Aviation Safety Council

Taipei, Taiwan

Aviation Occurrence Report

23 July, 2014

TransAsia Airways Flight GE222

ATR72-212A, B-22810

Impacted Terrain and Collided with a Residential Area

Northeast of the Threshold of Runway 20 at Magong Airport

Report Number: ASC-AOR-16-01-002

Report Date: January, 2016

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According to the Aviation Occurrence Investigation Act of the Republic of China and the International Civil Aviation Organization (ICAO) Annex 13, this report is only for the improvements of flight safety.

Aviation Occurrence Investigation Act of the Republic of China, Article 5：

> *The objective of the ASC's investigation of aviation occurrence is to prevent recurrence of similar occurrences. It is not the purpose of such investigation to apportion blame or liability.*

ICAO Annex 13, Chapter 3, Section 3.1：

> *The sole objective of the investigation of an accident or incident shall be the prevention of accidents and incidents. It is not the purpose of this activity to apportion blame or liability.*

This report is written in both Chinese and English.

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Executive Summary

On 23 July 2014, an ATR-GIE Avions de Transport Régional ATR72-212A (ATR72) aircraft, registered B-22810, TransAsia Airways (TNA) flight GE222, with two pilots, two cabin crew, and 54 passengers, was being operated on an instrument flight rules (IFR) regular public transport service from Kaohsiung to Magong in the Penghu archipelago. At 1906 Taipei Local Time, the aircraft impacted terrain approximately 850 meters northeast of the threshold of runway 20 at Magong Airport and then collided with a residential area on the outskirts of Xixi village approximately 200 meters to the southeast of the initial impact zone. At the time of the occurrence, the crew was conducting a very high frequency omni-directional radio range (VOR) non-precision approach to runway 20. The aircraft was destroyed by impact forces and a post-impact fire. Ten passengers survived the occurrence and five residents on the ground sustained minor injuries.

The occurrence was the result of controlled flight into terrain, that is, an airworthy aircraft under the control of the flight crew was flown unintentionally into terrain with limited awareness by the crew of the aircraft's proximity to terrain. The crew continued the approach below the minimum descent altitude (MDA) when they were not visual with the runway environment contrary to standard operating procedures. The investigation report identified a range of contributing and other safety factors relating to the flight crew of the aircraft, TransAsia's flight operations and safety management processes, the communication of weather information to the flight crew, coordination issues at civil/military joint-use airport, and the regulatory oversight of TransAsia by the Civil Aeronautics Administration (CAA).

This investigation identified important learning opportunities for pilots, operators and regulatory agencies to improve future aviation safety and to seek to ensure such an accident never happen again. The Aviation Safety Council (ASC) has issued a series of safety recommendations to TransAsia Airways, CAA, and the military to correct the safety deficiencies identified during the investigation.

According to Article 6 of the Republic of China (ROC) Aviation Occurrence Investigation Act, and the content of Annex 13 to the Convention on International Civil Aviation, the ASC, an independent aviation occurrence investigation agency, was responsible for conducting the investigation. The investigation team also included members from BEA (Bureau d'Enquêtes et d'Analyses, France), TSB (Transportation

Safety Board, Canada), NTSB (National Transportation Safety Board, USA), ATR (Avions de Transport Régional), P&WC (Pratt & Whitney Canada), Honeywell Aerospace/USA, CAA Taiwan, Ministry of National Defense ROC, and TNA.

The ‘Final Draft Report’ of the occurrence investigation was completed in July 2015. In accordance with the procedures, it was reviewed at ASC’s 35th Council Meeting on 29 July 2015 and then sent to relevant organizations and authorities for comments. After comments were collected and integrated, the English version of the investigation report was reviewed and approved by ASC’s 39th Council Meeting on 24 November 2015. The Chinese version of the investigation report was first reviewed by ASC’s 40th Council Meeting on 29 December 2015. With the approval of ASC’s 41st Council Meeting on 26 January 2016, both final reports were published on 29 January 2016.

There are a total of 46 findings from the Final Report, and 29 safety recommendations issued to the related organizations.

Findings as the result of this investigation

The ASC presents the findings derived from the factual information gathered during the investigation and the analysis of the occurrence. The findings are presented in three categories: **findings related to probable causes**, **findings related to risk**, and **other findings**.

The **findings related to probable causes** identify elements that have been shown to have operated in the occurrence, or almost certainly operated in the occurrence. These findings are associated with unsafe acts, unsafe conditions, or safety deficiencies associated with safety significant events that played a major role in the circumstances leading to the occurrence.

The **findings related to risk** identify elements of risk that have the potential to degrade aviation safety. Some of the findings in this category identify unsafe acts, unsafe conditions, and safety deficiencies including organizational and systemic risks, that made this occurrence more likely; however, they cannot be clearly shown to have operated in the occurrence alone. Furthermore, some of the findings in this category identify risks that are unlikely to be related to the occurrence but, nonetheless, were safety deficiencies that may warrant future safety actions.

Other findings identify elements that have the potential to enhance aviation safety, resolve a controversial issue, or clarify an ambiguity point which remains to be resolved. Some of these findings are of general interests that are often included in the ICAO format accident reports for informational, safety awareness, education, and improvement purposes.

Findings Related to Probable Causes

Flight Operations

1. The flight crew did not comply with the published runway 20 VOR non-precision instrument approach procedures at Magong Airport with respect to the minimum descent altitude (MDA). The captain, as the pilot flying, intentionally descended the aircraft below the published MDA of 330 feet in the instrument meteorological conditions (IMC) without obtaining the required visual references.

2. The aircraft maintained an altitude between 168 and 192 feet before and just after overflying the missed approach point (MAPt). Both pilots spent about 13 seconds attempting to visually locate the runway environment, rather than commencing a missed approach at or prior to the MAPt as required by the published procedures.

3. As the aircraft descended below the minimum descent altitude (MDA), it diverted to the left of the inbound instrument approach track and its rate of descent increased as a result of the flying pilot's control inputs and meteorological conditions. The aircraft's hazardous flight path was not detected and corrected by the crew in due time to avoid the collision with the terrain, suggesting that the crew lost situational awareness about the aircraft's position during the latter stages of the approach.

4. During the final approach, the heavy rain and associated thunderstorm activity intensified producing a maximum rainfall of 1.8 mm per minute. The runway visual range (RVR) subsequently reduced to approximately 500 meters. The degraded visibility significantly reduced the likelihood that the flight crew could have acquired the visual references to the runway environment during the approach.

5. Flight crew coordination, communication, and threat and error management were less than effective. That compromised the safety of the flight. The first officer did not comment about or challenge the fact that the captain had intentionally descended the aircraft below the published minimum descent altitude (MDA). Rather, the first officer collaborated with the captain's intentional descent below the MDA. In addition, the first officer did not detect the aircraft had deviated from the published inbound instrument approach track or identify that those factors increased the risk of a controlled flight into terrain (CFIT) event.

6. None of the flight crew recognized the need for a missed approach until the aircraft reached the point (72 feet, 0.5 nautical mile beyond

the missed approach point) where collision with the terrain became unavoidable.

7. The aircraft was under the control of the flight crew when it collided with foliage 850 meters northeast of the runway 20 threshold, two seconds after the go around decision had been made. The aircraft sustained significant damage and subsequently collided with buildings in a residential area. Due to the high impact forces and post-impact fire, the crew and most passengers perished.

8. According to the flight recorders data, non-compliance with standard operating procedures (SOPs) was a repeated practice during the occurrence flight. The crew's recurring non-compliance with SOPs constituted an operating culture in which high risk practices were routine and considered normal.

9. The non-compliance with standard operating procedures (SOPs) breached the obstacle clearances of the published procedure, bypassed the safety criteria and risk controls considered in the design of the published procedures, and increased the risk of a controlled flight into terrain (CFIT) event.

Weather

10. Magong Airport was affected by the outer rainbands of Typhoon Matmo at the time of the occurrence. The meteorological conditions included thunderstorm activities of heavy rain, significant changes in visibility, and changes in wind direction and speed.

Findings Related to Risk

Flight Operations

1. The captain did not conduct a descent and approach briefing as required by standard operating procedures (SOPs). The first officer did not question the omission of that required briefing. That deprived the crew of an opportunity to assess and manage the operational risks associated with the approach and landing.

2. The captain was likely overconfident in his flying skills. That might lead to his decision to continue the approach below the minimum descent altitude (MDA) without an appreciation of the safety risks associated with that decision.

3. The results of the fatigue analysis indicated that, at the time of the occurrence, the captain's performance was probably degraded by his fatigue accumulated from the multiple sectors/day flown and flight

and duty times during the months preceding the occurrence.

4. The TransAsia Airways observation flights conducted by the investigation team and the interviews with members of the airline's flight operations division show prevalent tolerance for non-compliance with procedures within the airline's ATR fleet.

5. The non-compliances with standard operating procedures (SOPs) during the TransAsia Airways' ATR simulator training sessions were observed by the investigation team but not corrected by the instructors. The tolerance for or normalization of SOPs non-compliance behaviors was symptomatic of an ineffective check and training system with inadequate supervision by the airline's flight operations management.

6. The non-compliance with standard operating procedures (SOPs) was not restricted to the occurrence flight but was recurring, as identified by previous TransAsia Airways ATR occurrence investigations, line observations, simulator observations, internal and external audits or inspections, and interviews with TransAsia Airways flight operations personnel, including managers. The non-compliant behaviors were an enduring, systemic problem and formed a poor safety culture within the airline's ATR fleet.

Airline Safety Management

7. The TransAsia Airways' inadequate risk management processes and assessments, ineffective safety meetings, unreliable and invalid safety risk indices, questionable senior management commitment to safety, inadequate safety promotion activities, underdeveloped flight operations quality assurance (FOQA) system, and inadequate safety and security office and flight operations resources and capabilities constituted an ineffective safety management system (SMS).

8. The safety risks associated with change within the TransAsia Airways were not assessed and mitigated. For example, the company did not assess or mitigate the safety risks associated with the increase in ATR operational tempo as a result of the recent increase in ATR fleet size and crew shortage that, in turn, elevated crew flying activities and the potential safety risks associated with crew fatigue.

9. Findings regarding non-compliance with standard operating procedures (SOPs) during operations by the TransAsia Airways' ATR crews had been identified by previous Aviation Safety Council occurrence investigations. The proposed corrective safety actions were not implemented by the airline.

10. TransAsia Airways self-audits were mostly spot checks rather than system audits or system self-evaluations. The self-audits failed to assess and address those safety deficiencies, including standard operating procedures non-compliance behaviors, lack of standardization in pilot check and training activities, and high crew flying activities on the ATR fleet. Such deficiencies had been pointed out in previous occurrences and audits and were considered by senior flight operations managers as problems.

11. The TransAsia Airways annual audit plan did not include an evaluation of the implementation and/or effectiveness of corrective actions in response to the safety issues identified in previous audits, regulatory inspection findings, or safety occurrence investigation recommendations. The airline's self-audit program was not consistent with the guidance contained in AC-120-002A.

12. The TransAsia Airways had not developed a safety management system (SMS) implementation plan. This led to a disorganized, nonsystematic, incomplete and ineffective implementation, which made it difficult to establish robust and resilient safety management capabilities and functions.

13. The Civil Aeronautics Administration's (CAA) safety management system (SMS) assessment team had identified TransAsia Airways' SMS deficiencies, but TransAsia Airways failed to respond to the CAA's corrective actions request. That deprived the airline of an opportunity to improve the level of safety assurance in its operations.

14. The TransAsia Airways did not implement a data-driven fatigue risk management system (FRMS) or alternative measures to manage the operational safety risks associated with crew fatigue due to fleet expansion and other operational factors.

15. The ATR flight operation did not include in its team a standards pilot to oversee standard operating procedures (SOPs) compliance, SOP-related flight operations quality assurance (FOQA) events handling, and standard operations audit (SOA) monitoring before the GE222 occurrence.

16. The safety and security office, due to resource and capability limitations, was unable to effectively accomplish the duties they were required to undertake.

17. The safety and security office staff was not included in the flight safety action group. That deprived the airline of an opportunity to identify, analyze and mitigate flight safety risks more effectively in

the flight operations.

18. The TransAsia Airways' safety management system was overly dependent on its internal reactive safety and irregularity reporting system to develop full awareness of the airline's safety risks. It did not take advantage of the instructive material from external safety information sources. That limited the capability of the system to identify and assess safety risks.

19. The TransAsia Airways' flight operations quality assurance (FOQA) settings and analysis capabilities were unable to readily identify those events involving standard operating procedures (SOPs) non-compliance during approach and likely other stages of flight. The FOQA events were not analyzed sufficiently or effectively, leaving some safety issues in flight operations unidentified and uncorrected. Some problems with crew performance and reductions in safety indicated in the FOQA trend analyses were not investigated further. Clearly, the airline's FOQA program was not used to facilitate proactive operational safety risk assessments.

Civil Aeronautics Administration

20. The Civil Aeronautics Administration's oversight of TransAsia Airways did not identify and/or correct some crucial operational safety deficiencies, including crew non-compliance with procedures, non-standard training practices, and unsatisfactory safety management practices.

21. To develop and maintain a safety management system (SMS) implementation plan at TransAsia Airways was not enforced by the Civil Aeronautics Administration. That deprived the regulator of an opportunity to assess and ensure that the airline had the capability to implement a resilient SMS.

22. Issues regarding the TransAsia Airways' crew non-compliance with standard operating procedures (SOPs) and deficiencies with pilot check and training had previously been identified by the Aviation Safety Council investigation reports. However, the Civil Aeronautics Administration (CAA) did not monitor whether the operator has implemented the recommended corrective actions; correlatively, the CAA failed to ensure the proper measures for risk reduction have been adopted.

23. The Civil Aeronautics Administration provided limited guidance to its inspectors to enable them to effectively and consistently evaluate the key aspects of operators' management systems. These aspects

included evaluating organizational structure and staff resources, the suitability of key personnel, organizational change, and risk management processes.

24. The Civil Aeronautics Administration did not have a systematic process for determining the relative risk levels of airline operators.

Air Traffic Service and Military

25. The runway visual range (RVR) reported in the Magong aerodrome routine meteorological reports (METAR) and the aerodrome special meteorological reports (SPECI) was not in accordance with the requirements documented in the Air Force Meteorological Observation Manual.
26. The discrepancies between the reported runway visual range (RVR) and automated weather observation system (AWOS) RVR confused the tower controllers about the reliability of the AWOS RVR data.
27. During the final approach, the runway 20 runway visual range (RVR) values decreased from 1,600 meters to 800 meters and then to a low of about 500 meters. The RVR information was not communicated to the occurrence flight crew by air traffic control. Such information might influence the crew's decision regarding the continuation of the approach.

Other Findings

1. The flight crew were properly certificated and qualified in accordance with the Civil Aeronautics Administration and company requirements. No evidence indicated any preexisting medical conditions that might have adversely affected the flight crew's performance during the occurrence flight.
2. The airworthiness and maintenance of the occurrence aircraft were in compliance with the extant civil aviation regulations. There were no aircraft, engine, or system malfunctions that would have prevented normal operation of the aircraft.
3. All available evidence, including extensive simulations, indicated that the enhanced ground proximity warning system (EGPWS) functioned as designed.
4. The enhanced ground proximity warning system (EGPWS) manufacturer's latest generation EGPWS equipment would have provided flight crews with an additional warning if aircraft encountered similar circumstances to the occurrence flight. Installing

the latest EGPWS equipment on the occurrence aircraft would have required approved modifications.

5. According to the Civil Aeronautics Administration (CAA) regulations, a 420 meter simple approach lighting system should have been installed to help pilots visually identify runway 20. The CAA advised that the Runway End Identification Lights, a flashing white light system, was installed at the runway's threshold as an alternative visual aid to replace the simple approach lighting system.
6. From the perspective of flight operations, the location of the runway 20 VOR missed approach point (MAPt) was not in an optimal position. With the same Obstacle Clearance Altitude, if the MAPt had been set closer to the runway threshold, it would have increased the likelihood of flight crews to visually locate the runway.
7. During holding, the occurrence flight crew requested the runway 02 instrument landing system (ILS) approach after receiving the weather information that the average wind speed for runway 02 had decreased to below the tailwind landing limit. While the decision for the use of the reciprocal runway was still under consideration by the Magong Air Force Base duty officer, the weather report indicated that the visibility had improved to 1,600 meters, which met the landing visibility minimal requirement for an approach to runway 20. The flight crew subsequently amended their request and elected to use runway 20.
8. At the time of the occurrence, the weather information exchange and runway availability coordination between civil and military personnel at Magong's joint-use airport could have been more efficient.
9. ATR's flight data recorder (FDR) readout document contained unclear information. That affected the efficiency of the occurrence investigation.

Safety Recommendations

To TransAsia Airways

1. Implement effective safety actions to rectify the multiple safety deficiencies previously identified by the Aviation Safety Council investigations, internal and external Civil Aeronautics Administration audit and inspection findings, and deficiencies noted in this report to reduce the imminent safety risks confronting the airline. (ASC-ASR-16-01-010)
2. Conduct a thorough review of the airline's safety management system

and flight crew training programs, including crew resource management and threat and error management, internal auditor training, safety management system (SMS) training and devise systematic measures to ensure:

- Flight crew check and training are standardized;
- All flight crews comply with standard operating procedures (SOPs);
- Staff who conduct audits receive appropriate professional auditor training;
- All operational and senior management staff receive SMS training, including thorough risk assessment and management training; and
- Proportional and consistent rules, in accordance with a “Just Culture”, are implemented to prevent flight crew from violating the well-designed SOPs and/or being engaged in unsafe behavior.

(ASC-ASR-16-01-011)

3. Conduct a rigorous review of the safety management system (SMS) to rectify the significant deficiencies in:

- Planning;
- Organizational structure, capability and resources;
- Risk management processes and outputs;
- Flight operations quality assurance (FOQA) limitations and operations, including inadequate data analysis capabilities;
- Safety meetings;
- Self-audits;
- Safety performance monitoring, including risk indices;
- Safety education; and
- Senior management commitment to safety.

(ASC-ASR-16-01-012)

4. Rectify the human resources deficits in the flight operations division and the safety and security office, including:

- Crew shortages;
- Inadequate support staff in the Flight Standards and Training Department, including insufficient standards pilots and crew to conduct operational safety risk assessments; and
- Safety management staff with the required expertise in flight operations, safety and flight data analytics, safety risk assessment and management, human factors, and safety investigations.

(ASC-ASR-16-01-013)

5. Review and improve the airline's internal compliance oversight and auditing system and implement an effective corporate compliance and quality assurance system to ensure that oversight activities provide the required level of safety assurance and accountability. (ASC-ASR-16-01-014)
6. Implement an effective safety management process, such as a data-driven fatigue risk management system (FRMS), to manage the flight safety risks associated with crew fatigue. (ASC-ASR-16-01-015)
7. Provide flight crew with adequate fatigue management education and training, including the provision of effective strategies to manage fatigue and performance during operations. (ASC-ASR-16-01-016)
8. Implement an effective change management system as a part of the airline's safety management system (SMS) to ensure that risk assessment and mitigation activities are formally conducted and documented before significant operational changes are implemented, such as the introduction of new aircraft types or variants, increased operational tempo, opening new ports, and so on. (ASC-ASR-16-01-017)
9. Implement a more advanced flight operations quality assurance (FOQA) program with adequate training and technical support for the FOQA staff to ensure that they can exploit the analytical capabilities of the program. As such, the FOQA staff can more effectively identify and manage the operational safety risks confronting flight operations. (ASC-ASR-16-01-018)
10. Implement an effective standard operating procedures (SOPs) compliance monitoring system, such as the line operations safety audit (LOSA) program, to help identifying threats to operational safety and to minimize the associated risks. The system should adopt a data-driven method to assess the level of organizational resilience

to systemic threats and can detect issues such as habitual non-compliance with SOPs. (ASC-ASR-16-01-019)

To Civil Aeronautics Administration

1. Strengthen surveillance on TransAsia Airways to assess crew's discipline and compliance with standard operating procedures (SOPs). (ASC-ASR-16-01-020)
2. Implement a more robust process to identify safety-related shortcomings in operators' operations, within an appropriate timescale, to ensure that the operators meet and maintain the required standards. (ASC-ASR-16-01-021)
3. Provide inspectors with detailed guidance on how to evaluate the effectiveness of an operator's safety management system (SMS), including:
    - Risk assessment and management practices;
    - Change management practices;
    - Flight operations quality assurance (FOQA) system and associated data analytics; and
    - Safety performance monitoring.

    (ASC-ASR-16-01-022)
4. Provide inspectors with comprehensive training and development to ensure that they can conduct risk-based surveillance and operational oversight activities effectively. (ASC-ASR-16-01-023)
5. Enhance inspector supervision and performance evaluation to ensure all inspectors conduct surveillance activities effectively and are able to identify and communicate critical safety issues to their supervisors. (ASC-ASR-16-01-024)
6. Enhance the oversight of operators transitioning from traditional safety management to safety management systems. (ASC-ASR-16-01-025)
7. Develop a systematic process for determining the relative risk levels of airline operators. (ASC-ASR-16-01-026)
8. Review the current regulatory oversight surveillance program with a view to implementing a more targeted risk-based approach for operator safety evaluations. (ASC-ASR-16-01-027)

9. Ensure all safety recommendations issued by the occurrence investigation agency are implemented by the operators. (ASC-ASR-16-01-028)
10. Develop detailed guidance for operators to implement effective fatigue risk management processes and training. (ASC-ASR-16-01-29)
11. Review runway approach lighting systems in accordance with their existing radio navigation and landing aids to ensure that adequate guidance is available for pilots to identify the visual references to the runway environment, particularly in poor visibility condition or at night. (ASC-ASR-16-01-030)
12. Review the design procedures for determining the location of missed approach point with the intention of increasing the likelihood of pilots to locate the runway without compromising the required obstacle clearance altitude. (ASC-ASR-16-01-031)
13. Request tower controllers to advise the flight crews of aircraft on final approach of the updated information in accordance with the provisions of the air traffic management procedures (ATMP). (ASC-ASR-16-01-032)
14. Coordinate with Air Force Command Headquarters to review and improve the weather information exchange and runway availability coordination between civil air traffic control and military personnel at Magong Airport. (ASC-ASR-16-01-033)

To ATR-GIE Avions de Transport Régional

1. Evaluate the feasibility of a modification to allow the new enhanced ground proximity warning system (EGPWS) to be fitted on all ATR72-500 aircraft. (ASC-ASR-16-01-034)
2. Review the flight data recorder (FDR) readout document for any erroneous information and provide timely revisions of the manual to assist airline operators and aviation occurrence investigation agencies. (ASC-ASR-16-01-035)

To Air Force Command Headquarters, Ministry of National Defense

1. Coordinate with the Civil Aeronautics Administration to ensure the reliability and validity of automated weather observation system (AWOS) runway visual range (RVR) sensors and their data. (ASC-ASR-16-01-036)
2. Conduct the runway visual range (RVR) reporting operations and

requirements in accordance with the provisions of the Air Force Meteorological Observation Manual. (ASC-ASR-16-01-037)

3. Coordinate with the Civil Aeronautics Administration to review and improve the weather information exchange and runway availability coordination between civil air traffic control and military personnel at Magong Airport. (ASC-ASR-16-01-038)

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Abbreviation

AC	Advisory Circular
ADs	Airworthiness Directives
ADU	Advisory Display Unit
AFB	Air Force Base
AFE	Above Field Elevation
AFCS	Automatic Flight Control System
AIC	Aeronautical Information Circular
AIK	Accident Investigator's Kit
AIP	Aeronautical Information Publication
ALA	Approach and Landing Accident
ALAR	Approach and Landing Accident Reduction
AMHS	ATS Message Handling System
ANWS	Air Navigation and Weather Services
AOC	Air Operating Certificate
AOM	Aerodrome Operating Minima
ARI	Average Risk Indicator
ASC	Aviation Safety Council
ATC	Air Traffic Control
ATIS	Automatic Terminal Information Service
ATMP	Air Traffic Management Procedures
AP	Autopilot
ATPL	Air Transport Pilot License
AWOS	Automated Weather Observation System
CAA	Civil Aeronautics Administration
CASS	Canadian Aviation Safety Seminar
CCTV	Closed-Circuit Television
CDFA	Continuous Descent Final Approach
CFIT	Controlled Flight Into Terrain
CFT	Cumulative Flight Time
CG	Center of Gravity
CIO	Combat Information Office
CPs	Check Pilots
CPL	Commercial Pilot License
CRM	Crew Resource Management
CSAG	Cabin Safety Action Group
CSMU	Crash Survival Memory Unit

CVOR	Conventional VOR
CVR	Cockpit Voice Recorder
CWB	Central Weather Bureau
DA/H	Decision Altitude/Height
DME	Distance Measuring Equipment
DPE	Designated Pilot Examiners
DRI	Direct Risk Indicator
DSM	Digital Surface Model
DTM	Digital Terrain Model
DVOR	Doppler VOR
EADI	Electronic Attitude Director Indicator
EASA	European Aviation Safety Agency
EDR	Eddy Dissipation Rate
EFIS	Electronic Flight Instrument System
EGPWS	Enhanced Ground Proximity Warning System
EHSI	Electronic Horizontal Situation Indicator
EAFDM	European Authorities Coordination Group on Flight Data Monitoring
ETOPS	Extended Range Twin-Engine Operations
FAA	US Federal Aviation Administration
FAF	Final Approach Fix
FCO	Flight Control Office
FD	Flight Director
FDAP	Flight Data Analysis Program
FDR	Flight Data Recorder
FFS	Full Flight Simulator
FIR	Flight Information Region
FMD	Fleet Management Department
FO	First Officer
FOD	Flight Operations Division
FOQA	Flight Operations Quality Assurance
FRMS	Fatigue Risk Management System
FSAG	Flight Safety Action Group
FSF	Flight Safety Foundation
FSMIS	Flight Safety Management Information System
GPS	Global Positioning System
GSAG	Ground Safety Action Group
IATA	International Air Transport Association

ICAO	International Civil Aviation Organization
IFALPA	International Federation of Air Line Pilots’ Associations
IFM	Institute of Forensic Medicine
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
IPs	Instructor Pilots
KSS	Karolinska Sleepiness Scale
LOC	Localizer
LOC-I	Loss of Control in Flight
LOCAL	Aerodrome Local Meteorological Report
LOFT	Line Oriented Flight Training
LOSA	Line Operations Safety Audit
LVO	Low Visibility Operations
MAC	Mean Aerodynamic Chord
MAPt	Missed Approach Point
MDA	Minimum Descent Altitude
MDA/H	Minimum Descent Altitude/Height
MEL	Minimum Equipment List
METAR	Aerodrome Routine Meteorological Report
MKG	Magong (VOR)
MO	Meteorological Office
MSAG	Maintenance Safety Action Group
MZG	Magong (Airport)
NALS	No Approach Lighting System
NDB	Non-Directional Beacon
NLR	National Aerospace Laboratory
NLSC	National Land Survey and Mapping Center
NM	Nautical Mile
NTSB	National Transportation Safety Board of United States
NVM	Non-Volatile Memory
OCA/H	Obstacle Clearance Altitude/Height
ORMIT	Operational Risk Management Integration Tools
PAPI	Precision Approach Path Indicator
PANS-OPS	ICAO Procedures for Air Navigation Services – Aircraft Operations
PBN	Performance Based Navigation
PEC	Propeller Controller

PF	Pilot Flying
PM	Pilot Monitoring
POI	Principal Operations Inspector
PVM	Propeller Valve Module
QCC	Quality Control Center
REIL	Runway End Identifier Lights
RFCF	Runway Field Clearance Floor
RNAV	Area Navigation
ROC	Republic of China
ROSE	Read-Out Support Equipment
RVR	Runway Visual Range
RVSM	Reduced Vertical Separation Minimum
SAFE	System for Aircrew Fatigue Evaluation
SAGs	Safety Action Groups
SARPs	Standards and Recommended Practices
SBs	Service Bulletins
SDR	Service Difficulty Reports
SIGMET	Significant Meteorological Information
SIGWX	Significant Weather
SMM	Safety Management Manual
SMS	Safety Management System
SOA	Standard Operations Audit
SOC	System Operations Control
SOPs	Standard Operating Procedures
SPECI	Aerodrome Special Meteorological Report
SSAG	Security Safety Action Group
SSCVR	Solid-State CVR
SSFDR	Solid-State FDR
SSO	Safety and Security Office
STC	Supplemental Type Certificate
STS	Standardization & Training Section
TAD	Terrain Awareness & Display
TAWS	Terrain Awareness and Warning System
TC	Type Certificate
TCF	Terrain Clearance Floor
TEM	Threat and Error Management
TERPS	FAA Standards for Terminal Instrument Procedures
TNA	TransAsia Airways

TQ	Torque
UAV	Unmanned Aerial Vehicle
USOAP	Universal Safety Oversight Audit Program
VHF	Very High Frequency
VOR	Very High Frequency Omni-Directional Range
WFO	Weather Forecast Officer
WO	Weather Observer
WWO	Weather Watch Office
YD	Yaw Damper

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Chapter 1 Factual Information

1.1 History of Flight

On 23 July 2014, an ATR-GIE Avions de Transport Régional ATR72-212A (ATR72) aircraft, Republic of China (ROC) registration B-22810, TransAsia Airways (TNA) flight GE222, with two pilots, two cabin crew, and 54 passengers, was being operated on an instrument flight rules (IFR) regular public transport service from Kaohsiung to Magong in the Penghu archipelago. At 1906 Taipei Local Time[1], the aircraft impacted terrain approximately 850 meters north-east of the threshold of runway 20 at Magong Airport[2] and then collided with a residential area on the outskirts of Xixi village approximately 200 meters to the southeast of the initial impact zone. At the time of the occurrence, the crew was conducting a very high frequency omni-directional range (VOR)[3] non-precision approach to runway 20. The aircraft was destroyed by impact forces and a post-impact fire. Ten passengers survived the occurrence[4]. Nine of those passengers sustained serious injuries and one passenger sustained minor injuries. Five residents on the ground sustained minor injuries.

The captain occupied the left seat in the cockpit and was the pilot flying (PF) for the occurrence flight. The first officer (FO) occupied the right seat and was the pilot monitoring (PM). The occurrence flight departed Kaohsiung International Airport at 1745:02 in a westerly direction before tracking northbound to Magong Airport at an altitude of 7,000 feet above mean sea level.

At the time of the occurrence flight, Typhoon “Matmo” was approximately 142 nautical miles (nm) north-northwest of Magong Airport and moving northwest away from Magong. The typhoon warning for Magong Airport was terminated at 1740. According to the aerodrome routine meteorological report (METAR) for Magong Airport current at 1800, the weather conditions were wind from 220 degrees at 17 knots gusting to 27

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[1] Unless otherwise noted, the 24-hour clock is used in this report to describe the local time of day, Taipei Local Time, as particular events occurred. Taipei Local Time is Universal Coordinated Time (UTC) +8 hours.

[2] ICAO airport code RCQC.

[3] A VOR is a radio navigation system that provides bearing information to the flight crew of an aircraft.

[4] An additional passenger died on 22 November, 2014. However, according to the Annex 13 to the Convention on International Civil Aviation, for statistical uniformity only, an injury resulting in death within thirty days of the date of the accident is classified as a fatal injury in aircraft accident reports.

knots with visibility of 800 meters in heavy thunderstorms with rain. The cloud coverage[5] was scattered at 200 feet, broken at 600 feet with few cumulonimbus[6] at 1,200 feet, and overcast at 1,600 feet.

Magong Airport had a single runway oriented north-northeast and south-southwest designated as runway 02/20. Runway 02 was equipped with an instrument landing system (ILS)[7]. The landing visibility limitation for runway 02 was 800 meters. Runway 20 was equipped with a VOR non-precision approach system with a landing visibility limitation of 1,600 meters. Given the wind direction, the runway in use at the time of the occurrence was runway 20.

According to the flight data recorder (FDR), cockpit voice recorder (CVR), and the air traffic control (ATC) radio communications recording, Kaohsiung Ground Control had informed the GE222 flight crew that the weather conditions at Magong Airport were below landing minima. The flight crew decided to continue their flight but to hold until weather conditions improved. When the aircraft approached Penghu Island, it was radar vectored by ATC and entered a holding pattern at 1811:17.

During the hold, the reported visibility at Magong Airport was 800 meters. Including GE222, there were a total of four aircraft in the hold waiting for an approach clearance for Magong runway 20. At 1827:38, the Magong Tower controller informed the GE222 flight crew that the visibility was still 800 meters with the wind for an arrival to runway 02 of 210 degrees at 6 knots maximum 11 knots. The reported wind for an arrival to runway 20 was 200 degrees at 12 knots maximum 16 knots. After the GE222 flight crew discussed the visibility and tail wind landing limitations for runway 02, at 1829:50, they requested radar vectors for the runway 02 ILS approach.

While the flight crew were still waiting for the runway 02 ILS approach clearance, at 1842:28 Kaohsiung Approach broadcast that the visibility for

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[5] Cloud amounts are reported in oktas. An okta is a unit of sky area equal to one-eighth of total sky visible to the celestial horizon. Few = 1 to 2 oktas, scattered = 3 to 4 oktas, broken = 5 to 7 oktas and overcast = 8 oktas. The METAR reports the height of the cloud base in hundreds of feet above aerodrome elevation.

[6] Thunderstorms are associated with cumulonimbus cloud.

[7] An ILS is a standard ground aid to landing, comprising two directional radio transmitters: the localizer, which provides direction in the horizontal plane or lateral flightpath tracking guidance; and the glideslope for vertical plane direction or vertical flightpath tracking guidance usually at an inclination of 3°. Distance measuring equipment (DME) or marker beacons along the approach provide distance information.

runway 20 had improved to 1,600 meters. At 1845, the GE222 flight crew subsequently requested the runway 20 VOR approach. Kaohsiung Approach issued radar vectors to the crew and assigned them a lower altitude.

At 1855:10, the GE222 flight crew were cleared for the runway 20 VOR approach from an altitude of approximately 3,000 feet when the aircraft was about 25 nm northeast of Magong Airport. The aircraft descended to and maintained 2,000 feet.

At 1902:50, shortly before overflying the final approach fix (FAF), the aircraft started to descend from 2,000 feet[8] to the crew selected altitude of 400 feet.

At 1905:12.4, three seconds after the "500 feet auto call-out" was annunciated, the captain stated "*um three hundred*" while the aircraft was passing through 450 feet, and then the selected altitude was reset to 300feet. At 1905:25.7, when the aircraft descended through 344 feet, the captain stated "*…two hundred*". The selected altitude was reset to 200 feet and the aircraft kept descending.

The minimum descent altitude (MDA)[9] for the Magong runway 20 VOR approach was 330 feet. No discussion by the flight crew regarding the necessity to obtain the required visual references by the MDA before continuing the approach was recorded on the CVR as the aircraft descended below the MDA.

When the aircraft descended through 249 feet, the first officer said "*we will get to zero point two miles*". At 1905:44 and at an altitude of 219 feet, the captain disengaged the autopilot (AP) and announced "*maintain two hundred*" four seconds later. The aircraft then maintained its altitude approximately between 168 and 192 feet for the following 10 seconds.

At 1905:57.8, the captain asked the first officer "*have you seen the runway*", and at almost the same time, the yaw damper (YD) was disengaged without the required announcement and acknowledgment by the flight crew of a change in system state. The flight crew then had a conversation for about 13 seconds attempting to locate the runway environment. In the meantime, the altitude, course, and attitude of the

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[8] Unless otherwise noted, the occurrence aircraft altitudes below 2,000 feet stated in this report were pressure altitudes with QNH 997 hPa.

[9] The minimum descent altitude (MDA) is a specified altitude in a non-precision approach or circling approach below which descent must not be made without the required visual reference.

aircraft started to conspicuously deviate from the intended settings (see Figure 1.1-1), but there was no conversation between the flight crew regarding the aircraft entering an undesired state.

At 1906:11, both pilots called "*go around*" at 72 feet and both engine power levers were advanced. Two seconds later, the aircraft hit the foliage 850 meters northeast of the runway 20 threshold. The aircraft sustained significant damage and consequently collided with a residential area. Due to the high impact forces and post-impact fire, the aircraft was totally destroyed.

Figure 1.1-1 Final approach track

1.2 Injuries to Persons

There were a total of 58 persons on board comprising two pilots, two cabin crew, and 54 passengers. All 4 crew members and 44 passengers sustained fatal injuries. Nine passengers sustained serious injuries and one passenger sustained minor injuries. Five residents on the ground sustained minor injuries.

