AIRCRAFT ACCIDENT REPORT 1/2005

ACCIDENT INVESTIGATION DIVISION

Civil Aviation Department
Hong Kong

Report on the accident to
Airbus A330-342 B-HYA
Within the Manila Flight Information Region
on 18 July 2003

Hong Kong
May 2005

民航處 **Civil Aviation Department**

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May 2005

The Chief Executive
Chief Executive's Office
5/F., Main Wing
Central Government Offices
Lower Albert Road
Hong Kong

Sir,

In accordance with regulation 10(6) of the Hong Kong Civil Aviation (Investigation of Accidents) Regulations, I have the honour to submit the report by Mr. Colman S.C. NG, an Inspector of Accidents, on the circumstances of the accident to an Airbus A330-342 aircraft, registration B-HYA, which occurred within the Manila Flight Information Region on 18 July 2003.

Yours faithfully,

(Norman S.M. LO)
Director-General of Civil Aviation

Contents Page

GLOSSARY

α	Angle of attack
α_{prot}	Angle of attack protection flight control law
°	Degree(s)
°M	Degree(s) Magnetic
AP	Autopilot
ATC	Air Traffic Control
ATPL	Airline Transport Pilot Licence
CAD	Civil Aviation Department
CB	Cumulonimbus Cloud
cm	Centimetres
CP	Chief Purser
CPL	Commercial Pilot Licence
CRM	Crew Resource Management
CVR	Cockpit Voice Recorder
DFDR	Digital Flight Data Recorder
ECAM	Electronic Centralized Aircraft Monitoring
FCOM	Flight Crew Operating Manual
FIR	Flight Information Region
FL	Flight Level
FLT	Flight
FMS	Flight Management System
FSBS	Fasten Seat Belt Signs
GOES-9	Geostationary Operational Environmental Satellite-9
HKIA	Hong Kong International Airport
IMC	Instrument Meteorological Conditions
JMA	Japan Meteorological Agency
M	Mach Number
MAC	Mean Aerodynamic Chord
MB	Megabyte
METAR	Aviation Routine Weather Report
MHz	Megahertz
Mmo	Maximum Operating Mach Number

MO	Magneto-Optical
MOD	Moderate
ND	Navigation Display
NEDIS	National Environmental Satellite Data and Information Service
NM	Nautical Miles
PA	Public Address
PF	Pilot Flying
PIC	Pilot-in-Command
PN	Part Number
PNF	Pilot Not Flying
QAR	Quick Access Recorder
QRH	Quick Reference Handbook
SEV	Severe
SIGMET	Significant Meteorological Warning
SOP	Standard Operating Procedure
SP	Senior Purser
TAF	Aerodrome Forecast
Turb	Turbulence
US NOAA	United States National Oceanic and Atmospheric Administration
UTC	Universal Time Co-ordinated
VHF	Very High Frequency
Vls	Lowest Selectable Speed
Vmo	Maximum Operating Speed
Wx	Weather
WAFC	World Area Forecast Centre

ACCIDENT INVESTIGATION DIVISION

CIVIL AVIATION DEPARTMENT

Aircraft Accident Report

Operator	:	Hong Kong Dragon Airlines Limited
Aircraft Type	:	Airbus A330-342
Registration	:	B-HYA
Flight Number	:	HDA060
Place of Accident	:	14 NM north-northeast of Reporting Point NOBEN within Manila FIR Latitude: 13° 00' N Longitude: 116° 51.3' E Flight Level 410
Date and Time	:	18 July 2003 at 0510 UTC (daylight)

All times in this report are in UTC.

SYNOPSIS

On 18 July 2003, a passenger flight, HDA060, was enroute from Kota Kinabalu to Hong Kong along Route M754 within the Manila FIR cruising at Flight Level (FL) 410. Prompted by weather returns displayed on the weather radar, the flight crew requested permission from Air Traffic Control (ATC) in Manila to deviate right of track to avoid weather. Soon after commencement of the track deviation, the aircraft encountered severe turbulence[1]. At the time of the occurrence, the Fasten Seat Belt Signs (FSBS) were selected ON and all

[1] Severe turbulence is described as conditions in which abrupt changes in aircraft attitude and/or altitude occur, aircraft may be out of control for short periods and usually with large variation in airspeed. Changes in accelerometer reading greater than 1.0 'G' at the aircraft's centre of gravity. Occupants are forced violently against seat belts. Loose objects are tossed about. (Ref. ICAO PANS-ATM Doc 4444)

passengers were seated with their seat belts fastened. However, as the cabin crew were serving meals along the aisles and galley areas they were not strapped in. Based on the Digital Flight Data Recorder (DFDR) data, during the turbulence encounter, the cruising level varied between FL 408 and FL 416. The aircraft experienced a rapid sequence of jolts that resulted in various degrees of injuries to all twelve cabin crew members. Of the 236 passengers on board, three sustained minor injuries.

The accident occurred within the Manila Flight Information Region (FIR) where a tropical depression had just moved to an area over the sea to the west of the Philippines, moving on a track of west-northwest and was forecast to intensify over water. At the time of the accident, the aircraft was deviating 6 NM to the right of Route M754 northbound at a position approximately 160 NM to the west-northwest of the centre of the tropical depression.

After the accident, the aircraft was promptly accorded priority landing at Hong Kong. It subsequently landed safely at Hong Kong International Airport (HKIA).

As the occurrence resulted in serious injuries, in the form of bone fractures, to persons on board, it was classified as an aircraft accident. The Chief Inspector of Accidents therefore ordered an Inspector's Investigation be carried out in accordance with the Hong Kong Civil Aviation (Investigation of Accidents) Regulations 1983.

The investigation concluded that the aircraft inadvertently flew into an area of turbulent weather caused by strong convective activity associated with the tropical depression. Based on the evidence as to the way in which the weather radar was operated, it was highly probable that the flight crew were not presented with the optimum weather radar picture that would have enabled a full appreciation of the intensity and extent of the weather in the vicinity of the aircraft. As a result, the deviation around weather was not initiated early enough, nor was the deviation large enough to avoid the weather.

1. FACTUAL INFORMATION

1.1. History of the Flight

1.1.1. On 18 July 2003, a Hong Kong Dragon Airlines Airbus A330-342 aircraft Registration B-HYA, was operated on a flight from Hong Kong to Kota Kinabalu and returned on the same day. The flight crew reported for duty at 2245 UTC on 17 July 2003 at the HKIA. After an uneventful flight to Kota Kinabalu, the aircraft, together with the same crew, departed Kota Kinabalu at 0412 for Hong Kong with a flight number of HDA060.

1.1.2. The weather conditions at the time were influenced by a Tropical Depression 'Koni' situated over the sea 170 NM southwest of Manila, moving west-northwest at 10 knots. Isolated and embedded cumulonimbus clouds (CB) with cloud tops of FL 450, associated with moderate or severe turbulence, were forecast within 200 NM of the centre of the Tropical Depression. The aircraft was tracking along Route M754 north bound (Area Route Chart is given in Appendix 1) and would route through the extensive cloud area associated with the Tropical Depression.

1.1.3. The aircraft was initially cleared to cruise at FL 370. Later on, the flight crew requested and received approval to cruise at FL 410.

Prior to NOBEN, with yellow and green weather returns observed on the radar, they requested permission from Manila ATC to deviate 10 NM to the right of track for weather avoidance. At 0510, shortly after commencing track deviation, the aircraft encountered severe turbulence. (Appendix 2 depicts the aircraft track at around the time of the turbulence encounter.)

1.1.4. The DFDR data showed that immediately before the turbulence encounter, the aircraft was cruising at an indicated Mach Number (M) 0.81. During the turbulence encounter, the speed increased beyond M 0.86. The Maximum Operating Speed/Maximum Operating Mach Number (Vmo/Mmo) overspeed warning was triggered and the Autopilot disconnected. The flight level recorded by the DFDR varied between FL 408 and FL 416.

1.1.5. At the time of the turbulence encounter, the cabin attendants were serving meals to the passengers. They were thrown into the air, some hitting their heads on the ceiling panels before falling back onto the cabin floor, causing various degrees of injuries to all twelve cabin attendants.

1.1.6. The flight crew reported the severe turbulence encounter to Manila ATC immediately after the occurrence. Both the Co-pilot and the Pilot-in-Command (PIC) subsequently inspected the cabin. The PIC conferred with a doctor, who was on board the aircraft as one of the passengers, before deciding to continue the flight to Hong Kong. Hong Kong ATC arranged for its priority landing and alerted the emergency units to meet the aircraft on arrival. The aircraft landed at Hong Kong International Airport at 0637.

1.1.7. The flight crew remained on the flight deck for approximately 23 minutes after parking the aircraft. During this time, the PIC completed an entry in the Technical Log concerning the encounter with severe turbulence. The flight crew left the cockpit at 0704 to check on the conditions in the cabin. After visiting the cabin and on being informed that all cabin crew would be sent to hospital for treatment or observation, the PIC designated a manager to oversee ground support and left the aircraft at approximately 0720 for the office, as instructed by the company.

1.2. Injuries to Persons

Injuries	Crew	Passenger	Other
Fatal	0	0	-
Serious	2	0	-
Minor	10	3	-
None	3	233	-

1.3. Damage to Aircraft

1.3.1. Post flight inspection revealed that the accident did not cause any damage to the primary structure of the aircraft. However, there was minor damage to the interior fittings within the aircraft cabin area, most of which being aft of Door 2 in the Economy Class compartment. Two aft galley ceiling light covers and one window light cover above Seat 42A were damaged as a result of impact with meal trays and other galley equipment. The ceiling panel covering the crew oxygen masks near Door 4L came off due to impact with loose objects, resulting in two oxygen masks falling off from the ceiling panel. The curtain rail in the vicinity of Door 4L was broken and came off at one end.

1.3.2. The sudden jolts experienced inside the cabin were indicated by excursions of vertical acceleration in the positive (+) and negative (-) sense recorded by the DFDR. The maximum vertical acceleration encountered was + 1.89 'G' during the first gust, while during the second gust the acceleration reached a maximum of + 1.27 'G' and a minimum of – 0.52 'G'. These excursions occurred over a period of 17 seconds. An engineering inspection was carried out after landing and revealed no structural damage to the aircraft. (Appendix 3 shows the DFDR Data Plot during the period of turbulence encounter.)

1.3.3. All overhead stowages remained securely latched throughout the period of the turbulence and the contents were safely contained. However, a significant amount of debris such as meal trays, food and beverage, crockery and broken glass was scattered over the cabin floor. Cabin crew started to clean up the cabin while the aircraft was still in flight and covered the debris and broken glass with blankets to minimize the hazard to persons on board.

1.3.4. The Maintenance Post Flight Report revealed that the "AUTO FLT AP OFF" ECAM (Electronic Centralized Aircraft Monitoring) warning, indicating disconnection of the Autopilot, was triggered at 0511. At this time, the aircraft experienced the maximum 'G' force of +1.89 and a speed in excess of M 0.86, which is the Mmo.

1.3.5. After landing, a special maintenance inspection on the aircraft, namely "Inspection after Flight in Excessive Turbulence or in Excess of Vmo/Mmo", was carried out in accordance with the Airbus Aircraft Maintenance Manual Task 05-51-17-200-001. On satisfactory completion of the inspection, the aircraft returned to service the same evening.

1.4. Other Damage

There was no other damage to the aircraft or personnel on the ground.

1.5. Personnel Information

1.5.1. Flight Crew

1.5.1.1 Pilot-in-Command	:	Male, aged 55
Licence	:	HK ATPL issued on 21 June 1989
Aircraft Rating	:	A330 renewed on 23 June 2003 and valid until 22 December 2003

Instrument Rating	:	A330 renewed on 23 June 2003 and valid until 22 July 2004
Medical Certificate	:	Class One – renewed on 25 April 2003 and valid until 31 October 2003
Date of Last Proficiency Check	:	23 June 2003
Date of Last Line Check	:	10 December 2002
Date of Last Emergency Training	:	22 November 2002
Date of Last CRM Training	:	27 July 1998

Flying Experience

Total all types	:17036 hours
Total on type	:4025 hours
Total in last 28 days	:38 hours
Total in last 7 days	:12 hours
Total in last 24 hours	:4.5 hours

Rest Period Prior to Duty :14 hours

1.5.1.2 Co-pilot : Male, aged 23

Licence	:	HK CPL issued on 18 March 2003
Aircraft Rating	:	A330 renewed on 16 March 2003 and valid until 15 September 2003
Instrument Rating	:	A330 renewed on 8 March 2003 and valid until 7 April 2004
Medical Certificate	:	Class One – renewed on 27 December 2002 and valid until 30 November 2003
Date of Last Proficiency Check	:	9 March 2003
Date of Last Line Check	:	5 June 2003
Date of Last Emergency Training	:	10 January 2003
Date of Last CRM Training	:	Not been trained

Flying Experience

Total all types	:	1437 hours
Total on type	:	213 hours

Total in last 28 days	:	36 hours
Total in last 7 days	:	15 hours
Total in last 24 hours	:	7.5 hours
Rest Period Prior to Duty	:	16.5 hours

1.5.1.3 The pilots were properly licensed and qualified to operate the flight. There was no record of any pre-existing medical or behavioural conditions that might have adversely affected the flight crew's performance during the flight.

