

Aircraft Serious Incident Investigation Report

KNKT/06.06/08.02.37

**NATIONAL
TRANSPORTATION
SAFETY
COMMITTEE**

PT. Adam SkyConnection Airline

PK – KKE

B 737-329

Tambolaka Airport

West Sumba – West Nusa Tenggara

11 February 2006



**REPUBLIC OF INDONESIA
MINISTRY OF TRANSPORTATION
NATIONAL TRANSPORTATION SAFETY COMMITTEE
2008**

This report was produced by the National Transportation Safety Committee (NTSC), Karya Building 7th Floor Ministry of Transportation, Jalan Medan Merdeka Barat No. 8 JKT 10110, Indonesia.

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GLOSSARY OF ABBREVIATIONS

AD	Airworthiness Directive
AFM	Airplane Flight Manual
AGL	Above Ground Level
ALAR	Approach-and-landing Accident Reduction
AMSL	Above Mean Sea Level
AOC	Air Operator Certificate
ATC	Air Traffic Control
ATPL	Air Transport Pilot License
ATS	Air Traffic Service
ATSB	Australian Transport Safety Bureau
Avsec	Aviation Security
BMG	Badan Meterologi dan Geofisika
BOM	Basic Operation Manual
CAMP	Continuous Airworthiness Maintenance Program
CASO	Civil Aviation Safety Officer
CASR	Civil Aviation Safety Regulation
CPL	Commercial Pilot License
COM	Company Operation Manual
CRM	Cockpit Recourses Management
CSN	Cycles Since New
CVR	Cockpit Voice Recorder
DFDAU	Digital Flight Data Acquisition Unit
DGCA	Directorate General Civil Aviation
DME	Distance Measuring Equipment
EEPROM	Electrically Erasable Programmable Read Only Memory
EFIS	Electronic Flight Instrument System
EGT	Exhaust Gas Temperature
EIS	Engine Indicating System
FL	Flight Level
F/O	First officer or Copilot
FDR	Flight Data Recorder
FOQA	Flight Operation Quality Assurance
GPWS	Ground Proximity Warning System
Hrs	Hours
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules

IIC	Investigator in Charge
ILS	Instrument Landing System
kg	Kilogram(s)
km	Kilometer(s)
kts	Knots (NM/hour)
mm	Millimeter(s)
MTOW	Maximum Take-off Weight
NM	Nautical mile(s)
KNKT / NTSC	Komite Nasional Keselamatan Transportasi / National Transportation Safety Committee
°C	Degrees Celsius
PIC	Pilot in Command
QFE	Height above aerodrome elevation (or runway threshold elevation) based on local station pressure
QNH	Altitude above mean sea level based on local station pressure
RESA	Runway End Safety Area
RPM	Revolution Per Minute
SCT	Scattered
S/N	Serial Number
SSCVR	Solid State Cockpit Voice Recorder
SSFDR	Solid State Flight Data Recorder
TS/RA	Thunderstorm and rain
TAF	Terminal Aerodrome Forecast
TSN	Time Since New
TT/TD	Ambient Temperature/Dew Point
TTIS	Total Time in Service
UTC	Coordinated Universal Time
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions

SYNOPSIS

On 11 February 2006, a Boeing Company 737-329 aircraft, registered PK-KKE, operated by Adam SkyConnection Airlines (AdamAir) as flight number DHI 782, was scheduled to depart Soekarno Hatta Airport, Jakarta at 06.00 LT (22.00 UTC) for Hasanuddin Airport – Makassar (Ujung Pandang). The crew consisted of 2 pilots and 4 flight attendants. There were also three trainee flight attendants, who were qualified Boeing 737-200 flight attendants. They were to be checked by the pilot in command (PIC) during the flight.

The pilots did the pre-flight inspection and found that the number-2 IRU had failed. The failed IRU was replaced by line maintenance engineers with a serviceable unit. They tested and aligned the IRUs on the ground and found them to be functioning normally.

The PIC reported that the takeoff, climb, and heading changes on track were normal and the FMC was using IRU 1 for inertial navigation data.

The recorded flight data showed that the aircraft started diverging right of the planned track after the Flight Management Computer (FMC) switched to Inertial Reference Unit (IRU) 2. The PIC reported that the divergence was not noticed because cockpit instruments showed tracking towards Makassar (MKS). This was confirmed by Flight Data Recorder (FDR) data. The pilots became unsure of their position and while attempting to establish their location saw an airport and elected to land. The aircraft landed safely and none of the occupants were injured.

Evidence gathered during this and a subsequent accident investigation conducted by the NTSC showed repeated IRS malfunctions that went unresolved for many months.

The aircraft's transponder was working normally and showing the assigned radar identification. The radar replay showed that Adam 782, the target aircraft was still captured by radar (on the screen of Bali Center and Bali East) during the time the pilots reported loss of navigation. However, due to a lack of appropriate coordination between the controllers, they had a degraded awareness of their areas of responsibility.

The investigation found that the aircraft deviated more than 10 miles, but the radar system did not generate a Route Adherence Monitoring (RAM) warning, so the controllers were deprived of the warning that the aircraft had diverged a significant distance from the planned track. At the time of serious incident, the RAM data was incorrectly set to 20 miles for airway W 52. The RAM trigger was required to be set to activate with a divergence of not more than 10 miles. When the aircraft target on the radar screen changed to radar track, the controller did not recognize it, because the colour of the symbol did not change to green. Therefore, the controller considered that the target was beyond his jurisdiction.

The radar controllers had not received the specified training in the MAATS. There was no Standard Operating Procedure for the MAATS.

1 FACTUAL DATA

1.1 History of the Flight

On 11 February 2006, a Boeing Company 737-329 aircraft, registered PK-KKE, operated by Adam SkyConnection Airlines (AdamAir) as flight number DHI 782, was scheduled to depart Soekarno Hatta Airport, Jakarta at 06:00 local time (23:00 UTC)¹ for Hasanuddin Airport – Makassar (Ujung Pandang). This was the first flight of the day for the aircraft and crew. The crew consisted of 2 pilots and 4 flight attendants. There were also 3 flight attendant students, who were qualified Boeing 737-200 flight attendants. They were to be checked by the pilot in command (PIC) during the flight.



Figure 1: PK-KKE at Soekarno Hatta Airport, Jakarta

The pilots did the pre-flight inspection and found that the number-2 inertial reference unit (IRU) had failed. The failed IRU was replaced by line maintenance engineers with a serviceable unit. They tested and aligned the IRUs on the ground and found them to be functioning normally.

The PIC stated that during the pre-flight checks, he completed the alignment and initialization of the left (number-1) and right (number-2) inertial references systems (IRS) and that the alignment was normal. He also added that he entered the flight plan route WIII-WAAA through available airways

¹ The 24-hour clock in Coordinated Universal Time (UTC) is used in this report to describe the local time as specific events occurred. Local time Jakarta, Western Indonesian Standard Time (WIB) is UTC+ 7 hours. Local time in the area of the serious incident, Central Indonesia Standard Time (Waktu Indonesia Tengah (WITA)) is UTC +8 hours.

method since the *NAV* data base does not have its own company route in the FMC.

The aircraft departed Jakarta at 23:20 with the PIC the flying pilot for the sector, and the copilot the monitoring/support pilot. There were 146 passengers.

The PIC reported that the takeoff, climb, and heading changes on track were normal and the FMC was using IRU 1 for inertial navigation data.



Figure 2: Flight planned track

After the pilots turned the fasten seat belt sign *OFF*, the flight attendants, including the trainee flight attendants, commenced the refreshment service for the passengers.

On completion of the refreshment service, one of the trainee flight attendants was invited to the cockpit to be orally tested by the PIC, see 1.17.2. She was in the cockpit for about 20 minutes.

When the aircraft was about 25 NM from the *ANY* VOR², the pilot asked Jakarta Control for clearance to track direct to waypoint *SIPUT*. The controller cleared Adam 782 to track to *SIPUT* and instructed the crew to contact Bali Center abeam *ANY* VOR/DME. Once cleared by air traffic control to track direct to *SIPUT*, the copilot reprogrammed the FMC for the direct track to *SIPUT* and then waypoint *SOLOM*, and removed the *ANY* VOR position in the FMC.

