KOMITE NASIONAL KESELAMATAN TRANSPORTASI
REPUBLIC OF INDONESIA

FINAL

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Aircraft Serious Incident Investigation Report

Hong Kong Airlines

Airbus 330-223; B-LNE

Near Banjarmasin

Republic of Indonesia

6 May 2016

2022

This Final Report was published by the Komite Nasional Keselamatan Transportasi (KNKT), Transportation Building, 3rd Floor, Jalan Medan Merdeka Timur No. 5 Jakarta 10110, Indonesia.

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Jakarta, 8 November 2022
KOMITE NASIONAL
KESELAMATAN TRANSPORTASI
CHAIRMAN

SOERJANTO TJAHJONO

TABLE OF CONTENTS

TABLE OF FIGURES

ABBREVIATIONS AND DEFINITIONS

AAIA	:	Hong Kong Air Accident Investigation Authority
AC	:	Advisory Circular
ACARS	:	Aircraft Communications Addressing and Reporting System
ACC	:	Area Control Centre unit
ADC	:	Aerodrome Control Tower
AED	:	Automated External Defibrillator
AoA	:	Angle of Attack
AP	:	Autopilot
APP	:	Approach Control unit
ARFF	:	Aircraft Rescue and Fire Fighting
ATPL	:	Airline Transport Pilot License
BMKG	:	*Badan Meteorologi, Klimatology dan Geofisika* (Indonesia Meteorology Climatology and Geophysics Agency)
CCN	:	Cabin Crew Notice
CPL	:	Commercial Pilot License
CVR	:	Cockpit Voice Recorder
FAA	:	Federal Aviation Administration
FCOM	:	Flight Crew Operation Manual
FCTM	:	Flight Crew Training Manual
FD	:	Flight Director
FDR	:	Flight Data Recorder
FL	:	Flight Level
FMA	:	Flight Mode Annunciation
ft	:	Feet
G	:	Gravitational Force
IOCC	:	Integrated Operations Control Center
Km	:	Kilometer
KNKT	:	Komite Nasional Keselamatan Transportasi / National Transportation Safety Committee
LT	:	Local Time
ND	:	Navigation Display
Nm	:	Nautical miles
OM	:	Operation Manual

PF	:	Pilot Flying
PIC	:	Pilot in Command
PM	:	Pilot Monitoring
PWS	:	Predictive WindShear
RTB	:	Return to Base
SCCM	:	Senior Cabin Crew Member
SIC	:	Second in Command
UTC	:	Universal Time Coordinated
VHF	:	Very High Frequency

SYNOPSIS

On 6 May 2016, an Airbus A330-223 aircraft registered B-LNE was being operated by Hong Kong Airlines as passenger scheduled flight from I Gusti Ngurah Rai International Airport (WADD), Bali, Indonesia to intended destination of Hong Kong International Airport (VHHH) Hong Kong.

The aircraft departed at 1749 UTC, on a night condition with flight number CRK6704. On board in this flight was with 216 occupants, consisted of two pilots, ten flight attendants and 204 passengers.

At 1823 UTC, the flight reached Flight Level (FL) 410 (altitude 41,000 feet) and the pilots started to see lightning near the flight track. The PIC then turned on the seatbelt sign and it was for the duration of the flight. The pilots noticed on the aircraft weather radar a clear path between two buildup cloud cells to the right of the flight direction. The pilots recalled that the distance between those buildup cloud cells was approximately 40 up to 60 Nm and decided to fly towards the clear path.

While flying between the buildup cloud cells, the flight encountered light turbulence and the pilots started to see magenta color displayed on the aircraft radar display about 5 Nm ahead. The PF decided to fly straight considering that the buildup cloud cells were on the left and right of the aircraft track. At 1834 UTC, the flight encountered severe turbulence for about 1 minute. Three flight attendants and 12 passengers injured. The aircraft had minor damage on the several passenger service units and the aft galley ceiling.

The aircraft returned to Bali and after landed at 2029 UTC, the injuries occupants were taken to the airport health facility by ambulances then transferred to the nearest hospital for further medical treatment.

The investigation determined that the aircraft system was not a safety issue in this occurrence and the contributing factors of the occurrence were as follows:

- The encountered storm cell that was most likely over scanned by the weather radar could make pilot underestimate or not detect a storm cell and underestimate the turbulence associated to the magenta cell displayed 5 Nm ahead of the aircraft.
- The absence of the turbulence encounters pre-warned resulted in the flight attendants did not prepare to secure the carts nor to be seated with fastened seatbelt.
- The improper fastened of the passenger seatbelt increased the severity of the passenger injury despite the flight crew had ensured the passenger to fasten their seatbelt.

The KNKT acknowledged the safety actions taken by the aircraft operator and considered that the safety actions were relevant to improve safety. Therefore, KNKT did not issue safety recommendations in this report.

1 FACTUAL INFORMATION

1.1 History of the Flight

On 6 May 2016, an Airbus A330-223 aircraft, registered B-LNE, was being operated by Hong Kong Airlines as a passenger scheduled flight from I Gusti Ngurah Rai International Airport (WADD), Bali, Indonesia[1] to Hong Kong International Airport (VHHH), Hong Kong with flight number CRK6704 (Figure 1).

During the preflight, the pilots noted the forecast weather chart which depicted significant clouds over Kalimantan Island surrounding the planned route of M522. Considering the weather, the pilots requested additional fuel to anticipate route deviation. The pilot also informed to the flight attendants, that the flight would encounter turbulence about one hour after departure and if the seatbelt sign was on, the flight attendants shall make sure that the passengers fastened their seatbelt.

Prior to the departure, during the passenger boarding process, the pilot also announced that the flight would encounter turbulence and reminded to the passengers to fasten the seatbelt whenever the fasten seatbelt sign was on. There was no record or report of aircraft system malfunction prior to the departure.

Figure 1: The flight plan route and the area of turbulence (red box)

1 I Gusti Ngurah Rai International Airport (WADD), Bali, Indonesia will be named as Bali for the purpose of this report.

At 0149 LT (1749 UTC[2]) on night condition, the aircraft departed Bali with 216 occupants on board consisting of two pilots, ten flight attendants and 204 passengers. The Pilot in Command (PIC) acted as Pilot Monitoring (PM) and the Second in Command (SIC) acted as Pilot Flying (PF).

The pilot was instructed by the Bali Aerodrome Control Tower unit (Tower) controller to climb to Flight Level (FL)[3] 240 (altitude 24,000 feet). After passing altitude 1,000 feet, the flight was transferred to the Bali Approach Control unit (APP).

At 1751 UTC, the pilot contacted the APP controller and was instructed to climb to FL240 and was approved to fly direct to waypoint GALKO[4].

At 1759 UTC, the flight was transferred to Ujung Pandang Area Control Center unit (ACC) and the ACC controller instructed the pilot to climb to FL330.

At 1809 UTC, the pilot reported that the flight was approaching FL330 and the ACC controller instructed the pilot to climb to FL350. At 1818 UTC, the pilot requested for higher flight level to the ACC controller for avoiding weather and was approved to climb to FL390. One minute later while climbing, the pilot requested turn left heading 325° to avoid bad weather condition to the ACC controller and was approved with an additional instruction to climb to FL410.

At 1823 UTC, the flight reached FL410 and the pilots started to see lightning near the flight track. The PIC then turned on the seatbelt sign which continued for the duration of the flight. When the seatbelt sign was on, the flight attendants were finishing the meal service. Thereafter, the flight attendants conducted cabin check for ensuring the passengers fastened their seatbelt.

The pilots noticed on the aircraft weather radar a clear path between two buildup cloud cells to the right of the flight direction. The pilots recalled that the distance between those buildup cloud cells was approximately 40 up to 60 Nm and decided to fly towards the clear path. At 1825 UTC the aircraft was turned to the right.

Both pilots selected the weather radar to be displayed on their Navigation Displays (NDs), and the radar were operated in Weather and Turbulence modes. The range on the PIC ND was set to 80 Nm. At 1832 UTC, the SIC ND range selection was changed from 40 Nm to 20 Nm. The SIC recalled that the weather radar gain setting was automatic and the tilt was selected at -0.8°.

While flying between the buildup cloud cells, the flight encountered light turbulence and the pilots started to see magenta[5] color displayed on the aircraft radar display about 5 Nm ahead. The SIC decided to fly straight considering that the buildup cloud cells were on the left and right of the aircraft track.

At 1834 UTC, the flight encountered severe turbulence for about 1 minute.

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2 The 24-hours clock in Universal Time Coordinated (UTC) is used in this report to describe the local time as specific events occurred. Local time is UTC+8 hours.

3 Flight Level (FL) is a surface of constant atmosphere pressure which is related to a specific pressure datum, 1013.2hPa, and is separated from other such surfaces by specific pressure intervals (e.g. FL240 = 24,000 feet above mean sea level when the pressure at sea level is 1013.2 mbs).

4 GALKO is a waypoint which located approximately 115 Nm from I Gusti Ngurah Rai International Airport on heading 357° (06°49’35.51” S 115°04’53.85” E).

5 Magenta colour on the radar display indicates the highest turbulence intensity.

After finishing the meal service, the flight attendants cleared up the food carts in the aft galley when the sudden turbulence occurred. Three flight attendants and two food carts lifted and hit the ceiling then fell back on the floor several times.

About five seconds after encountered the turbulence, the autopilot involuntary disengaged[6] and was reengaged at 1840 UTC. During the autopilot disengaged, the pilots flew manually.

At 1842 UTC, the turbulence ended and the PIC asked the Senior Cabin Crew Member (SCCM) to check the condition of the other crews and passengers then to come to the cockpit. Few minutes later, the SCCM came to the cockpit and informed to the pilots that two flight attendants seriously injured and several passengers injured.

At 1856 UTC, the PIC attempted to contact Integrated Operations Control Center (IOCC)[7] located in Hong Kong through satellite phone three times but there was no answer.

At 1900 UTC, the PIC communicated with the SCCM via interphone asked whether the injured occupants required immediate treatment. The SCCM could not determine whether the injured occupants required immediate medical treatment, however the injured occupants felt severe pain. Thereafter, the PIC decided to return to Bali after considering that the injured occupants might need further medical treatment.

At 1902 UTC, the pilot reported to the ACC controller that the flight was approaching waypoint NUGRO[8] and requested to return to Bali due to several occupants were injured during an in-flight turbulence. The ACC controller instructed the pilot to turn left and proceed to waypoint GALKO.

At 1905 UTC, the ACC controller informed the APP controller that the flight of CRK6704 was returning to Bali due to injured occupants and might require ambulance on arrival.

At 1906 UTC, the PIC pressed the emergency number on the satellite phone and connected to the Duty Operation Manager of Hong Kong Airlines (Duty Ops Manager) at Hong Kong. The PIC informed that they unable to contact the IOCC and explained that the flight was returning to Bali. The Duty Ops Manager then relayed the communication to the IOCC.

At 1910 UTC, the pilot communicated with the IOCC and explained that the flight condition and was returning to Bali with estimated time of arrival was 2028 UTC. The IOCC advised the pilot to contact the MedLink[9] after assessing the injured occupants, and also assisted the pilot to relay the occurrence to the Hong Kong Airlines representative in Bali to prepare medical assistance upon arrival. The pilot then advised the SCCM to assess the injured occupant using MedLink assessment form. During the assessment, it was found that three flight attendants were injured.

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6 Autopilot involuntary disengaged means the autopilot disengages without pilot command.

7 Integrated Operation Control Center is operation center located in the Hong Kong Airlines headquarter in Hong Kong which operates for 24 hours.

8 NUGRO is a waypoint which located approximately 510 Nm from I Gusti Ngurah Rai International Airport on bearing 359° (00°09.9'S 114°58.7'E).

9 MedLink is a company which provide medical assistance to the Hong Kong Airlines.

At 1947 UTC, the ACC controller communicated to the pilot asked whether the pilot needed ambulance and medical assistance upon arrival. The ACC controller then forwarded the information regarding the injury of the occupants to the APP.

After received the filled Medlink assessment form from the SCCM, at 1949 UTC, the PIC contacted the MedLink and advised the injured occupant condition. The medical assessment considered that the injury of the occupants was minor. Considering that the aircraft had enough fuel without any system abnormality and the occupant injury was minor, the pilot did not declare urgency nor emergency situation to the air traffic controller.

At 1950 UTC, the APP controller informed Bali Tower controller regarding the returning of CRK 6704. The Tower controller supervisor then informed the Aircraft Rescue and Fire Fighting unit (ARFF) related to the returning of flight CRK6704 with injured occupants and requested medical assistance on arrival.

At 2029 UTC, the aircraft landed and parked on parking stand number 19.

All injuries occupants were taken to the airport health facility by ambulances then transferred to the nearest hospital for further medical treatment.

1.2 Injuries to Persons

Injuries	Flight Crew	Passengers	Total in Aircraft	Others
Fatal	-	-	-	-
Serious	-	-	-	-
Minor	3	12	15	-
TOTAL	3	12	15	-

Based on further medical examination, the number of the injured occupants were identified. The injury of flight crew was classified as minor injury.

All the injured occupants were Hong Kong citizens.

