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AAIA

Air Accident Investigation Authority

Controlled Flight into Terrain Marginally Avoided

Serious Incident Investigation Final Report

B747-87UF

Lo Fu Tau, Lantau Island,

Hong Kong

24 September 2017

03-2021

AAIA Investigations

In accordance with Annex 13 to the Convention on International Civil Aviation and the Hong Kong Civil Aviation (Investigation of Accidents) Regulations (CAP. 448B), the sole objective of the investigation is the prevention of accidents and incidents. It is not the purpose of the investigation to apportion blame or liability.

The then Chief Inspector of Accident-cum-Director-General of Civil Aviation ordered an inspector's investigation into the serious incident in accordance with the provisions in CAP. 448B. As the powers of accident investigation were transferred to the Air Accident Investigation Authority (AAIA) with effect from 10 September 2018, the investigation of the serious incident was carried on by AAIA.

This serious incident final report contains information of an occurrence involving a Boeing B747-87UF aircraft, registration mark N856GT, operated under a wet-lease by Cathay Pacific Airways Limited (CPA), which occurred on 24 September 2017.

The National Transportation Safety Board (NTSB) of the United States of America, being the State of Registry, the State of the Operator, the State of Design and the State of Manufacture of the aircraft, Atlas Air Inc., Civil Aviation Department and CPA provided assistance to the investigation.

Unless otherwise indicated, recommendations in this report are addressed to the regulatory authorities of the State or Administration having responsibility for the matters with which the recommendation is concerned. It is for those authorities to decide what action is taken.

This final report supersedes all previous Preliminary Report and Interim Statements concerning this serious incident investigation.

All times in this Report are in Hong Kong Local Times unless otherwise stated. Hong Kong Local Time is Coordinated Universal Time + 8 hours.

Chief Accident and Safety Investigator

Air Accident Investigation Authority

Transport and Housing Bureau

Hong Kong

September 2021

Synopsis

On 24 September 2017, an Atlas Air Inc. Boeing 747-87UF freighter aircraft, registration mark N856GT, operated from Hong Kong International Airport (HKIA) to Ted Stevens Anchorage International Airport (PANC). The flight was operated under a wet lease[1] by Cathay Pacific Airways Limited (CPA) with flight number CPA86.

At 23:44 hrs, shortly after the aircraft took off from Runway 07R, the aircraft deviated to the right of the published Standard Instrument Departure (SID)[2] track and headed towards the high ground at Lo Fu Tau (elevation 1,527 ft) on Lantau Island. At 23:45 hrs, Air Traffic Control (ATC) informed the flight crew that the aircraft was off track and instructed the crew to turn left to resume the RASSE 1E SID. Shortly afterwards, ATC informed the flight crew of terrain to the right of the aircraft and instructed the crew to expedite the climb to 5,000 ft AMSL.

At approximately 2,000 ft AMSL, the Enhanced Ground Proximity Warning System (EGPWS) on board the aircraft was triggered with a Mode 2A[3] visual and the aural warning "TERRAIN, TERRAIN; PULL UP" annunciated. In response, the Pilot Flying (PF) reacted and the aircraft climbed, overflying the terrain. The aircraft evaded the high ground by approximately 670 ft AGL. Subsequently, the aircraft re-established the SID track at approximately 23:46 hrs and the flight continued without further incident. There was neither injury to personnel nor damage to the aircraft involved and no other air traffic was affected.

This report makes two Safety Recommendations.

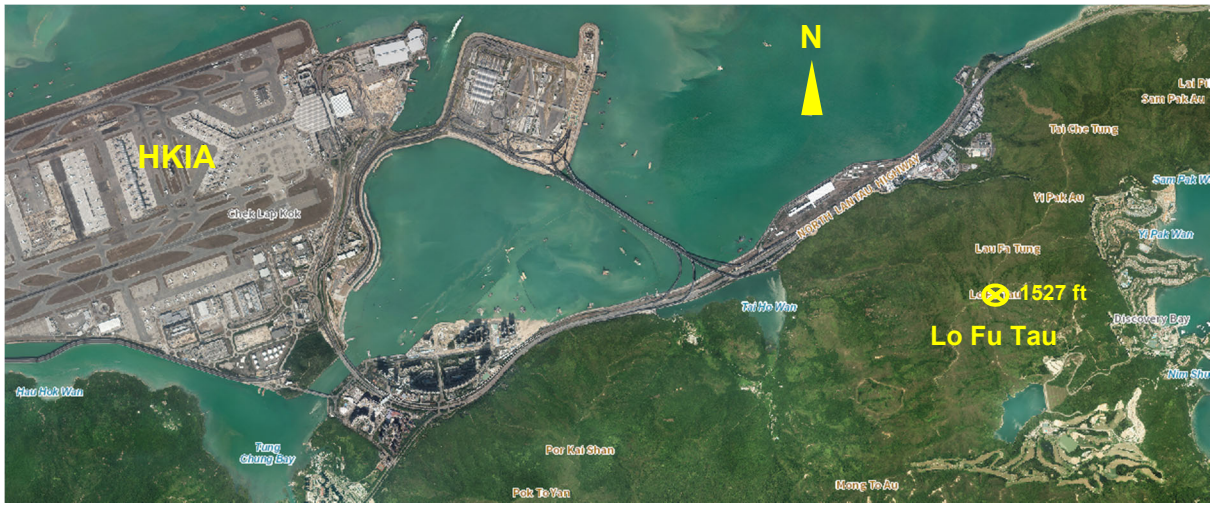

Figure 1: Overview of the area

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[1] A wet lease is a leasing arrangement in which one airline (the lessor) provides an aircraft, complete crew, maintenance, and insurance to another airline (the lessee). The aircraft is normally operated under the lessor's Air Operator's Certificate using their own Operations Manuals. The flights operated under a wet lease use the flight numbers of the lessee.

