risk of damage to aircraft running off a runway and protect aircraft flying over it during take-off or landing operations.

<sup>3</sup> The RESA is an area symmetrical about the extended runway centreline and adjacent to the end of the runway strip and is primarily intended to reduce the risk of damage to an aircraft undershooting or overrunning the runway.

be reopened between 1130LT and 1230LT to facilitate an aircraft landing on Runway 3.

- 1.1.4 A work team from Contractor S for the obstacle lights installation work (hereinafter referred to as the Work Team) arrived at the REP Hut at about 0945LT, accompanied by a manager of Contractor S (hereinafter referred to as the Manager). The Work Team consisted of a Supervisor, a driver and two other persons. The Supervisor had limited English proficiency. The Manager was able to communicate in English and also spoke the same native language as the Supervisor. The Work Team was using a crane vehicle.
- 1.1.5 At the REP Hut, the Manager filled in the names of the workers of the Work Team on a form. All workers were to sign in on the form when they start work and sign out after they have completed the day's work. The form also required the Manager to indicate the location of the Work Team's worksite on a map attached to the form. However, as the worksite of Contractor S was beyond the map, the Manager did not indicate anything on the map.
- 1.1.6 At the REP Hut, the Manager confirmed to the REPO the following points:
- (a) The worksite was located near the northern end but outside of Runway 3. The Work Team intended to access the worksite via Runway 3, as they did the day before<sup>4</sup>, instead of accessing via the aerodrome's perimeter road<sup>5</sup>.
  - (b) The Manager and the Supervisor were aware that an aircraft would be landing on Runway 3 between 1130LT and 1230LT. During this period, the Work Team would remain at the worksite.
  - (c) The Work Team would have to lower the crane before the aircraft arrival.
- 1.1.7 As the Manager would not be with the Work Team at the worksite, the REPO and the Manager agreed on the arrangement that the REPO would call the Supervisor to inform him of the runway reopening prior to aircraft arrival. She expected that this arrangement would serve as a reminder for the Supervisor

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<sup>4</sup> On this occasion, the Work Team was led by Contractor A to take the route via the runway to access the worksite.

<sup>5</sup> The REPO did not know that the aerodrome operator does not allow contractors to access, via the runway, worksites outside of the runway. According to the REPO, she was initially reluctant to let the Work Team access the worksite via the runway. She asked the Work Team for the reason of using the runway to access the worksite and was told that they took the same way to the worksite the day before. She relented and allowed the Work Team to enter the runway when the runway was closed.

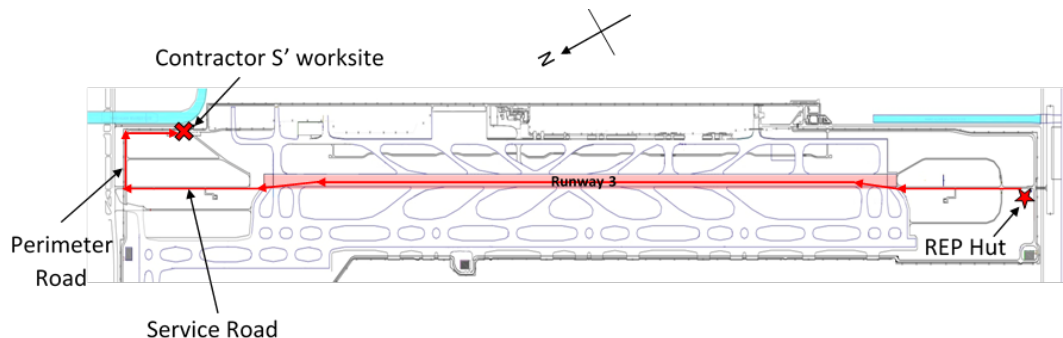
to get the Work Team to lower the crane.

1.1.8 According to the Manager, he reiterated to the Supervisor in their native language that:

- (a) the Work Team should remain at the worksite when the runway was reopened for the aircraft arrival; and
- (b) the REPO would give the Supervisor a call prior to the runway reopening as a reminder for the Work Team to lower the crane.