At 00:25 the FMC changed, uncommanded, to IRU 2 and the aircraft commenced a slow right turn. The PIC reported that he saw the caution *IRS NAV ONLY* appear on the FMC, but the copilot cleared the message.

² VOR: Very High Frequency Omni-directional Radio Range navigation aid.

The pilots reported that after they received the weather details for their destination Hasanuddin Airport, which was clear sky with good visibility, they conducted a crew briefing and prepared to conduct visual approach to runway 31 at Hasanuddin Airport.

Approaching *SOLOM* Air traffic control instructed the crew to transfer from Bali Control to Ujung Pandang Control. At the time, the ATC radar screen showed that the flight was 10 miles right of the correct track. The controller cleared the crew to track direct to MKS VOR. The copilot then reprogrammed the FMC track direct to the MKS VOR and eliminated the waypoint *OVINA* (110 Nm from MKS VOR).

When abeam *SOLOM*, the Adam 782 was 20 miles right of the correct track and diverging right. The controller saw the flight plan target on the screen. Adam 782 was the only aircraft coming from the west side of the airport for that morning.

The second trainee flight attendant was invited to the cockpit to be aurally tested. While in the cockpit she noticed that the sun was from the left side of the PIC seat, about 10 o'clock to the nose of the aircraft. The PIC subsequently covered the left cockpit window with paper. The trainee stayed in the cockpit for about 15 minutes and was the last student tested during this flight. The third trainee was to be tested during the next sector.

At what they believed to be *GUANO* waypoint, the copilot reported their position and the controller told the flight crew to call Ujung Control. The FDR showed that Adam 782 was continuing to diverge right of track, and was tracking to the south at that time. The pilots subsequently informed the National Transportation Safety Committee (NTSC) that their *GUANO* position report was based on the displayed position information in the FMC CDU and EFIS MAP on the EHSI.



Figure 3 : Flight paths (FMC and actual) following switch to IRU - R

The FMC utilised the right IRU for approximately 52 minutes during which time the aircraft was on a south-easterly heading with the FMC believing it was travelling in a north-easterly direction. The FMC switched back to using the left IRU at 01:25:53. At this time the aircraft was being flown manually on the required heading for ANY to Makassar. The recorded FMC position when the FMC was switched to the left IRU was also erroneous for the remainder of the flight.

Approaching what they believed to be 115 Nm from MKS the copilot requested clearance to descend from 33,000 feet and at 00:10 they commenced descent. When approaching 28,000 feet, the PIC saw a mountain on the right side of their track. That topography was not expected because the flight to Makassar does not pass a mountain. The pilots then opened a map to find their position. At that time the VOR inoperative warning flag appeared on the VOR instrument.

While passing 25,000 feet, the pitch command warning appeared, followed by a roll command. The autopilot then disengaged uncommanded. The PIC subsequently flew the aircraft manually. The pilots then referred to the standby compass and found that the aircraft's heading was 230 degrees.

Due to difficulty with direct communication with Ujung Control or Ujung Approach, the copilot requested ATC assistance for vectoring to MKS

VOR/DME. The copilot reported their position based on FMC information, which was on the 258 radial of the MKS VOR and 72 Nm from MKS. They reported that they were passing 16,000 feet on descent. The controller instructed them to contact Ujung Control again.

As they passed 16,000 feet the number-2 IRS fault warning appeared, followed immediately by the EADI and the EHSI on the copilot side going blank, with no instrument indications. The PIC elected to maintain 15,000 feet and complete the QRH, which required the flight crew to enter present magnetic heading value from the standby compass into the Computer Display Unit (CDU) *Pos.Init* page or overhead Internal System Display Unit (ISDU). The crew's attempt to enter the magnetic heading value into the CDU was not successful. They did not attempt to try it via the overhead ISDU. At 01:18 they selected the IRS Transfer Switch to *Both on Left* (IRS number 1). The PIC stated that after completing the QRH procedure, he felt a degree of confusion because of conflicting information between the direction on the EHSI and the standby compass. During that period, communication with Ujung Control was difficult and the pilots did not have response from Ujung Control.

The right EADI and EHSI screens reactivated and showed that MKS VOR was in front of them. However, after referencing the local terrain visually, it did not appear that they were on track to Makassar. There were many islands on both sides of their track.

The crew established communication with Ujung ATC by relaying through at least 6 aircraft on Ujung Approach frequency. The pilots informed the relay aircraft of their navigation difficulty and requested assistance in identifying geographical features. Two aircraft tried to assist the crew to locate their position, but that was not successful (see 1.11.5 Table 2). The attempts by the crew of Adam 782 to fix their position by navigational aids on airway W-52 resulted in an out-of-range indication. Their attempts to contact Balikpapan Approach and other air traffic services units in the MKS area also were not successful.

At 02:14, the PIC became concerned and stated *our fuel less than one hour. If required we ditching, be prepare*. Seven seconds later the copilot stated *sorry, there is a runway down there*. The PIC elected to land at that airport. For the next 12 minutes while descending the crew attempted to verify their position.

At 02:19 the PIC handed control of the aircraft to the copilot and instructed him to maintain 2,500 feet and airspeed 220 kts while he checked the charts and attempted to visually fix their position with ground features. The PIC also continued to communicate with another aircraft. The pilot of that aircraft asked the Adam 782 pilots to describe topographic features of the island and runway they had seen, but the other pilot was unable to verify their position based on that information.

The PIC told the senior flight attendant that they would shortly be landing somewhere in the Sulawesi Island and at 02:25 told flight attendant to prepare the cabin and passengers for landing and make an apology announcement; *We*

have navigation problem. We are going to land to a place. I'm not sure where is the area. The important is we are land.

At 02:27 the PIC resumed control of the aircraft and at 02:24 the copilot commenced the approach briefing and calling the approach checklist.

The aircraft landed safely at 02:40. There was no damage and none of the occupants were injured. The pilots subsequently found that they had landed at Tambolaka Airport (TMC) in West Sumba – Nusa Tenggara Timur (East Nusa Tenggara).

1.2 Injuries to Persons

Injuries	Flight Crew	Cabin Crew	Passengers	Total
Fatal	Nil	Nil	Nil	Nil
Serious	Nil	Nil	Nil	Nil
Minor	Nil	Nil	Nil	Nil
None	2	4	145	Nil
Total	2	4	145	Nil

1.3 Damage to Aircraft

The aircraft was not damaged.

1.4 Other Damage

There was no damage to other property.

1.5 Personnel Information

1.5.1 Pilot in Command

Gender : Male
 Date of birth : 16 June 1964
 License : ATPL 4186
 Valid to : 30 March 2006
 Aircraft ratings : B737-300/400/500
 Instrument rating : Valid
 Medical certificate valid to : 1 March 2006
 Last Proficiency Check : 5 August 2005
 Last Line Check : 5 August 2005
 Flying experience
 Total all types : 7,525 hours
 Total on type : 1,770 hours
 Last 90 days : 220 hours
 Last 28 days : 60 hours
 Last 24 hours : 5 hours

The PIC held a current Air Transport Pilot License issued by the Directorate General Civil Aviation (DGCA), which was valid until 30 March 2006. He held an endorsement for the Boeing 737-300/400/500 series aircraft. In addition, he held a multi-engine instrument rating.

There was no evidence that the PIC was not fit for duty, nor was there any evidence of physiological or psychological problems in the days preceding the accident.

1.5.2 Co-pilot

Gender	: Male
Date of birth	: 20 August 1972
License	: ATPL 4336
Valid to	: 30 August 2006
Aircraft ratings	: B737-300/400/500
Instrument rating	: Valid
Last medical check valid to	: 2 August 2006
Last proficiency check	: 4 March 2005
Last line check	: 4 March 2005
Flying experience	
Total all types	: 2,805 hours 10 minutes
Total on type	: 801 hours 40 minutes
Last 90 days	: 153 hours 30 minutes
Last 28 days	: 32 hours 30 minutes
Last 24 hours	: 5 hours 40 minutes

The copilot held a current Commercial Pilot License issued by the Directorate General Civil Aviation (DGCA), which was valid until 30 August 2006. He held an endorsement for the Boeing 737-300/400/500 series aircraft. In addition, he held a multi-engine instrument rating.

