Australian Government

Australian Transport Safety Bureau

ATSB TRANSPORT SAFETY REPORT

Aviation Occurrence Investigation AO-2008-033

Final

Operational non-compliance
Perth Airport, WA
9 May 2008
PK-GEF
Boeing Company 737-8CX

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Abstract

On 9 May 2008, a Boeing Company 737-8CX aircraft, registered PK-GEF, was being operated on a scheduled passenger service between Denpasar, Republic of Indonesia and Perth, WA. On board were two flight crew, six cabin crew and 76 passengers.

The flight crew reported that, once established in the cruise, they reviewed their briefing material and noted that the threshold for runway 21 at Perth was displaced due to runway works.

On approach to land at Perth, the aerodrome controller issued the flight crew with the landing clearance, '... runway 21 displaced threshold, cleared to land'. When the aircraft was about 15 seconds from touchdown, the flight crew questioned the presence of cars on the runway and conducted a go-around.

On the second approach, the flight crew were again issued the landing clearance '... runway 21, displaced threshold, cleared to land'. The aerodrome controller recalled observing the aircraft on what appeared to be an approach to land on the closed section of the runway and instructed the flight crew to go around. The go-around instruction also included information to assist the flight crew in identifying where the aircraft was to be landed. That additional information, together with the high workload being experienced by the flight crew at that time, may have momentarily confused them, with the effect that they did not assimilate and act on the instruction to go around.

As a result of this incident, the airport operator undertook a number of safety actions. Those actions included: the review of its dispatch of Method of Works Plans (MWOP) to relevant stakeholders; the implementation of a more robust MWOP receipt and acknowledge system; and the establishment of a project safety group in support of all critical airside works.

THE AUSTRALIAN TRANSPORT SAFETY BUREAU

The Australian Transport Safety Bureau (ATSB) is an operationally independent multi-modal bureau within the Australian Government Department of Infrastructure, Transport, Regional Development and Local Government. ATSB investigations are independent of regulatory, operator or other external organisations.

The ATSB is responsible for investigating accidents and other transport safety matters involving civil aviation, marine and rail operations in Australia that fall within Commonwealth jurisdiction, as well as participating in overseas investigations involving Australian registered aircraft and ships. A primary concern is the safety of commercial transport, with particular regard to fare-paying passenger operations.

The ATSB performs its functions in accordance with the provisions of the *Transport Safety Investigation Act 2003* and Regulations and, where applicable, relevant international agreements.

Purpose of safety investigations

The object of a safety investigation is to enhance safety. To reduce safety-related risk, ATSB investigations determine and communicate the safety factors related to the transport safety matter being investigated.

It is not the object of an investigation to determine blame or liability. However, an investigation report must include factual material of sufficient weight to support the analysis and findings. At all times the ATSB endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, and why, in a fair and unbiased manner.

Developing safety action

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues in the transport environment. The ATSB prefers to encourage the relevant organisation(s) to proactively initiate safety action rather than release formal recommendations. However, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation, a recommendation may be issued either during or at the end of an investigation.

The ATSB has decided that when safety recommendations are issued, they will focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on the method of corrective action. As with equivalent overseas organisations, the ATSB has no power to implement its recommendations. It is a matter for the body to which an ATSB recommendation is directed (for example the relevant regulator in consultation with industry) to assess the costs and benefits of any particular means of addressing a safety issue.

About ATSB investigation reports: How investigation reports are organised and definitions of terms used in ATSB reports, such as safety factor, contributing safety factor and safety issue, are provided on the ATSB web site www.atsb.gov.au

FACTUAL INFORMATION

History of the flight

On 9 May 2008, a Boeing Company 737-8CX aircraft, registered PK-GEF, was being operated on a scheduled passenger service between Denpasar, Republic of Indonesia and Perth, WA.

At about 1140 Western Standard Time[1], the flight crew commenced duty in Denpasar, for a planned departure time of 1240. After the flight crew's arrival at the aircraft, the company flight operations officer (FOO) provided them with an operational briefing and with the flight documents that were pertinent to the flight. The flight subsequently left the terminal at Denpasar at 1235. On board were two flight crew, six cabin crew and 76 passengers.

The flight crew reported that, once established in the cruise, they reviewed the Notices to Airmen (NOTAMs)[2] for the flight (see Appendix A) and noted that the threshold for runway 21 at Perth was displaced due to runway works.

At about 1530, in preparation for arrival, the flight crew obtained the Perth Automatic Terminal Information Service (ATIS)[3] and conducted a briefing covering the approach and landing.

At 1557, the approach controller cleared the flight crew to conduct the runway 21 localiser (LLZ) approach[4]. At 1600, and with the aircraft established on the standard runway 21 LLZ approach path, the aerodrome controller (ADC) issued the landing clearance, '... runway 21 displaced threshold, cleared to land'. When the aircraft was about 15 seconds from touchdown, the flight crew questioned the presence of cars on the runway with the ADC, and conducted a go-around.

On the second approach, the flight crew were again cleared to conduct a runway 21 LLZ approach and, at 1614, the ADC issued the landing clearance, '... runway 21, displaced threshold, cleared to land'. The ADC recalled observing the aircraft on what appeared to be an approach to land on the closed section of the runway and, at 1615, instructed the flight crew to go around.

Recorded air traffic services (ATS) audio data revealed that, in the go-around instruction, the ADC provided information to the flight crew that identified where they should land the aircraft.

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1 The 24-hour clock is used in this report to describe the local time of day, Western Standard Time (WST), as particular events occurred. Western Standard Time was Coordinated Universal Time (UTC) + 8 hours.

2 NOTAM. A notice or advisory that was disseminated by all means to provide crews with information on the establishment, condition or change in any aeronautical facility, service, procedure or hazard.

3 ATIS. An automatically-recorded message that was transmitted on a particular frequency, and advised crews of: the current weather conditions; the pressure altimeter setting that, when set, indicates the airfield height (QNH); active runway(s); and so on.

4 The localiser was a component of an instrument landing system (ILS) that provided azimuth guidance to a runway. It was used in conjunction with a published descent profile to assist flight crews to position their aircraft for landing.

The flight crew of a departing Fokker 50 aircraft that was holding at taxiway Delta, observed the 737 during the final stages of its approach. The crew recalled that the profile was consistent with what they felt was an aircraft approaching to land in the normal touchdown zone, and that they heard the ADC issue the instruction to go around. They then observed the aircraft fly level over the runway works area at an estimated 30 to 50 ft above ground level (AGL), prior to touching down beyond the displaced threshold. The recorded touchdown time was 1616.

Apart from the standard radio transmissions associated with the aircraft taxiing to its parking position, no further communications were recorded between the flight crew and the ADC or surface movement controller.

Personnel information

The pilot in command (PIC) held a valid Airline Transport Pilot Licence (Indonesian). Total flying experience was about 11,790 hours, including about 1,370 hours on the Boeing 737-800 series aircraft.