[2] A Standard Instrument Departure Route (SID) is a standard air traffic services route identified in an instrument departure procedure by which aircraft should proceed from take-off phase to the en-route phase.

[3] See paragraph 1.18.

Contents

1. Factual Information

1.1. History of the Flight

(1) On 24 September 2017, an Atlas Air Inc. Boeing 747-87UF freighter aircraft, registration mark N856GT, operated from Hong Kong International Airport (HKIA) to Ted Stevens Anchorage International Airport. The flight was operated under a wet lease by Cathay Pacific Airways Limited with flight number CPA86.

(2) The crew consisted of one Plot-in-command (PIC) and two first officers. The PIC was the Pilot Fying (PF). Of the two First Officers (FO), the junior FO was the Pilot Monitoring (PM). The senior FO, who was the Relief First Officer (RFO), sat in the cockpit observer seat during the departure. They all commented that they were well rested and ready for duty. In addition, a company captain not rated on Boeing 747-8 aircraft was in the cockpit as a passenger.

(3) The flight crew were based in Anchorage and two of them had flown together previously. The junior FO was inexperienced operating into HKIA. The PIC expected the senior FO to be the PM and the junior FO to watch the operation out of HK and act as the RFO. This was not assigned or discussed by the PIC with the crew. When the crew boarded the aircraft, the senior FO started to do the upper-deck preflight duties while the junior FO went to do the walk-around. When the junior FO returned to the cockpit after finishing the walk-around, he assumed the right seat as the PM. The PIC accepted the arrangement without comment.

1.1.1. Pre-departure

(1) As the crew was preparing the flight deck for departure, the PIC planned for a RNAV 1 SID RASSE 3A and gave a preliminary departure briefing to the PM. As part of his pre-flight duties, the PIC had already loaded the company filed flight plan in the Flight Management Computer (FMC). This was a data link upload and did not include the SID. The PIC also loaded the expected Runway 07R and the RASSE 3A SID per the Automatic Terminal Information Service (ATIS) information. The PM did not do an independent route verification.

(2) Prior to block out, the crew attempted a Data Link Departure Clearance (DLC) and eventually received a voice clearance from Hong Kong Delivery for the RASSE 1E, a Radius-to-Fix (RF) SID, with which the crew was unfamiliar. When the PIC selected and programmed RASSE 1E SID in the FMC, waypoint PORPA was overwritten and replaced by waypoint PORSH. Meanwhile, both the PIC and the PM had their respective Navigation Displays (NDs) selected in the Airport Moving Map (AMM)

display mode[4]. After execution, neither route verification nor a briefing on the new SID was conducted.

1.1.2. Departure

(1) The flight was cleared by ATC to depart HKIA from Runway 07R via the RASSE 1E SID. There were no questions raised by the crew during the Before Take-off checklist and Take-off / Departure Review while the aircraft was taxying prior to departure. The crew thought they reverted to the MAP display mode[5] on their NDs as the aircraft was turning onto the runway and both pilots simultaneously increased the range on their NDs. Neither the PF nor the PM analyzed the departure route that was being displayed.

(2) At 23:44 hrs, once the aircraft took off from Runway 07R, it commanded a right turn towards the first active waypoint PORSH.

(3) Climbing through approximately 1,800 ft AMSL, the PF called for PM to select the Left Autopilot (A/P) to command while the aircraft continued turning right towards the high ground at Lo Fu Tau. At 23:45:14 hrs, ATC informed the flight crew that the aircraft was off track and instructed the crew to turn left to resume the RASSE 1E SID. The PF started making a HDG Select heading change leaving VNAV engaged. Shortly afterwards, ATC informed the flight crew of terrain to the right of the aircraft and instructed the crew to expedite the climb to 5,000 ft AMSL (see Appendix).

(4) At approximately 2,000 ft AMSL, the Enhanced Ground Proximity Warning System (EGPWS) on board the aircraft was triggered with a Mode 2A visual alert and the aural warning “TERRAIN, TERRAIN; PULL UP” annunciated. In response, the PF immediately disconnected the A/P and increased pitch and thrust. The aircraft passed over the high ground by approximately 670 ft AGL. Subsequently, the aircraft re-established the SID track at approximately 23:46 hrs and continued without further incident. There was neither injury to personnel nor damage to the aircraft involved and no other air traffic was affected.

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[4] Airport Moving Map (AMM) display mode shows an illustration of the airport diagram on the ND.

[5] MAP display mode shows the magenta SID course line and waypoints on the ND.

Figure 2: Aircraft track

(Source: Atlas Air)

1.2. Injuries to Persons

The three pilots and the passenger were uninjured.