There was no evidence that the copilot was not fit for duty, nor was there any evidence of physiological or psychological problems in the days preceding the accident.

1.6 Aircraft Information

Aircraft Registration	PK-KKE
Aircraft Serial Number	23773
Aircraft Manufacturer	Boeing Company
Aircraft Type/Model	B 737 – 329
Year of Manufacture	1987
Certificate of Airworthiness Valid Until	28 February 2006
Certificate of Registration Valid Until	28 October 2006

Compass Swing valid to	27 May 2009
Radio Permit Valid Until	23 October 2006
Total Airframe Hours	40,700
Total Cycles	30,350
Last Major Inspection C5	28 April 2004
Next Major Inspection D Check	4 March 2006

1.6.1 PK-KKE navigation systems

The aircraft flight management system (FMS) comprises the flight management computer system (FMCS), the autopilot/ flight director system (AFDS), autothrottle (A/T) and two IRS. The FMCS compares the IRS generated position information with selected route information and uses this data to generate steering and thrust requests to maintain the aircraft on the requested route profile.

The two independent IRSs consist of IRUs in the Electrical and Electronics compartment plus display and mode selector units located in the cockpit. In normal navigation mode, the IRS provides attitude, true heading, magnetic heading, acceleration, vertical speed, groundspeed, present position and wind data to the various aircraft systems that require this inertial information.

System outputs are independent of external navigation aids. When the aircraft is within range of land-based radio navigation aids the FMC uses these to update its position. When radio updating is not available the FMC uses the IRS position as a reference. This mode of navigation is referred to as IRS NAV ONLY, and a message is displayed to the pilots that navigation accuracy may be less than required. During IRS NAV ONLY operation, the FMC applies an automatic correction to the IRS position to determine the most probable FMC position. This correction factor is developed by the FMC by monitoring IRS performance during periods of radio updating to determine the IRS error.

The aircraft operations manual advises that flight crews should closely monitor FMC navigation during period of IRS NAV ONLY operation and notes that inaccurate radio updating may cause the FMC to deviate from the desired track.

In IRS NAV ONLY mode, the FMS uses either of two separate but identical Inertial Reference Units (left, number-1 or right, number-2) as the reference. Normally the FMS receives data from the left IRU, but will switch automatically to the right IRU if the FMS detects a problem with the left IRU. Should either IRS fail, an IRS transfer switch (BOTH ON L, NORMAL, BOTH ON R) can be selected by the pilots to switch all associated systems to the functioning IRS. If the FMS detects a problem with an IRU, the FMS will automatically switch both electronic horizontal-situation indicators (EHSIs) to display information from the other IRU.

1.6.2 Maintenance

Technical log (pilot reports) and PK-KKE maintenance records showed that during the 60-day period between 8 December 2005 and 10 February 2006, there were repetitive problems related to the aircraft's IRS. During that period, the number of recurring defects totaled: December four entries, January nine entries and February five entries to the date of the serious incident. These IRS defects and associated defects included:

- Left / Capt/ #1 IRS Fault (5 write-ups).
- Right/ #2 inertial reference system Fault (8 write-ups).
- Left & Right fault (2 write-ups)
- FMC not accurate data (3 write-ups)

Line maintenance rectification action was limited to re-racking and swapping IRU positions and associated components, resetting circuit breakers and cleaning connections when the faults became repetitive

The AdamAir Continuous Airworthiness Maintenance Program approved by DGCA was supported by a Reliability Control Program (RCP). However, the RCP did not cover component reliability. There was no evidence that AdamAir included component reliability in their RCP, to ensure the effectiveness of the airworthiness of the aircraft components for the AdamAir fleet, at the time of the accident. There was also no evidence of AdamAir's maintenance management controlling the repetitive defects on their fleet prior to the accident.

The failure data records store the last nine flight sectors and the current ground segment. On each ground to air transition, the failure data records of current ground segment is cleared and new failure data records stored for the current flight segment for any existing or newly declared failures.

Most of the FMC recorded failures on PK-KKE involved both IRSs and DME left and right had steady state failures. The failure history indicates that the FMC Navigational Data Base (NDB) had 6 internal one bit corrections. These corrections were needed to avoid invalidating the NDB during normal operation.

1.6.3 Weight and Balance

The aircraft was being operated within the approved weight and balance limitations.

The FDR recorded a total fuel parameter. The total fuel on board at take-off from Jakarta was recorded as 22,920lbs. The fuel remaining on landing at Tambolaka was 6,000lbs.

1.7 Meteorological Information

Weather along the route from Jakarta to Makassar was clear.

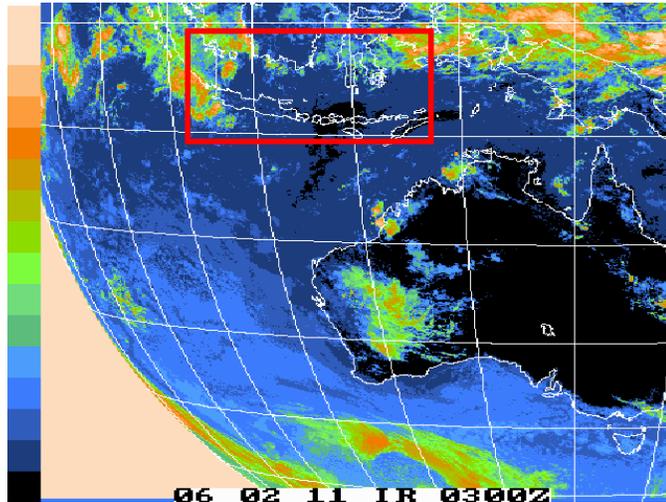


Figure 4: Satellite image at 03:00 UTC

1.8 Aids to Navigation

The MKS VOR was serviceable at the time of the flight. The aircraft's IRS malfunctioned during the flight, affecting the aircraft's navigation instruments.

1.9 Communications

The crew had no difficulty communicating with other aircraft during the flight. However they had problems communicating with the ATC in Makassar due to being out of VHF range.

1.10 Aerodrome Information

Prior to landing, the crew were unaware of the airport/runway details for the airport they had found. The airport designator/ICAO code was WRRT. Coordinated 09° 44' 32" S and 119° 49' 10" E. Elevation, 159 feet above mean sea level.

The runway was 1920 meters long and 150 meters wide, aligned 10/28. It was a Class 4 airport operated by DGCA. The aerodrome data sheet specified that the largest aircraft permitted to use the runway was the Fokker F28. Therefore it was not suitable for the Boeing 737-300 for normal operations.

1.10.1 Airport Management

Not relevant

1.11 Flight Recorders

The Cockpit Voice Recorder and Flight Data Recorder were secured and placed in the custody of the National Transportation Safety Committee (NTSC). Recorders were analysed at the Australian Transport Safety Bureau flight recorder laboratory in Canberra. Both recorders contained useable data.

1.11.1 Cockpit Voice Recorder

Manufacturer : Fairchild Aviation Recorders (Loral)
Type/Model : A100A
Part Number : 93-A100-30
Serial Number : 57351
Mod Status : 2-4, 6, 11-20, 26-28, 30
Configuration : 93-A100-30 Level 18
ULB : Model DK100, S/N DR4153,
Battery expiry date April 2006

The CVR recorded the last 31 minutes and 38 seconds of the flight commencing when the aircraft was at 11,000 feet.