1.3 Damage to Aircraft

The aircraft had minor damage on the several passenger service units and the aft galley ceiling.

1.4 Other Damage

There was no other damage to property and/or the environment.

1.5 Personnel Information

1.5.1 Pilot in Command

Gender	:	Male
Age	:	47
Nationality	:	Canadian
Marital status	:	Married
Date of joining company	:	27 October 2014

License	:	ATPL
Date of issue	:	8 January 2015
Aircraft type rating	:	A330, A320
Instrument rating issuance	:	4 January 2016
Medical certificate	:	First Class
Last of medical	:	21 July 2015
Validity	:	31 July 2016
Medical limitation	:	The holder shall possess glasses that correct for near vision
Last line check	:	2 April 2016
Last proficiency check	:	1 April 2016

Flying experience

Total hours	:	10,073 hours 54 minutes
Total on type	:	242 hours 48 minutes
Last 90 days	:	192 hours 6 minutes
Last 60 days	:	122 hours 54 minutes
Last 24 hours	:	2 hours 58 minutes
This flight	:	2 hours 58 minutes
Rest hour prior departure	:	23 hours

1.5.2 Second in Command

Gender	:	Male
Age	:	31
Nationality	:	Malaysian
Marital status	:	Single
Date of joining company	:	4 December 2015
License	:	ATPL
Date of issue	:	9 March 2016
Aircraft type rating	:	A330
Instrument rating issuance	:	13 February 2016
Medical certificate	:	First Class
Last of medical	:	16 October 2015
Validity	:	31 October 2016
Medical limitation	:	The holder shall wear corrective lens for defective distant vision and carry spare set of spectacles

Last line check	:	13 April 2016
Last proficiency check	:	13 February 2016
Flying experience		
Total hours	:	4,406 hours 17 minutes
Total on type	:	89 hours 44 minutes
Last 90 days	:	89 hours 44 minutes
Last 60 days	:	87 hours 41 minutes
Last 24 hours	:	2 hours 58 minutes
This flight	:	2 hours 58 minutes
Rest hour prior departure	:	23 hours

1.5.3 Flight Attendants

All flight attendants on this flight held valid licenses and medical certificate.

1.6 Aircraft Information

1.6.1 General Information

Registration Mark	:	B-LNE
Manufacturer	:	Airbus
Country of Manufacturer	:	France
Type/Model	:	A330-223
Serial Number	:	1039
Year of Manufacture	:	2009 (delivered in 2010)
Certificate of Airworthiness		
Issued	:	8 October 2015
Validity	:	20 October 2016
Category	:	Transport Category (Passenger)
Limitations	:	None
Certificate of Registration		
Number	:	720
Issued	:	16 November 2012
Time Since New	:	19,034 hours
Cycles Since New	:	7,278 cycles
Last Major Check	:	19 March 2016 (4C check)
Last Minor Check	:	3 February 2016 (A check)

1.6.2 Weather Radar

The aircraft was fitted with a Collins Multiscan WXR-2100 weather radar transceiver with capability of Predictive WindShear (PWS) function and a weather hazard prediction function. Prior to the departure, there was no record or report of aircraft weather system abnormalities.

The control panel of the weather radar showed in the Airbus A330/340 Flight Crew Operation Manual (FCOM) chapter DSC-34-SURV-30-30 as follows:

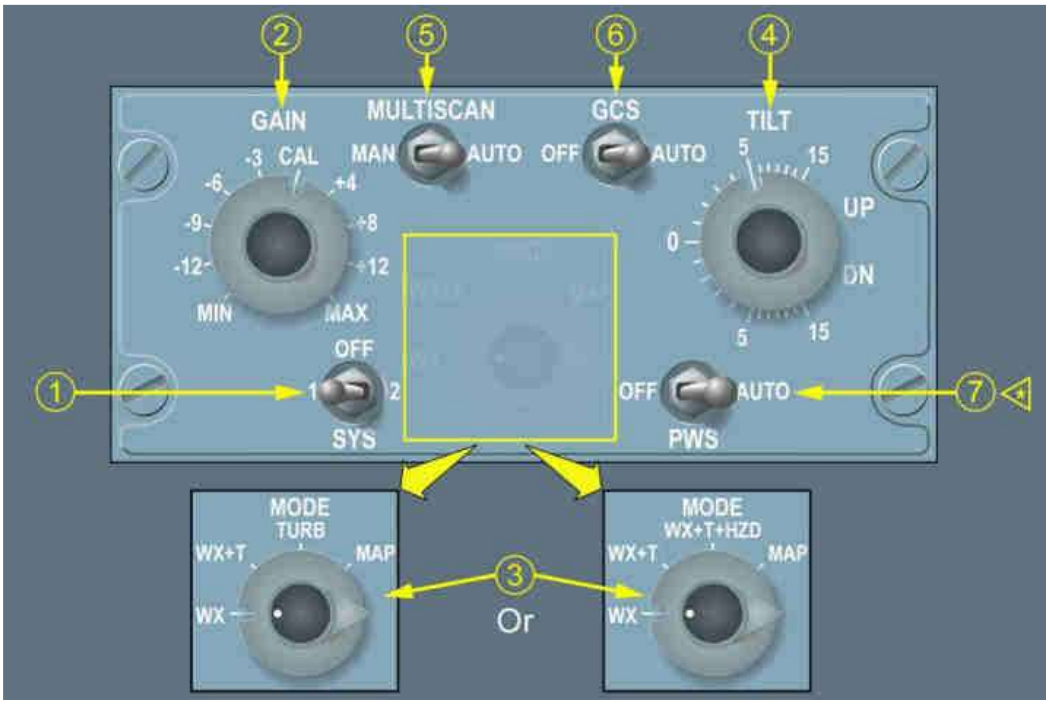


Figure 2: The control panel of the aircraft weather radar

1.7 Meteorological Information

The *Badan Meteorologi Klimatologi dan Geofisika*/BMKG (Indonesia Meteorology Climatology and Geophysics Agency) provided satellite image of clouds type surrounded the occurrence area at 1800 UTC and 2000 UTC (Figure 3).

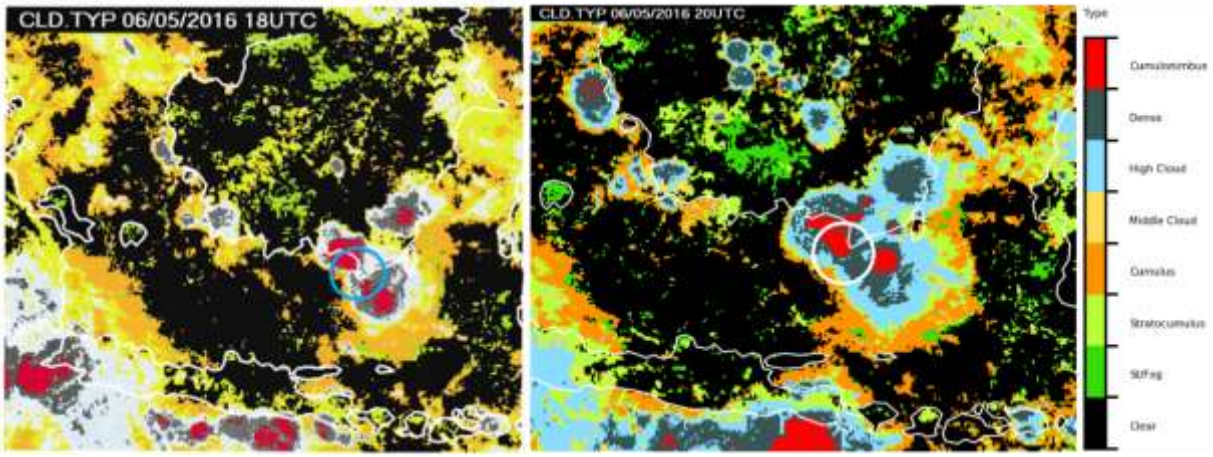


Figure 3: Clouds type satellite imagery on occurrence area at 1800 UTC (blue circle) and at 2000 UTC (white circle)

The satellite image of clouds type at 1800 UTC indicated two buildup cumulonimbus clouds at the occurrence location and the distance between the buildup cumulonimbus clouds was about 25 Nm. At 2000 UTC, the satellite image also indicated two buildup cumulonimbus clouds and the distance between the buildup cumulonimbus clouds was about 30 Nm

The aircraft operator utilized weather information provided by Hong Kong Airport Meteorological Office as part of the dispatch document prior to departure including prognostic chart[10] and wind/temperature chart issued by World Area Forecast Center London (Figure 4).

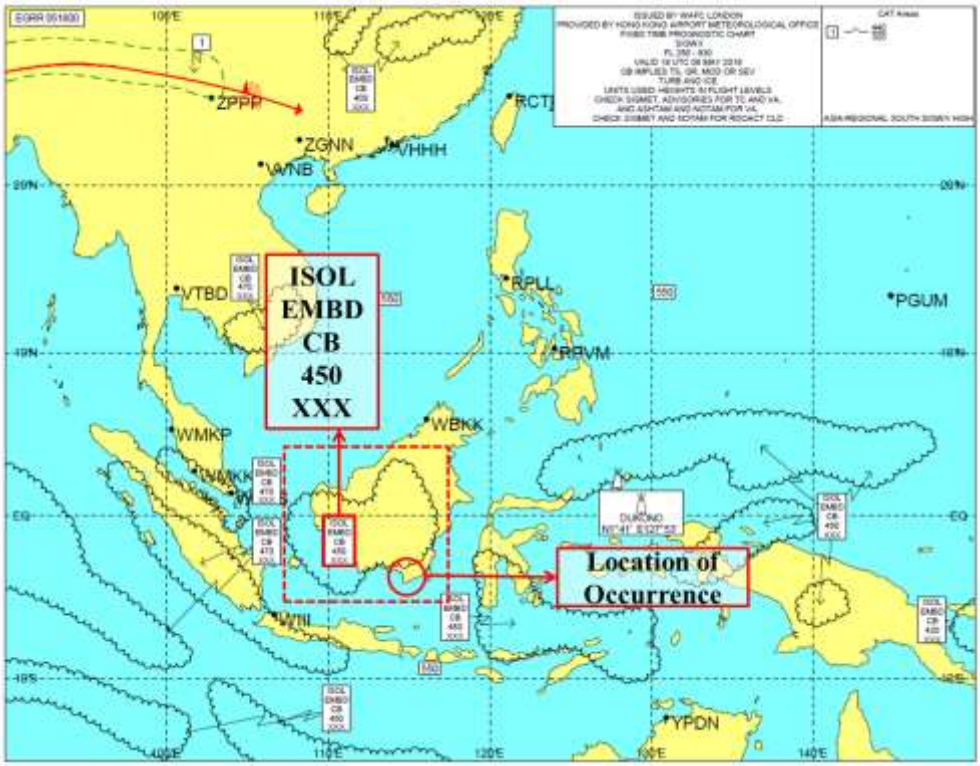


Figure 4: Prognosis chart FL250-630 valid for 6 May 2016 at 1800 UTC

The prognosis chart issued on 6 May 2016 at 1800 UTC showed the area of potentially develop isolated embedded cumulonimbus clouds was over most of Kalimantan including the occurrence area.

10 Prognosis chart is a map displaying the weather forecast.

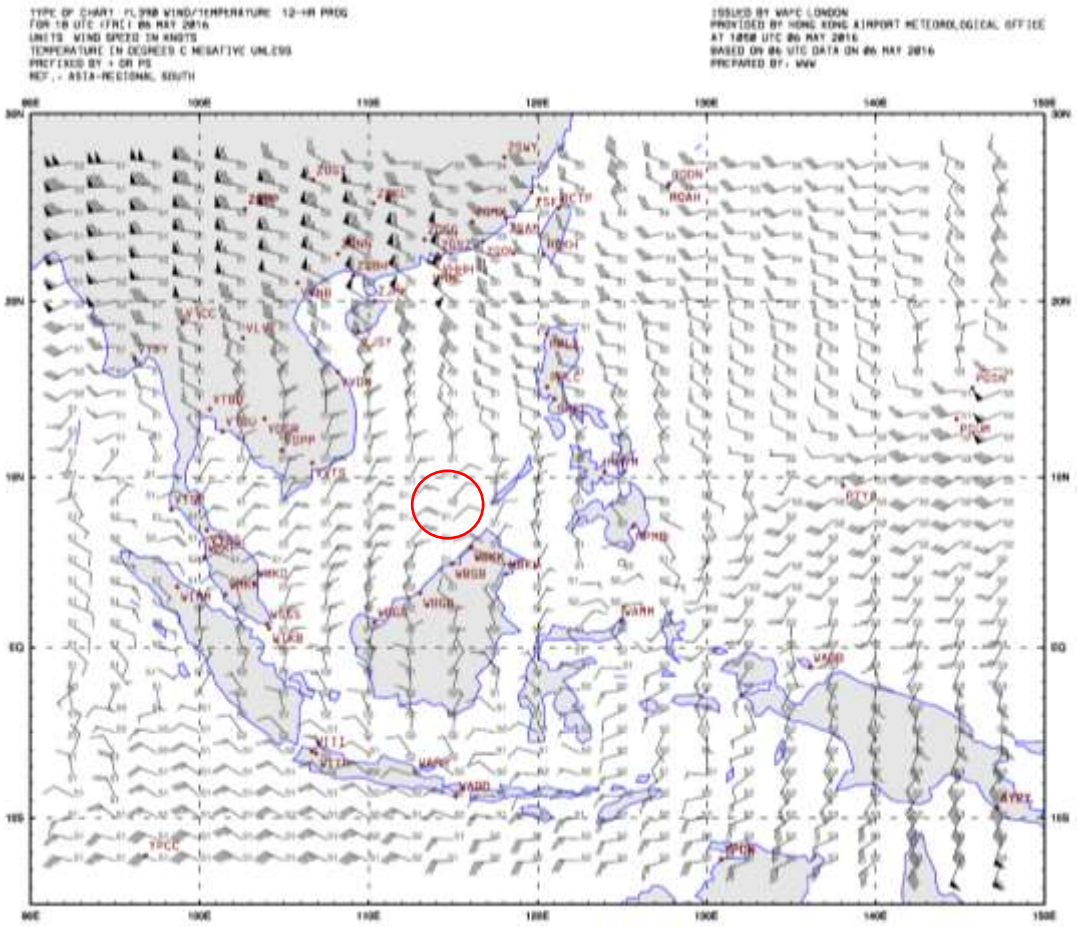


Figure 5: The wind/temperature chart at FL390 for 6 May 2016 at 1800 UTC over the occurrence area (circle in red)

The wind loft chart issued on 6 May 2016 at 1800 UTC showed 5 knots at FL 390 over the occurrence area with temperature of -52°C.