1.1.9 Subsequently, the REPO asked the Supervisor if he had understood the arrangement in paragraph 1.1.8 (a)-(b) but she did not elaborate on the details of the arrangement. The Supervisor replied that he had understood<sup>6</sup>, and the REPO was satisfied with this reply and assigned a vehicle tag<sup>7</sup> to the crane vehicle used by the Work Team. The Manager then left the REP Hut.

1.1.10 Runway 3 was closed at 0954LT. The Work Team's vehicle entered the runway and travelled to the northern end of the runway and then used a road (hereinafter referred to as the Service Road) to reach the perimeter road and then the worksite (see **Figure 2**).



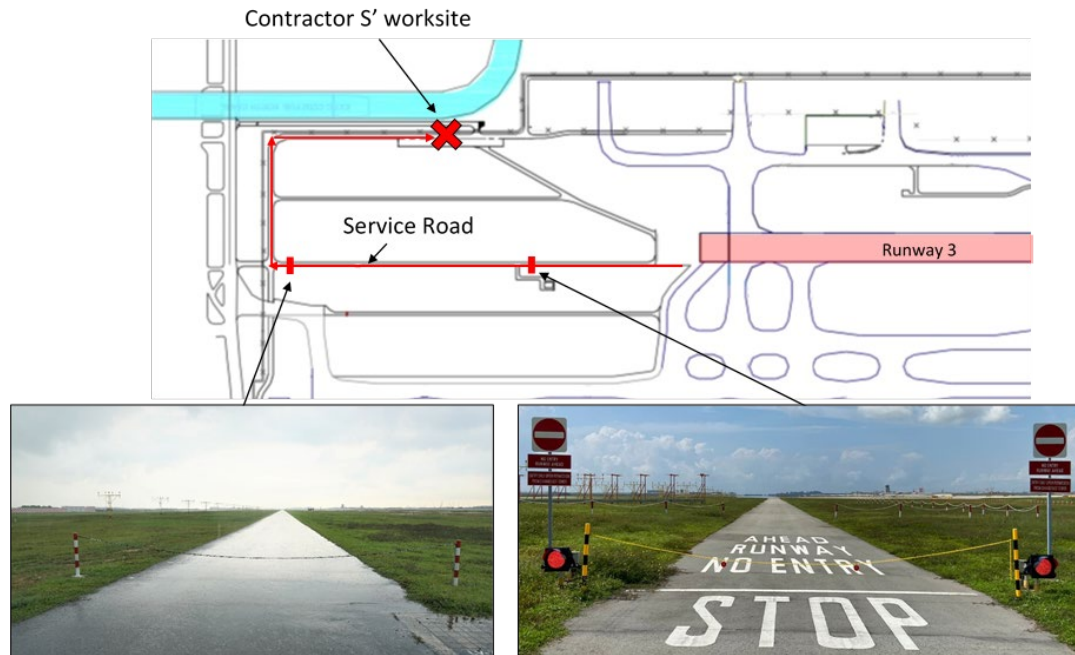
**Figure 2:** Route taken by the Work Team to the worksite.

1.1.11 There are two chain barriers on the Service Road located as shown in **Figure 3**. (More on the Service Road in paragraph 1.5.3)

<sup>6</sup> The Supervisor confirmed, during his interview by the investigation team that he had understood what the Manager conveyed to him in paragraph 1.1.8 (a)-(b).

<sup>7</sup> A vehicle tag is issued to each vehicle that reports to the REP Hut before a runway closure to account for the vehicles accessing the closed runway.





**Figure 3:** Locations and pictures of the chain barriers. (Note: The pictures were taken in the direction of the runway.)

- 1.1.12 When the Work Team reached the chain barriers on the Service Road, one of the workers in the Work Team unhooked the chain to let the vehicle pass through and then hooked up the chain after the vehicle had passed through. The Work Team arrived at the worksite at about 1030LT and commenced their work.
- 1.1.13 At about 1037LT, the Changi East Tower (CET) Leader informed the REPO via radio to prepare to reopen the runway at about 1100LT, 30 minutes earlier than planned. The REPO then instructed the REP Support Officer<sup>8</sup> (REP SO) to contact all the vehicles<sup>9</sup> on the runway on the mobile phone to ask them to vacate the runway in preparation for the runway reopening. The REPO herself called the Supervisor on the mobile phone to inform him that the runway would be reopening soon. She also reminded the Work Team to remain at the worksite. The Supervisor replied “Okay” to the REPO.