Figure 5 : PK-KKE Cockpit Voice Recorder

1.11.2 Flight Data Recorder

Manufacturer : Sundstrand Data Controls Inc
Type/Model : Universal Flight Data Recorder (UFDR)
Part Number : 980-4100-DXUN
Serial Number : 4780
Mod Status : 4-6, 10, 11, 13-16, 18, 22, 24, 27
ULB : Model DK120, S/N DU28459,
Battery expiry date June 2009



Figure 6 : PK-KKE Flight Data Recorder

1.11.3 Digital Flight Data Acquisition Management Unit (DFDAMU)

Part Number : 360424AOL30

Serial Number : 192

1.11.4 FDR data significant events

The FDR contained 25 hours of good quality flight data, consisting of 11 flights, including 9 previous flights, the incident flight and ferry flight from Tambolaka to Makassar following the incident. All nine previous flights were on the same route Jakarta – Makassar.

Latitude and longitude recorded in the FDR were data delivered from the IRU and displayed the flight path as plan.

The recorded data confirmed the pilot reports of the following events:

00:25 Before passing SOLOM waypoint, the IRU changed, uncommanded, from IRU 1 to IRU 2 and few seconds later the aircraft's track started diverge to the right.

01:10 Aircraft commenced descent.

01:18 A/P selected off & FMC switches back to IRU #1.

02:40 PK-KKE landed at Tambolaka Airport (TMC) in West Sumba – Nusa Tenggara Timur (East Nusa Tenggara).

The aircraft crossed at least 14 air routes during the period of the flight between SOLOM and Tambolaka Airport.

A sequence of events was developed from analysis of the data downloaded from the FDR.

Time	Event	Parameter Source
GMT (hh:mm:ss)		
23:27:50	PK-KKE takeoff from Soekarno-Hatta International airport, Jakarta using runway 25L. FMC selected to IRU - L	Latitude, longitude (FMC), magnetic heading, airspeed, altitude and air/ground switch, FMC discrete word-1, flight path in Google Earth
23:28:05	PK-KKE AFDS heading select (HDG SEL) mode engaged during climb at altitude of 772 ft.	AFDS discrete word-2, altitude
23:29:37	PK-KKE on heading of 102 deg M direct to ANY VOR/DME during climb at altitude of 3,235 ft	Magnetic heading, altitude, flight path in Google Earth
23:29:47	A/P ON during climb at altitude of 3,720 ft	AFDS discrete word-2, altitude
23:33:57	PK-KKE AFDS lateral navigation (L NAV) mode engaged during climb at altitude of 13,608 ft	AFDS discrete word-2, altitude
23:45:36	PK-KKE attained cruise altitude of 33,000 ft	Altitude
23:58:38 – 23:59:09	At approximately 23.6 NM from ANY VOR PK-KKE turns left onto heading 076 °M -078°M direct to SOLOM en route intersection	Latitude / longitude (FMC), magnetic heading, flight path in Google Earth
0:01:56	PK-KKE passes approximately 8.8 NM abeam ANY VOR (6°58.5'S, 110°22.8'E)	Latitude / longitude (FMC), magnetic heading, flight path in Google Earth
0:12:30	PK-KKE passes approximately 4.6 NM abeam LASEM en route intersection (6°37.1'S, 111°36.9'E)	Latitude / longitude (FMC), magnetic heading, flight path in Google Earth
0:20:47	PK-KKE passes approximately 3.7 NM abeam SIPUT en route intersection (6°17.0'S, 112°35.0'E)	Latitude / longitude (FMC), magnetic heading, flight path in Google Earth
0:34:14	FMC switches to IRU - R	FMC discrete word-1
0:34:17	PK-KKE commences gradual right turn away from intended track and recorded FMC track	Latitude / longitude (FMC), magnetic heading, flight path in Google Earth
0:41:46	FMC reported track indicated passing overhead SOLOM en route intersection	Latitude / longitude (FMC), magnetic heading, flight path in Google Earth

	(5°50.4'S, 115°03.8'E) on an ENE heading. Actual recorded aircraft heading was E	
0:56:05	FMC reported track indicated passing overhead GUANO en route intersection	Latitude / longitude (FMC), magnetic heading, flight path in Google Earth
	(5°37.8'S, 116°32.6'E) on an ENE heading. Actual recorded aircraft heading was SE	
1:03:37	FMC reported track indicated passing overhead OVINA en route intersection (5°31.6'S, 117°04.1'E) on an ENE heading. Actual recorded aircraft heading was SSE	Latitude / longitude (FMC), magnetic heading, flight path in Google Earth
1:13:50	PK-KKE commences descent from FL330	Altitude
1:15:40	PK-KKE AFDS lateral mode changes from L NAV to HDG SEL mode while overhead Simbawa at altitude of 31,159 ft	AFDS discrete word-2, altitude, Google Earth
1:18:04	AFDS lateral mode switches back to manual mode at altitude of 25,104 ft	AFDS discrete word-2, altitude
1:23:30	PK-KKE levels at FL150	Altitude
1:25:53	FMC switches to IRU - L at altitude of 16,285 ft	AFDS discrete word-2, altitude
1:26:06	Aircraft turns left towards Sumba at altitude of 16,402 ft	Magnetic heading, altitude, flight path in Google Earth
1:26:09	IRS master caution light illuminates for four seconds.	DFDAU discrete word-2
1:26:10	A/P turned OFF	AFDS discrete word-2
1:44:30	FMC lat/ long indicates 3.5 NM south of Hasanuddin VOR/DME (MKS) (5°02.3'S, 119°31.6'E).	Latitude / longitude (FMC), flight path in Google Earth
02:00:53 – 02:01:01	Aircraft 4NM abeam Tambolaka Airport (TMC) at altitude of 10,945 ft when pilot makes two radio transmission	Magnetic heading, altitude, VHF left keying, flight path in Google Earth
2:42:40	Aircraft lands at TMC on runway 10	Magnetic heading, air/ground, flight path in Google Earth

Table 1: Sequence of events from FDR data Time Event Parameter Source GMT (hh:mm:ss)

1.11.5 CVR transcript 2:19.44 to 2:22.31

In accordance with ICAO Annex 13 clause 5.12 1, the following excerpt from the CVR data is included in the report because it is pertinent to the analysis of this serious incident. During the period 2:19.44 to 2:22.31, the crew of Republic Express REP 811 contacted UPG Approach, and believing they had sighted DHI 782, informed UPG Approach they could see DHI 782. The crew of REP 811 attempted to provide position information to assist the crew of DHI 782. However, they had mistaken another Boeing 737 aircraft for DHI 782.

Legend:

- DHI 782: AdamAir flight 782
- A 1326: Air Force flight (C-130 aircraft)
- REP 811: Republic Express flight 811
- P1: Pilot in command
- P2: First Officer
- FA: Flight Attendant

UTC	Aircraft	Conversation as spoken	Translation of Bahasa words
2:19.44	REP 811	OK Break. Break. Approach we have ident on the right side, confirm altitude Adam is a.. one two zero.	
2:19.52	P2	<i>One one thousand.... One one thousand</i>	
2:19.54	DHI 782	One one thousand Sir, Adam seven eight two	
2:20.00	REP 811	OK Adam.	
2:20.00	?	... one six six zero.	
2:20.04	DHI 782	Say again, Adam Maintain one one thousand, Sir.	
2:20.08	REP 811	OK. Maintain one one five please. I will guide you I have ident you, traffic Mandala.... of Republic.	
2:20.17	P1	Republic ya?	
2:20.18	P2	Republic	
2:16.18	REP 811	Adam seven eight two, Republic.	
2:20.19	DHI 782	Go ahead Republic, could you still.....	
2:20.25	A 1326	Ujung one three two six. Adam seven eight two sudah di guide Republic and eh... one three two six ready for approach.	Ujung (old name of Makassar) Adam 782 has been guided by Republic flight. 1326 ready for approach.
2:20.31	P1	Ini Republic ya?	Is it Republic?
2:20.32	P2	Iya... Tapi di mana?	Yes. But where are they?
2:20.33	FA	Tapi di mana captain?	But where are they?
2:20.35	DHI 782	Republic where is your position? Kita belum lihat nih	Where is your position, we haven't seen you.

