# FINAL REPORT

## Taxiing Accident involving

## Arrow Air APWP6L

## McDonnell Douglas DC8-62
## Registration Mark: N1808E at

## Singapore Changi Airport

## on 28 February 2002

AIB/AAI/CAS.004

Ministry of Transport
Singapore

1 June 2004

**Preamble**

This report on the taxiing accident involving Arrow Air McDonnell Douglas DC8-62 aircraft N1808E at Singapore Changi Airport on 28 February 2002 has been prepared based upon the investigation carried out by the Singapore Ministry of Transport Investigator-in-charge in accordance with Annex 13 to the Convention on International Civil Aviation and the Singapore Air Navigation (Investigation of Accident) Regulations. In accordance with Annex 13, the sole objective of the investigation is the prevention of accidents and incidents. It is not the purpose of the investigation to apportion blame or liability.

MINISTRY OF TRANSPORT
SINGAPORE

## Synopsis

On 28 February 2002, Arrow Air flight APWP6L touched down on Runway 02L at Singapore Changi Airport at 0029 hours. The runway controller at Changi Tower instructed the aircraft to park at Bay 117, a remote aircraft parking bay. The ground movement planner at Changi Tower selected the taxiway centre line lights to guide the aircraft along Taxiway WA to Bay C7 (Bay 117 is the second parking bay after Bay C7).

Instead of stopping at the end of its assigned taxi route, the aircraft continued taxiing past Bay C7 along a diverted portion of Taxiway WA. At about 0037 hours, the aircraft called Changi Tower to indicate its position near Bay 106.

Realising that the aircraft had missed its assigned parking position, the ground movement planner at Changi Tower reselected the taxiway centre line lights to guide the aircraft back to Bay 117. The aircraft followed the return route until it was abeam Bay 117 on the straight section of the diverted portion of Taxiway WA.

At that location, the pilot saw the ground marshaller in position at Bay 117 on the aircraft's right side. Instead of continuing to follow the taxiway centre line lights on the assigned taxi route, the aircraft turned right. In doing so, it left the Taxiway WA centre line and went onto a grass area between Taxiway WA and the parking apron. The nose gear of the aircraft went across a drain within the grass area. The aircraft came to a halt when its main landing gears went into the drain at about 0044 hours.

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# 1 FACTUAL INFORMATION

## 1.1 History of the flight

All times quoted in this report are based on Singapore local time, which is 8 hours ahead of Coordinated Universal Time (UTC).

### 1.1.1 General information

| | |
|---|---|
| Aircraft type: | McDonnell Douglas DC8-62 |
| Operator: | Arrow Air |
| Nationality: | USA |
| Aircraft registration: | N1808E |
| Aircraft callsign: | APWP6L |
| Type of flight: | Chartered cargo flight |
| Date and time of accident: | 28 February 2002, 0044 hours |
| Place of accident: | Singapore Changi Airport, West Apron, near Bay 117<br>Latitude: N 01° 21.6', Longitude: E 103° 59.3' |
| Runway in use: | 02L |
| Phase of flight: | Taxi after landing |
| Persons on board: | Three crew members (comprising pilot-in-command, co-pilot, flight engineer) |

1.1.2 On 28 February 2002, Arrow Air flight APWP6L touched down on Runway 02L at Singapore Changi Airport at 0029 hours. The weather and visibility conditions were good (visibility in excess of 10 km).

1.1.3 Arrow Air flight APWP6L was assigned to park at Bay 117, a remote aircraft parking bay. After APWP6L had landed, the runway controller at Changi Tower instructed the aircraft to taxi towards Bay 117.

1.1.4 The aircraft exited the runway via rapid exit Taxiway W4. The ground movement planner at Changi Tower selected the taxiway centre line lights to guide the aircraft from Taxiway W4 onto Taxiway NC1, Taxiway WA and to Bay C7 (Bay 117 is the second parking bay after Bay C7). (See taxi route 'I' in the airfield layout shown in Appendix 1A.)

1.1.5 Due to airside construction works, there was no taxiway centre line lighting guidance on the short segment of taxi route from Taxiway WA from abeam Bay C7 to the adjacent parking Bays 117 and 118. There was a NOTAM in force that stipulated that during hours of darkness, aircraft could only be towed in to Bays 117 and 118. On reaching Bay C7, the flight crew of APWP6L did not stop but continued taxiing past Bay C7 onto a diverted portion of Taxiway WA. The taxiway centre line lights for this diverted portion of Taxiway WA were not switched on by ATC as it was not the intended route for the aircraft. (See taxi route marked 'II' in the airfield layout shown in Appendix 1A.)

1.1.6 At about 0037 hours, flight APWP6L called Changi Tower to indicate its position near Bay 106. Realising that flight APWP6L had missed its allocated parking position, the ground movement planner at Changi Tower routed the aircraft back to Bay 117 via Taxiways WA, SC, WP, V8 and Taxiway WA. (See taxi route marked 'III' in the airfield layout shown in Appendix 1A and taxi route marked 'IV' in the airfield layout shown in Appendix 1B.)

1.1.7 Flight APWP6L followed the return route until it was abeam Bay 117 on the straight section of the diverted portion of Taxiway WA, just before Taxiway VY. At that location, the pilot saw the ground marshaller at Bay 117 on the aircraft's right side. Instead of continuing to follow the assigned taxi route, the aircraft turned right. In doing so, it left the WA taxiway centre line and went onto a grass area between Taxiway WA and the parking apron. The nose gear of the aircraft went across an open drain of about 1.4 m wide and 0.8 m deep within the grass area. The aircraft came to a halt when its main landing gears went into the drain at about 0044 hours. See Appendix 1C for accident site layout.

## 1.2 Injuries to persons

| Injuries | Crew | Passengers | Others |
|---|---|---|---|
| Fatal | 0 | 0 | 0 |
| Serious | 0 | 0 | 0 |
| Minor | 0 | 0 | 0 |
| None | 3 | 0 | 0 |
| Total | 3 | 0 | 0 |

## 1.3 Damage to aircraft

1.3.1 The aircraft's nose landing gear was broken and the fuselage around it was damaged. The main landing gears were also damaged as a result of being lodged in the drain.

1.4 **Other damage**

1.4.1 Nil.

1.5 **Personnel information**

| | | |
|---|---|---|
| 1.5.1 | Pilot-in-Command: | Male |
| | Age: | 34 |
| | Licence: | FAA Airline Transport Pilot Licence |
| | Aircraft rating: | DC-8 |
| | Medical certificate: | Date of examination 1 February 2002, First class, Nil limitations |
| | Proficiency check: | 1 August 2001 |
| | Line check: | 24 August 2001 |
| | Flying experience: | Approximately 5,000 hours |
| | Rest period before accident: | 26 hours |
| | Duty time before accident: | Approximately 14 hours |
| | Flight time before accident: | First sector, 4 hours 42 minutes<br>Second sector, 4 hours 36 minutes |
| 1.5.2 | Co-pilot: | Male |
| | Age: | 33 |
| | Licence: | FAA Airline Transport Pilot Licence |
| | Aircraft rating: | Airplane Multi-engine Land |
| | Medical certificate: | Date of examination 18 January 2002, First class, Nil limitations |
| | Proficiency check: | 3 July 2001, DC-8 |
| | Flying experience: | Approximately 4,300 hours |
| | Rest period before accident: | 26 hours |
| | Duty time before accident: | Approximately 14 hours. |
| | Flight time before accident: | First sector, 4 hours 42 minutes<br>Second sector, 4 hours 36 minutes |

| | | |
|---|---|---|
| 1.5.3 | Flight Engineer: | Male |
| | Age: | 45 |
| | Licence: | FAA Flight Engineer Licence |
| | Aircraft rating: | Turbojet Powered |
| | Medical certificate: | Date of examination 16 January 2002, Second class, to wear correction lenses for vision |
| | Proficiency check: | 15 May 2001, DC-8 |
| | Flying experience: | Approximately 4,700 hours |
| | Rest period before accident: | 26 hours |
| | Duty time before accident: | Approximately 14 hours |
| | Flight time before accident: | First sector, 4 hours 42 minutes<br>Second sector, 4 hours 36 minutes |

## 1.6 Aircraft information

1.6.1 The airworthiness and maintenance of the Arrow Air aircraft did not have any bearing on this accident.

## 1.7 Meteorological information

1.7.1 The accident occurred at night, in good visibility and weather conditions. Weather condition was not a factor in this accident. Weather information as recorded under METAR WSSS was prepared by the Singapore Meteorological Service. The details of the METAR recorded at 271600z (0000 hrs 28 February 2002) and 271630z (0030 hrs 28 February 2002) were as follows:

METAR 271600z
Wind: 36004 kt 330V030 (Northerly winds at 4 knots)
Visibility: 9999 (good visibility, in excess of 10 Km)
Clouds: FEW015 BKN300 (few clouds with lowest cloud base of 1,500 ft and some high level clouds with cloud base of 30,000ft)
Temperature: 27 C
Dew point: 26 C
QNH: 1011 hPa
NOSIG (No significant change)

METAR 271630z

Wind: 36004 kt 320V040 (Northerly winds at 4 knots)
Visibility: 9999 (good visibility, in excess of 10 Km)
Clouds: FEW012 BKN300 (few clouds with lowest cloud base of 1200 ft, and some high level clouds with cloud base of 30,000ft)
Temperature: 27 C
Dew point: 25 C
QNH: 1011 hPa
NOSIG (No significant change)

## 1.8 Aids to navigation

1.8.1 All navigation aids at Singapore Changi Airport required for aircraft operations were working normally at the time of the accident.

## 1.9 Communications

1.9.1 The aircraft was in contact with Changi Control Tower on 118.6 MHz at the time of the accident. The aircraft did not report any communication problems with the Control Tower on this frequency. See Appendix 2 for ATC tape transcript.

## 1.10 Aerodrome information

1.10.1 Green bi-directional taxiway centre line lights are provided along all taxiways at Singapore Changi Airport to provide continuous guidance to pilots from the exit taxiways to the apron.

1.10.2 A NOTAM (see Appendix 3) issued on 1 February 2002 stated that with effect from 4 February 2002, during hours of darkness, aircraft could only be towed in and out of Bays 118, 117, 108 and 107 as there would be no green centre line lights from Taxiway VY and Taxiway WA behind Bay C7, leading to Bay 118 and Bay 117. The NOTAM was issued arising from construction works in progress at the worksite between Bay 116 and Bay 109.

## 1.11 Flight recording

1.11.1 See Appendix 4 for cockpit voice recorder (CVR) transcript.

## 1.12 Wreckage and impact information

1.12.1 Not applicable.

1.13 **Medical and pathological information**

1.13.1 The three flight crew members (pilot-in-command, co-pilot and flight engineer) were sent for toxicological tests on the night of the accident. The results of the tests on all the three crew members indicated that there was no toxicological evidence of alcohol or substance abuse.

1.14 **Fire**

1.14.1 There was no fire.

1.15 **Survival aspects**

1.15.1 Not applicable.

1.16 **Tests and research**

1.16.1 Nil.

1.17 **Organisational and management information**

1.17.1 Arrow Air is an airline based in Miami, Florida, USA. Arrow Air operates charter cargo flights through Singapore using DC8 freighter aircraft. In Singapore, the airline normally operates into Paya Lebar Airport. However, when Paya Lebar Airport is not available (e.g., during airport closure at night), the airline operates to Changi Airport. At Changi Airport, the ground handling agent contracted by Arrow Air to handle its aircraft is SIA Engineering Company (SIAEC). Flight plans and NOTAMs are handled by Arrow Air at its head office through faxes.