The copilot held a valid Airline Transport Pilot Licence (Indonesian). Total flying experience was about 3,530 hours, including about 1,150 hours on the Boeing 737-800 series aircraft.

Prior to the flight, both flight crew members completed a 2-day rest period. The most recent flight into Perth by the PIC was about 1 month prior to the incident and, by the copilot, about 10 days prior to the incident. On each of those occasions, the landing was conducted on runway 21 and prior to the commencement of the runway works that necessitated the displaced threshold. Both flight crew members reported operating into Perth on more than six occasions during the past 3 months.

Both pilots indicated their compliance with the 'Level 4' International Civil Aviation Organization (ICAO) English Language Proficiency[5] standard.[6]

Meteorological information

The forecast weather for the aircraft's arrival into Perth indicated mostly fine conditions with some scattered (SCT)[7] cloud at 3,000 ft. The relevant forecasts are included at Appendix B.

The ATIS indicated light and variable winds, cloud FEW at 1,500 ft and visibility greater than 10 km.

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[5] In September 2007, ICAO adopted Assembly Resolution A36-11, which related to the implementation of language proficiency requirements for holders of all flight crew licences issued by contracting States. That resolution recommended the implementation of those proficiency requirements prior to 5 March 2008.

[6] Level 4 was the minimum standard stipulated for crews conducting international operations.

[7] An okta is the unit of measurement that is used to report the total sky area that is visible to the celestial horizon. One okta is equal to 1/8th of that visible sky area. The term okta is also used to forecast or report the amount of cloud in an area, along a route or at an airfield. The numbers of oktas of cloud are reported or forecast as follows: Few (FEW), meaning 1 to 2 oktas; Scattered (SCT), meaning 3 to 4 oktas; Broken (BKN), meaning 5 to 7 oktas, and Overcast (OVC), meaning 8 oktas.

At the time of the incident, the sun was about 15 degrees above the north-west horizon. Consequently, the position of the sun was about 90 degrees from the runway heading and would not have impaired the crew's vision on the approach to runway 21.

Aids to navigation

Precision approaches to runway 21 were normally possible via an instrument landing system (ILS) that provided glidepath and LLZ (azimuth) information to appropriately-equipped aircraft. Due to the displacement of the threshold, the glidepath component of the runway 21 ILS was deactivated. Given the unavailability of the ILS, when using runway 21 for international arrivals, air traffic control (ATC) was required to sequence those aircraft via the LLZ approach.

The LLZ approach provided azimuth guidance to the runway and recommended altitudes at 1 NM intervals to touchdown. That approach profile assisted flight crews to position their aircraft at about 500 ft above the relevant runway threshold elevation at 2 NM (3.7 km) from touchdown. From that position, the remainder of the approach and landing was required to be conducted visually.

Communications

A review of recorded ATS and other data revealed that:

- The ATIS that was valid for the aircraft's arrival was broadcast between about 1500 and 1618, and included:

  Perth terminal information X-ray.

  Runway 21 and 24 for arrivals, runway 21 for departures. Runway 21 displaced threshold marked by vee markers and cones, temporary PAPI available. Runway 21 glidepath not available, taxiway golf not available, departure frequency 118.7.

  Wind variable, maximum downwind 3kts, visibility greater than 10 km, cloud few 1,500ft, temperature 26°, QNH 1016.

  On first contact with Perth ground or approach notify receipt of X-ray.

- The Take-off and Landing Data (TOLD) card that was compiled by the flight crew for the landing, indicated their receipt of information X-ray and detailed the above information. However, there was no reference to the displaced runway 21 threshold recorded on the TOLD card.
- At 1551, the flight crew contacted the approach controller and were advised to expect a LLZ approach for runway 21. In the read back of that instruction, the flight crew acknowledged the receipt of ATIS information X-ray.
- At 1559, the flight crew advised that they were established on the LLZ approach. The approach controller then cleared the flight crew for the LLZ approach, instructed them to reduce the aircraft's speed to the required final approach speed, and to contact Perth Tower on frequency 120.5 MHz.
- The ADC contacted the flight crew at 1600 and instructed them to continue the approach, passed traffic information about a light aircraft that was on approach to runway 24, and issued a landing clearance. That landing

clearance included specific reference to the displaced threshold. When the flight crew questioned the landing clearance, the controller responded 'affirm runway 21 with a displaced threshold, cleared to land'.

- About 25 seconds after the controller's confirmation of the landing clearance, the flight crew questioned the presence of cars on the runway. The tower controller responded 'displaced threshold sir you've got to overfly those to the displaced threshold south of taxiway Delta'. The flight crew responded by advising that they were conducting a go-around. The flight crew were subsequently provided with altitude and heading instructions to reposition the aircraft for another approach to runway 21.
- At 1614, the ADC instructed the aircraft to, 'continue approach runway 21 with displaced landing threshold'. About 20 seconds later, the controller issued the landing clearance 'wind 270 degrees at 7 kts, runway 21 displaced landing threshold, cleared to land'.
- At 1615, the ADC observed the aircraft undershooting the displaced threshold and issued the instruction 'go-around sir, go-around, you are in the undershoot of the runway, you'll land south of taxiway Delta, south of the [holding] Fokker 50'.

The flight crew recalled that, during the second approach, they only heard a clearance to land, and did not recall hearing the instruction to go around or any other information.

Aerodrome information

Perth Airport comprised two intersecting runways; runway 21/03 and runway 24/06. Runway 21/03 was the longest runway, measuring 3,444 m.

At the time of the incident, the threshold of runway 21 was displaced 888 m due to runway works. The runway works were associated with the installation of high intensity runway lights between taxiway Delta and the runway 21 threshold. The runway works were scheduled to take place daily, between the hours of 0730 and 1700.

The temporarily displaced landing threshold was marked by 'vee bar'[8] markers and strobe lights on each side of the runway. The permanent threshold and touchdown markings were not obscured, and the works area was marked by four, 6 m closed runway crosses (Figure 1).

[8] Markers comprising gable markers painted white and positioned on each side of the runway together with flush, white, arrow markings.

Figure 1: Runway 21 works area looking south. Note the 6m cross (circled)

The flight crew recalled that, during the first approach and subsequent go-around, they did not see the closed runway crosses and that, on the second approach, they saw the closed runway crosses 'too late'.

A temporary precision approach path indicator (PAPI)[9] was installed 407 m from the displaced threshold of runway 21 and was positioned to provide flight crews with visual approach slope guidance to the displaced threshold touchdown point.

The flight crew of the incident aircraft reported that, on each approach, they disconnected the autopilot and observed the PAPI at or prior to reaching the minimum descent altitude (MDA)[10] for the runway 21 LLZ approach. That observation by the crew indicated that the aircraft was undershooting the approach path to the displaced threshold.