2:20.38	P2	Belum lihat.	Not seen yet.
2:20.39	?	Heading three three zero?	
2:20.41	DHI 782	Confirm kita harus heading three three zero Pak?	Confirm we have to set heading 330 sir?
2:20.44	?	Three zero five	
2:20.45	P2	Belum-belum dia lagi navigasi....	Not yet they are navigating.
2:20.48	DHI 782	Ha? Confirm heading three three zero, Pak?	
2:20.51	A 1326	Two nine zero... eight thousand... one three two six...	
2:20.54	REP 811	Adam seven eight two change to one one five zero zero, I will guide you.	
2:20.58	DHI 782	Dimana posisi pak?...tolong..di..kita belum lihat soalnya	Where are you Sir? We haven't seen you.
2:21.02	REP 811	Ok mas lihat awan yang besar sekali..disitu ndak ada..kah..?	OK. Do you see the big cloud there?
2:21.05	DHI 782	Awan yang mana?...yang cumulus.?	Which one? The Cumulus?
2:21.08	REP 811	Betul..yang besar itu	Yes. The big one.
2:21.09	DHI 782	Sebelah kiri kitakah.?	On our left side?
2:21.12	REP 811	Sepertinya itu apa.? ..ada awan itu.?	Its look like.... There is a cloud....
2:21.16	DHI 782	Ada dimana ?	Where it is?
2:21.15	REP 811	Saya barusan meliwati awan dan saya ident posisi, seperti posisi anda itu dua.belas... ee... dua ribu diatas saya gitu	I had just passed cloud and I ident your position, like your position is at 2000 above us.
2:21.27	P2	Dia diatas kita ya....ok standby	Above us? OK stand by.
2:21.27	DHI 782	Coba didekatin ke kita mas ..kira-kita biar saya bias lihat dulu posisinya dimana ?	Tried to come to us, so we can see where you are.
2:21.32	P2	Dia disebelah kiri ya?	On our left side?
2:21.32	REP 811	Ok stand by	-
2:21.34	REP 811	Ujung Republik eight one one	-
2:21.36	DHI 782	Kita speednya soalnya kita reduce two two zero speednya	We reduce speed to 220
2:21.40	REP 811	Ok.. standby Adam	-
2:21.58	REP 811	Ujung confirm you ident traffic on right side maintaining one one zero.?	-
2:21.59	REP 811	Adam 782 tadi kalau anda menuju timur terus itu ..kurang lebih disitu posisi anda. Kalau memang betul tadi yang anda ter ident di ,Radar kami TCAS kami adalah Seven Eight Two...Berarti anda posisi dua puluh mile..eh..dua puluh sembilan miles menuju Makassar.	Adam, if you keep going to the east, if it is correct the traffic that we identify in our TCAS was you that means you are 29 miles to MKS.
2:22.20	DHI 782	Sekarang Republik masih lihat Adamkah..?	Are you still seeing us?
2:22.26	DHI 782	Republik...Adam seven eight two	
2:22.31	P2	Wah....	
2:22.31	REP 811	Ok..sorry..sorry.	
2:22.35	FA	Belum kelihatan Capt..ya.?	Not seen yet, Capt?

2:22.36	P1	Belum.belum.kelihatan	No not yet.
2:22.39	P1	Dua ribu tiga ratus.. OK you have control bentar	2300 OK you have control
2:22.41	REP 811	Roger..Heading zero six zero, four hundred, eight one one	
2:22.46	P1	Ok..terusin dekat pinggir pantai dulu aja	OK Keep stay near the beach.
2:22.47	P1	Yak Sekali lagi ya ?	Yes one more time.
2:23.14	KI 782	Republik Adam seven eight two	-
2:23.17	REP 811	Go ahead	-
2:23.22	KI 782	Ok Republik Adam seven two.. seven eight two..bisa lihatkah ?	Republic, Adam 782 can you see us?
2:23.33	P2	Diet? Atau....	Are you in diet or....
2:23.35		Click (similar to cockpit door closing)	
2:23.39	FA (other)	Di announced aja Capt?.... Wah itu penumpangnya pada cerewet deh... Dari tadi... Pesawat nggak apa-apa kan?	We better announced Capt? The passengers are very annoying since while. Is the aircraft OK?
2:23.46	FA	Ga apa-apa.	It OK...
		Conversation between FA (unintelligible)	
2:23.50	REP 811	Standby one	
2:23.53	REP 811	Adam seven eight two kita bisa change frequency one two one five gitu	Adam 782 can you change to 121.5?
2:23.57	KI 782	One two one five, thank you pak	
2:24.06	KI 782	Rogers Adam seven eight two	
2:24.12	REP 811	Adam seven eight two Rep eight one one	
2:24.14	KI 782	Ok..go ahead pak, bisa lihatkah pak ?	Go ahead sir. Can you see us?
2:24.19		Click (sound similar to door closing) End of flight attendants conversation.	
2:24.20	KI 782	Halo Republik...	
2:24.40	P1	Kota apa sebelah itu? Kayaknya nggak ini ya?	What city is that? It doesn't look like....
2:24.43	P1	Orang Makassar ada nggak di sini orang Makassar?	Is there any people from Makassar here?
2:24.47	FA	Contact Makassar nggak dapet ya Captain?	We can't contact with Makassar Capt?
2:24.49	P1	Nggak dapet..... Dapet, tapi dia.... Radarnya tetap pada blank semua... ini....	No. But they.... All the radars are keep blank.
2:24.52	** FA	He eh itu kok nge blank begitu?	Why is that blank like that?
2:25.03	KI 782	Republik..Adam seven eight two	
2:25.09	P2	Kalau dekat-dekat dia bilang dua puluh sembilan mile tapi kita ga kenal...	If they were close, they said that we are 29 miles, but we do not recognize....
2:25.12	KI 782	Republik	
2:25.15	KI 782	All station Adam seven eight two	

Table 2 : CVR transcript 02:19.44 to 02:25.15

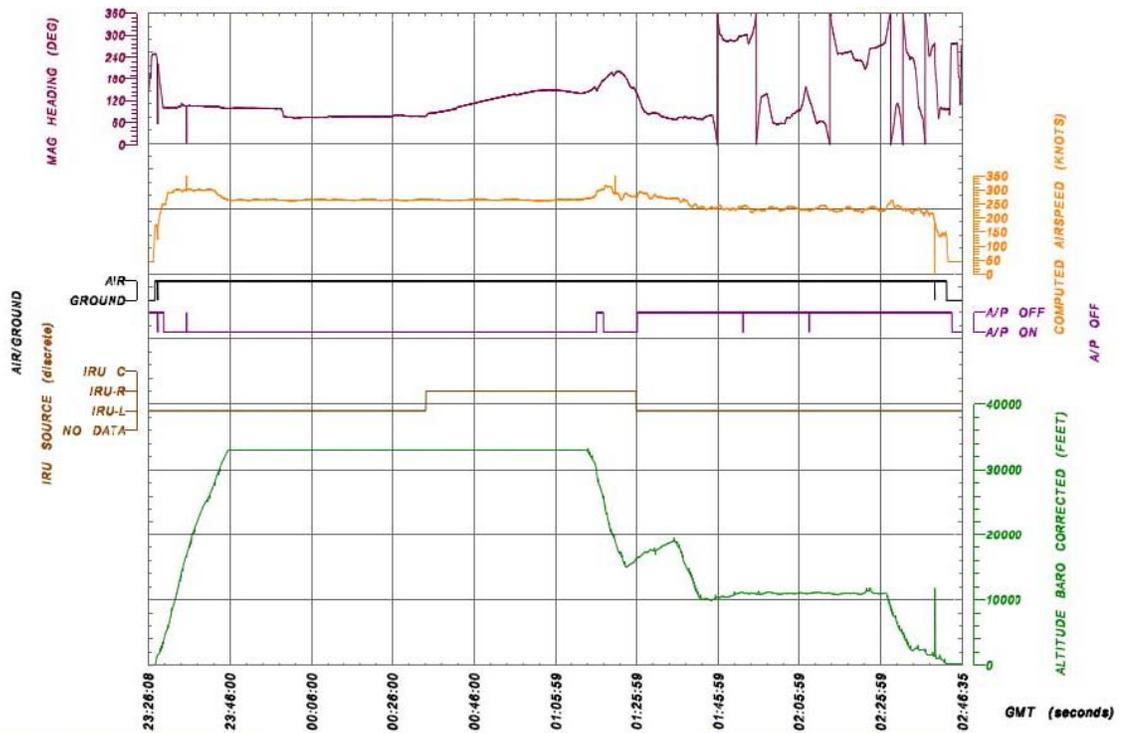


Figure 7: FDR plot between 23:26:08 and 02:46:35

1.12 Wreckage and Impact Information

Not relevant.