1.17.2 The function of the Air Traffic Control (ATC) at Singapore Changi Airport is performed by the Operations Division of the Civil Aviation Authority of Singapore. As part of this function, at Changi Airport, the Changi Control Tower provides the aerodrome control service including control of aircraft and vehicle movements on runways and taxiways. The Control Tower was manned by a watch manager, a runway controller and a ground movement planner at the time of the accident.

1.17.3 At Changi Airport, the allocation of parking bays is performed by the Apron Control/Management Service (ACMS) of the Airport Management Division of CAAS. The ACMS was manned by an apron supervisor and two operations assistants at the time of the accident.

## 1.18 Additional information

### 1.18.1 Interview with Arrow Air pilot-in-command (PIC)

1.18.1.1 The PIC for the flight said he was the pilot taxiing the aircraft. The aircraft landed on Runway 02L and exited via rapid exit Taxiway W4. He was given instructions by ATC to follow the green taxiway centre line lights to Bay 117. He mentioned that he passed by the brightly lit apron (Terminal 1 West Apron), behind the tails of the aircraft already parked there. He said he had initially passed by Bay 117 without noticing it.

1.18.1.2 After overshooting Bay 117, he turned around. With assistance from the Tower he followed the green taxiway centre line lights to try to reach Bay 117 again, but he was unsure of the actual route he had taken for the turn-around. When he was on the straight section of the diverted portion of Taxiway WA and abeam Bay 117, he saw the marshaller waving a "move ahead" signal with his wands at the bay and he turned right toward the marshaller. He confirmed that he did not at any time see the marshaller give him a turn signal. (See illustration of marshalling signals at Appendix 8.)

1.18.1.3 There was a wide expanse of pavement between the aircraft and Bay 117 and the PIC did not notice the grass area beyond the paved area as there were no "blue edge lights". He said that his taxi speed was normal as he was looking out for the tow tug as he knew about the NOTAM for the tow-in. He said that the area in front of him towards Bay 117 was rather dark. He confirmed that his taxi lights were on but he was focusing on the marshaller. He said that even after the aircraft landing gear had gone into the drain, the marshaller was still waving the wands.

1.18.1.4 The PIC said that, from hindsight, he was disorientated. As he was first taxiing towards Bay C7 after landing, he saw a construction area towards the south and a very dark ramp area, and beyond that several aircraft parked at the far end in a brightly lit apron (West Remote Apron). He said he had the impression that Bay 117 was at a distance beyond the construction area to the south.

1.18.1.5 He confirmed that this was his first time he was assigned Bay 117. The normal parking bay allocation for their company's operations was one of the Bays 303 to 306 at the North Remote Apron. He normally operated into Paya Lebar Airport but had been into Changi Airport about 5 times since the first time in November 2001.

1.18.1.6 He was queried about flight duty time and stated that he had a rest day on 26 February 2002. He confirmed that he was well within flight time limitations and had adequate rest before the flight to Singapore.

1.18.2. **Interview with Arrow Air co-pilot**

1.18.2.1 The co-pilot said that he had landed the aircraft on Runway 02L. He last flew into Changi Airport about two weeks ago. During the deceleration at about 80 knots and in accordance with company procedures, the captain took back control for the taxi to the parking bay. The co-pilot then operated the radio and was given the instruction to follow the green taxiway centre line lights to Bay 117. He said that he had the airport taxi charts and was referring to the charts to assist in the navigation. He explained that after taxiing towards the end of the taxiway (Terminal 1 West Apron), he noticed the construction area at the end as well as several B747s parked at the far end (West Remote Apron). The aircraft passed Bay 117 without the crew noticing it.

1.18.2.2 As to the query whether the aircraft taxi light was on, the co-pilot mentioned that according to the "after landing checklist", the need to turn on the landing lights was 'as required'. He was sure that the landing lights were turned on, although he was not sure whether the taxi light was on.

1.18.2.3 The crew called ATC when they were at Bay 106 and was given green taxiway centre line lights selected by the Tower to go back towards Bay 117. He was sure the aircraft turned around Taxiway SC and then V8 before going back to Bay 117. When the aircraft was on the straight section of the diverted portion of Taxiway WA, all the three crew members saw the marshaller on the right. The co-pilot was sure the marshaller was waving a "move ahead" signal with his wands, and did not stop waving even after the accident. The co-pilot confirmed that the marshaller did not give the aircraft any turn signal. He believed that the marshaller did not know about the existence of the grass/drain patch.

1.18.2.4 To the query about taxiway lights, the co-pilot confirmed that there were blue lights to the left of the aircraft but none to the right of the aircraft. There were no blue edge lights bordering the drain. The area where the aircraft turned towards the parking Bay 117 appeared black and appeared to be a giant tarmac.

1.18.2.5 The co-pilot said he was aware of the tow-in requirement for Bay 117. He confirmed that the crew did not receive any new NOTAMs before the flight departed for Singapore from Diego Garcia. All the required documents were obtained from Paya Lebar Airport from which they had earlier flown the Singapore – Diego Garcia sector.

1.18.2.6 The co-pilot had flown with the PIC for about 5 years and with the flight engineer for about 2 years. He confirmed that he had approximately 26 hours of rest before flying the earlier Singapore - Diego Garcia sector.

1.18.3 **Interview with Arrow Air flight engineer**

1.18.3.1 The flight engineer said that after landing, ATC told the crew to taxi to Bay 117 following the green taxiway centre line lights. They missed Bay 117 and were given guidance using the green taxiway centre line lights again for the turn around back to Bay 117. He was sure that he was able to see the marshaller waving the wands since he was sitting up in his seat and facing forward. He confirmed that the marshaller did not signal a turn as the marshaller was waving a "move ahead" signal with both hands all the time, even after they had been stopped by the drain. He said that the co-pilot had the airport taxi charts and was referring to them.

1.18.3.2 In answer to the question regarding taxiway lights, he noticed blue lights to the left of the aircraft when they were on the straight section of the diverted portion of Taxiway WA but there were no lights to the right of the aircraft. The area to the right of the aircraft was very dark.

1.18.4 **Interview with ATC watch manager**

1.18.4.1 The watch manager said that the aircraft landed at 0029 hours on 28 February 2002. At Changi Control Tower, there were two controllers on duty, one performing ground movement planning and one performing runway control.

1.18.4.2 When the aircraft missed Bay 117, the controllers were occupied with other tasks and they only realised that the aircraft had missed Bay 117 when the aircraft called the Tower.

1.18.5 **Interview with ATC runway controller**

1.18.5.1 The runway controller said that his role was to prepare and set up the runway for aircraft arrival. The green taxiway centre line lights were set up to Taxiway VY by the ground movement planner. When the aircraft missed Bay 117, the green lights were reselected on to guide it back to Bay 117. While the aircraft was abeam Bay 117, the pilot reported having the marshaller in sight. He then told the pilot that the Bay 117 was to his right and obtained the pilot's reconfirmation that he had the marshaller in sight.

1.18.5.2 The runway controller was not aware of the NOTAM that required aircraft to be towed into Bay 117 during hours of darkness. He said that from his experience, when pilots approached the end of the green lights, they would call Tower for further guidance if they were not sure and required guidance.

1.18.6 **Interview with ATC ground movement planner**

1.18.6.1 The ground movement planner said his role was to give ATC clearances and to set the green taxiway centre line lights for both departure and arrival aircraft. His function was basically to inform the aircraft to follow the green taxiway centre line lights.

1.18.6.2 He recalled that the APWP6L flight crew had reported to the runway controller that they had missed Bay 117. The aircraft was then re-routed to Bay 117 by progressively operating the green taxiway lights on the return route. He said that from his experience, the pilot would call up Tower to request guidance when in doubt.

1.18.7 **Interview with auxiliary policeman**

1.18.7.1 The auxiliary policeman (engaged by the ground handling company, SIAEC) assigned to provide security for the APWP6L arriving flight said that he was performing his duty at Bay 117 from about 0020 hours on 28 February 2002. At the start he saw the aircraft taxiing towards Bay 117 but missed it. When the aircraft returned he noticed it made a right turn towards the Bay 117. Then he heard a loud sound and saw the aircraft's nose drop. The next thing he knew was that the aircraft had gone into a drain within the grass area. Before that, he saw the marshaller holding a wand in each hand. But he did not notice what signal the marshaller was giving as he was looking at the aircraft when it came in.

1.18.8 **Interview with Apron Control duty supervisor**

1.18.8.1 The Apron Control duty supervisor said that he was on duty from 1800 hours on the night of the accident. He allocated Bay 117 to the Arrow Air aircraft at about 1900 hrs. He said that according to the procedures, he was not required to do anything further after allocating the bay as the allocation was displayed to ATC as well as the ground handler via the airport's flight information display system. He was aware of the NOTAM that required aircraft to be towed into Bay 117 during hours of darkness.

1.18.9 **Interview with marshaller**

1.18.9.1 The marshaller said that he had been trained and had worked as a marshaller for the past 37 years. On 27 February 2002 at 2345 hours, he went to Bay 117 to receive the arriving aircraft. He recalled that after the aircraft landed at 0030 hours on 28 February 2002, it taxied towards Bay 117 but missed Bay 117. On the return of the aircraft, he held up the marshalling wands so as to indicate the position of the parking bay. After the aircraft had turned towards Bay 117, he then heard a loud bang. That

was when the aircraft was stuck in the drain. He said he was sure he did not wave the wands or give any turn signal.

### 1.18.10 Interview with SIA Engineering Company (SIAEC) duty supervisor

1.18.10.1 The SIAEC duty supervisor said he received information from the airport's flight information display system terminal in his operations room that Bay 117 was assigned to Flight APWP6L. He was unaware of the requirement for aircraft to be towed in, hence he positioned a marshaller at Bay 117 to receive the arriving aircraft at the bay.

## 1.19 Useful or effective investigation techniques

1.19.1 Not applicable.

## 2 ANALYSIS

### 2.1 General

2.1.1 The analysis by the investigation team has focused on the following areas:

a) Individual/team actions
b) Apron and taxiway
c) Organisational factors

### 2.2 Individual/Team Actions

#### 2.2.1 Flight crew

2.2.1.1 Both the pilot-in-command (PIC) and co-pilot had operated into Changi Airport several times before. The PIC was familiar with the 'follow-the-greens' taxiing guidance system which assists flight crew to taxi from the runway to the parking positions. In their previous visits to Changi Airport, the PIC and co-pilot had been assigned parking bays at one of the Bays 303 to 306 at the North Remote Apron. On the night of the accident, the crew was allocated parking Bay 117. Bay 117 was new to the PIC.