Organisational and management information

Airport operator

The runway works were promulgated by the airport operator via Method of Working Plan (MOWP) YPPH 02/08. That plan advised that the runway works were scheduled to occur between 23 March 2008 and 9 May 2008, and included a

[9] PAPI. An optical aid that assisted pilots to maintain glidepath to the touchdown point (nominally 300 m beyond the runway threshold), and comprised banks of red and white lights that were precisely aligned towards incoming aircraft. Red lights showed that an aircraft was too low and white that it was too high.

[10] MDA. A specified altitude in a non-precision runway or circling approach below which descent could not be made without visual reference. In this instance, where the recommended distance/altitude table was followed, the MDA placed the aircraft at about 500 ft above the runway threshold elevation and 2 NM (3.7 km) from the permanent threshold of runway 21.

plan view of the works (Figure 2) and a number of draft NOTAMs for promulgation at the appropriate stage of the works. There was no indication in the MWOP or draft NOTAMs of the consideration of the effect of those works on the final approach profile to the displaced threshold from the MDA of the runway 21 LLZ approach.

At the time of the incident, the mailing addresses on the distribution list for the MOWP, including for the aircraft operator, were predominantly to local offices that were located at Perth airport.

The MOWP included a covering letter that summarised the details of the runway works and provided contact details should recipients of the plan have any enquiries. Also included, was a form for the acknowledgement of receipt of the MOWP and any comments. That form listed the following specific instructions and conditions:

> The purpose of this acknowledgement form is to ensure that a copy of the Taxiway Lima 2 Overlay Repairs and Resealing and Runway 03/21 Inset Light Installation MOWP YPPH 02/08 has been delivered and reviewed by an organisation representative qualified to provide comment in relation to the proposed works. Where applicable, documentation forwarded to airlines should be reviewed by the Manager, Flight Operations.
>
> Please ensure that a suitably qualified officer reads the content of the Draft MOWP document and where necessary provides comment. The acknowledgement form must be signed and returned to [the airport operator].
>
> Conditions
>
> - I/We have read the DRAFT Method of Working Plan and acknowledge and accepted the restrictions and constraints to aircraft traffic and operations.
> - The Flight Operations Manager (airline)/Organisation Manager has reviewed the content of the Method of Working Plan, and fully understands the restrictions associated with aircraft activity.
> - I/We understand that the comments provided above may or may not be adopted by [the airport operator] in documentation of the final Method of Working Plan.

The airport operator reported that there was a poor response rate overall to the covering letter, and that there was no acknowledgement from the aircraft operator that was involved in this incident.

Aircraft operator

The company FOO provided operational control over company flights, and flight planning support to the flight crew. Those support duties were specified in the company's Basic Operations Manual, and included, but were not limited to:

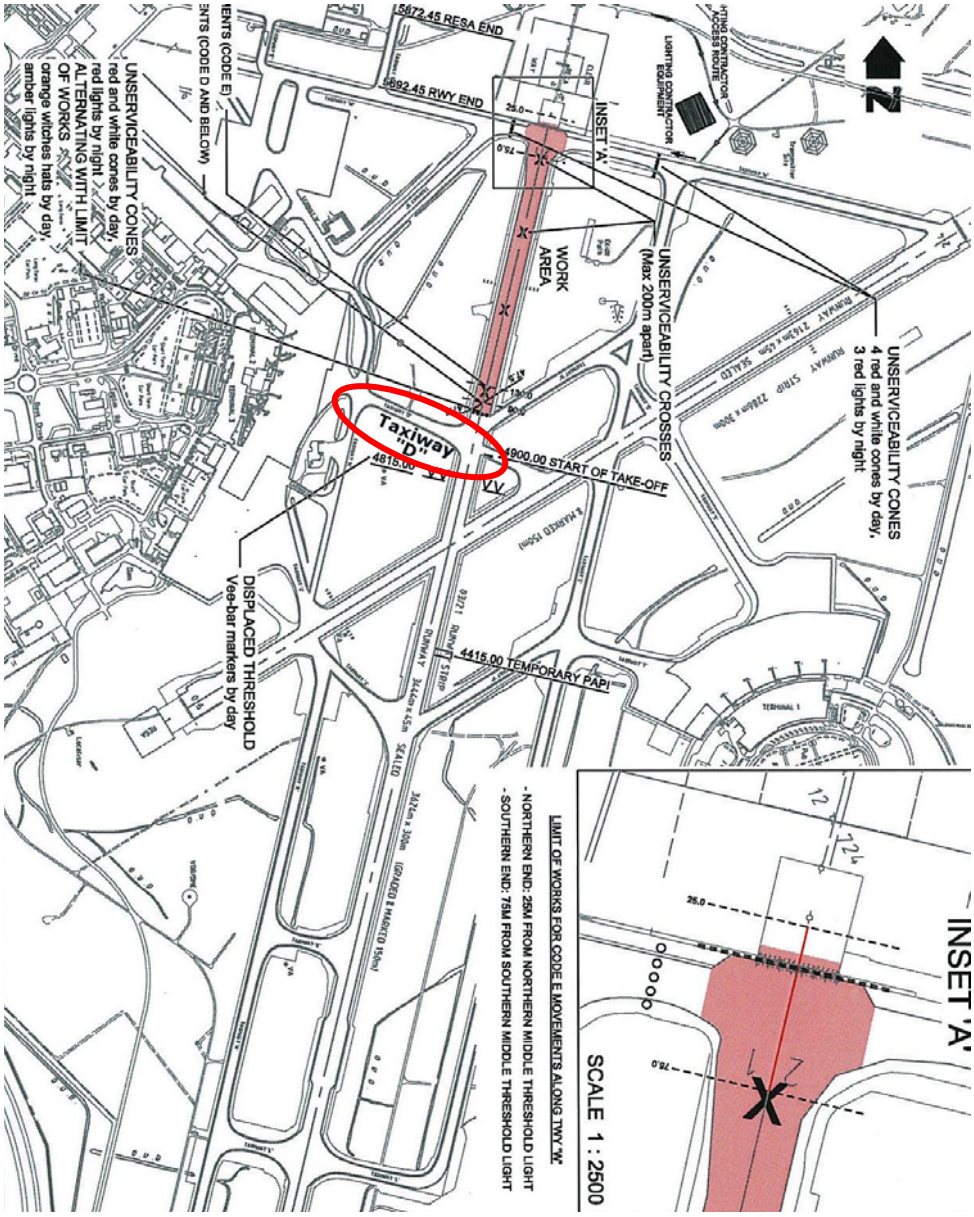
- receiving and providing handout briefing material
- providing a route/weather analysis
- having a thorough knowledge of the serviceability of airports, airways and navigational facilities
- ensuring that all essential information was forwarded to the flight crew in a timely manner to ensure a safe and efficient flight

- conducting a thorough and professional flight crew briefing that included all significant information that may affect the operation of the flight, etc
- being fully familiar with all NOTAMs applicable to the operation.