Injuries to Persons						
Persons on board:	Crew	3	Passengers	1	Others	0
Injuries:	Crew	0	Passengers	0		

Table 1: Injuries to Persons

1.3. Damage - Aircraft

Not applicable.

1.4. Other Damage

Not applicable.

1.5. Personnel Information

Refer to paragraph 6.2 for personnel details.

1.6. Aircraft Information

Refer to paragraph 6.3 for aircraft details.

1.6.1. Flight Management System

(1) The Flight Management System (FMS) is an integrated computer system using Flight Management Computers (FMCs) that provides the flight crew with navigation, performance information, and cockpit instrumentation displays. The FMS contains a Navigation Database (NDB) that is updated regularly. The NDB has the information required including SIDs for constructing a flight route. For the flight crew, the FMS is controlled through a Control Display Unit (CDU). In the cockpit, there are three CDUs of which two are located at either side of the center pedestal for both PIC and PM, respectively.

(2) During preflight, the flight crew enters the flight plan, the applicable route and flight data into the CDUs. The flight plan is entered into the CDU either by typing it in, selecting it from a saved file of routes or via an Aircraft Communications Addressing and Reporting System (ACARS) datalink with the airline dispatch center. The FMS then uses the navigation database, airplane position, and supporting system data to calculate commands for manual and automatic flight path control.

1.6.2. CDU and Navigation Display (ND)

A CDU incorporates a small screen and keyboard. After the data on each preflight page is entered and selecting ACTIVATE on the ROUTE page, the execute (EXEC) light illuminates. Pushing the EXEC key activates the route. The FMS then sends the flight route information for display on the Navigation Display (ND) of the cockpit instrumentation.

1.6.3. ND Display Mode

Different modes can be selected to display on the ND. The Airport Moving Map (AMM) display mode shows an illustration of the airport diagram. The MAP display mode shows the flight route including the SID as a magenta line with the associated radio aids and waypoints.

1.6.4. Deletion of Waypoint

The Departure Arrival (DEP ARR) page is used to select a SID. Selection of the SID may cause a route discontinuity. Resolution of the discontinuity and execution of the modification is accomplished on the LEGS page. The LEGS page displays the enroute waypoints in sequence from the top of the screen according to the route executed. Deletion of the first waypoint (i.e. the uppermost waypoint displayed) automatically makes the following waypoint become the first and active waypoint.

1.7. Meteorological Factors

The meteorological aerodrome weather report for VHHH at 23:47 hrs indicated that the wind was from 110º at 12 kt. The visibility was 10 km, with few clouds at 1,500 ft and scattered clouds at 2,800 ft. The temperature was 30º C with dew point at 25º C. Neither low level windshear nor turbulence warning was reported around the time of the incident.

1.8. Navigation Aids

1.8.1. RASSE 3A SID

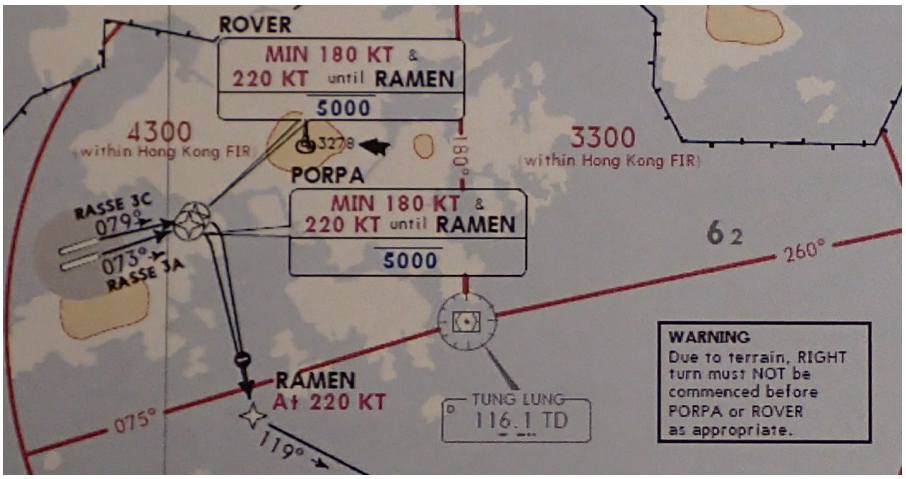

Figure 3: RASSE 3A SID

(Source: Atlas Air)

For the RASSE 3A SID, PORPA is a flyover waypoint and the departure chart includes a WARNING regarding right turn must not be commenced before waypoint PORPA.