Table 1.2-1 Injury table

Injuries	**Flight Crew**	**Flight Attendants**	**Passengers**	**Other**	**Total**
Fatal	2	2	44	0	48
Serious	0	0	9	0	9
Minor	0	0	1	5	6
None	0	0	0	Not applicable	0
Total	2	2	54	5	63

Note: According to the Annex 13 to the Convention on International Civil Aviation, for statistical uniformity only, an injury resulting in death within thirty days of the date of the accident is classified as a fatal injury in aircraft accident reports.

1.2.1 Distribution of Injuries

The ATR72's passenger cabin was configured with 72 economy class seats. There were two pilot seats in the cockpit and two cabin crew seats in the cabin.

Figure 1.2-1 shows the injury and fatality distribution via seat location. The passenger seating positions were based on the airline seating plan and interviews with the surviving passengers.

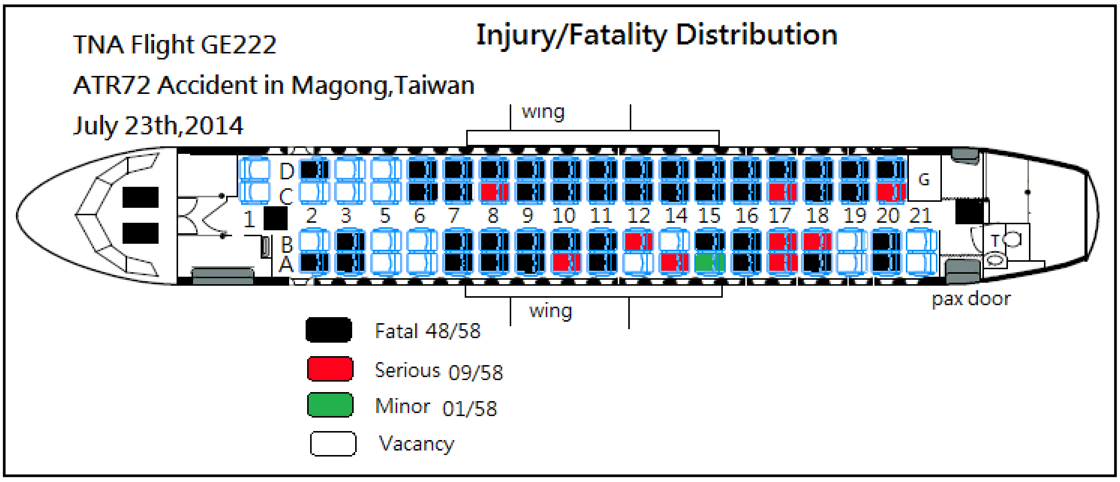

Figure 1.2-1 Injury and fatality distribution

1.3 Damage to Aircraft

The aircraft was destroyed.

1.4 Other Damage

The occurrence resulted in the collapse of nine residential dwellings, one ground vehicle, and one electric power pole.

1.5 Personnel Information

1.5.1 Flight Crew Background and Experience

1.5.1.1 Captain

The captain, a Republic of China citizen, had served in the Army Aviation Command as a pilot. He joined TNA in July 1992 after he retired from the army. He completed first officer training in December 1992 and served as a first officer on the ATR42/72 fleet. In October 1995, he completed ATR42/72 command upgrade training and was promoted to captain in November 1995. As of the occurrence, he had accumulated a total flight time of 22,994 hours, which included 19,069 hours on the ATR42/72 aircraft type.

The captain held an air transport pilot license (ATPL) issued by the Civil Aeronautics Administration (CAA) of the Republic of China with Multi-Engine Land rating, ATR72 type rating, and endorsed with radiotelephone privileges. The pilot’s English language proficiency was recorded as ICAO level 4 with an expiry date of 23 March 2014[10].

1.5.1.2 First Officer

The first officer was a Republic of China citizen. He was hired by TNA in July 2011 with no previous airline experience. After completing flight training, he was appointed and served as an ATR72 first officer. His total flight time was 2,392 hours at the time of the occurrence.

The first officer held a commercial pilot license (CPL) issued by the CAA with Multi-Engine land rating, ATR72 first officer type rating, and endorsed with radiotelephone privileges. The pilot’s English language proficiency was recorded as ICAO level 4 with an expiry date of 8 January 2015.

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[10] English language proficiency is not a requirement for flight crew solely operating Taiwan domestic flights.

Table 1.5-1 Flight crew basic information

Item	Captain	First Officer
Gender	Male	Male
Age as of the Occurrence	60	39
Commenced Employment with TNA	01 July 1992	01 July 2011
License type issued	ATPL – Aeroplane	CPL – Aeroplane
Aircraft Type Rating Date of Expiry	ATR 72 08 November 2015	ATR 72 F/O 08 January 2017
Medical certificate issued Date of Expiry	First Class 31 August 2014	First Class 31 May 2015
Total flying time	22,994 hrs. and 29 min.	2,392 hrs. and 55 min.
Total flying time on ATR 42/72	19,069 hrs. and 56 min.	2,083 hrs. and 55 min.
Total flying time last 12 months	945 hrs. and 10 min.	964 hrs. and 46 min.
Total flying time last 90 days	278 hrs. and 06 min.	264 hrs. and 44 min.
Total flying time last 30 days	100 hrs. and 59 min.	88 hrs. and 55 min.
Total flying time last 7 days	22 hrs. and 18 min.	22 hrs. and 35 min.
Total flying time last 24 hours	03 hrs. and 31 min.	03 hrs. and 31 min.
Available rest period before occurrence	15 hrs. and 07 min.	15 hrs. and 07min.

1.5.2 Flight Crew Training Record

1.5.2.1 Captain

Initial training:

The captain completed initial ATR42 type rating training at Flight Safety International from 14 September to 28 September 1992. The training included academic and simulator training. He completed the initial training successfully as indicated by the certification issued by Flight Safety

International on 28 September 1992. He continued his training with the airline and qualified as an ATR42/72 first officer on 06 November 1992. He finished his ATR42/72 route training on 12 December 1992 and passed the first officer line check on 14 December 1992.

Upgrade training:

The captain attended ATR42/72 command upgrade training at Flight Safety International from 16 August 1995 to 22 September 1995. The training included ground school and simulator training. He completed the upgrade training successfully as indicated by the certification issued by Flight Safety International. He qualified as a captain on 12 October 1995 and passed the line check on 27 October 1995.

Recurrent training:

The most recent annual recurrent ATR72 ground school was undertaken by the captain on 6 March 2014. The 8 hours of training included adverse weather operations, terrain awareness, abnormal procedures, and aircraft limitations. The captain's most recent annual proficiency training was conducted on 17 March 2014. The captain's performance was assessed as "satisfactory". The subsequent annual proficiency check was passed on 18 March 2014. The latest annual line check was successfully completed on 25 December 2013.

1.5.2.2 First Officer

Initial training:

The first officer commenced initial ATR72 type rating training on 18 July 2011 at the TNA. The training curriculum included ground school of 326 hours, route observation training of 25 hours, 15 sessions of simulator training, 5 hours of local training, and 3 phases of line training comprising 135 hours. He completed initial training on 8 April 2012 with a successful line check.

Recurrent training:

The first officer completed annual recurrent ATR72 ground school on 9 May 2014. The 8 hours of training included adverse weather operations, terrain awareness, abnormal procedures, and aircraft limitations. The first officer's most recent annual proficiency training and subsequent proficiency check was successfully completed between 21 and 22 April 2014. The latest annual line check was successfully completed on 10 April 2014.

1.5.3 Flight Crew Medical Information

1.5.3.1 Captain

The captain's first class medical certificate was issued by the CAA on 14 April 2014 with the limitation that the "Holder shall wear corrective lenses".

1.5.3.2 First Officer

The first officer's first class medical certificate was issued by the CAA on 08 May 2014 with no limitations.

1.5.4 Flight Crew Activities within 72 hours Before the Occurrence

1.5.4.1 Captain

1. 20 July: Reported to Songshan Airport at 0640 and operated scheduled flights from Songshan to Magong to Songshan to Magong to Kinmen to Magong to Kaohsiung, then had a layover at Kaohsiung after the flight duty ended at 1502.
2. 21 July: Reported to Kaohsiung Airport at 1420 and operated scheduled flights from Kaohsiung to Magong to Kaohsiung to Magong to Kaohsiung to Magong to Kaohsiung, then had a layover at Kaohsiung after the flight duty ended at 2108.
3. 22 July: Reported to Kaohsiung Airport at 1440 and operated scheduled flights from Kaohsiung to Kinmen to Kaohsiung to Magong to Kaohsiung to Magong to Kaohsiung, then had a layover at Kaohsiung after the flight duty ended at 2213.
4. 23 July: Reported to Kaohsiung Airport at 1320 and were expected to operate Kaohsiung to Magong to Kaohsiung to Magong (the occurrence flight) to Songshan to Magong to Songshan.

1.5.4.2 First Officer

From 20 July to 23 July, the first officer was assigned to the same flight duty patterns as the captain.

1.5.5 Flight Crew Alertness and Fatigue

Fatigue can be defined as a state of impairment that can include physical and/or mental elements associated with lower alertness and reduced performance. Fatigue can impair individual capability to a level where a person cannot continue to perform tasks safely and/or efficiently[11].

The investigation examined the likelihood that the operating flight crew were fatigued at the time of the occurrence and the effect that fatigue may have had on their performance. Both the captain and first officer were based in Taipei. However, the flight crew's operating pattern in the three days before the occurrence commenced and ended at Kaohsiung. Therefore, the flight crew spent the three nights before the occurrence in company provided accommodation in Kaohsiung. While the flight crew had sufficient opportunity to obtain sleep, the investigation was unable to determine the quantity and quality of sleep obtained by the flight crew in Kaohsiung.

QinetiQ's biomathematical fatigue model System for Aircrew Fatigue Evaluation (SAFE) was used to assess, in part, the flight crew's level of alertness and task effectiveness. It is a well validated model.[12,13,14,15,16] Both the flight crew's rosters for the two months before the occurrence were assessed by SAFE. SAFE's estimated sleep function was used to allocate sleep at appropriate times in between crew duties because actual sleep data was not available. While the automated sleep data was based on airline pilot fatigue research findings, it provides a conservative sleep solution which may not necessarily coincide with the quantity or quality of actual sleep obtained.

The captain's SAFE result was consistent with the pilot being a little tired on approach to Magong. The captain's SAFE metrics included:

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[11] Yen, J. R., Hsu, C. C., Yang, H., & Ho, H. (2009). An investigation of fatigue issues on different flight operations. Journal of Air Transport Management, 15(5), 236-240.

[12] Civil Aviation Authority. (2007). Aircrew fatigue: A review of research undertaken on behalf of the UK Civil Aviation Authority (CAA Paper 2005/04, Issue 2). London, UK: CAA.

[13] Powell, D., Spencer, M. B., Holland, D., Broadbent, E., & Petrie, K. J. (2007). Pilot fatigue in short-haul operations: Effects of number of sectors, duty length, and time of day. Aviation, Space, and Environmental Medicine, 78, 698-701.

[14] Powell, D., Spencer, M. B., Holland, D., & Petrie, K. J. (2008). Fatigue in two-pilot operations: Implications for flight and duty time limitations. Aviation, Space, and Environmental Medicine, 79, 1047-1050.

[15] Spencer, M. B., & Robertson, K. A. (2000). A diary study of aircrew fatigue in short-haul multi-sector operations (DERA Report No. DERA/CHS/PPD/CR00394). Farnborough, UK: DERA.

[16] Spencer, M. B., & Robertson, K. A. (2002). Aircrew alertness during short-haul operations, including the impact of early starts (QinetiQ Report No. QINETIQ/CHS/PPD/CRO10406/1.0). Farnborough, UK: QinetiQ.

- Alertness score 45.2 out of 100;
- Samn-Perelli[17] score of 3.7 (OK, between somewhat fresh to a little tired);
- Karolinska Sleepiness Scale[18] (KSS) indicating neither sleepy nor alert;
- Response time on a visual vigilance task degraded by 7.5% compared with a typical rested value;
- Response time on a warning light on a complex task degraded by 48.4% compared to a typical rested value;
- Percentage of missed responses in a sustained attention task 22.04% compared to a typical rested value of 6%; and
- Performance equivalent to that of a person with 0.034% blood alcohol concentration.

However, there were some salient indications recorded on the CVR that suggested the captain was experiencing a higher level of fatigue than that derived from SAFE. The captain stated he was very tired and his yawning was detected by the CVR. In addition, lapses in radio communications with ATC, incorrect VOR approach course selection, and incorrect automatic flight control system (AFCS) mode selections, all requiring the first officer to intervene. Furthermore, the captain's real-time roster indicated an elevated flying activity where he routinely completed 6 sector days and had accumulated a total flight time of 278 hours in the last 90 days.

There were no salient indications recorded on the CVR to indicate that the first officer was fatigued; such as yawning and prolonged silence, or the disengagement of the first officer from conversations. The first officer's SAFE result was consistent with the pilot not being unduly affected by fatigue. The first officer's SAFE metrics included:

- Alertness score of 56.9 out of 100;

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[17] The Samn Perelli (SP) is a 7-point scale with possible scores ranging from 1 ("fully alert, wide awake") to 7 ("completely exhausted, unable to function effectively"). This scale has been validated and widely used in aviation (Samn & Perelli, 1982; Samel et al, 1997) and is one of the metrics provided as an output of the SAFE model.

[18] The Karolinska Sleepiness Scale (KSS) is a one-dimensional scale ranging from 1 ("very alert") to 9 ("very sleepy, great effort to keep awake"). It has been validated against objective measurement of sleepiness such as electroencephalographic (EEG) and electrooculographic (EOG) activity (Å kerstedt & Gillberg, 1990) and performance evaluation (Kaida et al, 2006).

- Samn-Perelli score of 3.2 (OK, somewhat fresh);
- KSS in between alert and neither sleepy nor alert;
- Response time on a visual vigilance task degraded by 4.9% compared with a typical rested value;
- Response time on a warning light on a complex task degraded by 27.6% compared to a typical rested value;
- Percentage of missed responses in a sustained attention task 14.66% compared to a typical rested value of 6%; and
- Performance equivalent to that of a person with 0.017% blood alcohol concentration.

1.6 Airplane Information

1.6.1 Aircraft and Engine Basic Information

Basic information of the occurrence aircraft is shown in Table 1.6-1

Table 1.6-1 Aircraft basic information table

Aircraft basic information (date: 23 July 2014)	
Nationality	Taiwan, R.O.C.
Aircraft registration number	B-22810
Aircraft Model	ATR72-212A[19]
Manufacturer	ATR-GIE Avions de Transport Régional
Aircraft serial number	0642
Date manufactured	14 June 2000
Delivery date	6 July 2000
Owner	TransAsia Airways
Operator	TransAsia Airways
Number of certificate of registration	93-945
Certificate of airworthiness, validity date	102-08-145, 31 July 2014
Total flight time (hours:minutes)	27,039:27
Total flight cycles	40,387
Last check, date	9C6E “A” CHK / 28 May 2014
Flight hours/ cycles elapsed since last "A" check	349:18/ 522

Basic information about the two Pratt & Whitney Canada PW127F/M engines is shown in Table 1.6-2

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[19] ATR72-212A: Model as per Type design; ATR72-500 : marketing name for legacy ATR72-212A; ATR72-600 : marketing name for ATR72-212A with new avionic suite.

Table 1.6-2 Engine basic information table

Engine basic information（statistics date: 23 July 2014）		
Number/position	No. 1/ Left	No. 2/ Right
Serial number	AV0051	EB0069
Manufacture date	26 APR 1998	06 MAY 2001
Date of last shop visit	23 MAR 2012 /REPAIR	23 JAN 2013 /OVERHAUL
Date of installation	13 JUN 2012	20 FEB 2013
Time since installed (hours:minutes)	4,185:25	3,076:54
Cycle since installed	6,388	4,670
Total time(hours:minutes)	26,657:55	18,712:27
Total cycles	40,239	23,015

1.6.2 Aircraft Maintenance Records

There were no defects reported or inoperative items under the minimum equipment list (MEL)[20] for the occurrence flight when the aircraft was dispatched from Kaohsiung Airport. A review of the last 6 months of the aircraft's technical logbook indicated that there was no system anomaly related to the occurrence. A review of the aircraft's maintenance records indicated that it was in compliance with all applicable airworthiness directives (ADs) and service bulletins (SBs).

1.6.3 Enhanced Ground Proximity Warning System

The enhanced ground proximity warning system (EGPWS)[21] is a terrain awareness and warning system (TAWS) that provides basic GPWS functions in addition to enhanced terrain alerting and display features. The EGPWS uses aircraft inputs including geographic position, attitude, altitude, airspeed, and glideslope deviation. These are used with respect to

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[20] A minimum equipment list (MEL) is a list of aircraft equipment and systems that may be inoperative for flight, subject to specified conditions. The MEL is approved by the State of the Operator and will enable the pilot-in-command to determine whether a flight may be commenced or continued from any intermediate stop should an instrument, equipment or systems become inoperative.

[21] EGPWS is the Honeywell Inc. proprietary name for a Terrain Awareness and Warning System (TAWS). TAWS is the term used to describe equipment meeting the ICAO standards and recommendations for GPWS equipment that provides predictive terrain-hazard warnings.

internal terrain, obstacle, and airport databases to predict a potential conflict between the aircraft flight path and terrain or an obstacle. A conflict will result in the EGPWS providing a visual and audio caution or warning alert. In addition, the EGPWS provides alerts for excessive glideslope deviation, too low with flaps extended or gear not in the landing configuration. The system also provides bank angle and altitude callouts based on system configuration selection.

The occurrence aircraft was equipped with a Honeywell EGPWS, model MARK VIII, Part Number 965-1216-011. The EGPWS contained the following alert modes:

- Basic GPWS modes

  - Mode 1: excessive descent rate
  - Mode 2: excessive terrain closure rate
  - Mode 3: altitude loss after take-off
  - Mode 4: unsafe terrain clearance
  - Mode 5: below glideslope
  - Mode 6: altitude callouts

- Enhanced modes

  - Terrain clearance floor (TCF)
  - Terrain awareness & display (TAD)

The TCF mode creates an increasing terrain clearance envelope around the airport runway directly related to the distance from the runway. The alert is based on current aircraft location, nearest runway center point position and radio altitude. TCF is activated during takeoff, cruise and final approach and complements the existing Mode 4 by providing an alert based on insufficient terrain clearance even when in the landing configuration. A runway field clearance floor (RFCF) alert is also provided for runways that are located on top of a hill. This alert is similar to the TCF alert but is based on height above the runway. The aural message "Too Low Terrain" will occur once when the TCF envelope is initially breached and one time thereafter for each 20% degradation in radio altitude. At the same time the "GPWS" red alerts are illuminated on the instrument panels and remain on until the alert envelope is exited (see Figures 1.6-1 and 1.6-2).

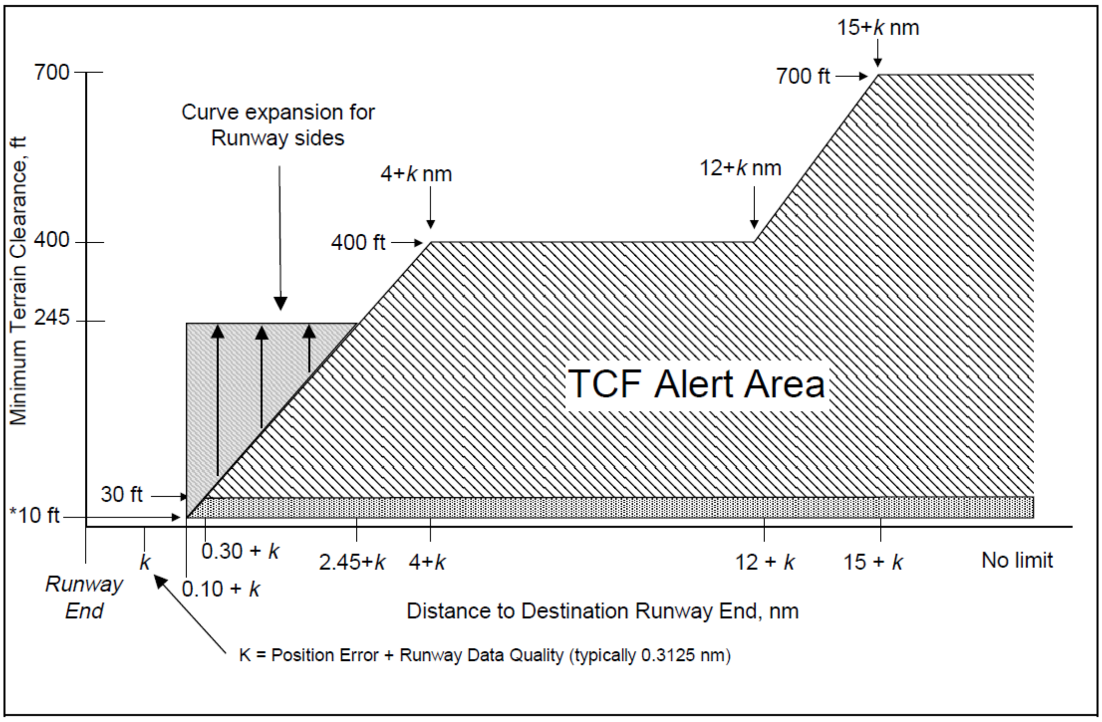


Figure 1.6-1 TCF alert curve

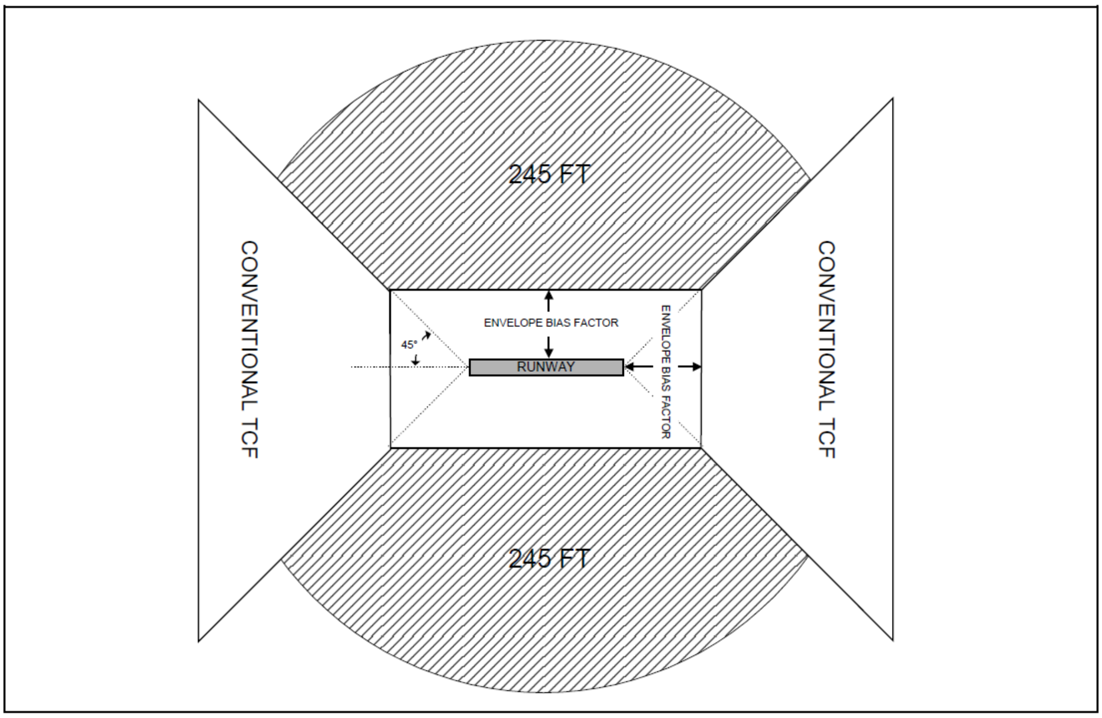


Figure 1.6-2 Plan view of expanded alert

The terrain awareness function uses the aircraft’s geographic position provided by the onboard global positioning system (GPS), aircraft altitude and a worldwide terrain database to predict potential conflicts between the aircraft flight path and the terrain. It also provides an aural alert and graphic display of the conflicting terrain. Caution and Warning envelopes below and ahead of the aircraft path are computed as a function of groundspeed and flight path angle.

If the terrain penetrates the Caution envelope boundary, an aural message "TERRAIN AHEAD. TERRAIN AHEAD" is generated with the red "GPWS" alerts illuminated on each pilot’s instrument panel. Simultaneously, the terrain areas which conflict with the Caution criteria are shown in solid yellow on the terrain display. If the terrain penetrates the Warning envelope boundary, an aural message "TERRAIN AHEAD, PULL UP" is generated with the red "GPWS" alerts illuminated on each pilot’s instrument panel. Simultaneously, the terrain areas which conflict with the warning criteria are shown in solid red on the terrain display.

The terrain data can be displayed on the electronic flight instrument system (EFIS). When the terrain display is present, it replaces the weather radar display and can be available to the flight crew at any time. A discrete pop-up signal provided by the EGPWS is used to automatically display the detected threatening terrain on the EFIS with an auto-range of 10 nm. The local terrain forward of the aircraft is depicted as variable density dot patterns in green, yellow or red. The density and color are a function of how close the terrain is relative to the aircraft’s altitude. Terrain Alerts are depicted by painting the threatening terrain as solid yellow or red.

1.6.4 Automatic Flight Control System

1.6.4.1 General

The ATR72 is equipped with an automatic flight control system (AFCS, see Figure 1.6-3) which includes:

- Autopilot function and/or yaw damper (AP/ YD);
- Flight director function (FD); and
- Altitude alert.

Main components include:

- One computer;
- One control panel;
- One advisory display unit (ADU); and
- Three servo-actuators (one on each axis).

Systematic use of the AP/FD is highly recommended by ATR in order to:

- Increase the accuracy of guidance and tracking in all weather conditions, from early climb after takeoff down to landing minima;
- Provide increased passenger comfort through smooth and repeatable altitude and heading changes in all atmospheric conditions; and
- Reduce crew workload and increase safety.

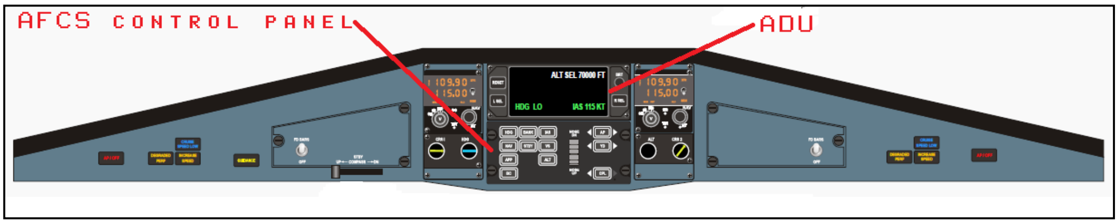


Figure 1.6-3 Automatic Flight Control System (AFCS)

1.6.4.2 Advisory Display Unit

The advisory display unit (ADU) provides advisory/caution messages and mode information to the pilots (see Figure 1.6-4).

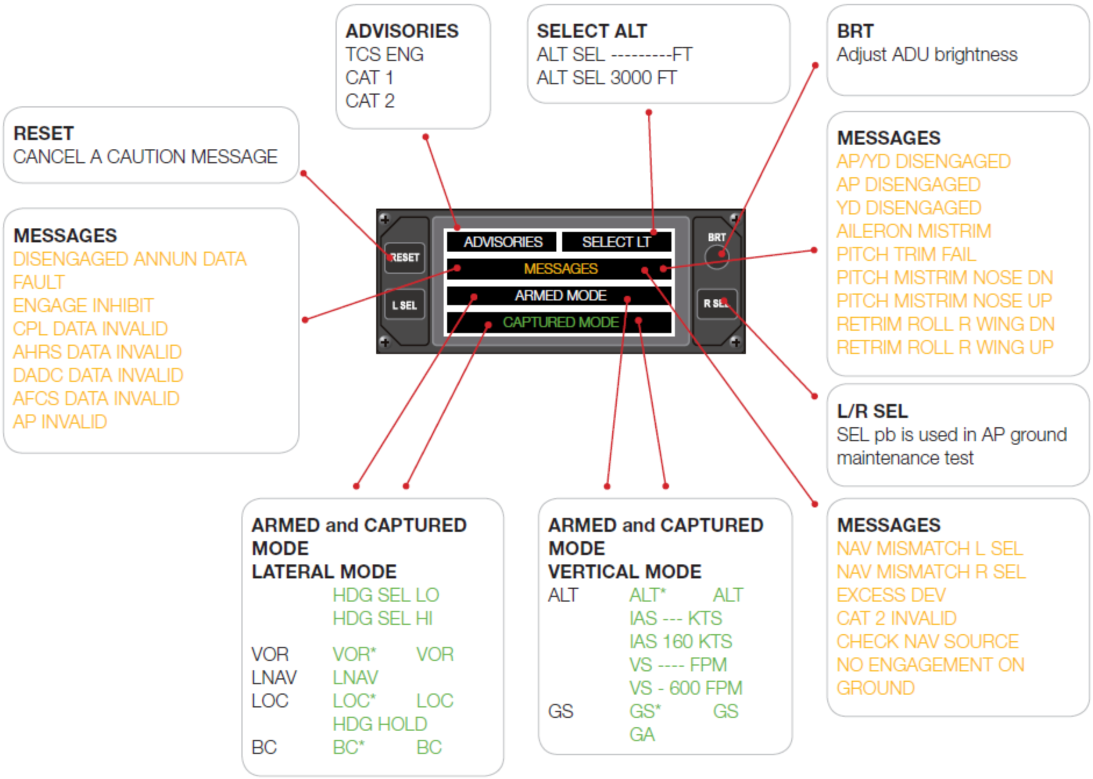


Figure 1.6-4 Advisory Display Unit (ADU)

1.6.5 Weight and Balance Information

The actual takeoff weight of the occurrence aircraft was 46,235 lbs. The aircraft’s center of gravity (CG) for takeoff was located at 29.2% mean aerodynamic chord (MAC) which was within the certified limitation between 19.7% and 37 % MAC. Table 1.6-3 shows the weight and balance data. The aircraft’s weight and balance was within the specified limitations for the duration of the occurrence flight.

Table 1.6-3 Weight and balance data

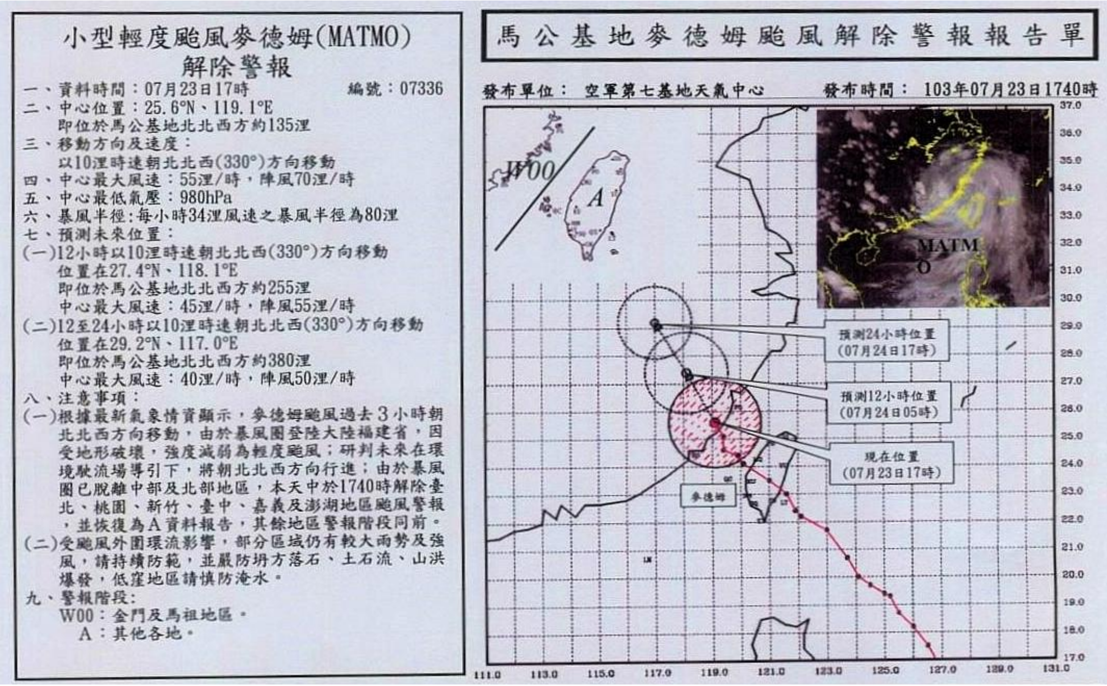
Max. zero fuel weight	44,092 lbs.
Actual zero fuel weight	41,294 lbs.
Max. takeoff weight	48,501 lbs.
Actual takeoff weight	46,235 lbs.
Take off fuel	4,941 lbs.
Estimated trip fuel	800 lbs.
Max. landing weight	48,171 lbs.
Estimated landing weight	45,435 lbs.
Takeoff CG	29.2% MAC
CG: center of gravity MAC: mean aerodynamic chord	

1.7 Weather Information

1.7.1 Synopsis

The center of Typhoon Matmo was approximately 142 nm north-northwest of Magong Airport around the time of occurrence. The typhoon’s radius was approximately 80 nm. The typhoon warning for Magong Airport was terminated at 1740, as shown in Figure 1.7-1. The Magong Weather Center issued a hazardous weather forecast for Magong Airport at the same time as follows:

1740 to 1940 hours, visibility 1,200 meters in rain and mist, broken cloud at 200 feet, intermittent thunderstorm rain.



小型輕度颱風麥德姆(MATMO)
解除警報

一、資料時間：07月23日17時　　編號：07336
二、中心位置：25.6°N、119.1°E
　　即位於馬公基地北北西方約135浬
三、移動方向及速度：
　　以10浬時速朝北北西(330°)方向移動
四、中心最大風速：55浬/時，陣風70浬/時
五、中心最低氣壓：980hPa
六、暴風半徑:每小時34浬風速之暴風半徑為80浬
七、預測未來位置：
(一)12小時以10浬時速朝北北西(330°)方向移動
　　位置在27.4°N、118.1°E
　　即位於馬公基地北北西方約255浬
　　中心最大風速：45浬/時，陣風55浬/時
(二)12至24小時以10浬時速朝北北西(330°)方向移動
　　位置在29.2°N、117.0°E
　　即位於馬公基地北北西方約380浬
　　中心最大風速：40浬/時，陣風50浬/時
八、注意事項：
(一)根據最新氣象情資顯示，麥德姆颱風過去3小時朝北北西方向移動，由於暴風圈登陸大陸福建省，因受地形破壞，強度減弱為輕度颱風；研判未來在環境駛流場導引下，將朝北北西方向行進；由於暴風圈已脫離中部及北部地區，本天中於1740時解除臺北、桃園、新竹、臺中、嘉義及澎湖地區颱風警報，並恢復為A資料報告，其餘地區警報階段同前。
(二)受颱風外圍環流影響，部分區域仍有較大雨勢及強風，請持續防範，並嚴防坍方落石、土石流、山洪爆發，低窪地區請慎防淹水。
九、警報階段:
　　W00：金門及馬祖地區。
　　　A：其他各地。

馬公基地麥德姆颱風解除警報報告單

發布單位：空軍第七基地天氣中心　　發布時間：103年07月23日1740時

Figure 1.7-1 Magong typhoon warning termination report

The CAA’s air navigation and weather services (ANWS) Taipei Aeronautical Meteorological Center issued multiple significant meteorological information advisories (SIGMET)[22] for the Taipei flight information region (FIR) on the day of the occurrence, one of which remained valid at the time of the occurrence as follows:

SIGMET 5- valid from 1800 to 2100 hours for Taipei FIR, tropical cyclone Matmo centered at N2536 E11906 at 1700L, moving NW at 11 knots with intensity weakening, cumulonimbus is within 190 nautical miles of the center with a cloud top altitude below FL420. The storm center was forecasted to be located at N2630 E11830 at 2300 hours.