1.13 Medical and Pathological Information

Not relevant.

1.14 Fire

There was no fire in this incident.

1.15 Survival Aspects

Not relevant.

1.16 Tests and Research

Not relevant.

1.17 Organizational and Management Information

1.17.1 Adam SkyConnection Airlines (AdamAir)

Aircraft Owner : Wells Fargo Bank Northwest, National Association

Aircraft Operator : PT. Adam Sky Connection Airlines

Trading as : AdamAir

Address : Jl. Gedong Panjang No.28
Kelurahan Pekajon
Kecamatan Tambora
Jakarta Barat

Certificate Number: No.AOC/1 21-036

1.17.2 Flight Attendant checks

During cruise, prior to passing abeam *ANY* VOR/DME and tracking toward *SIPUT*, the PIC conducted a “flight-check” in the form of an oral quiz with one of trainee flight attendants. This was done in the cockpit to accomplish her in-flight qualification program for flight attendants on the B737-300/400/500 series aircraft. This was conducted at the request of AdamAir management personnel. The oral quiz with the second trainee followed.

The PIC was a DGAC Inspector, occasionally flying for AdamAir to maintain his currency and recency on the Boeing 737-300 series aircraft type. The PIC stated that the “flight-check” activity with each trainee flight attendant only lasted less than 20 minutes and during that period he instructed the copilot to monitor the progress of the flight. The PIC also stated that he did not instruct the copilot to take the controls, so there was no “pilot flying” hand over during that time. Even though the PIC was a DGAC Inspector, he did not hold the authority to perform crew checks because, within DGCA, he was assigned under the Flight Standard Section and not under the Flight Operations Section, which had crew check authority.

1.17.3 Air Traffic Services

The Makasar airport commenced operating a new radar system in July 2005; the Makasar Airport Air Traffic Services (MAATS). The system has many inputs from radar heads and collects them in a computer to integrate all radar inputs. The Makasar ATS is divided into four areas of control; Bali West, Bali Center, Bali East and Ujung Lower. Each controller is responsible for their own area, termed Jurisdiction. Bali control area is from Semarang to the east of Indonesia and 24,500 feet and above. When a target or aircraft comes into a controller's specific area, the colour of the target will change to green, while that target remains in their control area. The target on the screen has a label and icon. There are two icons as follows:

- The circle icon and green colour indicate that the target is captured by the radar and matched with the aircraft's flight plan track.
- The square icon and green colour indicate that the target is not captured by any radar head or the aircraft transponder isn't working (no signal) and the default system will change automatically to the flight planned track only. When in this mode, the target is displayed on the screen based on computer calculations according to the flight plan previously entered in the system.

When the radar track and the flight plan track separate by 10 miles or more, there should be a warning in the MAATS system called RAM (Route Adherence Monitoring). The RAM should produce a warning. However, the display was not showing the divergence, so it was not evident to the controllers that the radar track and flight plan track had separated by 10 miles or more. At the time of serious incident, the RAM data was incorrectly set to 20 miles for airway W 52. According to the regulations, the RAM trigger was required to be set to activate with a divergence of not more than 10 miles, or 5 miles (left and right of the track).

In order to change the RAM data set, the computer system needs to be shut down and restarted. There are two conditions when RAM will not generate warning:

1. RAM is to be acknowledged by the controller as temporary. For example, when the aircraft requests to deviate from its track (outside RAM) due to weather or another known reason, the controller clicks the acknowledgement on the radar screen. The RAM will be deactivated until the aircraft is back on its track.
2. Reroute by the controller. For example, if the pilot requests direct *SIPUT* to *GUANO*, when the initial route is *SIPUT* to *SOLOM* and *GUANO* (Route according flight plan), then the controller will make a new flight plan track, which is *SIPUT* direct *GUANO*. So the RAM will move and follow the new track. While the aircraft track is moving to the new track, the RAM will not activate until the aircraft reaches the new track. During this situation it must be monitored continuously by the controller.

For Adam 782, the label on the screen contained the following information:

- Flight number (DHI 782)
- Altitude actual (330) and altitude clearance (330)
- Aircraft type (WAA 733)
- Last W point (Siput)

1.17.4 Significant notes during radar replay for the investigation

The radar replay was started at 00:15 for the day of the flight. Based on the interview with the pilots and the ATC transcript, there was no abnormality before that time. The following significant deviations were noted during the radar replay:

- Between waypoints *SIPUT* and *SOLOM*, the aircraft started to deviate to the right about 3 miles.
- Between waypoints *SIPUT* and *SOLOM*, the radar track became too weak and at times was not captured by the radar.
- About 20 miles before *SOLOM*, the aircraft deviated about 10 miles to the right and there was no RAM warning.
- 00:40:05 the aircraft was abeam *SOLOM* and had deviated about 13 miles to the right of track but there was no RAM warning
- 00:41:03 the radar track (signal) became too weak, the radar track defaulted to the flight plan track and the aircraft's position moved automatically to the track of *SOLOM* and *GUANO*, but the actual aircraft had deviated about 13 miles to the right of the track. The label followed the flight plan track and did not follow the actual aircraft.
- 00:43:08 the flight plan track target label contained information as mentioned above and while the aircraft displayed on the radar appeared to be a radar track (circle and black colour) with label squawk number or transponder code (2351) and inv (invalid) below the track (to the right about 15 miles). On the screen there were two targets and the radar track was captured for about two seconds.
- From 00:44:33, the radar track was captured for about 26 seconds and showed 20 miles off track.
- 00:53:25, the flight plan track reached *GUANO*.
- 00:54:25 the radar track was captured for about 3 seconds and showed that the aircraft was off track about 72 miles and tracking about 137 degrees; parallel to airway A 344.
- 00:54:56, AdamAir pilots reported to Bali Control that they had reached point *GUANO*. The controller saw the flight plan track on his screen and that the target had also reached *GUANO*. The aircraft's position (reported by the pilots, base on the flight plan track of the aircraft) and the radar paints matched.

- 00:55:07, the Bali Center controller transferred Adam 782 to Ujung Lower.
- 00:58:20, the radar track appeared for about 11 seconds with the track 150 degrees and crossing airway W 44.
- 01:00:06, the radar track appeared and showed the aircraft crossing airway W 41, tracking 160 degrees.
- 01:00:38, the radar track again appeared and showed the aircraft's altitude 330 and tracking about 160 degrees.
- 01:04:59, the radar track showed the aircraft crossing airway W 44.
- 01:18:07, the aircraft was tracking 180 degrees.
- 01:19:03, the aircraft was crossing W 33 tracking 190 degrees, 15 miles east of *GABIT*.

Significant Note During Reply Radar at Ngurah Rai Airport

The radar screen at Ngurah Rai airport shows the aircraft target with label (Squawk number, Altitude and speed in TAS). The significant notes taken during radar reply as follows:

- 00:40:40 the aircraft's position was between *SIPUT* and *SOLOM* and off track about 15 miles.
- 00:41:45 at waypoint *SOLOM* the aircraft was off track 14 miles and then target disappeared.
- 01:26:00 distance to DPS 180 miles and altitude 160, then the target disappeared and the target did not appear again.