1.5.2. Cabin Crew

There were 12 cabin crew members, comprising a Chief Purser (CP), a Senior Purser (SP), a Supernumerary In-flight Service Manager who was on board to observe the standards of cabin service of the flight, and nine other cabin attendants. They had been provided with adequate rest prior to the flight. Their Annual Emergency Procedures training and Smoke and Fire Drills were valid. Additionally, a riding engineer, who performed ground engineering duties at Kota Kinabalu, was on board.

1.6. Aircraft Information

1.6.1. Aircraft Particulars

Manufacturer	:	Airbus, Toulouse, France
Aircraft type	:	A330-342
Constructor's serial number	:	98
Year of manufacture	:	1995
Certificate of Registration	:	No. 403 issued on 17 May 2001
Certificate of Airworthiness	:	No. 269-6, valid from 22 May 2003 to 21 May 2004 in Transport Category (Passenger)
Certificate of Maintenance Review	:	Valid from 7 May 2003 to 21 May 2004
Total airframe hours and landings	:	19141 hours; 10298 landings

1.6.2. Maintenance History

The last major maintenance was a combination of 2C and 4A Checks that were carried out in December 2002. Special maintenance work on the aircraft had been carried out in June 2003 for pylon modification with both engines removed and the completion of Armoured Cockpit Door Modification, after which, it had a sample airworthiness flight test on 5 June 2003 flown with no significant defects found. Prior to departure from Hong Kong on 18 July 2003, several minor Acceptable Deferred Defects of little technical significance were noted in the aircraft maintenance record.

1.6.3. Aircraft Weight and Centre of Gravity

Maximum Take-Off Weight Authorized	:	205,000 kg
Aircraft Take-Off Weight	:	173,668 kg
Maximum Landing Weight Authorized	:	177,000 kg
Aircraft Landing Weight	:	159,068 kg
Aircraft Centre of Gravity (on take-off)	:	25.5% Mean Aerodynamic Chord (MAC)

The load sheet showed that the aircraft was within the authorized weight limits for take-off and landing, and the centre of gravity was within the authorized limits.

1.6.4. Weather Radar

1.6.4.1. The aircraft is equipped with a Honeywell RDR-4B X-band weather radar, which operates at an extremely high frequency of 9,345 Megahertz (MHz) and a very short wavelength of 3.2 cm. Liquid water in the forms of water droplets, water covered ice, or super-cooled water droplets are highly radar reflective to such a frequency. The antenna assembly produces a forward-scanning radio beam that searches for weather by emitting electronic energy pulses into the atmosphere ahead of the aircraft and measures the reflected energy. The weather radar system also provides a 180º monitor that displays information on weather and turbulence as images on the Navigation Display (ND) in the cockpit. Depending on the amount of liquid water present, which is related to the level of precipitation, different colours are displayed on the ND.

1.6.4.2. Weather targets detected are colour-coded based on the intensity of the radar signal return. The table below shows how the display colour coding correlates to the approximate intensity of rainfall as given in the Honeywell RDR-4B Forward Looking Windshear/ Weather Avoidance Radar System User's Manual: -

Colour	**Interpretation**	**Rainfall Rate**
Black	Very light or no returns	Less than 0.7 mm/hr
Green	Light returns	0.7 – 4 mm/hr
Yellow	Medium returns	4 – 12 mm/hr
Red	Strong returns	Greater than 12 mm/hr
Magenta	Turbulence	Not applicable

1.6.4.3. The weather radar was serviceable and no defect relating to the weather radar system was recorded in the Aircraft Technical Log or Maintenance Post Flight Report. According to the PIC, who was the Pilot Flying (PF), and the Co-pilot, prior to the occurrence, the weather radar antenna was set at a tilt angle of –1.75º with Weather Mode and Auto Gain selected and the range of the ND varied between 40 and 80 NM. The PIC also stated that he had varied the Gain manually at some stage. The Mandatory Occurrence Report submitted by the PIC stated that, during deviation around weather prior to the severe turbulence encounter, there were no weather returns on the weather radar display.

1.6.5. Automatic Pilot System

The Autopilot system was operative for the duration of the flight.

1.7. Meteorological Information

1.7.1. Meteorological Information at Departure and Destination Aerodromes

As the occurrence took place during the enroute phase at FL 410, meteorological information at departure and destination aerodromes had no bearing on the accident.

1.7.2. Meteorological Information Enroute

1.7.2.1. On 18 July 2003, a Tropical Depression in the South China Sea named ‘Koni’ had moved past the Philippines and was forecast to continue in a west-northwesterly direction at 10 knots. (Appendix 4 shows the track of

Tropical Depression ‘Koni’ relative to the Flight Plan Track of HDA060.) The estimated position of the centre of ‘Koni’ at 0600 was 12.2N 119.4E. Having passed the Philippines to an area over the sea, ‘Koni’ was forecast to intensify. At 0600, with the maximum sustained wind speed in excess of 63 knots, Hong Kong Observatory upgraded ‘Koni’ to a Tropical Storm. As the aircraft was approaching NOBEN, the center of ‘Koni’ was approximately 160 NM east-southeast of the aircraft position. Isolated and embedded CB extending up to FL 450, with associated moderate or severe turbulence, were forecast within 200 NM of the centre of the Tropical Depression. At the time of the accident, the flight conditions were reported by the flight crew as IMC (Instrument Meteorological Conditions) in cirrus cloud.

1.7.2.2. The satellite weather picture at 0525 (Appendix 5 refers) showed that layered and convective clouds associated with ‘Koni’ extended to 200 NM west of its centre. The tops of these clouds also have a lumpy texture, which is a characteristic of convective clouds. Based on the infrared satellite picture, the temperature of the cloud tops in the area of the occurrence was -78º C, suggesting that the cloud tops could reach up to FL 500.

1.7.3. Meteorological Information Provided to the Flight Crew

1.7.3.1. On departure from Hong Kong for Kota Kinabalu, the flight crew was provided with a meteorological information package containing the following documents:

a) Aerodrome Forecast (TAF) and Aviation Routine Weather Report (METAR) for Hong Kong, Kota Kinabalu, Brunei (Alternate) and a number of aerodromes in the region.

b) Wind and Temperature Charts for FL 300, FL 340 and FL 390.

c) Significant Weather Chart FL 250 – 630.

d) Significant Weather Chart FL 100 – 250.

e) A list of Significant Meteorological Warnings (SIGMET).

1.7.3.2. Prior to the return flight from Kota Kinabalu to Hong Kong, the flight crew was provided with updates on weather, which included the following documents:

a) TAF for Kota Kinabalu, Hong Kong and Macao (Alternate) and a number of aerodromes in the region.

b) Tropical Cyclone Warning.

c) Infrared Satellite Weather picture from GOES-9.

1.7.3.3. The Significant Weather Chart FL250 – 630 issued by the Weather Area Forecast Centre (WAFC) London valid for 0600 on 18 July 2003, which was provided to the flight crew, showed an area of "Isolated Embedded CB" up to FL 450. The forecast height of the tropopause indicated was FL 500. Appended to the chart was the note 'CB IMPLIES MOD OR SEV TURBULENCE, ICE and HAIL'. (Appendix 6 refers).

1.7.3.4. At 0334, Manila issued a SIGMET on the Tropical Depression, valid from 0000 to 0600; the crew did not receive this SIGMET prior to departure from Kota Kinabalu as it was issued after the compilation of the meteorological documents by the local handling agent. However, pre-departure meteorological information previously received sufficiently covered the weather conditions associated with the Tropical Depression.

1.8. Aids to Navigation

There was no report of malfunction on any navigational aids along Route M754.

1.9. ATC and Communications

1.9.1. The accident took place within the Manila FIR when the aircraft was under the jurisdiction of Manila ATC. At the time of the occurrence, Manila ATC was operating on 118.9 MHz using 2 transmitters - one transmitter was located in Manila while the other one was the extended range VHF located in Palawan (approximately 320 NM southwest of Manila).

1.9.2. According to information provided by Manila ATC, although there had been no report of moderate or severe turbulence from other aircraft operated in the vicinity, a number of weather deviations were recorded. During the outbound flight from Hong Kong to Kota Kinabalu, HDA061, operated by the same crew, twice requested weather deviation in the GUKUM – NOBEN area. (Appendix 7 refers.)

1.9.3. At 0507, HDA060 requested and was given permission by Manila ATC to deviate 10 NM right of track to avoid weather. At 0510, shortly after commencing the track deviation, the aircraft encountered severe turbulence. This was promptly reported to Manila ATC on VHF 118.9 MHz. At 0554, i.e. 5 minutes prior to entering Hong Kong FIR, the flight crew reported the severe turbulence encounter and the injuries sustained by the cabin crew to Hong Kong ATC. The flight crew also reported the accident to the company, who subsequently made arrangements for a medical team to meet the aircraft on arrival. Upon entering Hong Kong

FIR, HDA060 was offered priority landing at Hong Kong International Airport.

1.10. Aerodrome Information

As the occurrence took place during the enroute phase at FL 410, aerodrome information is considered not relevant to the investigation.

1.11. Flight Recorders

1.11.1. Digital Flight Data Recorder (DFDR)

1.11.1.1. The aircraft was equipped with an Allied Signal DFDR, Part Number (PN): 980-4700-003. Data from the DFDR solid-state memory was successfully retrieved and decoded shortly after the aircraft landed.

1.11.1.2. The DFDR record showed that just before NOBEN, the aircraft commenced a 23º right turn, from a heading of 013ºM to a heading of 036ºM. The aircraft was cruising at FL 410 and at a speed of M 0.81. At 0510:47, the aircraft encountered the first onset of severe turbulence that led to a maximum vertical acceleration of 1.89 'G' and a minimum of 0.16 'G'. The speed exceeded M 0.86, which triggered the Vmo/Mmo overspeed warning. The Autopilot was disconnected and was re-engaged 6 seconds later. About 15 seconds after the first severe turbulence encounter, another encounter resulted in a maximum of 1.27 'G' and a minimum of - 0.52 'G'. During the second turbulence encounter, the speed varied between M 0.86 and M 0.77. The pressure altitude varied between 41,628 feet and 40,772 feet. The whole duration of the turbulence encounter lasted for about 30 seconds. When the Autopilot was disconnected at the first onset of turbulence, a momentary elevator angle change from 0º to 7.4º was recorded. The sidesticks of both pilots remained neutral at the time.

1.11.2. Cockpit Voice Recorder (CVR)

The Honeywell CVR, PN: 980-6020-001, has a recording capacity of 30 minutes on solid-state memory. As such, voice recording at the cockpit during the period of the occurrence had been over-written well before the aircraft landed. On completion of the flight, the CVR was removed from the aircraft and voice signal was retrieved with good playback quality. Subsequent analysis of the CVR tape revealed that the "Push To Erase" button was activated at 0658:13 (21 minutes after the aircraft landed), erasing all cockpit voice recording prior to that point.

1.11.3. Quick Access Recorder (QAR)

The aircraft was fitted with a Penny and Giles QAR system, PN: D52000-60000. It acquires data directly from ARINC 429 buses and writes the data to an industry standard re-writable Magneto-Optical (MO) disk with 128 MB capacity. After landing, the ground engineer attempted to retrieve data from the QAR. However, retrieval of data for both the Hong Kong – Kota Kinabalu and Kota Kinabalu – Hong Kong sectors was unsuccessful due to unidentifiable reasons.

1.12. Wreckage and Impact Information

Not applicable.

1.13. Medical and Pathological Information

1.13.1. The PIC, Co-pilot and the riding engineer were not injured in the accident.

1.13.2. The entire cabin crew, comprising twelve female flight attendants, sustained various degrees of injuries and were sent to hospital after landing. Two flight attendants sustained serious injuries involving bone fracture and joint dislocation. They were hospitalized for six and seven weeks respectively. Ten flight attendants received treatment for minor injuries, eight of whom were released from hospital on the same day, while the other two were discharged after treatment over the following two days.