1.7.2 Surface Weather Observations

The Weather Center was in charge of weather observations and dissemination for Magong Airport. METAR, aerodrome special meteorological reports (SPECI) and aerodrome local meteorological reports (LOCAL) around the time of the occurrence were as follows:

METAR at 1800 hours, wind from 220 degrees at 17 knots gusting to 27 knots, visibility 800 meters in heavy thunderstorm rain, scattered clouds at 200 feet, broken at 600 feet, few cumulonimbus at 1,200 feet, overcast at

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[22] Information concerning the occurrence or expected occurrence of specified en-route weather phenomena which may affect the safety of aircraft operations.

1,600 feet, temperature 23℃; dew point temperature 22℃, altimeter setting 995 hPa, trend forecast-no significant change. Remarks: altimeter setting 29.41 in-Hg, runway visual range[23] 800 meters with no significant change at Runway 20, hourly precipitation 13.5 millimeters[24], stationary thunderstorm overhead (ATIS L[25]).

METAR at 1830 hours, wind from 200 degrees at 14 knots gusting to 24 knots, visibility 800 meters in heavy thunderstorm rain, scattered clouds at 200 feet, broken at 600 feet, few cumulonimbus at 1,200 feet, overcast at 1,600 feet, temperature 22℃; dew point temperature 22℃, altimeter setting 995 hPa, trend forecast-no significant change. Remarks: altimeter setting 29.41 in-Hg, runway visual range 800 meters at Runway 20, stationary thunderstorm overhead (ATIS M).

SPECI at 1840 hours, wind from 190 degrees at 13 knots gusting to 24 knots, visibility 1,600 meters in thunderstorm rain, scattered clouds at 200 feet, broken at 600 feet, few cumulonimbus at 1,200 feet, overcast at 1,600 feet, temperature 22℃; dew point temperature 22℃, altimeter setting 996 hPa. Remarks: altimeter setting 29.42 in-Hg, recent heavy rain, stationary thunderstorm overhead (ATIS N).

METAR at 1900 hours, wind from 220 degrees at 11 knots gusting to 21 knots, visibility 1,600 meters in thunderstorm rain, scattered clouds at 200 feet, broken at 600 feet, few cumulonimbus at 1,200 feet, overcast at 1,600 feet, temperature 23℃; dew point temperature 22℃, altimeter setting 997 hPa, trend forecast-no significant change. Remarks: altimeter setting 29.45 in-Hg, recent heavy rain, hourly precipitation 7.0 millimeters, stationary thunderstorm overhead (ATIS O).

SPECI at 1910 hours, wind from 250 degrees at 18 knots gusting to 28 knots, visibility 800 meters in heavy thunderstorm rain, scattered clouds at 200 feet, broken at 600 feet, few cumulonimbus at 1,200 feet, overcast at 1,600 feet, temperature 22℃; dew point temperature 22℃, altimeter setting 998 hPa. Remarks: altimeter setting 29.48 in-Hg, runway visual range 800 meters at Runway 20, stationary thunderstorm overhead (ATIS

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[23] Runway visual range (RVR) is the distance at which the runway, or the specified lights or markers delineating it, can be seen from a position above a specified point on its centerline. It is normally included in aerodrome meteorological reports when visibility or RVR is less than 1,500 meters.

[24] Hourly precipitation in the METAR of Magong airport was not presented in ATS message handling system (AMHS) of ANWS, CAA.

[25] It indicated that meteorological information used in automatic terminal information service (ATIS) No. L was extracted from the report (excluding remarks) but in different format.

P).

LOCAL[26] at 1918 hours, wind from 230 degrees at 23 knots gusting to 33 knots, visibility 800 meters in heavy thunderstorm rain, scattered clouds at 200 feet, broken at 600 feet, few cumulonimbus at 1,200 feet, overcast at 1,600 feet, temperature 24℃; dew point temperature 23℃, altimeter setting 998 hPa. Remarks: altimeter setting 29.48 in-Hg, runway visual range 800 meters with no significant change at Runway 20, stationary thunderstorm overhead (ATIS Q).

METAR at 1930 hours, wind from 230 degrees at 19 knots gusting to 29 knots, visibility 800 meters in heavy thunderstorm rain, scattered clouds at 200 feet, broken at 600 feet, few cumulonimbus at 1,200 feet, overcast at 1,600 feet, temperature 24℃; dew point temperature 23℃, altimeter setting 998 hPa, trend forecast-no significant change. Remarks: altimeter setting 29.48 in-Hg, runway visual range 800 meters with no significant change at Runway 20, stationary thunderstorm overhead (ATIS R).

METAR at 2000 hours, wind from 210 degrees at 13 knots gusting to 23 knots, visibility 800 meters in heavy thunderstorm rain, scattered clouds at 200 feet, broken at 600 feet, few cumulonimbus at 1,200 feet, overcast at 1,600 feet, temperature 24℃; dew point temperature 23℃, altimeter setting 997 hPa, trend forecast-no significant change. Remarks: altimeter setting 29.46 in-Hg, runway visual range 800 meters at Runway 20, hourly precipitation 26.0 millimeters, stationary thunderstorm overhead (ATIS S).

1.7.3 Automated Weather Observation Systems

Magong Airport’s new automated weather observation system[27] (AWOS) became operational in June 2011. The AWOS sensors were located at the approach ends and midpoint of the runway, providing real-time weather information to the displays located at the Weather Center and Magong tower, as shown in Figure 1.7-2. The location of Magong Airport’s AWOS sensors and the Central Weather Bureau’s (CWB) Penghu weather station are shown in Figure 1.7-3. The relevant weather parameters from 1800 to 2000 hours are shown in Figure 1.7-4 to 1.7-5.

AWOS N was located approximately 0.5 nautical mile south-southwest of

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[26] This report was the additional observation after Weather Center received the notification of the occurrence.

[27] AWOS is a system that continuously measures weather information, including wind speed and direction, visibility, RVR, precipitation, cloud cover, temperature, dew point, altimeter setting, and lightning. The previous AWOS was not equipped with RVR capability.

the occurrence site. The wind gradually turned westerly from south-southwest between 1837 and 1847 hours, and then returned to the south-southwest at 1932 hours. One-minute average wind speed increased from 9 knots at 1858 hours to 31 knots at 1913, gusting to 36 knots at 1911 hours. Rainfall began to intensify at 1900 hours, accompanied by the runway visual range (RVR) reducing from more than 2,000 meters at 1859 hours, to between 500 and 900 meters between 1901 and1931 hours. RVR returned to more than 2,000 meters at 1947 hours.

SCT029
SCT035
OVC051

QNH 1008 (hPa)
QFE 1006 (hPa)

WD2 002 (Deg) WS2 10 (Kts) WD10 011 (Deg) WS10 10 (Kts)
TWIND2 08T (Kts) CWIND2 06R (Kts) GUST2 13 (Kts) GUST10 13 (Kts)
DPT 26.2 (Deg.C) AT 30.7 (Deg.C) RH 77.0 (%) RAIN 00.0 (mm/10min)
VIS 50000 (Meters) RVR ABV 2000M (Meters)
PW NSWR RW NSWR Luminance 05106

WD2 011 (Deg) WS2 07 (Kts) WD10 008 (Deg) WS10 07 (Kts)
TWIND2 06T (Kts) CWIND2 03R (Kts) GUST2 10 (Kts) GUST10 11 (Kts)
Lx 1 (Total)

SCT011
BKN023
OVC031

QNH 1010 (hPa)
QFE 1008 (hPa)

WD2 359 (Deg) WS2 10 (Kts) WD10 351 (Deg) WS10 08 (Kts)
TWIND2 07T (Kts) CWIND2 06R (Kts) GUST2 12 (Kts) GUST10 12 (Kts)
DPT 22.3 (Deg.C) AT 28.5 (Deg.C) RH 69.2 (%) RAIN 00.0 (mm/10min)
VIS 35000 (Meters) RVR ABV 2000M (Meters)
PW NSWR RW NSWR Luminance 05106

Figure 1.7-2 Weather Center and Magong tower AWOS displays

Figure 1.7-3 AWOS sensor locations

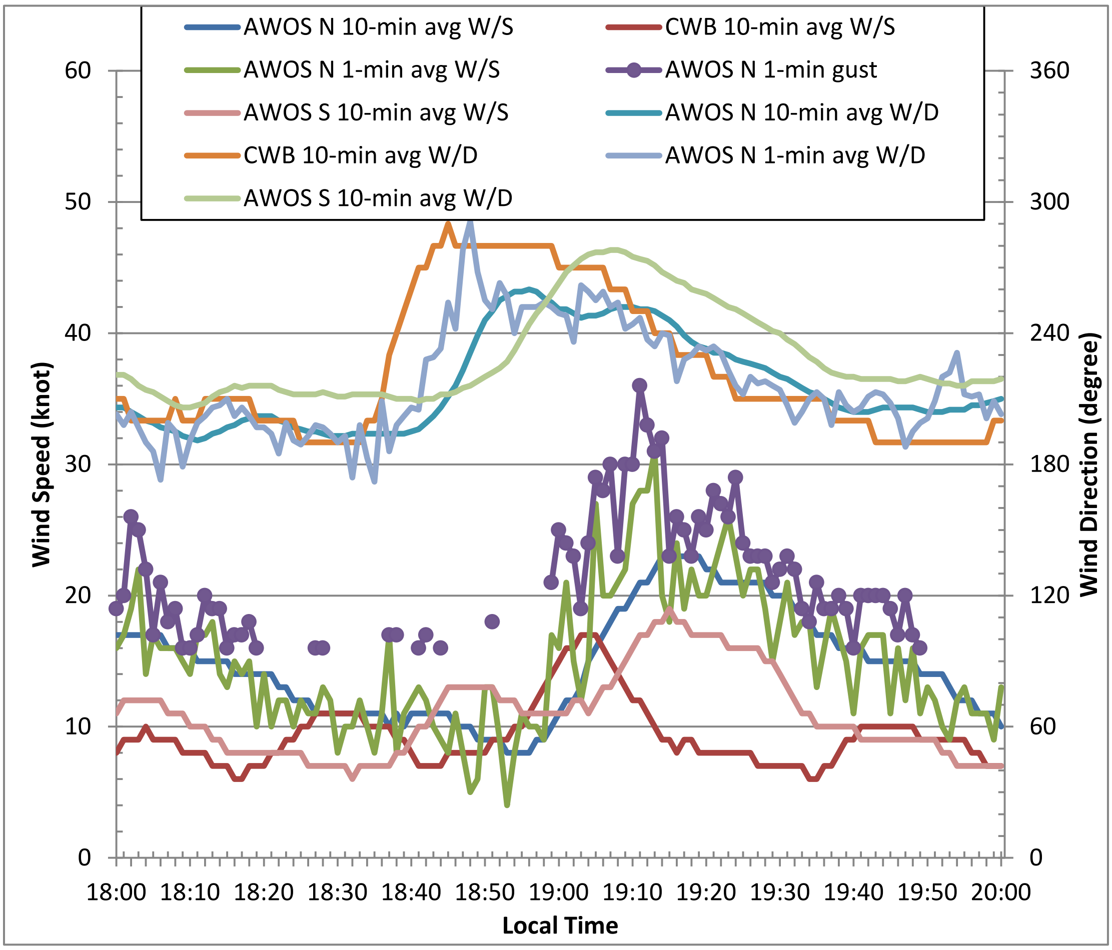

Figure 1.7-4 AWOS wind speed/direction

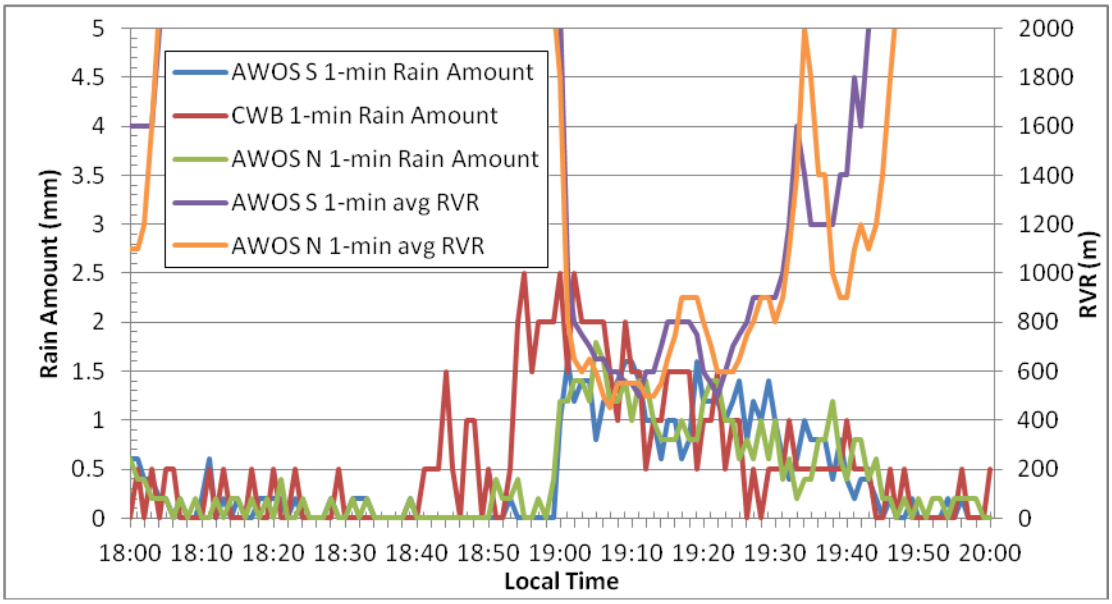

Figure 1.7-5 AWOS rainfall and RVR

1.7.4 Weather Information Summary

The visibilities, RVRs and other weather information provided by Weather Center, AWOS, and ATC units were summarized in Table 1.7-1.

Table 1.7-1 Summarized weather information

Time	**Source**	**Details**	**GE222 received**
1700	METAR	Visibility 2,400 meters in thunderstorm rain, ceiling at 600 feet (ATIS I)	No
1700	AWOS RVR[28]	Above 2,000 meters	No
1728	Kaohsiung Tower	Thunderstorm overhead at Magong Airport	Yes
1730	METAR	Visibility 2,400 meters in thunderstorm rain, ceiling at 600 feet (ATIS J)	No
1730	AWOS RVR	Above 2,000 meters	No
1740	AWOS RVR	From above 2,000 to 500 meters from 1731 to 1740	No
1742	Kaohsiung Tower	Magong Airport was below landing minima	Yes
1751	GE222 CVR	ATIS Information Kilo of Magong Airport Visibility 800 meters in heavy thunderstorm rain, ceiling at 600 feet	Yes
1756	Kaohsiung Approach	Magong Airport was below landing minimum. Broadcasted hazardous weather forecast of Magong Airport	Yes
1800	AWOS RVR	Around 900 to 1,400 meters from 1751 to 1800	No
1801	GE222 CVR	ATIS Information Lima of Magong Airport Visibility 800 meters in heavy thunderstorm rain, ceiling at 600 feet	Yes
1821	Kaohsiung Approach	Broadcasted thunderstorm will probably continue for another hour at Magong Airport	Yes
1827	Kaohsiung Approach	Broadcasted Magong Airport runway 02 instant wind was 210 degrees at 5 knots maximum 11 knots, runway 20 instant wind was 190 degrees at 11 knots maximum 15 knots	Yes
1830	AWOS RVR	Above 2,000 meters	No
1836	Kaohsiung Approach	ATIS Information Mike of Magong Airport Visibility 800 meters in heavy thunderstorm	Yes

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[28] In tower, one-minute mean RVRs were reported to aircraft. In METAR/SPECI, ten-minute mean RVRs are reported. There were only one -minute mean RVRs recorded in AWOS.

Time	Source	Details	GE222 received
		rain, ceiling at 600 feet	
1840	AWOS RVR	Above 2,000 meters	No
1841	Magong Tower	Informed Kaohsiung Approach visibility was 1,600 meters	No
1842	Kaohsiung Approach	Visibility was 1,600 meters and thunderstorm overhead at Magong Airport	Yes
1845	Kaohsiung Approach	ATIS Information November of Magong Airport Visibility 1,600 meters in thunderstorm rain, ceiling at 600 feet	Yes
1859	AWOS RVR	Above 2,000 meters	No
1900	METAR	Visibility 1,600 meters in thunderstorm rain , ceiling at 600 feet (ATIS O)	No
1900	AWOS RVR	1,800 meters	No
1901	AWOS RVR	800 meters	No
1901	Magong Tower	QNH was 997	Yes
1902	AWOS RVR	650 meters	No
1903	AWOS RVR	600 meters	No
1903	Magong Tower	Wind was 250 degrees at 19 knots	Yes
1904	AWOS RVR	650 meters	No
1905	AWOS RVR	600 meters	No
1906	AWOS RVR	500 meters	No
1910	SPECI	Visibility 800 meters in heavy thunderstorm rain, RVR 800 meters at runway 20, ceiling at 600 feet (ATIS P)	No

1.7.5 Sounding Data

The 2000 hours routine upper air sounding (that is, a vertical profile of atmospheric conditions) for Magong Airport was conducted at 1835 hours on the day of the occurrence. A SkewT/logP[29] diagram drawn from the observation data is shown in Figure 1.7-6. The wind profile presented in Figure 1.7-7 identified a southwest wind near the surface at about 16 knots. Above the surface, the wind backed to the south-southwest, then veered to the southwest, and increased in magnitude to about 50 knots at 2,000 feet.

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[29] SkewT/logP diagram is a standard meteorological plot using temperature and the logarithmic of pressure as coordinates. It is used to display winds, temperature, dew point, and various indices used to define the vertical structure of the atmosphere.

Between 2,000 feet and 9,000 feet, the wind was generally from a southwesterly direction at about 45 to50 knots.

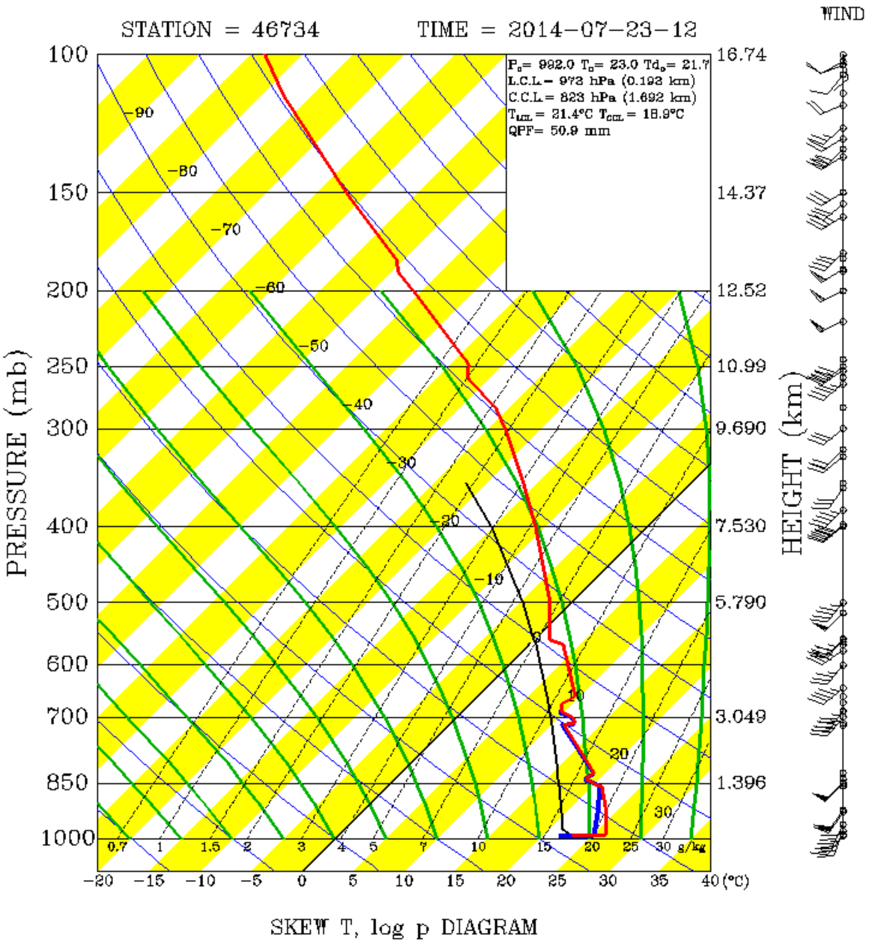

Figure 1.7-6 Skew T log P diagram

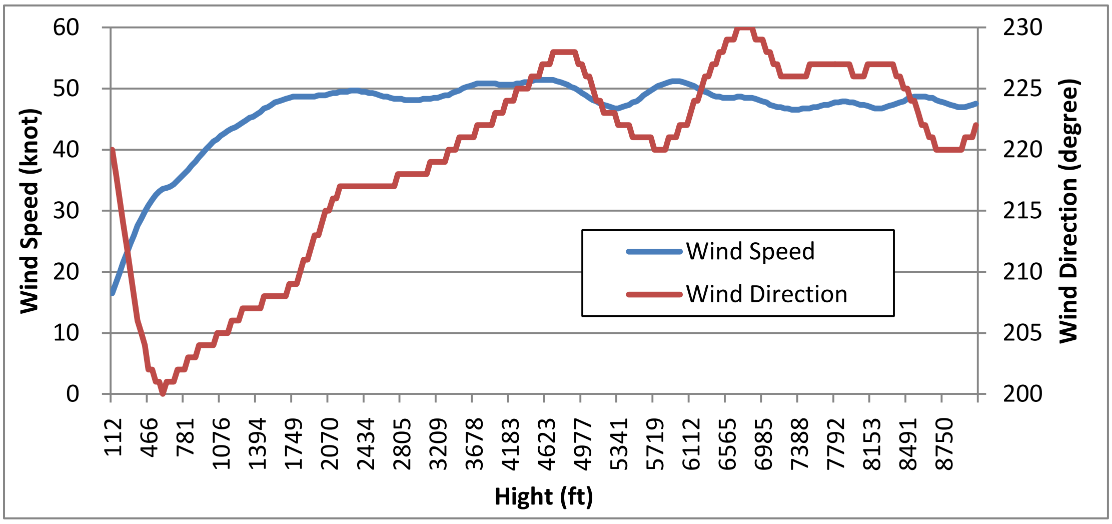

Figure 1.7-7 Wind profile from the surface to 9,000 feet

1.7.6 Satellite Data

The Japan Meteorological Agency's MTSAT infrared satellite image[30] of the area at 1857 hours is shown in Figure 1.7-8. Compared with the sounding data, the cloud top height was about 53,000 feet over Penghu.

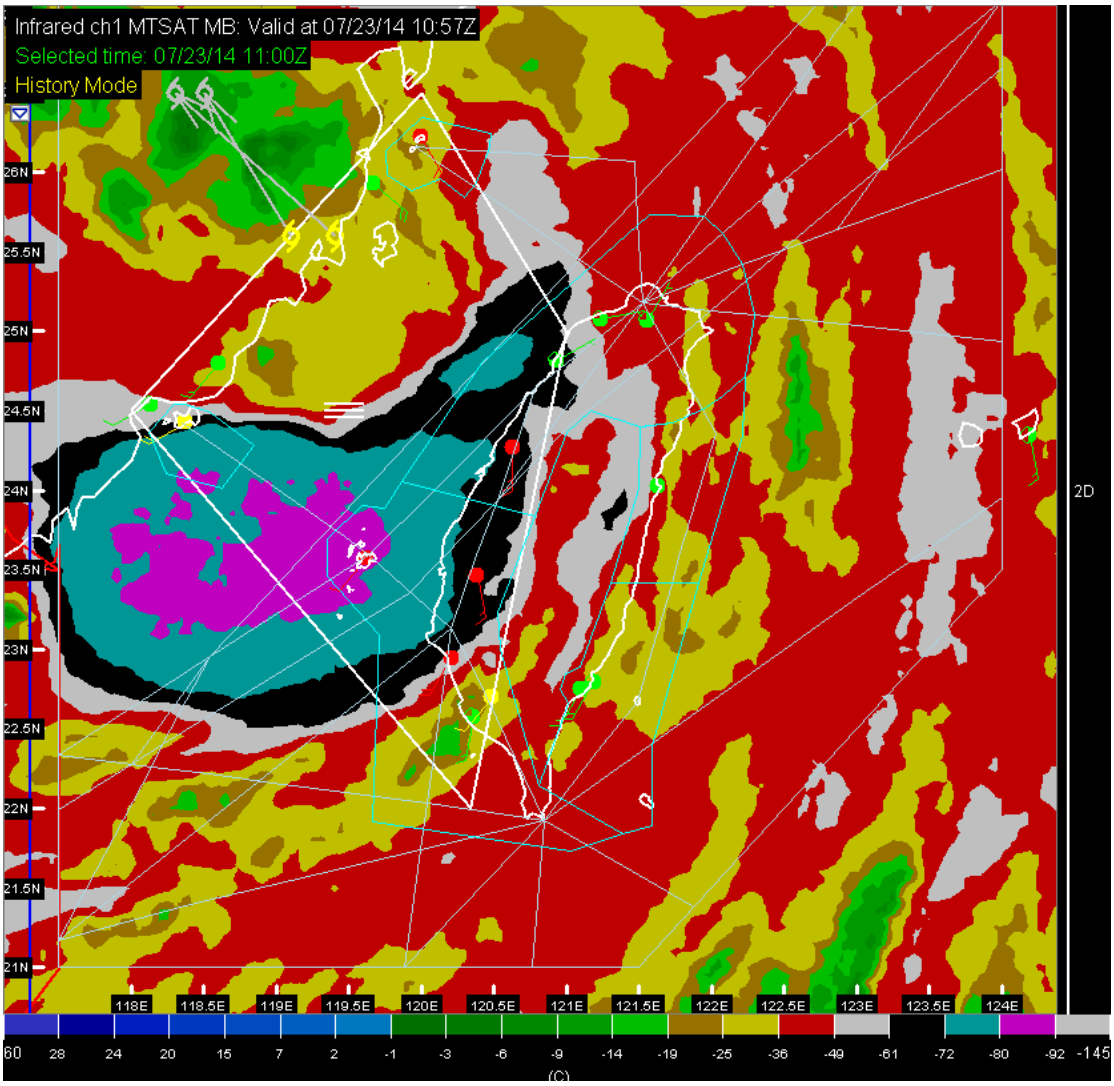

Figure 1.7-8 Infrared satellite image at 1857 hours

1.7.7 Weather Radar Information

The CWB had four S-band 10 centimeter wavelength Doppler weather radars. It took 6 to 7.5 minutes to complete a series of specific scans. The composite image of the radars at 1900 hours and cropped images of the Penghu area from 1830 to 1912 hours are shown in Figure 1.7-9. The time

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[30] Operates on channel 1 with a wave length between 10.3 and 11.3µm, it provides cloud top temperature information.

indicated on the figure is the start time for the scans. The figure shows that a stronger echo moved to Magong Airport from southwest to northeast between 1900 and 1912 hours.

Chiku weather radar was located approximately 35 nm to the southeast of the occurrence site. A scan was completed every 7.5 minutes. With the scan taken at 0.5° elevation, the airspace between about 1,100 and 4,700 feet above mean sea level above the occurrence site was captured. The images from Chiku's radar between 1823:10 and 1915:40 are depicted in Figure 1.7-10.

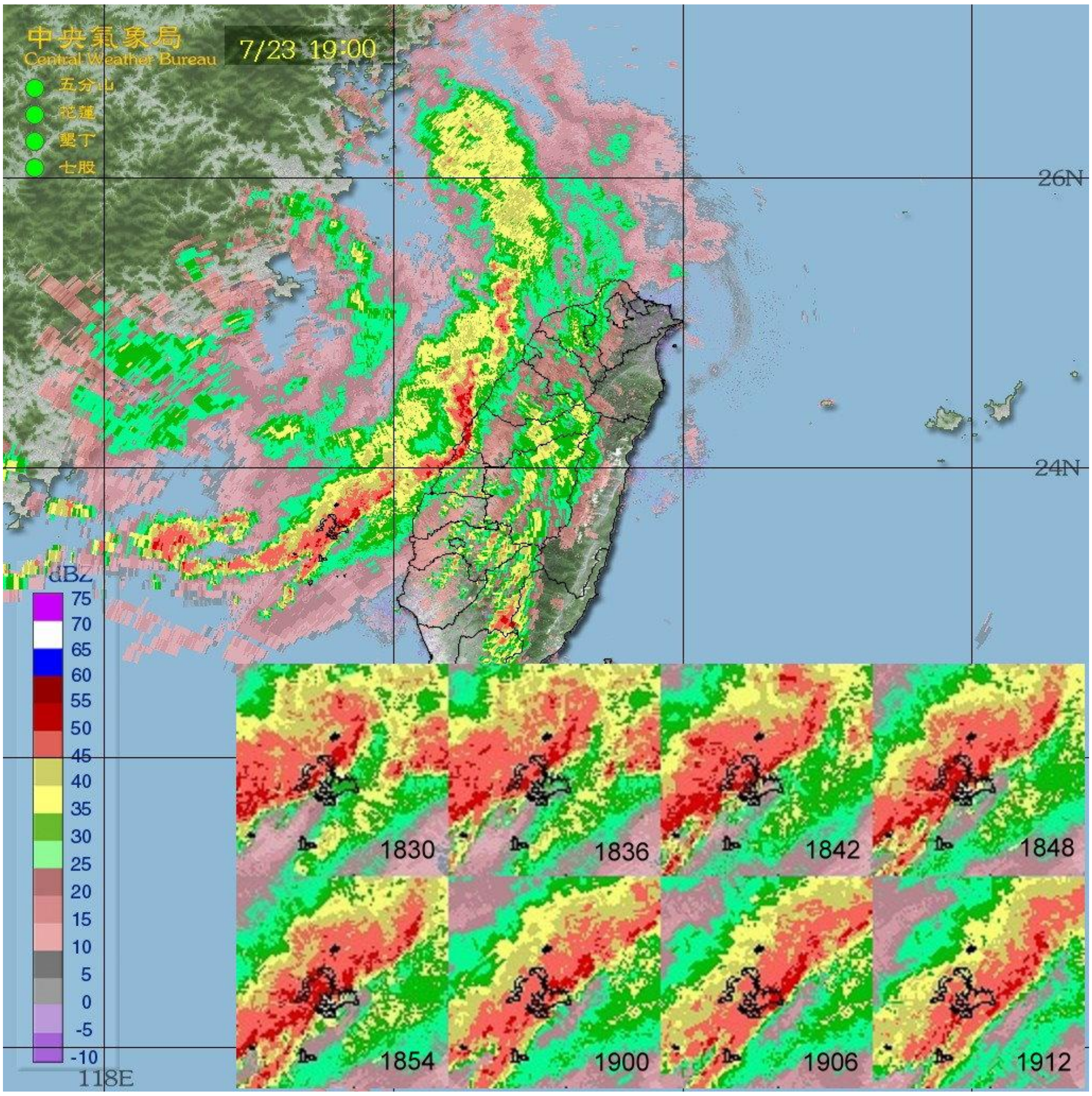

Figure 1.7-9 CWB weather radar composite images

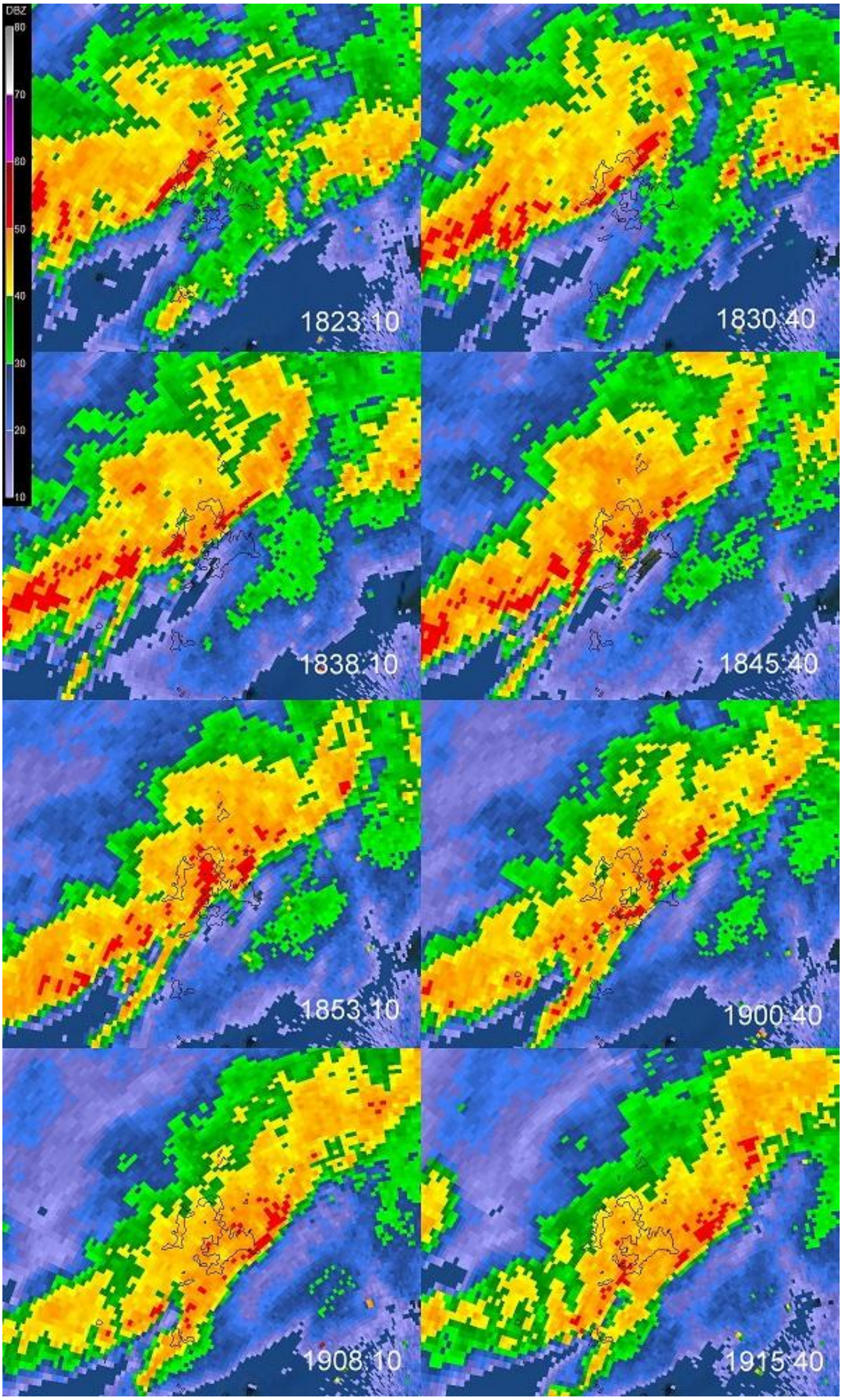

Figure 1.7-10 Chiku weather radar images before and after the occurrence

1.7.8 Significant Weather Chart

The significant weather (SIGWX) chart which was valid at 2000 on July 23 is shown in Figure 1.7-11. It indicated that frequent cumulonimbus with a ceiling of 1,500 feet and a height over 45,000 feet around the Penghu area.