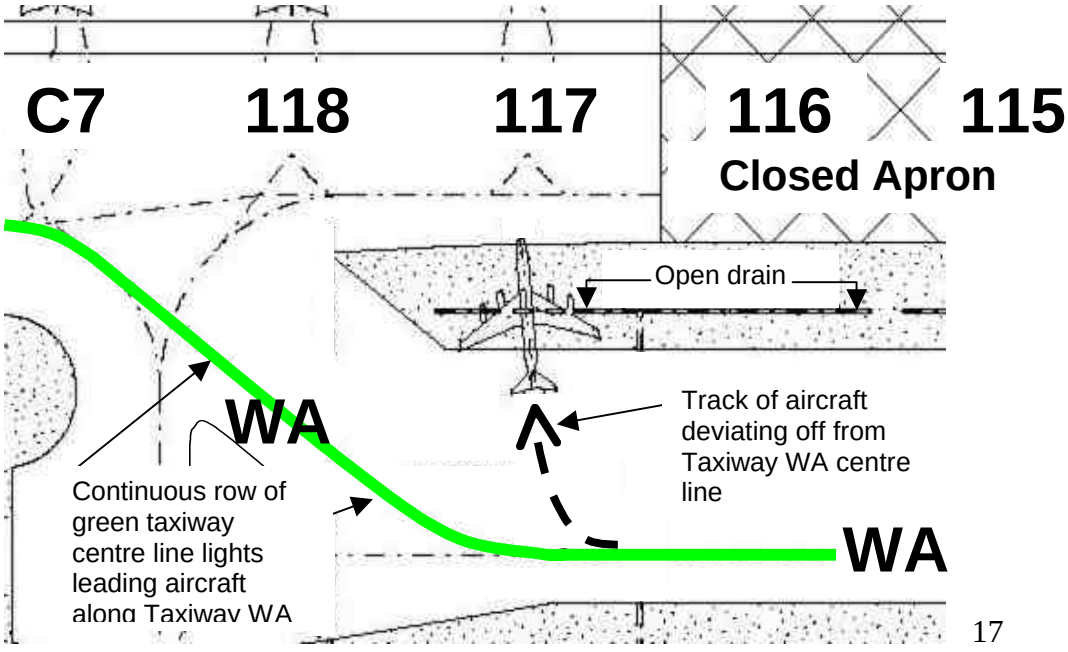
2.2.1.2 After landing, the PIC took over from the co-pilot to taxi the aircraft. The PIC was instructed by ATC to follow the taxiway green centre line lights to Bay 117. The PIC taxied the aircraft via the rapid exit Taxiway W4, Taxiway NC1 and Taxiway WA. The co-pilot was using the airport charts to assist in the navigation.

2.2.1.3 The 'follow-the-greens' taxiway guidance lights selected by ATC terminated abeam Bay C7, two parking bays before Bay 117. When the crew reached Bay C7, they did not stop to query about the absence of further 'follow-the-greens'. They also did not ask about the tow-in arrangements. Instead, they continued taxiing along Taxiway WA, without centre line light guidance, in search of the Bay 117 on their own. In the event, the crew passed by Bay 117 without noticing it. The PIC had the impression that Bay 117 was at a distance beyond the construction area to the south where several aircraft were parked in the brightly lit West Remote Apron.

2.2.1.4 After passing Bay 117, the PIC taxied along Taxiway WA in a southerly direction to the vicinity of Bay 106. The crew then called ATC to indicate its position near Bay 106. Realising that the aircraft had missed its assigned parking position, the ground movement planner at Changi Tower then reselected the green taxiway centre line lights to guide the aircraft back to Bay 117. The PIC taxied the aircraft following the return route green taxiway centre line lights until it was abeam Bay 117 on the straight section of the diverted portion of Taxiway WA.

2.2.1.5 At this moment, all three crew members saw the ground marshaller in position at Bay 117 on the right of the aircraft. Instead of continuing to follow the green taxiway centre line lights on Taxiway WA, the PIC turned the aircraft to the right to go directly to Bay 117 even though there was no turn signal from the marshaller or instruction to turn from ATC. At the location where the aircraft turned right, there was no aircraft parking bay guidance marking on the ground to indicate that the aircraft should turn. After turning right the aircraft went onto the paved area adjacent to the taxiway and subsequently onto a grass area between Taxiway WA and the parking apron. The flight crew did not see the grass area although the aircraft's landing lights were on. They only realised that the aircraft was on the grass after the aircraft's nose gear had gone across the drain. The PIC had not noticed the grass area as there were no "blue edge lights" to indicate the edge of the taxiway. The unmarked paved area adjacent to the taxiway may have given the PIC the impression that the entire length between the aircraft and Bay 117 was paved.

2.2.1.6 In summary, the crew was aware of the NOTAM that required aircraft to be towed in to Bay 117 during hours of darkness. However, they were unsure of the location of Bay 117. There were no instructions from the ATC as to what they could expect when they reached the end of the centre line guidance lights. They also did not stop at the end of the centre line guidance lights to verify their position or to ask ATC for instructions. The PIC was disorientated. Although the crew was referring to the airport charts, they missed Bay 117 initially. The flight crew's unfamiliarity with the apron area where Bay 117 was located contributed to their missing Bay 117. On the way back towards the Terminal 1 West Apron, ATC only asked the crew to follow the green lights and did not ask to find out what had caused the crew to miss Bay 117 earlier. Without additional instructions from ATC and while the PIC was looking out for a tow tug to lead the aircraft to Bay 117, the marshaller's raising his wands to help indicate the position of Bay 117 prompted the PIC to decide to turn the aircraft and go directly towards Bay 117.



2.2.2 **Air Traffic Control (ATC)**

2.2.2.1 The Changi Tower runway controller handled the landing of flight APWP6L normally. In accordance with the ATC procedures in the Air Traffic Services Manual (ATSM), he gave instructions to the flight crew to exit the runway. He also instructed flight APWP6L to follow the green taxiway centre line lights to Bay 117, the parking bay assigned by Apron Control.

2.2.2.2 The ground movement planner at Changi Control Tower initially selected the taxiway green centre line lights to terminate just abeam Bay C7, just two parking bays before Bay 117. The lights terminated abeam C7 instead of continuing past Bay 117 because of the construction work south of Bay 117.

2.2.2.3 After the flight crew had missed Bay 117 and later called Tower to ask for directions, the ground movement planner guided the aircraft to return via Taxiway WA by progressively operating the green taxiway centre line lights on the return route back to the point abeam Bay C7.

2.2.2.4 ATC did not ask to find out what had caused the crew to miss Bay 117 earlier and the crew did not tell ATC why they missed the assigned bay. However, to direct the aircraft to its assigned bay, ATC activated another set of taxiway centre line lights for the aircraft to follow. The runway controller instructed the aircraft: "Just follow the green lights. The green lights will lead you all the way back to your right Bay 117." (See ATC transcript in Appendix 2.)

2.2.2.5 The runway controller was not aware of the NOTAM requiring aircraft to be towed into Bays 117 and 118 during hours of darkness and he did not notice that there were no green taxiway centre line lights from Bay C7 to Bay 117. He expected the flight crew of APWP6L to taxi to Bay 117 on its own by following the taxiway centre line lights. Hence, he did not give any additional instructions to the flight. In the circumstances of the aircraft having already missed its first attempt to locate Bay 117, had the runway controller been aware of the NOTAM requirement, he could have provided useful additional instructions to the crew.

2.2.2.7 The watch manager was aware of the NOTAM on the restrictions at Bays 117 and 118. However, at the time of the accident, the watch manager was in the Tower cabin performing other tasks and was not looking at the aircraft.

2.2.3 **Apron Control**

2.2.3.1 The officer in Apron Control who assigned Bay 117 to flight APWP6L was the Apron Control duty supervisor. He assigned Bay 117 to flight APWP6L at about 1900 hours on 27 February 2002. He assigned this bay

because the remote bays normally used for Arrow Air flights were occupied by other aircraft. The duty supervisor entered the assigned bay number into the flight information display system (FIDS), in accordance with the Apron standard operating procedures. Once the bay number is entered into the FIDS, the information is displayed to ATC at Changi Tower and to the ground handler at the ground handler's operations room.

2.2.3.2 The Apron Control duty supervisor was aware of the NOTAM that required aircraft to be towed into Bays 117 and 118 during hours of darkness. However, he did not coordinate with ATC and the ground handler on the arrangements to tow the aircraft into Bay 117. There were no standing procedures established for the towing of aircraft from Taxiway WA to Bay 117 or 118.

### 2.2.4 **Ground handler**

2.2.4.1 The duty supervisor of the ground handler (SIAEC) received information from the FIDS terminal in his operations room that Bay 117 was assigned to flight APWP6L. He was not aware of the tow-in requirement. He positioned a marshaller at Bay 117 to receive the arriving aircraft at the bay. He was not informed by Apron Control to arrange for any tow tug.

2.2.4.2 The marshaller was instructed by his supervisor to go to Bay 117 to receive the arriving aircraft. The marshaller saw the aircraft initially approached and missed Bay 117. On the return of the aircraft, he held up the marshalling wand so as to indicate the position of the parking bay. Although the flight crew said they saw the marshaller waving a "move ahead" signal with his wands (but not a turn signal), the marshaller said he did not wave or give any turn signal to the aircraft. The auxiliary policeman engaged by the ground handling company and assigned to provide security for APWP6L saw the marshaller holding a wand in each hand but did not notice what signal the marshaller was giving.

2.2.4.3 It cannot be ascertained if the marshaller waved a "move ahead" signal. But the PIC was prompted, on seeing what he thought was a "move ahead" signal and despite the absence of a turn signal from the marshaller, to decide to turn the aircraft and go directly towards Bay 117, resulting in the aircraft being caught in the drain.

## 2.3 **Apron and Taxiway**

### 2.3.1 **Taxiway centre line lights**

2.3.1.1 Green bi-directional taxiway centre line lights are provided along all taxiways at Singapore Changi Airport to provide continuous guidance to pilots from the exit taxiways to the apron. These lights are selectable from the Control Tower, so that only specific routes are lighted to guide aircraft

taxiing on the ground. These lights are provided in accordance with ICAO Annex 14, Volume I, paragraphs 5.3.15.2 and 5.3.15.3 (Recommended Practices). (See extracts of ICAO Annex 14 at Appendix 6.)

2.3.1.2 On the night of the accident, the taxiway centre line lights were working normally. There was no report of any unserviceable taxiway centre line lights at the time of the accident. Records of inspections carried out before and after the accident showed that all the lights and signs were serviceable.

### 2.3.2 Taxiway edge lights

2.3.2.1 Blue taxiway edge lights are provided at all taxiway junctions in Changi Airport to better demarcate the edges of the taxiway turns and to serve as a contingency in case of any taxiway centre line light failures. These lights are provided in accordance with ICAO Annex 14, Volume I, paragraph 5.3.16.1. The lights provided at the Taxiway WA-VY junction are shown in Appendix 1C (see also figure at paragraph 2.2.1.6). In the case of the straight section of the diverted portion of Taxiway WA, blue reflective taxiway edge markers are also installed along the western edge. The eastern edge was adjoining a paved area and there were no blue reflective markers installed along it.

2.3.2.2 According to ICAO Annex 14, Volume I, paragraph 5.3.16.1, taxiway edge lights shall be provided on a taxiway not provided with taxiway centre line lights and intended for use at night. (See Appendix 6.) In the case of Changi Airport, since taxiway centre line lights are available along all taxiways, there is no requirement to provide taxiway edge lights. However, where there is a large unmarked paved area adjacent to a taxiway, to avoid aircraft inadvertently straying into the unmarked paved area, it would be an additional safeguard if edge lights or reflective markers were provided to demarcate the edge of the taxiway although there is no requirement in ICAO Annex 14 to do so.

### 2.3.3 Drain within grass area

2.3.3.1 The drain (about 1.4 m wide and 0.8 m deep) located within the grass area between Taxiway WA and the parking apron was not covered. The distance between the drain and the taxiway centre line was 75.5 m. The drain is therefore outside the taxiway strip which extends 47.5 m on either side of the taxiway centre line. ICAO Annex 14 does not have requirement for such drains to be covered.

2.3.3.2 It is normal at airports to have grass areas between paved areas, for example, between runways and taxiways or between taxiways and parking areas. There is no requirement in ICAO Annex 14 to mark or light such grass areas. It may not be practical to provide markers for each grass area.