The flight crew reported that, in the flight crew briefing that was provided by the FOO in Denpasar, the FOO stated that there were no significant NOTAMs affecting the flight, and did not include any reference to a displaced threshold on runway 21 at Perth.

The aircraft operator's Perth office recalled receiving a copy of the MOWP, which was retained in Perth for reference by flight crew. The MOWP was not forwarded to the operator's flight operations department in Indonesia. The aircraft operator reported that, had they received a copy of the MOWP, they would have issued a notice to their flight crew.

Figure 2: Part of the MOWP showing the stage 2 runway works area



International Civil Aviation Organization

ICAO published a number of standards and recommended practices that related to aircraft operations, personnel requirements, and the requirements affecting airways and auxiliary services. Those standards and recommended practices were contained in various Annexes to the Convention on International Civil Aviation, which were signed at Chicago on 7 December 1944 (*the Chicago Convention*). Of those, Annex 14 related to aerodrome requirements.

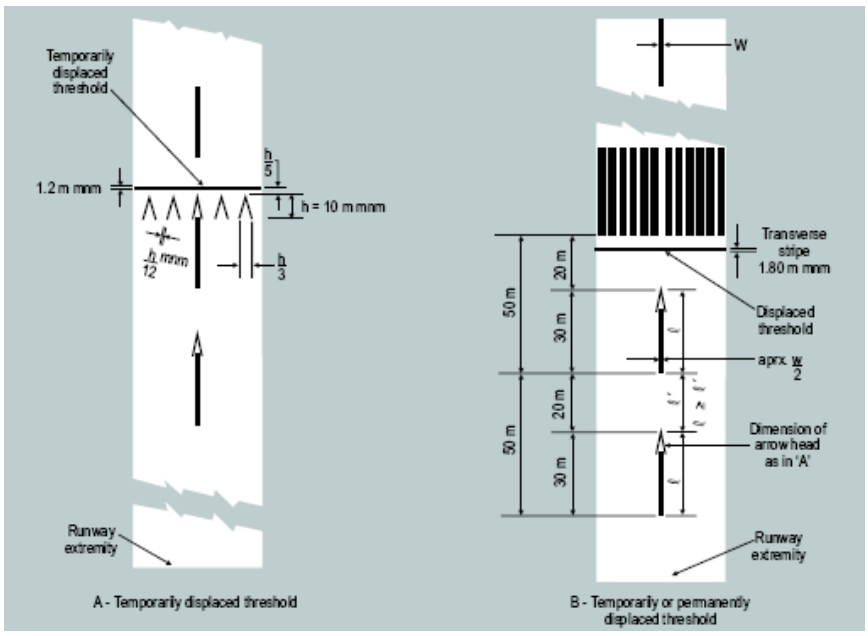
As a contracting State to the convention, Australia was obliged under Article 37 to conform to the ICAO standards, and to endeavour to conform to its recommended practices. Article 38 of the convention required contracting States to notify ICAO of any noncompliance with any ICAO standard by way of lodging 'differences' to those standards.

ICAO Annex 14 Aerodromes

The recommended runway markings to identify a displaced runway threshold were defined in *ICAO Annex 14 Aerodromes,* Chapter 5 and in part stated:

> 5.2.4.10 When a runway threshold is temporarily displaced from the normal position it shall be marked as shown in figure 2 (A) or 2 (B) and all markings prior to the displaced threshold shall be obscured except the runway centre line marking, which shall be converted to arrows [Figure 3 below].
>
> *Note 1; In the case where a threshold is temporarily displaced for only a short period of time, it has been found satisfactory to use markers in the form and colour of a displaced threshold marking rather than attempting to paint this marking on the runway.*
>
> *Note 2; When the runway before a displaced threshold is unfit for the surface movement of aircraft, closed markings as described in 7.1.4 are required to be provided.*

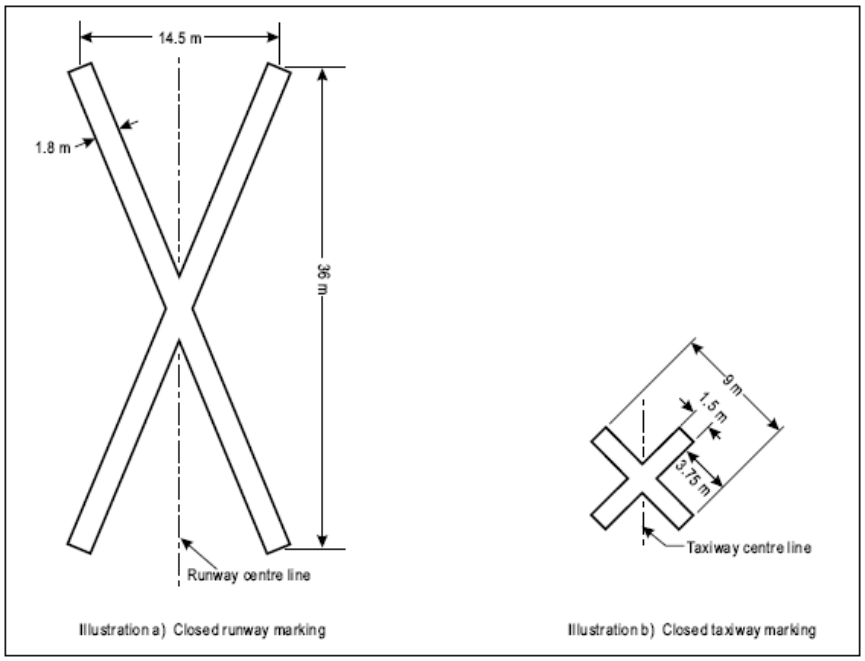
Figure 3: ICAO-recommended displaced threshold markings



The recommended runway markings to identify closed runways and taxiways were defined in *ICAO Annex 14 Aerodromes,* Chapter 7. In part, that chapter stated:

> 7.1.1 A closed marking shall be displayed on a runway or taxiway, or portion thereof, which is permanently closed to the use of all aircraft.
>
> 7.1.2 **Recommendation**. *A closed marking should be displayed on a temporarily closed runway or taxiway or portion thereof, except that such marking may be omitted when the closing is of short duration and adequate warning by air traffic services is provided.*
>
> 7.1.4 The closed marking shall be of the form and proportions as described in Figure 3, illustration a), when displayed on a runway, and shall be of the form and proportions as detailed in Figure 3, illustration b), when displayed on a taxiway. The marking shall be white when displayed on a runway and shall be yellow when displayed on a taxiway [Figure 4 below].
>
> *Note; When a area is temporarily closed, frangible barriers or markings utilizing materials other than paint or other suitable means may be used to identify the closed area.*