1.8 Aids to Navigation

Ground-based navigation aids, on board navigation aids, aerodrome visual ground aids and their serviceability was not a factor in this occurrence.

1.9 Communications

The aircraft was equipped with Very High Frequency (VHF) radio communication systems. The crew used two of the VHF radios to communicate to the air traffic controller, and the remaining set was used for the Aircraft Communications Addressing and Reporting System (ACARS) data link system. All VHF radios were serviceable.

All communications between air traffic controllers and the pilots were recorded by ground based automatic voice recording equipment and cockpit voice recorder. The quality of the aircraft's recorded transmissions was good.

The aircraft operator provided a satellite phone on the aircraft to be use by the crew to communicate to the air operator head office or other relevant agencies.

1.10 Aerodrome Information

I Gusti Ngurah Rai International Airport is the main airport in Bali, located 13 km south of Denpasar, the airport has a port health facility, first aid, Automated External Defibrillator (AED) and 4 ambulance units. The nearest hospital located about 4 km from the airport.

1.11 Flight Recorders

1.11.1 Flight Data Recorder

The aircraft was equipped with a Honeywell Flight Data Recorder (FDR) with part number 980-4700-042 and serial number 19544. The FDR was successfully downloaded in the KNKT recorder facility and consisted of 1,171 parameters of approximately 27 hours aircraft operation, which contained 6 flights including the serious incident flight (Figure 6).

The significant parameters of the FDR are shown at the following graph.

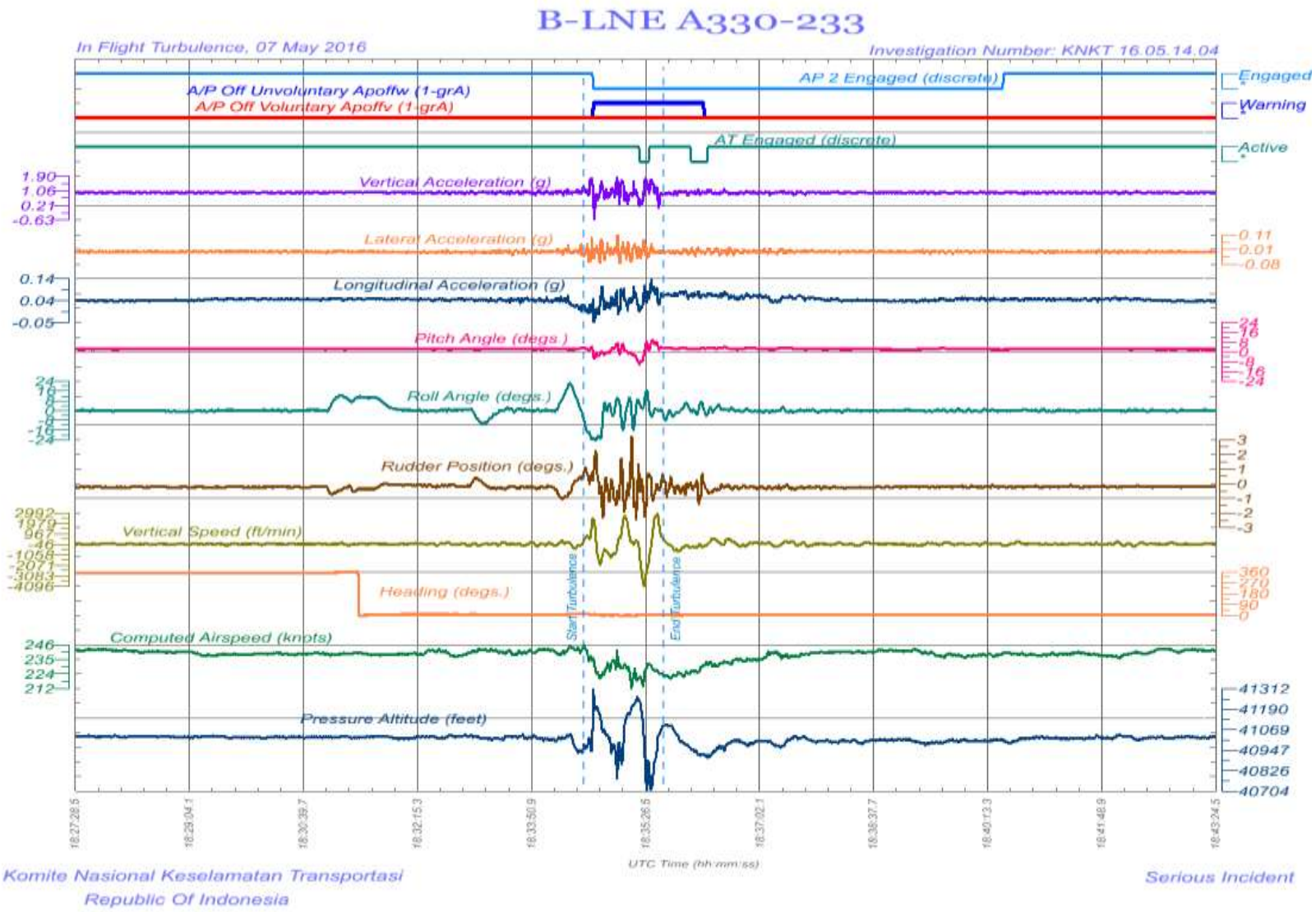


Figure 6: The significant FDR parameters

The following are the significant sequence of events data from the FDR:

1. The weather radar operated in Weather and Turbulence mode on both CAPT and FO navigation displays (ND). The range on CAPT ND (PIC Navigation Display) was set to 80 Nm. The range on FO ND (SIC Navigation Display) was changed from 40 Nm to 20 Nm about two minutes before encountered the turbulence.
2. 18:23:57 UTC, the aircraft reached and maintained FL410 (altitude 41,000 feet). The cruising speed was 0.81 Mach and the autopilot was engaged, the FMA (Flight Mode Annunciation) showed "MACH" (Mach speed), "ALT CRZ" (altitude cruise) and "NAV" (navigation). AP2 (autopilot 2), FD (flight director) and auto thrust were engaged. The wind was from 028° at 10 knots.
3. 18:25:23 UTC, the aircraft heading started to increase from 320° (the aircraft turned to the right).
4. At 18:34:22 UTC, the selected speed was changed from 241 to 231 kts and the aircraft rolled to the right with selected heading 031, FMA was changed to from "NAV" to "HDG" (heading).
5. At 18:34:35 UTC, fluctuations on the roll angle, rate of descend and speed were observed. The speed was 246 kts (Mach 0.82), decreased toward green dot of 227 kts.
6. At 18:34:37 UTC, selected speed was changed to 237 kts.
7. Between 18:34:39 to 18:35:39 UTC, the parameters of vertical acceleration, lateral acceleration, longitudinal acceleration, altitude, speed, and vertical speed fluctuated, indicated that the aircraft encountered turbulence.

During encountered turbulence between 18:34:39 to 18:35:39 UTC

1. At 18:34:41 UTC, vertical acceleration of 1.744 g was recorded.
2. At 18:34:42 UTC, the speed decreased to 233 kts (Mach 0.80), continued with a decreasing speed trend. The vertical speed was increased from +500 fpm to +2400 fpm over 2 seconds. The vertical acceleration recorded 1.54 g.
3. At 18:34:43 UTC, the autopilot involuntary disengaged.
4. At 18:34:44 UTC, a vertical acceleration of -0.022 g was recorded.
5. At 18:34:48 UTC, side stick input from the FO side was recorded. Vertical acceleration recorded was +0.865 g.
6. At 18:34:51 UTC, dual input was observed for approximately 1 second.
7. At 18:35:22 UTC, auto thrust disengaged and the FMA changed to "MAN THR" (manual threshold), then to "MAN TOGA" (manual takeoff go around).
8. At 18:35:30 UTC, auto thrust was re-engaged and FMA changed back to "MACH".
9. Throughout the course of the event, the maximum vertical acceleration recorded was +1.94 g, and the minimum vertical acceleration recorded was -0.63 g.

1.11.2 Sequence of Event Based on FDR Data Provided by Airbus

1. Turbulence with large variation on normal load factor at CG +1.9 g (maximum) and -0.63 g (minimum) was encountered at 18:34:39 UTC and lasted around 1 minute:
2. AP2 (autopilot 2) was recorded involuntarily disengaged at 18:34:43 UTC, upon the activation of the Angle of Attack (AoA) protection as per design.
3. Wind reconstructed based on the comparison between ground speed and true airspeed vectors.
4. The large AoA excursion (from 18:34:40 UTC), leading to AP2 disengagement, was due to the encounter with an updraft gust estimated to around 7,000 fpm, lasting around 2 seconds. Aircraft rate of climb increased up to 2,400 fpm. Normal load factor has varied between +1.8 g and -0.65 g.
5. Around 4 seconds after the first normal load factor peak at -0.65 g, manual take-over began with a nose up sidestick deflection (FO side) applied up to ~1/2 maximum deflection.
6. Several transient AoA excursions beyond AoA protection threshold led to the transient activation of High Angle of Attack (AoA) protection several times.

The recorded parameters of latitude and longitude from the FDR were superimposed with the Google Earth (figure 7) and the satellite image to provide actual flight track during the occurrence (figure 8 and 9).