1.8.2. RASSE 1E SID

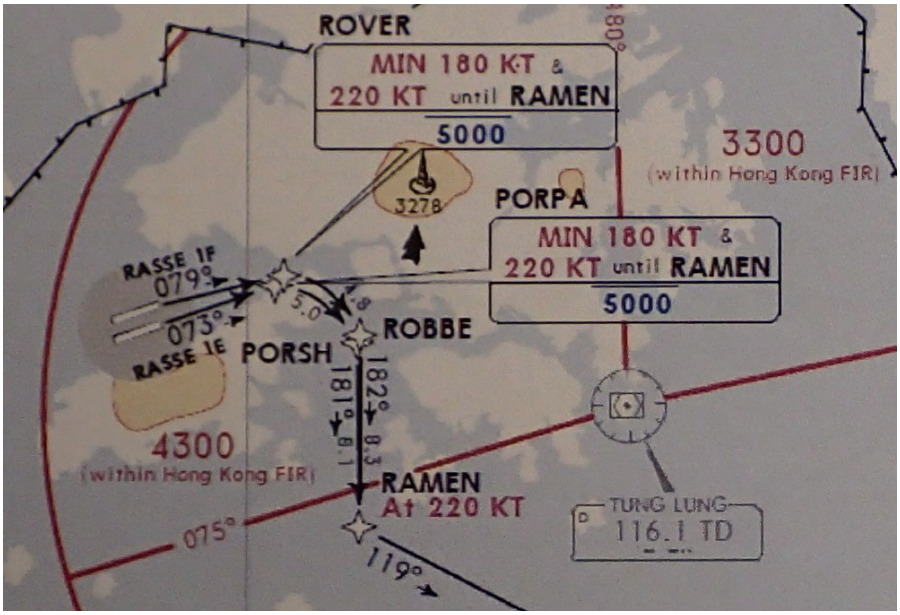

Figure 4: RASSE 1E SID

(Source: Atlas Air)

In comparison with the RASSE 3A SID, despite the WARNING regarding PORPA is not stated, the aircraft Radius-to-Fix (RF) capability will ensure aircraft flying the RASSE 1E SID tracking overhead waypoint PORPA.

1.8.3. SID Assignment

The flight was assigned the RASSE 1E SID. They did not realize they had been assigned an RF SID which they were unfamiliar with. The PIC selected and executed the RASSE 1E SID. The PM was busy with the aircraft electronic checklist and did not confirm the selection of the new SID. The PIC then turned toward the RFO and asked what the difference between the 3A and 1E was. The RFO did not see PORPA on the RASSE 1E chart and told the PIC that PORPA was not on the RASSE 1E chart. The PIC selected PORSH on the LEGS page of the CDU and placed it over PORPA, making PORSH the first and active waypoint of their departure route.

1.8.4. Selection of Navigation Display (ND) Mode

The crew stated that during the route modification both NDs were in the AMM display mode. They did not notice the active waypoint change or the magenta SID course line had shifted. The NDs remained in the AMM display mode until the aircraft was on the runway just prior to takeoff.

1.9. Communications

The crew was on two-way radiotelephony (RTF) communication with Hong Kong Departure on the designated VHF frequency of 123.8 MHz.

1.10. Aerodrome Information[6]

1.10.1. Standard Instrument Departure (SID) Procedures

Unless specifically notified an IFR departure shall expect a SID. RNP 1 SIDs have been implemented in Hong Kong Terminal Control Area (TMA).

1.10.2. Departure Report

After takeoff, on first contact with 'Hong Kong Departure', the pilot shall state the aircraft callsign, report the passing altitude to the nearest 100 ft and assigned altitude.

1.10.3. Speed Control

Speed control shall be in force unless otherwise advised - pilots will be individually informed by ATC when speed control is cancelled. Unless otherwise instructed, departing aircraft shall fly at 250 KIAS or less below 10,000 ft AMSL. Pilots shall also comply with speed control restrictions published in the SIDs. ATC may issue further speed adjustment instructions during the various phases as and when required by traffic situations.

1.10.4. Track Keeping Accuracy

(1) SID procedures are based on aircraft accurately following the published track as defined by the SID navigation aids, significant points and waypoints. Pilots using FMS/RNAV equipment should note that in order to ensure terrain clearance, Hong Kong SID Significant Points PORPA, PRAWN and ROVER are 'flyover' waypoints. All other SID Significant Points are 'flyby' waypoints and turn anticipation by the FMS/RNAV is permitted, however pilots shall comply with the published speed control procedures to limit the radius of turn, unless otherwise advised by ATC.

(2) If aircraft are unable to follow the SID track, pilots should advise ATC and request assistance.

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[6] Hong Kong Aeronautical Information Publication

(3) On termination of a SID, aircraft must connect to the appropriate terminal transition route. Terminal transition routes are detailed in chapter ENR 3.1 of Hong Kong Aeronautical Information Publication (HKAIP).

1.11. Flight Recorders

(1) Neither the Cockpit Voice Recorder (CVR) nor the Flight Data Recorder (FDR) data was available from Atlas Air. Atlas Air provided the investigation with Figure 2: Aircraft track in this report and a flight animation based on the Quick Access Recorder (QAR)[7] data.

(2) No Secondary Surveillance Radar (SSR)[8] data was available from CAD. CAD provided the investigation with a manually recorded radar screen replay.

1.12. Wreckage and Impact

Not applicable.

1.13. Pathological Information

There was no evidence that the crewmembers were under the influence of alcohol or drugs.

1.14. Smoke, Fire, and Fumes

Not applicable.

1.15. Survival Aspects

Not applicable.

1.16. Tests and Research

Not applicable.

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[7] Quick Access Recorder (QAR) is an airborne flight data recorder designed to provide quick and easy access to raw flight data.

[8] Secondary Surveillance Radar (SSR) is a radar system that interrogates the transponders equipped on aircraft. The reply to each interrogation signal by the transponder of an aircraft transmits encoded data such as an identity code, the aircraft's altitude and ground speed back to the radar station.