Figure 4: ICAO-recommended closed runway or taxiway markings



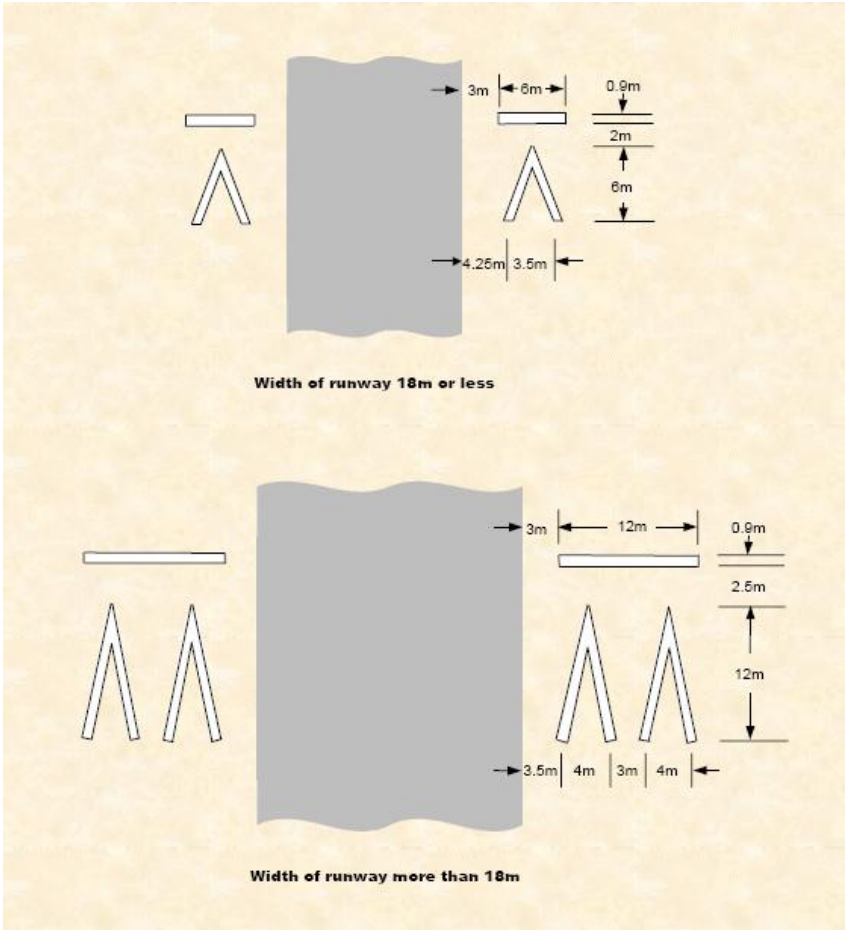
Australian requirements

The runway markings used in Australia to identify a displaced threshold were specified in the *Manual of Standards (MOS) Part 139 Aerodromes*. Temporarily displaced threshold markings were described in Chapter 8 of that MOS*, Visual Aids Provided by Aerodrome Markings, Markers, Signals and Signs.*

The Perth runway 21 works were scheduled in the MWOP to occur between the hours of 0730 and 1700 daily, and normal runway operations existed outside of those times. The airport operator therefore assessed that the threshold was temporarily displaced for a period of 5 days or less, and that section 8.3.9.8 of the MOS applied as follows:

> 8.3.9.8 When a threshold at an air traffic controlled aerodrome is to be temporarily displaced for 5 days or less, and the displacement is more than 450 m, the new threshold location is to be indicated by the above markings [Figure 5 below] but the permanent threshold markings may be retained.

Figure 5: Australian temporarily displaced threshold markings (less than 5 days)



In the case where the threshold was displaced for more than 5 days, the permanent threshold markings were required to be obscured.

The markings associated with a closed works area were also specified in the MOS, section 8.9 and included:

8.9.2.1 An unserviceable marking or closed marking must be used to indicate any part of the runway, which is not to be used by aircraft. The markings must comprise a white cross placed on the unserviceable portion of the runway.

8.9.2.3 There are two types of unserviceability markings, shown in Figure 5 and Figure 6. Where feasible, the larger marking is the preferred marking for a runway.

8.9.2.4 Unserviceability marking is not required for time-limited works.

8.9.2.5 The larger markings must be used on Code 4 runways [Perth runway 21 was classified as a code 4 runway] when the whole or part of the runway is permanently closed to aircraft operations, for more than 30 days [Figure 6 below]. Markings must be displayed at each end of the unserviceable runway, and also in the intermediate area, at intervals of not more than 300m.

8.9.2.7 In other cases of runway unserviceability, if markings in accordance with the larger configuration are not used, then the smaller markings [Figure 7, see next page] must be used. The smaller markings must be displayed at each end of the unserviceability and in the intermediate area at intervals of not more than 200m.

Figure 6: Unserviceability markings - large (smaller-sized marking included in the inset for comparison)

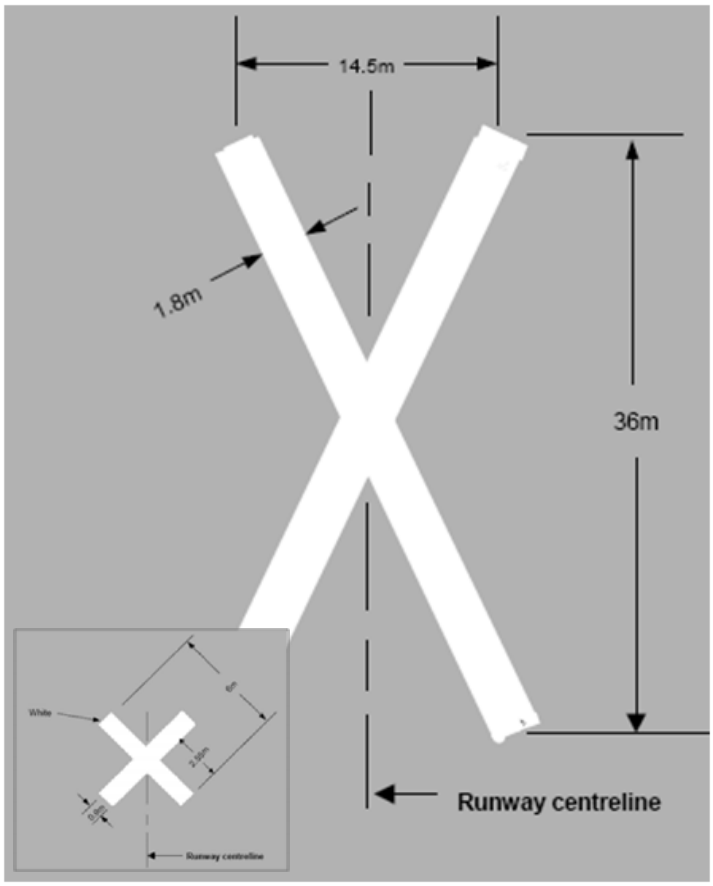
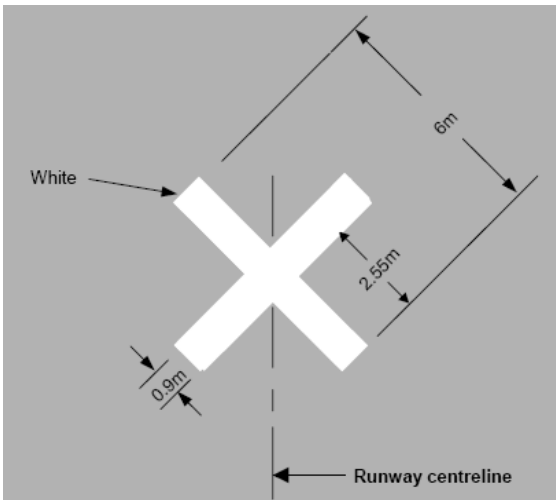