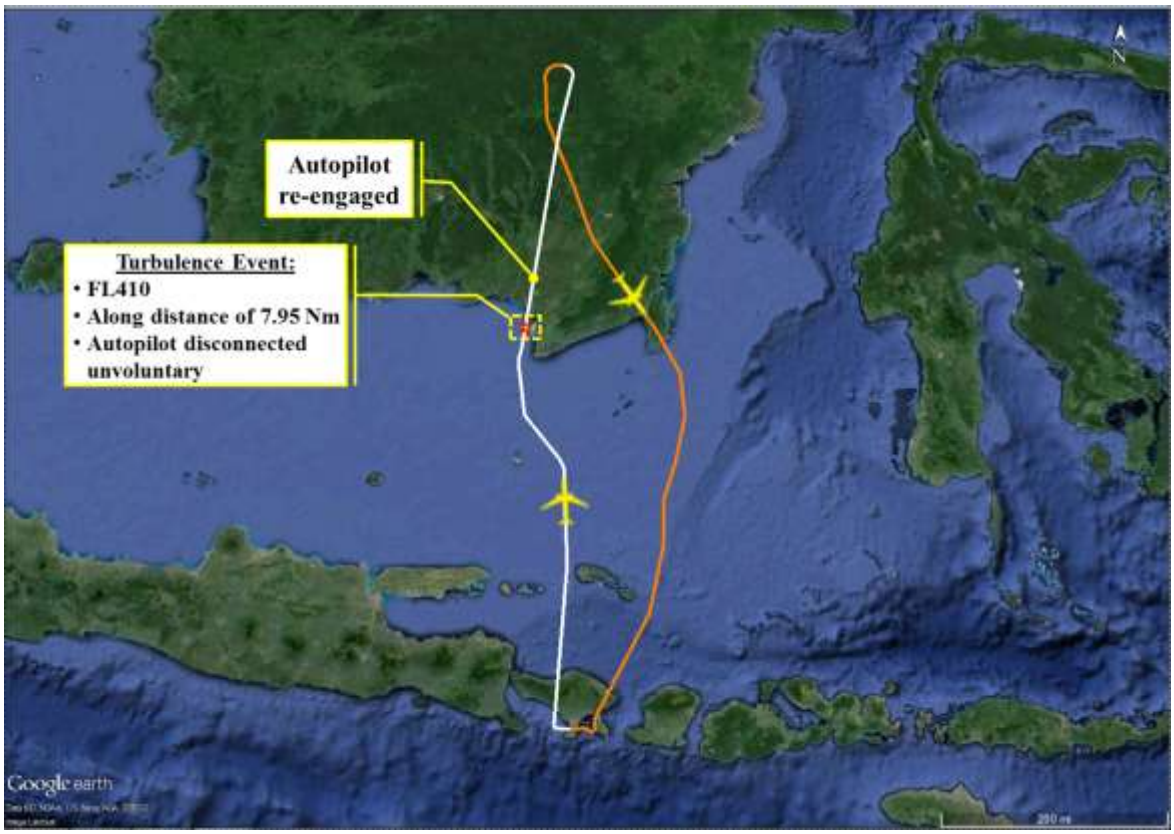


Figure 7: Aircraft flight track based on FDR data

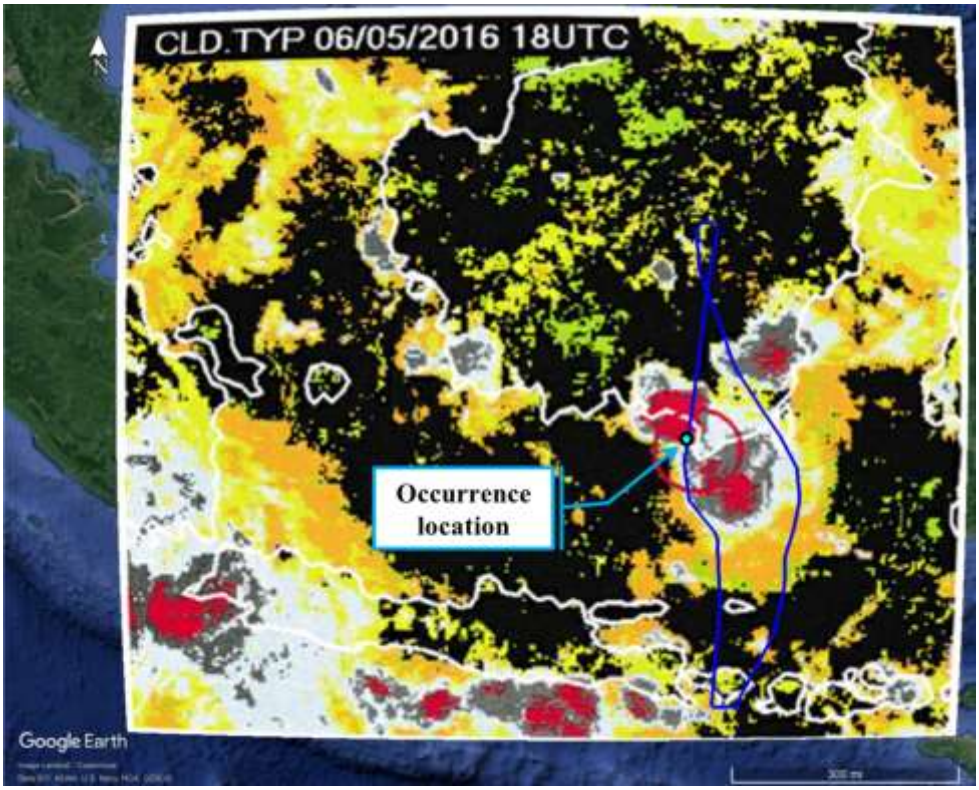


Figure 8: Aircraft flight track superimposed with satellite image at 1800 UTC

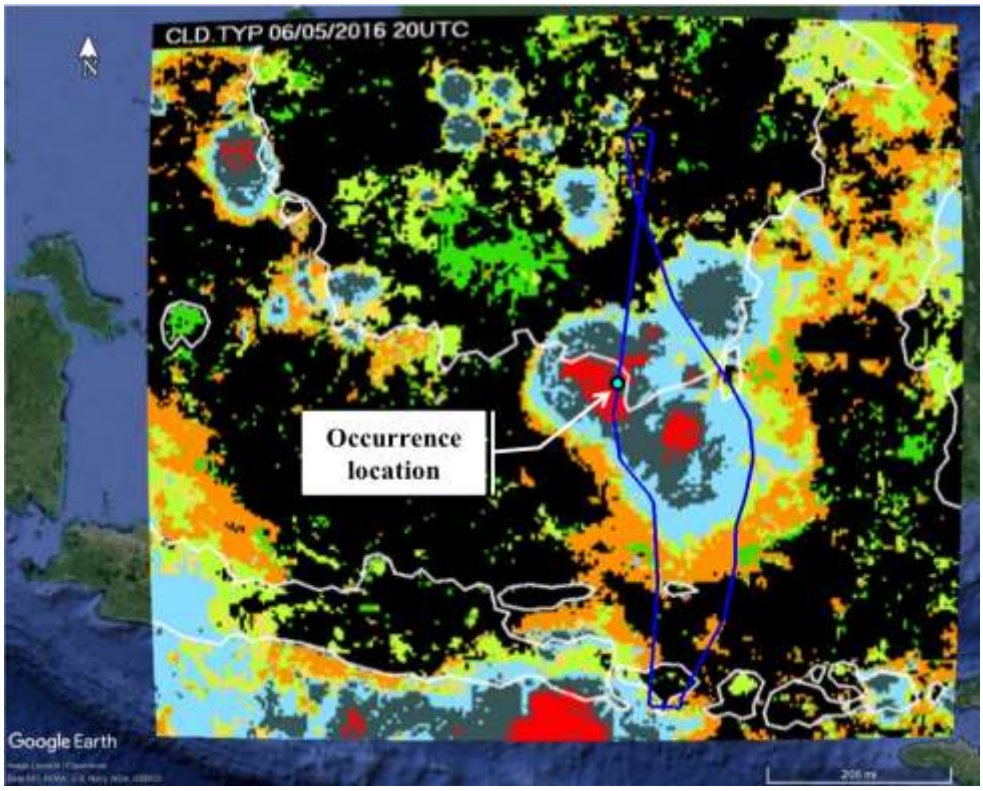


Figure 9: Aircraft flight track superimposed with satellite image at 2000 UTC

1.11.3 Cockpit Voice Recorder

The aircraft was equipped with an L-3 Communications Cockpit Voice Recorder (CVR) with part number 2100-1025-02 and serial number 000604296. The CVR was successfully downloaded in KNKT recorder facility and retrieved data of 2 hours and 4 minutes of good quality recording data. The recorded data initiated while the aircraft experienced severe turbulence until the end of the flight.

The significant excerpts from the CVR are as follows:

Note:

- P1 is the Pilot in Command
- P2 is the Second in Command
- SCCM is the Senior Cabin Crew Member
- ACC is the Ujung Pandang Area Control Center unit controller
- APP is the Bali Approach Control unit controller is the Second in Command
- TWR is the Bali Aerodrome Control Tower unit controller
- GND is the Bali Ground Control Tower unit controller

Time (UTC)	From	To	Communication
18:35:03			Noisy sound in the cockpit.
18:35:11			Horn sound similar to altitude alert
18:35:38	P1	P2	The PIC took over control the aircraft
18:35:50	P2	FA	Announcement for cabin crew to be seated (2x)
18:37:11	P2	P1	The SIC took over control the aircraft
18:37:24	SCCM	P1	(Communication via interphone) Informed several food carts fell down
18:37:24	P1	SCCM	Instructed to remain seated and to assess the condition
18:38:12	P1	P2	The PIC took over control the aircraft
18:42:37	P1	SCCM	Asked Senior Cabin Crew Member (SCCM) to come to the cockpit then explained the flight was encountered turbulence and asked to check the passenger condition.
18:47:39	P2	P1	The SIC took over control the aircraft
18:49:49	P1	ACC	Checked the radio transmission and it was readable and good.
18:52:44	SCCM	P1	Informed that two flight attendants seriously injured and five passengers injured.
18:56:54	P1	IOCC	PIC called IOCC and there was no reply.
18:57:58	P1	IOCC	PIC called IOCC and there was no reply.
18:58:44	P1	P2	Decided to return to Bali.

Time (UTC)	From	To	Communication
18:58:50	P1	IOCC	PIC called IOCC and there was no reply.
19:00:20	P1	SCCM	Asked whether the injured occupants could continue for approximately one hour or they need immediate treatment. The SCCM advised that they were conscious and did not need immediate treatment. The SCCM had asked whether any doctor on board and there was no doctor on board.
19:01:34	P1	ACC	Informed that the flight was approaching NUGRO waypoint and requested to return to Bali due to in flight turbulence that caused several injuries of the occupants.
19:03:13	ACC	P1	Confirmed that there were occupants injured and affirmed by the PIC. The ACC then instructed to turn left and proceed to GALKO way point.
19:04:50	P1	P2	Advised the SIC that the aircraft remained normal with enough fuel to return to Bali.
19:06:15	P1	DOM	Informed the duty operation manager that the flight returned to Bali due to turbulence caused injury to the occupants and asked to relay the communication to the IOCC.
19:09:35	P1	P2	Discussed that the flight did not require priority to land as the occupants did not require immediate treatment.
19:10:41	P1	IOCC	Explained the occurrence and the estimate arrival in Bali was 2028 UTC. The IOCC officer would inform Bali flight operation for preparing medical assistant on arrival.
19:12:58	P2	ACC	Requested 40 Nm left of track due to weather and was approved
19:14:21	SCCM	P1	Informed that some of the passengers injured and several ceilings damage.
19:15:33	IOCC	P1	Advised to contact MedLink.
19:18:09	SCCM	P1	Advised that before call the MedLink, they required to perform injury assessment by filling the medical complaint form.
19:20;36	P1		Announced to the passenger that the flight was returning to Bali due to injury to some occupants.
19:23:53	OPS	P1	Confirmed that the flight was returning to Bali due to occupants injured and affirmed, the PIC informed would contact MedLink.

Time (UTC)	From	To	Communication
19:30:27	P1	SCCM	Informed that as precaution, the flight was diverted away from weather and asked the crew and passenger to remain seated.
19:38:44	P1	ACC	Requested right turn on fly heading 150 and was approved.
19:39:18	P1	P2	The PIC took control the aircraft.
19:46:00	P1	ACC	Informed that the flight was maintaining FL410 and the ACC instructed after clear of weather proceed to KEPIK waypoint to follow GALKO 3D arrival.
19:47:36	ACC	P1	Confirmed the number of injuries to occupants and answered that there were two crewmembers seriously injured and five passengers injured.
19:49:09	P2	P1	The SIC took over control the aircraft.
19:49:37	P1	MED	Explained the situation of the injured occupants.
20:29:25			A sound of aircraft landed.
20:30:20	GND	P1	Requested clarification the detail of the occurrence.
20:36:14	P1	GND	Explained the flight encountered clear air turbulence and caused two crews and ten passengers injured. There was no damage on the aircraft.

1.12 Wreckage and Impact Information

After finishing the meal service, the flight attendants were clearing up the food carts in the aft galley when the sudden turbulence occurred. In the aft galley, three flight attendants and two food carts lifted and hit the ceiling then fell back on the floor.

There were some damages on the ceiling and two food carts fell back to the floor.

Figure 10: The aft galley condition after encounter turbulence

Several passengers service units damaged found above passenger seats number 11A, 11C, 46C, 57E, 58F, 58G, 59F and 59G.

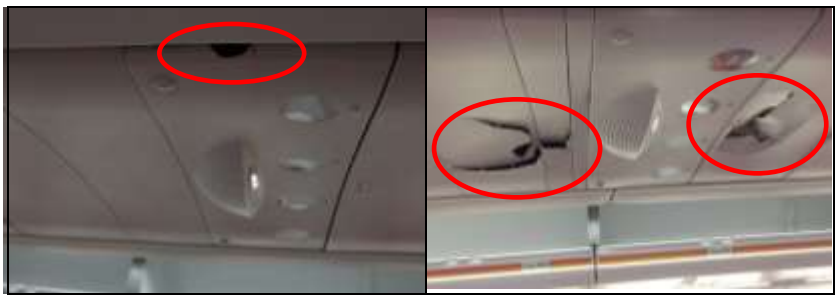


Figure 11: Damage on passenger service units

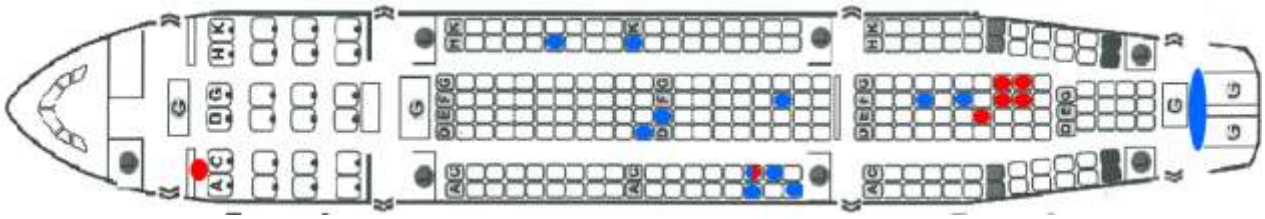


Figure 12: Position of ceiling damage (red marks) and seat position of the injured occupants (blue marks)

1.13 Medical and Pathological Information

The injured occupants were taken to the airport health facility for initial treatment and thereafter to the nearest hospital for further treatment. The report of the medical facility stated that the injured occupants experienced varying degrees of injuries, including minor cuts, bruising, sprains, and abrasions on leg, arms, shoulders, head and nose. None of the injured occupants suffered serious injury.