Figure 8: Flight plan track target (square with label, green color) was separated from radar track (circle with squawk number label, black color)



Figure 9: The aircraft was in between waypoints *SOLOM* and *GUANO* and off track about 15 miles

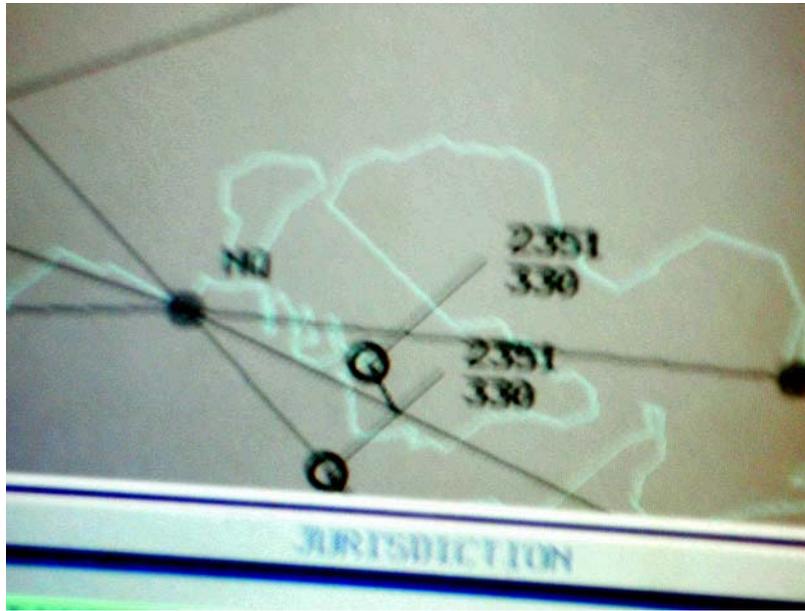


Figure 10: The aircraft's (radar track) at near waypoint *NQ* and captured by two radar heads (dupe) Ngurah Rai and Waingapu radars

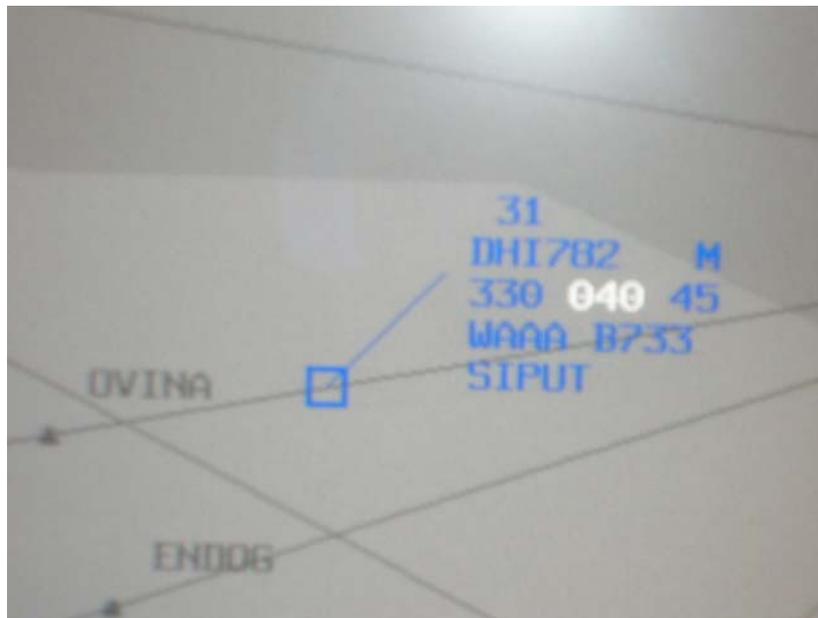


Figure 11: The aircraft's flight plan track (not actual target) coming to Ujung Lower area, but the target was square; the primary radar did not capture the target



Figure 12: The aircraft at 01:06:51, was still at FL 330 (altitude 33,000 feet) and captured by two radar heads

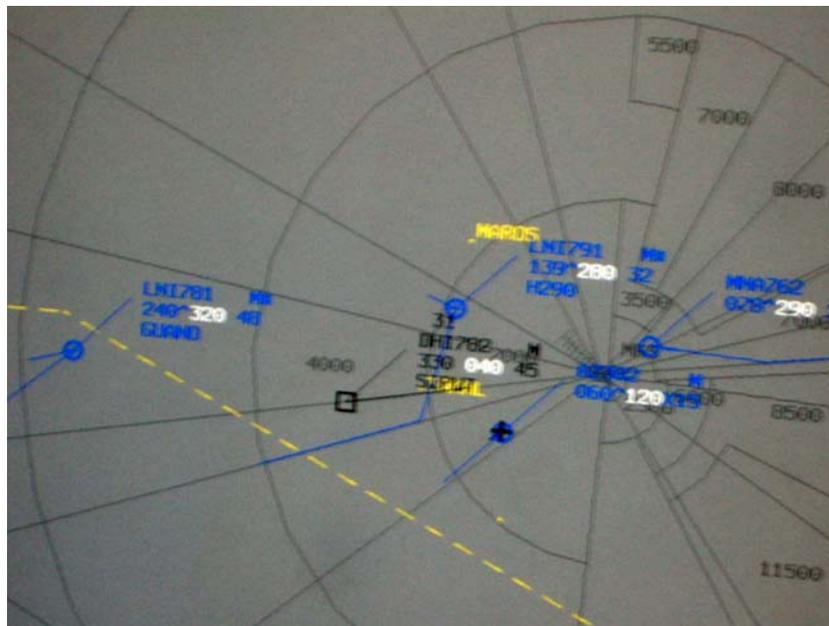


Figure 13: The flight plan track close to MKS (about 20 miles) showing the icon square and black colour; the primary radar did not capture the target

1.18 Additional Information

The pilot reported that after landing at Tambolaka, he contacted AdamAir Operations in Jakarta and was instructed to disembark the passengers and await the arrival of the AdamAir team from Jakarta, which would include maintenance engineers to inspect the aircraft.

Maintenance engineers subsequently realigned the IRS and cleared the aircraft for a ferry flight to Makassar. Verbal approval for the ferry flight was obtained from DGCA. Prior to departure, the CVR was replaced with a serviceable unit and the CVR covering the incident flight was quarantined for NTSC. Due to the FDR being capable of recording 25 hours of data it was not immediately quarantined. Following the ferry flight to Makassar, the FDR was quarantined for the NTSC.

Subsequent engineering tests conducted on the IRUs were unable to determine the reason the FMC switched the navigation source (IRS) from number 1 (left side) to the right side or IRS number 2.

The reason for the aircraft diverging to the right when the FMC showed that it was maintaining the flight plan track could not be determined using the available data.

2 ANALYSIS

The recorded flight data showed that the aircraft started diverging to the right of the planned track after the Flight Management Computer (FMC) switched, uncommanded, to Inertial Reference Unit (IRU) 2. The pilot in command (PIC) reported that the divergence was not noticed because cockpit instruments showed that the aircraft was tracking towards Makassar (MKS). This was confirmed by recorded information on the Flight Data Recorder (FDR).

Only the last 31 minutes prior to shut down at Tambolaka were recorded on the cockpit voice recorder (CVR). The investigation was therefore unable to determine the extent of trouble shooting actions taken by the pilots. The observation of the sun being at 10 o'clock position from the nose of the aircraft indicated that at that time the aircraft was heading south-southeast. That should have been an indicator to the pilots that they had diverged significantly from the flight planned track even though the navigation displays were indicating that they were tracking as planned to MKS. The PIC consulted the appropriate section of the aircraft's Quick Reference handbook, but did not complete the checks. Specifically he did not attempt to enter the magnetic heading value into the overhead Internal System Display Unit (ISDU) when their effort to enter it into the Computer Display Unit (CDU) was not successful.

The CVR data recorded the pilots' actions and decision making while attempting to verify their geographical position and make a diversion for a safe landing.

The actions by the PIC to conduct unauthorised checks with the trainee flight attendants were inappropriate and diverted his attention from operating the aircraft. However, given that the on-board navigation displays showed track and distance to MKS, it is unlikely that reference to the FMC alone, would have alerted the pilots to a navigation error.

The aircraft crossed at least 14 air routes during the period of the flight between *SOLOM* and Tambolaka Airport.