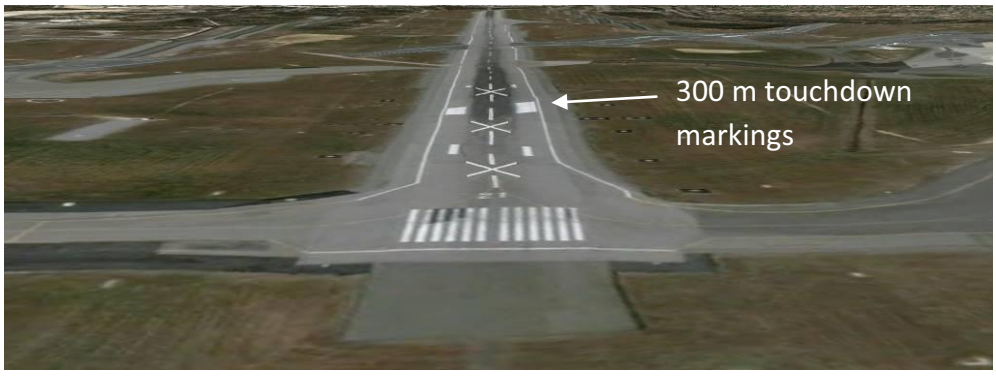
Figure 7: Unserviceability markings (small)



Simulated views of the 6 m and 36 m closed runway markings are at Figures 8 and 9 respectively. Those markings are indicative of the final approach to a runway as viewed by the flight crew just prior to touchdown. Note the 300 m touchdown marking as normally used by this type of aircraft.

Figure 8: Closed runway 21 markings (6 m) as used at the time of the incident

Figure 9: 36 m closed runway markings



At the time of this incident, the Civil Aviation Safety Authority (CASA) had lodged differences with ICAO in relation to the use of displaced threshold markings in Australia. However, no differences were lodged with ICAO pertaining to Australian closed runway markings.

Additional information

Instrument approaches to Perth runway 21 during periods of reduced visibility

A number of days after the occurrence, the Australian Transport Safety Bureau (ATSB) was notified of an incident where, in conditions of reduced visibility, the flight crew of an arriving aircraft on a LLZ approach to runway 21, experienced difficulty adjusting their final approach profile to the displaced threshold from the MDA. That incident occurred despite the flight crew being familiar with the airport and location of the runway works.

Following consultation with CASA, the airport operator later issued a NOTAM that raised the MDA for the runway 21 LLZ approach to the relevant circling minima. The increased MDA provided additional time for flight crews to identify/confirm the location of the displaced threshold.

Similar events

On 24 April 2005, also during a period of runway works on Perth runway 21, an Airbus Industrie A340 landed short of the runway 21displaced threshold.[11] On that occasion, the threshold was displaced by 1,331 m and, despite good visibility, that flight crew also reported difficulties in identifying the markings that were associated with the displaced threshold. The runway markings and approach systems used at that time were similar to those used during this incident.

[11] See ATSB Transport Safety Report 200501819, available at www.atsb.gov.au.

ANALYSIS

The inaccurate report by the Flight Operations Officer (FOO) of there being no significant Notices to Airmen (NOTAM) affecting the arrival at Perth Airport should have been identified by the crew's in-flight review of that information and receipt of Automatic Terminal Information Service (ATIS) X-ray. In addition, the content of the respective landing clearances by the aerodrome controller (ADC) should have cleared up any misunderstanding as a result of the content of the pre-flight brief. The investigation concluded that the inaccurate pre-flight brief by the FOO was not a factor in the development of the incident.

This analysis will examine those factors that affected the flight crew's understanding of the runway 21 works, and the subsequent action by the flight crew during the approach to land.

Approach and landing

There appeared to be no consideration in the Method of Working Plan (MOWP) and the relevant NOTAM texts, of the effect of the runway 21 works on the final approach profile necessary from the MDA of the runway 21 localiser (LLZ) approach. Given the difficulty reported by flight crews with experience of the runway 21 works in adjusting their final approach profile from the MDA to the displaced threshold , it might be expected that the flight crew of the incident aircraft experienced at least as much difficulty. The subsequent action by the airport operator to raise the MDA (and the resultant increase in time available to crews to identify/confirm the location of the displaced threshold) was taken to address that risk.

Given that the flight crew reported they were aware of the displaced runway 21 threshold at Perth, it would have been expected that they were 'on the alert' during the first approach for the relevant displaced threshold and closed runway markings. In addition, given the flight crew's level of experience, they might have anticipated the earlier-than-expected 'on glidepath' indication from the precision approach path indicator (PAPI) during the localiser approach. Had that been the case, the flight crew should have been able to adjust the aircraft's descent profile and use that glidepath information to land beyond the displaced threshold. It was possible that the crew's interpretation and application of that information was adversely affected by their more normal use of the runway 21 instrument landing system (ILS) approach aid, and of their more immediate concern with locating the displaced threshold.

The action by the flight crew to question the presence of cars on the runway during the initial approach, and to conduct a go-around, indicated that they did not associate those vehicles with the runway works, and therefore the likely general location of the displaced threshold. However, the presence during the first approach of vehicles on the runway, and the repeated advice to the flight crew by the ADC of the displaced threshold, should have intensified their efforts to locate the displaced threshold during the second approach. Despite that additional focus and effort, their apparent difficulty in locating the threshold on that approach, and the appearance to witnesses and the ADC of the aircraft approaching to land within the works area, suggested that the temporary markings that were used to alert crews of the closed section of the runway were ineffective in this instance.

Despite the direction by the ADC to go-around, the flight crew instead momentarily levelled out over the runway 21 works, before landing beyond the displaced threshold. The flight crew, having been issued their landing clearance, would have turned their attention to locating the displaced threshold, and landing the aircraft. Although the flight crew reported not hearing the go-around instruction, it was possible that, given the then high workload being experienced by the crew, rather than acting to caution the crew of the displaced threshold, the advice in the latter part of the go-around instruction '...you'll land south of the displaced threshold...', acted to confirm the initial clearance to land. Alternatively, the unexpected ADC go-around instruction and advice may have momentarily confused the flight crew, with the effect that they did not assimilate, and therefore act on, the instruction to go around.