### 2.3.4 **Jeppesen charts**

2.3.4.1 The flight crew was using current Jeppesen charts that showed the layout of Singapore Changi Airport, including the runways, taxiways, parking bays and terminal buildings. The Jeppesen charts used by the crew included a "yellow" supplementary chart dated 18 January 2002, which was current at the time of the accident. The chart showed in greater detail the area around Bay 117 where there was construction work. In particular, the yellow supplementary chart showed the location of Bay C7 relative to Bay 117 (two bays away) as well as the diverted portion of Taxiway WA. The yellow supplementary chart also showed that there was a turf island between Taxiway WA and the parking apron at which Bay 117 was located.

2.3.4.2 The crew did not notice the turf island between Taxiway WA and the parking apron that was shown on the Jeppesen charts. Had they been aware of the turf island, they could have been prompted to ask ATC for guidance instead of turning the aircraft towards Bay 117 while still on the straight section of the diverted portion of Taxiway WA.

## 2.4 **Organisational Factors**

### 2.4.1 **Coordination procedures for parking bays**

2.4.1.1 The NOTAM on the tow-in requirement at Bays 117 and 118 arose from the nearby construction work of which CAAS Engineering Division was in charge. Before the NOTAM was issued, the CAAS divisions concerned held discussions to coordinate the management of aircraft movements along the taxiways and to the parking bays. The discussions did not include towing procedures for aircraft assigned to Bay 117 or 118.

2.4.1.2 The NOTAM was disseminated to Changi Tower. However, the runway controller was not aware of the NOTAM. Apron Control duty supervisor was aware of the NOTAM but did not remind Changi Tower that the assigned Bay 117 was a tow-in only bay. There was no procedure that required Apron Control to remind Changi Tower about the tow-in requirement.

2.4.1.3 Procedures for towing of aircraft assigned to Bay 117 or 118 were not established with ground handling companies providing handling service to airlines operating here.

2.4.1.4 Arising from the above, there were no instructions by ATC nor arrangements by Apron Control for the aircraft to stop near Bay 117 to await towing. The right turn into the grass area made by flight APWP6L was not the result of any ATC or Apron Control action.

## 3 CONCLUSIONS

### 3.1 Findings and Contributory Factors

3.1.1 The accident took place at night in clear weather.

3.1.2 The flight crew members were properly licensed, qualified, medically fit, and in compliance with flight and duty time regulations.

3.1.3 The flight crew had the latest revision of the Jeppesen charts showing the layout of Singapore Changi Airport, including the yellow supplementary chart showing the area near Bay 117 in greater detail.

3.1.4 The flight crew was not familiar with the Terminal 1 West Apron area where Bay 117 was located.

3.1.5 The flight crew was aware of the NOTAM tow-in requirement at Bay 117 during hours of darkness.

3.1.6 The Apron Control duty supervisor was aware of the requirement for aircraft to be towed into Bay 117. He did not coordinate with ATC and the ground handler on towing arrangements as there was no towing procedure established for aircraft assigned to Bay 117 or 118.

3.1.7 The runway controller was not aware of the requirement for aircraft to be towed into Bay 117. He instructed flight APWP6L to follow the green lights to Bay 117 in accordance with standard ATC procedures.

3.1.8 The flight crew did not stop at Bay C7 to ask for instructions or guidance to get to Bay 117.

3.1.9 After missing Bay 117 initially, the flight crew continued taxiing in search of the bay on their own.

3.1.10 On the subsequent return towards Terminal 1 West Apron, after sighting Bay 117 and the marshaller on the right of the aircraft, the flight crew deviated from the Taxiway WA centre line marking and green centre line lights and turned the aircraft to the right directly towards Bay 117.

3.1.11 The flight crew did not see a turn signal from the marshaller but believed they saw the marshaller waving a “move ahead” signal.

3.1.12 The flight crew did not notice on the Jeppesen charts that there was a turf island separating Taxiway WA from the parking apron where Bay 117 was located.

3.1.13 The flight crew turned right from the straight section of the diverted portion of Taxiway WA to head directly towards Bay 117 even though there was no turn signal from the marshaller, no instruction to turn from ATC and no aircraft parking bay guidance marking on the ground to indicate to the flight crew to turn right.

3.1.14 The landing lights of the aircraft were turned on.

3.1.15 As taxiway centre line lights were provided along Taxiway WA, according to ICAO Annex 14, there was no requirement for taxiway edge lights to be provided. However, where there is a large unmarked paved area adjacent to a taxiway, the provision of taxiway edge lights or reflective markers (in addition to taxiway centre line lights) would provide an additional cue to pilots to stay within the taxiway. This may help to prevent pilots inadvertently straying off the taxiway.

3.1.16 There were no edge lights or markers to show the grass area between Taxiway WA and the parking apron where Bay 117 was located. There is no requirement in ICAO Annex 14 for edge lights or markers to show the presence of grass areas adjacent to taxiways.

3.1.17 The drain located within the grass area between the diverted portion of Taxiway WA and the parking apron was outside the taxiway strip. According to ICAO Annex 14, drains located outside a taxiway strip are not required to be covered.

3.1.18 The airworthiness of the aircraft was not a factor in this accident.

## 4 SAFETY RECOMMENDATIONS

4.1 Arrow Air should ensure that its pilots are familiar with the layout of the airports they operate to, in particular, the location of parking bays, in accordance with the published charts. [AAIB Recommendation R-2004-005]

4.2 Arrow Air should review its taxiing procedures and remind its pilots regarding adherence to taxiway centre line guidance markings and lighting, as well as seeking assistance when in doubt about their location. [AAIB Recommendation R-2004-006]

4.3 CAAS should review its procedures on coordination among Apron Control, ATC, Engineering Division and ground handlers regarding restrictions or special procedures at parking bays. [AAIB Recommendation R-2004-007]

4.4 CAAS should consider installing taxiway edge lights or reflective markers along the edge of Taxiway WA next to the unmarked paved area to provide an additional cue to pilots to stay within the taxiway. [AAIB Recommendation R-2004-008]

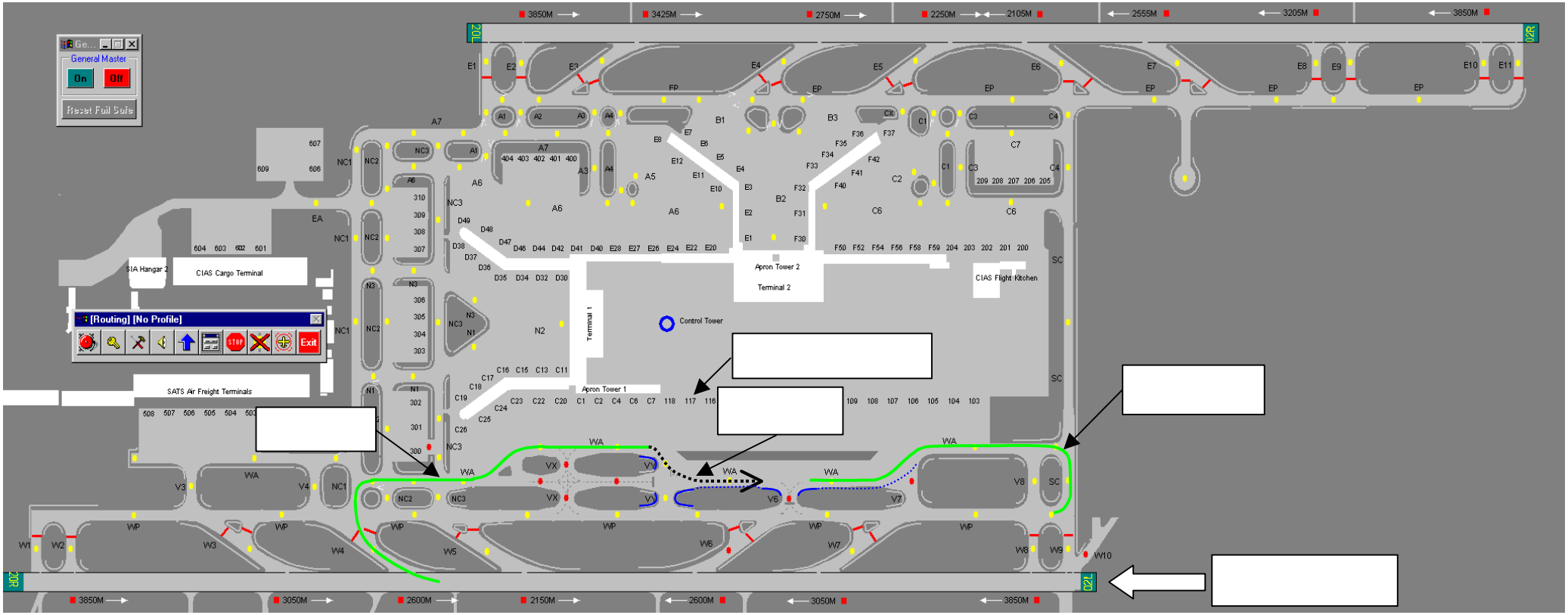
## 5 SAFETY ACTIONS

5.1 CAAS has reviewed and enhanced its NOTAM dissemination procedures to ensure that air traffic controllers are reminded of the relevant NOTAMs' requirements regarding restrictions or special procedures at parking bays, by adding paragraph 3 to Part II, Chapter 1 of its Air Traffic Services Manual.

## 6 APPENDICES

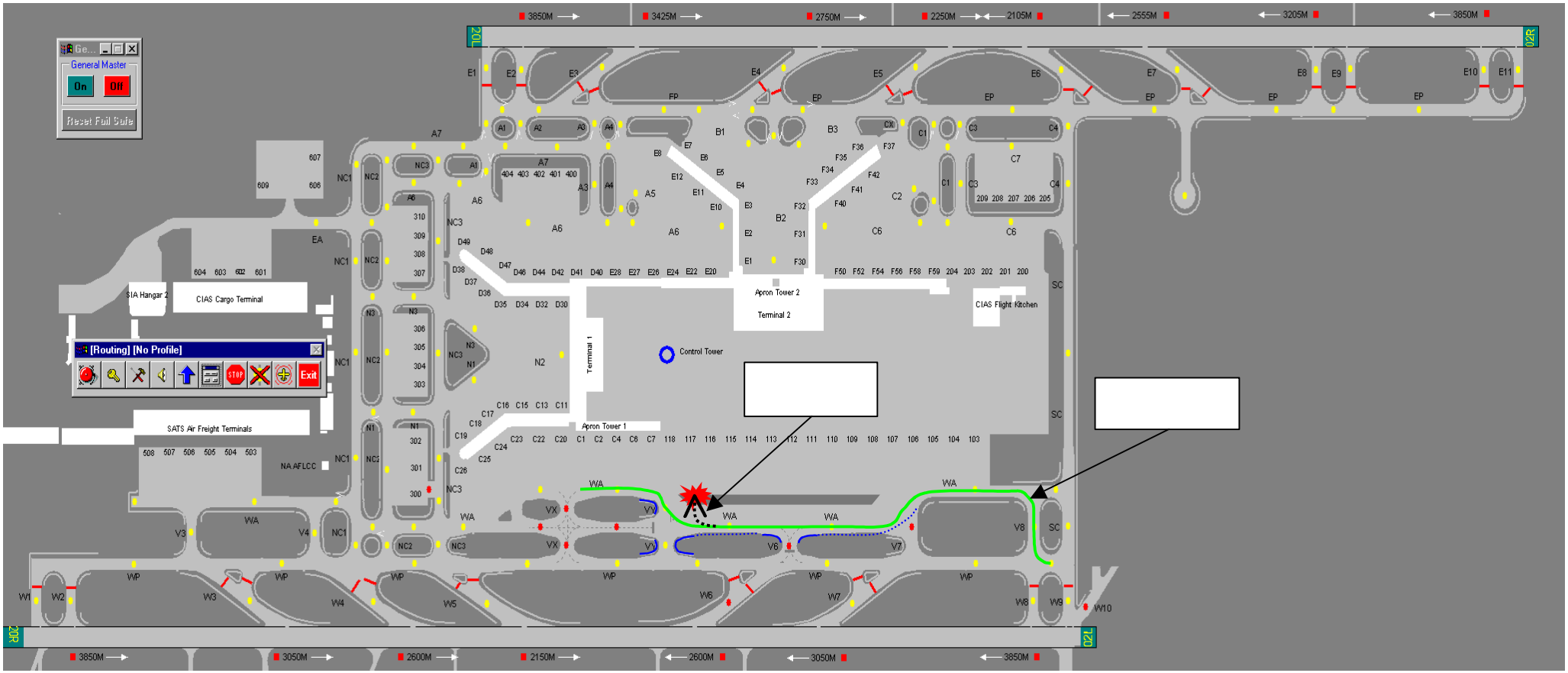
| | |
|---|---|
| Appendix 1A | Flight APWP6L Taxi Route, Part 1 |
| Appendix 1B | Flight APWP6L Taxi Route, Part 2 |
| Appendix 1C | Accident site layout |
| Appendix 2 | ATC tape transcript of Tower frequency 118.6 MHz |
| Appendix 3 | NOTAM |
| Appendix 4 | CVR transcript |
| Appendix 5 | Photographs of damage to aircraft |
| Appendix 6 | Extracts of Standards and Recommended Practices from ICAO Annex 14 |
| Appendix 7 | Jeppesen Charts |
| Appendix 8 | Marshalling signals |