1.13.3. Three of the 236 passengers were sent to hospital for examination. Only one of them required treatment. They were all discharged from hospital on the same day.

1.14. Fire

There was no fire.

1.15. Survival Aspects

1.15.1. All crew and passengers survived the accident.

1.15.2. Upon the FSBS being selected ON shortly before the turbulence encounter, the cabin crew had checked to ensure that the passengers had fastened their seat belts and, as a result, the majority of the passengers sustained no injury. All twelve cabin attendants were serving meals and were not seated at the time of the accident. During the period of the severe turbulence encounter, the aircraft experienced a series of rapid changes in positive and negative 'G' forces. The cabin attendants tried to secure themselves by holding onto fixtures inside the cabin. Those who did not manage to do so were thrown into the air, some hitting their heads against the ceiling panels, then crashing to the floor. The two cabin attendants who sustained the most serious injuries were working at the rear galley at the time.

1.15.3. On being notified of the accident, ground emergency units proceeded to the airport, standing-by to meet the aircraft on arrival. The company arranged extra ground staff at the airport to assist the injured crew after landing. Five ambulances and three helicopters were deployed to transport casualties to the hospitals.

1.16. Test and Research

The DFDR data was sent to the aircraft manufacturer for analysis in order to determine if the aircraft performed normally as per design. It was also noted that during the initial period of the turbulence encounter, when the Autopilot was disconnected, the elevator angle changed momentarily from 0º to 7.4º without any input from the pilots. The aircraft manufacturer was requested to verify that this change in elevator angle was normal.

1.17. Organizational and Management Information

1.17.1. Crew Resources Management (CRM)

The operator conducts separate CRM courses for flight crew and cabin crew. While the theme of these two CRM courses such as teamwork, crew behaviour, communication and co-ordination are similar, their contents and formats are quite different. The CRM course for the flight crew is a two-day course that mainly features the review of aircraft accidents/incidents, their causal factors and the lessons learnt. The one-day CRM course for the cabin crew mainly focuses on the practical aspects of in-flight handling of critical situations e.g. seeking assistance from passengers, conflict management and communications with flight crew.

1.17.2. Training Records and Training Material

1.17.2.1. According to the flight crew training records, the PIC last completed his CRM training on 27 July 1998. There was no record of recurrent CRM training having been conducted since then.

1.17.2.2. The Co-pilot was recruited as a Second Officer in November 2002. He had not attended any local CRM training course prior to the day of the accident. This is acceptable under the Air Operator's Certificate Requirements Document (CAD 360), which only requires flight crew to complete CRM training within 12 months of commencing airline operations.

1.17.2.3. Before conversion to Airbus A330, the PIC had been flying as a Commander of the Lockheed L1011 aircraft. Training records revealed that the PIC completed his A330 Line Training in September 1995 and was provided with supplementary Line Training in December 1998. On neither occasion was there any record that 'Use of Radar and Weather Avoidance' had been discussed.

1.17.2.4. The training records of the Co-pilot indicated that 'Use of Radar and Weather Avoidance' had been discussed twice during his Line Training that was completed in June 2003.

1.17.2.5. Review of the record of training materials distributed to the flight crew concerned indicated that they had been issued copies of the Flight Crew Operating Manual (FCOM) Volume 1, 2, 3, and 4 and the A330 Operations Manual Volume 7, 8 and 12. Both pilots stated that the Honeywell RDR-4B Forward Looking Windshear/Weather Avoidance Radar System User's Manual had not been used during training.

1.18. Additional Information

The operator had in the past experienced incidents in which flight attendants had sustained injuries due to turbulence while the FSBS were selected ON. As a result, an A330 Operational Notice No. 75/02 – Turbulent Air, was issued on 7 October 2002 (Appendix 8). This Notice, accompanied by a copy of an article titled 'Flight In Severe Turbulence' copied from Airbus Flight Operations Support, was withdrawn, coincidently, on 18 July 2003, the day of the accident. Another A330 Operational Notice No. 59/03 on the same subject was re-issued on 22 August 2003 (Appendix 9). The contents of both notices were similar and required the cockpit crew to brief the CP or SP of expected areas of turbulence prior to each departure. Both the CP and the SP however stated that such a briefing had not been conducted on this occasion. However, one of the pilots recalled that prior to departure from Kota Kinabalu, the CP had been briefed on the weather conditions.

2. ANALYSIS

2.1. Weather Conditions

2.1.1. The weather enroute was consistent with the meteorological briefing received before departure from Hong Kong – upper cloud requiring a number of diversions from track, with the aircraft experiencing periods of light turbulence. A supplementary weather briefing was received prior to departure from Kota Kinabalu, which confirmed the meteorological briefing in Hong Kong. A satellite picture depicting the position of Tropical Depression 'Koni' was provided to the flight crew in Kota Kinabalu.

2.1.2. The meteorological information provided to the flight crew as listed in Para. 1.7.3 sufficiently covered the sector of the return flight from Kota Kinabalu.

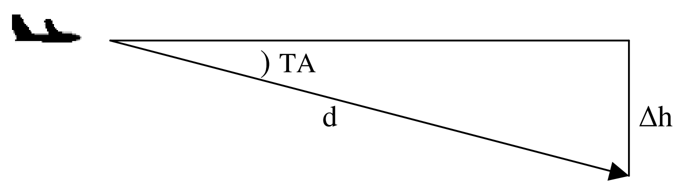
2.2. Operation of the Weather Radar

2.2.1. For the sector from Kota Kinabalu to Hong Kong, the PIC was the PF. According to the PIC, prior to the turbulence encounter the weather radar antenna was set at a tilt angle of -1.75º with Weather Mode and Auto Gain selected and the range of the ND varied between 40 and 80 NM. The Co-pilot also confirmed that the tilt angle was set at -1.75º at the time of the turbulence encounter.

2.2.2. Weather radar detects droplets of precipitation. The strength of the return depends on the size, composition and amount of droplets. Water particles are almost five times more radar reflective than ice particles of the same size. Weather radar is therefore effective in detecting rainfall and wet hail but not effective in detecting the upper level of a storm cell where most moisture exists in a dry, frozen state, i.e. in the forms of snow, ice crystals and hail. To determine the positions of storm cells, the antenna tilt angle should be adjusted to scan the icing level, where reflective water-covered ice/hail would be abundant. Above the icing level, ice crystals have minimal radar reflectivity. Although convective activities and turbulence exist at these levels, they do not show up readily on radar. To keep track of weather in the vicinity of the flight path, the antenna tilt angle should be frequently adjusted to scan the most reflective area in the icing level band. As altitude changes or as the aircraft gets closer to the storm cell, the tilt angle has to be changed so that the radar beam keeps scanning the most radar reflective area. The icing level band is generally between the levels where temperature ranges from 0° C to -15° C. Based on the meteorological information available, typically, the icing level band in that part of the region was estimated to be between FL 150 and FL 230. Given that the energy transmitted from the 3-degree radar beam is focused and radiated by the antenna in such a way that it is most intense in the centre of the beam with decreasing intensity near the edge, the weather radar would most likely pick up the strongest signal of weather returns when the antenna tilt angle was adjusted to aim at the icing level band.

2.2.3. To calculate the vertical distance (Δh) between the aircraft and the level at which the centre of the radar beam is scanning, the following formula given in the A330 FCOM 3 can be used: -

$$\Delta h \text{ (Delta Altitude)} \approx d \text{ (NM)} \times \text{Tilt Angle (TA)}^{\circ} \times 100$$



Δh = vertical distance between the level being scanned and the aircraft flight level (feet)

d = distance from the storm cell (NM)

TA = tilt angle (degrees)

2.2.4. For the case of a tilt angle setting of –1.75º; at a distance of 40 NM, the centre of the radar beam would be scanning around 7,000 feet below the cruising level; and at 80 NM, the radar would be scanning at around 14,000 feet below. However, the above formula is an approximation that does not take into consideration the curvature of the earth, which could be a significant factor when calculating the target level at long range. Based on information provided by the radar manufacturer, with the earth's curvature taken into account, at 40 NM the centre of the beam would be at about 6000 feet below the cruising level, and at 80 NM about 9000 feet. Thus, while cruising at FL 410, with a tilt angle setting of -1.75º at 40 NM distance, the centre of the radar beam would be scanning for weather at around FL 350 and at 80 NM, at around FL 320. Although the lower edge of the 3-degree radar beam could be scanning the upper portion of the icing level band, the radar return would be diminished because of the reduced power at the periphery of the conical beam – approximately half of the power at the centre of the beam. It was therefore very likely that, with -1.75º tilt angle selected, the radar was 'over-scanning' i.e. the centre of the beam was scanning above the most reflective part of the weather cells, hence no significant weather (red) returns were displayed on radar.

2.2.5. The Honeywell RDR-4B Forward Looking Windshear/Weather Avoidance Radar System User's Manual gives a very detailed description of the operating procedures for the weather radar, with particular emphasis on range selection and antenna tilt management. Adopting the procedures in this document, or alternatively, those described in FCOM 3.04.34, would have adequately established a protection zone ahead of the aircraft. Both documents stress that it is important for the antenna tilt angle to be lowered progressively as the aircraft approaches weather to maintain a clear radar picture of the weather ahead. This will help to ensure that a deviation will clear any weather hazard by a safe margin. However, there was no evidence that these procedures were adopted prior to the occurrence. Although the Honeywell RDR-4B radar has a feature that provide an automatic increase in gain above 25,000 feet to compensate for the lower reflectivity of the ice crystals in the upper levels of a storm cell, the radar remains limited by the reflectivity characteristics of the target being scanned and the available gain. It is for this reason that the RDR-4B Users Manual stated repeatedly that effective tilt management is the single, most important key to more informative weather radar displays.

2.3. Weather Avoidance

2.3.1. On approaching position NOBEN, weather returns were sighted on the ND and the Co-pilot called Manila ATC to request permission to deviate 10 NM right of track, upwind of the weather as indicated on the ND. However, it was unlikely that, at the settings used, the weather radar was scanning that portion of the convective storm cell giving the strongest returns.

2.3.2. The use of weather radar for weather avoidance is contained in FCOM 3.04.34 Pages 3–5 (Appendix 10) and tilt adjustment is contained in FCOM 3.03.15 Page 2 (Appendix 11). FCOM 3.04.34 Page 5, under a section titled “Red/Magenta Areas: Thunderstorm, Tornado, Hail”, recommends the use of the 160 NM scale for the PNF (Pilot Not Flying) and the 80 NM scale for the PF when scanning for thunderstorms. It also states that: -

- "*Frequent tilt adjustments are recommended to monitor the storm development and to provide the maximum cell echo*"; and
- "*Do not forget that omission to periodically adjust tilt downwards causes targets to disappear*".

2.3.3. Although this section is titled "Red/Magenta Area: Thunderstorm, Tornado, Hail", the above recommended procedures are obviously also applicable to operation of the weather radar under circumstances other than those when "red/magenta areas" are present. The flight crew stated that they observed yellow and green returns 10 NM north of NOBEN, which prompted their request for deviation. It was likely that had they increased the negative tilt angle at that time they would have seen red returns on the ND; and possibly magenta, if the "Wx/Turb" Mode had been selected.

2.3.4. Had the flight crew progressively increased the negative tilt angle, with an ND setting of 160 NM for the PNF and 80 NM for the PF as recommended in FCOM 3, it is likely that they would have obtained a reasonable profile of any storm cell by observing the returns from the icing level.

2.3.5. At a cruising level of FL410 with an ND range scale setting of 80 NM, there will be surface returns at downward radar tilt angle settings of 5 degrees and greater, covering the outer range segments of the ND display. However, any storm cell ahead of the aircraft, 'masked' by these surface returns will progressively emerge from the returns as the distance from the cell reduces. By approximately 40 NM it should be identifiable as a cell, enabling avoidance action to be taken. It is essential that the radar tilt be adjusted continuously and positively when the presence of CB cells is forecast or suspected so that an effective track deviation around weather returns can be initiated in sufficient time.

2.3.6. Having reviewed the company procedures on the use of weather radar, the investigation team consider that, for the purpose of crew training, FCOM 3 is not sufficiently clear in its description of the recommended technique for operating the radar for weather avoidance. On the other hand, the Honeywell RDR-4B Forward Looking Windshear/Weather Avoidance Radar System User's Manual gives a clearer and more detailed description of the subject. However, both pilots stated that the Honeywell RDR-4B user's manual was not used during training and that they had not been given a copy of the manual.