<sup>8</sup> The REP Support Officer is an employee of another contractor assigned to the aerodrome operator to assist the REPO in the REP duties.

<sup>9</sup> These were the vehicles of the work parties who were tasked to put up mandatory markers on the runway during runway closure. Other than Contractor S' Work Team, there were no other contractors doing work on or near the runway at that time.

- 1.1.14 According to the Supervisor, the worksite was noisy, and he could not hear the message from the REPO clearly. The Supervisor did not hear the REPO asking the Work Team to remain at the worksite and thought that she was asking the Work Team to leave the worksite and return to the REP Hut. Although this differed from the initial arrangement, the Supervisor did not ask the REPO for clarification.
- 1.1.15 After the phone call with the Supervisor, the REPO entered the runway in her vehicle, accompanied by colleagues in two other vehicles, to conduct a final inspection in preparation for runway reopening. According to the aerodrome operator's REP procedure, a REPO is required to ensure that all the vehicles that had entered the runway have all exited the runway (by collecting back the vehicle tags that had been issued to these vehicles) before conducting the final inspection. However, in this incident, the REPO had entered the runway when there were still a few vehicles on the runway.
- 1.1.16 The REPO exited the runway at about 1053LT after conducting the final inspection. The two other vehicles assisting the REPO vacated the runway at about 1055LT.
- 1.1.17 During this time, all other vehicles that were still on the runway when the REPO entered the runway had also vacated the runway. The REP SO assisted the REPO in accounting for the vehicle tags. Believing that the Work Team would remain at the worksite and would not be returning their vehicle tag, the REP SO informed the REPO that all vehicle tags had been accounted for, except the one issued to the Work Team's vehicle.
- 1.1.18 The REPO then informed the CET Leader over the radio that the runway was clear and ready for reopening. After ensuring that there was no vehicle on the runway by scanning the runway and ATC's Advanced-Surface Movement Guidance and Control System (A-SMGCS), the CET Leader declared the reopening of the runway at 1057LT. Meanwhile, the Work Team had left the worksite and entered the runway at about 1100LT via the Service Road.
- 1.1.19 At about 1104LT, the CET Ground Controller (GMC5), while looking out from the tower, noticed a crane vehicle travelling southwards from the northern end of Runway 3 and alerted the CET Leader. The CET Leader immediately informed the REPO of the vehicle on the runway. The CET Leader then closed the runway to allow the REPO to enter the runway to escort the vehicle out to the REP Hut. After that, the runway was opened again to receive the arriving

aircraft. The aircraft landed at about 1123LT.

## 1.2 Injuries to persons

1.2.1 There was no injury to any person.

## 1.3 Personnel information

### 1.3.1 REPO

Working experience	10 years with the aerodrome operator <ul style="list-style-type: none"><li>• 2 years with Airside Control Centre</li><li>• 8 years with Airside Management Centre</li></ul>
Provisional licence	Valid Changi Category 1 Airfield Driving Permit

### 1.3.2 The Supervisor

Working experience	2 years working at Changi Airport with Contractor S
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## 1.4 Meteorological information

1.4.1 The incident happened in daytime and there was no precipitation.

## 1.5 Aerodrome information

### 1.5.1 Access to worksite

1.5.1.1 For worksite outside of the runway or at adjacent taxiways<sup>10</sup>, the aerodrome

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<sup>10</sup> According to the aerodrome operator, adjacent taxiways mean the Rapid Exit Taxiways and the Runway Holding Position. However, this was not documented by the aerodrome operator, nor communicated by the aerodrome operator to its personnel and contractors.

operator requires contractors to get to their worksite via the perimeter road<sup>11</sup>.

1.5.1.2 For worksite within the runway and the adjacent taxiways, the aerodrome operator requires contractors to report to the REP Hut.