# FLIGHT APWP6L TAXI ROUTE (PART 1)



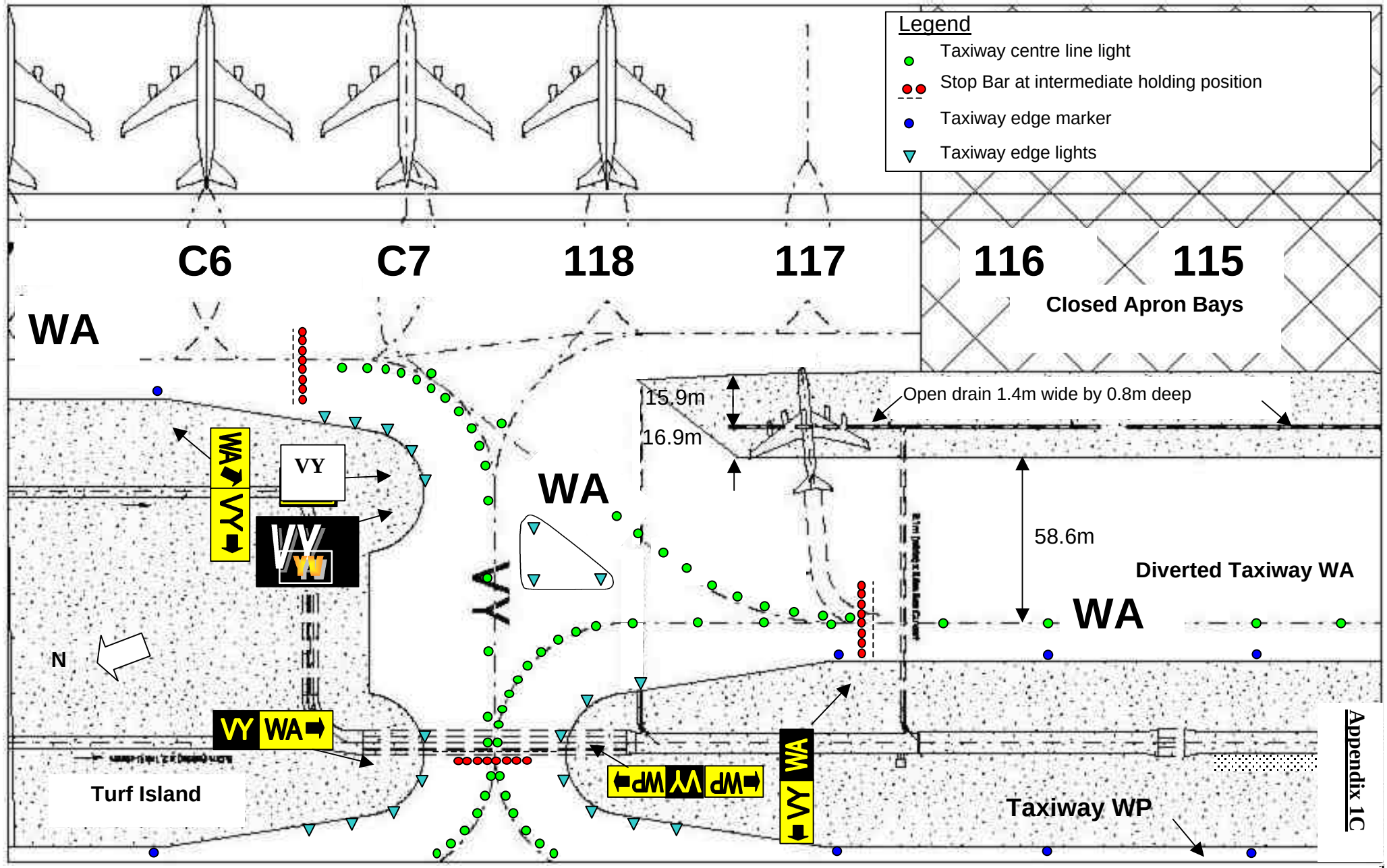

Appendix 1A

# FLIGHT APWP6L TAXI ROUTE (PART 2)




Appendix 1 B

# SITE LAYOUT DRAWING



**Appendix 2**

# ATC tape transcript of Tower frequency 118.6 MHz

**TAPE TRANSCRIPT OF CONVERSATION BETWEEN RUNWAY CONTROLLER AND APWP6L ON FREQUENCY 118.6 ON 27 FEBRUARY 2002**

| TIME (UTC) | FROM | TO | MESSAGE |
|---|---|---|---|
| 1630:30 | RWC | APWP6L | APWP6L, follow the green lights to bay 117. And you may remain on this frequency. |
| 1630:40 | APWP6L | RWC | Follow the green lights to 117, on this frequency P6L |
| 1636:40 | APWP6L | RWC | APWP6L |
| | RWC | APWP6L | Say again |
| 1636:50 | APWP6L | RWC | Tower. This is APWP6L confirm we're parking into spot 116 |
| 1637:00 | RWC | APWP6L | PWL. Your stand is 117. Where is your position now ? |
| | APWP6L | RWC | We are right at 106 |
| 1637:10 | RWC | APWP6L | WL. Your bay is way before that. We'll set another set of green lights for you, sir. Standby please. |
| 1637:40 | RWC | APWP6L | AWL. Can you see the green lights |
| | APWP6L | RWC | Affirmative. |
| | | | (Distortion) |
| 1638:00 | RWC | APWP6L | And AWL. Just follow the green lights. The green lights will lead you all the way back to your right bay 117 |
| | APWP6L | RWC | OK. After this we'll go follow the green lights back to 117, APWP6L. Thanks. |
| 1642:20 | RWC | APWP6L | And AWL, Singapore |
| 1642:30 | APWP6L | RWC | Go ahead for AWL. We've got the marshaller in sight now. |
| | RWC | APWP6L | OK. Anyway the Bay 117 is now just to your right sir and you have the marshaller in sight now. |
| 1642:40 | APWP6L | RWC | Got it. We got them in sight. |
| | RWC | APWP6L | OK. |
| | APWP6L | RWC | Thank you for your help |
| 1643:20 | RWC | APWP6L | AWL Singapore |
| 1643:30 | RWC | APWP6L | AWL Singapore |

**Appendix 3**

**NOTAM AO 179/02 DATED 1 FEBRUARY 2002 ON NON-AVAILABILITY OF TAXIWAY CENTRE LINE LIGHTS LEADING TO BAYS 117 AND 118**

NNNNZCZC ZFA335 011413
65 5431826
GG WSZCACXX WSZZADXX FMM YX VORGYTYN OMDBYQYX VIDPYNYR SBRJ
WSSSAYSP
011413 WSSSYNYX
(A0179/02 NOTAMN
Q)WS/IC/OMXXX/IV/B/A/000/999/
A)WSSS B)0202040100 C)PERM
E)NEW TWY WA STRETCHING FM BEHIND ACFT STANDS C7 TO 107 OPEN FOR OPS.
THE FOLLOWING RESTRICTIONS ARE APPLICABLE:

1) DRG DARKNESS, ACFT CAN ONLY BE TOWED IN/OUT FM ACFT STANDS 118,
117, 108 AND 107 AS THERE WILL BE NO CL LGT FM TWY VY AND TWY WA
BEHIND ACFT STAND C7 LEADING TO ACFT STANDS 118 AND 117; AND
FM TWY V7 LEADING TO ACFT STANDS 107 AND 108.
2) THERE WILL BE NO CL LGT AND MARKINGS FM THE NEW TWY WA LEADING TO
ACFT STANDS 107 AND 108. ACFT ARE TO BE TOWED IN/OUT FM THE NEW
TWY WA TO ACFT STANDS 107 AND 108 DRG DAY AND NGT.
3) ACFT ARE NOT ALLOWED TO TURN DIRECTLY RIGHT FM THE NEW TWY WA TO
TWY V7 AND DIRECTLY LEFT FM TWY V7 TO THE NEW TWY WA.
)

B0179/C0191

*** CHANGI AIS - 01 FEB 2002 ***

**Appendix 4**

# CVR TRANSCRIPT

**Italics = Area Microphone**
**Non-italics = Radio Communication**
**T = Tower**
**PIC = Pilot In Command**
**CP = Co-pilot**