2.3.7. At a tilt angle setting of –1.75°, the radar beam was probably scanning above the level necessary to give more significant weather returns. Hence it is likely that the most significant areas of weather were not properly presented on the radar display and the aircraft inadvertently flew into an area of turbulent weather caused by strong convective activity associated with Tropical Depression 'Koni'. Based on information provided by Manila ATC, no other aircraft were known to be in sufficient proximity to the position of HDA060 to have caused wake turbulence. There was no other form of known turbulence that conceivably could have affected the aircraft, in a manner consistent with the circumstances.

2.3.8. The DFDR record showed that just before NOBEN, the aircraft commenced a 23° right turn at time 0508:48, from a heading of 013°M to 036°M to avoid weather. At 0510:47, just 2 minutes after commencement of the track deviation, when the aircraft was 14 NM north-northeast of NOBEN, the first onset of severe turbulence was encountered. At that time, the aircraft was only 6 NM right of track. The investigation team is of the view that given the radar setting selected prior to the turbulence encounter, it was highly probable that the way in which the weather radar was operated precluded optimum detection and indication of the position and intensity of the weather in the vicinity of the aircraft. As a result, the deviation around weather was not initiated early enough, nor was the deviation large enough to avoid the weather.

2.4. Standard Operating Procedures (SOP) for Turbulence Penetration

2.4.1. Both the cabin and flight crew stated that shortly before the turbulence encounter the aircraft experienced "light chop". This was consistent with the DFDR data readout. The PF stated that the aircraft was cruising at M 0.80. The DFDR record showed that, prior to the initial encounter with the severe turbulence, the indicated Mach Number was M 0.81. This rapidly increased thereafter to M 0.86; the 'G' loading increased to +1.89 and the aircraft climbed to a maximum pressure altitude of 41,628 feet. The DFDR record showed that at that point, the Autopilot disengaged. The PF then disengaged the Autothrust and reduced both engines to idle thrust.

2.4.2. The PIC stated that the climb from FL 370 to FL 410 was requested in an attempt to fly above the weather so as to improve the 'ride'. At that level, prior to the encounter, the aircraft was in IMC and in cloud.

2.4.3. The operating ceiling of the A330 is FL 411. The optimum level at which an A330 can be flown is dependent on the aircraft weight, the cruising Mach Number and the ambient temperature. The aircraft Flight Management System (FMS) will compute the optimum and maximum cruising levels, which will increase as the aircraft weight decreases. The aircraft weight at the time of the encounter was estimated to be approximately 165,000 Kg. At this weight, the optimum cruising level derived by the FMS would have been in excess of FL 410, at all temperatures, at speeds up to M 0.82. Furthermore, at this weight, the bracket of speeds available, from the Lowest Selectable Speed (Vls) to the Maximum Operating Speed (Vmo) was 210 – 254 knots (M 0.73 – M 0.86) i.e. a range of 44 knots. The intended cruising speed on this occasion was at M 0.80 to M 0.81, which was close to the mid-point of the speed bracket. Thus the decision to climb from FL 370 to FL 410 was in accordance with normal operating practice, notwithstanding the subsequent unforeseen encounter with severe turbulence and the resultant exceedance of aircraft operating ceiling and Vmo/Mmo limits.

2.4.4. The operator's Standard Operating Procedure for turbulence penetration is specified in the Quick Reference Handbook (QRH). This requires a turbulence penetration speed of 260 knots/M 0.78, with FSBS selected ON, Autopilot to remain Engaged. When the thrust changes become excessive, the Autothrust is to be disconnected. The engine thrust setting is then adjusted, in accordance with the "Speed and Thrust Setting for Turbulence Speed Table" in the QRH, which is based on the aircraft weight, to obtain a smoother ride.

2.4.5. Pilots experience turbulence of differing degrees on most flights, particularly in tropical latitudes. The recommended turbulence penetration speed as specified in the QRH is for SEVERE turbulence, which all pilots seek to avoid, and is thus rarely experienced. The common practice is to reduce speed progressively as light or moderate turbulence is experienced, towards the turbulence penetration speed. On this occasion, as the aircraft had been experiencing only light turbulence prior to the occurrence, a cruising speed of M0.80 – M0.81 was reasonable.

2.4.6. Given the insignificant weather information presented on the ND, and the fact that the aircraft was only experiencing light turbulence prior to the encounter, the crew's decision to select the FSBS ON and to allow the cabin crew to continue with meal services was considered not unreasonable, under the circumstances.

2.5. Decision to Continue the Flight to Hong Kong

At the point of the severe turbulence encounter, the aircraft was at a position 260 NM west of Manila and 610 NM south-southeast of Hong Kong. Subsequent to the occurrence, both the Co-pilot and the PIC inspected the cabin in turn. The PIC conferred with the doctor on board to assess the conditions of those injured. Considering the less favourable weather conditions in Manila than in Hong Kong, the relative positions of the airports, and more importantly, the fact that the injured were in a stable condition, the decision to continue the flight to Hong Kong was a logical one.

2.6. Crew Training and Documentation

2.6.1. Use of Weather Radar

2.6.1.1. In addition to those contained in A330 FCOM 3, the company instruction on the use of weather radar as stated in Operations Manual Volume 8 (Appendix 12 refers), in its entirety, is as follows:

Section 8.1.1 Page 15 Para. 33:

"If it is anticipated that the weather radar will be required shortly after take off, it is to be selected ON whilst lining up for take off."

2.6.1.2. Apart from the very brief instruction given in the above paragraph and the procedures in FCOM 3, no supplementary procedures or guidance material to flight crew as to the use of weather radar could be found. At interview, the PIC asserted that he could not recall any classroom discussion on severe turbulence.

2.6.1.3. The investigation team reviewed the training records of the flight crew concerned and noted that "Use of Radar/Weather Avoidance" was one of the "Discussion Items" in the check list used for Line Training but was not included as a "Practice Item". The record of the PIC's A330 Line Training that was completed in September 1995 used a training checklist that did not include "Use of Radar/Weather Avoidance" as one of the discussion items. His supplementary Line Training conducted in December 1998 showed that the boxes against "Use of Radar/Wx Avoidance" were vacant suggesting that this item had not been discussed. The training record of the Co-pilot showed that "Use of Radar/Wx Avoidance" had been discussed twice during his Line Training conducted between March and June 2003. However, as this item did not constitute a "Practice Item", there was no clear evidence that the use of radar for weather avoidance had actually been practiced during the period of his Line Training.

2.6.1.4. It is recognized that all airborne weather radars do operate in a similar fashion and on broadly the same principles. However, there are significant differences between modern, 'flat-plate' antenna radars, such as the RDR-4B, and older, parabolic antenna radars. These older radars, on which many senior pilots gained experience, have up to 15 times the power of modern radars, are able to detect close-in weather at lower altitudes relative to the aircraft due to large side lobes and generally require less 'effort' to interpret a radar picture. In comparison, the RDR-4B radar focuses radar energy in a narrow 'pencil' beam, the power of which is greatest at the centre and reduces as the angular distance from the centre of the beam increases, with little energy emitted as extraneous side lobes. The narrow beam and loss of side lobes make tilt and range control more critical. The beam width of the RDR-4B radar is nominally 3 degrees. The radar energy is focused at the middle of the 3-degree beam, reducing to half power at the edge of the beam. Thus while radar targets having good reflectivity may produce returns from the 3 degree periphery, targets with less reflectivity may not 'paint' at all.

2.6.1.5. From the way in which the weather radar was operated, as described by the flight crew, the investigation team is of the opinion that the flight crew had not been provided with sufficient technical and guidance information, nor was there clear evidence that they were adequately trained to operate the RDR-4B Weather Radar. In this respect, the regulatory authority should consider stepping up regulatory oversight of the training standards of operators, with a view to ensuring a more comprehensive coverage of weather radar operation and weather avoidance procedures for flight crew.

2.6.1.6. Without CVR and weather radar recording, the investigation into the accident and the operation of the weather radar had to rely on the description of the radar settings selected and observations by the flight crew, based on their recollection of events prior to the accident. Because of the nature of the evidence available, the above therefore can best be regarded as the most probable scenario leading up to the accident. However, based on the training documentation and records available, and considering the importance of proper use of weather radar to flight safety, it can be concluded with reasonable certainty that there has been insufficient emphasis placed on the training of the flight crew in its use.

2.6.2. Weather Briefing to Cabin Crew

2.6.2.1. According to the operator's A330 Operational Notice 75/02, titled "Turbulent Air", flight crew were required to study the weather charts and SIGMET's for areas of possible turbulence, and to brief CP or SP prior to each departure with regard to the approximate time during the flight that these weather conditions may be encountered. Although one of the flight crew believed that the CP had been briefed on the weather conditions prior to departure from Kota Kinabalu, neither the CP nor the SP could recall that this had been done. The investigation could not establish if the flight crew had actually briefed the CP or the SP on the possibility of a turbulence encounter in accordance with the operator's A330 Operational Notice No. 75/02. However, given that the flight conditions were reported to be 'bumpy' with 'light chop' experienced during the previous sector from Hong Kong to Kota Kinabalu, the cabin crew would not have anticipated a smooth ride on the return flight to Hong Kong. The effects of whether such a briefing had actually been conducted therefore remain relatively insignificant.

2.6.2.2. The investigation team noted that the A330 Operational Notice 75/02 was withdrawn on 18 July 2003. The operator explained that withdrawal of the Notice on the day of the accident was purely coincidental. Operational Notice 59/03 on the same subject was subsequently issued on 22 August 2003 as it was considered that there was a need to remind crew members again of the requirement for flight crew to conduct weather briefing to cabin crew in light of further incidents involving air turbulence in the preceding weeks.

2.7. Handling of the Injured and Cabin Management

2.7.1. All cabin crew interviewed stated that the preparation of the cabin for turbulence was discussed during cabin crew emergency training. It was evident that the cabin crew were conversant with the company policy and procedures in preparation for turbulence and that they were adequately trained to handle the situation as was demonstrated in this accident.

2.7.2. After the accident, the CP, though slightly injured, promptly informed the flight crew of the occurrence. She made a number of Public Address (PA) broadcasts to the passengers and crew. She enlisted the help of a doctor, six passengers with nursing experience and a policeman to attend to the injured cabin attendants. She also solicited help from passengers to assist in cleaning up the cabin to avoid further injuries to passengers and crew.

2.7.3. Subsequent to the turbulence encounter, on the instructions of the PIC, the Co-pilot left the flight deck on several occasions to check on the conditions in the cabin and to keep the PIC informed. He assisted in the control of passengers and helped the cabin crew, who were caring for their seriously injured colleagues.

2.7.4. The CP demonstrated commendable competence and professionalism in handling a difficult situation in the cabin. She orchestrated available resources to ensure that the injured persons were given appropriate attention. The remainder of the cabin crew members, who were all injured to some degree, continued to function effectively as a team in a challenging situation and to discharge their duties for the remainder of the flight. Those passengers who volunteered assistance to the cabin staff are also to be commended.

2.8. Crew Communication and CRM Training

2.8.1. The suddenness and severity of the turbulence encounter and the rapid changes in aircraft altitude and speed demanded the immediate attention of the PF, whose proper priority was to fly the aircraft. After the turbulence encounter, both the PIC and the Co-pilot inspected the cabin. The Co-pilot had assisted the cabin crew in the control of passengers.

2.8.2. After parking the aircraft, the flight crew remained on the flight deck for approximately 23 minutes. During this period, besides completing an entry in the Technical Log concerning the encounter with severe turbulence, it was stated that some technical issues were discussed between the PIC and the Co-pilot. However, as the

CVR tape was erased at 0658:13, the remaining portion of the CVR tape did not reveal any record of such discussion nor of any record of communication with the cabin.

2.8.3. In the cabin, after the turbulence encounter, the CP re-allocated staff resources for the remainder of the flight to cope with reduced cabin staff capability, to attend to the seriously injured crew members and to prepare the cabin for landing.

2.8.4. The investigation team looked into the effectiveness of communication between flight crew and cabin crew in handling the emergency situation. Whilst no serious deficiency was identified, the investigation team noted that certain aspects of CRM training do not entirely conform to the requirements stipulated in the Air Operator's Certificate Requirements Documents (CAD 360).

2.8.5. The successful resolution of aircraft emergencies requires effective co-ordination and interaction between flight crew and cabin crew. To this end, CAD 360 states that operators should, as far as practicable, provide combined CRM training for flight crew and cabin crew and that CRM recurrent training should be provided. However, the operator currently runs CRM courses for flight crew and cabin crew separately. It is also noted that the operator conducts annual CRM recurrent training only for cabin crew but not for flight crew. The investigation team is of the view that more emphasis should be placed on the importance of effective co-ordination and communication among all crew members through combined CRM training and recurrent CRM training for both flight crew and cabin crew. There is therefore a need for the operator to review its CRM training programme so as to conform to the CAD 360 requirements.