Perth runway works

The non-receipt of the MOWP for the planned runway works by the operator's flight operations department in Indonesia precluded the operator's assessment of the impact of the proposed works on their operations to Perth, and of the need to issue a notice to their flight crew. The issue of that notice could have raised the flight crew's awareness of the particular type and location of the runway works, and assisted them in identifying the displaced threshold.

The Australian requirements for marking runway thresholds that were displaced for 30 days or less differed from those recommended by the International Civil Aviation Organization (ICAO). When compared with the likely visibility of the ICAO-recommended 36 m closed runway markings, the Australian 6 m markings, as used in this case, increased the difficulty for the crews in locating the precise location of the displaced threshold. As a result, there was an increased risk of a flight crew conducting a visual approach to the permanent threshold/touch-down area. The use of the larger–sized crosses, as specified in *ICAO Annex 14 Aerodromes*, would have been visible to the flight crew much earlier during their approach, allowing additional time for the identification of the closed runway area and displaced threshold. That would have allowed an early adjustment to their approach path, ensuring a stabilised approach and landing.

Despite the relevant Australian requirements allowing for the permanent runway 21 markings to be left in view, the obscuration of those markings, as recommended by ICAO, would have increased the likelihood that the crew would identify the displaced threshold. It was possible in this instance that, had the flight crew not noticed the vehicles on the runway during the initial landing approach, they may have landed within the runway works area.

FINDINGS

From the evidence available, the following findings are made with respect to the operational noncompliance involving the Boeing Company 737-8CX aircraft, registered PK-GEF, which occurred at Perth Airport, WA on 9 May 2008, and should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing safety factors

- The existing runway 21 threshold and touchdown markings were not required to be obscured and were clearly visible to the flight crew. Those markings continued to provide approach and landing cues to the normal touchdown zone, which was located within the runway works area. *[Safety issue]*
- The use of the 6 m closed runway markings in lieu of the recommended 36 m markings increased the risk of a flight crew conducting a visual approach to the permanent threshold/touchdown area. *[Safety issue]*

Other safety factors

- The combination of the instruction to go around with landing information, and high workload at that stage of the approach, may have momentarily confused the flight crew, with the effect that they did not assimilate and act on the instruction to go around.
- The distribution system that was used by the airport operator to disseminate the Method of Working Plan (MOWP) did not ensure that all users of the airport were appropriately notified of the planned runway works. *[Safety issue]*
- There was no follow-up action taken by the airport operator to address the lack of responses from aircraft operators to the MOWP, as required by the receipt and acknowledgement system.
- There was no evidence of any consideration in the MOWP of the effect of the runway 21 works on the final approach profile necessary from the MDA of the runway 21 localiser (LLZ) approach. *[Safety issue]*

Other key findings

- The runway markings associated with the MOWP were in accordance with the regulator's Manual of Standards (MOS).

SAFETY ACTION

The safety issues identified during this investigation are listed in the Findings and Safety Actions sections of this report. The Australian Transport Safety Bureau (ATSB) expects that all safety issues identified by the investigation should be addressed by the relevant organisation(s). In addressing those issues, the ATSB prefers to encourage relevant organisation(s) to proactively initiate safety action, rather than to issue formal safety recommendations or safety advisory notices.

Depending on the level of risk of the safety issue, the extent of corrective action taken by the relevant organisation, or the desirability of directing a broad safety message to the aviation industry, the ATSB may issue safety recommendations or safety advisory notices as part of the final report.

Aircraft operator

Although not identified by the investigation as a safety issue, as a result of this incident, the aircraft operator undertook a number of safety actions including:

- issuing a notice to all flight crews highlighting the factors associated with this incident
- joint recurrent training involving both flight crews and Flight Operations Officers.

Airport operator

Method of Working Plan distribution

Safety issue

The distribution system that was used by the airport operator to disseminate the Method of Working Plan (MOWP) did not ensure that all users of the airport were appropriately notified of the planned runway works

Action taken by the airport operator

In response to this incident, the airport operator undertook a review of its distribution list and procedures, to ensure that future correspondence is dispatched via hard copy and e-mail to all appropriate stakeholders.

Although the airport operator's receipt and acknowledgement system was not identified by the investigation as a safety issue, at the time of drafting this report, the airport operator was investigating methods for implementing a more robust verification system. The operator's aim was to encourage a higher compliance rate from operators.

ATSB assessment of response/action

The action taken by the operator appears to adequately address the safety issue.

Effect of the runway 21 works on the final approach profile

Safety issue

There was no evidence of any consideration in the MOWP of the effect of the runway 21 works on the final approach profile necessary from the MDA of the runway 21 localiser (LLZ) approach.

Action taken by the airport operator

At time of drafting this report, the airport operator was implementing a revised process to manage critical airside works. That revised process will include the establishment of a safety group for each project, who will review the relevant project's draft MOWP, and assess all risks associated with the works and the effectiveness of any safety procedures.

In addition, the operator intends that, during the initial planning stages of any works, the project manager and manager airside safety will determine the necessary restrictions to the works and to aircraft operations, consulting where necessary with the Civil Aviation Safety Authority (CASA) and with Airservices Australia. The consultation process will include an assessment of the likely impact of the planned works on the airport's navigational aids and associated published instrument approach procedures.

ATSB assessment of response/action

The action taken by the operator appears to adequately address the safety issue.

Civil Aviation Safety Authority

Obscuration of permanent threshold and touchdown markings

Safety issue

The existing runway 21 threshold and touchdown markings were not required to be obscured and were clearly visible to the flight crew. Those markings continued to provide approach and landing cues to the normal touchdown zone, which was located within the runway works area.

Use of 6 m closed runway markings versus 36 m markings

Safety issue

The use of the 6 m closed runway markings in lieu of the recommended 36 m markings increased the risk of a flight crew conducting a visual approach to the permanent threshold/touchdown area.

Action taken by CASA

During the development of this draft report, the ATSB met with CASA officers to discuss the possible safety benefits of the use of the International Civil Aviation Organization (ICAO)-recommended 36 m closed runway markings in Australia when the affected permanent threshold and touchdown markings were not required to be obscured.

In response to that meeting and the Directly Involved Party process (see Appendix C) CASA advised that, 'any changes to runway marking standards will be subject to mandatory consultation with industry. The proposal for the use of the International Civil Aviation Organization (ICAO) recommended 36 m closed runway markings will be incorporated into the Part 139 amendment work program.'

ATSB assessment of the CASA response/action

The ATSB acknowledges the commitment by CASA to consult with industry as a part of the Part 139 amendment work program. The ATSB will continue to monitor CASA's progress in addressing this safety issue when reviewing similar occurrences that may occur in the future.