Evidence gathered during this investigation, and a subsequent accident investigation conducted by the NTSC, showed repeated IRS malfunctions in Boeing 737 aircraft in the AdamAir fleet that went unresolved. The NTSC accident report KNKT/07.06/07.02.35 noted:

The AdamAir Continuous Airworthiness Maintenance Program approved by DGCA was supported by a Reliability Control Program (RCP). However, the RCP did not cover component reliability. There was no evidence that AdamAir included component reliability in their RCP to ensure the effectiveness of the airworthiness of the aircraft components for the AdamAir fleet. There was also no evidence of AdamAir's maintenance management controlling the repetitive defects on their fleet prior to the accident resulting in defects not being appropriately rectified.

The repeated/recurring IRS problems created a working environment that tolerated continued operation of the aircraft with known IRS faults. This tolerance was evident in both the management of flight operations and also maintenance engineering.

The airline's management did not anticipate the need for sufficient spare parts to ensure the safe operation. The management did not have an adequate safety policy to provide training programs for operation and maintenance personnel. The fact that AdamAir was still having fleetwide recurring IRS/IRU defects 11 months after the accident (November 2007), clearly shows that the engineering supervision and oversight changes that were put in place after the accident, to resolve the recurring problems, were not effective.

Air Traffic Control

The aircraft's transponder was working normally and showing the assigned radar (transponder code) identification. The radar replay showed that Adam 782, the target aircraft, was still captured by radar (on the screen of Bali Center and Bali East) during the time the pilots reported loss of navigation. However, due to a lack of appropriate coordination between the controllers, they had a degraded awareness of their areas of responsibility or jurisdiction.

When the radar track and the flight plan track separate by 10 miles or more, there should be a warning in the MAATS system called RAM (Route Adherence Monitoring). The RAM should produce a warning, however, the display was not showing the divergence, so it was not evident to the controllers that the radar track and flight plan track had separated by 10 miles or more. At the time of serious incident, the RAM data was incorrectly set to 20 miles for airway W 52. According to the regulations, the RAM trigger was required to be set to activate with a divergence of not more than 10 miles.

The area between waypoints *SOLOM* and *GUANO* was not adequately covered by the Banjarmasin radar at the time of the flight. The investigation found that the aircraft deviated more than 10 miles and the system did not generate a RAM. So the controllers were deprived of the warning that the aircraft had diverged a significant distance from the planned track. When the aircraft target on the radar screen changed to radar track, the controller did not recognize it, because the colour of the symbol changed from green circle to black circle. Therefore, the controller considered that the target was beyond his jurisdiction.

The radar controllers had not received the specified training in the MAATS. They had received computer based training for one week and simulator training for 6 hours instead of the specified 40 hours. There was also no Standard Operating Procedure for the MAATS.

3 CONCLUSIONS

3.1 Findings

3.1.1 Operational

1. The pilots were appropriately licensed and qualified to operate the Boeing 737-300 series aircraft.
2. There was no evidence that the pilots were not medically fit.
3. The pilots complied with the Directorate General Civil Aviation (DGCA) and company flight and duty limitations.
4. The aircraft was being flown by the pilot in command at the time of the serious incident.
5. The aircraft was being operated within the approved weight and balance limitations.
6. The IRU malfunctioned but continued to indicate track and distance to MKS although the aircraft was significantly diverging from that track.
7. The pilot in command (PIC) diverted his attention from the operation of the aircraft and conducted unapproved tests of trainee flight attendants.
8. The pilots did not detect the deviation from the intended track for a period of approximately 45 minutes.
9. The pilots consulted the appropriate section of the aircraft's Quick Reference Handbook (QRH) to attempt to resolve the IRS 2 fault warning, however they did not attempt to try to enter the magnetic heading via the overhead Inertial System Display Unit (ISDU), in accordance with the QRH procedures.

3.1.2 Maintenance Related Issues

1. The aircraft's certificates of airworthiness and registration were current.
2. The Universal Flight Data Recorder (UFDR) provided good quality data.
3. The Solid State Cockpit Voice Recorder provided good quality data.
4. There was no evidence of airframe failure or system malfunction that could have affected the performance or handling characteristics of the aircraft.
5. Both left and right IRU's fitted to PK-KKE malfunctioned during the 11 February 2006 flight from Jakarta to Makassar.
6. It is likely that the aircraft departed Jakarta with an unserviceable right IRU following replacement at Jakarta.

7. The IRUs, when used by the Flight Management System, provided erroneous global position location to the FMC and flight instruments.
8. During the 2-month period prior to the accident, there were 18 recurring IRS defects.
9. Line maintenance rectification action was limited to re-racking and swapping IRU positions and associated components, resetting circuit breakers and cleaning connections when the faults became repetitive
10. There was no evidence that AdamAir included component reliability in their Reliability Control Program (RCP), to ensure the effectiveness of the airworthiness of the aircraft components for the AdamAir fleet, at the time of the accident.
11. There was no evidence of AdamAir's maintenance management controlling the repetitive defects on their fleet prior to the serious incident.

3.1.3 Air traffic control related issues

1. The MAATS Route Adherence Monitoring (RAM) data was incorrectly set to trigger a track divergence warning when an aircraft diverged 20 miles. The RAM trigger was required to be set to activate with a divergence of not more than 10 miles.
2. The radar display did not show the divergence, so it was not evident to the controllers that the radar track and flight plan track had separated by ten miles or more.
3. When the aircraft target on the radar screen changed to radar track, the controller did not recognize it, because the colour of the symbol changed from green circle to black circle. Therefore, the controller considered that the target was beyond his jurisdiction.
4. The radar controllers had not received the specified training in the MAATS.
5. There was no Standard Operating Procedure for the MAATS.

3.2 Causes

- 1 The aircraft's IRS malfunctioned resulting in the IRU providing erroneous and misleading navigation indications. The on-board navigation displays showed that the aircraft was on the planned track.
- 2 The pilot in command diverted his attention from the operation of the aircraft to conduct unauthorised testing of a flight attendant.
- 3 The MAATS Route Adherence Monitoring (RAM) data was incorrectly set to trigger a track divergence warning when an aircraft diverged 20 miles instead of 10 miles.

- 4 The radar display did not show the divergence, so it was not evident to the controllers that the radar track and flight plan track had separated by ten miles or more.
- 5 When the aircraft target on the radar screen changed to radar track, the controller did not recognize it, because the colour of the symbol did not change to green. Therefore, the controller considered that the target was beyond his jurisdiction.
- 6 The radar controllers had not received the specified training in the MAATS.
- 7 There was no Standard Operating Procedure for the MAATS.

4 SAFETY ACTION

4.1 Angkasa Pura I

On 16 April 2007, Angkasa Pura I issued a revision to the *Standard Operating Procedure, Air Traffic Services Hasanuddin International Airport, Makassar, effective 16 July 2007*. The revision covered procedures in the event of radar track not being displayed to the receiving controller and also procedures for identification of aircraft, including by referring to other controllers. The procedures require that *if doubt concerning the aircraft's identity exists, an alternative method shall be used to establish positive identification*.

However, the procedures supplied to the NTSC did not provide an adequate assurance that alternative methods of positive identification and assessing if an aircraft was in distress, were promulgated to controllers. This is particularly important in the event of radar track being lost and not available to any controller.

5 SAFETY RECOMMENDATIONS

The National Transportation Safety Committee recommends that the Directorate General Civil Aviation (DGCA) review the Makassar Airport Air Traffic Services (MAATS) operation to ensure:

1. The controllers receive the specified training, including simulator training in MAATS.
2. The Makassar airport operator publishes Standard Operating Procedures for MAATS and that controllers are trained in their use.
3. The Makassar airport operator reviews the organization and establishes a quality control and engineering standard within the organization.
4. All memorandums of understanding, instructions, and other requirements in the use of MAATS shall be included in the Standard Operating Procedures for MAATS.
5. Controllers are fully aware of their area control responsibility and maintain an adequate level of monitoring and surveillance their area of responsibility or jurisdiction at all times.