1.17. Organisation, Management, System Safety

1.17.1. OPERATIONAL INSTRUCTION 39/15[9]

(1) The purpose of this Operational Instruction is to update the procedures for flight activation of RWY 07 departures during Noise Mitigating Period (FPL EOBT 1445-2300 UTC).

(2) This Operational Instruction is addressed to all operational staff of the Aerodrome and Approach Stream.

(3) Currently, RF SID (e.g. RASSE 1E) will not be input into the Flight Data Processing System (FDPS) during flight activation. Approved aircraft planning to fly the RF SID will make request to Clearance Delivery Control (CDC) when obtaining ATC clearance. Tower Flight Planning (TFP) upon instruction from CDC will update the FDPS and order-print the updated strip to Air Traffic Control Centre (ATCC).

(4) CPA and other local airlines have notified that most of their aircraft have been approved to fly the RF SID. To streamline the flight activation process and co-ordination with pilots, arrangements have been made with the airlines for their departing flights during the noise mitigating period when RWY 07 is in use to be given the RF SID, effective from 11 November 2015, unless otherwise requested by the pilot.

1.18. Additional Information

1.18.1. Enhanced Ground Proximity Warning System (EGPWS)

(1) The EGPWS is a terrain awareness and alerting system providing terrain alerting and display functions to alert pilots if their aircraft is in immediate danger of flying into the ground or an obstacle. The EGPWS uses aircraft inputs including geographic position, attitude, altitude, ground speed, vertical speed and glideslope deviation combined with a worldwide digital terrain database to predict a potential conflict between the aircraft flight path and terrain or an obstacle.

(2) If an aircraft is approaching ground surface or ocean surface in excess of specific rate, the system compares the aircraft's location and topographic data, and provides the pilot with visual, and audio caution or warning alerts.

[9] Operational Instructions are internal instructions concerning operational matters issued by the Air Traffic Management Division (ATMD) of the Civil Aviation Department (CAD) and addressed to ATC operational staff.

(3) Mode 2A is one of the alerting modes that is active during climb out, cruise, and initial approach (flaps not in the landing configuration and the aircraft not on glideslope centreline) with respect to excessive terrain closure rate. If the aircraft penetrates the Mode 2A caution envelope, the aural message “TERRAIN, TERRAIN” is generated and cockpit EGPWS caution lights will illuminate. If the aircraft continues to penetrate the envelope, the EGPWS warning lights will illuminate and the aural warning message “PULL UP” is repeated continuously until the warning envelope is exited.

(4) Upon exiting the warning envelope, if terrain clearance continues to decrease, the aural message “TERRAIN” will be given until the terrain clearance stops decreasing. In addition, the visual alert will remain on until the aircraft has gained 300 ft of barometric altitude, 45 seconds has elapsed, or landing flaps or the flap override switch is activated.

1.19. Useful or Effective Investigation Techniques

Not applicable.

2. Safety Analysis

The Safety Analysis provides a detailed discussion of the safety factors identified during the investigation, providing the evidence required to support the findings, contributing factors and the safety recommendations.

2.1. Crew Resource Management (CRM)

(1) The flight crew were based in Anchorage and two of them had flown together previously. The junior FO was inexperienced operating into HKIA.

(2) Operating from an unfamiliar airport at night time would inevitably put additional pressure on the junior FO. The PIC would have been aware of this as he expected the senior FO to be the PM and the junior FO, acting as RFO, to watch the operation out of Hong Kong. It is very likely that the PIC had planned for the respective roles of the senior FO and the junior FO with regard to their experience for the flight. However, the respective flying duties of the senior FO and the junior FO were neither discussed nor assigned explicitly by the PIC among the three in the first place.

(3) Without having been assigned by the PIC, the senior FO and the junior FO assumed their duties as RFO and PM, respectively when they entered the cockpit. At this juncture, as there had been no communication initiated to discuss the arrangement, the PIC, the PM and the RFO could have perceived that it was mutually accepted even though it would have been contrary to the PIC's original planning. This arrangement would have been contrary to the PIC's original planning.

2.2. Anticipated SID

Before push-back as part of his pre-flight duties, the PIC had already loaded the company filed flight plan, the anticipated Runway 07R and RASSE 3A SID in the FMS. Also, he gave a preliminary departure briefing to the PM. The PM then did an independent route verification including the RASSE 3A SID. At that stage, the crew were mentally prepared for the RASSE 3A SID that they were anticipating. The names and symbols of the waypoints and the SID course magenta line that would have displayed on the CDU and ND with respect to the RASSE 3A SID are depicted in Figure 5.

Figure 5: Simulated RASSE 3A SID that displayed on the CDU and ND

2.3. Issue of the RADIUS-TO-FIX (RF) RASSE 1E SID Clearance

The flight was operated under a wet lease by CPA with flight number CPA86. As per the Operational Instruction 39/15, ATC assigned the RADIUS-TO-FIX (RF) RASSE 1E SID in accordance with the standing agreement with CPA.

2.4. Acceptance of the RASSE 1E SID Clearance

(1) For the departure preparation, the crew of CPA86 followed paragraph 3.1.1 – START-UP PROCEDURES of the Jeppesen Airport Briefing Page[10] stating that approved aircraft planning to fly the Radius-to-Fix SID shall make request when obtaining ATC clearance, using recommended phraseology – "Request Radius-to-Fix SID". No request was made by the crew of CPA86 as they did not plan to fly the RF SID in the first place.