1.14 Fire

Not applicable to this investigation.

1.15 Survival Aspects

After the turbulence ended, the PIC asked the SCCM to check the condition of the other crews and passengers. Few minutes later, the SCCM informed to the pilots that there were two flight attendants seriously injured and several passengers injured. The SCCM could not determine whether the injured occupants required immediate medical treatment, however the injured occupants felt severe pain. Thereafter, the PIC decided to return to Bali after considering that the injured occupants might need further medical treatment. The PIC then contacted the IOCC to coordinate of medical assistance upon arrival.

About 15 minutes after the turbulence, the SCCM came to the aft galley and assisted to clear the galley. The uninjured flight attendants treated the three injured flight attendants and passengers using the first aid kit. An uninjured flight attendant also made an announcement seeking medical assistance from qualified medical personnel among the passengers, and there were no qualified medical personnel on board.

The pilot requested to the ACC controller to return to Bali as the flight experiencing in flight turbulence and several occupants were injured. The request was approved and the ACC controller advised the APP controller that the flight of CRK6704 was returning to Bali due to injured occupants and might require ambulance on arrival.

The pilot then advised the SCCM to assess the injured occupant using MedLink assessment form. During the assessment, the injured occupants was updated with three flight attendants injured.

After completing the MedLink assessment form, the SCCM submitted the forms to the pilots. The PIC then contacted the MedLink and the medical assessment considered that the injury of the occupants was minor. The communication was about 15 minutes and there was no advice of further treatment to be conducted.

After landing, the pilot was instructed to park the aircraft on parking stand number 19, where the ambulances and paramedics have been waited for about 30 minutes.

The paramedics taken care and evacuated the injured occupants to the airport medical facility by ambulances. Several injured occupants were transferred to the nearest hospital for further medical treatment.

1.16 Tests and Research

There was no test or research was required to be conducted as a result of this occurrence.

1.17 Organizational and Management Information

Aircraft Owner & Operator	:	Hong Kong Airlines Limited
Address	:	11/F, One City gate, 20 Tat Tung Road, Tung Chung, Lantau, Hong Kong
Aircraft Operator Certificate	:	AOC No. 15
Validity	:	31 March 2018

For the purpose of investigation analysis, some relevant parts of flight procedures and policies which are considered relate to the occurrence are described on the following subchapter.

1.17.1 Turbulence Encounters Procedures

The Hong Kong Airlines Operations Manual-A (OM-A) subchapter 8.3.9.6.1 described general operation procedures when encounters turbulence as follow:

Turbulence is defined as a disturbed, irregular flow of air with embedded irregular whirls or eddies and waves. An aircraft in turbulent flow is subjected to irregular and random motions while, more or less, maintaining the intended flight path.

Procedures for "Flight in severe turbulence" refer to type specific FCOM.

Good communication with cabin crew and passenger is a vital strategy to avoid potential harm from expected or encountered turbulence. If the weather conditions and route forecast indicate that turbulence is likely, the Cabin Crew should be prewarned prior to entering the expected turbulence area.

The PIC shall brief the cabin crew on the expected level of turbulence and duration and advised passenger to return to, and/or remain seated and to ensure that their seat belts are securely fastened. Catering and other loose equipment should be stowed and secured until it is evident that the risk of further turbulence has passed.

When encountering turbulence, pilots should report PIREPS to ATC as soon as practicable in stating: (i) Aircraft location, (ii) Type of aircraft, (iii) Time of occurrence in UTC, (iv) Turbulence intensity & duration, (v) Aircraft altitude or FL.

The OM-A subchapter 8.3.9.6.2 described turbulence classification and crew action as follow:

<table>
<tr><th>Intensity/Code</th><th>A/C Response</th><th>Cabin Situation</th><th>Crew Actions prior or in turbulence</th></tr>
<tr><td>Light Chop (1)</td><td>No significant change in attitude or altitude.</td><td>Occupants may feel strain against seat belt; liquids shake but do not splash out of containers.</td><td rowspan="2">Flight Crew:
1) Seat belt sign "ON" for light turbulence.

Cabin Crew:
1) Turbulence PA.
2) Check passenger seat belts fastened.
3) Secure loose galley equipment.
Continue service with caution but no hot beverage.</td></tr>
<tr><td>Light Turbulence (2)</td><td>Slight changes in attitude or altitude of short duration.</td><td>Walking can be difficult; liquids shake but do not splash out of containers.</td></tr>
<tr><td>Moderate Chop (3)</td><td>Rapid bumps or jolts, but no significant change in attitude or altitude.</td><td rowspan="2">Occupants feel definite strain against seat belt.
Loose objects move about; liquid splashes from cups.
Very difficult to walk.</td><td rowspan="3">Flight Crew:

1) Seat belt sign "cycle once" and remain "ON".
2) PA Command;
"Cabin Crew be seated".
3) Turbulence PA if time permits

Cabin Crew:
1) Turbulence PA.
2) Stop service. Sit down and hold on if required.
3) Set cart brakes in present position,

(*) Inspect cabin damage after turbulence.</td></tr>
<tr><td>Moderate Turbulence (4)</td><td>Changes in airspeed, attitude or altitude occur, but control is normal.</td></tr>
<tr><td>Severe Turbulence (5) Intentional flight prohibited</td><td>Large, abrupt changes in airspeed, attitude or altitude occur. Airplane may be briefly out of control.
TLB entry is required.</td><td rowspan="2">Occupants forced against seat belts.
Loose objects tossed about cabin or lifted from floor.
Walking is impossible without holding on to something.</td></tr>
<tr><td>Extreme Turbulence (6) Intentional flight prohibited.</td><td>Airplane tossed violently about; control is practically impossible.
May cause structural damage.
TLB entry is required.</td></tr>
</table>

The management of the turbulence was detailed in the OM-A subchapter 8.3.9.6.3 as follows:

Light Turbulence/Chop:

- *The Flight Crew will switch 'ON' the Seat Belt Sign.*
- *Service may still continue except for the serving of hot beverages. Should Light Turbulence become Moderate or Severe Turbulence, the PIC shall make a PA as reflected in "Moderate and Severe Turbulence" below.*

Moderate Turbulence/Chop:

- *The Flight Crew will cycle once and remain "ON" the Seat Belt Sign.*
- *The PIC will make a PA:*
- *The PIC shall inform the SCCM* (Senior Cabin Crew Member) *of the anticipated duration and severity of turbulence.*
- *Turbulence Duration:*

Occasional	less than 1/3 of the time
Intermittent	between 1/3 and 2/3 of the time
Continuous	more than 2/3 of the time

Severe and Extreme Turbulence:

- *The Flight Crew will cycle twice and remain "ON" the Seat Belt Sign.*
- *The PIC will make a PA:*
- *The PIC shall inform the SCCM of the anticipated duration and severity of turbulence.*
- *Turbulence* Duration:

Occasional	less than 1/3 of the time
Intermittent	between 1/3 and 2/3 of the time
Continuous	more than 2/3 of the time

The Hong Kong Airlines Operation Manual-E (OM-E) subchapter 9.2.1 also described general turbulence procedures as follow:

If turbulence is expected before the flight departs, the preflight briefing to the cabin crew MUST include turbulence considerations. These include:

- *Actions required to be taken by Cabin Crew whenever turbulence is expected or encountered*
- *Intensity of turbulence expected*
- *Methodology for communicating to the Cabin Crew onset or worsening of turbulence, e.g., cabin interphone or P.A*
- *Phraseology for the Cabin Crew to communicate the severity of turbulence*
- *Expected duration of the turbulence and how an "all clear" will be communicated*

Passengers shall be informed of turbulence via the P.A to fasten their seat belts. Do not rely on the seat belt sign alone. Cabin Crew are to be informed via interphone.

If at any time cabin crew experiences turbulence with no notice from the Flight Deck, they shall secure themselves and inform the Flight Crew. All service items must be properly secured or stowed. Service carts/ trolleys must not be left unattended on the aisle.

The Airbus A330/340 Flight Crew Training Manual (FCTM) chapter SI-010 of Adverse Weather described:

TURBULENCE

PREFACE

The flight crew must use weather reports and charts to determine the location and altitude of possible CBs, storms, and Clear Air Turbulence (CAT). If turbulence is expected, the flight crew must turn on the seatbelt signs, in order to prepare passengers and prevent injury.

IN FLIGHT

USE OF THE RADAR

Areas of known turbulence, associated with CBs, must be avoided. Good management of the radar tilt is essential, in order to accurately assess and evaluate the vertical development of CBs. Usually, the gain should be left in AUTO. However, selective use of manual gain may help to assess the general weather conditions. Manual gain is particularly useful, when operating in heavy rain, if the radar picture is saturated. In this case, reduced gain will help the flight crew to identify the areas of heaviest rainfall that are usually associated with active CB cells. After using manual gain, it should be reset to AUTO, in order to recover optimum radar sensitivity.

A weak echo should not be a reason for the flight crew to underestimate a CB, because only the wet parts of the CB are detected. The decision to avoid a CB must be taken as early as possible, and lateral avoidance should, ideally, be at 20 NM upwind.

The Airbus A330/340 Flight Crew Training Manual (FCTM) chapter SI-070 of Weather Avoidance described:

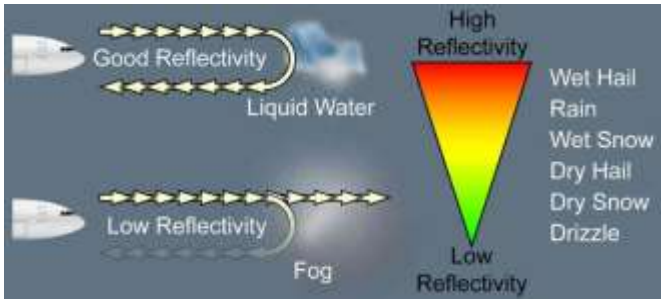
GENERAL

…

Weather detection is based on the reflectivity of water droplets. The weather echo appears on the ND with a color scale that goes from red (high reflectivity) to green (low reflectivity).

The intensity of the weather echo is associated with the droplet size, composition and quantity (e.g. the reflectivity of a water particle is five times more than an ice particle of the same size). The flight crew must be aware that the weather radar does not detect weather that has small droplets (e.g. clouds or fog), or that does not have droplets (e.g. clear air turbulence).

Weather Radar Principle

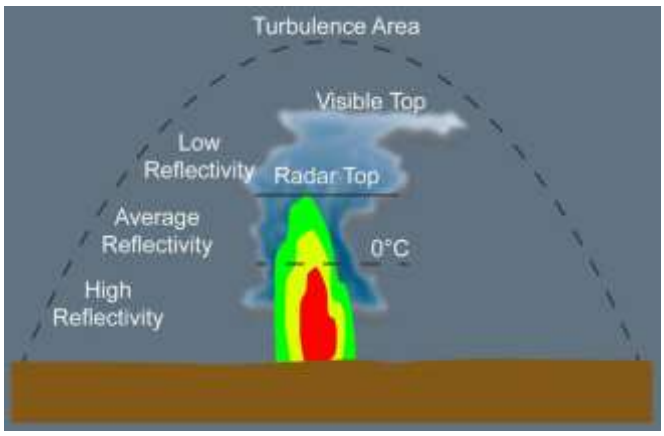


The purpose of the weather radar is to help the flight crew detect and avoid storm cells (e.g. cumulonimbus). Due to its large vertical expansion, a storm cell does not have the same reflectivity depending on the altitude. The quantity of liquid water in the atmosphere decreases with the altitude. Therefore the reflectivity of a storm cell decreases with the altitude.

The upper detection limit of the weather radar is called the radar top. The flight crew must be aware of both of the following:

- *The radar top is not the visible top of the storm cell*
- *The storm cell and associated turbulence extend significantly above the radar top.*

Reflective Image of a Cumulonimbus



WEATHER DETECTION

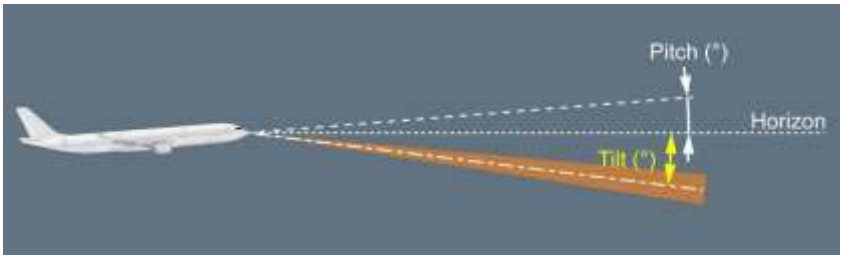
The flight crew uses the following controls and functions to operate the weather radar:

- *TILT*
- *GAIN*
- *RANGE.*

MANUAL TILT MANAGEMENT

The tilt refers to the angle between the antenna beam centerline and the horizon. The radar uses data from the IRS to stabilize its antenna. Therefore, the antenna tilt is independent of the aircraft pitch and bank angle.