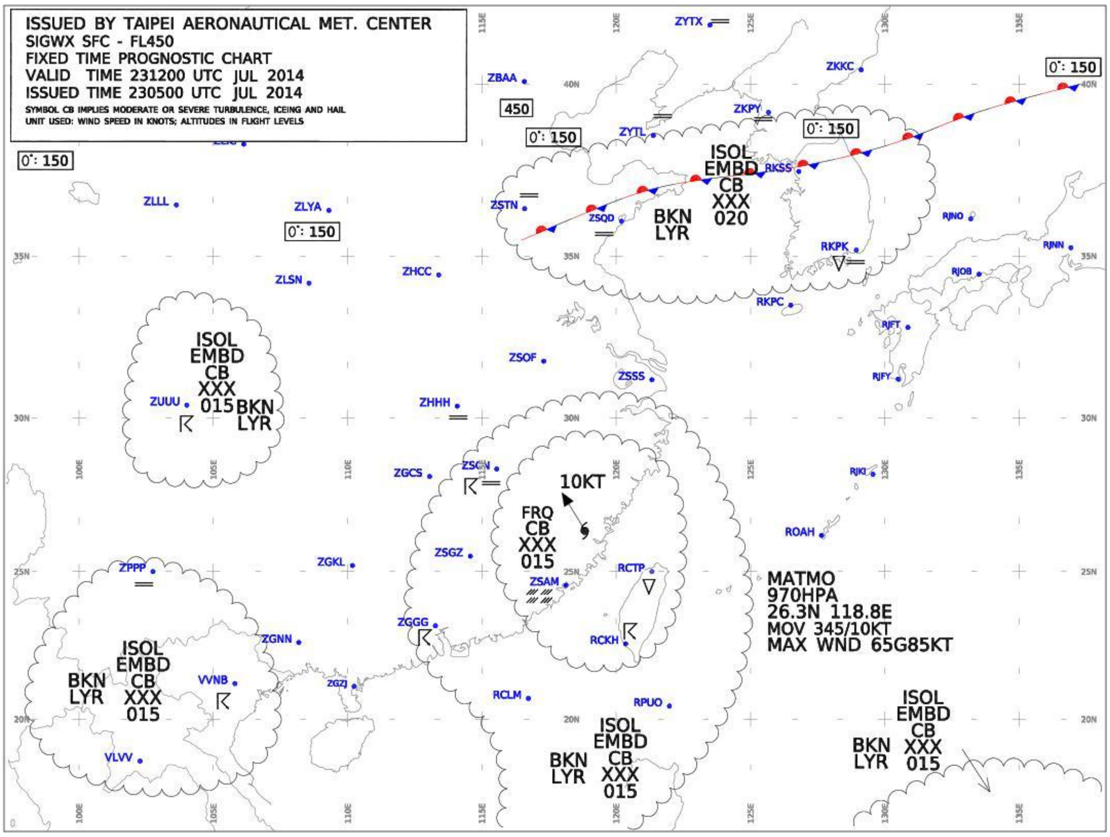

Figure 1.7-11 SIGWX chart

1.8 Aids to Navigation

According to the Taiwan CAA aeronautical information publication (AIP), there are several radio navigation and instrument approach landing aids for Magong Airport. VOR, non-directional beacon (NDB), and area navigation (RNAV) global navigation satellite system approaches were available for runway 20. Instrument landing system/localizer (ILS/LOC), VOR, NDB, and RNAV approaches were available for runway 02.

The visibility required for Magong VOR approaches was 1,600 meters. The Magong runway 02 ILS approach required 800 meters visibility.

1.8.1 VOR/DME

The VOR navigation and non-precision approach aid is an aircraft navigation system operating in the very high frequency (VHF) band.

VORs broadcast a VHF radio composite signal and data that allows the airborne receiving equipment to derive the magnetic bearing from the station to the aircraft. An infinite number of bearings can be obtained and they may be visualized as radiating from the beacon like spokes from the hub of a wheel. However, for practical purposes the number of bearings can be considered to be limited to 360, one degree apart, and these 360 bearings are known as radials. A radial is identified by its magnetic bearing outbound from the VOR beacon. The VOR enables a pilot to select, identify, and locate a line of position from a particular VOR beacon.

Magong VOR was upgraded from a conventional VOR (CVOR) to a Doppler VOR (DVOR) 1 June 1 2013. The DVOR system is more resistant to multipath interference compared to the traditional CVOR. The Magong DVOR (model DVOR1150A) was manufactured by SELEX, and was equipped with dual transmitters, dual monitors and dual power supplies to ensure VOR signal integrity and continuity. The Magong VOR operating frequency was 115.2 MHz with an identifier of MKG. There were two main functions of the DVOR: enroute, which provided aircraft tracking guidance for air routes[31] A1 and W6; and terminal, which provided approach tracking guidance for both runway 02 and runway 20.

The Magong DME (distance measuring equipment) was a transponder-based radio navigation aid that measured slant range distance from a land-based transponder by timing the propagation delay of UHF radio signals.

Magong DME was replaced on 1 June 1 2013. The new unit (model DME1119A) was manufactured by SELEX and was equipped with dual transmitters, dual monitors and dual power supplies, and was co-located with the DVOR as an aid to enroute navigation and instrument approaches. The DME identifier and frequency was the same as the DVOR.

The Magong VOR monitoring receiver log indicated that the system was fully functional on the day of the occurrence. In addition, the most recent flight testing of the Magong VOR, conducted on 6 May 2014, indicated that the system was performing within standard tolerances and was “unrestricted”. There were no pilot reports of the VOR malfunctioning since its commissioning on 1 June 2013.

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[31] An air route is a specified route designed for channeling the flow of traffic as necessary for the provision of air traffic services. A legacy design feature of air routes, prior to the development and implementation of the Global Positioning System, Area Navigation, Performance Based Navigation (PBN) and improved aircraft navigation capabilities, was the requirement to track via ground-based radio navigation aids.

1.9 Communication

The radio communication frequencies used by Kaohsiung tower, Kaohsiung approach and Magong tower were 121.9/118.7 MHz, 124.7/128.1 MHz and 118.3 MHz respectively.

The telephone communication transcripts between the Magong tower controllers, Kaohsiung approach controllers, Magong flight operations section, the meteorological office, weather watch office and Magong flight control office are summarized in Appendix 1.

1.10 Aerodrome

1.10.1 Airside Basic Information

Magong Airport[32] is located 10.2 km northeast of Magong City. It had a single runway oriented north-northeast and south-southwest designated as runway 02/20. Runway 02's precise magnetic heading was 21.67° with declared dimensions of 3,000 meters long, 45 meters wide, and an elevation of 103 feet at the threshold. It had a clearway which was 300 meters long and 60 meters wide but no stopway. Runway 20's precise magnetic heading was 201.67° and an elevation of 46 feet at the threshold. It had a 285 meter long clearway that was 75 meters wide but no stopway (see Figure 1.10-1).

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[32] Aeronautical information publication (AIP) TAIPEI FIR effective10 JUL 14. ICAO airport code RCQC.

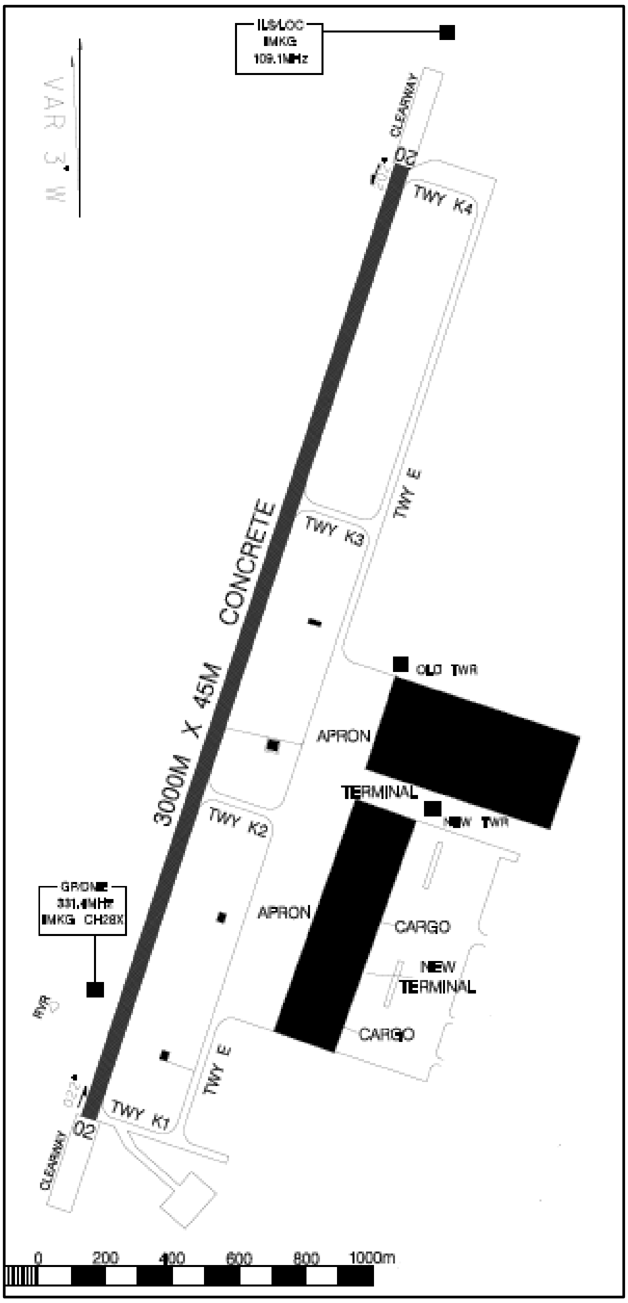
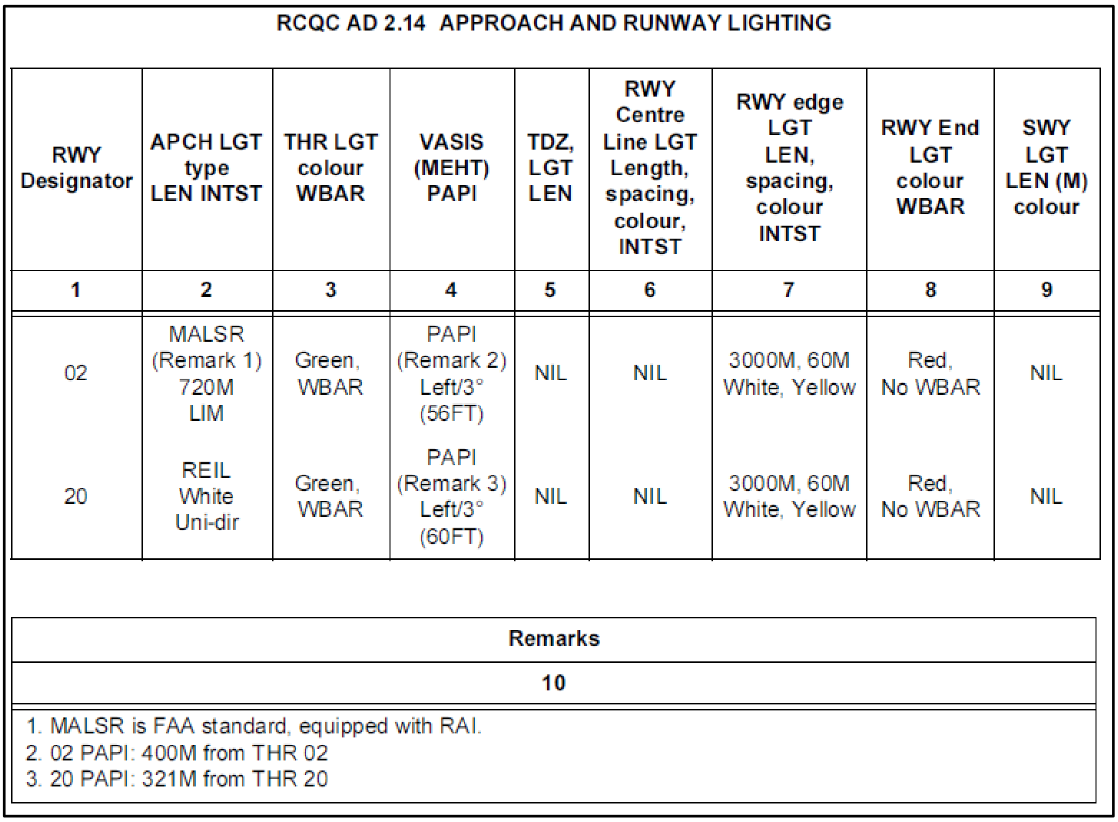


Figure 1.10-1 Magong Airport chart

1.10.2 Approach and Runway Lighting Systems

Magong Airport’s approach and runway lighting system configuration is shown in Figure 1.10-2.



RCQC AD 2.14 APPROACH AND RUNWAY LIGHTING

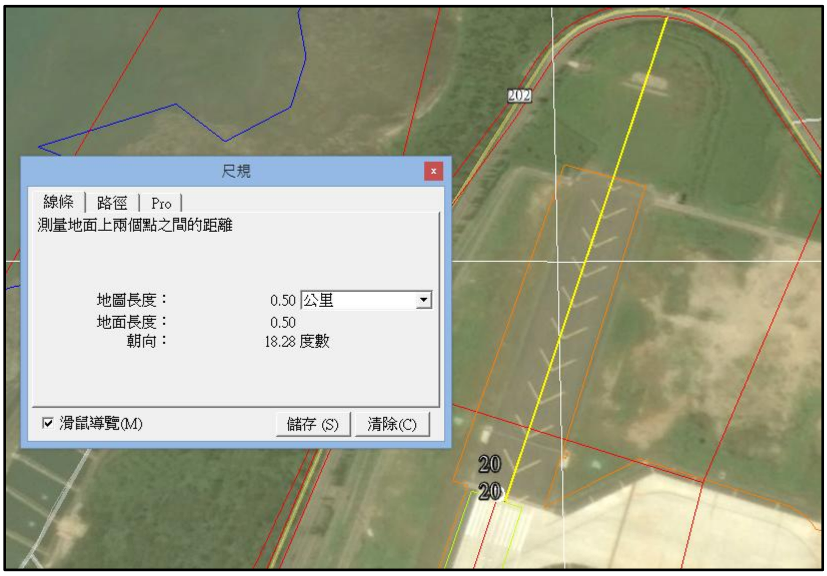
RWY Designator	APCH LGT type LEN INTST	THR LGT colour WBAR	VASIS (MEHT) PAPI	TDZ, LGT LEN	RWY Centre Line LGT Length, spacing, colour, INTST	RWY edge LGT LEN, spacing, colour INTST	RWY End LGT colour WBAR	SWY LGT LEN (M) colour
1	2	3	4	5	6	7	8	9
02	MALSR (Remark 1) 720M LIM	Green, WBAR	PAPI (Remark 2) Left/3° (56FT)	NIL	NIL	3000M, 60M White, Yellow	Red, No WBAR	NIL
20	REIL White Uni-dir	Green, WBAR	PAPI (Remark 3) Left/3° (60FT)	NIL	NIL	3000M, 60M White, Yellow	Red, No WBAR	NIL

Remarks
10
1. MALSR is FAA standard, equipped with RAI. 2. 02 PAPI: 400M from THR 02 3. 20 PAPI: 321M from THR 20

Figure 1.10-2 Magong Airport's approach and runway lighting system

There was no approach lighting system for runway 20. According to ICAO Annex 14 section 5.3.4 and the CAA Civil Aerodrome Design and Operations Specifications section 5.3.4, where physically practicable, a simple approach lighting system shall be provided to serve a non-precision approach runway. A simple approach lighting system shall consist of a row of lights on the extended center line of the runway extending, where possible, over a distance of not less than 420 meters from the threshold.

Measurement of the extended center line for runway 20 indicated that about 500 meters was available for an approach lighting system within the airport area, as shown in Figure 1.10-3.



測量地面上兩個點之間的距離

地圖長度： 0.50 公里
地面長度： 0.50
朝向： 18.28 度數

☑ 滑鼠導覽(M)

Figure 1.10-3 Available distance measured from Runway 20 (image from Google Earth)

1.10.3 Runway Lighting System

Both runway 02 and runway 20 had 6 fixed bidirectional runway threshold/end lights[33] installed, which were illuminated green in the direction of approach to the runway. Runway 02 and runway 20 also had installed 10 fixed unidirectional runway threshold lights which were illuminated green in the direction of approach to the runway. The runway also had two groups of green wing bar lights positioned symmetrically about the runway centerline on each side of the runway threshold. Each wing bar contained 5 lights extending 10 meters outward from, and at right angles to, the line of the runway edge lights. The innermost light of each wing bar was aligned with the runway edge lights.

The western side of runway 02 was equipped with a precision approach path indicator (PAPI)[34] guidance system positioned 400 meters forward of the runway threshold. The eastern side of runway 20 was equipped with a PAPI positioned 321 meters forward of the runway threshold.

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[33] Magong Airport runway/taxiway reconstruction engineering contract.

[34] The precision approach path indicator (PAPI) is a visual aid that provides guidance information to help a pilot acquire and maintain the designated glideslope (typically 3°) for an approach to an airport. It is generally located beside the runway beyond the landing threshold of the runway. The ratio of white to red lights seen is dependent on the angle of approach to the runway. Above the designated glideslope a pilot will observe more white lights than red, at approaches below the ideal angle more red lights than white will be seen. For the optimum approach angle the ratio of white to red lights will remain equal throughout.

Runway 02/20 had white/yellow runway edge lighting installed at 60 meter (200 feet) intervals.

Runway end identifier lights (REIL) were also installed on both sides of the runway 20 threshold. The REIL provided a rapid and positive identification of the end of the runway[35]. The system comprised two types of synchronized flashing lights that were unidirectional or omni-directional. The unidirectional lights were directed towards the approach area. REIL were effective for: identification of a runway surrounded by a preponderance of other lighting; identification of a runway which lacked contrast with surrounding terrain; and identification of a runway under reduced visibility. The REIL had three intensity settings and can be seen by flight crew at an approximate range of 3 miles during daylight and 20 miles at night.

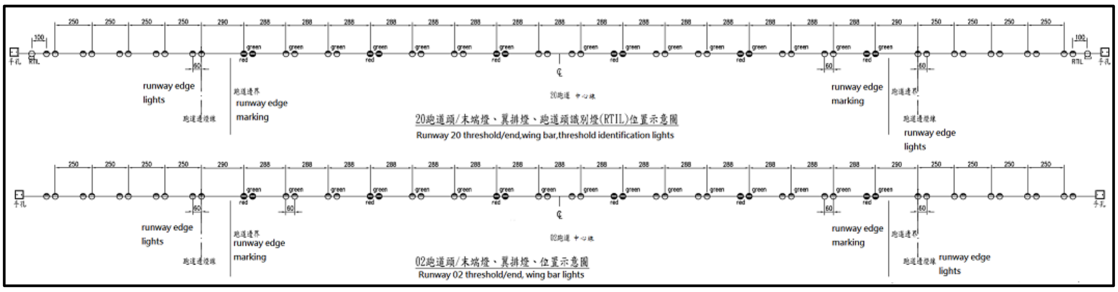

Figure 1.10-4 RWY 02/20 lighting systems

1.10.4 Information from Airport CCTV

Magong Airport’s closed-circuit television (CCTV) provided information on the status of the runway lighting systems, local visibility, and emergency response activities at the time of the occurrence.

The investigation team obtained copies of the video footage from No.7 and No.9 airport surveillance cameras. The camera locations and filming directions are shown in Figure 1.10-5. The camera footage encompassing the time period between 1830 and 1930 on the day of the occurrence was examined. Relevant images extracted from No.7 and No.9 cameras are presented in Appendix 2. A summary of the information obtained from the video footage is presented in Table 1.10-1.

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[35] https://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/techops/navservices/lsg/reil/

Table 1.10-1 Summary of airport video footage

Time	Observations
1830-1858	Raining, runway edge lights and control tower visible.
1858-1903	Storm suddenly intensifies accompanied by continuous lightning, runway edge lights not visible.
1903-1910	Very poor visibility, no objects could be recognized from camera.
1913-1930	Airport rescue firefighting vehicles were dispatched. Storm conditions improved and some runway edge lights were visible.

Figure 1.10-5 The location of airport CCTV No.7 & No.9

1.11 Flight Recorders

The flight data recorder (FDR) and the cockpit voice recorder (CVR) were recovered by the search and rescue team at Xixi village on the night of the occurrence, and were later handed over to the duty officer at Magong Airport. The recorders were transported to the Aviation Safety Council (ASC) Investigation Laboratory for disassembly and readout on 24 July.

1.11.1 Cockpit Voice Recorder

The aircraft was equipped with an L-3 Communications solid-state CVR (SSCVR), model A200S, serial number 00452. The CVR is capable of recording 2 hours of 2-channel standard quality cockpit audio, and 30 minutes of 4-channel high quality cockpit audio.

CVR Condition and Disassembly

The exterior of the CVR sustained significant structural damage as a result of impact forces. While the CVR's exterior casing was deformed, it was not punctured or compromised by fire. In accordance with ASC standard damaged recorder disassembly procedures, the dust cover was removed by cutting it away from the steel crash case (Figure 1.11-1). The crash survival memory unit (CSMU) was then removed from the CVR, and was found in good condition.

CVR Download and Readout

Following the A200S accident investigator's kit (AIK), provided by the recorder manufacturer L-3 Communications, download operation of the recorder was performed.

SSCVR Original Exterior Damage Conditions

SSCVR Teardown (1)

SSCVR Teardown (2)

SSCVR Download with another A200S

Figure 1.11-1 (a) Damaged SSCVR exterior view and its teardown; (b) Raw data download as suggested in the A200S AIK

An examination of the downloaded CVR data indicated that the first 25 minutes and 57 seconds of the 2-channel, standard quality recordings, and the final 4 minutes of the 4-channel, high quality recordings, were both misplaced to the other end of their tracks, probably as a result of impact forces. However, the audio quality of each channel was either good or excellent.

The CVR recording applicable to the occurrence started at 1739:09.5 and ended at 1906:18.9. It covered the entire occurrence flight from pushback to final approach. The CVR transcript for the entire flight is available at Appendix 3.

<u>Recorder Timing Synchronization and Correlation</u>

Timings for the CVR recording were established by correlating the CVR events to common events on the FDR and then synchronizing those events with the Kaohsiung Approach timing system. The entire air traffic equipment and surveillance radar timing system was based on GPS time, provided by the National Time and Frequency Standard Laboratory, Telecommunication Laboratories, Chunghwa Telecom Co., Ltd[36]. As a result of the synchronization:

FDR UTC + 28.0 seconds = ATC UTC

CVR UTC + 28.2 seconds = ATC UTC

1.11.2 Flight Data Recorder

The aircraft was equipped with an L-3 Communications solid-state FDR (SSFDR), part number S800-3000-00, serial number 00381.

Disassembly and readout of the FDR were accomplished using the standard hardware and software at the ASC’s laboratory, which included the L-3 Communications F1000 AIK, read-out support equipment (ROSE), and Insight analysis software. The ATR reader database was used in accordance with service letter no. ATR72-31-6010 revision 10.

The FDR recording contained about 35 hours 41 minutes and 7 seconds of data. The occurrence flight was the last flight of the recording and its duration was 1 hour 27 minutes and 10 seconds. The FDR stopped recording at 1906:18.9, which was the time of the occurrence.

<u>FDR Condition and Disassembly</u>

There was no evidence of heat or fire damage on the exterior of the FDR. The FDR casing had sustained some impact damage and two CSMU

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[36] Website http://www.stdtime.gov.tw/english/e-home.aspx.

support units were broken. The CSMU was not damaged and all applicable data was recovered. Figures 1.11-2 shows the FDR exterior view, teardown and download process.

SSFDR Original Exterior Damage Conditions

SSFDR Teardown

SSFDR Download with another F1000

SSFDR Download Program- ROSE V 4.5

Figure 1.11-2 FDR exterior view, teardown and download process

Download, Readout, and Data Plots

After downloading the raw data from the L-3 read-out support equipment in accordance with the F1000 accident investigator's kits procedures, the FDR raw data was converted to an un-pack binary formation and imported into the Insight Analysis software.

The plot of selected parameters covering the entire occurrence flight is presented in Figure 1.11-3. Parameters in Figure 1.11-3 include master warning, main landing gear air/ground status, barometric pressure setting, VHF keying status, vertical acceleration, both engine NP speeds, both engine power lever positions, indicated airspeed, GPS ground speed, standard pressure altitude, and associated QNH corrected pressure altitude[37]- PALT (QNH 997).

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[37] Pressure altitude correction: the pressure altitude recorded by the FDR is standard pressure altitude, which corresponds to the static pressure sensed at the aircraft's static port. For the occurrence flight, the QNH altimeter settings varied between 1000 and 996 milibars (mb), in accordance with information provided by Kaohsiung approach and Magong tower. From 1902:43, the Magong QNH was 997 mb.

The plot of recorded parameters during the final approach (below 1,000 feet Radar Altitude [RA]) and associated wind information is presented in Figure 1.11-4. Parameters displayed in Figure 1.11-4 include: autopilot engaged status, yaw damper[38] status, VOR capture status, pitch attitude, roll attitude, angle of attack, wind direction, wind speed, selected altitude, indicated airspeed, ground speed, radio height and pressure altitude.

Figure 1.11-5 presents the engine related parameters and accelerations for the last 30 seconds of the recording. Parameters displayed in Figure 1.11-5 include: vertical acceleration, longitudinal acceleration, lateral acceleration, magnetic heading, both engine NP speeds, engine torques, engine power lever angles, radio height and pressure altitude.

Below a pressure altitude of 2,000ft and before impact, the average wind speed was 41 knots +/- 10.6 knots, average wind direction 242 degrees +/- 38 degrees. In addition, the aircraft’s average vertical acceleration was 1.025g +/- 0.0086 g’s. The turbulence intensity was based on the Eddy Dissipation Rate[39] which is calculated from vertical acceleration and true airspeed.

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[38] The yaw effort, applied on the rudder pedal, which triggers the yam damper disagreement parameter recording on the FDR is in the range of 25.5 daN to 31.5daN.

[39] Refer to ICAO Annex 3, Meteorological Service for International Air Navigation.

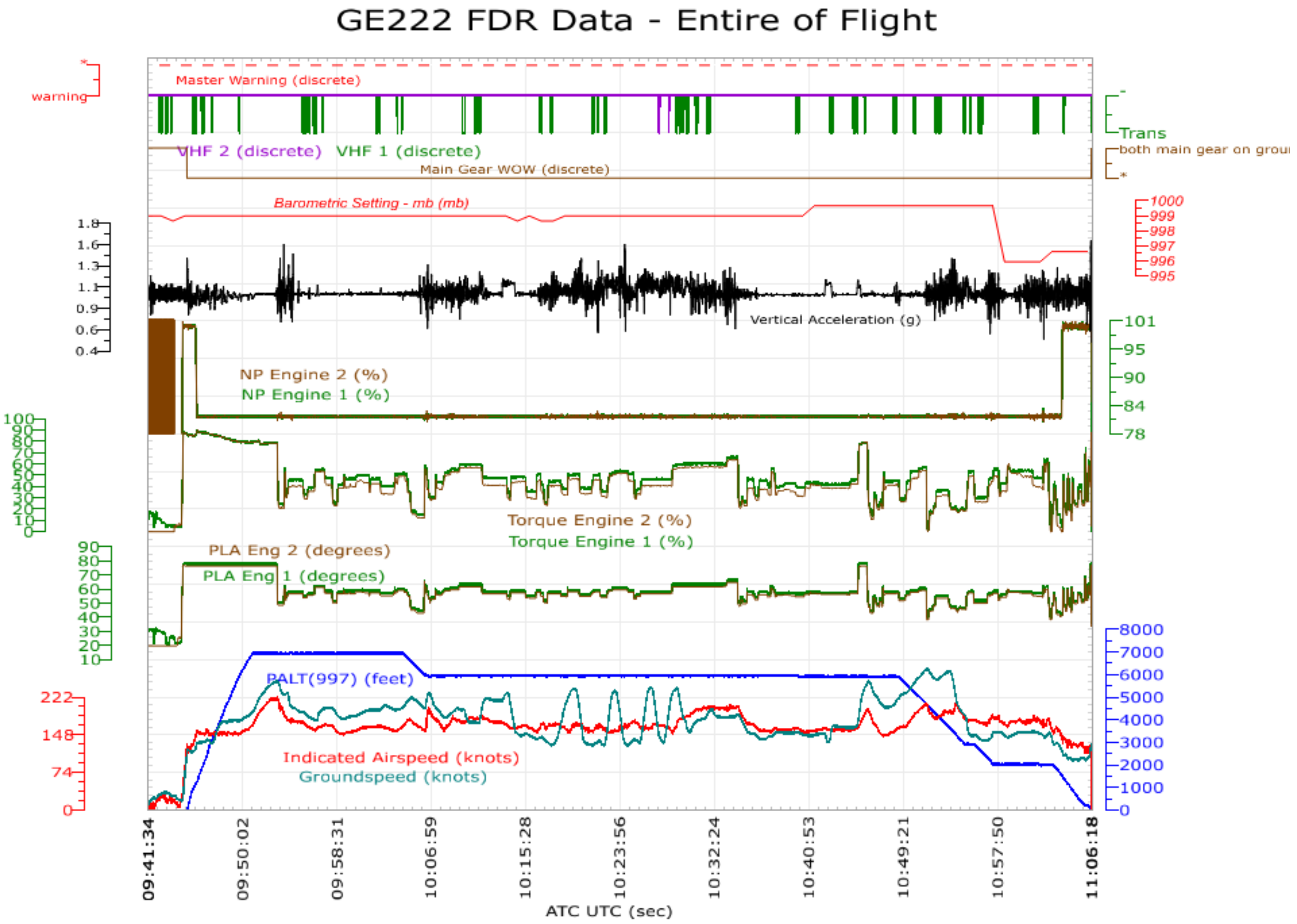

Figure 1.11-3 Entire Flight Data Plot for occurrence flight GE222 (source: FDR)

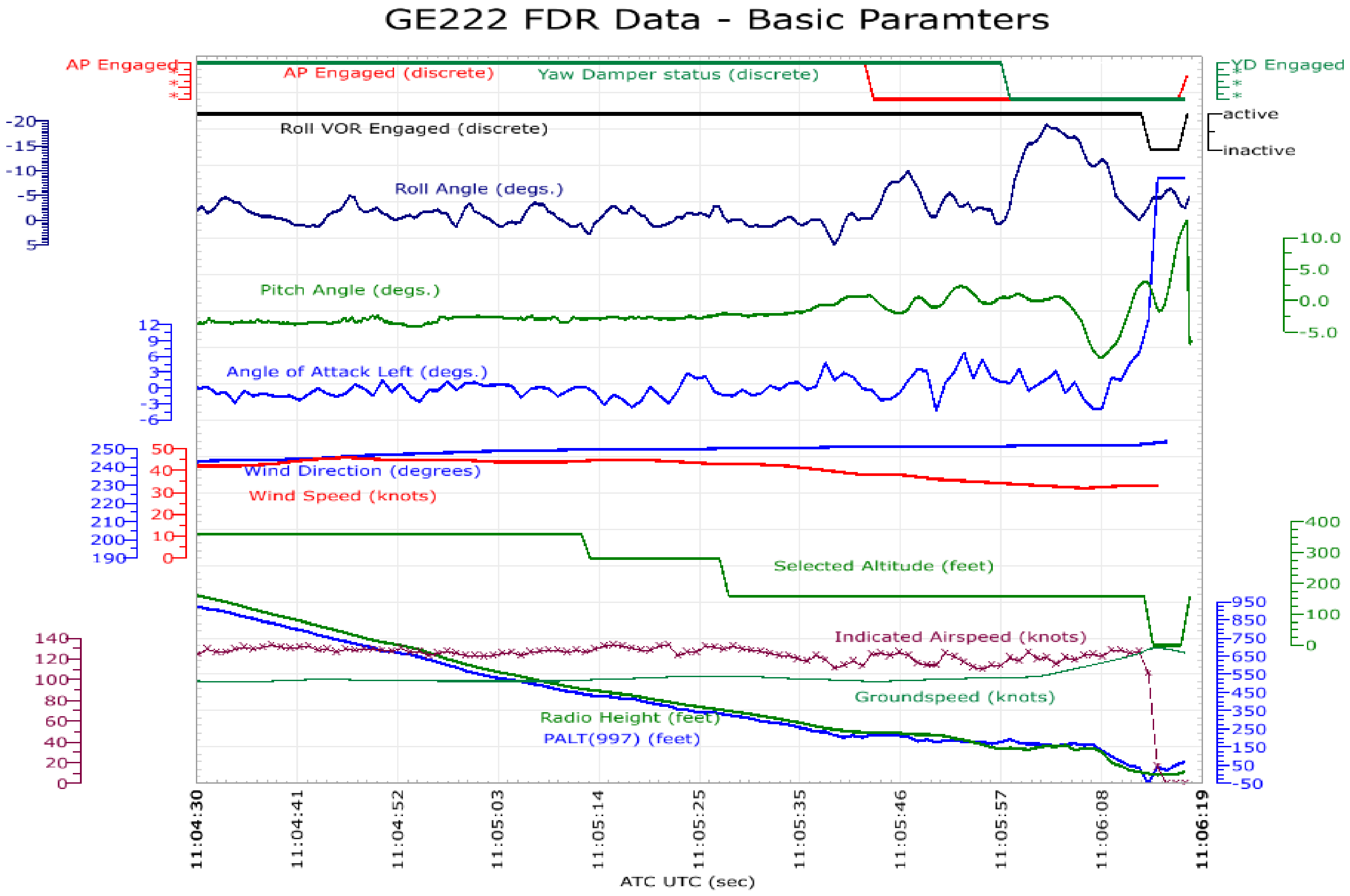

Figure 1.11-4 Flight Data Plot (Below 1,000 feet RA)

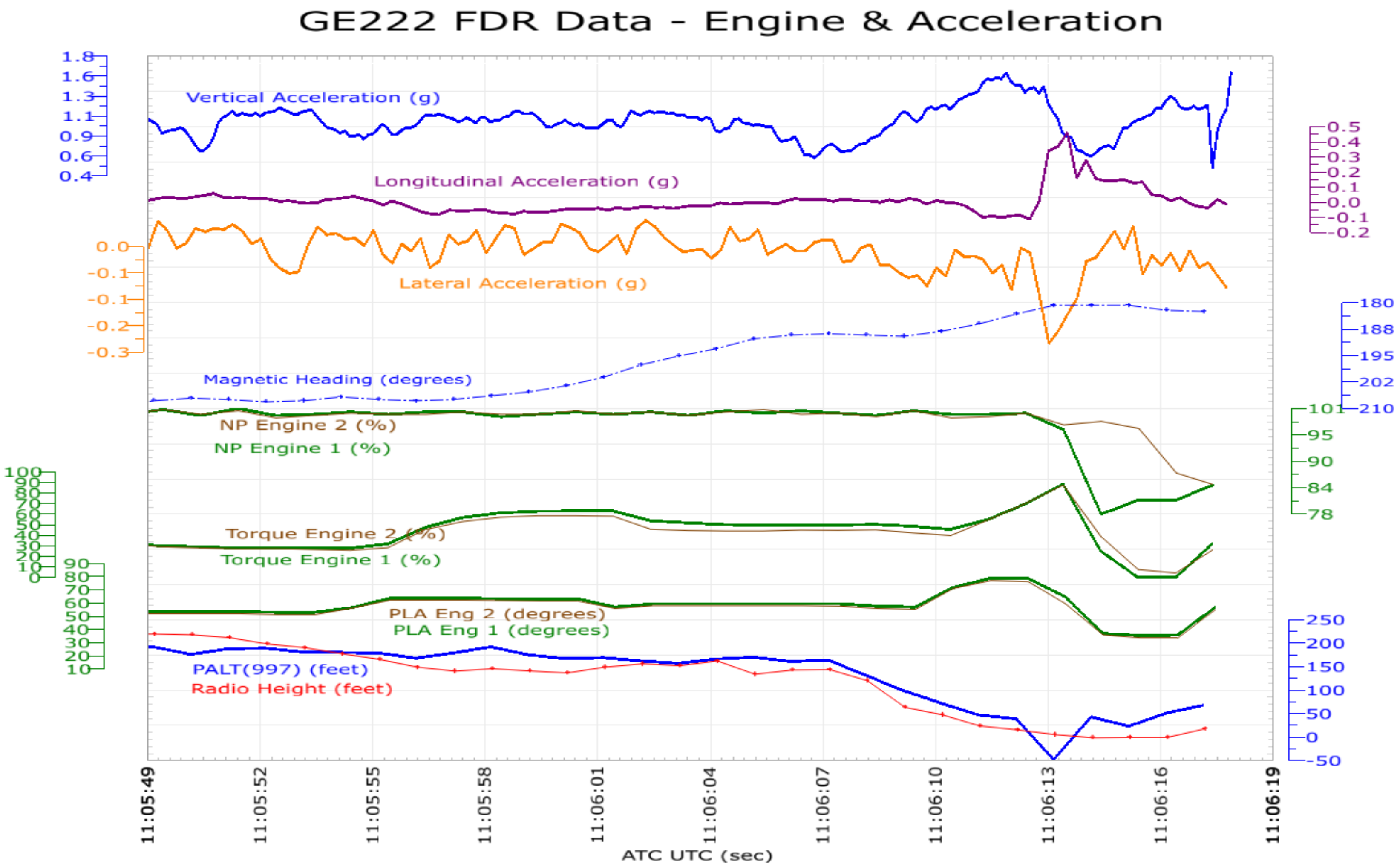

Figure 1.11-5 Flight Data Plot (Below 250 feet RA)

1.11.3 Other Flight Data and Radar Track Data

1.11.3.1 GE220 Flight Data

The flight crew had flown the occurrence route in the same aircraft earlier in the day as TNA flight GE220. On that flight, the aircraft took off from runway 27 at Kaohsiung International Airport at 1448:40 and landed on runway 20 at Magong Airport at 1510:36. Figure 1.11-6 displays the descent, approach and landing data below 2,500 feet for that flight. Between 1518:38 and 1519:01, one of the GPWS modes was activated during the descent from 296 feet to 235 feet (RA).