(2) As Atlas Air was not a local airline and as Operational Instruction 39/15 was an arrangement between local airlines and ATC, the crew of CPA86 would not have known the reason they were given a RF SID clearance without making an initial request to ATC and accepted it.

[10] Section 3.1.1 Start-Up Procedures of the Jeppesen 10-1 P8 Airport Briefing Page.

2.5. Time Pressure

Once an ATC clearance has been received, unless there is a specific time restriction included in the clearance, any delay in being ready to push-back, start engines or taxi may result in the clearance being cancelled. Being new to the Hong Kong operational environment and concerned being able to push-back on time, the PM felt pressured but did not communicate this to the PIC.

2.6. Technical Misunderstanding

The crew was not familiar with the RF RASSE 1E SID and it was the first time that the crew received this clearance. Having been given the RASSE 1E SID that was unanticipated, unfamiliar and compounded with time pressure, the crew accepted the clearance. After discussion amongst the crew and possibly due to the perceived time constraint, it was eventually decided that waypoint PORPA was not part of the SID. The SID was thus manually modified, making waypoint PORSH as the first active waypoint after takeoff. By doing so, the SID course magenta line would have veered to the right (see Figure 6).

Figure 6: Simulated modified RASSE 1E SID that displayed on the CDU and ND

(Source: Atlas Air)

2.7. Situational Awareness

(1) It is critical that the loaded flight plan and SID be cross-checked to ensure that discrepancies between the flight plan and the ATC route clearance do not exist. The CDU should be used to cross check the route entry and the ND should be used for illustration during the cross-check and reference made to the approved chart to ensure the SID entered is as published.

(2) During the Before Takeoff checklist and Takeoff/Departure Review there were no questions raised by the crew as they taxied for departure. Both NDs remained in the AMM display mode, that shows only an illustration of

the airport diagram, between the time the SID was amended and just prior to takeoff. Not having selected the MAP display mode that shows the SID course during this period would preclude the crew from cross-checking, thus noticing and analysing the veering of the SID course magenta line to the right.

(3) Had the RASSE 1E SID not been amended and a cross-check been done with either ND selected on the Map display mode, the crew would have seen the illustration of RASSE 1E SID (see Figure 7). As the crew amended the SID with both NDs on the AMM display mode, they would not have seen the illustration of the un-amended RASSE 1E SID in the first place. When the NDs were eventually selected to the MAP display mode at the very last moment just prior to takeoff, the right veering of the SID course would appear to be less conspicuous as the crew had not looked at the depiction of the un-amended RASSE 1E SID, with which they could compare to notice the difference. It was also not noticed that the display indicated that the first active waypoint PORSH was not on the runway heading (see Figure 8).

Figure 7: RASSE 1E SID

(Source: Atlas Air)

Figure 8: Modified RASSE 1E SID

(Source: Atlas Air)

(4) It was not a requirement of the operator's SOP to have the TERRAIN page superimposed on the MAP display mode in the Before Takeoff checklist and Takeoff/Departure Review. It is very likely that the crew before takeoff would not have been aware of the amended RASSE 1E SID course that turns right towards waypoint PORSH would cross the terrain to the south of the airport after airborne.

(5) As a result, the flight departed on Runway 07R and once airborne the aircraft commanded a right turn toward the first waypoint PORSH. The crew were then alerted by both ATC and EGPWS warnings.

(6) Boeing advised the investigation that the company publishes a specific recommendation for use of the Terrain Display within the relevant Flight Crew Training Manual. The excerpt is provided below:

*Weather Radar and Terrain Display Policy**

Whenever the possibility exists for adverse weather and terrain/obstacles near the intended flight path, one pilot should monitor the weather radar display and the other pilot should monitor the terrain display. The use of the terrain display during night or IMC operations, on departure and approach when in proximity to terrain/obstacles, and at all times in non-radar environments is recommended. Note: It may be useful to show the terrain display at other times to enhance terrain/situational awareness.

**source: 747 Flight Crew Training Manual, Section 1.48*

3. Conclusions

3.1. Findings

From the evidence available, the following findings are made with respect to this occurence. These findings should not be read as apportioning blame or liability to any particular organisation or individual.

(1) The crewmembers were qualified (paragraph 1.5).

(2) The arrangement of the crew's duties would have been contrary to the PIC's original planning (paragraphs 1.1 and 2.1).

(3) The crew anticipated and prepared for RASSE 3A SID during the pre-flight phase (paragraphs 1.1.1 and 2.2).

(4) The crew did not request the RF SID (paragraphs 1.1.1, 1.8.3 and 2.4).

(5) A RF RASSE 1E SID was assigned to CPA86 in accordance with Operational Instruction 39/15 (paragraphs 1.17 and 2.3).

(6) The crew were unfamiliar with the RASSE 1E SID (paragraph 1.1.1).

(7) Waypoint PORPA was replaced by waypoint PORSH while programming the RASSE 1E SID into the FMC (paragraphs 1.1.1 and 1.8.3).

(8) Being new to the Hong Kong operational environment and concerned being able to push-back on time, the PM felt pressured but did not communicate this to the PIC (paragraphs 1.1 and 2.5).