2.9. Fasten Seat Belt Signs (FSBS)

2.9.1. On the day of the occurrence, the same flight crew and cabin crew operated both sectors Hong Kong – Kota Kinabalu – Hong Kong. On the outbound sector from Hong Kong to Kota Kinabalu, the flight conditions were reported to be 'bumpy' with 'light chop' by the flight crew. Although normal passenger service was carried out, it is reasonable to conclude that both the flight and cabin crew would not have anticipated a smooth ride on the return sector to Hong Kong as the weather forecast showed that the centre of the Tropical Depression 'Koni' was moving northwest towards the planned track of Route M754. Upper cloud, turbulence and weather deviations could therefore be expected.

2.9.2. The departure and climb out from Kota Kinabalu were normal and the FSBS were cycled to signal to the cabin crew that cabin services may commence, although the CP kept the cabin crew seated for a few more minutes due to light turbulence at the time. Witness statements from the pilots, cabin crew and passengers were consistent with regard to the FSBS being ON when the severe turbulence was encountered. According to the cabin crew, when the FSBS were turned ON about 10 to 15 minutes prior to the accident, they had, in accordance with company procedures, conducted a check on the passenger seat belts and stopped serving hot drinks, before continuing with the meal service. The facts that the passengers were seated with their seat belts fastened and that none of the passengers sustained any serious injuries were consistent with witness evidence that the FSBS were ON before the turbulence encounter.

2.9.3. The aircraft is equipped with QAR which records, amongst other data, the exact time when the FSBS is selected "ON" or "OFF". Had QAR data been available (Para. 1.11.3 and Para. 2.11.2 refer), it would have been possible to clearly identify the actual time of activation and deactivation of the FSBS.

2.10. ATC and Emergency Services

2.10.1. The accident took place within the Manila FIR when the aircraft was under the jurisdiction of Manila ATC. The request from HDA060 for a 10 NM deviation right of track was promptly approved. Satisfactory two-way communication was established between Manila ATC and the aircraft, except that when HDA060 reported the turbulence encounter to Manila ATC, the radio transmission was garbled and was apparently not picked up by the controller. However, this had no bearing on the outcome of the event.

2.10.2. On entering Hong Kong FIR at 0559, HDA060 was offered priority landing at Hong Kong International Airport in accordance with normal ATC practice. Suitable priority was also given for its ground taxi into the parking bay.

2.10.3. Handling of the flight by both Manila and Hong Kong ATC was in order. Emergency units were alerted in a timely manner and adequate resources were provided to transport the injured persons to hospitals.

2.11. Quick Access Recorder

2.11.1. Unlike the DFDR, which uses solid-state memory, the QAR incorporates components with moving parts and are thus sensitive to shock and heat. Its performance is also dependent upon the quality of the MO disk being used.

2.11.2. The MO disk installed on HDA060 was of 128 MB capacity and was 20% full at the time when it was removed from the aircraft after landing. When attempting to download the QAR data for the Hong Kong - Kota Kinabalu - Hong Kong sectors on 18 July 2003, no data could be retrieved. The only data available on the MO disk were those of the sectors flown on the previous day. However, there was no defect reported on either the QAR system or the MO disk after the accident. In the absence of records from the QAR, the investigation team was therefore unable to cross check the data between the DFDR and those of the QAR. Hence, only the DFDR data was used to obtain the parameters for reconstruction of the flight profile. Apart from the lack of cross-reference between the QAR and DFDR data, the absence of QAR data did not affect the investigation as most of the required information was available from the DFDR.

2.11.3. According to the operator, on average, QAR data was recorded successfully on only 80% of flights and it happened that no data could be retrieved from the QAR unit on this occasion. Although equipage of QAR is not a regulatory requirement, from a technical point of view, such a reliability level is considered less than satisfactory.

2.12. Cockpit Voice Recorder

2.12.1. Most A330 aircraft operated by Hong Kong Dragon Airlines are fitted with CVR that retain the last 2 hours of recording. However, some aircraft are still equipped with CVR that retain only the last 30 minutes of recording. As the CVR fitted to B-HYA had a recording capacity of 30 minutes, voice communication between the PIC and the Co-pilot in the cockpit and the PA broadcast made at around the time of the accident had already been over-written by the time the aircraft landed at 0637 i.e. 1 hour and 27 minutes after the turbulence encounter. On completion of the flight, the voice recorder was removed from the aircraft and voice signal was retrieved with good playback quality. However, an irregularity in the CVR record was noted. A command input of “Push To Erase” was identified at 0658:13 (21 minutes after the aircraft landed) and all voice recording prior to that point was erased. Thereafter, a period of 18 minutes and 17 seconds was recorded, which included the voices of the flight crew before they left the cockpit at around 0704.

2.12.2. Constrained by the CVR recording capacity, cockpit voice recording during the period of the accident had already been over-written well before the aircraft landed. The erasure of the CVR recording after landing therefore did not materially affect the course of the investigation. However, considering that the "Push to Erase" button can only be activated when the aircraft is on the ground with parking brakes selected ON, it is clear that this was an action on the part of a person who possessed sufficient knowledge of the aircraft systems to be aware of the nature and consequence of such an action. Although the investigation team was unable to establish the precise reason of the "Push To Erase" input, it can be inferred that it was an attempt to erase the CVR record. This action was in contravention of the company's instruction with regard to the preservation of flight records. Volume 12 (Organization) of the operator's A320/A321/A330 Operations Manual states: "Commanders and engineers are reminded that DFDR and CVR recordings should not be erased" (Appendix 13 refers). However, given that Volume 12 of the Operations Manual mainly contains organizational and administrative information, it would be appropriate for the operator to consider issuing additional instructions to flight crew and maintenance staff with regard to the need for preserving the integrity of DFDR and CVR data, or alternatively, to incorporate the instruction into FCOM 8.

2.13. Analysis of the DFDR Data

In response to the investigation team's request for a review of the DFDR data to verify the aircraft performance, the aircraft manufacturer conducted an analysis of the data and subsequently submitted an Event Report and Analysis. In the report, it was concluded that the aircraft behaved normally during the period of severe turbulence encounter. No system anomaly was found. No structural load limits were exceeded both in the longitudinal and lateral axes. The maximum angle of attack (α) recorded was +6.7º, which triggered the angle of attack protection flight control law (α_{prot}) and disconnected the Autopilot. The PF subsequently disconnected the Autothrust and reduced both engines to idle power. Both the α protection and the pitch up compensation laws commanded a pitch down elevator input of 7.4º, in accordance with design parameters.

3. CONCLUSIONS

3.1. Findings

3.1.1. The pilots were properly licensed and qualified to operate the flight. There was no evidence suggesting any pre-existing medical or behavioural conditions that might have adversely affected the flight crew's performance during the flight. (Ref. Para. 1.5.1.3)

3.1.2. Loading for the flight was within authorized weight limits, and the aircraft was operating within prescribed centre of gravity limits. (Ref. Para. 1.6.3)

3.1.3. The weather in the vicinity of NOBEN where the severe turbulence was encountered was affected by the presence of a tropical depression situated at approximately 160 NM east-southeast of the aircraft position, with isolated and embedded CB extending up to FL 450. (Ref. Para. 1.7.2.1)

3.1.4. The meteorological information provided to the flight crew prior to departure from Kota Kinabalu sufficiently covered the flight. (Ref. Para. 1.7.3)

3.1.5. For the purpose of training, the company procedures in FCOM 3 on the use of weather radar are not sufficiently clear in its description of the recommended technique for operating the radar for weather avoidance. (Ref. Para. 2.3.6)

3.1.6. The aircraft inadvertently flew into an area of turbulent weather caused by strong convective activity associated with a tropical depression. (Ref: Para. 2.3.7)

3.1.7. While deviating to the right of track, the aircraft encountered severe turbulence at FL 410 at 14 NM north-northeast of NOBEN. (Ref. Para. 2.3.8)

3.1.8. It was highly probable that the way in which the weather radar was operated precluded optimum detection and indication of the position and intensity of the weather in the vicinity of the aircraft. As a result, the deviation around weather was not initiated early enough, nor was the deviation large enough to avoid the weather. (Ref. Para. 2.3.8)

3.1.9. The flight crew had not been provided with sufficient technical and guidance information, nor was there clear evidence that they were adequately trained to operate the Honeywell RDR-4B Weather Radar. (Ref. Para. 2.6.1.5)

3.1.10. The cabin crew were qualified and adequately trained to handle the unusual situation after the accident. The cabin crew functioned effectively as a team in a demanding situation. The CP demonstrated competence and professionalism in cabin resource management to ensure that the injured were attended to. (Ref. Para. 2.7)

3.1.11. The operator runs separate CRM courses for flight crew and cabin crew. Annual CRM recurrent training is provided only to cabin crew but not to flight crew. (Ref. Para. 2.8.5)

3.1.12. The FSBS were selected ON before the turbulence encounter. (Ref. Para. 2.9.2)

3.1.13. Handling of the flight by Manila and Hong Kong ATC was in order. Emergency units were alerted in a timely manner and adequate resources were provided to transport the injured persons to hospitals. (Ref. Para. 2.10.3)

3.1.14. No data could be retrieved from the QAR concerning the flight from Hong Kong to Kota Kinabalu and return. (Ref. Para. 2.11.2)

3.1.15. After parking, the "Push to Erase" button on the CVR was operated. This contravenes the company's instruction with regard to preservation of flight records. (Ref. Para. 2.12.1 & Para 2.12.2)

3.1.16. The aircraft behaved normally during the period of severe turbulence encounter with no system anomaly found. (Ref. Para. 2.13)

3.2. Cause

3.2.1. The aircraft encountered severe turbulence as it flew into an area of turbulent weather caused by strong convective activity associated with a tropical depression. (Ref: Para. 2.3.7)

3.3. Contributing Factors

3.3.1. It was highly probable that the weather radar was operated in such a way that it did not achieve optimum detection and indication of the position and intensity of the weather in the vicinity of the aircraft. As a result, the deviation around weather was not initiated early enough, nor was the deviation large enough to avoid the weather. (Ref: Para. 2.3.8)

3.3.2. The flight crew had not been provided with sufficient technical and guidance information nor were they adequately trained to operate the Honeywell RDR-4B Weather Radar for weather avoidance. (Ref: Para. 2.6.1.5)

4. SAFETY RECOMMENDATIONS

4.1. Recommendation 11-2004

It is recommended that the operator should review and augment the relevant parts of the A330 FCOM 3 and FCOM 8 to provide more details on the technique in the operation of weather radar. (Ref. Para. 2.6.1.1 & 2.6.1.2)

4.2. Recommendation 12-2004

It is recommended that the operator should strengthen the training of flight crew on the use of weather radar for weather avoidance. (Ref. Para. 2.6.1.3)

4.3. Recommendation 13-2004

It is recommended that the regulatory authority should consider stepping up regulatory oversight on the training standards of operators with a view to ensuring a more comprehensive coverage of weather radar operation and weather avoidance procedures for flight crew. (Ref. Para. 2.6.1.5)

4.4. Recommendation 14-2004

It is recommended that the operator should review its CRM training programme so as to conform to the CAD 360 requirements. (Ref. Para. 2.8.5)

4.5. Recommendation 15-2004

It is recommended that the operator should consider issuing additional instructions to flight crew and maintenance staff with regard to the need for preserving the integrity of DFDR and CVR data, or alternatively, to incorporate the instruction into FCOM 8. (Ref. Para. 2.12.2)

Colman S.C. Ng
Inspector of Accidents
Accident Investigation Division
Civil Aviation Department
Hong Kong Special Administrative Region
China

References

Cathay Pacific Airways Weather Radar Manual (1997) – Published by Cathay Pacific Airways Ltd.

Dragonair A330 FCOM 3, A320/A321/A330 Operations Manual Volume 8 and 12 – Published by Hong Kong Dragon Airlines Ltd.

Dragonair Severe Turbulence Event Report and Analysis – Published by Airbus

Honeywell RDR-4B Forward Looking Windshear/Weather Avoidance Radar System User's Manual – Published by Honeywell International Inc.

Acknowledgement

The invaluable contributions and assistance offered by the following organizations in the investigation are gratefully acknowledged: -

Flight Safety Department, Airbus

Honeywell International Inc.