1.5.1.3 Contractor A and Contractor S were unsure whether they could proceed directly to the worksite or they were required to report to the REP Hut. On 23 October 2021, the day before the incident, Contractor A and Contractor S decided to report to the REP Hut prior to the start of their work (more on this in paragraph 1.7.1).

## 1.5.2 Approval for crane operation

The civil aviation authority (CAA) had issued to a contractor, Contractor H<sup>12</sup>, an approval to operate a crane at the obstacle lights installation worksite during the runway closure period. The approval was valid for three days, on 23 and 30 Oct 2021 from 1000LT to 2400LT and 24 October 2021 from 1000LT to 2300LT. In this incident, the crane was actually operated by the Work Team of Contractor S, who worked for Contractor A who in turn worked for Contractor H.

1.5.2.1 In issuing the approval, the CAA also required Contractor H to provide, for emergency purposes, the contact numbers of two persons who would be present at the worksite when work was being carried out. Contractor H provided the contact numbers of the Supervisor and another employee of Contractor S. During this incident, only the Supervisor was at the worksite. According to the CAA, the two such contact persons must be present at the worksite. However, the CAA did not mention in its approval to Contractor H that the two persons named by Contractor H must be present at worksite when work was being carried out, nor did the CAA convey this requirement to Contractor H through other means.

1.5.2.2 According to the CAA, it is not its responsibility to ensure that the two contact persons are on site but the aerodrome operator's. The aerodrome operator was however not aware that the CAA required the two contact persons to be on site.

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<sup>11</sup> At the worksite, a contractor who had been approved to operate a crane outside of the runway or at adjacent taxiways was required to obtain real time approval before operating the crane by calling the REP SO or Rover 34 (Rover 34 refers to the personnel in a vehicle assisting the REPO in ensuring runway is safe for aircraft operation. Together with the REPO, Rover 34 ensures that the runway is clear of all equipment, vehicles and obstacles before the runway reopens.)

<sup>12</sup> Contractor H was engaged by the aerodrome operator for a project at Runway 3 which included the obstacle lights installation.

### 1.5.3 Service Road

1.5.3.1 As regard the Service Road, there are two chain barriers along the road (see **Figure 3**). The barrier nearer to the runway is located at the road holding position. A vehicle found beyond this point is considered to have entered the runway. The road holding position is accompanied by ground markings, flashing red lights and warning signs for warning drivers and other personnel that they are not allowed to cross the barrier into the runway without authorisation from ATC.

1.5.3.2 The barrier further away from the runway is not accompanied by any warning sign. According to the aerodrome operator, contractors, if authorised by the aerodrome operator to use the Service Road, may unhook the chains and hook them back as necessary. However, the aerodrome operator did not have procedure regarding how contractors could seek authorisation from the aerodrome operator and the circumstances under which the aerodrome operator may authorise contractors to use the Service Road.

1.5.3.3 According to the REPO, there had been previous instances where contractors used the Service Road to travel from Runway 3 to access their worksite.

### 1.5.4 Use of runway and roadways as transit pathways to worksites outside of the runway and adjacent taxiways

1.5.4.1 According to the aerodrome operator, during runway closure:

- (a) Contractors who are not working on the runway or on adjacent taxiways are not allowed to enter the runway, nor use the runway, or the roadways linking the runway/taxiway and the perimeter road, as a transit pathway to a worksite located outside of the runway and the adjacent taxiways.
- (b) Contractors who are working on the runway or on the adjacent taxiways are required to report to the REP.

1.5.4.2 However, there were no explicit instructions as regards the arrangements/restrictions in paragraph 1.5.4.1(a)-(b). The Manager, the Supervisor, the REPO and the REP SO did not know of the arrangements/restrictions in 1.5.4.1(a).

1.5.4.3 Other than the criterion “on the runway or on the adjacent taxiways”, the

aerodrome operator did not have clearer guidelines on the boundary between “on the runway or on the adjacent taxiways” and “outside the runway and the adjacent taxiways”.