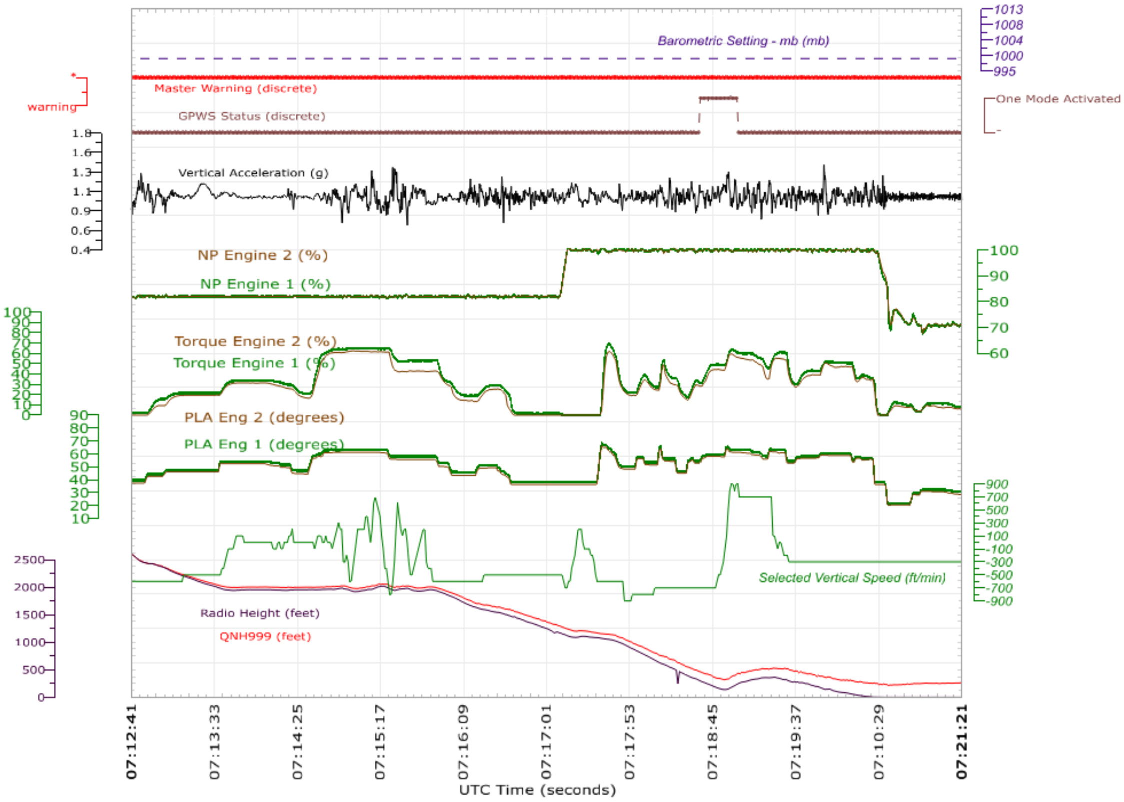

Figure 1.11-6 GE220 flight data plot (below 2,500 feet)

1.11.3.2 B7 647 Flight Data

Before Magong Tower cleared flight GE222 to land, Uni Airways flight B7 647, an ATR72-600 aircraft, successfully conducted a runway 20 RNAV approach and landing. The investigation team acquired the flight data from the Uni Airways ATR72-600 on 28 July to obtain more information regarding the wind velocity at Magong Airport. Figure 1.11-7 provides a plot of recorded parameters for that aircraft. The data indicated that the ATR72-600 took off from runway 36 at Tainan Airport at 1705:10 on 23 July and landed on runway 20 at Magong Airport at 1857:25.

The flight parameters in Figure 1.11-7 include: UTC time, air/ground switch status, pitch attitude, ro1l attitude, magnetic heading, wind speed, wind direction, vertical acceleration, airspeed, ground speed, GPS latitude position, GPS longitude position, and Baro-corrected altitude. The data indicated that below 2,000ft baro-altitude, average wind speed was 22.5 knots +/- 6.6 knots, average wind direction was 259 degrees +/- 4.6 degrees, and the average vertical acceleration was 1.0066 g +/- 0.061 g's.

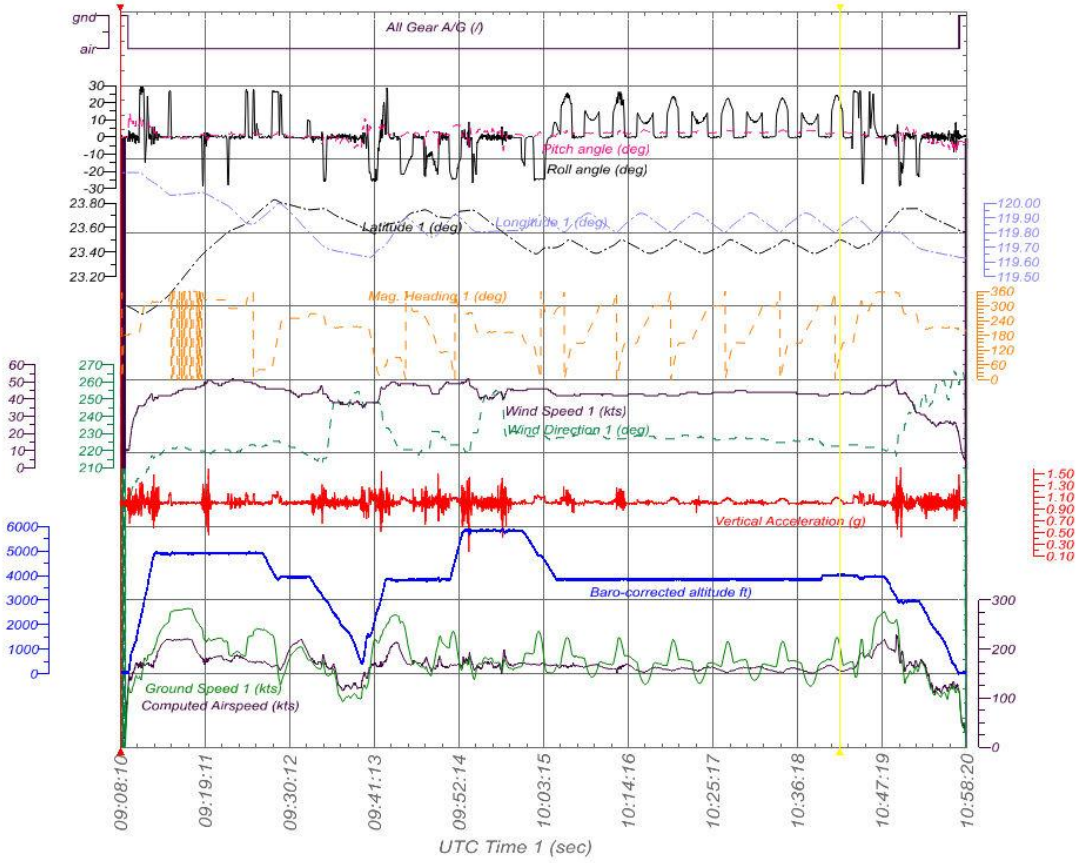

Figure 1.11-7 Uni Airways ATR72-600 Flight Data Plot

1.11.4 Flight Path Reconstruction and Unrecorded Parameters

1.11.4.1 Flight Path Reconstruction and Mapping

The occurrence aircraft's position was recorded by the FDR every 4 seconds. The recorded position parameters included GPS latitude and GPS longitude at a sampling rate 1/4 Hz. By applying double-integration[40] of

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[40] Double-Integration and flight path reconstruction: initial point at 1906:15 was GPS recorded position of N23°35'14.30", E119°38'19.35" and using three-axes acceleration data (sampling rate 8 Hz) to calculate the flight path.

the acceleration data recorded by the FDR, the position of the aircraft at every second was calculated, which enabled a reconstruction of the occurrence flight path. At 1906:18.9, the aircraft's last recorded position was N23°35'08.2", E119°38'21.1". Figure 1.11-8 displays key points along the occurrence flight path with the radar track superimposed with the Magong runway 20 VOR chart. Figure 1.11-9 presents the occurrence aircraft's trajectory during the last 40 seconds overlaid on a satellite image of the area.

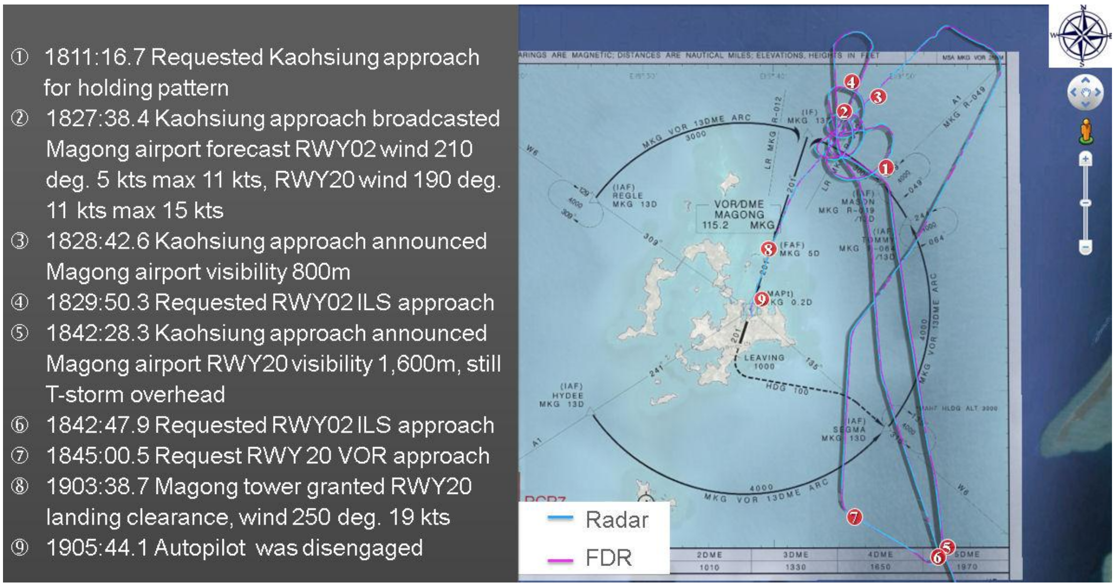
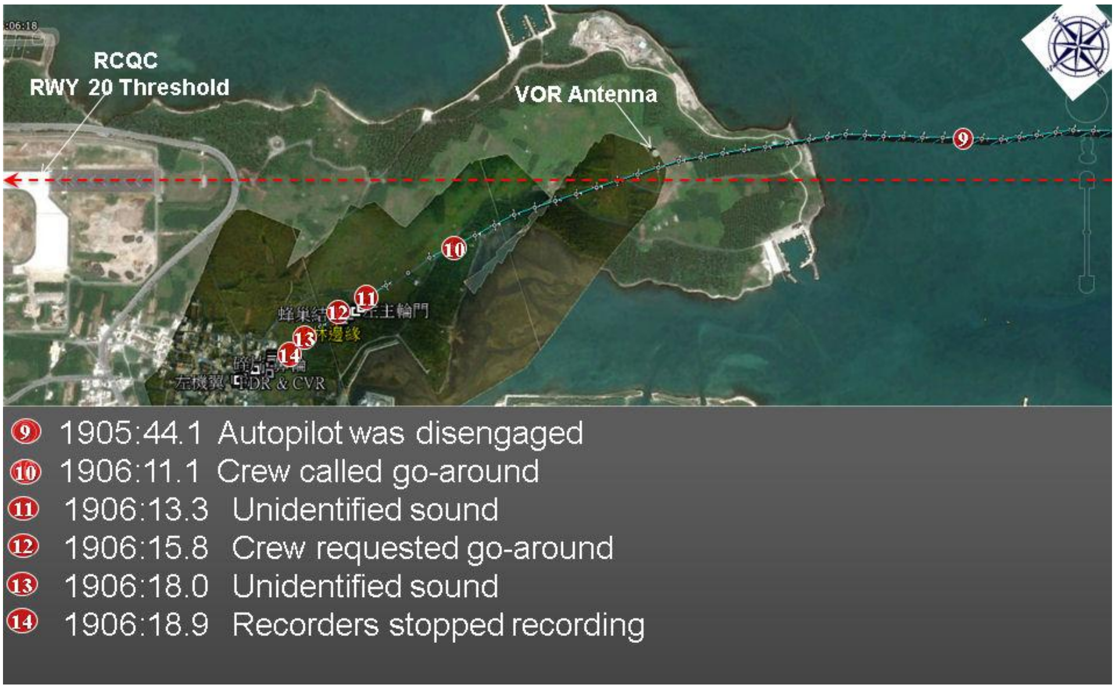

① 1811:16.7 Requested Kaohsiung approach for holding pattern
② 1827:38.4 Kaohsiung approach broadcasted Magong airport forecast RWY02 wind 210 deg. 5 kts max 11 kts, RWY20 wind 190 deg. 11 kts max 15 kts
③ 1828:42.6 Kaohsiung approach announced Magong airport visibility 800m
④ 1829:50.3 Requested RWY02 ILS approach
⑤ 1842:28.3 Kaohsiung approach announced Magong airport RWY20 visibility 1,600m, still T-storm overhead
⑥ 1842:47.9 Requested RWY02 ILS approach
⑦ 1845:00.5 Request RWY 20 VOR approach
⑧ 1903:38.7 Magong tower granted RWY20 landing clearance, wind 250 deg. 19 kts
⑨ 1905:44.1 Autopilot was disengaged

Figure 1.11-8 Superimposed GE222 flight path and VOR chart



⑨ 1905:44.1 Autopilot was disengaged
⑩ 1906:11.1 Crew called go-around
⑪ 1906:13.3 Unidentified sound
⑫ 1906:15.8 Crew requested go-around
⑬ 1906:18.0 Unidentified sound
⑭ 1906:18.9 Recorders stopped recording

Figure 1.11-9 Superimposed GE222 flight path with satellite imagery for the last 40 seconds.

1.11.4.2 Unrecorded Parameters and Derived Parameters

The reference distance between the aircraft and Magong runway 20 threshold, vertical speed, control column position and control wheel position were derived from the relevant recorded parameters.

Calculation of Reference Distance and Vertical Speed

Based on the FDR recording parameters (DME 1, DME 2) and the relevant way points around Magong Airport, the flight crew selections on the on-board GPS were calculated.

The results indicated that during the approach, from 1857:13 to 1858:37, DME 1 and DME 2 recorded the distance of the occurrence aircraft to the MKG VOR 13 DME (the initial approach fix). From 1858:38 to 1901:45, DME 1 and DME 2 recorded the distance of the occurrence aircraft to MKG VOR. From 1901:46 until the end of the FDR recording, DME1 recorded the distance to MKG VOR; DME 2 recorded the distance to Magong Airport's runway reference point.

The distance between the aircraft and the runway 20 threshold was calculated and presented as "ref. Distance". Parameters in Figure 1.11-10 include: autopilot engaged status, selected vertical speed, derived vertical speed[41] (presented as "VS_SM_5pt"), left elevator position (positive value: pitch surface down and nose down), pitch attitude, left aileron position (positive value: left aileron down and right bank), roll attitude, rudder position (positive value: rudder to left), magnetic heading, selected altitude, radio height and pressure altitude.

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[41] Derived vertical speed: uses precise terrain elevation data and recorded radio height time differential to calibrate the values; then apply the 5-second moving average algorithm and multiply by 60 to convert the units into feet per minute. Terrain elevation data is available in section 1.12.

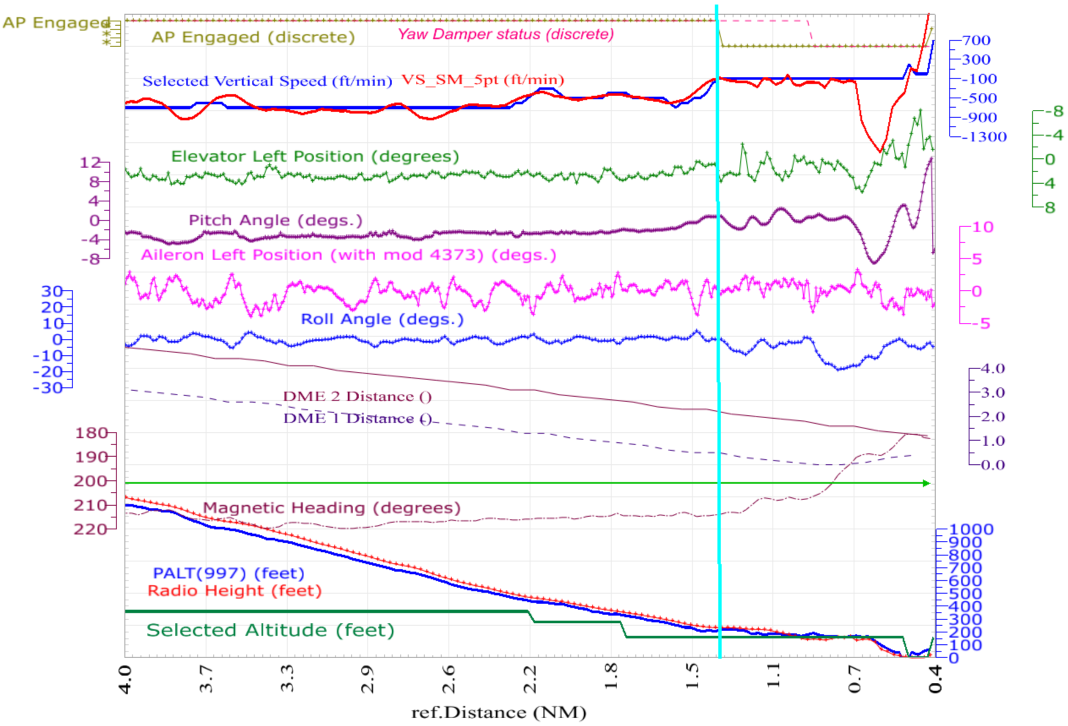

Figure 1.11-10 Calculated reference distance and vertical speed

Calculation of Control Column Position and Control Wheel Position

The control column position and control wheel position were not recorded by the FDR. However, the aircraft manufacturer provided the technical information detailing the relationships between control column position, control wheel position, elevator deflection and aileron deflection which allowed the positions of those flight controls to be calculated[42].

Figure 1.11-11 depicts the following parameters below 2,000 feet, including: derived control column position, derived control wheel position, aileron left position, elevator left position, pitch attitude, roll attitude, selected vertical speed, derived vertical speed, radio height and pressure altitude.

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[42] Detail information is available in GE222 Factual Report 09 Flight Recorders, Appendix 9-6.

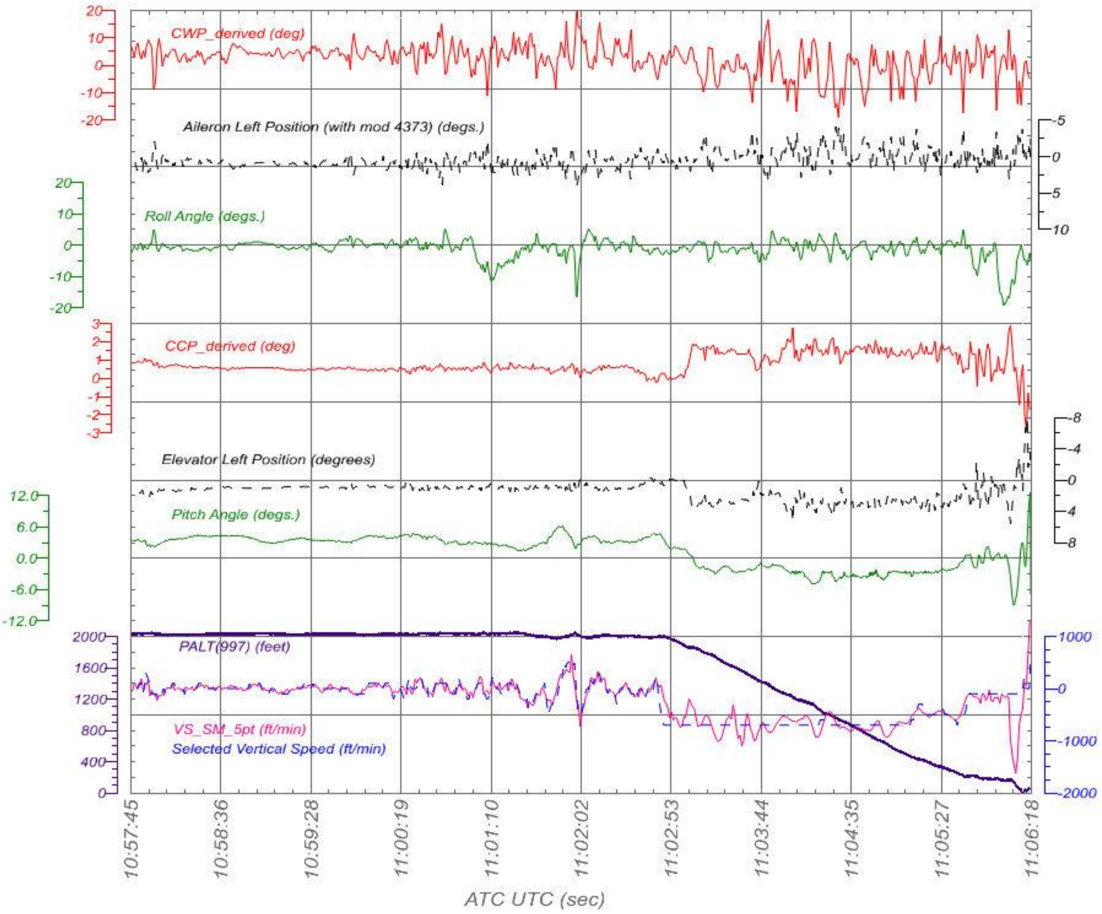

Figure 1.11-11 Derived control column and control wheel positions and associated parameters below 2,000 ft.

1.12 Wreckage and Impact Information

1.12.1 Site Survey

The investigation team utilized GPS equipment, compass, and measuring tape to conduct a ground survey of the occurrence site. The team also deployed an autonomous rotary-wing unmanned aerial vehicle (UAV) to conduct an aerial survey of the site. The UAV was equipped with on-board GPS, pressure altitude sensor, digital compass and digital camera, which enabled it to fly a pre-defined route and take photos.

Figure 1.12-1 illustrates that the aircraft wreckage was distributed in two areas: the foliage or brushwood area (Zone 1); and the residential area (Zone 2). The aircraft impacted terrain approximately 850 meters north-east of the threshold of runway 20 at Magong Airport and then collided with a residential area on the outskirts of Xixi village approximately 200 meters to the south-east of the initial impact zone.

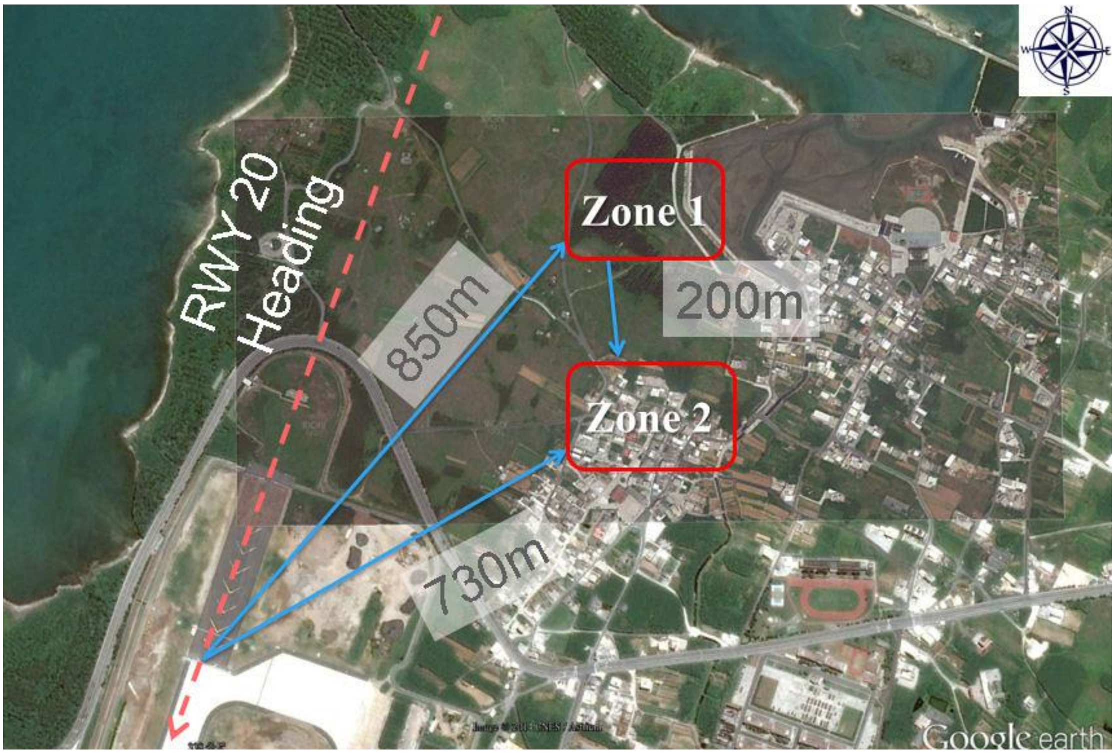

Figure 1.12-1 GE222 site survey zones superimposed on Google map

1.12.1.1 Terrain Profile and Height of Foliage

The UAV aerial survey generated a geo-reference map and 3D terrain model (DSM[43]) of the occurrence area. Figure 1.12-2 shows the UAV area of operations superimposed on the occurrence flight path with timings and wreckage zones.

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[43] DSM - digital surface model, represents the earth's surface, and includes all objects on it.

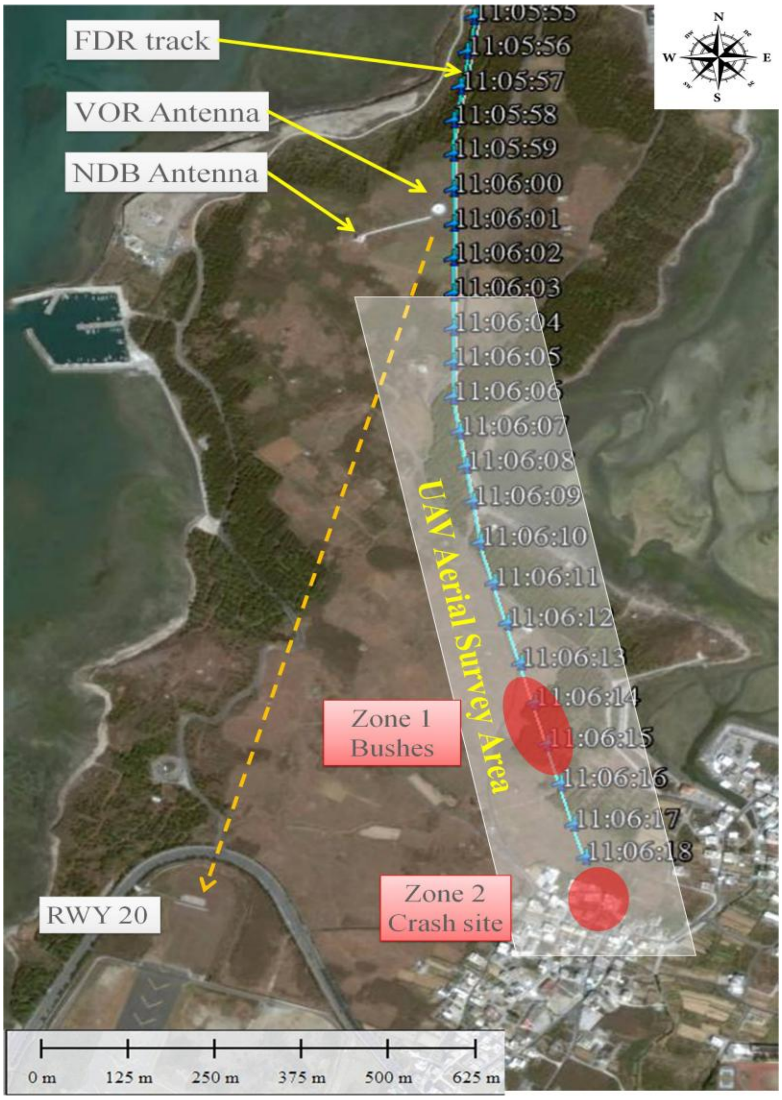

Figure 1.12-2 Superimposed GE222 flight path with time marks and wreckage zones

A set of terrain data (DTM[44]) from the National Land Survey and Mapping Center (NLSC) was obtained to compare with the UAV survey results. The results are shown in Figure 1.12-3. The comparative terrain profiles are depicted for the last 9 seconds of the occurrence flight and extend a further 200 meters to ensure coverage of the wreckage display and associated collateral damage.

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[44] DTM - digital terrain model, represents the bare ground surface without any objects like plants and buildings. The DSM and DTM data provided by the NLSC was measured between year 2007 and 2009.

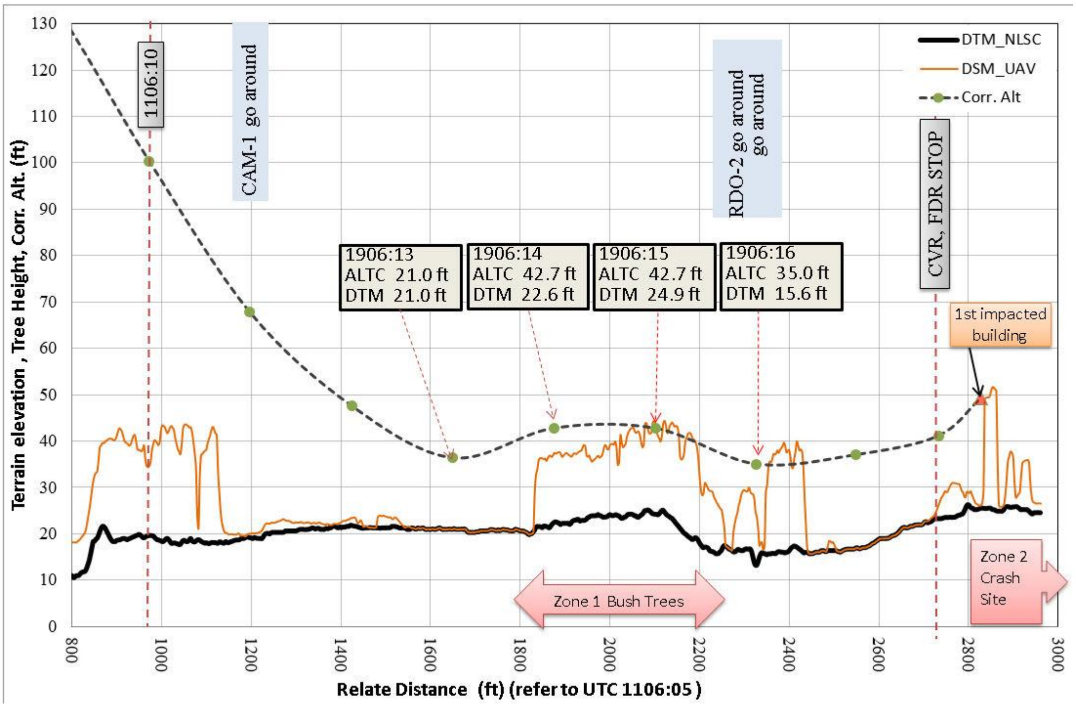

Figure 1.12-3 Comparison of terrain profiles

1.12.2 Wreckage in Zone 1

Zone 1 comprised brushwood, trees and other foliage, which were damaged by the initial impact. The height of the foliage varied from 4.4 meters to 6.5 meters. The area of the initial impact zone was approximately 110 meters by 10 meters.

The aircraft cut a swathe through the foliage as depicted in Figure 1.12-2. Moreover, Figures 1.12-4 (a), (b), (c) illustrate two parallel grooves through the brushwood on a heading of 170 degrees with a width between 5 meters and 7 meters.

The damaged tree tops indicated where the aircraft first impacted the foliage. The area contained many bent trees and broken branches.

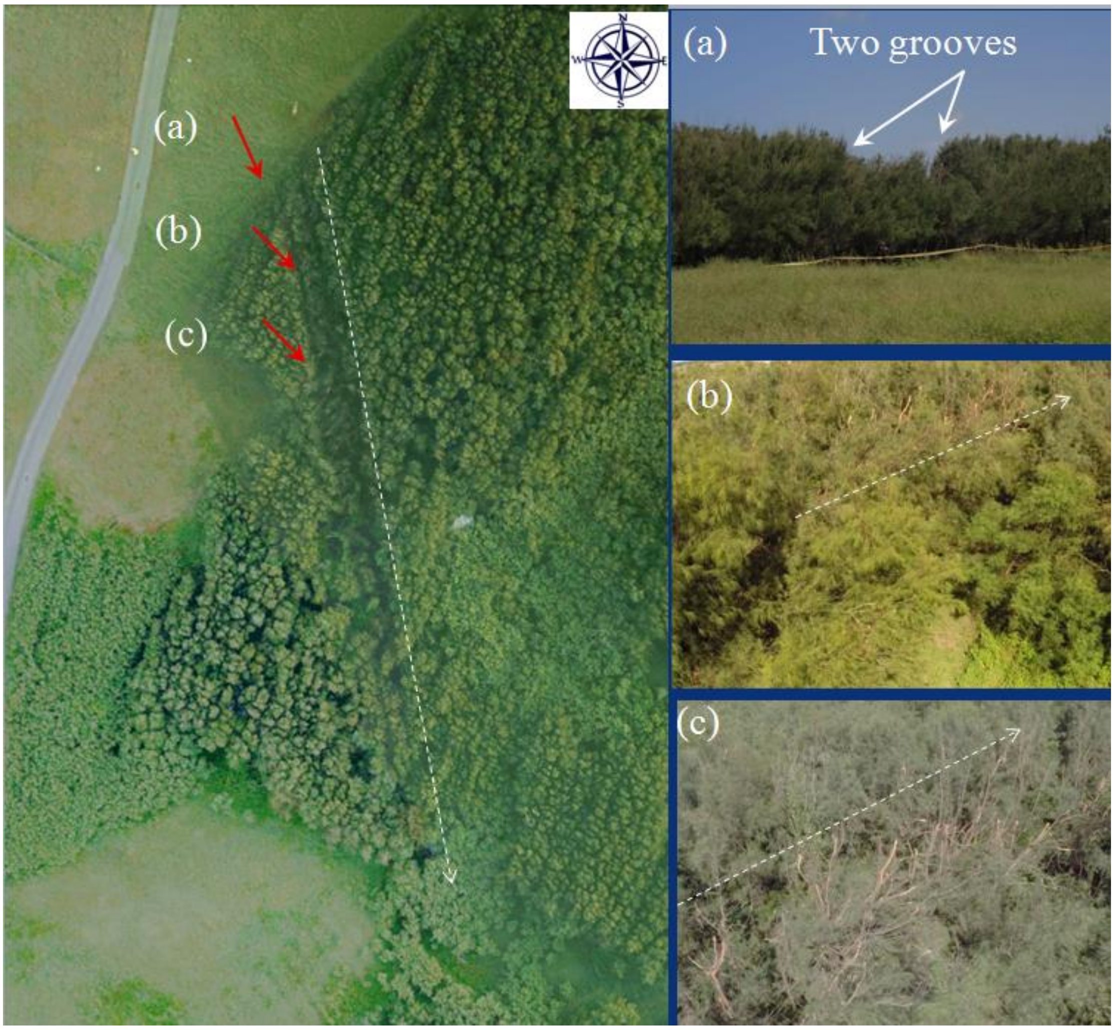

Figure 1.12-4 Initial impact point and damaged foliage in Zone 1

Damaged foliage and relevant tree height (H) information is depicted in Figure 1.12-5〔(a) Damaged trees on the ground, (b) Damaged tree in canopy (H=6.3 meters), (c) Damaged tree in canopy (H=5.5 meters), (d) Felled trees)〕. The largest damaged tree had a diameter of about 25 cm.