Tilt Angle Definition

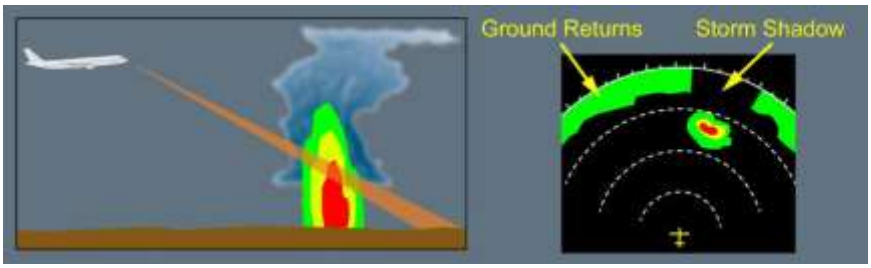


The flight crew should regularly scan the area ahead of the aircraft, at several ND ranges. In order to identify the strongest weather returns, the flight crew should tilt the weather radar antenna up and down.

To obtain a correct display of a storm cell, the flight crew must use the tilt knob to point the weather radar beam to the most reflective part of the storm cell. A correct tilt setting prevents the overscanning of the storm cell.

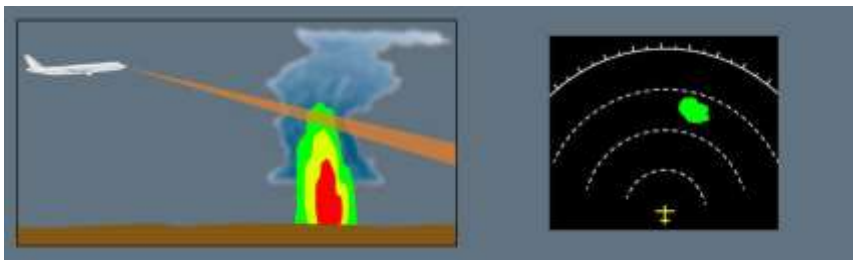
Note: Common practice is to ensure that the ground return is at the top of the ND screen.

Correct Storm Display



At high altitude, a storm cell may contain ice particles that have low reflectivity. If the tilt setting is not correct, the ND may display only the upper (less reflective) part of a storm cell (overscanning). As a result, the flight crew may underestimate or not detect a storm cell.

Overscanning



…

GENERAL RECOMMENDATION

In the case of the detection of a significant storm cell, the flight crew should apply the following recommendations:

- *To avoid a large and active storm cell, the flight crew must make a decision at a distance of 40 NM from the storm cell*
- *The flight crew should deviate upwind instead of downwind of a storm cell (there is less probability of turbulence or hail)*

- *For storm cell avoidance planning, the flight crew should consider the height of the storm cell* and apply the following:
  - *Avoid all yellow, red, or magenta areas by at least 20 NM*
  - *Avoid all green, yellow, red, and magenta areas of storm cells above 28 000 ft by at least 20 NM*
  - *The flight crew should consider storm cells above 35 000 ft as highly hazardous. Therefore the flight crew should apply an additional separation to the 20 NM already applied*
- *If the top of the storm cell is at or above 25 000 ft, the flight crew should not overfly, because the aircraft may encounter turbulence stronger than expected*
- *The flight crew should not attempt to enter a storm cell, or overfly its top by less than 5 000 ft, because the aircraft may encounter severe turbulence*
- *In addition, the flight crew should not fly under a storm cell, because the aircraft may encounter windshear, microbursts, severe turbulence, or hail*
- *The flight crew should avoid areas where attenuation is identified:*
  - *By radar attenuation effect*
  - *By the attenuation detection function of the radar*
- *For weather radars equipped with hazard prediction functions, avoidance of the detected weather always has priority over avoidance of the predicted hazards. The flight crew must apply standard storm avoidance recommendations in priority, and hazard areas should be avoided as much as possible. Refer to FCOM/DSC-34-60-30 Weather Hazard Prediction Function Indication on ND.*

The Airbus A330/340 Flight Crew Operation Manual (FCOM) chapter PRO-SUP-91-10 described:

GENERAL

When possible, the flight crew should plan to fly above or around areas of severe turbulence. If turbulence is unavoidable, aim to keep the speed in the region of the target speed given in this section, so as to provide the best protection against the effect of gust on the aircraft structure, whilst maintaining an adequate margin above VLS.

Sufficient buffet margin exists at optimum altitude. In order to further increase the margin to buffet onset, consider descending to a lower altitude.

Severe turbulence is defined as turbulence that causes large, abrupt changes in altitude and/or attitude. It usually causes large variations in airspeed.

Occupants are forced violently against their seat belts and loose objects will move around the aircraft.

If severe turbulence occurs during a flight, the flight crew must make a logbook entry in order to initiate maintenance action.

Note: Recommendations for severe turbulence are also applicable to extreme turbulence.

SIGNS

Before entering an area of known turbulence:

- *All loose equipment must be secured in the cockpit and in the cabin*
- *The flight crew must set the CABIN SIGNS to ON*

AUTOPILOT/AUTOTHRUST

Keep the autopilot ON.

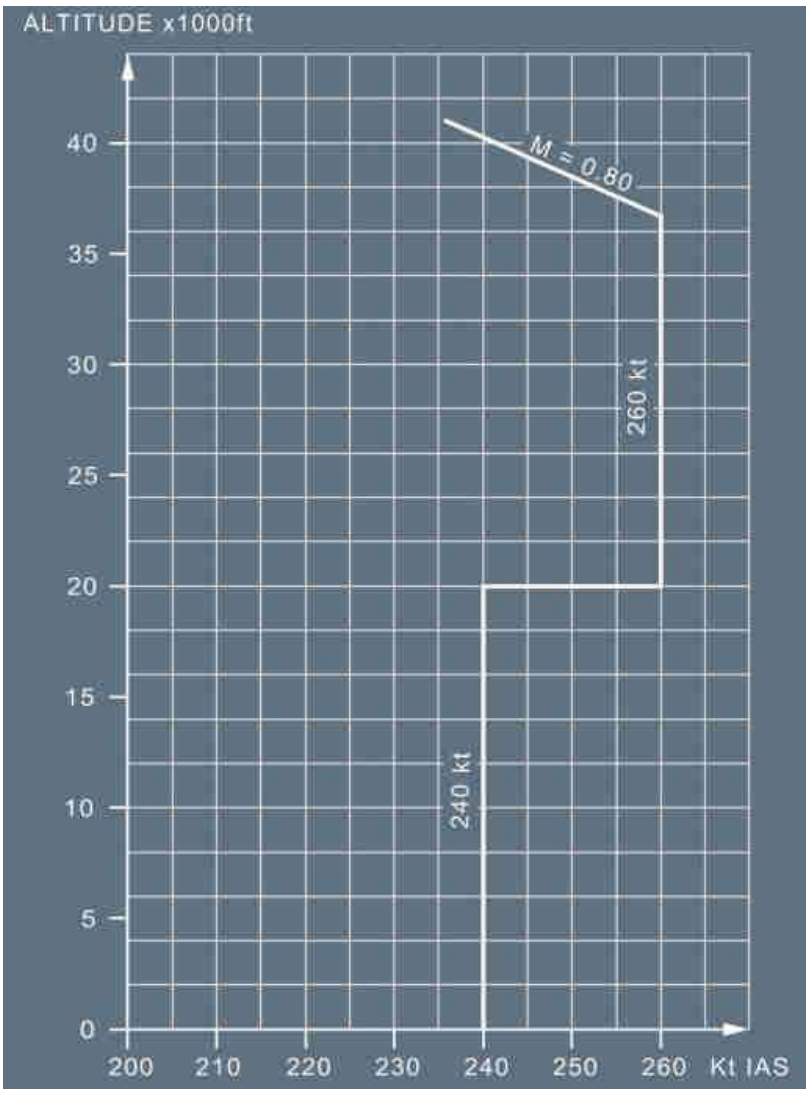
- *When thrust changes are excessive: Disconnect autothrust.*
- *For approach: Use autothrust for managed speed.*

THRUST AND AIRSPEED

Set the thrust to give the recommended speed (Refer to PRO-SUP-91-10 Thrust Setting For Recommended Speed). This thrust setting aims to obtain, in stabilized conditions, the speed for turbulence penetration given in the graph below.

Change thrust only in case of an extreme variation in airspeed, and do not chase your Mach or airspeed.

A transient increase is preferable to a loss of speed that decreases buffet margins and is difficult to recover.



THRUST SETTING FOR RECOMMENDED SPEED

FL	SPD or Mach	GROSS WEIGHT (1000 kg)												
		120	130	140	150	160	170	180	190	200	210	220	230	240
410	0.8	78.0	78.8	79.8	80.8	81.8	83.4	85.4	–	–	–	–	–	–
390	0.8	76.9	77.7	78.5	79.4	80.3	81.2	82.3	83.8	85.8	–	–	–	–
370	0.8	76.0	76.6	77.4	78.1	78.9	79.7	80.6	81.5	82.5	84.0	–	–	–
350	260	74.2	74.8	75.5	76.3	77.1	78.0	78.8	79.7	80.6	81.7	82.9	84.3	–
330	260	72.9	73.5	74.1	74.8	75.6	76.5	77.4	78.3	79.2	80.1	81.1	82.2	83.5
310	260	71.3	72.1	72.9	73.6	74.3	75.0	75.9	76.8	77.7	78.7	79.7	80.6	81.7
290	260	69.8	70.5	71.3	72.2	73.0	73.8	74.5	75.4	76.3	77.2	78.2	79.3	80.2
270	260	68.7	69.3	70.0	70.7	71.6	72.5	73.2	74.1	75.0	75.9	76.7	77.6	78.8
250	260	67.3	67.8	68.4	69.1	69.9	70.7	71.6	72.5	73.4	74.3	75.2	76.0	76.9
200	240	62.0	62.7	63.4	64.1	64.9	65.7	66.5	67.4	68.3	69.3	70.3	71.4	72.6
150	240	58.5	59.2	59.9	60.7	61.4	62.2	63.0	63.8	64.6	65.4	66.3	67.2	68.2
100	240	54.6	55.3	56.0	56.8	57.6	58.5	59.4	60.3	61.2	62.1	62.9	63.7	64.6
50	240	51.2	51.8	52.5	53.2	54.0	54.8	55.7	56.6	57.6	58.7	59.8	60.8	61.6

ALTITUDE

If the flight crew flies the aircraft manually:

- *The flight crew may expect large variations in altitude, but should not chase altitude*
- *The flight crew should consider descending to or below the OPT FL, in order to increase the margin to buffet.*

1.17.2 Use of Seatbelt Procedure

The OM-A subchapter 8.3.12.1 described the use of seatbelt procedure as follow:

During takeoff and landing, and whenever deemed necessary by the Commander in the interest of safety, each Crew Member shall be properly secured by all safety belts and harnesses provided. During other phases of the flight, each Flight Crew Member on the flight deck shall keep his safety belt fastened while at his station.

Before takeoff and landing, during taxi, and whenever deemed necessary in the interest of safety, the Commander shall ensure that each passenger on board occupies a seat or berth with his safety belt, or harness where provided, properly secured.

The Commander shall ensure that multiple occupancy of seats will only be allowed on specified seats, and that it does not occur other than by one adult and one infant who is properly secured by a supplementary loop belt or other restraint device.

Any occupant shall fasten his seat belt during takeoff & landing, en-route in case of turbulence, and as a general rule each time the SEAT BELT sign is illuminated.

Unless otherwise briefed by the PIC, the SEAT BELT sign does not indicate a requirement for Cabin Crew Members to be seated.

As long as the SEAT BELT signs are illuminated, Cabin Crew shall make frequent checks that passenger seat belts remain fastened.

Seat belt must be worn by all Crew Members and passengers under the following conditions:

- During takeoff
- During the approach & landing
- In turbulent conditions (see above)
- At the PIC's discretion or as required by abnormal or emergency procedures

When the seat belts must be fastened, each infant must be kept in the supplementary loop belt of the accompanying person or strapped in a dedicated restraining device.

The OM-E subchapter 9.1 also described the use of seatbelt procedure as follow:

The "Seat Belt" sign is controlled by the Captain to indicate that passengers are required to be seated and with their seat belts fastened.

Cabin Crew have to be alert to the signs so as to ensure passengers' compliance.

If the "Seat Belt" sign is found to be defective, crew shall make a P.A announcement to alert passengers of the defect and reinforce the importance of seat belt regulation compliance.

A cabin check is to be carried out by the crew normally to ensure all passengers are secured before take-off, descending and when any situations like turbulence or an emergency is declared.

All passenger seats are fitted with adjustable seat belts. Cabin Crew seats are further equipped with shoulder harness. Extension seat belts and child seat belts are also carried on board.

Seat belt and no smoking regulations must be observed and enforced as long as these signals are "ON" in the flight. Should passenger refuse to follow any of these regulations, Cabin Crew must report to the L1 crew and Captain has to be informed.

Passengers are to be seated until the "Seat Belt" sign has been turned OFF after take-off. The cabin crew will remain seated as well, unless otherwise advised by the Flight Crew.