# COMBINED TRACKS

| TIME (UTC) | PERSON | DIALOGUE |
|---|---|---|
| 15:59:59 | T | Alpha papa six lima contact Singapore approach on one two zero decimal three |
| 16:00:05 | PIC | One two zero decimal three begin ? papa six six one |
| 16:00:10 | T | Thanks |
| 16:00:13 | | *Fifteen tape??* |
| 16:00:23 | PIC | Singapore approach good evening begin papa six lima leaving |
| | | one niner zero clear one five zero golf |
| 16:00:32 | T | Alpha papa whiskey papa six lima descend on one zero thousand and clear direct Samco runway zero two left |
| 16:00:42 | | *Prepare snap of??* |
| 16:00:43 | PIC | Direct Samco (pause) descend one zero thousand papa six |
| 16:00:49 | T | Papa one niner continue approach contact the tower on one eight six |
| 16:00:52 | O | Eighteen six good day |
| 16:00:54 | O | Singapore four zero four contact radar one three three decimal two five |
| 16:00:58 | O | One three three two five Singapore four zero four good day |
| 16:01:23 | | *Suppose to cross Samco on??* |
| 16:01:53 | | *Four?* |
| 16:02:45 | | *One one??* |
| 16:03:12 | T | Alpha six lima Q N H one zero one one descend to four thousand feet and fly heading zero seven five |
| 16:03:18 | PIC | Zero seven five four thousand feet one zero one one papa lima |
| 16:03:27 | | *Down force??* |
| 16:03:48 | | *Side of the airport, right* |

| | | |
|---|---|---|
| 16:04:15 | | *It's before you get* |
| 16:04:26 | | *Buzzer sound* |
| | | *Followed by conversation* |
| 16:04:53 | | *Where are you?* |
| | | *Where am I now?* |
| | | *I wouldn't say I was over the water now* |
| 16:05:43 | O | Singapore in range in six, two niner morning passing level two zero three for flight level one five zero… heading one three five |
| 16:05:52 | O | Zero six two niner, good morning and descend six thousand feet and runway zero two right |
| 16:05:56 | O | Six thousand Malaysian zero six two nine and feet confirmed |
| 16:06:01 | T | Confirm and speed control is in force |
| 16:06:02 | O | M six two nine |
| 16:07:34 | O | Five eight two good morning identify flight level one six zero |
| 16:07:33 | | *Some clicking sounds* |
| 16:07:38 | O | Recom one six zero to the point Singapore eight eight two |
| 16:07:43 | T | Alpha six lima you have er two three flight miles to touch down, descend to three thousand feet |
| 16:07:49 | PIC | Three thousand begin papa six |
| 16:07:53 | T | Malaysian four six two descend at four thousand feet |
| 16:07:57 | O | Four thousand, Malaysian four six two nine |
| 16:07:57 | | *Approach check* |
| 16:08:03 | | *Not yet??* |
| 16:08:21 | | *Approach checks ?* |
| ? | | *Cockpit checks* |
| ? | | *Buzzer sound* |
| 16:09:20 | | *Tinking sound* |
| 16:09:34 | T | Alpha six lima you have sixteen miles to touch down turn left with zero five zero clear I L S for zero two left |
| 16:09:42 | | Zero five zero begin papa six lima |
| 16:09:48 | | *Some conversation & another tinking sound* |
| 16:09:53 | O | Singapore eight two Seletar ? Available |
| 16:09:58 | T | Singapore eight two standby |
| 16:10:15 | | *Wrong way* |
| 16:10:15 | T | Singapore eight two you need to fly heading three six zero |
| 16:10:19 | O | Heading three six zero Singapore eight two |
| 16:10:24 | | *Sounds* |

| | | |
|---|---|---|
| 16:10:24 | T | Malaysian six two niner descend three thousand feet |
| 16:10:27 | O | Three thousand Malay six two nine |
| 16:10:39 | CP | *Am I going in soon?* |
| 16:10:40 | PIC | Are we clear for the approach begin? papa six lima |
| 16:10:44 | T | Affirm, clear? for the approach runway zero two left |
| 16:10:47 | PIC | Roger |
| 16:10:49 | | *There is a bad side?* |
| 16:11:05 | | *Flaps 20 degrees* |
| 16:11:10 | O | Approach Singapore three twenty eight? good evening passing one thousand feet for five thousand feet |
| 16:11:13 | | *Switching sounds* |
| 16:11:15 | O | Proceed to eight, good morning leaving? departure flight level one four zero |
| 16:11:19 | O | Flight level one four zero Singapore three twenty eight? |
| 16:11:34 | O | One two three seven Singapore eight eight today |
| 16:11:39 | T | Papa six lima confirm fully established? |
| 16:11:43 | PIC | Established  I L S two left papa six lima |
| 16:11:46 | T | Six lima continue, first contact tower, on one one eight six |
| 16:11:49 | PIC | Eighteen six good evening |
| 16:11:51 | O | M six niner seven nine three |
| 16:12:00 | PIC | Singapore tower good evening …papa six, |
| | | Lima .er. Eight miles to landing? (two left)? |
| 16:12:08 | T | Papa whiskey papa six lima, Singapore tower, |
| | | surface winds zero one zero degrees five knots, clear to land zero two left |
| 16:25:51 | PIC | Clear to land zero two left biggen papa six lima (whistling sound in background) |
| 16:25:53 | | *Whistling sounds* |
| 16:25:54 | T | Singapore two three one, line up |
| 16:25:55 | O | Line up and wait zero two right |
| 16:26:36 | FE & PIC | *Before landing checks* |
| 16:26:42 | | *Buzzing sound* |
| 16:26:56 | T | Singapore two three one Lufthansa seven seven nine contact approach one two zero decimal three |
| 16:26:58 | O | Two zero three Lufthansa seven seven nine bye bye |
| 16:27:01 | | *Buzzing sound* |
| 16:27:35 | T | Singapore two three one the surface winds zero three zero degrees at one three knots climb five thousand feet for take off |

| | | |
|---|---|---|
| 16:27:42 | O | Five thousand feet clear for take off zero two right Singapore two three one |
| 16:27:53 | | *LBL units check??* |
| 16:28:31 | | *Buzzing sound* |
| 16:29:01 | | *Minimum, minimum* |
| 16:29:14 | | *Minimum* |
| 16:29:27 | | *??  change in engine noise* |
| 16:29:32 | T | Singapore two three one contact approach one two zero three |
| 16:29:35 | O | Singapore two three one good night |
| 16:29:38 | | *( Touchdown)* |
| 16:29:58 | FE | *On reverse, one hundred knots* |
| 16:30:10 | | *Aircraft* |
| 16:30:15 | O | Singapore tower this is Malaysian six two nine morning were southbound zero two right |
| 16:30:19 | T | Malaysian six two nine, tower good morning surface wind zero three zero degrees one two knots clear to land zero two right |
| 16:30:26 | O | Clear to land zero two right Malaysian six two nine |
| 16:30:27 | | *Engine noise decrease* |
| 16:30:30 | T | Alpha whiskey papa six lima follow the green lights to bay one one seven and you may remain on this frequency |
| | | |
| 16:30:40 | CP | Follow the green lights to bay one one seven and you may remain on this frequency. Papa six lima |
| | | |
| 16:30:46 | PIC | *That's a new one* |
| 16:30:49 | CP | *Bay one one six, all settled??* |
| 16:30:55 | CP | *Green lights to the right. Yep* |
| 16:31:07 | | *Ok* |
| 16:31:11 | CP | *Go back this way…and park just over there.* |
| 16:31:26 | | *Buzzing sounds* |
| 16:31:46 | | *All rightee* |
| 16:31:48 | FE | *Checklists* |
| 16:32:39 | CP | *Can't be sure at this point whether we're one one six or one one seven. You're sure it was one one seven* |
| 16:32:48 | CP | *Actually we're going to find out when we go there at one o'clock* |
| 16:32:48 | | *Conversation* |

| | | |
|---|---|---|
| 16:33:06 | PIC | *We're running out of sight, we got the audio sorted out* |
| 16:33:21 | CP | *Please let there be jet lag for us (waiting for us???)* |
| 16:33:30 | CP | *'C'* |
| 16:33:31 | PIC | *Yes, C is a handout, all the way down* |
| 16:33:36 | | *God* |
| 16:33:38 | | *Damned* |
| 16:33:42 | FE | *I don't know* |
| 16:33:43 | FE | *C got know* |
| 16:33:52 | PIC | *I got the green lights here* |
| 16:33:56 | PIC | *Keep following the stuff* |
| 16:34:08 | PIC | *How we're doing?* |
| 16:34:09 | O | Malaysian six two niner due traffic roll out use echo four two to Phuket and after that follow green lights to foxtrot three three, remain on this frequency |
| 16:34:11 | CP | *Veer off to the right then left & then we're off* |
| 16:34:18 | CP | *We should go down the taxiway right here* |
| 16:34:19 | T | Malaysian echo four and foxtrot three three remain on this frequency Malaysian six two |
| 16:34:23 | O | Pass by second left please thank you |
| 16:34:34 | CP | *Follow the green lights my arse* |
| 16:34:38 | PIC | *It's a full system* |
| 16:34:40 | CP | *Yeah but its always a bit those* |
| 16:34:42 | CP | *Its Saturday up here……and we handle??? on our own shit* |
| 16:35:01 | | *(Knocking* |
| 16:35:09 | | *Sounds)* |
| 16:35:23 | | *Come on man…… triple some does not have as much stars* |
| 16:35:52 | | *Did you ever get a hold of operations for now* |
| 16:36:00 | | *FBI there now* |
| 16:36:02 | | *What part of it now* |
| 16:36:07 | | *One one seven is er..right about the second spot* |
| 16:36:12 | | *About one sixteen* |
| 16:36:16 | | *Pretty good* |
| 16:36:19 | | *One of us is……* |
| 16:36:38 | | *No Marshaller* |

| | | |
|---|---|---|
| 16:36:39 | O | Tower good evening Singapore two six |
| 16:36:46 | T | Singapore two six continue holding?? For departure right |
| 16:36:50 | O | Holding in place for zero two right Singapore two six |
| 16:36:54 | | *Probably all over three oh three* |
| 16:36:58 | CP | Singapore alpha whiskey papa six lima |
| | | |
| 16:37:03 | T | Say again |
| 16:37:05 | CP | This is alpha whiskey papa six lima confirm we are parking at spot one one six |
| 16:37:14 | T | Papa whiskey six lima your stand is one one seven, what is your position now |
| 16:37:14 | CP | *That's one zero six* |
| 16:37:19 | T | *One zero six* |
| 16:37:21 | | We are right at one zero six |
| 16:37:29 | T | Ah whiskey lima your bay is way before that we will set another set of green lights for you Sir. Standby please |
| | | |
| 16:37:30 | | Thank you |
| 16:37:31 | | *I guess it's the spot before this, but it doesn't show that I'm here* |
| 16:37:38 | | *Look this shows a big long line here* |
| 16:37:45 | | *Its stopped, the green lights has stopped* |
| 16:37:49 | FE | *Where did it go out* |
| 16:37:49 | | Papa whiskey lima can you see a green lights |
| 16:37:53 | | That's affirmative |
| 16:37:58 | | *When these green lights stopped you/re supposed to hang alone* |
| 16:38:03 | | *Go give the truck it* |
| 16:38:07 | PIC | *The signals who's been misleading here* |
| 16:38:11 | PIC | *Shows a wrong with a Y* |
| 16:38:14 | PIC | *Take a fag, we went right by it* |
| | | *(follow the green light to one one seven) – (tower in background)* |
| 16:38:18 | | And alpha whiskey lima, just follow the green lights, the green lights will lead you all the way back to your right bay, one one seven |
| | | |

| | | |
|---|---|---|
| 16:38:27 | | Ok I see what we do here I'll follow the green lights back to one one seven alpha papa whiskey papa six lima thanks |
| 16:38:41 | | Singapore two six ready |
| 16:38:43 | T | Singapore two six the surface wind zero three zero degrees one two knots climb five thousand clear take off zero two right |
| 16:38:43 | CP | *Saturday didn't approve through I got here admit it* |
| 16:38:48 | | *The little pictorials bite my arse, that's the problem here* |
| 16:38:51 | O | Clear take off climb to five thousand Singapore two six |
| 16:38:58 | | *The more black time never kill anybody* |
| 16:39:01 | | *Separate laser* |
| 16:39:07 | | *Filthy? Green light at the end here* |
| 16:39:11 | FE | *there's more green lights right here* |
| 16:39:26 | | *Wot's the wot's* |
| 16:39:28 | | *Its got to be this – pilot's error – insane I have ever seen* |
| 16:39:31 | | *Hey* |
| 16:39:33 | PIC | *How can you f00:00:k up following the green lights, somebody please explain that to me* |
| 16:39:41 | | *Blue – Leeson* |
| 16:39:44 | | *Naw* |
| 16:39:46 | FE | *Leeson you will get in the news for this before you know you know all this shift time for flying that triple seven* |
| 16:39:51 | | Singapore two six holding(rolling?) |
| 16:39:54 | | Roger |
| 16:39:56 | | *Yah I have to acquire such green lights* |
| 16:40:00 | FE | *Yeah you gotta some…..* |
| 16:40:02 | | *Unlike here they just got the guy here or here what's the problem* |
| 16:40:07 | | *Laughter* |
| 16:40:10 | | *Do you read it* |
| 16:40:11 | | *What* |
| 16:40:12 | FE | *Like the whole Jepperson before you took off* |