Figure 1.12-5 Damaged foliage and relevant trees

Some aircraft wreckage was found along the swathe through the foliage. Those pieces of wreckage were identified as: nose landing gear aft doors, radome, left-hand heat exchanger, ram air inlet, ram air check valve, left-hand main landing gear door, belly fairing inspection doors, and belly fairing panels. The superimposed aircraft wreckage distribution and identified components on the UAV's orthogonal image[45] is shown in figure 1.12-6.

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[45] The ground resolution of the UAV orthogonal image was 5 centimeters.

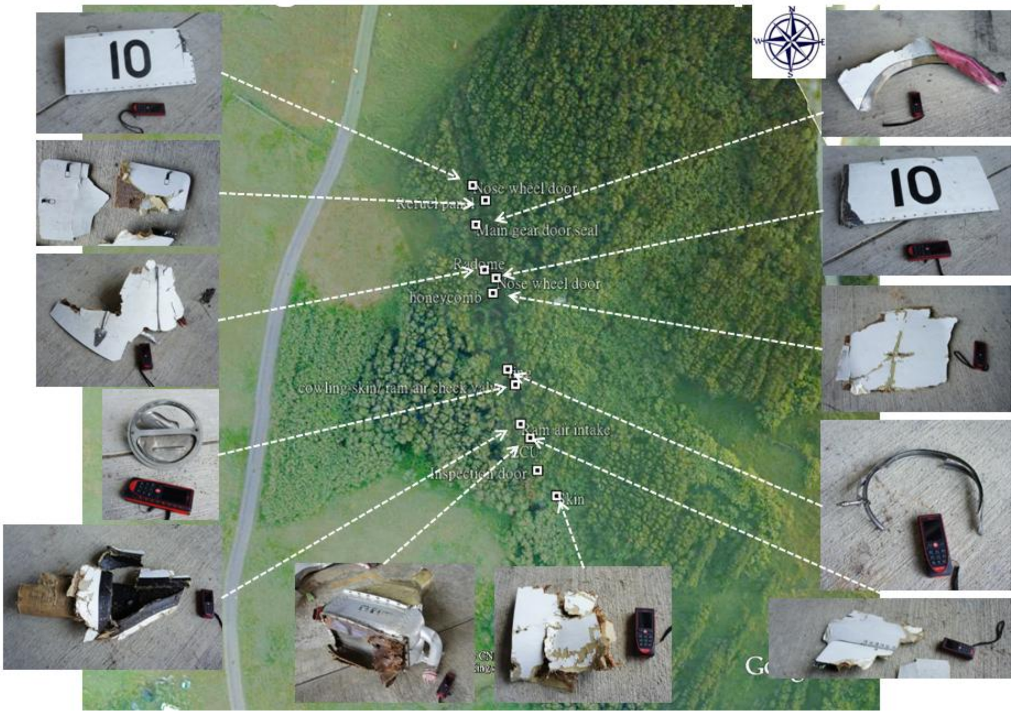

Figure 1.12-6 Superimposed aircraft wreckage distribution and component photos

1.12.3 Wreckage in Zone 2

Zone 2 was located in a residential area of Xixi village. The trajectory of the aircraft was from north to south. The aircraft collided with multiple buildings and broke apart into several major sections. The main wreckage site, which included the cockpit, forward fuselage, left wing, and no.1 engine came to rest in a street in the south of Zone 2. The distance between the main wreckage site and the first building collision was about 120 meters. Figure 1.12-7 depicts the aircraft wreckage distribution overlaid on a Xixi village street map. The red area indicates extensive damage to housing; the yellow area indicates houses with minor damage; and the light blue area indicates undamaged houses. In addition, smaller items of debris such as passenger seats, window frames, baggage, and fuselage skin were scattered throughout Zone 2 over an area of approximately 80 meters by 120 meters. The aircraft main wreckage distribution and damaged buildings are shown in Figure 1.12-8.

Figure 1.12-7 Wreckages distribution overlaid on Xixi village street map

Figure 1.12-8 Aircraft main wreckage distribution and damaged buildings

Building no. 7-1 was the first building that the aircraft collided with. It exhibited impact damage primarily on its northern wall. One window on the second floor was shattered and the wall was pushed in. The iron bars reinforcing the wall structure were damaged in the direction of aircraft movement.

The damage on the second floor was consistent with a main landing gear impact. The northeastern corner of the roof exhibited rubber traces from either the tires or wing deicing boots. Five parallel, almost evenly distributed, witness marks were visible on the top of the roof. Those marks were consistent with contact from the right side propellers. There was also a long prominent mark almost as wide as the wall, at the top of the northern side of the building. It continued on to the western wall. The mark was close to horizontal (approximately 10 to 15 degrees). That damage was consistent with right-wing impact. Figure 1.12-9 depicts the relevant aircraft impact marks, propeller marks, rubber marks and cracks at no. 7-1 building.

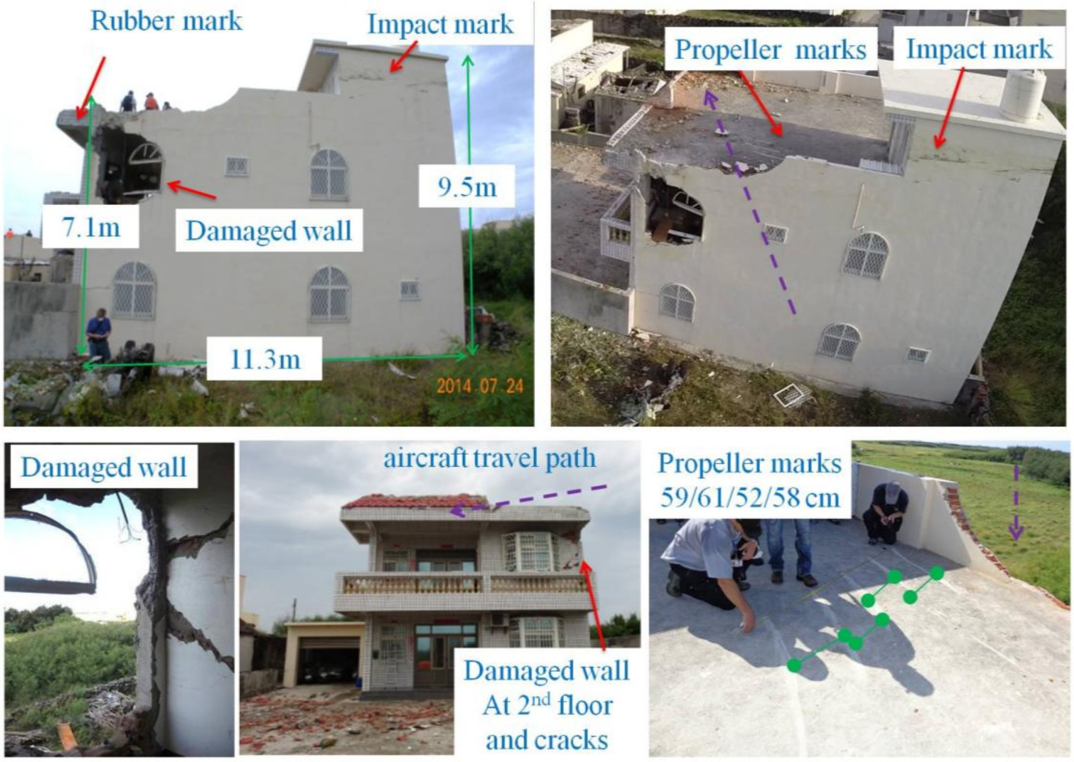

Figure 1.12-9 Initial aircraft impact, propeller, and rubber marks on building

1.12.4 Power Plant

Both engines were recovered from the occurrence site. The no.1 engine was still attached to the left wing. The propeller pitch angle was estimated to be -10°. The no.1 engine air inlet was found full of tree debris. An impact dent was located at the lower part of the intake (see Figure 1.12-10).

Figure 1.12-10 No.1 Engine

The no.2 engine had separated from the wing but was located in wreckage Zone 2 (see Figure 1.12-11). The propeller pitch angle was estimated to be 10°. No tree debris was found in the air inlet. The remaining propeller blades from the no.2 engine sustained more impact damage than the propellers from the no. 1 engine.

Figure 1.12-11 No.2 Engine

- **No.1 Engine Examination (S/N AV0051)**

External Condition: The engine was still fully contained in its nacelle. The rear portion of the nacelle showed fire damage between the 6 and 9 o'clock position, just forward of the exhaust case. The remainder of the nacelle was structurally intact. The engine was partially covered in soot; however, there was no evidence of fire originating from the engine itself. The damage was consistent with an external post-impact fire.

External Cases: All cases were structurally intact. All oil, fuel and air lines including the P3 line from the intercompressor case to the fuel control were intact. All fittings leading to the fuel control were tight and secured.

Turbine Section: Examination of the second stage power turbine through the exhaust showed no evidence of damage. Oil residues covered some blades. The turbine assembly was free to rotate and continuous with the propeller. The power turbine blades exhibited no evidence of impact damage.

Combustion Section: The internal components were not examined. Externally, the fuel nozzles, manifolds and all fuel delivery tubes were intact and no evidence of fuel leakage was observed.

Compressor Section: The engine inlet was filled with a large quantity of organic debris mostly comprising small branches twigs and cone nuts. This debris was carried from the time the aircraft exited the initial impact zone with the tree line to its final post-crash resting point. The visible portion of the impeller showed light leading edge impact damage.

Reduction Gearbox: The internal components were not examined. Free rotation was observed and no evidence of internal distress was noted during rotation.

Accessory Gearbox: The internal components were not examined. Free rotation and continuity was observed with the high pressure rotor.

Controls and Accessories Evaluation: All components were intact and no visual damage was observed. The fuel control unit, fuel pump, electronic engine control, propeller controller (PEC) and propeller valve module (PVM) were retained for precautionary examination should it be required.

No.1 Engine Chip Detectors and Filter Checks: Detailed observations listed in Table 1.12-1.

Table 1.12-1 No.1 engine chip detectors and filter checks

Item	Observation
Main Chip Detector	Clean
Main Oil Filter	Clean of any large debris. The residual oil contained in the housing appeared to contain a small quantity of fine shiny metallic like debris.
Reduction Gearbox Scavenge Chip Detector	Clean
Reduction Gearbox Scavenge Oil Filter	The filter was clean. The filter housing contained only a small quantity of oil which could not be drained into a sample container. The oil appeared clear and free of debris.
Fuel Filters	The low pressure filter was clean. The housing was clean but contained no residual fuel. The high pressure filter was not examined and remained with the fuel pump.

- **No.2 Engine Examination (S/N EB0069)**

External Condition: The engine nacelle was heavily damaged and partially torn from the engine. The engine showed impact damage on most external oil, fuel and air lines. The P3 line from the intercompressor case to the fuel control was intact and all fittings were tight and secure. Fracture of the rear inlet case resulted in axial displacement of approximately 10° towards the right side in the plane of the diffuser case. This partially exposed the low pressure impeller shroud and gave partial access to the impeller which could be rotated with force on a small arc. Tactile examination of accessible impeller blades revealed light leading impact damage. Soot and fire damage to the external airframe components was observed behind the firewall. There was no evidence that this fire originated from the engine itself.

External Cases: All reduction gearbox housings appeared intact.

Inlet Cases: The rear inlet case/accessory gearbox was fractured adjacent and into the bolting flange to the low pressure diffuser case between the 2 and 6 o'clock position. The low pressure diffuser case was intact except for some slight bending of its mounting flange where the rear inlet case was found fractured. The intercompressor case appeared structurally intact. The gas generator case appeared structurally intact. The impact damage to the turbine support case was visible in the plane of the power turbines. The damage was located between the 11 and 12 and between the 2 and 3 o'clock position. This damage prevented removal of the engine exhaust duct.

Turbine Section: The power turbine module was free to turn with no apparent restriction. The shaft was no longer coupled to the reduction gearbox and propeller. Removal of the torque shaft cover on the front inlet case revealed no damage to the torque shaft. This suggested that the shaft was sectioned at a location corresponding to the axial displacement of the engine. The power turbine blades exhibited no evidence of impact damage.

Combustion Section: The internal components were not examined. Externally, the fuel nozzles, manifolds and all fuel delivery tubes were intact and no evidence of fuel leakage was observed.

Compressor Section: The compressor inlet revealed a significant amount of mud accompanied with small rocks adhering to all surfaces. The impeller showed light impact damage to the leading edge of all blades. The impeller could be moved only slightly and was not capable of rotation.

Reduction Gearbox: The gearbox was intact. Internal components were not examined.

Accessory Gearbox: The gearbox portion from the rear inlet case was intact. The transfer tube of the drive shaft to the angle drive was bent and dislodged exposing the drive shaft itself.

Controls and Accessories Evaluation: The AC generator drive shaft was fractured at the "shear shaft" feature. The fracture surface showed features characteristic of torsional overload with no evidence of fatigue. The handling bleed valve was fractured from the engine and heavily damaged by impact. Fracture of the oil cooler support was noted. The fuel control unit, fuel pump, electronic engine control, PEC and PVM were intact and retained for precautionary examination should it be required.

No.2 Engine Chip Detectors and Filter Checks: Detailed observation listed in Table 1.12-2.

Table 1.12-2 No.2 engine chip detectors and filter checks

Item	Observation
Main Chip Detector	Clean
Main Oil Filter	The oil filter was clean. Residual oil found in the housing contained what appeared to be a small amount of metallic like fine particles. The oil was very cloudy and showed a slight greenish color. The impending bypass indicator was in the stowed position.
Reduction Gearbox Scavenge Chip Detector	Clean
Reduction Gearbox Scavenge Oil Filter	The filter was clean. Residual oil contained in the filter appeared clear but contained a small amount of what appeared to be fine metallic like particles. The impending bypass indicator was in the stowed position.
Fuel Filters	The low pressure filter was clean. The housing was also clean and contained residual fuel clear in color. No phase separation was noted and no visual contaminants were visible.

1.12.4.1 Fuel and Oil Samples

The occurrence aircraft’s fuel and oil samples and associated filters taken from both engines were sent to a Taiwan Air Force Laboratory for examination on 6 August 2014. The engine manufacturer reviewed the results. No anomalies which could have prevented normal engine operation were found.

1.13 Medical and Pathological Information

1.13.1 Medical Treatment of Injured

The injured were initially transported to Penghu Hospital and Tri-Service General Hospital, Penghu Branch. They were then transported to various hospitals in Taiwan main island a few days later when they were in a stable condition.

1.13.2 Flight Crew Medical History

The captain's medical records indicated that he had hypertension. The treatment included taking a Syntace[46] 10mg/tablet and an Amlodipine[47] 5mg/tablet per day.

1.13.3 Flight Crew Toxicology

The Institute of Forensic Medicine (IFM), Ministry of Justice, conducted toxicology examinations of the two flight crew members. The test items included alcohol content, poisons, sedatives, hypnotics, carbon monoxide hemoglobin and the basic drugs screen (about one thousand items).

The captain's toxicology report indicated 1% of carbon monoxide in the hemoglobin and the presence of Ramipril[48] and Amlodipine in the urine. No other drug or toxin was detected.

The first officer's toxicology report was clear.

1.13.4 Flight Crew Autopsies

The forensic pathologists from the IFM conducted the autopsies of the two flight crew members.

The autopsy reports indicated that both flight crew members had suffered multiple traumatic injuries.

1.13.5 Victims' Inspections

The victims' inspections conducted by the IFM indicated that the primary causes of death were multiple traumatic injuries and burns.

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[46] The product name of Ramipril.

[47] Amlodipine: A calcium channel blocker heart medication used in the treatment of hypertension. (FAA website: http://jag.cami.jccbi.gov/toxicology/DrugDetail.asp?did=128)

[48] Ramipril is an angiotensin-converting enzyme (ACE) inhibitor, used to treat hypertension and congestive heart failure. (FAA website: http://jag.cami.jccbi.gov/toxicology/DrugDetail.asp?did=279)

1.14 Fire

1.14.1 Notification and Dispatch

The local Magong fire bureau’s notification records indicated that three people reported the aircraft accident and/or houses on fire between 1906 and 1912. At 1907:12, the local emergency command center initially dispatched 1 fire engine (2 people), 1 water tank (2 people) and 1 ambulance (1 person) from the Huxi firefighting station to the scene. At 19:09, the command center was noticed that the aircraft had crashed by a local policeman. After the first responders arrived on site at 1912:45 and reported the situation to the command center, a further 30 firefighting and search and rescue personnel from Peng Nan, Baisha, Shiyeu and Magong firefighting stations were dispatched to the scene.

According to airport task logs and local fire bureau notification records, at approximately 1910, the Magong air traffic control tower notified the airport’s airside operations division that they had lost contact with an aircraft. At 1929, airport personnel confirmed that an aircraft had crashed and notified the local fire bureau. Three airport standby fire fighting vehicles were dispatched to the scene after the airport was closed at 1943.

1.14.2 Post Fire and Fire Fighting

According to interviews with Xixi village residents, at around 1900, there was heavy rain with thunder and lightning in the area. A few minutes later, one of the residents heard a loud bang similar to thunder and then heard a noise like a rotating propeller hitting objects. The resident walked outside from his house and saw flames erupting nearby in front of an alley. He notified emergency services immediately.

Interviews with the local fire fighters revealed that their vehicles could not access the occurrence site because the alleyways in the village were too narrow. The fire fighters did not see any smoke or fire when they first arrived at the village. When they disembarked from their vehicles to confirm the location of the occurrence site, they heard a loud explosion and saw towering flames. The fire fighters positioned their hoses along an alley towards the occurrence site. Their efforts were impeded by a further explosion and the need to don oxygen masks. They attempted to extinguish the burning cockpit and wing sections using foam. They also requested more personnel and vehicles for support. The fire was suppressed at 2005 and extinguished at 2037. However, the fire reignited at 0231 the next morning. Firefighting personnel from Huxi station were dispatched to extinguish the secondary flare up.

The local fire bureau’s records and report indicated that there had been a total of 87 firefighting and rescue vehicle movements, 26 ambulance movements and a total of 1,526 people involved in the search and rescue response.

1.15 Survival Aspects

1.15.1 Escape from the Aircraft

The surviving passengers reported that the aircraft encountered frequent turbulence on the occurrence flight and that there was heavy rain with thunder and lightning before the aircraft approached Penghu. At approximately 1900, the captain announced to the passengers to prepare for landing. Shortly thereafter, there were loud impact sounds. The aircraft was still moving after the initially impact until it finally came to a stop. The aircraft's front cabin was engulfed in flames and the fuselage broke apart. Some passengers were thrown out of the cabin while the aircraft was still moving forward and other passengers ran out of the cabin through the holes in the fuselage. There were two reported explosions after the survivors egressed from the aircraft. Most of the surviving passengers went to a nearby house for help.

1.16 Tests and Research

1.16.1 EGPWS Simulation Flights

No EGPWS warning was recorded by the aircraft's FDR or CVR. However, the FDR records indicated that an EGPWS warning had occurred on the same aircraft with the same flight crew, operating the same route[49] on approach to Magong earlier on the day of the occurrence. To determine if the aircraft's EGPWS was operating correctly on the day of the occurrence a series of simulated flights were conducted using the aircraft manufacturer's flight simulator at Toulouse, France, on 5 November 2014. The testing also examined the nature of the EGPWS warning that had occurred on GE220 earlier on the day of the occurrence. The testing indicated that[50]:

- The investigation team conducted three simulations of the occurrence flight using the FDR data. None of the simulated flights triggered an EGPWS terrain warning because the flight profile was just outside the terrain warning zone.

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[49] TNA flight GE220 from Kaohsiung to Magong.

[50] The simulation scenarios and settings were described in the Flight Operations Group Factual Report available at www.asc.gov.tw.

- The investigation team also conducted three simulations of the earlier flight GE220 using the applicable FDR data. Consistent with the actual flight, all three simulated flights triggered the EGPWS alerts "Too Low Terrain" and "Terrain Ahead Pull-up. The alerts were activated at 1.6 nm or 1.8 nm from the Magong VOR station.

1.16.2 EGPWS NVM Data Download and Simulation

The aircraft was equipped with a Honeywell EGPWS model MARK VIII. The EGPWS computer (Part Number: 965-1216-011, Serial Number: 2573) was recovered from occurrence site. According to maintenance records, the EGPWS database was updated on 23 April 2014 and contained the current version 470, which included runway data for Magong Airport.

The recovered EGPWS computer was sent to Honeywell for non-volatile memory (NVM) data download. The data download was performed by Honeywell on 16 October 2014 and witnessed by the United States National Transportation Safety Board (NTSB). At ASC’s request, Honeywell used the downloaded data and FDR data to generate an “Analysis of enhanced ground proximity warning system” report for this occurrence investigation. That report and further communications with the manufacture indicated:

- EGPWS Warning Flight History Database did not contain alert event data for the occurrence flight.

- No EGPWS caution or warning was triggered during the simulations of the occurrence flight. The aircraft did not penetrate the terrain envelopes including the TCF envelope, runway field clearance floor (RFCF) envelope and Terrain Awareness “Look-Ahead” envelope for Software Version -011.

- EGPWS Warning Flight History Database for the earlier flight (GE220) on approach to Magong included: “Too Low Terrain” (RFCF) at 346 feet Geometric Altitude / 315 feet RA, “Terrain Ahead” at 226 feet Geometric Altitude / 182 feet RA, and “Terrain Ahead Pull-Up” at 176 feet Geometric Altitude / 142 feet RA. A comparison of the altitude data from the FDR and EGPWS indicated an altitude analysis error of up to 170 feet for GE220.

- Simulation of the occurrence flight using the latest EGPWS software version (-022 and newer) would have triggered the "Too Low Terrain" warning. That is, the occurrence flight would have penetrated RFCF and TCF envelopes.

- The latest EGPWS software version (-022 and newer) requires hardware with base part number 965-1180/1190/1210/1220/1610. The Honeywell service bulletin relevant to this new version is ATA No. 965-1180/ 1190/ 1210/ 1220/ 1610-XXX-34-33 (Pub. No. 012-0709-133)[51] which was released on 14 August 2004.

- The Honeywell Service Information Letter, SIL NO. EGPWS-MKVI-MKVIII- 07, released on 30 May 30 2003, referred to the introduction of new Honeywell Mk VI/VIII EGPWS part numbers: numbers: 965-1180-020, 965-1190-020, 965-1210-020, 965-1220-020 and Real Time Clock Configuration Module, 700-1710-020.
- No faults were present in the downloaded EGPWS data to suggest a malfunction of the aircraft's EGPWS system. No alert was generated by the EGPWS during the occurrence flight. Therefore, no data was recorded by the EGPWS and the actual parameters being monitored were not retained. If the EGPWS installation utilizes the barometric altitude rate[52], for turboprop aircraft, the presence of ground effect on the barometric rate data prevents its use close to the ground because of the potential for nuisance warnings. Consequently, Mode 1 is inhibited at 50 feet radio altitude. In addition, there is a 0.8 second delay for the "Sinkrate" caution to minimize nuisance alerts caused by momentary penetration of the outer envelope. There is also a delay for the "Pull Up" warning to guarantee that at least one "Sinkrate" (or equivalent) message will be annunciated before the "Pull Up" message is activated.

1.16.3 Simulation Flights of GE222 Performance

To further understand the occurrence aircraft's performance and behavior under different conditions, two additional simulator sessions were conducted at the ATR training center, Toulouse, France from 5 to 7 November 2014[53]. The main objective was to understand the ATR72-500's performance under the following conditions:

- Stabilized power settings during the occurrence approach

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[51] This SB was not applicable to the EGPWS (P/N: 965-1216-011) installed on the occurrence aircraft.

[52] Product specification for the MK VI and MK VIII Enhanced Ground Proximity Warning System, EGPWS, P/Ns_965-1176-XXX.

[53] The full flight simulators (FFS) are designed and certified for training purposes based on mandatory items defined by the respective certification authorities (such as the European Aviation Safety Agency (EASA) and FAA). In that intent any test performed on an FFS, outside of the above mentioned mandatory items, may not be fully representative of the aircraft handling characteristics.

- AFCS and FD behavior when approaching and passing Magong VOR
- Aircraft behavior after the AP disconnected
- Aircraft behavior after the YD was disengaged
- Rudder force required to disengage the YD
- Control column force required to obtain 9° pitch down
- Descent rate with 9° pitch down
- AFCS basic mode

The simulated flight profile was derived from the FDR occurrence data and the weather at the time of the occurrence. The final approach profile was flown in accordance with the ATR maneuver guide[54].

The findings from the simulated flights included:

- 28 % torque (TQ) was required on both engines to stabilize the descent at a 700 feet/minute descent rate and 125 knots Indicated Air Speed.
- 43 % TQ was required on both engines to stabilize the descent at a 100 feet/minute descent rate and 125 knots Indicated Air Speed.
- If the aircraft remained on course, the course deviation bar on the EHSI (electronic horizontal situation indicator) remained center and the green VOR changed to green VOR* on the ADU when the aircraft passed the Magong VOR at either 200 feet or 500 feet altitude.
- Aircraft attitude did not change after the AP was disconnected.
- Aircraft banked to 9° left after the YD was disengaged with minor left bank angle (1°or 2°).
- Aircraft banked to 11° right after the YD was disengaged with minor right bank angle (1°or 2°).
- 30 daN rudder pedal force was required to disengage the YD.
- 15 daN control column push force was required to reach 9° pitch down.
- Base on the simulation results[55], 4 sets of data were presented to

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[54] The scenarios and setting of the simulation are described in the GE222 Flight Operation Group Factual Report at www.asc.gov.tw.

[55] The simulation noted that the Vertical Speed Indicators showed a descent of 900 feet/minute with 9° pitch down, which was published in the Flight Operations Group Factual Report. After reviewing the

indicate the aircraft response to the pitch down attitude commanded by the occurrence captain. Compared to the FDR data which indicated that the occurrence aircraft pitched down to -9° at 1906:09, the results of the simulations were a pitch down to -7.1°, with a maximum descent rate of 1,400 feet/minute; pitch down to -7.5°, with a maximum descent rate of 1,300 feet/minute; pitch down to -9.7°, with a maximum descent rate of 1,600 feet/minute; pitch down to -8.0°, with a maximum descent rate of 1,450 feet/minute. The results of the simulations are attached in Appendix 4.

In addition, the simulated performance of the aircraft was re-examined using different turbulence intensity settings. No aircraft performance differences were identified between the conditions with and without turbulence[56].

1.16.4 Line Operation Observation

The purpose of the line operation observations was to develop an understanding of operational practices on TNA's ATR72-500 fleet

A total of 24 flights were observed between 4 August and 5 September 2014. All flights were turn around flights from Songshan to Hualien, Magong, or Kinmen. A summary of the findings were listed in Table 1.16-1.

Table 1.16-1 Findings from the line observation flights on TNA's ATR72-500 fleet

Item	Line operation observations
1	Instead of using the applicable checklist, the flight crew actioned the normal checklists from memory, especially after takeoff and after landing.
2	Some flight crew did not refer to the applicable abnormal checklists while encountering abnormal conditions such as, starter fault, bleed air fault and ice detection fault.
3	During aircraft systems preparation, clocks were not correctly set, and/or some crew dismissed that procedure.
4	During start engine phase, "FUEL FLOW RISING", "ITT RISING", "OIL PRESSURE RISING" the required callout response "CHECK" was not

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vertical speed recorded in the simulator, the investigation team decided to use the recorded data instead of the observed data.

[56] Turbulence intensity was set as high as 50%.

Item	Line operation observations
	verbalized by some crew members
5	During the before takeoff phase, “LIGHT ON” check was supposed to be performed by checking the spoiler light panel after the associated pilot checked “SPOILER UP” by looking outside. It seemed that this procedure was just a called out by crew without actually visually confirming the status of the associated lights.
6	Take off TORQUE was not computed for certain flights.
7	During the climb phase, “GEAR UP SET” was not announced by PM[57]; “SET SPEED TO WHITE BUG” was not called out by PF[58] after the “ACCELERATION ALTITUDE” call by PM. Either “TEN MILES” or “ONE ZERO THOUSAND FEET” call outs were missed on certain flights.
8	Some crews were not following the climb speed specified in the standard operating procedure (SOP).
9	No call outs were made for IAS, V/S and HDG change and adjustment during AFCS operation.
10	During approach briefings, certain flight crew did not cross check the FMC or the approach course setting against the aeronautical charts.
11	During the approach phase, “OM/FAF/FAP, ALTITUDE ______ FEET”, “CHECKED ____ FEET” calls were not performed on certain flights, reported airport in sight well before 30NM to obtain a visual approach from ATC, and applied basic modes without good reason. Crew flew too low on some approaches as indicated by four red lights on the PAPI but without challenge and response calls from the PF and PM.
12	During the after landing phase, certain flight crew performed the after landing checklist from memory.
13	During the landing rollout phase, “LOW PITCH LIGHTS ON” call out was missed on certain flights.
14	Flight crew did not announce or positively identify and test the radio navigation aids selected before the approach. They also did not cross check the approach plate number and date with each other.
15	Some unstable approaches were observed with approach speeds in excess of Vref +20kts but the PM did not challenge the PF.

1.16.5 TNA Simulator Training Observation

The investigation conducted an abridged evaluation of the airline’s ATR72 simulation training and checking at TNA’s contracted training center in Bangkok, Thailand.

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[57] PM is the designated pilot monitoring for the sector.

[58] PF is the designated pilot flying for the sector.

Three simulator sessions were observed. Each session was four hours and split evenly between two pilots. The last transition training lesson 7 was observed on 12 October 2014 with two first officer trainees. The transition check was observed on 14 October 2014 with the same flight crew. Proficiency training was observed on 15 October 2014 with a line captain and first officer.

The observations were summarized in Table 1.16-2.

Table 1.16-2 Observations of TNA ATR simulator sessions

Item	**Simulator training observations**
1	There were 19 technical subjects and 5 maneuvers, including steep turns, stall recovery, unusual attitude recovery, TCAS and EGPWS events to practice in the two hour session.
2	Non-precision approaches were conducted via step-down rather than with a constant descent profile as illustrated in TNA's operations manual.
3	For an unusual high pitch attitude with bank, pilot under instruction was told to recover by leveling the wing first then lowering the nose. The trainee did not challenge the instructor for that non-compliance with the TNA Flight Crew Training Manual.
4	DH for a non-precision approach was set on the electronic attitude director indicator (EADI) instead of the DH for a precision approach.
5	Both pilots operated the AFCS control panel with AP engaged, when the PF was designated to do so.
6	Scenario: ON GROUND ENG FIRE followed by ON GROUND EMER EVACUATION. The evacuation was executed immediately after the second fire extinguishing bottle was discharged without checking whether the fire had been extinguished. Had the fire been extinguished, there was no requirement to evacuate.
7	During two unstable approaches, one pilot failed by flying one dot too high on the glideslope at 1,000 feet but the other pilot passed when he was too high as indicated by 4 white PAPI lights on short final and a subsequent long landing.
8	TO/MCT was not selected on PWR MGT panel for EGPWS maneuver as required by procedures.
9	CL was not set OVRD position for TCAS escape maneuver as required by procedures.
10	The following discrepancies were not corrected by the instructors. ➢ 4 white PAPI lights (too high on approach) were visible on short final, PM did not call it out and the PF was not instructed to correct it. ➢ PM did not callout speed low or high on short final. PF was not instructed to correct it. ➢ None of the pilots made the standard "Approaching Minimum" callouts

Item	Simulator training observations
	during a non-precision approach. ➢ None of the pilots made the standard “OM/FAF” callouts during approach. ➢ “Minimum” standard callouts were not made. ➢ PM “FLAPS ZERO” and PF “CHECKED” standard callouts were not announced during some flap movements. ➢ PM “GEAR UP SET” and PF “CHECKED” standard callouts were not announced during some landing gear operations. ➢ “Level two on” standard callouts for icing conditions were not made. ➢ Start timing on start push button depressed during engine start. ➢ CM1[59] “STARTER ON” CM2 “STARTER LGHT OFF” CM1 “CHECKED” standard callouts were not made during engine start. ➢ CM1 “TIMING” and “NOTCH” standard callouts were not made during take-off. ➢ Some AFCS mode selection standard callouts were not made. ➢ Missing ADU annunciation standard callouts. ➢ ACW TOTAL LOSS abnormal checklist was only partially read. ➢ After Take Off checklist was not executed. ➢ The slip indicator was not in the correct position during single engine operations. ➢ The aircraft descended during a single engine go around without the PM announcing it. ➢ LOC/GS deviation standard callout was not made. ➢ Stabilized approach criteria were not met during a raw data ILS approach. ➢ LO BANK was selected for simulator session. ➢ NDB identification was not made by pilots.

1.16.6 Magong Runway 20 VOR Special Flight Inspection

After the occurrence, the ASC requested a validation of the VOR’s signal stability for approaches. An inflight evaluation of the VOR was conducted by the CAA on 30 July 2014. The test procedure comprised three tests as follows:

The first test: The runway 20 VOR approach was flown commencing from an altitude of 3,000 feet and 10 nm from the aid. The test aircraft flew overhead the VOR at 330 feet.

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[59] CM1 refers to the crewmember in the LEFT hand seat; CM2 refers to the crewmember in the RIGHT hand seat.

The second test: The runway 20 VOR approach was flown commencing from an altitude of 3,000 feet and 10 nm from the aid. The test aircraft flew overhead the VOR at 200 feet.

The third test: The runway 20 VOR approach was flown commencing from an altitude of 3,000 feet and 10 nm from the aid. The test aircraft completed the instrument approach to landing.

The test flight results were:

Test Item	First Test	Second Test	Third Test
Where did CDI begin to shift	1.5 NM (nautical mile)	1.4 NM	0.1 NM
How many dots of deviation were indicated on the CDI	2.0 dots maximum (around 0.2 DME)	1.9 dots maximum (around 0.2 DME)	2.0 dots maximum (around 0.1 DME)
Where did the TO/FROM indication of the VOR begin to oscillate to indicate station passage	0.5 NM	0.4 NM	0.1 NM

Note: According to the CAA's Flight Check Group, Flight Standards Division, the distance described in the table was "before" passing the MKG VOR.

1.17 Organizational and Management Information

1.17.1 CAA Airline Operations Inspection

The primary objective of the CAA airline operations inspection regime is to determine that a person, an item, or a certain segment of an operation associated with air transportation meets at least the same standards that were required for initial certification or approval by the CAA. For inspectors to make these determinations, inspections must be conducted in an orderly and standardized manner. Each type of inspection must have individual objectives and be conducted each time in generally the same manner according to the direction and guidance in the CAA Operations Inspector's Handbook.

CAA inspectors were assigned to oversee each operator. The principal operations inspector (POI) was the primary interface between the assigned operator and the CAA. The POI was responsible for ensuring that assigned organizations met CAA regulations and policies. The POI was also responsible for determining the annual surveillance and inspection programs. The annual work program usually comprised annual, semi-annual, quarterly and monthly surveillance activities based on the inspection job functions. The job functions were described in the Chapter 4, Volume II of the CAA Operations Inspector's Handbook.

CAA inspectors conducted 1,044 operations inspections[60] of the operator from 1 August 2013 to 22 July 2014 and issued 41 comments, including 6 findings, 10 concerns and 25 recommendations. Of the 41 comments: 22 were related to the annual Main Base Inspections in 2013 and 2014; 7 were related to flight safety events; and the remaining 12 comments were the results of routine operations/cabin inspections. The 41 comments were classified according to their common characteristics:

- Record or sheet related deficiencies: 13 comments;
- Manual related deficiencies: 9 comments;
- Flight safety events follow-up: 7 comments;
- Insufficient personnel resources and staff turnover issues: 4 comments;
- Self-audit frequency or record related deficiencies: 3 comments;
- Flight crew did not carry license on their person: 2 comments;
- Cabin diagram or equipment deficiencies: 2 comments;
- Training insufficient: 1 comment.

Official records and documentation indicated that contact between the CAA and TNA included quarterly flight safety meetings attended by the CAA POIs/AOIs[61] and senior TNA managers. Meeting agendas included the presentation of CAA safety policy statements and instructions by POIs/AOIs.

The CAA POI assigned to TNA stated that there was no fixed format for the joint CAA-industry meetings[62] between the regulator and the operator.

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[60] Total operations inspection activities.

[61] Assistant Operations Inspector.

[62] According to the CAA Operations Inspector's Handbook Section 2.1.1, Chapter 1, Volume 1, the POI should chair the joint CAA-industry meetings to maintain regular contact with the assigned organizations and coordinate with senior management officials.