1.17.3 Occupants Injury during Inflight

The OM-A subchapter 8.3.15.1 described incapacitation of a crew member (pilot and flight attendant) procedure as follow:

Incapacitation of a Crew Member is defined as any condition, which affects the health of a Crew Member during the performance of duties, which renders him incapable of performing the assigned duties either fully or partially.

…

In the event of injury or illness occurring to any Crew member in flight, the crew should assess whether to land at the nearest suitable airport where adequate medical facilities are available. In these circumstances, normal route and aerodrome competency requirements need not necessarily apply.

If crew incapacitation leads to the number of effective Crew members (Flight and Cabin Crew) falling below the minimum specified in the Operations Manual, an emergency shall be declared to ATC.

The OM-A subchapter 4.1.2 described the minimum number of pilots for Airbus A330 was two pilots and the subchapter 4.1.3.2 described the minimum number of cabin crew requirement for Airbus A330-200/300 was 8 flight attendants.

The OM-E subchapter 5.1 described procedure when passenger was injured during inflight as follows:

> *First aid is the immediate and temporary care given to the victim of an accident or sudden illness until the service of a physician can be obtained.*
>
> *Among the duties of a cabin crew, is to care for passengers suffering from illness and injury in-flight. While it is a decision of the Captain to decide whether an unscheduled landing is necessary to save the life of very sick and injured passenger, cabin crew should be equipped with the basic knowledge of first aid and the skills to comfort a suffering passenger.*

1.18 Additional Information

1.18.1 Thunderstorm Turbulence

According to the Advisory Circular (AC) number 120-881 published by the United States of America Federal Aviation Administration (FAA), a thunderstorm turbulence was described as turbulence associated within and in the vicinity of thunderstorms or cumulonimbus clouds. A cumulonimbus cloud with hanging protuberances is usually indicative of severe turbulence.

1.18.2 Investigation Process

Investigation involved Hong Kong Air Accident Investigation Authority (AAIA) that assigned accredited representative according to the ICAO Annex 13.

1.19 Useful or Effective Investigation Techniques

The investigation was conducted in accordance with the KNKT approved policies and procedures, and in accordance with the standards and recommended practices of Annex 13 to the Chicago Convention.

2 ANALYSIS

The investigation did not find any aircraft system abnormality prior to the occurrence. Therefore, the investigation did not consider aircraft system as a safety issue in this occurrence and the analysis will discuss the following relevant safety issues:

- In flight weather avoidance;
- Flight crew member action;
- Post turbulence encountered.

2.1 Inflight Weather Avoidance

The Airbus A330/340 Flight Crew Training Manual (FCTM) subchapter SI-070 required pilot to avoid large and active storm cell, and the avoidance planning should consider that the storm cells above 35,000 feet was highly hazardous where pilot must apply an additional separation to more than 20 Nm to the storm cell.

During climbing to FL410, the pilot requested to turn left on heading 325° for weather avoidance. After the aircraft had been maintained at FL410, the pilots started to see lightning near the flight track and noticed on the aircraft weather radar a clear path between two buildup cloud cells to the right of the flight direction. At 1825 UTC, the aircraft was turned to the right for another weather avoidance. The pilots recalled that the distance between those buildup cloud cells was approximately 40 up to 60 Nm, and considered the flight would have enough separation with the buildup cloud cells.

The FCTM subchapter SI-070 also described that due to the large vertical expansion, a storm cell does not have the same reflectivity depending on the altitude. The quantity of liquid water in the atmosphere decreases with the altitude and make the reflectivity of a storm cell also decreases. The FCTM then required pilot to be aware that the radar top was not the visible top of the storm cell, and the storm cell included the associated turbulence extend significantly above the radar top. In addition, at high altitude a storm cell may contain ice particles that have low reflectivity. If the tilt setting is not correct, an over scanning occurred and make the ND display only the upper (less reflective) part of a storm cell which can make pilot underestimate or not detect a storm cell.

Both pilots selected weather radar on their Navigation Displays (NDs), and the weather radar was operated in Weather and Turbulence modes. The range on the PM ND was 80 Nm, while on the PF ND was 40 Nm. After the aircraft turned to the right and flying between build up cells, about 1832 UTC, the PF zoomed the radar display from 40 Nm to 20 Nm and the setting of the weather radar used automatic and the tilt was selected at -0.8°. While flying between the buildup cloud cells, the magenta color displayed on the radar 5 Nm ahead of the aircraft. The PF decided to fly straight to the magenta area as shown on the radar considering that the buildup cloud cells were on the left and right of the aircraft track, thereafter the aircraft encountered severe turbulence for about one minute.

Considering the flight was at high altitude with a tilt angle selected to -0.8°, the encountered storm cell was most likely over scanned with the weather radar. Only the upper part of the encountered storm cell may have been displayed on the Navigation Display (ND) that may contain ice particles with a low reflectivity. It can make pilot underestimate or not detect a storm cell and underestimate the turbulence associated to the magenta cell.

The investigation was unable to retrieve satellite image when the turbulence occurred at 1834 UTC, however the satellite image at 1800 UTC and 2000 UTC indicated two buildup cumulonimbus clouds at particular area of turbulence occurred, and the distance between the buildup cumulonimbus indicated less than 30 Nm. The superimposed flight track from the FDR and the satellite images at 1800 UTC and 2000 UTC indicated that the aircraft was flying within the identified buildup cumulonimbus clouds when the turbulence occurred.

The encountered storm cell that was most likely over scanned by the weather radar tilt setting could make pilot underestimate or not detect a storm cell and underestimate the turbulence associated to the magenta cell displayed 5 Nm ahead of the aircraft.

2.2 Flight Crewmember Action

Prior to the departure, the pilot had reviewed the forecast weather chart which depicted significant clouds surrounding the planned route and decided to add fuel onboard to anticipate a flight diversion for weather avoidance. In the preflight briefing, the pilots advised flight attendants that the flight would encounter turbulence about one hour after departure in the preflight briefing. The pilot also made public announcement that the flight would encounter turbulence and reminded to fasten the seatbelt when the fastened seatbelt sign was on. Those efforts indicated that the pilot had expected the flight would encounter turbulence.

The Hong Kong Airlines Operations Manual-A (OM-A) subchapter 8.3.9.6.1 described a good communication with cabin crew and passenger was a vital strategy to avoid potential harm from expected or encountered turbulence. The flight attendant should be pre-warned prior to entering the expected turbulence area. The PIC also required to brief the flight attendant on the expected level of turbulence and duration, and advised passenger to return to, and/or remain seated and to ensure that their seat belts are securely fastened.

The OM-A subchapter 8.3.9.6.3 described that when light turbulence occurred, the flight crew must switch ON the seat belt sign. If the turbulence become moderate or severe, PIC must make several actions included a cycle once and remain “ON” the seat belt sign, make a Public Announcement “Cabin Crew be seated”, and inform the Senior Cabin Crew Member (SCCM) of the anticipated duration and severity of turbulence. Following the PIC sign of moderate or severe turbulence, the flight attendant shall make turbulence PA, stop service, seated and hold if necessary, and set the carts brake at present position.

The subchapter 8.3.9.6.1 also described that unless otherwise briefed by PIC, seatbelt sign ON did not indicate a requirement for flight attendants to be seated. In addition, when the sign was ON, flight attendants must make frequent checks that passenger seat belts remain fastened.

After the aircraft was maintained at FL410, the pilot turned the seatbelt signs to ON position, thereafter the flight attendants conducted cabin check and made passenger announcement for ensuring the passenger remained seated and fastened their seatbelt. However, the sign did not indicate the requirement of the flight attendant to be seated, as the seatbelt sign ON did not cycle once nor any PIC command "Cabin Crew be seated".

While flying between the buildup cloud cells, the pilots were aware that the flight encountered light turbulence and had identified magenta color displayed on the aircraft radar display about 5 Nm ahead. Considering that the buildup cloud cells were on the left and right of the aircraft track, the SIC decided to penetrate the magenta area as shown on the radar, however, there was no pre-warned to the flight attendant prior to enter the area with turbulence possibility, and due to the large abrupt changes of aircraft altitude the pilot was unable to press the Public Announcement button to advise the flight attendant during the turbulence.

The Airbus A330/340 Flight Crew Operation Manual (FCOM) chapter PRO-SUP-91-10 general required the pilot to keep the auto pilot engaged when entering the turbulence.

At 18:34:43 UTC, the autopilot was involuntary disengaged. This was because a large Angle of Attack (AoA) excursion as result of the aircraft encountering updraft gust about 7,000 fpm following with several transient AoA excursions beyond AoA protection threshold lasting around two seconds.

The large of AoA excursion which resulting a large abrupt change in airspeed, attitude and vertical speed caused the two food carts in the aft galley and several occupants were lifted and hit the ceiling then fell back on the floor several times. Those indicated that the aircraft was encountering severe turbulence, where according to the OM-A subchapter 8.3.9.6.2, the flight attendant required to make public announcement of the turbulence, set cart brakes in present position, stop the service, sit down and hold on if required.

The absence of the turbulence encounters pre-warned from the pilot resulted in the flight attendants did not prepare to secure the carts nor to be seated with fastened seatbelt, which then injured the flight attendants.

The flight attendants had conducted cabin check and made passenger announcement for ensuring the passenger remained seated and fastened their seatbelt after the seatbelt sign was turned to ON position. However, during the severe turbulence several passengers were injured as their seatbelts were not properly fastened. The improper fastened of the passenger seatbelt increased the severity of the passenger injury despite the flight crew had ensured the passenger to fasten their seatbelt.

2.3 Post Turbulence Encountered

The OM-A subchapter 8.3.15.1 described incapacitation of a crew member (pilot and flight attendant) as any condition, which affects the health of a crew member during the performance of duties, which renders him incapable of performing the assigned duties either fully or partially. The subchapter also described in the event of injury or illness occurring to any crew member in flight, the pilot or flight attendant should assess whether to land at the nearest suitable airport where adequate medical facilities are available. If the crew incapacitation leads to the number of the effective flight attendant below the minimum specified in the Operations Manual, which for this aircraft type was 8 flight attendants, an emergency shall be declared to air traffic controllers.

About three minutes after the turbulence, the PIC instructed the SCCM performed assessment to the condition of the occupants. Then the SCCM reported to the pilots that there were two flight attendants were seriously injured and several passengers were injured. The SCCM could not determine whether the injured occupants required immediate medical treatment, however the injured occupants felt severe pain. Thereafter, the PIC decided to return to Bali after considering that the injured occupants might need further medical treatment. The decision to return to Bali was in accordance with the requirement of the OM-A to land at the nearest suitable airport where adequate medical facilities are available.

About 15 minutes after the turbulence, the SCCM came to the aft galley and assisted to clear the galley. The uninjured flight attendants treated the three injured flight attendants and passengers using the first aid kit. An uninjured flight attendant announced of seeking medical assistance from qualified medical personnel among the passengers, and there were no qualified medical personnel on board. The pilot had advised to the IOCC to prepare medical assistance upon arrival at Bali. In addition, the ACC controller after being advised the occurrence from the pilot also had communicated with the APP controller for preparing the medical assistance.

The pilot advised the SCCM to assess the injured occupant using MedLink assessment form. After receiving the assessment form, the PIC contacted the MedLink and the medical assessment considered that the injury of the occupants was minor. The pilots also assessed that the aircraft condition remained normal with enough fuel. Those conditions made the pilots considering that declaration emergency was not necessary.

The information of the injured occupants provided to the ground personnel including the air traffic controller (ACC) by the pilot after the decision to return, resulted in the medical assistance had prepared upon arrival at Bali. The ambulances and paramedics have been ready for about 30 minutes prior the estimated arrival time of the aircraft. The paramedics taken care and evacuated the injured occupants to the airport medical facility by ambulances. Several injured occupants were transferred to the nearest hospital for further medical treatment.

3 CONCLUSION

3.1 Finding

The findings are statements of all significant conditions, events or circumstances in the accident sequence. The findings are significant steps in the accident sequence, but they are not always causal, or indicate deficiencies. Some findings point out the conditions that pre-existed the accident sequence, but they are usually essential to the understanding of the occurrence, usually in chronological order.

In this occurrence, the KNKT identified several findings as follows:

1. The aircraft had valid Certificate of Airworthiness and prior to the departure there was no record or report of aircraft system malfunction.
2. The pilots and flight attendants held valid licenses and medical certificates.
3. Prior to the departure, the pilot had reviewed the forecast weather chart and aware that the flight would enter turbulence area. The pilot conducted anticipative actions including added fuel onboard to anticipate weather avoidance, briefed the flight attendants and made the public announcement to the passengers.
4. The Hong Kong Airlines Operations Manual-A (OM-A) described a good communication from pilot to flight attendant and passenger was a vital strategy to avoid potential harm from expected or encountered turbulence. The flight attendant should be pre-warned prior to entering the expected turbulence area. The Pilot in Command also required to brief the flight attendant on the expected level of turbulence and duration, and advised passenger to return to, and/or remain seated and to ensure that their seat belts are securely fastened.
5. The Hong Kong Airlines OM-A described when light turbulence occurred, the flight crew must switch ON the seat belt sign. If the turbulence become moderate or severe, PIC must make several actions included a cycle once and remain "ON" the seat belt sign, make a Public Announcement "Cabin Crew be seated", and inform the Senior Cabin Crew Member (SCCM) of the anticipated duration and severity of turbulence. Following the PIC sign of moderate or severe turbulence, the flight attendant shall make turbulence PA, stop service, seated and hold if necessary, and set the cart brake at present position.
6. After the aircraft was maintained at FL410, the pilot turned the seatbelt signs to ON position, thereafter the flight attendants conducted cabin check and made passenger announcement for ensuring the passenger remained seated and fastened their seatbelt. However, the sign did not indicate the requirement of the flight attendant to be seated, as the seatbelt sign ON did not cycle once nor any PIC command "Cabin Crew be seated".
7. The pilots noticed on the aircraft weather radar, a clear path between two buildup cloud cells to the right of the flight direction. The distance between those buildup cloud cells was approximately 40 up to 60 Nm and considered the flight would have enough separation with the buildup cloud cells. At 1825 UTC the aircraft was turned to the right.