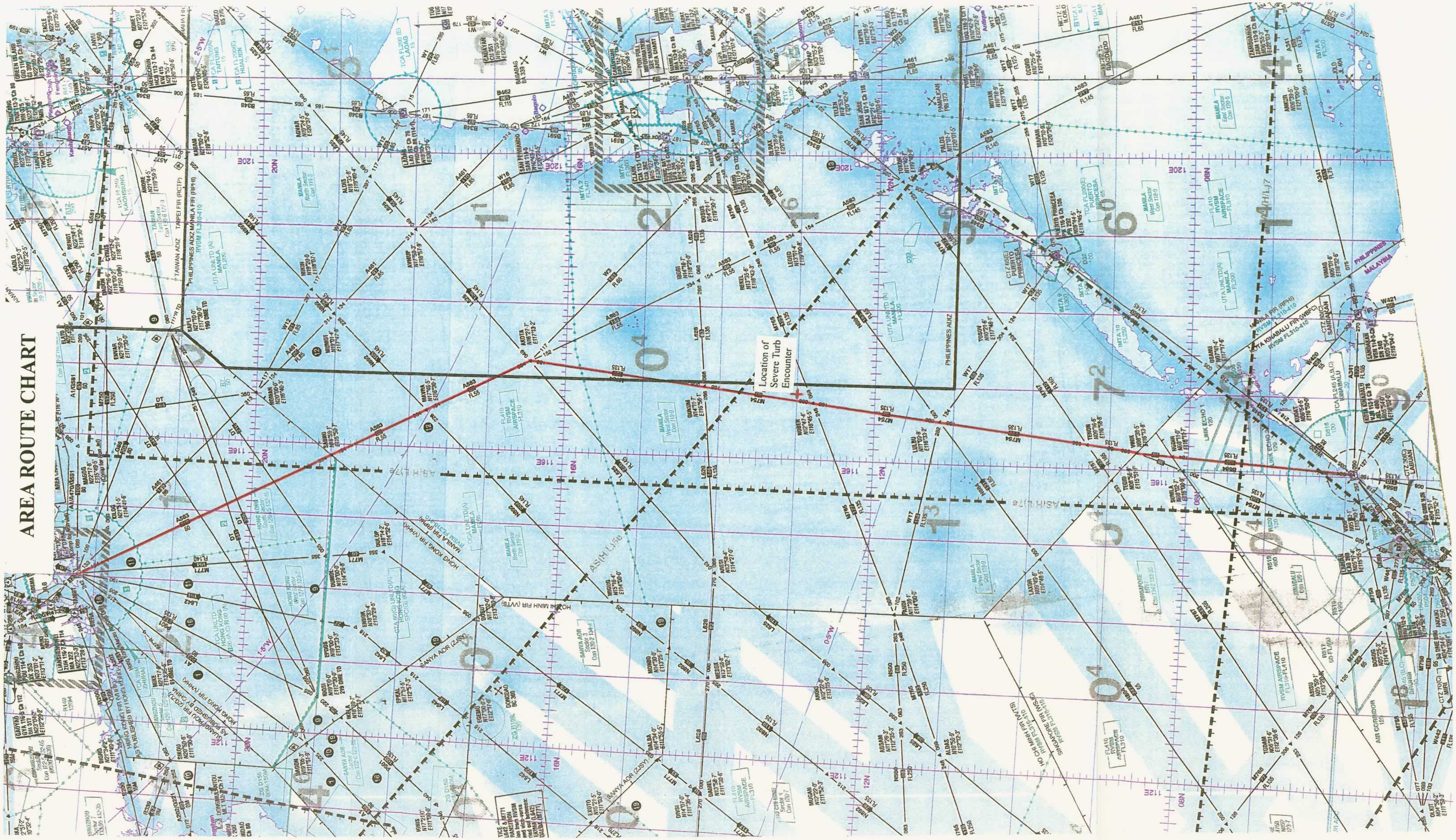
Manila Area Control Centre, Department of Transport and Communications, Republic of the Philippines

Corporate Safety Department, Cathay Pacific Airways Ltd.

Hong Kong Dragon Airlines Ltd.