Numerous operator meetings were held with the participation of the POI and operator’s staff on a regular and irregular basis. For example, meetings included instructor pilot/check pilot meetings and flight safety meetings, in which key position holders attended and where major safety issues and associated corrective measures and areas for improvement were discussed. Meeting minutes were documented.

1.17.1.1 Cockpit En Route Inspection

The primary objective of the cockpit enroute inspections was for an inspector to observe and evaluate the inflight operations of a certificate holder within the total operational environment of the air transportation system. According to the CAA Operations Inspector’s Handbook, enroute inspections were one of the most effective methods of accomplishing the regulatory surveillance objectives and responsibilities. These inspections provided the CAA with an opportunity to assess elements of the aviation system that were both internal and external to an operator.

The CAA conducted 166 Cockpit En Route Inspections of TNA from 1 August 2013 to 22 July 2014 and issued one recommendation. It recommended that flight crews hold a valid checklist and chart during the departure and arrival briefings; flight crews performed each step of a given procedure and cross check to ensure that the procedure had been actioned correctly in the interests of flight safety. The recommendation was consistent with and indicative of flight crews not complying with standard operating procedures. The CAA closed the case after TNA issued a relevant notice to flight crews. Since it was not a requirement to follow up the actions taken for a recommendation, no further assessment of the apparent procedural non-compliance behavior was conducted.

1.17.1.2 Operator In-depth Inspections

The objective of an operator in-depth inspection was to determine if an operator or repair station was in compliance with ICAO standards and recommended practices (SARPs), domestic CAA regulations, and the operator’s manuals and procedures. The inspection was designed to identify compliance deficiencies and ensure appropriate corrective actions were implemented. The inspection formed part of the CAA’s systematic approach in fulfilling its regulatory surveillance responsibilities. One of the key features of the inspection program included a focus on critical areas with significant or acute deficiencies.

An in-depth inspection of an operator was normally conducted every three years by a selected team of inspectors. The inspection was conducted in accordance with specific terms of reference, scope and objectives. For example, the areas of an airline to be examined were selected by the CAA's Flight Standards Division. Such an inspection might focus on operations, management and administration, operations specifications, operations training, crew qualifications, manuals and procedures, flight controls, flight operations, operations records and facilities and equipment. Inspection methods included reviews of manuals, records and other documentation, reviews of operator's training programs and procedures, and an inspection of the operator's aircraft and facilities. The inspectors assigned to the operator were usually not part of the team. However, they were advised of the inspection's progress.

The in-depth inspection report contained findings that were categorized into two groups: Category A which was any non-compliance with a regulation; and Category B which was a failure of the operator to adhere to its documented standard operating procedures that have been approved or accepted by the CAA's Flight Standards Division.

Non-compliance findings and associated corrective actions were followed-up by the assigned POI.

Special in-depth inspections were conducted on an as-needed basis whenever there were indications that the performance of a particular operator was falling below an acceptable level or in the event of an accident, incident, violation, complaint or serious company financial situation.

CAA conducted an in-depth inspection of the TNA flight operations division (FOD), system operations control (SOC) and safety and security office from 14 to 30 August 2014 after the GE 222 occurrence. The inspection scope included: policy making, operations standards, personnel analysis, operational systems, resource requirements and corrective action schedule, etc. An inspection report was issued to TNA on 16 October 2014. The safety issues identified during the in-depth inspection included problems with: the airline's safety management system (SMS) and flight operations quality assurance (FOQA) systems, standardization of flight crew training and checking, procedures for continuous descent final approach (CDFA), crew resource management and flight crew fatigue management.

1.17.2 SMS Development and Oversight

1.17.2.1 CAA SMS Development Policy and Oversight

The Aircraft Flight Operations Regulations require all Taiwan civil aviation operators to establish and implement a SMS acceptable to the CAA. The Advisory Circular (AC) 120-32C[63] for SMS issued on 25 January 2011 by CAA stated that an operator should develop, adhere to, and maintain a SMS implementation plan. The implementation plan should be based on the results of a SMS gap analysis[64] and be endorsed by the operator's applicable senior manager. The AC also provided guidance on developing a SMS implementation plan and suggested that an operator should develop a SMS in four progressive phases. The final phase should be completed by 31 December 2012.

The CAA was responsible for overseeing and assessing the implementation and effectiveness of an operator's SMS and included routine surveillance and SMS assessment projects[65].

SMS assessment projects were conducted by a specialist CAA SMS assessment team. After an assessment, the POI was tasked with monitoring the operator's corrective actions.

As of the end of 2013, the CAA had conducted SMS assessments for six civil air transportation operators and two repair stations. The objectives of the project[66] were:

- To review/ensure SMS implementation of the certificate holders (operators and repair stations) consistent with ICAO SMS documentation, and CAA regulations and policy;
- To adjust CAA SMS promotional strategies and assist the certificate holders in implementing an SMS effectively based on the data collected from the assessment project.

All deficiencies identified during the SMS assessments were not to be categorized as a finding or concern in the CAA flight safety management

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[63] The purpose of the AC was to describe an acceptable means for compliance with the requirements of CAR 07-02A, article 9, and CAR 06-02A, article 27, in the establishment and implementation of a safety management system. The AC also contained guidance material for operators and repair stations on how to implement and maintain a SMS.

[64] A SMS gap analysis is the first step in developing a SMS. The analysis determines which components and elements of a SMS are currently in place and which components or elements must be included or modified to meet the SMS's requirements.

[65] Job Function 18.1 safety management system Assessment in Chapter 5, Volume II of CAA Operations Inspector's Handbook（The 11th edition and effective date is January 1st, 2013).

[66] The following information is based on the CAA response to the GE222 Investigation Questionnaire (Attachment 8-42).

information system (FSMIS), but rather the CAA was to notify the concerned certificate holder to improve its SMS implementation plan and to comply with the regulations and CAA policy within the SMS implementation timeline.

After the SMS assessment project, CAA held a SMS conference for senior managers of operators and repair stations on 4 December 2013. The CAA representatives at the conference advised that:

- The 2013 SMS assessment project identified that some operators had not developed a SMS implementation plan, and therefore, recommended that all operators establish a SMS implementation plan;
- Safety management system AC 120-32D will be published before 2014 and will be based on the 3rd edition of the applicable ICAO DOC 9859 issued in May 2013;
- The timeline for SMS implementation will be extended until the end of 2015;
- SMS training courses will be provided to operators and repair stations before 2014; and
- The CAA will conduct a second SMS assessment in accordance with the SMS development progress of operators.

The CAA conducted two SMS training courses for operators/repair stations on 19-21August 2014 and 15-17 September 2014.

The CAA issued AC 120-32D for SMS on 20 October 2014 and further extended the SMS implementation timeline until 31 December 2016 (5 years required for the implementation of a mature SMS) in accordance with ICAO Annex 19 and ICAO Document 9859 Safety Management Manual 3rd edition issued in May 2013.

1.17.2.2 TNA SMS Development

The TNA conducted a SMS gap analysis in 2011. TNA did not develop a SMS implementation plan which is required in the AC 120-32C. The TNA safety and security office (SSO) Supervisor stated that the TNA developed SMS via internal discussions and tasks assignments, and reviewed SMS development progress in routine meetings.

The CAA conducted an assessment of TNA's SMS between 23 April and 31 May 2013 and notified the assessment results to TNA via official document on 11 June 2013. The official document indicated that the CAA had identified 24 deficiencies during the assessment and required TNA to submit a corrective actions plan for re-assessment. TNA did not officially submit any corrective actions plan to the CAA but engaged in communications with the CAA about the corrective actions plan.

Interviews with the TNA SSO manager indicated that the CAA SMS assessment team stated that the purpose of 2013 SMS assessment was to assist operators to develop an SMS. Therefore, TNA thought that the SMS assessment results should be considered as recommendations only, not deficiencies. TNA reported the status of their SMS implementation to the CAA on two occasions as a result of the POI's inquiry. Towards the end of 2013, TNA advised the POI orally that they would improve their SMS through the acquisition of an SMS software system. In July 2014, TNA advised the CAA via e-mail that they would complete their Safety Management Manual (SMM) revision and implement the SMS software system by the beginning of 2015.

1.17.3 TNA Flight Operation Division

1.17.3.1 Organization Structure

The head of the airline's flight operations division (FOD) was designated an assistant vice president. The FOD comprised the fleet management department and standard & training department as described in the flight operations division operations manual[67]. The organization chart for the FOD is shown in Figure 1.17-1.

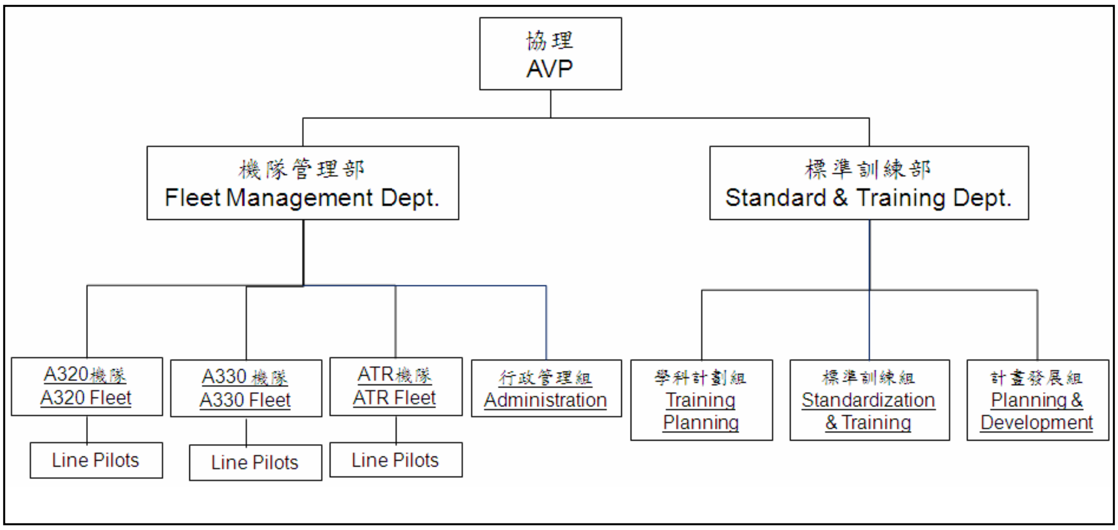

Figure 1.17-1 TNA flight operations division organization chart

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[67] The 31st edition dated 2 February 2014.

1.17.3.2 Fleet Management Department

The manager of the fleet management department (FMD) was responsible for line operations on the A320 fleet, A330 fleet, ATR fleet and administration. A chief pilot was designated for each fleet. The responsibilities of the fleet management department included:

- Pilots' personnel management;
- Assignment and execution of flight tasks;
- Flight time monitoring and record keeping; and
- SMS implementation and operational security.

1.17.3.2.1 ATR Fleet Manpower Management

In 2013, there were 9 ATR72-500 aircrafts in the TNA ATR fleet. In 2014, TNA introduced ATR72-600 and phased out several ATR72-500 aircrafts. Since April 2014, TNA had 10 ATR72 aircraft, including 3 ATR72-600s and 7 ATR72-500s. TNA data indicated significant growth in demand for the airline's services of 9.7% and 15.3% between 2013 and 2014. However, the increase in flying activity was accompanied by a 3.7% decrease in the number of pilots at the airline[68].

The TNA staff advised that that the increase of one additional ATR aircraft to a total of 10 aircraft was not in the original operating plan. TNA expected to maintain an ATR flight crew/aircraft ratio of 6 to 1. That is, the ATR fleet of 10 aircraft required 60 pilots, which meant that the airline was 8 ATR crew short at the time of the occurrence. The chief executive had decided not to phase out the 3rd ATR72-500 in order to increase flight numbers. The issues associated with an insufficient number of ATR flight crew and the subsequent increase in flight and duty times were highlighted but the decision remain unchanged.

The airline subsequently changed the daily ATR flight patterns from a maximum of 6 sectors/day in 2013 to a maximum of 8 sectors/day from May to July 2014.

In addition, the data also showed that 30 ATR fleet pilots had accrued over 270 hours cumulative flight time (CFT) from May to July in 2014.

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[68] The ATR fleet had 2,376 revenue flights in May 2013. The revenue flights increased 231 flights to 2,610 in May 2014. And 354 revenue flights increased from 2,311 flights in June 2013 to 2,665 flights in June 2014. However, the number of the ATR pilots decreased from 54 in May and June, 2013 to 52 pilots in the corresponding period of 2014.

Compared with the same period in 2013, there were only 4 pilots with CFT over 270 hours[69]. During the peak travel season from July to September in 2013, there were 14 pilots with CFT over 270 hours[70].

The coordinator responsible for pilot rosters and scheduling stated that the factors contributing to the significant increase in CFT from May to July 2014 included the introduction of the ATR72-600, increased revenue flights, and a reduction in the number of available fight crew. Those factors were also the reasons that ATR pilots had 8-flight sectors in the daily schedule.

The FMD manager reported that the ATR fleet did have a crewing shortage in 2014. The monthly roster data also showed that flight crews had high average flight times. The FMD manager stated that monthly flight times of 85 hours for three consecutive months might be a warning signal from a fleet management perspective. However, he stated that the Department had to accept this condition because the flight times were still within the regulated flight and duty time limitations.

1.17.3.3 Standard & Training Department

An assistant manager was responsible for the Standard & Training Department, which included three sections: Training Planning, Standardization and Training, and Planning and Development. The tasks conducted by the Standard and Training Department included:

- Establishing and revising flight crew SOPs;
- Conducting standard operations audits;
- Conducting aircraft performance analyses;
- Establishing and maintaining the flight operations manuals;
- Developing and implementing of digital learning systems for crew;
- Monitoring flight crews' qualifications and certifications; and
- Implementing operational aspects of the SMS.

The Standard & Training Department provided the following flight crew trainings and checks for all aircraft, including the ATR fleet:

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[69] GE 222 Captain (227.03hrs)/ First Officer (260.58hrs).

[70] GE 222 Captain (256.13hrs)/ First Officer (297.95hrs).

(a) Aircraft Type Training
(b) Ground School
(c) Initial Training
(d) Recurrent Training
(e) Transition Training
(f) Upgrade Training
(g) Instructor and Examiner Training
(h) Ab-initio Training
(i) Re-Qualification Training
(j) Cross Crew Qualification (Airbus) and Differences (ATR) Training.

In addition, the standard & training department provided dangerous goods training and special operations training, such as reduced vertical separation minimum (RVSM), performance based navigation (PBN), extended range twin-engine operations (ETOPS), low visibility operations (LVO), cold weather operations, high elevation airport operations, and fatigue management.

TNA flight crews received two hours of crew fatigue management training in April 2013. That training addressed revised flight and duty time limitations and rest periods in the CAA's Aircraft Flight Operations Regulations. Advanced training regarding to crew fatigue was not provided and the airline had not implemented a fatigue risk management system (FRMS) nor was it required to do so at the time of the occurrence.

The CAA had authorized the standard & training department to nominate suitably qualified and experienced training captains as designated pilot examiners (DPE) to conduct aircraft type rating checks.

Between 2011 and 2013, only one pilot had failed a proficiency check on the ATR72-500 fleet. All other pilots on the fleet had passed the type rating, proficiency and line checks during that period.

1.17.3.3.1 Standardization & Training Section

An Airbus A330 captain managed the airline's standardization & training section (STS) and was designated as the STS Supervisor. While the STS Supervisor officially had no support staff, the airline's designated instructor pilots (IPs) and check pilots (CPs) were tasked with assisting the STS Supervisor in the conduct of the airline's check and training program. The responsibilities of the STS Supervisor included:

- Establishing and revising flight crew SOPs, checklists and relevant training manuals;

- Collating and preparing flight crew training materials and the test database;
- Supervising the conduct and performance of the IPs and CPs;
- Evaluating and improving flight crew training programs; and
- Participating in pilot selection and evaluation.

1.17.4 TNA Safety Management Organization and Activities

1.17.4.1 Safety Committee

According to TNA's Safety Management Manual[71] (SMM), the airline safety committee was responsible for reviewing the overall safety performance of the operations in the company. The President of the company was the chairman of the safety committee. The Committee members included managers from the FOD and the SSO. The SSO manager was the Executive Secretary and was responsible for organizing the meeting schedule and preparing meeting agendas and minutes. The Committee met at quarterly intervals.

Five safety action groups (SAGs) reported to the airline safety committee. Those SAGs included the flight safety action group (FSAG), cabin safety action group (CSAG), ground safety action group (GSAG), maintenance safety action group (MSAG), and the security safety action group (SSAG). Each SAG conducted monthly meetings. However, except the SSAG, SSO staffs were not members of nor did they attend the other SAGs meetings.

The airline safety committee reviewed the company's safety performance indicators and targets, and any revisions to safety-related company policies and procedures. The implications of CAA regulatory changes on company operations and procedures were also reviewed. The Committee members also reported self-audit findings, flight operations risk assessment status, internal safety investigation findings, quality assurance audit findings, and associated corrective actions and preventive measures.

According to airline safety committee meeting minutes and materials between 2013 and 2014, the following topics were discussed:

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[71] The airline's Safety Management Manual (SMM) current at the time of the occurrence, comprised 10 Chapters including safety management organization, safety policy and safety culture, SMS concepts, safety reporting systems, safety investigation, safety monitoring system, self and external audit, safety risk management, and safety promotion.

- Actions taken since previous meetings;
- Safety information and CAA policy announcements;
- Reports on all safety relevant topics and issues;
- Identified safety deficiencies and corrective actions taken;
- Safety management performance of each safety action groups;
- Service difficulty reports (SDR) and incidents reported to the CAA; and
- FOQA events and standard operations audit frequency and findings.

The SSO manager presented the following items at the airline safety committee meetings: safety & irregularity reports, FOQA self-report numbers, safety investigation updates, self-audit results, FOQA events and trend analysis, and the Direct Risk Index and Average Risk Index for specific airline divisions and the company overall.

The safety meeting minutes indicated that few safety issues of any substance were raised by the SAGs.

1.17.4.1.1 Flight Safety Action Group

The flight safety action group (FSAG) was responsible for assessing operational safety risks in flight operations. The FSAG chairman was the manager of the FMD. Members comprised managers, supervisors, engineers and coordinators from the flight operations division and system operations control. The FSAG conducted monthly meetings.

The FSAG was also responsible for:

- Ensuring that appropriate flight safety data collection mechanisms and safety reporting systems were available;
- Ensuring that hazard identification and safety risk assessments were conducted by appropriate personnel; and
- Ensuring that safety improvements were implemented in an effective and timely manner.

The FSAG's routine meeting topics included the preceding monthly safety & irregularity reports, FOQA results, standard operations audit results, and flight statistics. The flight statistics included revenue flight numbers, flight cancellation numbers and air return/diversions. Other items included SMS implementation progress, and safety issues such as bird strike events and aircraft configuration setting errors[72].

Interviews with the FMD manager indicated that the focus of FSAG meetings was on the previous monthly FOQA events and corrective actions, flight data trends for higher risk yellow and amber events, standard operations audit results and safety issues raised by the attendees. The purpose of the meeting was to identify and address recurring safety issues.

1.17.4.2 Safety and Security Office

The airline's safety and security office (SSO) had 6 staffs. The SSO manager had a reporting line to the airline's President. The SSO was responsible for: implementing and supervising the annual safety working plan; handling voluntary safety reports, investigating safety events, analyzing FOQA data and monitoring associated corrective actions. The SSO also reviewed and analyzed information which might affect flight safety, monitored safety trends, conducted risk assessments, implemented preventive and corrective measures to reduce the level of risk, and published safety bulletins on the SSO website.

The SSO conducted quarterly flight safety meetings where they discussed safety bulletins, policy announcements, recent regulatory enforcement action and bulletins, local and international safety occurrences and reports.

1.17.5 Safety & Irregularity Reporting System

The airline had a safety and irregularity reporting system to identify safety issues and risks. The airline's Safety Management Manual required staff to complete a safety and irregularity report for all aircraft accidents, serious incidents, incidents, or operational hazards. Safety & irregularity reports were submitted through two channels and required the reporter's name in each case: the applicable operational department and/or the SSO. Reports sent directly to the SSO contained some protections for the reporter's identity.

The SSO did not have a confidential reporting system in place. The SSO manager advised that SSO received confidential reports directly from staff but the SSO did not maintain the records or share the report's content.

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[72] The information was based on FSAG meeting minutes from January 2013 to July 2014.

1.17.6 FOQA Operations and Analysis

1.17.6.1 Flight Data Analysis Program

A flight data analysis program (FDAP) is also known as a flight operations quality assurance (FOQA) program. FOQA provides a systematic tool to proactively identify, assess, and manage flight operations hazards and their associated risks.

The ICAO FDAP Manual (DOC 10000) states:

> *FDAP is a non-punitive program for routine collection and analysis of flight data to develop objective information for advancing safety through improvements in flight crew performance, training effectiveness, operational procedures….*
>
> *FDAP involves:*
>
> *a) capturing and analyzing flight data to determine if the flight deviated from a safe operating envelope;*
> *b) identifying trends; and*
> *c) promoting action to correct potential problems.*

1.17.6.2 TNA FOQA Program

The airline's FOQA program used the AirFASE® system to analyze all flights. The system was configured with the standard operational data set for the ATR72. The system potentially enabled the airline to evaluate flight operations trends in each fleet, identify associated operational safety risks and to initiate information-based, preventive and/or corrective safety actions.

The FOQA system analyzed between 1,000 to 1,500 flights for the ATR fleet each month. The system automatically identified flights where a pre-set parameter was exceeded and quantified the magnitude of that exceedance. Further investigation was required to ascertain the reasons for a given exceedance, including non-compliance with standard operating procedures.

The SSO was responsible for the administration of the FOQA program, including:

- Implementing the FOQA program;
- Conducting FOQA event analysis;
- Identifying FOQA event trends;
- Reviewing corrective actions in response to FOQA events;

- Updating and amending FOQA-related procedures; and
- Organizing FOQA event review meetings.

The FOD was responsible for:

- Arranging flight crew to attending FOQA event review meetings;
- Conducting FOQA events investigations;
- Developing and implementing improvement measures; and
- Assist in modifying FOQA parameters.

1.17.6.2.1 TNA FOQA Event Category

FOQA events were categorized as red, amber and yellow depending on the degree of deviation or exceedance. After review, the events were designated as either a corrective case or for information.

A red event was defined as a critical safety event that exceeded aircraft structural limits or standard operating procedures (SOPs). Red events were automatically classified as corrective cases. Red events were sent to the applicable operational division (e.g., flight operations, engineering) for action. Corrective action plans were required to be documented within five working days of notification of the event.

An amber event was defined as a safety event where SOPs were exceeded but there was no immediate threat to flight safety. Amber events were reviewed at the FOQA event review meeting to determine if the case should be designated for corrective action or for information or no action. FOQA corrective cases were investigated by the applicable operational division. For FOQA information cases, the event flight crew were notified and asked to provide a context for or explanation of the event with suggested corrective action within 10 working days.

Yellow events were defined as relatively minor events that exceeded SOPs. The data was used for trend and statistical analyses. The safety and security office informed the applicable operational division when an analysis indicated an upward trend. Routine event analysis included information such as the number, nature and trend of different red, amber, and yellow events for each fleet.

1.17.6.2.2 FOQA Self-report

Flight crews were required to complete a FOQA self-report if they identified any non-compliance with SOPs in flight. The report was to be sent to the SSO within three working days. The SSO retained such reports until the completion of the FOQA event review meeting. Disciplinary action was discretionary and in proportion to the seriousness of the event and the degree of intent to deviate from SOPs.

1.17.6.3 FOQA Event Handling Process

1.17.6.3.1 FOQA Event Review Meeting

The FOQA event review meeting was coordinated by the SSO. The review board members included the SSO manager, FOD managers, and four pilots from the fleet. Additional information and FOQA self-reports were also provided.

FOQA review members assessed the amber FOQA events and determined via vote if the event warranted corrective action. All FOQA review meeting attendees reviewed the amber events and documented their assessments on a FOQA Event Review Form. That form included basic event information without the name of the crew.

The SSO was required to forward all red FOQA events and the monthly FOQA event review meeting minutes to the company’s President.

1.17.6.3.2 FOQA Case Handling

FOQA cases that involved technical or operational issues or the violation of SOPs requiring subsequent disciplinary consideration were forwarded to the Standard & Training Department. Events were reviewed for their potential training benefit. Cases that involved the violation of SOPs were sent to the respective fleet chief pilot for disciplinary action.

The SSO sent the FOQA Event Review Forms to the FOD after the FOQA event review meetings. The respective fleet chief pilot or deputy would review the event data and animation with the event crew in the SSO. The chief pilot then completed an event form, which included an event description and any corrective actions.

The FOD was responsible for conducting FOQA event investigations and developing and implementing safety improvement measures. The SSO also recorded the FOQA corrective actions implemented by the FOD in the monthly FOQA event review meeting minutes.

1.17.6.3.3 FOQA Event Statistics and Analysis

The SSO generated quarterly FOQA analysis and statistics reports. The reports included the top 10 Amber events and landing or take-off events at domestic airports. The FOD provided comments and corrective actions in response to the safety issues identified by the flight data analysis. The reports were also sent to the company president, vice president and FOD management.

There were three FOQA quarterly analysis and statistics reports produced in 2013 and two quarterly reports produced in 2014 before the GE222 occurrence. In 2013, the flight data program recorded two red events and 23 amber information events resulting in seven corrective cases. In 2014, there were 13 amber information events resulting in one corrective case.

The airline's ATR72 FOQA data during the three months before the occurrence identified two amber events related to approaches that were triggered by: (1) speed low, approach speed low detected at 1,170 feet; and (2) rate of descent high on approach, between 1,000 feet and 500 feet. The crews did not execute a go around in those cases as required by SOPs.

1.17.7 Operational Safety Risk Management[73]

1.17.7.1 Risk Management Process

The FSAG was responsible for hazard identification, risk assessment, control and evaluation. Hazards and associated safety risks were identified through documented safety reports, verbal safety reports, and feedback on safety issues during standard operations audits (SOA).

The airline's FOD has identified and assessed the risks associated with 201 hazards at the time of the occurrence. If the FSAG identified a new hazard, an assessment was conducted and the risk register was updated. If an already documented risk was a recurring problem, an assessment of the effectiveness of the risk controls was undertaken.

The airline's flight operations safety risk register had not been updated since March 2011. The register divided risks into phase of flight. Non-compliance with SOPs had been identified but the risk control was to remind crews to follow procedures. The crew non-compliance with SOPs had continued unabated as indicated by the line observations, interviews and the occurrence itself.

1.17.7.2 Monitoring the Effectiveness of Risk Control

To monitor the effectiveness of risk controls and evaluate the overall flight operations safety risk, the FOD calculated two risk metrics known as the direct risk indicator (DRI) and average risk indicator (ARI) by using the

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[73] The details of safety risk management operations of FOD are described in Chapter 9 and Appendix 9-Risk Management Program of SMM.

operational risk management integration tools (ORMIT) software. The risk indices were calculated on a monthly basis and reported at all safety meetings.

DRI Calculation and Record Review

The DRI was calculated by weighting the results of 140 individual risk indicators. Each indicator was selected from the FOD operations risk checklist.

Within the 140 individual indicators, the measurements of 13 indicators were involved with the results of flight crew self-evaluation, such as: standard operating procedure (SOP) compliance, flight briefings, sleep conditions, team cooperation, monitoring weather conditions and so on.

Several individual indicators were evaluated positively or as satisfactory from May to July in 2014. For example, the indicators of fleet manpower evaluation, flight crew duty periods, and internal communication were all evaluated favorably, despite some of the reported problems with crew shortages and flight and duty times on the ATR72 fleet.

ARI Calculation and Record Review

The monthly ARI was calculated by weighting the number of identified hazards in accordance with their different risk levels. The ORMIT software included three types of ARI calculations as follows:

- Original ARI: the risk level of an organization at the beginning of a risk management project. The input data was the number of safety events that occurred before the project;
- Expected ARI: the expected risk level of an organization after implementing risk control measures. The input data was the number of expected safety events; and
- Real ARI: the real risk level of an organization after implementing risk control measures. The input data was the number of actual safety events.

The FOD only utilized the ARI calculation and used the number of identified hazards as input data rather than number of actual safety events during the ARI calculation process.

The ARI records showed that the FOD had maintained an ARI value of 1.36 since March 2011. The identified flight operations also remained unchanged during the same period.

The FSAG chairman advised that he was aware that the ARI and DRI had not changed significantly during the previous two years. However, he was not aware that the ARI had been static since March 2011. The FSAG reviewed the ARI and DRI risk indices each month. If an individual indicator experienced a significant change, the FSAG would discuss the reasons for such a change. The FSAG did not have a periodic review mechanism for evaluating the suitability of the individual DRI indicators.

1.17.8 Self-audit Program

1.17.8.1 Program Introduction

The TNA’s self-audit program was designed to:

- Identify and correct potential safety issues;
- Provide a high level of assurance that the company’s safety risk controls were effective;
- Meet company safety targets; and
- Ensure conformance to and compliance with company policies and procedures and regulatory requirements.

There were two levels of self-audit. The first level was conducted internally by all operational divisions no less than four times per year. The second level was conducted by the SSO and quality control center (QCC) twice a year. The QCC conducted second level audits of the Engineering and Maintenance Division. The SSO conducted second level audits of the Flight Operation Division, System Operations Center, In-Flight Services Division, Cargo Sales Department and Freight/Ramp Service operations at each airport terminal. The scope of the audits was to confirm the division was in compliance with the operational standards and regulations.

All operational departments/divisions were required to develop, review, amend and implement their self-audit plans. The SSO summarized and reviewed all departments/divisions self-audit plans and supervised their implementation.

Self-audits were conducted by trained auditors using checklists. Audit findings or corrective actions were issued to the relevant divisions. Responses were assessed during subsequent audits. The audit reports were also submitted to the SSO. The SSO provided the company President with a summary of the audits every 6 months.

The auditor training was conducted by the SSO or by qualified auditors within the divisions. The minimum training was two hours, which was below the aviation industry’s average quality assurance auditor training.

Such courses typically require up to five days of training, with even higher qualifications, training and experience required for lead auditors and evaluators.

1.17.8.2 Self-audit of the Flight Operation Division

The assistant vice president of the FOD was responsible for supervising all FOD departments' self-audit activities.

The self-audit check items for the fleet management department included crew flight and duty time management and planning. The self-audit check items for the Standards and Training Department included deficiencies identified during annual simulator training or by the SOA. The Risk Management Team Operations self-audit check items for the safety management system included safety reporting, investigations, inspection and audit, safety risk management and safety promotion.

The FOD conducted quarterly self-audits in March, June, September and December 2013 and in March and June of 2014, before the GE222 occurrence. There were no audit findings issued during 2013 and 2014.

1.17.8.2.1 Standard Operations Audit

The airline's Flight Operations Division Operating Manual stated that the purpose of the standard operations audit (SOA) program was to:

- Implement non-routine audits to ensure flight crew complied with SOPs;
- Ensure the effectiveness of safety risk controls;
- Identify safety deficiencies and the implementation of corrective actions;
- Implement risk prevention measures;
- Continue to monitor SOP compliance;
- Ensure that the company's safety performance indicators and targets were met; and
- Comply with regulatory requirements.

There were two types of SOA auditors: the Flight Crew Auditors; and the Office Staff Auditors. FOD management pilots, CPs or IPs served as Flight Crew Auditors. The supervisor, deputy supervisor and other authorized personnel from the Standards and Training Department served as Office Staff Auditors. A minimum of 20 SOAs were conducted each month, four of which were conducted by Flight Crew Auditors. If the monthly audit targets were not met, the audit shortfall could be made up within the same year if approved by the FOD assistant vice president.

The SOA auditors utilized checklists to conduct and record the results of the audit, which were then submitted to the Standards and Training Department. The Standards and Training Department reviewed the audits and produced a report with a view to improving operations.

An SOA Checklist Review Meeting was conducted each December to re-examine and update the content of the audit checklists. One SOA audit checklist item had been revised since the beginning of the SOA program.

SOA auditors were to receive risk management training and be familiar with operational risk factors. Auditors were expected to annotate observed safety risk factors on the SOA form. If safety risk issues manifested during the audit, flight crew were to be issued a Self-Evaluation Form during the audit. The completed form was to be submitted to the auditor and then reviewed by the FSAG with a view to conducting a more detailed risk assessment of the identified safety issues.

SOA Records Review

The airline’s monthly SOA statistics showed that 245 audits had been conducted in 2013 (Airbus fleet 157, ATR fleet 88) and 134 audits had been conducted up until 31 July 2014 (Airbus fleet 59, ATR fleet 75). Only 24 ‘Self-Evaluation Forms’ were filed from a total of 379 audits.

From 1 January 2013 to 31 July 2014, 8 SOA checklists (3 ATR fleet and 5 Airbus fleet) had been ticked with ‘No’ items, which meant that the flight crew were not complying with standard operating procedures. However, only two of those audits were recorded in the monthly SOA statistics report. In addition, the ‘12-month-rolling accumulation’ [74] statistics in the monthly report were also not accurate.

SOA Related Interview Summary

The Standards and Training Department supervisor stated that no specific risk management training had been given to the SOA auditors except the basic risk management course provided by safety and security office. Office Staff Auditors would check whether the operation was in compliance with the checklist only. They would not comment or evaluate crew performance. To explain the discrepancies in the audit reports and records, the supervisor stated that there may have been an oversight by the

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[74] The sum of all ‘No’ items in the previous 12 months.

staff responsible for maintaining the records. The supervisor only reviewed the statistics and did not verify the detailed audit data.

The newly employed engineer in charge of audit records stated that the errors in the ‘12-month-rolling accumulation’ report might have been the result of his omission of the initial value input and not updating the excel file. Furthermore, the absence of ‘Self-Evaluation Forms’ might have been a result inadequate file management or some flight crew auditors may not know that the ‘Self-Evaluation Form’ is required to be issued to flight crew during the audit.

The ATR chief pilot stated that when he observed deficiencies during a SOA, he usually made recommendations to the pilot in person rather than recording the deficiencies in the checklist. He was not aware that any manual required flight crew to fill out ‘Self-Evaluation Forms’ during the SOA. Therefore, he didn’t ask flight crews to do it when conducting the audit.

SOA in Consequence of FOQA Event

In response to some FOQA events, the ATR chief pilot had recommended that some SOAs be conducted to further evaluate the factors for the FOQA events. Most of the subsequent audits were conducted by the ATR chief pilot. Interviews with the standards and training department manager indicated that the Department may conduct further training if the FOQA event was related to non-compliance with SOPs. In addition, if the chief pilot recommended conducting SOAs for a FOQA event, the Standards and Training Department would monitor the corrective actions taken after the audit.

1.17.8.3 Self-audit of the Safety and Security Office

The SSO produced an annual audit plan, including a self-audit plan of all operating departments/divisions. The annual audit reports were presented to the President for approval.

Checklist Review

The SSO self-audit and safety audit checklists for airports, airline office facilities and flight operations were in the Safety Management Manual.

The SSO audits of flight operations included regulatory compliance, manual conformance, bulletins, emergency response procedures, safety related practices, and crew check and training records.

The checklist items for the SSO self-audit included:

- Safety reports and investigations;

- Procedures for reviewing the effectiveness of the airline’s safety performance;
- Effectiveness of self-reporting system;
- The risk identification, assessment and control system;
- Effectiveness of the risk controls;
- Efficacy of the company safety inspection, corrective action process; and
- Issuing safety recommendations and proposed corrective actions to senior management.

Record Review

The safety and security office conducted first level SSO self-audits in March, June, September and December 2013 and in January, May, and June 2014 just prior to the occurrence.

The SSO conducted second level self-audits of flight operations on 17 July and 31 December 2013 with no findings. A subsequent SSO second level self-audit of flight operations conducted on 22 May 2014, the month before the GE222 occurrence, contained no findings.

The SSO and FOD self-audit records showed that auditors usually ticked ‘satisfied’, ‘dissatisfied’, or ‘not implemented’ for each check item without referring to explicit audit standards and objective reference information.

Interview Summary

Interviews with the SSO manager indicated that the SSO self-audit checklists for flight operations were inadequate. For example, there were no items pertaining to risk assessment, management and evaluation, or the effectiveness of the internal self-audit or SOA program.

1.17.9 Safety Information Sharing

1.17.9.1 Policy and Technical Notices

The FOD provided flight operations and safety information to pilots via policy and technical notices. The notices were available on the FOD intranet.