| | | |
|---|---|---|
| 16:40:21 | CP | *With American has all these classes before you fly this show, Guatamala – whoap* |
| 16:40:29 | PIC | *On the board go after that picture, good laughter. Go sign that book. Laughter* |
| 16:40:37 | CP | *X speed up go on. Very good I didn't get to see the book wolf* |
| 16:40:41 | PIC | *Go and then we will sign it when we get back go look at the picture* |
| 16:40:53 | | *Ok somewhere between these two places there should be another spot to park* |
| 16:40:57 | | *Look at all the lights there* |
| 16:41:00 | | *Yeah we weren't suppose ……laughter* |
| 16:41:03 | | *Laughter* |
| 16:41:06 | | *We may be parking at a . . .  lousy store C spot* |
| 16:41:13 | | *I don't get that, I don't believe I see any spot between here and there but I'll take another gander and look* |
| 16:41:22 | | Hullo Singapore three three four good morning |
| 16:41:25 | T | Singapore three three four morning advise ready and call again holding point zero twelve (two right??) |
| 16:41:30 | | Local Singapore three three four |
| 16:41:36 | | Singapore two six approach one two zero decimal three |
| 16:41:39 | | One two zero point three Singapore two six good night |
| 16:42:00 | | *Or five all the whites this time – laughter* |
| 16:42:07 | | *I didn't see the . …. All the way back there . . . either* |
| 16:42:17 | | *I'll tell you right now, one one seven if we go by Victor Yankee we've gone too far* |
| 16:42:26 | | *Aye* |
| 16:42:30 | | *Jet Flag, Jet Flag, Jet Flag, Jet Flag, Jet Flag* |
| 16:42:36 | | *I quote screwed that up Victor Yankee just now slow down* |
| 16:42:45 | | *Ok its going to be right here in this slot by seven four* |

| | | |
|---|---|---|
| 16:42:51 | | *F**k* |
| 16:42:53 | | *There are people laughing their arse off* |
| 16:42:54 | T | …. Alpha whiskey lima, Singapore |
| 16:42:56 | | …. Alpha whiskey lima, we got the marshaller on sight now |
| 16:42:57 | | *Here they go to left side going party* |
| 16:43:01 | T | Ok. Way way bay one one seven is now just to your right Sir and you have marshaller in sight now |
| 16:43:08 | | Just now we got him in sight |
| 16:43:10 | | Ok |
| 16:43:11 | | Thanks for your help |
| 16:43:12 | | Ok |
| 16:43:15 | O | Singapore three three four approaching holding point ready for take off |
| 16:43:18 | | *They are all waving at us heh heh* |
| 16:43:19 | | *Joe! Hey!* |
| 16:43:19 | O | Singapore three three four roger |
| 16:43:23 | | Line up zero zero two right |
| 16:43:24 | | *Crash sound* |
| 16:43:25 | | End of zero two right Singapore three three four |
| 16:43:25 | | *Oh shit, that's grass* |
| 16:43:26 | | *Sound of Crash, Ooh's & Wah's* |
| 16:43:36 | | *Oh f**ks* |
| 16:43:39 | | *That was grass* |
| 16:43:42 | | *Shh* |
| 16:43:43 | | *Son...of..a..bitch!* |
| 16:43:46 | T | Alpha whiskey lima Singapore |
| 16:43:47 | | *That's some yellow bar its going to fart out, we gotta shut it down all right.* |
| 16:43:51 | | *Come on come on* |
| 16:43:54 | | *F**k man, he's marshalling me over there* |
| 16:44:02 | | *How come* |
| 16:44:04 | | *I think we've got to shut down that engine* |
| 16:44:08 | | *No engine noise* |
| 16:44:24 | | End of tape. |

**Appendix 5**

**PHOTOGRAPHS OF AIRCRAFT"S DAMAGE**

**Appendix 6**

## EXTRACTS OF STANDARDS AND RECOMMENDED PRACTICES FROM ICAO ANNEX 14 (IN ASCENDING ORDER OF PARAGRAPH NUMBER)

<table>
<tr><th>Para</th><th>Standard/Recommended Practice</th></tr>
<tr><td>3.8.4</td><td>Width of taxiways<br><br>Recommendation. – A straight portion of a taxiway should have a width of not less than that given by the following tabulation:<br><br>
<table>
<tr><th>Code letter</th><th>Taxiway width</th></tr>
<tr><td>A</td><td>7.5m</td></tr>
<tr><td>B</td><td>10.5m</td></tr>
<tr><td>C</td><td>15m if the taxiway is intended to be used by aeroplanes with a wheel base less than 18m;<br>18m if the taxiway is intended to be used by aeroplanes with a wheel base equal to or greater than 18m.</td></tr>
<tr><td>D</td><td>18m if the taxiway is intended to be used by aeroplanes with an outer main gear span of less than 9m;<br>23m if the taxiway is intended to be used by aeroplanes with an outer main gear span equal to or greater than 18m.</td></tr>
<tr><td>E</td><td>23m</td></tr>
<tr><td>F</td><td>25m</td></tr>
</table></td></tr>
<tr><td>3.8.7<br><br>Table 3-1</td><td>Taxiway minimum separation distances<br><br>Recommendation. – The separation distance between the centre line of a taxiway and the centre line of a runway, the centre line of a parallel taxiway or an object should not be less than the appropriate dimension specified in Table 3-1, except that it may be permissible to operate with lower separation distances at an existing aerodrome if an aeronautical study indicates that such lower separation distances would not adversely affect the safety or significantly affect the regularity of operations of aeroplanes.<br><br>(The relevant part of Table 3-1 mentioned above is reproduced below. The number in brackets indicate column number.)<br><br>
<table>
<tr><th>Code letter</th><th>Taxiway centre line to taxiway centre line (metres)</th><th>Taxiway, other than taxilane, centre line to object (metres)</th></tr>
<tr><td>(1)</td><td>(10)</td><td>(11)</td></tr>
<tr><td>A</td><td>23.75m</td><td>16.25m</td></tr>
<tr><td>B</td><td>33.5m</td><td>21.5m</td></tr>
</table></td></tr>
</table>

| | | | |
|---|---|---|---|
| | C | 44m | 26m |
| | D | 66.5m | 40.5m |
| | E | 80m | 47.5m |
| | F | 97.5m | 57.5m |
| 3.10.2 | Width of taxiway strip<br><br>Recommendation. – A taxiway strip should extend symmetrically on each side of the centre line of the taxiway throughout the length of the taxiway to at least the distance from the centre line given in Table 3-1, column 11.<br><br>(Column 11 of Table 3-1 is reproduced in the table row above on Taxiway minimum separation distances.) | | |

| Para | Standard/Recommended Practice |
|---|---|
| 3.10.3 | Objects on taxiway strips<br><br>Recommendation. – The taxiway strip should provide an area clear of objects which may endanger taxiing aeroplanes.<br><br>Note. – Consideration will have to be given to the location and design of drains on a taxiway strip to prevent damage to an aeroplane accidentally running off a taxiway. Suitably designed drain covers may be required. |
| 3.11.4 | Intermediate holding positions<br><br>Recommendation. – An intermediate holding position should be established in a taxiway at any point other than a runway-holding position where it is desirable to define a specific holding limit. |
| 5.2.8.1 | Taxiway centre line marking<br><br>Taxiway centre line marking shall be provided on a paved taxiway, de/anti-icing facility and apron where the code number is 3 or 4 in such a way as to provide continuous guidance between the runway centre line and aircraft stands. |
| 5.2.10.1 | Intermediate holding position marking<br><br>Recommendation. – An intermediate holding position marking should be displayed along an intermediate holding position. |
| 5.2.12.1 | Aircraft stand markings<br><br>Recommendation. – Aircraft stand markings should be provided for designated parking positions on a paved apron and on a de/anti-icing facility. |
| | Apron safety lines |

| | |
|---|---|
| 5.2.13.1 | Apron safety lines should be provided on a paved apron as required by the parking configurations and ground facilities. |
| 5.3.15.2 | Taxiway centre line lights<br><br>Recommendation. – Taxiway centre line lights should be provided on a taxiway intended for use at night in runway visual range conditions of 350m and greater, and particularly on complex taxiway intersections and exit taxiways, except that these lights need not be provided where the traffic density is light and taxiway edge lights and centre line marking provide adequate guidance.<br><br>Note. – Where there may be a need to delineate the edges of a taxiway, e.g. on a rapid exit taxiway, narrow taxiway or in snow conditions, this may be done with taxiway edge lights or markers. |

| Para | Standard/Recommended Practice |
|---|---|
| 5.3.15.3 | Recommendation. – Taxiway centre line lights should be provided on an exit taxiway, taxiway, de/anti-icing facility and apron in all visibility conditions where specified as components of an advanced surface movement guidance and control system in such a manner as to provide continuous guidance between the runway centre line and aircraft stands. |
| 5.3.15.11 | Recommendation. – Taxiway centre line lights on a straight section of a taxiway should be spaced at longitudinal intervals of not more than 30m, except that:<br><br>a) larger intervals not exceeding 60m may be used where, because of the prevailing meteorological conditions, adequate guidance is provided by such spacing;<br><br>b) intervals less than 30m should be provided on short straight sections; and<br><br>c) on a taxiway intended for use in RVR conditions of less than a value of 350m, the longitudinal spacing should not exceed 15m. |
| 5.3.15.13 | Recommendation. – On a taxiway intended for use in RVR conditions of less than a value of 350m, the lights on a curve should not exceed a spacing of 15m and on a curve of less than 400m radius the lights should be spaced at intervals of not greater than 7.5m This spacing should extend for 60m before and after the curve.<br><br>Note 1. – Spacings on curves that have been found suitable for a taxiway intended for use in RVR conditions of 350m or greater are:<br><br>Curve radius — Light spacing<br><br>Up to 400m — 7.5m<br>401m to 899m — 15m<br>900m or greater — 30m |
| 5.3.16.1 | Taxiway edge lights<br><br>Taxiway edge lights shall be provided at the edges of a holding bay, de/anti-icing facility, apron, etc. intended for use at night and on a taxiway not provided with taxiway centre line lights and intended for use at night, except that taxiway edge lights need not be provided where, considering the nature of the operations, adequate guidance can be achieved by surface illumination or other means. |
| 5.3.21 | Apron floodlighting<br><br>Recommendation. – Apron floodlighting should be provided on an apron, on a de/anti-icing facility and on a designated isolated aircraft parking position |

| | |
|---|---|
| | intended to be used at night. |
| 5.3.23.1 | Aircraft stand manoeuvring guidance lights<br><br>Recommendation. – Aircraft stand manoeuvring guidance lights should be provided to facilitate the positioning of an aircraft on an aircraft stand on a paved apron or on a de/anti-icing facility intended for use in poor visibility conditions, unless adequate guidance is provided by other means. |

| Para | Standard/Recommended Practice |
|---|---|
| 5.4.3.8 | Information signs<br><br>A combined location and direction sign shall be provided when it is intended to indicate routing information prior to a taxiway intersection. |
| 5.4.3.9 | A direction sign shall be provided when there is an operational need to identify the designation and direction of taxiways at an intersection. |
| 5.4.3.10 | Recommendation. – A location sign should be provided at an intermediate holding position. |
| 5.4.3.12 | A location sign should be provided in conjunction with a direction sign, except that it may be omitted where an aeronautical study indicates that it is not needed. |
| 5.4.6.1 | Aircraft stand identification signs<br><br>Recommendation. – An aircraft stand identification marking should be supplemented with an aircraft stand identification sign where feasible. |
| 7.2.1 | Non-load-bearing surfaces<br><br>Shoulders for taxiways, holding bays and aprons and other non-load-bearing surfaces which cannot readily be distinguished from load-bearing surfaces and which, if used by aircraft, might result in damage to the aircraft shall have the boundary between such areas and the load-bearing surface marked by taxi side stripe marking. |
| 8.7.1 | Siting and construction of equipment and installations in operational areas<br><br>Unless its function requires it to be there for air navigation purposes, no equipment or installations shall be:<br><br>a) on a runway strip, a runway end safety area, a taxiway strip or within the distances specified in Table 3-1, column 11, if it would endanger an aircraft; or<br><br>b) on a clearway if it would endanger an aircraft in the air. |
| 8.7.2 | Any equipment or installation required for air navigation purposes must be located:<br><br>a) on that portion of a runway strip within:<br>1) 75m of the runway centre line where the code number is 3 or 4; or<br>2) 45m of the runway centre line where the code number is 1 or 2; or |

| | |
|---|---|
| | b) on a runway end safety area, taxiway strip or within the distances specified in Table 3-1; or<br><br>c) on a clearway and which would endanger an aircraft in the air;<br><br>shall be frangible and mounted as low as possible. |