1.5.4.4 During runway closure, where works need to be carried out on the runway or on the adjacent taxiways, working personnel’s vehicles may travel on the runway or the perimeter road to reach their worksites. As mentioned in paragraph 1.5.4.1(b), contractors who are working on the runway or on the adjacent taxiways are required to report to the REP.

## 1.6 Medical and pathological information

1.6.1 The Supervisor and the Work Team’s driver underwent a medical check following the incident. There was no evidence of any medical/toxicological factors that could have affected the performance of the Supervisor or the driver.

## 1.7 Additional Information

### 1.7.1 Runway closure a day before to the incident

1.7.1.1 On 23 October 2021, the day before the incident, when Contractor A and Contractor S’ Work Team (which included the Manager and the Supervisor) arrived at the REP Hut, the REPO for the day (not the same REPO as on the incident day, 24 October 2021) was away briefly from the REP Hut. The Work Team presented the crane operation approval letter from the CAA to the REP SO (who was the same REP SO as on the incident day, 24 October 2021) and this latter issued the Work Team a vehicle tag, which allowed the team to enter the runway during the runway closure. Subsequently the Work Team travelled to the same worksite using the same route as it took on the incident day.

1.7.1.2 The REP SO knew that the work location of the Work Team was outside of the runway, but he did not check with the Work Team the route which they would be taking to reach the worksite. Anyway, the REP SO did not know that the aerodrome operator does not allow contractors to access, via the runway, worksites outside of the runway. According to the REP SO, contractors with such approval from the CAA would not usually report to the REP Hut unless they needed to enter the runway to carry out their works.

## 2 ANALYSIS

The investigation looked into the following:

- (a) The Supervisor's decision to return to the REP Hut prior to runway reopening
- (b) Access to worksite outside of the runway and the adjacent taxiways
- (c) Use of runway and roadways as transit pathways to worksites outside of the runway
- (d) Approval for crane operation

2.1 The Supervisor's decision to return to the REP Hut prior to runway reopening

2.1.1 On the one hand, prior to going to the worksite, the Supervisor of the Work Team had understood from his Manager, if not also from the REPO, that the Work Team was to remain at the worksite when the runway was reopened for an aircraft arrival, and that the REPO would give him a call prior to the runway reopening as a reminder for the Work Team to lower the crane.

2.1.2 On the other hand, the Supervisor claimed that, when the REPO was calling him, the worksite was noisy, and he could not hear what the REPO was saying. Yet he assumed that the REPO was asking him to leave the worksite and return to the REP Hut and he also simply answered "Okay" to the REPO without telling her that he could not hear her message clearly.

2.1.3 It is difficult for the investigation team to comprehend the Supervisor's action. There was no clear basis for him to assume that the REPO was asking the Work Team to return to the REP Hut. At the very least, the Supervisor should have asked the REPO to clarify her message. He could have moved to a quieter corner to talk to the REPO, or he could have asked his Manager to talk to the REPO to have the matter clarified. He did neither.

2.1.4 It cannot be over-emphasised that the parties in a communication must ensure that the messages are clearly given and understood and that, when in doubt, clarification must be sought.

- 2.2 Access to worksite outside of the runway and the adjacent taxiways
  - 2.2.1 As the worksite was outside of the runway and the adjacent taxiways, Contractor A and Contractor S actually did not need to report to the REP Hut and could proceed directly to their worksite. However, as mentioned in paragraph 1.5.1.3, these contractors were unsure of this. It would be desirable for the aerodrome operator to make it clear to contractors whose worksites are outside the runway or adjacent taxiways that they do not need to report to REP and that they are to take the perimeter road to their worksites.
  