(9) Both NDs were in the AMM display mode during the route modification and remained in that mode until just prior to takeoff (paragraph 1.8.4).

(10) Prior to departure it is highly unlikely the crew would have been aware that the amended departure course towards waypoint PORSH would cross the high terrain to the south of the airport (paragraph 2.7).

(11) ATC informed the crew that the aircraft was off track at 23:45:14 hrs (paragraph 1.1.2).

(12) At about 2,000 ft AMSL, the EGPWS Mode 2A onboard the aircraft was activated and gave the associated aural and visual warnings ‘TERRAIN, TERRAIN; PULL UP’ (paragraph 1.1.2).

(13) After the EGPWS 2A warnings, the PF disconnected the autopilot, increased pitch, and advanced the thrust levers (paragraph 1.1.2).

(14) The aircraft flew over terrain at Lo Fu Tau, Lantau Island at approximately 670 ft AGL (paragraph 1.1.2).

3.2. Causes

Modification of the RF SID RASSE 1E while programming the SID into the FMC by overwritten waypoint PORPA, making PORSH the first active waypoint (paragraphs 1.8.3 and 2.6).

3.3. Contributing Factors

(1) CRM – assignment of the FOs’ duties and lack of communication amongst the crew (paragraphs 2.1 and 2.5).

(2) The crew accepted the RF SID RASSE 1E with which they were not familiar (paragraph 2.4).

(3) The SID course and the first active waypoint were not verified (paragraph 2.7).

4. Safety Actions Already Implemented

Whether or not AAIA identifies safety issues in the course of an investigation, relevant organisations may proactively initiate safety action in order to reduce their safety risk.

AAIA has been advised of the following proactive safety action in response to this occurrence.

4.1. Proactive Safety Actions Taken by Atlas Air

(1) Immediate actions:

(a) Company, Jeppesen 10-0 pages have been created for HKIA to highlight procedures and threats.

(b) Operations Bulletin (Must Read) to all crewmembers outline prohibition of modifying RNAV procedures.

(c) Release Remark in flight plan to contact dispatch for HKIA briefing.

(2) Flight operations:

(a) FCOM Revisions – all approaches/departures must be retrievable from the FMC Navigation Database, waypoints cannot be added or deleted. ND Range must be increased prior to takeoff to verify first fix/waypoint and track altitude and speed as required. One pilot must display TERRAIN on the ND at any airport with terrain.

(b) Develop PBN training module for all crewmembers.

(c) Formal captain crew briefing prior to aircraft arrival.

(d) Enhance operating experience training.

(e) Recurrent training airports to change annually.

5. Safety Recommendations

5.1. Safety Recommendation 08-2021

It is recommended that SID procedures should not be manually modified (paragraph 3.2).

Safety Recommendation Owner: Atlas Air

5.2. Safety Recommendation 09-2021

It is recommended that the FCOM of the operator be reviewed to ensure that discrepancies between flight plan and ATC route clearance do not exist prior to take-off (paragraphs 2.7 and 3.3.3).

Safety Recommendation Owner: Atlas Air

6. General Details

6.1. Occurrence Details

Date and time:	24 September 2017 23:45 hrs (Local)	
Occurrence category:	Serious Incident	
Primary occurrence type:	Controlled Flight into Terrain Marginally Avoided	
Location:	Lo Fu Tau, Lantau Island, Hong Kong	
	Latitude: 22º 17.9” N	Longitude: 114º00.1” E

6.2. Personnel Details

6.2.1. Captain (Pilot Flying)

Licence:	Airline Transport Pilot Certificate
Ratings:	MD-11, B737, B747-400, B747-800
Date of issue:	February 2008
Medical certificate:	Class 1 (issued in September 2017)
Aeronautical experience:	31,970 total hours (14,070 hours at Atlas)

6.2.2. First Officer (Pilot Monitoring)

Licence:	Airline Transport Pilot Certificate
Ratings:	CL-65, ERJ170, ERJ190, B747-400, B747-800
Date of issue:	July 2017
Medical certificate:	Class 1 (issued in July 2017)
Aeronautical experience:	11,898 total hours (77 hours at Atlas)

6.2.3. Relief First Officer (seated on jump seat)

Licence:	Airline Transport Pilot Certificate
Ratings:	CW-46, EMB120, L382, B747-400, B747-800
Date of issue:	October 2015
Medical certificate:	Class 1 (issued in August 2017)
Aeronautical experience:	15,932 total hours (982 hours at Atlas)

6.3. Aircraft Details

Manufacturer and model:	Boeing Aircraft Company B747-87UF
Registration:	N856GT
Aircraft Serial number:	MSN 37561
Engine:	GE Genx-2B67 turbo-fan engine
Operator:	Atlas Air Inc.
Type of operation:	Cargo
Departure:	VHHH
Destination:	PANC