**Appendix 7**

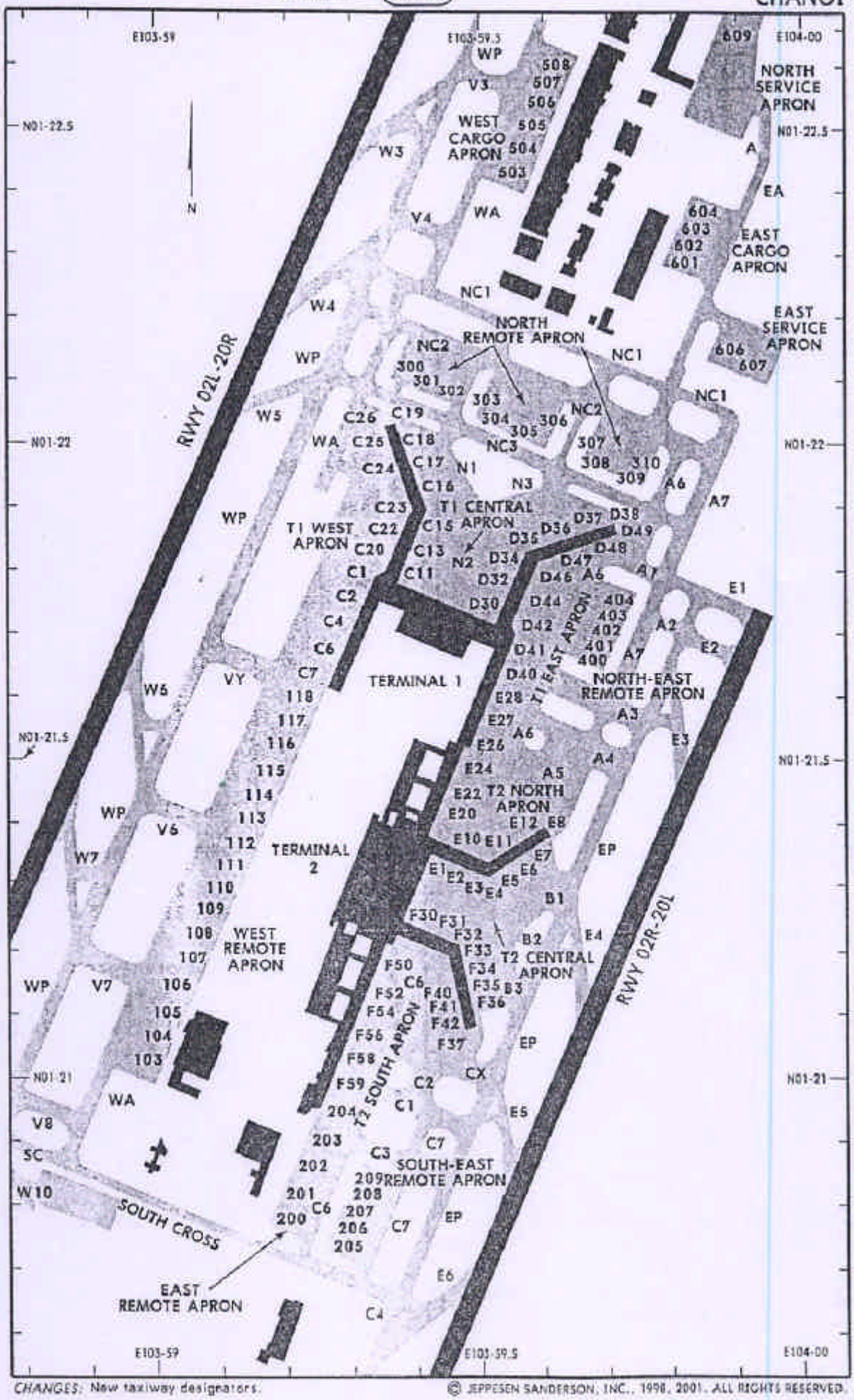
# JEPPESEN CHARTS

WSSS

JEPPESEN

27 APR 01 (10-9B)

# SINGAPORE, SINGAPORE
## CHANGI

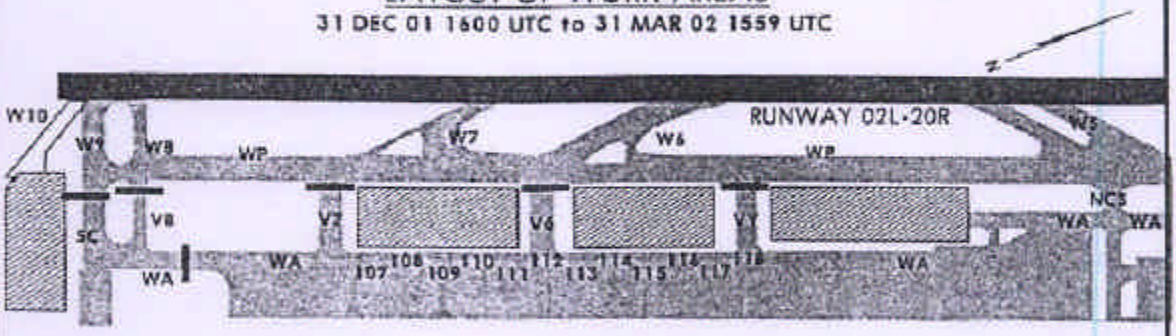



CHANGES: New taxiway designators.

## DIAGRAM 1

### LAYOUT OF WORK AREAS

**31 DEC 01 1600 UTC to 31 MAR 02 1559 UTC**

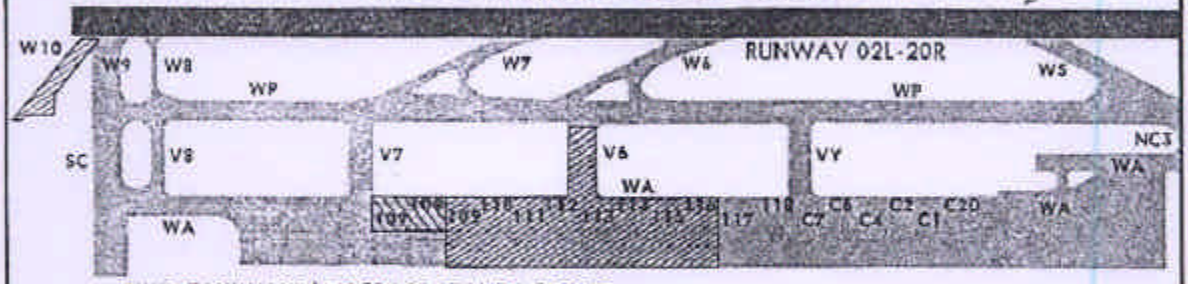



WORK AREAS FROM 31 DEC 01 1600 UTC TO 31 MAR 02 1559 UTC
(TAXIWAYS and AIRCRAFT STANDS AFFECTED ARE SHOWN IN DIAGRAMS 2A-2B)
(AIRCRAFT PUSHBACK PROCEDURES ARE GIVEN IN DIAGRAMS 3A-3C)

DESIGNATED VEHICULAR CROSSINGS

## DIAGRAM 2A CLOSURE OF TAXIWAYS/AIRCRAFT STANDS

**31 DEC 01 1600 UTC to 28 FEB 02 0159 UTC**

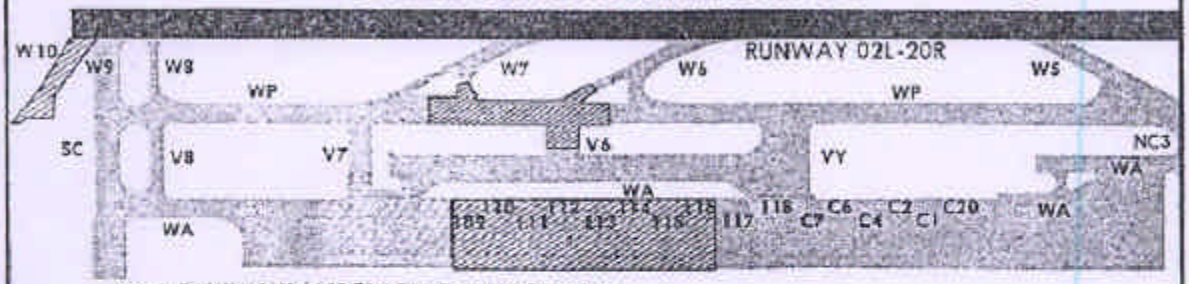



TAXIWAYS/AIRCRAFT STANDS CLOSED:
W10 and V6
WA (BETWEEN AIRCRAFT STANDS 109 and 116)
AIRCRAFT STANDS 109, 110, 111, 112, 113, 114, 115 and 116

TAXIWAY CLOSED DAILY FROM
0000 UTC TO 1400 UTC:
WA (BETWEEN AIRCRAFT STANDS 107 and 108)

## DIAGRAM 2B CLOSURE OF TAXIWAYS/AIRCRAFT STANDS

**28 FEB 02 0200 UTC to 31 MAR 02 1559 UTC**




TAXIWAYS/AIRCRAFT STANDS CLOSED:
W10 and V6
WP (BETWEEN TAXIWAYS W7 and W6)
WA (BETWEEN AIRCRAFT STANDS 109 and 116)
AIRCRAFT STANDS 109, 110, 111, 112, 113, 114, 115, and 116

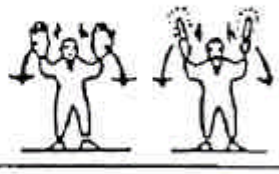
CHANGES: Chart revised.

**Appendix 8**

# MARSHALLING SIGNALS

## Move ahead

Arms a little aside, palms facing backward and repeatedly moved upward-backward from shoulder height.



## Turn

a) *Turn to your left:* right arm downward, left arm repeatedly moved upward-backward. Speed of arm movement indicating rate of turn.

b) *Turn to your right:* left arm downward, right arm repeatedly upward-backward. Speed of arm movement indicating rate of turn.