- 2.3 Use of runway and service road as transit pathways to worksites outside of the runway
  - 2.3.1 As mentioned in paragraph 1.5.4.1 (a), the aerodrome operator does not allow contractors to use the runway, or the roadways linking the runway to the perimeter road, as a pathway to a worksite located outside of the runway and the adjacent taxiways. This restriction is consistent with the aerodrome operator's arrangement of positioning a REP as the only entry/exit point for the runway during runway closure. The investigation team noted that this restriction had not been documented in any procedure. There is also no evidence that this restriction was made known to the aerodrome operator's personnel nor to the contractors, since the persons involved in this incident (in particular, the REPO, the REP SO, the Manager and the Supervisor) did not know that working personnel are not allowed to use the runway and roadways as a pathway to their worksite located outside of the runway and the adjacent taxiways. This suggests that the aerodrome operator needs to improve its procedure to ensure that its operational requirements are conveyed to the personnel manning the REP and to its contractors.
  - 2.3.2 In addition, as mentioned in paragraph 1.5.4.3, other than the criterion "on the runway or on the adjacent taxiways", there was no clear delineation of the boundary between "the runway and the adjacent taxiways" and "outside the runway and the adjacent taxiways". Without a clear delineation, it is difficult to know if a worksite is outside of the runway and the adjacent taxiways, and hence difficult to prevent contractors' personnel, whose worksite is outside of the runway and the adjacent taxiways, from using the runway as a transit pathway. The aerodrome operator may wish to consider aligning this boundary with that of the runway strip.



## 2.4 Approval for crane operation

2.4.1 In the course of its investigation, the investigation team noted the following although it was not a contributing factor to the incident:

In issuing the approval for crane operation, the CAA required Contractor H to provide the contact numbers of two persons who would be present at the worksite. The CAA expected that the aerodrome operator to ensure that the two persons who have provided their contact numbers to be on site but did not convey this expectation clearly to the aerodrome operator. In this incident, only one of the two persons was on site. Following the incident, the CAA has made an arrangement with the aerodrome operator for the aerodrome operator to verify that the contact persons are on site.

### **3 CONCLUSIONS**

- 3.1 Although the Supervisor had apparently heard an instruction from the REPO's call that was different from the initial instruction given by the REPO and his Manager, the Supervisor did not ask the REPO to clarify her message nor ask the Manager to seek clarification from the REPO before deciding to return to the REP Hut via the runway.
- 3.2 The aerodrome operator did not inform contractors whose worksites were outside the runway or adjacent taxiways that they were to access their worksites using the perimeter road.
- 3.3 The aerodrome operator's method of conveying to the personnel manning the REP and to its contractors the restriction on the use of the runway, or the roadways linking the runway to the perimeter road, as a pathway to a worksite located outside of the runway seems inadequate.
- 3.4 There was no clear delineation of the boundary between "the runway and the adjacent taxiways" and "outside the runway and the adjacent taxiways".
- 3.5 The crane approval issued by the CAA required a contractor to provide contact numbers of two persons who will be on site during works. However, it was unclear who should ensure that the two persons were on site.

## 4 SAFETY ACTIONS

Arising from discussions with the investigation team, the aerodrome operator has taken the following safety action:

- (a) The aerodrome operator has reviewed its procedures and processes pertaining to the control and monitoring of the movements and locations of contractors who are required to carry out works in the vicinity of the runway during runway closure. The revised procedures and processes are documented in the aerodrome operator's Airport Operational and Safety Requirements (AOS) manual (which is disseminated to all contractors), and they include the following:
- Statement that defined the area within "the runway and the adjacent taxiways" as the area bounded by the runway strip and RESA.
  - Statement informing contractors working in the aerodrome that under no circumstances shall contractors use the runway to gain access to their work areas that are outside of the runway strip and RESA and that only contractors whose works are within the runway strip or RESA may enter the runway via the REP.
  - Requirements for contractors whose works are within the runway strip or RESA to register their intent to enter the runway for works at least 3 days before runway closure. The REPO will only allow registered contractors to enter the runway.
  - Requirements for contractors whose works are outside of the runway strip or RESA to access their worksite using perimeter roads.
  - Requirements for contractors who need to operate a crane to obtain clearance from the aerodrome operator's AMC via a phone call before commencing their crane operation.
  - Requirements and process for contractors to seek approval from the REPO to use the service roads.
- (b) The aerodrome operator has increased its frequency of on-site

inspections to ensure all procedures in the AOS manual with regard to runway closure are followed.

## **5 SAFETY RECOMMENDATIONS**

- 5.1 In view of the safety actions taken by the aerodrome operator, no safety recommendation is proposed.