7. Abbreviations

ACARS	Aircraft Communications Addressing and Reporting System
AGL	Above Ground Level
AMM	Airport Moving Map
AMSL	Above Mean Sea Level
Annex 13	Annex 13 to the Convention on International Civil Aviation
ATC	Air Traffic Control
ATCC	Air Traffic Control Centre
ATIS	Automatic Terminal Information Service
ATMD	Air Traffic Management Division
A/P	Autopilot
CAD	Civil Aviation Department
Cap. 448B	Hong Kong Civil Aviation (Investigation of Accidents) Regulations
CDC	Clearance Delivery Control
CDU	Control Display Unit
CPA	Cathay Pacific Airways Limited
CRM	Crew Resource Management
CVR	Cockpit Voice Recorder
º C	Degree Celsius
DLC	Data Link Departure Clearance
EGPWS	Enhanced Ground Proximity Warning System
ENR	En-route
ft	Feet
FCOM	Flight Crew Operations Manual
FDPS	Flight Data Processing System
FDR	Flight Data Recorder
FMC	Flight Management Computer
FMS	Flight Management System
FO	First Officer
GEN	General
HDG	Heading
HKAIP	Hong Kong Aeronautical Information Publication
HKIA	Hong Kong International Airport
hrs	Hours

ICAO	International Civil Aviation Organization
kg	Kilograms
KIAS	Indicated Airspeed in Knots
km	Kilometres
kt	Knots (nautical miles per hour)
m	Metres
MHz	Megahertz
ND	Navigation Display
NDB	Navigation Database
NTSB	National Transportation Safety Board of the United States
PBN	Performance Based Navigation
PIC	Pilot-in-command
PF	Pilot Flying
PM	Pilot Monitoring
QAR	Quick Access Recorder
RF	Radius-to-Fix
RFO	Relief First Officer
RNAV	Area Navigation
RNP	Required Navigation Performance
RTF	Radiotelephony
s	Seconds
SID	Standard Instrument Departure
SSR	Secondary Surveillance Radar
TFP	Tower Flight Planning
TMA	Terminal Control Area
UTC	Universal Time Coordinated
VHF	Very High Frequency
VHHH	Hong Kong International Airport
VNAV	Vertical Navigation

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8. Table of Figures, Photos, Tables

9. Appendix

9.1. R/T COMMUNICATION TRANSCRIPT OF CPA86

R/T COMMUNICATION TRANSCRIPT OF CPA86
(TWR South & DEP) ON 24 September 2017

TIME (UTC)	STATION	R/T COMMUNICATION
15:37:21	CPA86	Hong Kong Tower, Cathay Eighty-six on Kilo holding short of the Cat two....er...hold short point
15:37:28	HK TOWER SOUTH	Cathay Eight-six, taxi Kilo-one Holding Point
15:37:31	CPA86	Kilo-one Holding Point, Cathay Eighty-six
15:41:05	HK TOWER SOUTH	Cathay Eight-six, line up and wait Runway zero-seven-right
15:41:10	CPA86	Line up and wait zero-seven-right, Cathay Eighty-six
15:42:39	HK TOWER SOUTH	Cathay Eight-six, wind one-one-zero degrees eight knots runway zero-seven-right, clear for takeoff
15:42:46	CPA86	Clear for takeoff zero-seven-right, Cathay Eight-six
15:44:07	HK TOWER SOUTH	Cathay Eight-six, contact Departure one-two-three decimal eight, good day
15:44:12	CPA86	One-two-three decimal eight, Cathay Eight-six
15:44:23	CPA86	Departure, Cathay Eight-six, one-thousand climbing five-thousand
15:44:28	HK DEPARTURE	Cathay Eight-six, Departure identified
		(Other transmissions)
15:45:10	SYSTEM	(Beep) (Incoming intercom from Tower)
15:45:11	HK DEPARTURE	(Intercom) Yeah?
15:45:12	HK TOWER	(Intercom) Contact with Cathay Eight-six
15:45:14	HK DEPARTURE	Cathay Eight-six, er…Cathay Eight-six …er… you are off track now. Turn left now to resume RASSE One-Echo, please
15:45:23	HK DEPARTURE	(Intercom) Affirm

R/T COMMUNICATION TRANSCRIPT OF CPA86 (TWR South & DEP) ON 24 September 2017

TIME (UTC)	STATION	R/T COMMUNICATION
15:45:23	HK TOWER	(Intercom) Okay
15:45:25	HK DEPARTURE	Cathay Eight-six?
15:45:28	CPA86	On track for Cathay Eight-six
15:45:30	HK DEPARTURE	Cathay Eight-six, er.....there's terrain on your right. Expedite your climb to five-thousand feet
15:45:36	CPA86	Climbing five-thousand feet Cathay Eight-six
15:45:38	HK DEPARTURE	Cathay Eight-six and turn left now to resume RASSE One-Echo
15:45:48	CPA86	Cathay Eight-six, on track
		(Other transmissions)
15:46:22	HK DEPARTURE	Cathay Zero-eight-six, er.... You can turn right, er... to resume the RASSE One-Echo, please
15:46:29	CPA86	Right turn to resume the RASSE One-Echo, Cathay Eight-six
15:46:33	HK DEPARTURE	Cathay Eight-six, you can turn right direct to RAMEN
15:46:36	CPA86	Right turn direct RAMEN Sky er...Cathay Eight-six
		(Other transmissions)
15:47:23	HK DEPARTURE	Cathay Zero…
15:47:24	CPA905	(Inaudible - double transmission) maintaining three-thousand.
15:47:26	HK DEPARTURE	Cathay Niner-zero-five, identified
15:47:29	CPA905	We would like to climb to four-thousand-five-hundred, thanks