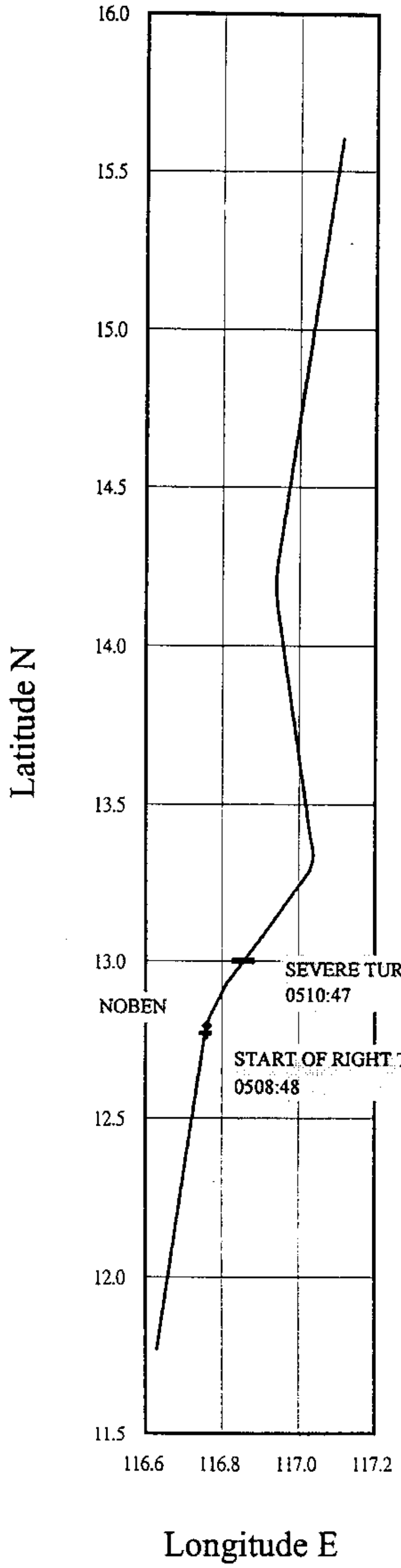
Hong Kong Observatory

Appendix 1



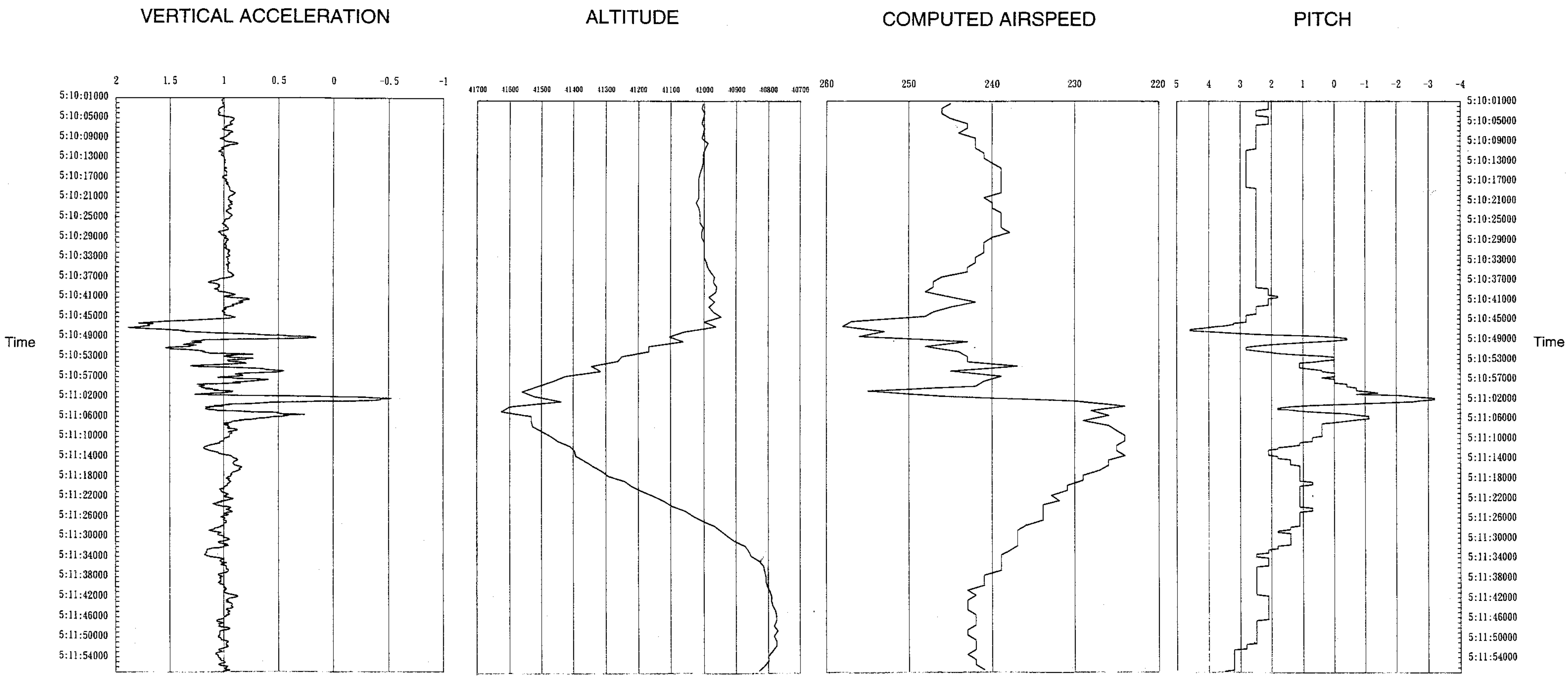
Acknowledgment : AIDU RAF

PLOT OF AIRCRAFT TRACK

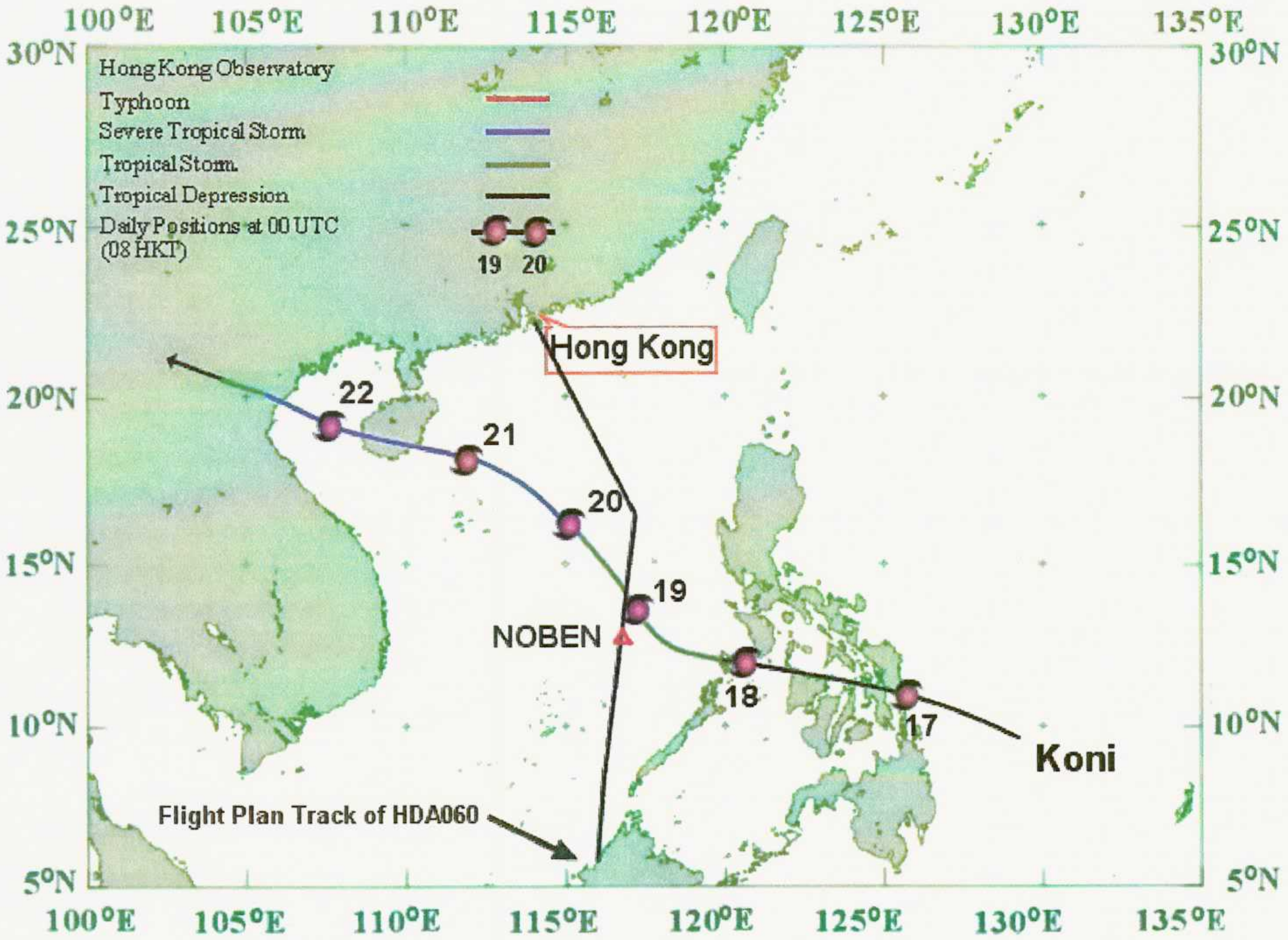


PLOT OF DFDR DATA

Appendix 3



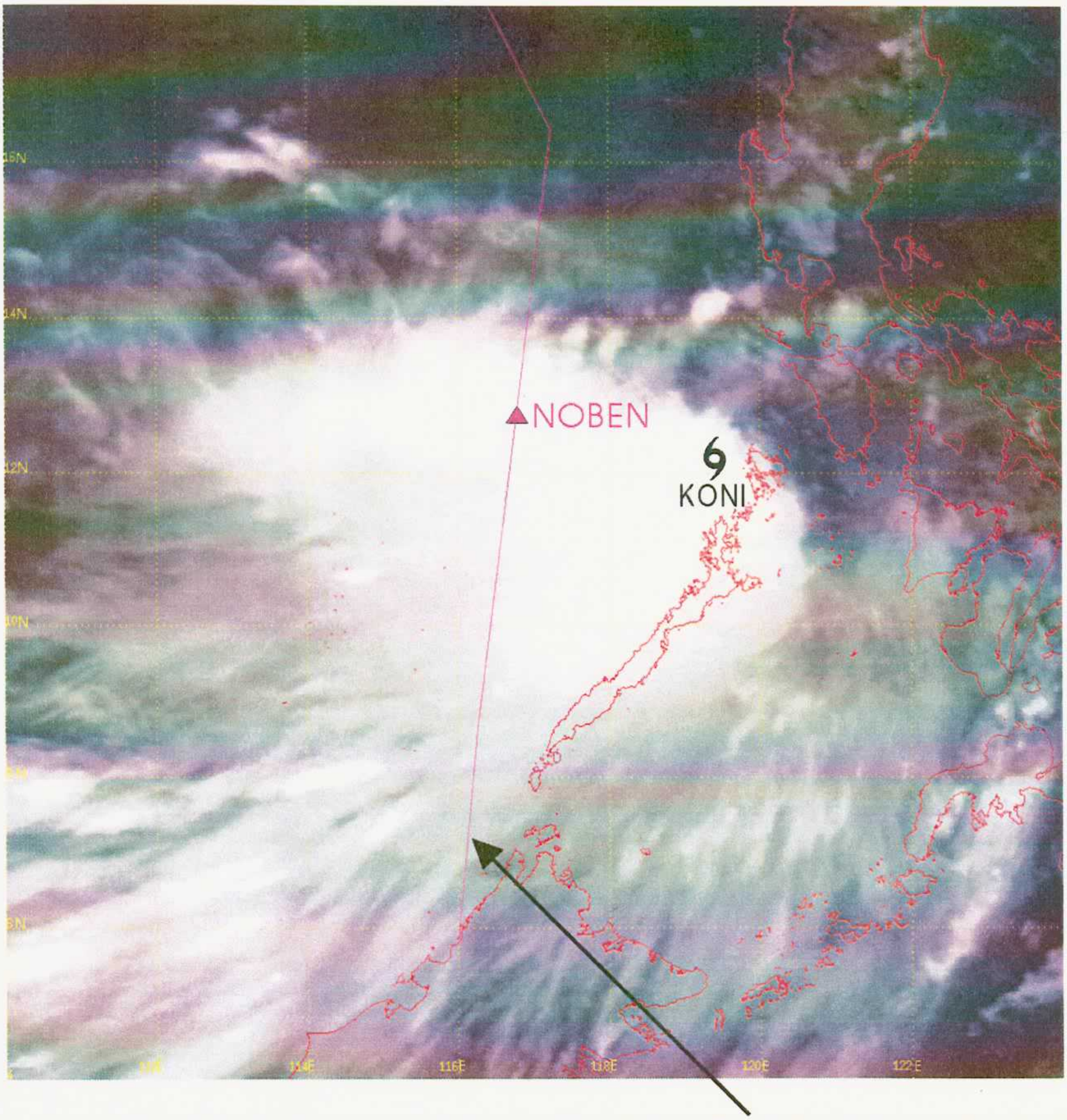
TRACK OF TROPICAL DEPRESSION/STORM "KONI"



The track of "KONI" was prepared by the Hong Kong Observatory based on tropical cyclone track and intensity data (post-analysis).

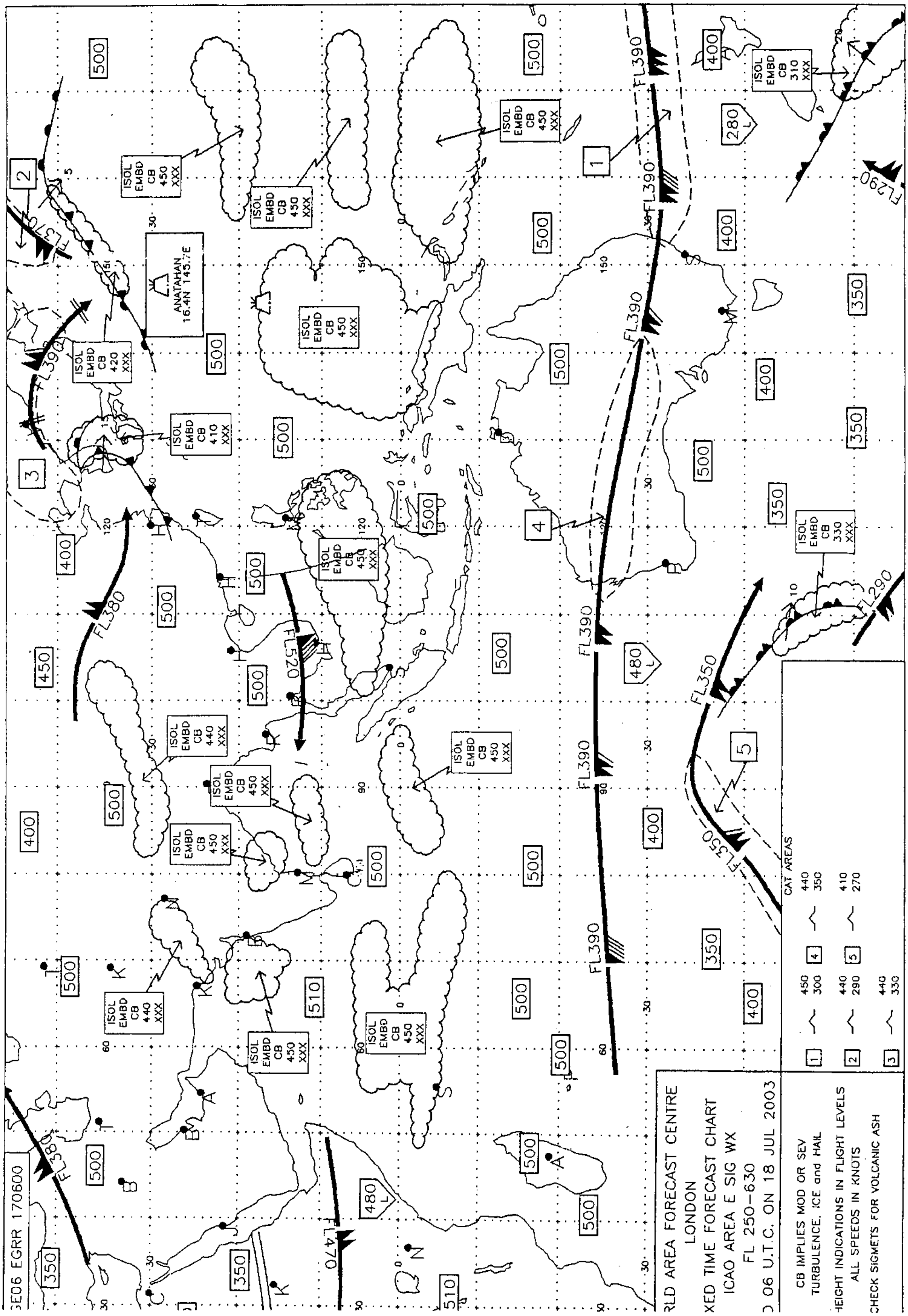
GOES-9 INFRA-RED SATELLITE PICTURE

0525 UTC 18 July 2003



The satellite imagery was captured with GOES-9 operated by the joint effort of Japan Meteorological Agency (JMA) and United States National Oceanic and Atmospheric Administration National Environmental Satellite Data and Information Service (US NOAA NEDIS). Position of "KONI" is a post-analysis position for 0600 UTC 18 July 2003.

WAFC Significant Weather Forecast Chart Valid for 0600 on 18 July 2003



Record of Traffic Operated in the Vicinity of NOBEN

AIRCRAFT REPORTS WITHIN 100 NM RADIUS FROM NOBEN AT 0030-0700 UTC
(Information provided by Manila ATC)

CALLSIGN	TYPE	ROUTE	POSITION	TIME	FL	DEVIATION (NM / Direction)
RPC6003	LJ60	M765	NOBEN	0043	430	15 / LEFT
HDA061	A333	M754	GUKUM	0140	390	10 / LEFT
HDA061	A333	M754	NOBEN	0152	390	10 / RIGHT
CPA777	A343	M754	NOBEN	0322	390	--
CAL367	B742	M765	NOBEN	0332	350	10 / RIGHT
CPA785	A333	M754	NOBEN	0346	390	10 / RIGHT
UPS6845	B752	N884	LULBU	0357	380	10 / LEFT
SIA072	B772	N884	LAXOR	0352	360	30 / RIGHT
SIA072	B772	N884	LULBU	0407	360	10 / LEFT
SVA862	B744	L628	GUKUM	0413	370	10 / LEFT
PAL502	A333	N884	LULBU	0423	380	10 / LEFT
CPA780	A333	M754	NOBEN	0424	370	10 / LEFT
PAL659	A340	L628	GUKUM	0440	370	--
MAS704	A332	N884	LULBU	0455	400	20 / LEFT
SVA863	B743	L628	GUKUM	0457	280	--
HDA060	A333	M754	NOBEN	0508	410	10 / RIGHT
GFA254	A343	L628	GUKUM	0515	370	--
QTR646	A332	L628	GUKUM	0545	370	--
THA620	A333	L628	GUKUM	0642	370	10 / LEFT

DRAGONAIR

File Ref No.	:	OPS/04/163(N)
A330 Operational Notices No.	:	75/02
Subject	:	TURBULENT AIR

Over the last few weeks we have had several incidents where flight attendants have been injured due to clear air turbulence while the seat belt sign was ON.

In an endeavor to improve our operation, I have held an internal departmental meeting to review and possibly improve our present procedures. It was agreed that our Volume 7 and Volume 8 clearly reflect Flight Operations present policy, and therefore no further clarification is required.
However, it is imperative that we highlight this important topic, so that with a greater awareness we may avoid this type of incident in the future.

The In-flight Service Department have issued an operations notice highlighting to their cabin crew that they are to stay alert at all times for the possibility of unexpected turbulence. They have been given further clarification on how they should respond if such turbulence is encountered.

Cockpit crews are to study the Significant Weather chart and Sigmet's for areas of possible severe turbulence, and brief SP / CP's prior to each departure with regard the approximate time during the flight that these weather conditions may be encountered. This information will be then be clearly passed on to all cabin crew so that when the seat belt sign is turned ON, crews can take the necessary precautions and care.

This briefing in no way reduces the flight crews normal responsibilities as per our Volume 7 and Volume 8.

I have taken this opportunity to leave in your personal mail box a copy of an Airbus article entitled "Flight in Severe Turbulence" written by Michel TREMAUD from Airbus Flight Operations Support. Please study this article for more relevant background information.