APPENDIX A: NOTAMS

GG YBBBNOFX
190157 YBBBYNYX
(F1760/08 NOTAMR F1653/08
Q) YMMM/QMRAU/IV/ BO/A/000/999/
A) YPPH
B) 0805072330 C) 0805230900 EST
D) DAILY 2330/0900
E) RWY 03/21 792M N END NOT AVBL DUE WIP REFER METHOD OF WORKING PLAN YPPH 02/08 STAGE 2.
RWY 21 PERM PAPI NOT AVBL.
RWY 21 THR DISP 888M AND MARKED EACH SIDE OF RWY BY V BAR MARKERS AND RWY THR IDENTIFICATION LIGHTS(HJ).
OBST IS MAE AT 14FT AGL ON RWY 2742M FM RWY 03 START OF TKOF.
RWY 21 TDZ IS 400M FM TEMPO DISP THR AND MARKED BY TEMPO PAPI.
TEMPO PAPI AVBL FOR B747 AND BLW.
PAPI APCH SLOPE IS 3DEG 71 FT.
PAPI INTST SET AT STAGE 5 AND 5 MIN NOTICE RQ TO CHANGE INTST.
SCHEDULED INT LONG HAUL DEP WITH OPR RQMNTS FOR FULL LENGTH OF RWY MUST CALL PH ACD ON 118.55 FOR DEP SLOT ALLOCATION. A DEP SLOT WILL BE ASSIGNED WI 30 MIN OF START CLEARANCE REQUEST.
RWY 21 DEP VIA TWY NOVEMBER OR TWY DELTA ROLLING FORWARD TO DUNN(COLOUR)START OF TKOF GABLE MARKER LEFT HAND SIDE .
RWY 21 NOT AVBL FOR LDG FOR UP TO 30 MIN DURING DISPLACED THR TRANSITIONS.
CROSSING RWY 21 AT TWY WHISKEY NOT AVBL UNLESS DIRECTED BY ATC.
DECLARED DIST
RWY TORA TODA ASDA LDA
03 2562 2652 (4.70) 2562 2562
21 2652 2852 (2.39) 2652 2556

SUPPLEMENTARY TKOF DIST
RWY 03 2520 (1.6) 2547 (1.9) 2572 (2.2) 2592 (2.5) 2627 (3.33) RWY 21 2189 (1.6) 2516 (1.9) 2742 (2.2)

GG YBBBNOFX
190158 YBBBYNYX
(F1761/08 NOTAMR F1636/08
Q) YMMM/QICAS/I/ BO/A/000/999/
A) YPPH
B) 0805072330 C) 0805230900
D) 2330 - 0900 DAILY
E) GP RWY21 'IGD' FREQ 332.6 NOT AVBL
DUE RWY WORKS)

APPENDIX B: Weather

YPPH TTF

2008-05-09 13:03 TTF METAR YPPH 090300Z 06004KT 9999 FEW024 23/17 Q1019 RMK RF00.0/000.0 FU NOSIG

2008-05-09 13:31 TTF METAR YPPH 090330Z 04002KT 9999 FEW028 23/15 Q1019 RMK RF00.0/000.2 FU NOSIG

2008-05-09 14:05 TTF METAR YPPH 090400Z 01005KT 9999 FEW035 BKN280 25/15 Q1018 RMK RF00.0/000.2 FU NOSIG

2008-05-09 14:35 TTF METAR YPPH 090430Z 02005KT 9999 FEW035 BKN280 25/14 Q1018 RMK RF00.0/000.2 FU NOSIG

2008-05-09 15:02 TTF METAR YPPH 090500Z 36005KT 9999 FEW040 BKN280 26/14 Q1017 RMK RF00.0/000.0 FU NOSIG

2008-05-09 15:35 TTF METAR YPPH 090530Z 35005KT 9999 FEW040 BKN280 26/12 Q1017 RMK RF00.0/000.2 FU NOSIG

2008-05-09 16:02 TTF METAR YPPH 090600Z 31005KT 9999 FEW042 BKN280 27/13 Q1016 RMK RF00.0/000.2 FU NOSIG

2008-05-09 16:31 TTF METAR YPPH 090630Z 34003KT 9999 FEW042 BKN280 27/13 Q1016 RMK RF00.0/000.2 NOSIG

YPPH TAF

TAF YPPH 082149Z 090024
06007KT 9999 FEW030
FM06 25008KT 9999 FEW030
PROB30 0001 0300 FG
RMK
T 17 26 28 25 Q 1019 1018 1016 1016

TAF AMD YPPH 090417Z 090606
23007KT 9999 SCT035
FM18 04006KT 9999 BKN040
FM02 33012KT 9999 -SHRA SCT020 BKN040
INTER 0406 33015G26KT 2000 SHRA BKN010
PROB30 1624 0300 FG
RMK
T 25 23 17 14 Q 1017 1016 1017 1016

APPENDIX C: SOURCES AND SUBMISSIONS

Sources of information

The main sources of information during the investigation included:

- the flight crew
- the involved air traffic services (ATS) personnel
- ATS audio recordings
- the airport operator
- flight crew witnesses from other aircraft
- International Civil Aviation Organization (ICAO) *Annex 14 Aerodromes*
- Civil Aviation Safety Authority (CASA) documentation
- Airservices Australia (Airservices).

Submissions

Under Part 4, Division 2 (Investigation Reports), Section 26 of the Transport Safety Investigation Act 2003, the Executive Director may provide a draft report, on a confidential basis, to any person whom the Executive Director considers appropriate. Section 26 (1) (a) of the Act allows a person receiving a draft report to make submissions to the Executive Director about the draft report.

A draft of this report was provided to the Indonesian National Transportation Safety Committee (NTSC), CASA, Airservices, aircraft operator, airport operator, flight crew, and the involved ATS personnel.

Submissions were received from CASA, Airservices, the aircraft operator, the airport operator, and the aerodrome controller. Those submissions were reviewed and where considered appropriate, the text of the report was amended accordingly.

APPENDIX D: MEDIA RELEASE

The Australian Transport Safety Bureau (ATSB) has released its final investigation report into the serious incident at Perth Airport, WA on 9 May 2008, involving an approach and landing by a Boeing Company 737-800, registered PK-GEF, during a period of planned runway works.

The ATSB report found that the permanent runway 21 threshold and touchdown markings were not required to be obscured and were clearly visible to the flight crew. Those markings continued to provide approach and landing cues to the normal touchdown zone, which was located within the runway works area. The use of 6 m closed runway markings, in lieu of 36 m markings as recommended by the International Civil Aviation Organization (ICAO), increased the risk of a flight crew conducting a visual approach to the still-visible permanent threshold/touchdown area.

The report outlines a number of differences between the closed runway markings as recommended by ICAO *Annex 14 Aerodromes,* and the Civil Aviation Safety Authority (CASA) *Manual of Standards (MOS) Part 139 Aerodromes.*

A number of safety issues were identified as a result of the ATSB investigation. Safety action undertaken by the aircraft operator, the airport operator, and CASA in response to those safety issues should, when completed, reduce the risk of a similar event in the future.