8. While flying between the buildup cloud cells, the flight encountered light turbulence and the pilots started to see magenta color displayed on the aircraft radar display about 5 Nm ahead. The SIC decided to fly straight considering that the buildup cloud cells were on the left and right of the aircraft track.
9. When the flight was about to penetrate the magenta area, and the light turbulence occurred, there was no pre-warned to the flight attendant. Afterward the flight entered severe turbulence and due to the large abrupt changes of aircraft altitude the pilot was unable to press the Public Announcement button to advise the flight attendant.
10. The superimposed flight track from the FDR and the satellite images at 1800 UTC and 2000 UTC indicated that the aircraft was flying within the identified buildup cumulonimbus clouds when the turbulence occurred.
11. The Airbus A330/340 Flight Crew Training Manual (FCTM) required pilot to avoid large and active storm cell. The avoidance planning should consider that the storm cells above 35,000 feet was highly hazardous and pilot must apply an additional separation more than 20 Nm to the storm cell.
12. The encountered storm cell was most likely over scanned by the weather radar with a tilt angle selected to -0.8°. It can make pilot underestimate or not detect a storm cell and underestimate the turbulence associated to the magenta cell displayed 5 NM ahead of the aircraft.
13. At 18:34:39 UTC, the flight encountered severe turbulence for about 1 minute. At 18:34:43 UTC, the autopilot involuntary disengaged. This was because a large Angle of Attack (AoA) excursion as result of the aircraft encountering updraft gust about 7,000 fpm following with several transient AoA excursions beyond AoA protection threshold lasting around two seconds.
14. The severe turbulence occurred when the flight attendants were clearing up of the food carts in the aft galley and caused the two food carts in the aft galley and several occupants were lifted and hit the ceiling then fell back on the floor.
15. During the severe turbulence, the OM-A requires the flight attendant to make public announcement of the turbulence, set cart brakes in present position, stop the service, sit down and hold on if required.
16. The turbulence caused 3 flight attendants and 12 passengers were minorly injured.
17. The absence of the turbulence encounters pre-warned from the pilot resulted in the flight attendants did not prepare to secure the carts nor to be seated with fastened seatbelt.
18. The flight attendants had conducted a cabin check and made passenger announcement for ensuring the passenger remained seated and fastened their seatbelt after the seatbelt sign was turned ON. However, during the severe turbulence several passengers were injured as their seatbelts were not properly fastened.

19. The improper fastened of the passenger seatbelts increased the severity of the passenger injury despite the flight crew had ensured the passenger to fasten their seatbelts. The improper fastened of the passenger seatbelt increased the severity of the passenger injury despite the flight crew had ensured the passenger to fasten their seatbelt.
20. After the turbulence, the SCCM reported to the pilots that two flight attendants were seriously injured and several passengers were injured. The SCCM could not determine whether the injured occupants required immediate medical treatment, however the injured occupants felt severe pain.
21. The PIC decided to return to Bali after considering that the injured occupants might need further medical treatment. The decision to return to Bali was in accordance with the requirement of the OM-A to land at the nearest suitable airport where adequate medical facilities are available.
22. The pilot advised the SCCM to assess the injured occupant using MedLink assessment form. After receiving the assessment form, the PIC contacted the MedLink and the medical assessment considered that the injury of the occupants was minor. The pilots also assessed that the aircraft condition remained normal with enough fuel. Those conditions made the pilots considering that declaration emergency was not necessary.
23. The information of the injured occupants provided to the ground personnel including the air traffic controller (ACC) by the pilot after the decision to return, resulted in the medical assistance had prepared upon arrival at Bali.
24. The ambulances and paramedics have been ready for about 30 minutes prior the estimated arrival time of the aircraft. The paramedics taken care and evacuated the injured occupants to the airport medical facility by ambulances. Several injured occupants were transferred to the nearest hospital for further medical treatment.

3.2 Contributing Factors

Contributing factors is defined as actions, omissions, events, conditions, or a combination thereof, which, if eliminated, avoided or absent, would have reduced the probability of the accident or incident occurring, or mitigated the severity of the consequences of the accident or incident.

The identification of contributing factors does not imply the assignment of fault or the determination of administrative, civil or criminal liability. The presentation of the contributing factors is based on chronological order and not to show the degree of contribution.

The KNKT concluded the contributing factors are as follows:

- The encountered storm cell that was most likely over scanned by the weather radar could make pilot underestimate or not detect a storm cell and underestimate the turbulence associated to the magenta cell displayed 5 Nm ahead of the aircraft.
- The absence of the turbulence encounters pre-warned resulted in the flight attendants did not prepare to secure the carts nor to be seated with fastened seatbelt.
- The improper fastened of the passenger seatbelt increased the severity of the passenger injury despite the flight crew had ensured the passenger to fasten their seatbelt.

4 SAFETY ACTION

At the time of issuing this report, the Komite Nasional Keselamatan Transportasi (KNKT) had been informed safety action taken by the aircraft operator, as follows

1. Conducted Safety Theme of turbulence awareness in May (after the occurrence) and June 2016
2. On 12 May 2016, issued Cabin Crew Notice which highlighted to maintain high alert for turbulence during flight.
3. On 26 September 2016, provided guidance material of the Multiscan WXR-2100 weather radar to all pilots, and in May 2017 published operational overview document of the weather radar usage and weather identification for all pilots.
4. On 5 June 2017, introduced Weather on Board (WOB), an application which can be used as decision-making tool for pilot to assist the perception and understanding of observed meteorological phenomena.
5. Since 2017, several reminders related to turbulence encounter events have been issued to flight attendants which included numerous safety enhancement campaigns.
6. In 2019, developed a turbulence working group which review policies, procedures and industry best practices related to turbulence encounters and injuries, in order to identify areas for potential improvements.
7. In 2020, enhanced the significant weather report monitored by IOCC, including to provide pilot with turbulence information via Aircraft Communication Addressing and Reporting System (ACARS) during inflight.

5 SAFETY RECOMMENDATIONS

The KNKT acknowledged the safety actions taken by the aircraft operator and considered that the safety actions were relevant to improve safety. Therefore, KNKT did not issue safety recommendations in this report.

6 APPENDICES

6.1 Cabin Crew Notice

HONGKONG AIRLINES
香港航空

FOR INTERNAL DISTRIBUTION ONLY

CABIN CREW NOTICE – Safety reminder		
Reference Code	**Subject**	**Date Issued**
CCN 16047	**Turbulence Reminder**	**12 May 2016**

Effective Date: 12 May 2016
Aircraft Type: All
Crew Category: All cabin crew

Background:
For preparing the high season of typhoon/ thunderstorm in the summer time, cabin crew should maintain high alert for the turbulence during the flight.
Recently, we have experienced Severe Turbulence and Clear Air Turbulence (CAT) causing cabin crew and passengers injuries.

Safety Reminders/ Details:
For your own and passengers' safety, it should be reminded the following safety information/ details before flight.

1. Good communication with cabin crew and passenger is a vital strategy to avoid potential harm from expected or encountered turbulence. If the weather conditions and route forecast indicate that turbulence is likely, the Cabin Crew should be pre-warned prior to entering the expected turbulence area. PIC shall brief the cabin crew on **the expected level of turbulence** and **duration** and advised passenger to return to, and/or remain seated and to ensure that their **seat belts are securely fastened**. (OM-E 9.2.1)
2. Catering and other loose equipment should be **stowed and secured** until it is evident that the risk of further turbulence has passed.

Page **1** of **5**

3. The crew actions regarding different Types of Turbulence has been shown as below table:

9.2.2 Type of Turbulence and Crew Actions (OM-A 8.3)

Turbulence Classification / Crew Actions
Classification of intensity may be defined as follows. Crew actions in the event of turbulence should be as indicated.

Intensity/ Code	A/C Response	Cabin Situation	Crew Actions prior or in turbulence
Light Chop (1)	No significant change in attitude or altitude.	Occupants may feel strain against seat belt; liquids shake but do not splash out of containers.	**Flight Crew**: 1) Seat belt sign "ON" for light turbulence. **Cabin Crew**: 1) Turbulence PA. 2) Check passenger seat belts fastened. 3) Secure loose galley equipment. Continue service with caution but no hot beverage.
Light Turbulence (2)	Slight changes in attitude or altitude of short duration.	Walking can be difficult, liquids shake but do not splash out of containers.	
Moderate Chop (3)	Rapid bumps or jolts, but no significant change in attitude or altitude.	Occupants feel definite strain against seat belt. Loose objects move about; liquid splashes from cups. Very difficult to walk.	**Flight Crew**: 1) **Seat belt** sign "cycle once" and remain "**ON**". 2) PA Command; **"cabin crew be seated".** 3) Turbulence PA if time permits **Cabin Crew:** 1) Turbulence PA. 2) Stop service. Sit down and hold on if required. 3) Set cart brakes in present position, (*) Inspect cabin damage after turbulence.
Moderate Turbulence (4)	Changes in airspeed, attitude or altitude occur, but control is normal.		
Severe Turbulence (5) intentional flight prohibited	Large, abrupt changes in airspeed, attitude or altitude occur. Airplane may be briefly out of control. TLB write-up required.	Occupants forced against seat belts. Loose objects tossed about cabin or lifted from floor. Walking is impossible without holding on to something.	
Extreme Turbulence (6) Intentional flight prohibited.	Airplane tossed violently about; control is practically impossible. May cause structural damage. TLB write-up required.		

4. For the period of meal and hot beverage service, cabin crew are advised to maintain good communication with cockpit crew regarding turbulence, route and weather information with the consideration of service-time-management. According to the cockpit information, CIC shall provide **service flexibility** and appropriate arrangement to avoid potential harm from expected or encountered turbulence. The main objective is to reduce the risk of crew members and/or passengers injury during turbulence. If significant weather or turbulence is expected, CIC is to use his/ her discretion to shorten the service. For any feedbacks/ difficulties regarding service procedure alternation/ cancelation, CIC should **make a note on flight report** accordingly.

5. Section Leaders should be able to determine if there is a need to suspend service and instruct crew members to secure themselves i.e. take the nearest seats if the cabin movement is too great to continue with the service. Cabin crew should always take extra precaution, secure themselves on the nearest seat and hold on to the strong points in the cabin such as the **overhead handrail, armrest** etc. Keep SP/ FP informed of the situation in your area whenever possible.

6. For the cabin crew **Pre-Flight Briefing at ABO**, CIC are advised to ask **at least ONE** safety question regarding turbulence. Kindly find the following Turbulence related safety questions as a reference:

Pre-flight Safety Question on Jan 2016:

Q1. Please state Cabin Crew actions prior or in turbulence under Light Chop/ Light Turbulence are:

Ans. :

•Turbulence PA
•Check passenger seat belts fastened
•Secure loose galley equipment. Continue service with caution but no hot beverage

Q3. In the middle of the flight or during cruising attitude. Please state the indication if seat belt sign turns "ON".

Ans.:

Light turbulence/Light Chop.

Q4. The PA command and Signal Cabin Crew will receive under Moderate/ Severe Turbulence are:

Ans. :

• Seat belt sign "cycle once" and remain "ON"
• PA: "Cabin Crew be seated"
• Turbulence PA if time permits

Q9. Cabin Crew actions prior or in turbulence under Moderate/ Severe Turbulence are:

Ans. :

•Turbulence PA
•Stop service. Sit down and hold on if required.
•Set cart brakes in present position

7. When turbulence encountered:
   i. Assess the bumpiness of the flight
   ii. Make PA to alert passengers
   iii. Check the cabin and lavatories to ensure all passengers strapped in if situation allows
   iv. Cabin crew is suggested to use the handrail under the overhead locker when performing the cabin checks
   v. Secure yourself by grasp hold the handle in the galley
   vi. Ensure overhead locker and galley equipment secure
   vii. Do not handle / serve hot beverage during turbulence
   viii. If necessary, stop all service, take the nearest seat and fasten seat belt as soon as possible
   ix. Crew should not leave any food cart and service cart unattended during flight. Stow carts and service equipment if situation allows.
   x. If the cabin condition becomes vigorous (i.e. Severe Turbulence or Clear Air Turbulence), cabin crew shall take appropriate action to protect yourself first, take any available seat nearby and secure yourself as soon as possible.