Marcus De Santis
Manager Airbus

Issued by : MA
Date Issued : 07 OCT 02.
Valid : UFN

HAD A330 OPERATIONAL NOTICE 59/03 – TURBULENT AIR

DRAGONAIR

File Ref No.	:	OPS/04/163(N)
A330 Operational Notices No.	:	59/03
Subject	:	TURBULENT AIR

Over the last few weeks we have had further incidents where flight attendants have been injured due to turbulence while the seat belt sign was ON. It is imperative that we again highlight this important topic, so that with a greater awareness we may avoid this type of incident.

The In-flight Service Department have issued an operations notice highlighting to their cabin crew that they are to stay alert at all times for the possibility of unexpected turbulence. They have been given further clarification on how they should respond if such turbulence is encountered.

During briefing, the cockpit crew, are to study the Sigmets and Weather charts for areas of possible turbulence. Using this information, the commander must ensure that the SP/CP have been adequately briefed including the expected time, duration and strength of these conditions.

An ideal opportunity for this briefing is during crew transport to the aircraft. Based on this brief the SP/CP will decide the cabin service schedule for the flight.

This briefing in no way reduces the flight crews' normal responsibilities as per our FCOM, Volume 7 and Volume 8. The above measures will give our cabin crew members a greater awareness of possible turbulence and the intensity which may be encountered during the flight, so they can take the necessary precautions.

Marcus De Santis
Manager Airbus

Issued by : MA
Date Issued : 22 AUG 03

Extract from FCOM 3.04.34 Page 3-5

WEATHER RADAR

R Airborne weather radar gives the flight crew an efficient tool for detecting bad weather
R during flight. The digital weather radar with its multicolor navigation display allows the
R crew to follow the best route to avoid weather problems.
To this end, some operational advice, based upon a general knowledge of the radar capabilities, is given in this chapter.

R **GENERAL**

R The radar is nothing more than a precipitation detector. How much weather it detects
R depends upon the raindrops, their size, composition and number.
R The radar does not detect :
· clouds, fog or wind (too small droplets or no precipitation at all)
· clear air turbulence (no precipitation)
· windshear (no precipitation except in microburst)
· lightning.
R The radar does detect :
· rainfall
· wet hail and wet turbulence
· ice crystals, dry hail and dry snow (above 30 000 feet) will only give small reflections.

OPERATIONAL FUNCTIONS

TILT, RANGE AND GAIN

R The three things that the flight crew must understand in order to take full advantage of the
R weather radar are :
R – antenna tilt, which causes the center of the radar beam to scan above or below the
R attitude reference plane
R – range control which, in coordination with tilt governs the range of the navigation display
R – gain control, which adjusts the sensitivity of the receiver (and should normally be set
R to AUTO). The sensitivity of the receiver may vary from one type of radar system to
R another.

COLOR CODE

R A color code distinguishes areas by the intensity of the precipitation in them :
R – black for the lowest intensity (nothing appears on the ND)
R – green, amber and red for progressively higher intensities
R – magenta for saturated areas, in the weather and turbulence mode (WX + T).

GROUND MAPPING

R The Ground Mapping mode enables more returns to be produced from less reflective targets on the ground. The associated color code is thus : Black for standing water (no R returns), green for the ground, and amber/red for cities and mountains (strong returns).

OPERATIONAL USE

CAUTION

Before selecting WX, WX/T, or MAP mode on the control unit, make certain that :
- No one is within a distance less than 5 meters from the antenna in movement within an arc of plus or minus 135° on either side of the aircraft centerline.
- The aircraft is not directed towards any large metallic obstacle, such as a hangar, which is within 5 meters in an arc of plus or minus 90° on either side of the aircraft centerline.

TILT AND RANGE MANAGEMENT

Refer to 3.03.

DETECTION AND INTERPRETATION ADVICE

General

1. Weather monitoring should be done at longer ranges, in order to assess weather developments and, thus, plan course changes.
2. Shorter ranges should periodically be changed to larger ranges to observe distant conditions and avoid blind alley or box canyon situations.
3. Generally speaking, ground returns appear smaller, sharper, more packed, well-defined, and usually more angular than weather targets ; whereas, the latter usually appear with less definite shapes and tend to remain relatively unchanged.
4. It is recalled that the line of sight distance to the horizon is :
   $D(NM) = 1.25 \sqrt{\text{(Aircraft altitude (feet))}}$.

Red/magenta areas : Thunderstorm, tornado, hail

It is recalled that the greater the rate of rainfall, the stronger the turbulence (magenta color) and the possibility of hail.

- To cope with thunderstoms, the following ranges should be selected on the NDs (if possible) :
  at least : 160 NM on the PNF ND
  80 NM on the PF ND
- In case of a large storm, the avoidance decision should be taken at 40 NM from the cell. To this end, the following recommendations apply :
  - Avoid magenta (Wx/T mode) /red areas and fringes by at least 20 NM if above the FL 230 and by 5 to 10 NM if below FL 230.
  - Avoid single magenta areas of turbulence (not associated with heavy precipitation) by at least 5 NM.
- Frequent tilt readjustments are recommended to monitor the storm development and to provide the maximum cell echo.
- Do not forget that omission to periodically adjust the tilt downwards causes targets to disappear.
- The following formula may be used to determine the vertical distance between the top of the cell and the aircraft flight level :

  $\boxed{\Delta h \text{ (feet)} \sim d(\text{NM}) \times \text{Tilt (degrees)} \times 100.}$

  Example :
  Cell at 40 NM disappearing at less than 3 degrees downtilt
  $\Delta h \sim 40 \times 3 \times 100 = 12000$ feet.
- Penetration or overflying by less than 5000 feet should not be attempted since severe turbulence might be encountered.

R If the top of cell is at or above 25000 feet, overflying should be avoided due to the
R possibility of encountering turbulence stronger than expected.

In the same way, flight under a thunderstorm should be avoided due to possible windshears, microbursts, severe turbulence or hail.

Turbulence mode : Wx + T

- The turbulence detection mode provides the most effective detection when on the 40 nm range on ND and with an appropriate tilt such that no ground returns are produced.
- As for heavy rainfall areas it is recommended to adjust frequently the tilt antenna, when in Wx + T mode, since turbulence areas vary with altitude.
- It is worth noting that closely spaced (or thin lines between) color gradations are usually associated with severe turbulence.

FLIGHT INSTRUMENT TOLERANCES

The values given below apply to an aircraft in symmetrical flight (no side slip), in clean configuration, in a straight and level flight.

Extract from FCOM 3.03.15 Page 2

DRAGONAIR A330 FLIGHT CREW OPERATING MANUAL	STANDARD OPERATING PROCEDURES	3.03.15	P 2
	CRUISE	SEQ 001	REV 18

– **NAVIGATION ACCURACY .... CHECK**
On aircraft equipped with GPS PRIMARY, the navigation accuracy check is not required, as long as GPS PRIMARY is available.
Otherwise, navigation accuracy must be monitored, particularly when any of the following occurs :
· IRS only navigation
· The PROG page displays LOW accuracy, or
· "NAV ACCUR DOWNGRAD" message appears.
Methods for checking accuracy :
· Manually tune VOR (VOR/DME or ADF) that is within range on RAD NAV page and select associated needles on ND.
Check that the needle (raw data) overlies the corresponding blue navaid symbol (FM computed) and that the DME distance is equal to the distance in between the aircraft symbol and the navaid symbol on the ND, or
· Insert a VOR/DME ident in the BRG/DIST TO field of the PROG page, and compare the computed BRG (DIST) with the raw data on the ND. This last method allows the FM error to be quantified.
If the check is positive (error ≤ 3NM EN ROUTE) : FM position is reliable.
– ND ARC or NAV and managed lateral guidance may be used.
If the check is negative (error > 3NM EN ROUTE) : FM position is not reliable.
– Use raw data for navigation and monitor it.
– If there is a significant mismatch between the display and the real position : Disengage MANAGED NAV mode and use raw data navigation (possibly switch to ROSE VOR so as not to be misled by FM data).

– **RADAR TILT .... ADJUST**
Below 20000 feet : A near zero degree tilt setting should be adjusted. Should two different ranges be selected on both NDs it is recommended to set a down tilt with the shorter ND range (in order to monitor and detect weather activity) and a near zero tilt with the longer ND range (in order to monitor course changes).
Above 20000 feet : A slight downward tilt is recommended.

– **CABIN TEMP .... MONITOR**
Pay regular attention to the ECAM CRUISE page in order to monitor passenger cabin temperatures and adjust them, as necessary.

R ● **If the oxygen mask has been used :**

R – **OXYGEN MASK .... CHECK**
R Check that the oxygen mask has been properly stowed, as indicated in the FCOM
R 1.35.20.

Extract from Operations Manual Volume 8 – Company Instructions

The call "TAKE OFF" should be made AFTER power has stabilised at 1.05 [1. 10] EPR, and when committed to take off by advancing the thrust lever towards the take off position; PNF is to start the CHRONO on the clock at that time.

During the take off roll the PNF is to monitor the flight instruments and ECAM and is to call any malfunction affecting safety.

The decision to continue or reject a take off is always to be made by CM1 and be announced by him calling "STOP" or "GO" . The commital speed for take off is always to be V1.

Monitoring duties take priority over all others to at least 2000 ft AAL and a good lookout must be maintained.

No turns are to be made below 500 ft AAL unless specified in an EOSID.

33. WEATHER RADAR

If it is anticipated that the weather radar will be required shortly after take off, it is to be selected ON whilst lining up for take off.

34. PACKS OFF TAKE OFF

For PACKS OFF take off select both PACKS off. The Packs Off selection may be completed as a 'Read and Do' item in the Before Take Off checklist to avoid an extended period of time on the ground with the Packs Off. Switching the APU Bleed ON may be used instead of selecting the Packs Off.

35. NOISE ABATEMENT

Apply TOGA/FLEX to 1500 ft AGL, Climb Thrust to 3000 ft AGL maintaining flaps at the Take Off position, then accelerate and retract flap.

36. ENGINE FAILURE ON TAKE OFF

If an engine failure occurs during T/O the ECAM actions are to be carried out down to the ENG SHUT DOWN items. An initial assessment of Damage or No Damage will have to be made. If there is damage (indicated by abnormal engine indications, vibration, noise etc) the ENG FIRE P/B should be pushed and AGENT 1 discharged. If there is no apparent damage a relight may be attempted but this should only be carried out when the aircraft is established in the climb from 1500ft or at a safe altitude and when both crew members are able to monitor the Relight Procedure.

37. ENGINE OUT SID

If an Engine Out SID is included in the Port Pages for a given runway, then the computer-generated Take Off Performance Data has been calculated using that procedure to avoid one or more obstacles. In the event of an engine failure on take off, the stated procedure MUST be flown for the performance information to be valid.

Extract from Operations Manual Volume 12 – Organization

3. SUBMISSION OF REPORTS

Pilots are to make occurrence reports on the Dragonair Air Safety Report (ASR) Form which has been approved by CAD as meeting the requirements of CAD 382 - The Mandatory Occurrence Reporting Scheme. The form may be returned to the CAD at the following address:

Airworthiness and Airports Operations Section, 10/F., Commercial Building, Airport Freight Forwarding Centre, 2 Chun Wan Road, Chek Lap Kok, Lantau, Hong Kong.

However, the preferred method is through the Dragonair Manager Flight Safety by completing the Air Safety Report (ASR) Form. The Flight Safety Department will then complete and submit any additional forms that are required by the CAD. This also allows for reports based on a broader criteria. The company will assess the reports received and submit only those it believes qualify as reportable occurrences. It is, however, the right of a pilot to insist that his report be submitted as Mandatory, if he so wishes.

Pilots, who have submitted a report will be informed of its progress and its submission to the CAD, if applicable.

NOTE: Occurrence Reports must be despatched to the Civil Aviation Department within 96 hours. The Manager Flight Safety will ensure that this requirement is met, however, reportees must do their part by ensuring timely dispatch of reports by fax to Manager Flight Safety.

Circumstances may arise which prevent crews from filing a written report within the specified period, in such cases alternative methods are available:

a. Forward the relevant details to the Dragonair Operations Department, attention Manager Flight Safety; by fax on +852 3193 2128 or by telephone on +852 3193 3473.

b. Fax the Civil Aviation Department direct. Fax No: +852 2362 4250.

c. If a report is submitted using any of the above methods, ensure that it is supported by a written report to Operations as soon as possible.

d. Air Safety Report (ASR) Forms are available from Operations and Crew Briefing. Air Safety Report Form is also carried in the navigation bags on board the aircraft.

4. DFDR/CVR/QAR RECORDINGS

Commanders and Engineers are reminded that DFDR and CVR recordings should not be erased. After an incident/accident the Commander may be approached by local authorities with a request for immediate access to CVR, DFDR and QAR data. Such requests should be referred to Dragonair Movement Control.