The policy notices included:

- General safety bulletins;
- Flight safety bulletins;

- FOD regular meeting minutes;
- FOD flight safety meeting materials; and
- Safety reminders from FOD managers.

Both of the FOD assistant vice president and ATR fleet chief pilot issued policy notices to flight crew in April and May 2014 admonishing crews to keep adhering to SOPs and that safety is the first priority in mind with increased working hours, reduced manpower and an increase in flight demands.

The technical notices include:

- Findings from FOQA reviews;
- Resolutions from IPs meetings;
- Corrective actions in response to the airline's safety occurrences;
- Findings from CAA operations inspections; and
- FSAG meeting minutes.

1.17.9.2 Safety Information Update

The airline's safety and security office established an internal website for safety information sharing with staff. However, the SSO did not periodically update the safety information available on its website. A review of the website found that:

- The aviation occurrence investigation reports were current up until 2005;
- The monthly safety meeting materials were current up until Q4 2012; and
- The Safety Bulletins were current up until 2013.

1.17.10 Previous Occurrence Investigation Findings and Safety Actions

On 2 May 2012, TNA flight GE515 flight, an ATR72, experienced an in-flight engine fire during the climb. The ASC conducted an investigation and published the report in May 2013. The ASC recommended that TNA ensure that flight crew conduct ILS approaches in accordance with company SOPs, including the conduct of an approach briefing, setting the approach course, adjusting speed appropriately, and performing the standard callouts as required by SOPs.

Similar recommendations were issued to the CAA to supervise the operator's corrective actions. The CAA replied in August 2013 that TNA flight crew auditors would specifically focus on the approach and standard callouts when conducting standard operations audits.

During the GE222 occurrence investigation, the investigation team reviewed related records and found that there was no evidence to indicate that TNA had conducted relevant standard operations audit activities with a focus on approaches and standard callouts.

The SSO manager stated at interview that the safety recommendations from the previous occurrence were reviewed and the corrective actions forwarded to the CAA. The investigation conclusions and findings were conveyed by the chief pilot to flight crews.

The TNA ATR chief pilot was responsible for the implementation of flight operations safety actions in response to occurrences. Interviews with the ATR chief pilot indicated that he had reviewed the draft ASC reports of TNA's two previous occurrences[75] but he was not aware of the follow-up actions by the company after the investigation reports were published. Regarding corrective safety actions in response to the two previous occurrences, the corresponding procedures were modified and simulator training had been enhanced in accordance with the safety recommendations. He stated that standard callouts were already one of the check items in the standard operations audit. He did not specifically focus on the approach and standard callouts during routine standard operations audits.

1.18 Additional Information

1.18.1 Aircraft Operating Procedures

Contents of the airline's operations manuals and procedures related to the occurrence are presented below:

1.18.1.1 Flight Operations Manual

Chapter 2 Definitions and Abbreviations

2.1 Definitions

Minimum descent altitude (MDA). A specified altitude in a non-precision approach or circling approach below which descent must not be made without the required visual reference. Minimum descent altitude (MDA) is

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[75] There was another TNA ATR-72 occurrence, flight GE 5111 on 1 July 2013.

referenced to mean sea level.

Chapter 7 Flight Operations Procedure

7.1 Standard Operating Procedure

7.1.11 Approach

1. General:

b. Approach may not be continued below the applicable DA/DH or MDA unless:

(a) the aircraft is continuously in a position from which a descent to a landing on the intended runway can be made at a normal rate of descent using normal maneuvers and where such a descent rate will allow touchdown to occur within TDZ of the runway of intended landing;

(b) the flight visibility is not less than the visibility prescribed in the standard instrument approach procedure being used; and

(c) at least one of the following visual references for the intended runway is distinctly visible and identifiable to the flight crew.

- *Elements of the approach light system, except that below 100 ft above TDZ, approach lights may not be used as a reference;*
- *The threshold;*
- *The threshold markings;*
- *The runway end identification lights;*
- *The visual glide slope indicator;*
- *The TDZ or TDZ markings;*
- *The TDZ lights;*
- *The runway or runway markings;*
- *The runway lights.*

If at any time after descent below the DH/DA or MDA, the PF cannot maintain visual contact with the runway environments, he/she shall immediately execute a go-around following the appropriate missed approach procedure and inform ATC.

4. The following guidance applies to continuation of non-precision approaches:

(a) an instrument approach shall not be continued beyond below 300 m (1000ft) above the airport unless the reported visibility or controlling RVR is above the specified minimum.

(b) If after descending below 300 m (1,000 ft) above the airport, the reported visibility or controlling RVR falls below the specified

minimum, the approach may be continued to MDA. In the event that a go-around is required, pilots shall follow the standard charted missed approach procedure or ATC instructions.

(c) Unless otherwise defined by local authorities, the controlling RVR specified in item (a) & (b) above means RVR measured at the touch down zone area.

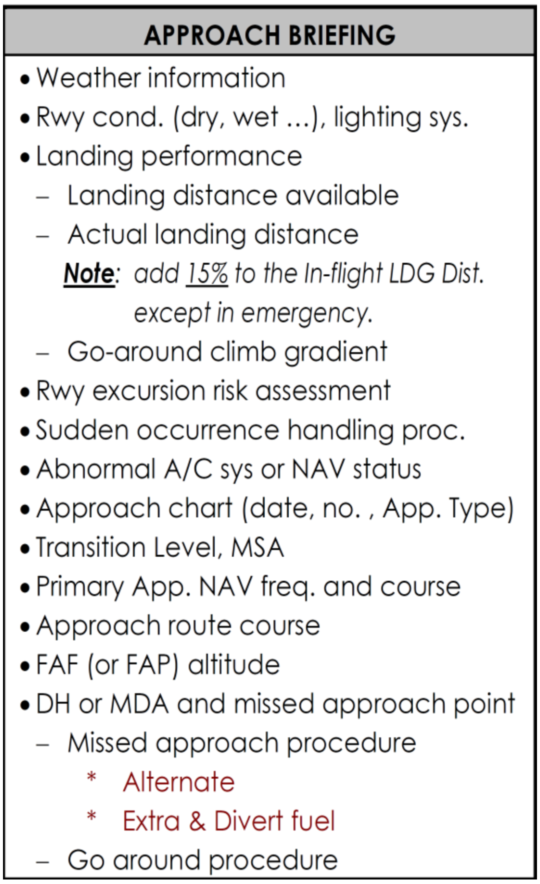
7.1.14 Go-Around

1. *A go-around shall be made without hesitation at any time a successful landing becomes doubtful, especially when any operating crew or ATC instructing a go-around. (For the definitions of a stable approach, see 7.1.11.7.)*
2. *Go-around is a normal procedure. The company shall not check into the responsibility of a go-around. When a PF performs a go-around under abnormal circumstances, Flight Operations Division will only ask the reason, make a record and analyze it for future training reference. Make an entry into "Aircraft Flight Log and Simplified Operational Flight Plan" to inform Flight Operations Division of those events.*
3. *A missed approach is normally commenced at or before the applicable MAP (Miss Approach Point) for an approach. However, to ensure flight safety, flight crew (PF/PM) shall assertively carry a rejected landing or baulked landing when encountering sudden deterioration in forward visibility, extreme wind velocity variations or any other situations which would render the flight unsafe at a later stage.*

7.5.10 Crew Monitoring And Cross-Checking

13. *During Flight, if any pilot finds the flight course, altitude, speed, attitude of the aircraft is deviating from normal or expected setting, he or she shall call out timely to arise situational awareness by using standard callouts: "Course!" or "Localizer!", Altitude!", "Speed!", and "Attitude!".*

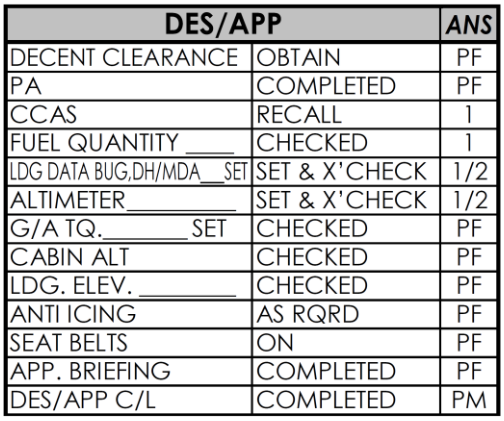
1.18.1.2 ATR72-212A Normal Checklist



APPROACH BRIEFING

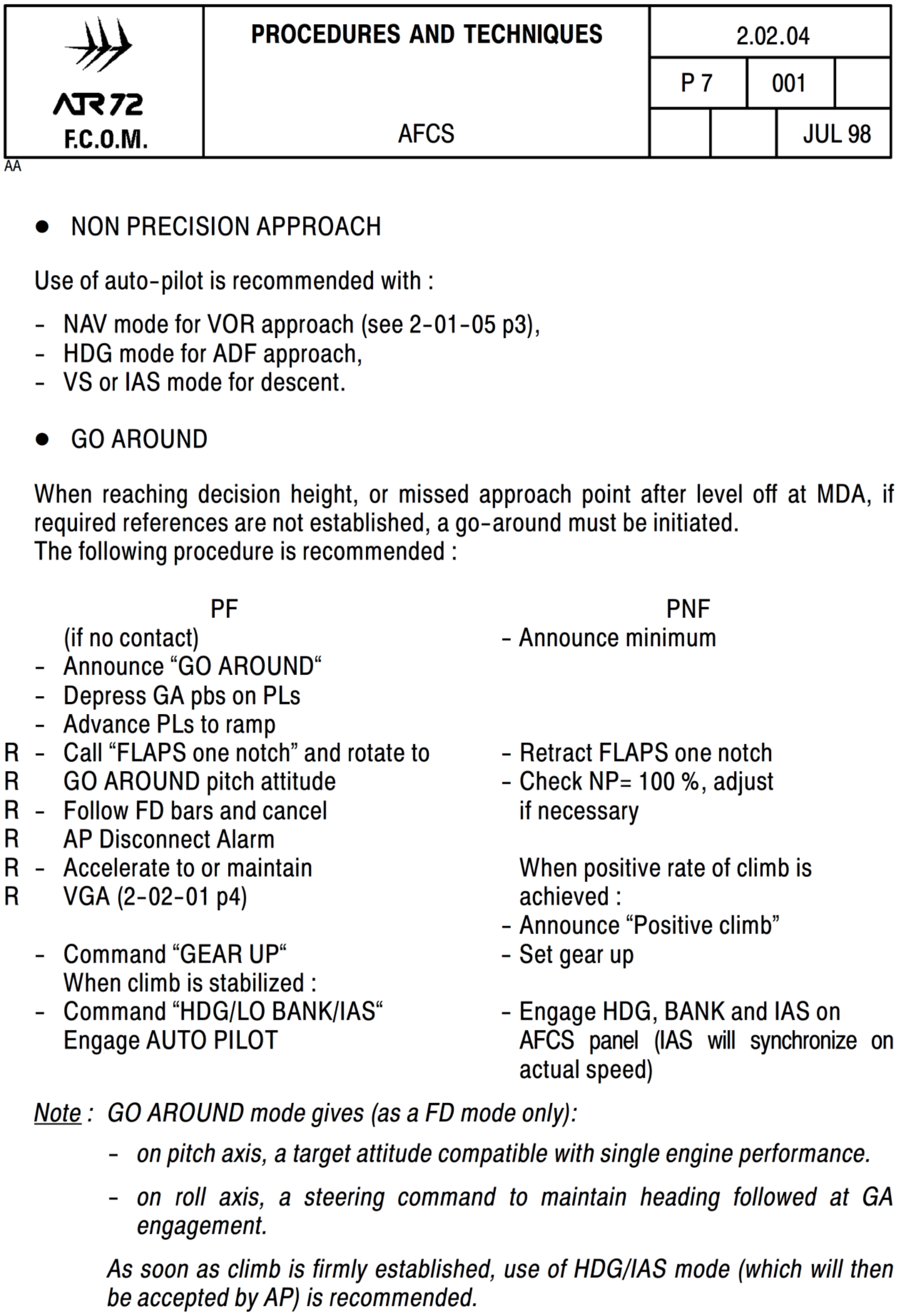
- Weather information
- Rwy cond. (dry, wet ...), lighting sys.
- Landing performance
  - Landing distance available
  - Actual landing distance

    Note: *add 15% to the In-flight LDG Dist. except in emergency.*
  - Go-around climb gradient
- Rwy excursion risk assessment
- Sudden occurrence handling proc.
- Abnormal A/C sys or NAV status
- Approach chart (date, no. , App. Type)
- Transition Level, MSA
- Primary App. NAV freq. and course
- Approach route course
- FAF (or FAP) altitude
- DH or MDA and missed approach point
  - Missed approach procedure
    - * Alternate
    - * Extra & Divert fuel
  - Go around procedure



DES/APP		***ANS***
DECENT CLEARANCE	OBTAIN	PF
PA	COMPLETED	PF
CCAS	RECALL	1
FUEL QUANTITY ____	CHECKED	1
LDG DATA BUG,DH/MDA__SET	SET & X'CHECK	1/2
ALTIMETER__________	SET & X'CHECK	1/2
G/A TQ._______SET	CHECKED	PF
CABIN ALT	CHECKED	PF
LDG. ELEV. ________	CHECKED	PF
ANTI ICING	AS RQRD	PF
SEAT BELTS	ON	PF
APP. BRIEFING	COMPLETED	PF
DES/APP C/L	COMPLETED	PM

1.18.1.3 ATR72 Flight Crew Operation Manual, FCOM



ATR 72
F.C.O.M.
AA

PROCEDURES AND TECHNIQUES

AFCS

2.02.04
P 7
001
JUL 98

- NON PRECISION APPROACH

Use of auto-pilot is recommended with :

- NAV mode for VOR approach (see 2-01-05 p3),
- HDG mode for ADF approach,
- VS or IAS mode for descent.

- GO AROUND

When reaching decision height, or missed approach point after level off at MDA, if required references are not established, a go-around must be initiated.
The following procedure is recommended :

	PF	PNF
	(if no contact)	- Announce minimum
	- Announce “GO AROUND“	
	- Depress GA pbs on PLs	
	- Advance PLs to ramp	
R R	- Call “FLAPS one notch” and rotate to GO AROUND pitch attitude	- Retract FLAPS one notch - Check NP= 100 %, adjust if necessary
R R	- Follow FD bars and cancel AP Disconnect Alarm	
R R	- Accelerate to or maintain VGA (2-02-01 p4)	When positive rate of climb is achieved : - Announce “Positive climb”
	- Command “GEAR UP“	- Set gear up
	When climb is stabilized :	
	- Command “HDG/LO BANK/IAS“ Engage AUTO PILOT	- Engage HDG, BANK and IAS on AFCS panel (IAS will synchronize on actual speed)

Note : *GO AROUND mode gives (as a FD mode only):*

- *on pitch axis, a target attitude compatible with single engine performance.*
- *on roll axis, a steering command to maintain heading followed at GA engagement.*

As soon as climb is firmly established, use of HDG/IAS mode (which will then be accepted by AP) is recommended.

R Maximum demonstrated crosswind:

	AutoPilot
Headwind	30 kt
Tailwind	10 kt
Crosswind	15 kt

▶ TASK SHARING

The philosophy of the task sharing is based on the following considerations:

- **PF**(1) task is **aircraft flying** during all the approach, he is in charge of speed control. Approaching DH + 100ft, he looks outside to acquire external visual references.
He **makes decision** for landing or go-around.
- **PNF**(2) task is **approach monitoring** with permanent reference to the instruments.

(1)**PF**, pilot flying,
- Monitors the A/C position, the flight path parameters and the AP.
- Controls the speed.
- Requests checklist, flaps setting and gear extension.
- Selects the modes and announces changes.

(2)**PNF**, pilot non flying,
- Is in charge of radio communications.
- Monitors the flight path, the speed, the mode changes, the systems and the engines.
- Reads the checklist.
- Selects flaps setting and gear extension.

▶ NORMAL APPROACH AND LANDING SEQUENCE

■ Prior to approach

- DESCENT procedure (PF / PNF):
  - Last weather information reviewed (destination and alternate).
  - Landing data collecting and ASI and TQ bugs setting (refer to 2.03.14 p1 for bugs setting description).
  - Approach briefing stating runway in use, MSA, DH, missed approach procedure, radio aids setting...
- APPROACH procedure (PF / PNF):
  - AP/FD coupled PF side.
  - Speed references set (VAPP, VGA, VmLB).
  - Markers volume set.
  - DH setting confirmed.

... / ...

- Before capture
  - **PF** has to perform the following tasks:
    - NAV set to ILS frequency, ADF set as required.
    - CRS set to final approach course.
    - APP armed.
    - IAS as required.
  - **PNF** has to perform the following task:
    - NAV and ADF set as required
- From capture to decision height

Note: The call-outs are written in bold with “ ...”.

CAT 2 events	Tasks and call-outs	
	PF	PNF
Localizer capture	**“LOC STAR”**	- Set runway HDG - Set ILS on NAV & CRS - Check CAT 2 on ADU
Glide slope capture	**“GS STAR”** Check GA altitude	Set GA altitude
	Request normal sequence for LDG configuration	Set LDG configuration in sequence
(1): Outer marker or equivalent position (not lower than 1000ft)	Check altitude on RA and altimeter, and if aircraft is stabilized **“WE CONTINUE”**	**“OUTER (1) ALTITUDE CHECKED, STABILIZED(2)”** Check altitude on RA and altimeter and if aircraft stabilized
800 ft RA **(3)**	Check dual coupling and no star on LOC and G/S modes **“CHECK”**	**“800 FT, DUAL CPL, NO STAR“** Check dual coupling and no star on LOC and G/S modes
500 ft RA		**“500”**
DH + 100 ft RA	Looks outside for visual references	**“100 ABOVE”** Monitors the instruments
DH / auto call-out		**“DECISION”**

(2): Stabilized means:
- On the final approach segment flight path.
- Landing flaps selected, VAPP reached.
- Final checklist completed.

(3): **Any failure that is not completely treated before 800ft AGL, or that occurs below 800ft AGL shall always lead to a missed approach.**

- If visual references sufficient

CAT 2 events	Tasks and call-outs	
	PF	**PNF**
Visual at DH	**"LANDING"**	
80 ft RA		**"80"**
50 ft RA	Disconnect AP	**"50"**
20 ft RA	Reduce PL and flare visually	**"20"**

- If visual references insufficient

CAT 2 events	Tasks and call-outs	
	PF	**PNF**
No visual at DH	**"GO AROUND, SET POWER, FLAPS ONE NOTCH"** - Press GA pb - Advance PL to the ramp - Follow FD bars	- Retract flaps one notch - Adjust power
Positive rate of climb	- Request gear retraction - Request HDG, low bank, IAS, VGA - Request AP engagement	**"POSITIVE CLIMB"** - Retract gear - Select HDG, low bank, IAS, VGA - Engage AP

1.18.1.4 Flight Crew Compliance with Airline's ATR72 Standard Operating Procedures on Occurrence Flight

The investigation compared the flight crew's actions on the occurrence flight with the required actions stipulated in the airline's ATR72 standard operating procedures (SOPs). Table 1.18-1 lists the flight crew's non-compliant actions and omissions during the flight.

Table 1.18-1 Occurrence flight crew's non-compliance with SOPs

Item	Phase	Flight Crew Behaviors	TNA ATR SOP
1	After Takeoff	PF did not call for "Flap Zero" and "AFTER TAKE OFF CHECKLIST", but the PM announced "flap zero set after takeoff checklist".	PF: "FLAPS ZERO" PM: "FLAPS ZERO" "FLAPS ZERO SET" PF: "CHECKED" PF: "AFTER TAKE OFF CHECKLIST"
2	Cruise	In CRUISE CHECKLIST, PM read out "ALTIMETER 999" and PF responded "999 set"	PM should read out "ALTIMETER, SPEED AND ALTITUDE" and both PF and PM respond "SET & CROSSCHECK"
3	Descent	Did not conduct approach briefing after requesting MKG VOR RWY 20 APP.	Should conduct approach briefing when leaving cruise altitude.
4	Approach	Did not perform DESCENT/APPROACH CHECKLIST.	Should conduct DESCENT/APPROACH CHECKLIST when descent clearance is obtained.
5		PF called for "FLAPS 15" from 0.3 NM before FAF and PM set "FLAPS 15" from 0.1 NM before FAF.	Should begin this process from 3 NM Before FAF.
6		PF did not call for "BEFORE LANDING CHECKLIST", but PM performed and completed it without responses from PF, when the aircraft position was 0.5 NM after FAF, and the autopilot was engaged.	PF and PM should crosscheck and confirm the "Before Landing Checklist" when the aircraft position is 0.5 NM before FAF.
7		When the aircraft position was at FAF, PF and PM did not crosscheck altitude and position agreement with the approach chart.	When the aircraft position is at FAF, PF and PM should crosscheck altitude and position agree with the approach chart.

Item	Phase	Flight Crew Behaviors	TNA ATR SOP
8	Approach	PM advised PF of the MDA and preselected it before reaching FAF, but PF selected altitudes lower than MDA after passing the FAF and before reaching the missed approach point (MAPt) during the final approach, and descent below MDA.	PF should obtain required visual reference before making decision to continue descending below MDA. PM should raise disagreement to PF’s nonstandard operations.
9		100 Feet Above MDA, PM did not call “APPROACHING MDA”, PF did not respond “CHECKED”.	100 Feet Above MDA, PM should call “APPROACHING MDA”, PF should respond “CHECKED”.
10		Due to PF selecting altitudes commanding descent below MDA, MDA ALT won’t capture and “SET MISSED APPROACH ALTITUDE” was not initiated by PF and performed by PM, then checked by PF.	When MDA ALT Captured PM: “ALTITUDE CAPTURE” PF: Check the MDA Altitude is Held “CHECKED” “SET MISSED APPROACH ALTITUDE _____” PM: Preset Missed Approach Altitude on ADU “MISSED APPROACH ALTITUDE _____ SET” PF: Check the Missed Approach Altitude on ADU “CHECKED”
11		When the aircraft position was at MAPt: PM did not call “MISSED APPROACH POINT, RUNWAY NOT IN SIGHT, GO AROUND”, the PF asked the PM whether he saw the runway or not when the aircraft was passing the MAPt, instead of initiating a missed approach.	When the aircraft position is at MAPt: PM: “RUNWAY NOT IN SIGHT, GO AROUND”, (or “MISSED APPROACH POINT, RUNWAY CLEAR”) PF: “GO AROUND”, (or “LANDING”)
12		PF did not call out before he disengaged the autopilot.	To establish crew resource management (CRM), the communications between flight crewmembers shall be based on standard callouts. Except as otherwise noted specifically, all changes to switches, push buttons and flight modes have to be called out and
13		There was no call out before the YD was disengaged.	

Item	Phase	Flight Crew Behaviors	TNA ATR SOP
			crosschecked by PF and PM according to respective SOPs.

1.18.1.5 The Importance of Standard Operating Procedures

Standard operating procedures (SOPs) provide flight crews a step-by-step guidance to ensure that operations are conducted in a predictable, uniform and safe manner. They are one of the most important factors in assuring flight safety during normal and abnormal operations.

Research on the use of procedures in complex socio-technical industries, such as the airline, maritime and nuclear power industries, found that procedural deviations were the highest ranking category in crew or operator caused accidents.[76, 77] Degani and Weiner's (1997) study on the use of procedures in airline operations concluded that:

> *The function of a well-designed procedure is to aid flight crews by dictating and specifying a progression of sub-tasks and actions to ensure that the primary task at hand will be carried out in a manner that is logical, efficient, and also error resistant.* [78]

Lautman and Gallimore (1987) found that pilot deviation from basic operational procedures was the leading 'crew-caused factor' in 93 hull-loss accidents that occurred in the period 1977-1984.[79] A study of 37 airline accidents conducted by the NTSB determined that procedural errors accounted for 24% of all flight crew errors, and was by far the most dominant factor.[80]

1.18.1.6 Violations

Violations[81] are intentional deviations from an organization's safety

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[76] Perrow, C. (1984). Normal accidents. New York, NY: Basic Books.

[77] Trager, E. A. (1988). Special study report: Significant events involving procedures (Office for Analysis and Evaluation of Operational Data AOED/S801).Washington, DC: Nuclear Regulatory Commission.

[78] Degani, A., and Wiener, E. L. (1997). Procedures in complex systems: The airline cockpit. IEEE Transactions on Systems, Man, and Cybernetics, 27(3), 302-312.

[79] Lautman, L., and Gallimore, P. L. (1987, April-June). Control of the crew caused accident: Results of a 12-operator survey. Boeing Airliner, 1-6.

[80] National Transportation Safety Board. (1994). A review of flightcrew-involved major accidents of U.S. air carriers, 1978 through 1990. (Safety study, NTSB/SS-94/01).Washington, DC: Author.

[81] The material for this section is based on Walker, M. (2010). Topic 2: Individual actions. ATSB

procedures[82] drawn up for the safe or efficient operation and maintenance of plant or equipment.[83] In broad terms, the individual's plan, and execution of that plan, has achieved what they wanted, but in doing so their behavior has deviated, with some degree of intention, from some form of procedure. Violations typically reflect a social/motivational phenomenon rather than an information processing problem.

The emphasis in the definition of violations is on the word 'intentional'. Many individual actions may involve non-compliance with a procedure of some form, but with violations the key issue was that there was some intention to deviate. Even though violations are intentional breaches, it should be noted that they can be conducted with good intentions (i.e. to assist the organization to meet its objectives).[84]

Violations are not usually the last event in an occurrence sequence. However, they tend to increase the risk of subsequent errors as they make the environment less understood and less error-tolerant.[85] Violations are a significant safety issue because they undermine a basic assumption of a safety management system – that procedures will be followed. Some violations can also be difficult to detect because employees tend to hide them because they want to minimize the likelihood of any disciplinary action. Violations are also important because of what they say about an organization. The extent of violations, and the way they are treated by employees and managers, provides a good insight into the overall safety culture in an organization.

Three types of violation are of particular interest to safety management[86, 87].

Routine violations: These violations are those which have become the normal way of operating for employees in the work environment of interest. They usually involve cutting corners at the skill-based level of

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human factors course (pp.1-18). Canberra, ACT: ATSB.

[82] The term 'procedures' also includes rules, instructions and regulations in this context.

[83] Health and Safety Executive. (1995). Improving compliance with safety procedures. London: HSE Books.

[84] Mason, S. (1997). Procedural violations—causes, costs and cures. In F. Redmill & J. Rajan (Eds.), Human factors in safety-critical Systems. Oxford: Butterworth.

[85] Hudson, P. (2000). Non-adherence to procedures: Distinguishing errors and violations. Proceedings of the 11th Airbus Human Factors Symposium, Melbourne.

[86] Reason, J. (1997). Managing the risks of organizational accidents. Aldershot, UK: Ashgate.

[87] Reason, J., & Hobbs, A. (2003). Managing maintenance error: A practical guide. Aldershot, UK: Ashgate.

performance. They have usually developed because they reduce effort or discomfort and are associated with a very low perception of accident risk. They are also usually associated with a lack of enforcement or appear to be tolerated by management.

Optimizing violations: These violations develop due to an individual's desire to improve his/her work situation by fulfilling motivational goals unrelated to the functional aspects of their job. Examples of such motives include a need for excitement (during a boring task), a desire to impress others or inquisitiveness. The tendency to optimize non-functional goals can become part of some individual's style of working. Optimizing violations are generally done at a rule-based level of performance and involve a low perception of risk.

Situational violations: These violations arise in a particular situation because a deviation from procedures appears to be needed to get the job done. In other words, employees have to deal with a mismatch between the work situation and the procedures. Situational violations are typically conducted at a rule-based level of performance, but in exceptional cases can occur at the knowledge-based level. They can be associated with a higher level of perceived risk than routine violations. If the situation keeps repeating, then the employee behavior may develop into a routine violation.

1.18.2 Non-Technical Skills Training

While technical skills are important, over recent decades another set of pilot skills has been identified as contributing to airline accidents. These skills are termed human factors or non-technical skills, and include crew resource management (CRM) and threat and error management (TEM).

1.18.2.1 Crew Resource Management

In a multi-crew cockpit environment, human factors is also concerned with ensuring the crew work in a coordinated way with each other, the aircraft systems, and the broader aviation system. Traditionally, this has been known as crew resource management. Crew resource management (CRM) has generally been defined as a crew's 'effective use of all available resources - people, equipment, and information – to achieve safe, efficient operations'[88]. Effective CRM means that all crew members function as a team, rather than as a collection of technically competent individuals.

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[88] Lauber, J. K. (1984). Resource management in the cockpit. Air Line Pilot, 53, 20-23.

The TNA had adopted the following definition for CRM: CRM consists of all the knowledge, skills and roles used to most effectively direct, control and coordinate all available resources towards safe and efficient operations.

The airline had documented the following CRM policy:

1. CRM ability and a facility for teamwork will be one of the criteria for flight crewmember selection.
2. CRM principles and practices will be fully integrated into all aspects of flight operations training.
3. All crewmembers will share the responsibility for establishing an environment of trust and mutual commitment prior to each flight, encouraging his fellow crewmember(s) to speak out and to accept mutual responsibility for the safety and well-being of the passengers and equipment entrusted to them. “What’s right, not who’s right” will be the motto of TNA crews.
4. Each flight crewmember will be responsible for notifying the pilot in command if any condition or circumstance exists that could endanger the aircraft or impair the performance of any crewmember.

According to the TNA’s Flight Training Management Manual, CRM ground and simulator training were included as part of every transition and initial training. Recurrent CRM ground training was conducted at least every three years and CRM training in the simulator was conducted annually.[89] The airline’s CRM instructors had received specific Human Performance and Human Factors training.

The airline’s flight crew, cabin crew and dispatchers also completed joint CRM course.

1.18.2.2 Threat and Error Management

Threat and error management (TEM)**[90]** is a method that can be used by flight crew to identify and mitigate risks and errors that may have an impact on safe flight. The concept of TEM was derived from the line operations safety audit (LOSA) program by researchers involved in the

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[89] Known as line oriented flight training (LOFT).

[90] Material based on Australian Transport Safety Bureau. (2009). Threat and error management: Attitudes towards training and the applicability of TEM to general aviation and low capacity air transport operations (Aviation Research and Analysis AR-2006-156(1)). Canberra, ACT: Author.

University of Texas Human Factors Research Project.[91] The LOSA program involves trained observers recording the non-technical aspects of crew performance from the flight deck observation seat. At the core of the LOSA process are the crew's identification and management of threats and errors.

There are three basic components in the TEM model: threats, errors and undesired aircraft states.

Threats are 'events or errors that occur beyond the influence of the flight crew, increase operational complexity, and which must be managed to maintain the margins of safety'.[92] When undetected, unmanaged or mismanaged, threats may lead to errors or even an undesired aircraft state.

Errors are 'actions or inactions by the pilot that lead to deviations from organizational or pilot intentions or expectations'.[93] When undetected, unmanaged or mismanaged, errors may lead to undesired aircraft states.

Undesired aircraft states are defined as 'an aircraft deviation or incorrect configuration associated with a clear reduction in safety margins'[94]. Undesired aircraft states are considered the last stage before an incident or accident. Therefore, the management of undesired aircraft states represents the last opportunity for flight crews to avoid an unsafe outcome.

While the TEM model is not a linear model of adverse event causation, the basic principles are consistent with the idea that threats that are not adequately managed can lead to errors, and errors that are not adequately managed often lead to undesired aircraft states. These in turn can lead to undesired consequences.

Effective monitoring and assessment of environmental cues, being aware of what is going on, and detecting any changes are essential if pilots are to recognize potential threats and mitigate the associated safety risks before they escalate. Moreover, to ensure the highest levels of safety each flight crewmember must carefully monitor the aircraft's flight path and systems,

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[91] Helmreich, R.L., Klinect, J.R., & Wilhelm, J.A. (1999). Models of threat, error, and CRM in flight operations. In Proceedings of the Tenth International Symposium on Aviation Psychology (pp. 677-682). Columbus, OH: The Ohio State University.

[92] Maurino, D. (April, 2005). Threat and Error Management (TEM). Paper presented at the meeting of the Canadian Aviation Safety Seminar (CASS), Vancouver, BC.

[93] Maurino, D. (April, 2005). Threat and Error Management (TEM). Paper presented at the meeting of the Canadian Aviation Safety Seminar (CASS), Vancouver, BC.

[94] Maurino, D. (April, 2005). Threat and Error Management (TEM). Paper presented at the meeting of the Canadian Aviation Safety Seminar (CASS), Vancouver, BC.

as well as actively crosscheck the actions of each other. Effective crew monitoring and cross-checking can literally be the last line of defense.[95]

The crucial task of monitoring was highlighted in the results of a LOSA cited at the First Pan American Aviation Safety Summit in 2010[96], where it was identified that 19 % of errors and 69% of undesired aircraft states could have been eliminated through more effective crew monitoring and crosschecking.

In 2006, the ICAO adopted TEM in pilot licensing standards and recommended practices. [97] Further information on ICAOs TEM requirements for flight crew training and the flight crew licensing requirements are detailed in Annex 1, *Personnel Licensing*.

The TNA had developed and implemented a TEM training program for its crews but had not implemented the optional LOSA program.

1.18.2.3 Trans-cockpit Authority Gradient

A trans-cockpit authority gradient refers to the differences in the expected operational contributions by each crew member. The gradient may be influenced by the crew member’s experience, authority, national culture, company culture, and willingness to act as an individual or as part of a team. An inappropriate balance of these factors can interfere with the effective exchange of information in the cockpit, which will adversely affect the safe operation of the aircraft. A steep gradient between a highly experienced and older captain and younger much less experienced first officer may result in the first officer being less willing to communicate important information to the captain or acceding to his non-compliant behavior.

An optimum trans-cockpit authority gradient recognizes the command authority of the captain, while encouraging the first officer to contribute to the crew’s decision making processes. This optimum gradient facilitates communication, enables participative leadership, establishes a team culture and enhances crew situational awareness. These concepts are part of the CRM training syllabus outlined in the ICAO Human Factors

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[95] Sumwalt, R.L., Thomas, R.J., & Dismukes, K. (2002). Enhancing flight-crew monitoring skills can increase flight safety. Paper presented at the 55th International Air Safety Seminar, Dublin, Ireland.

[96] Curzio, J. C. G. & Arroyo, C. (2010). Pilot monitoring training. Presentation at the First Pan American Aviation Safety Summit 2010, Sao Paulo, Brazil.

[97] International Civil Aviation Organization (2006). Annex 1 to the Convention on International Civil Aviation – Personnel Licensing (10th ed.). Montréal, Quebec: Author.

Training Manual.[98]

1.18.3 Aerodrome Operating Minima

In order to meet ICAO Universal Safety Oversight Audit Program (USOAP) standards, the CAA decided to convert Taiwan’s Instrument Flight Procedures, based on the US Federal Aviation Administration (FAA) standards for terminal instrument procedures (TERPS) to ICAO procedures for air navigation services – aircraft operations (PANS-OPS) standards in 2009. Three meetings were conducted to discuss the conversion on 12 November 2009 (2 meetings) and 25 January 2010. The CAA had also issued aeronautical information circular (AIC) 02/10 to describe this conversion on 13 August 2010.

According to ICAO DOC 8168 PANS-OPS, Volume I, Flight Procedures, Section 4, the relationship between obstacle clearance altitude/height (OCA/H) to operating minima (landing) is shown in Figure 1.18-1.

At interview, the CAA flight operations section manager indicated that the Air Traffic Services division was responsible for the transition of approach chart designs from TERPS to PANSOPS specifications. To explain why the approach charts in the AIP only showed the OCA (H) instead of DA (H) / MDA (H) on the Jeppesen charts, the section manager stated that, with regard to “aerodrome operating minima (AOM)”, section 4.2.8 in Annex 6 stated “The State of the operator shall require that the operator establish aerodrome operating minima for each aerodrome to be used in operations and shall approve the method of determination of such minima. Such minima shall not be lower than any that may be established for such aerodromes by the State in which the aerodrome is located, except when specifically approved by that State.” The section manager stated that the standard is prescribed in the article 28 of Aircraft Flight Operation Regulations and it does not require the State in which the aerodrome is located to establish aerodrome operating minima.

Operators shall implement the aforementioned regulation by adding required contents in company manuals such as Operations Specifications, Operations Manuals, Route Manuals, and Jeppesen charts and AIP procedures. Operators shall also instruct flight crew members to comply with the minima prescribed in the manuals. Such minima shall be treated as the minimum standard for takeoff, approach and landing.

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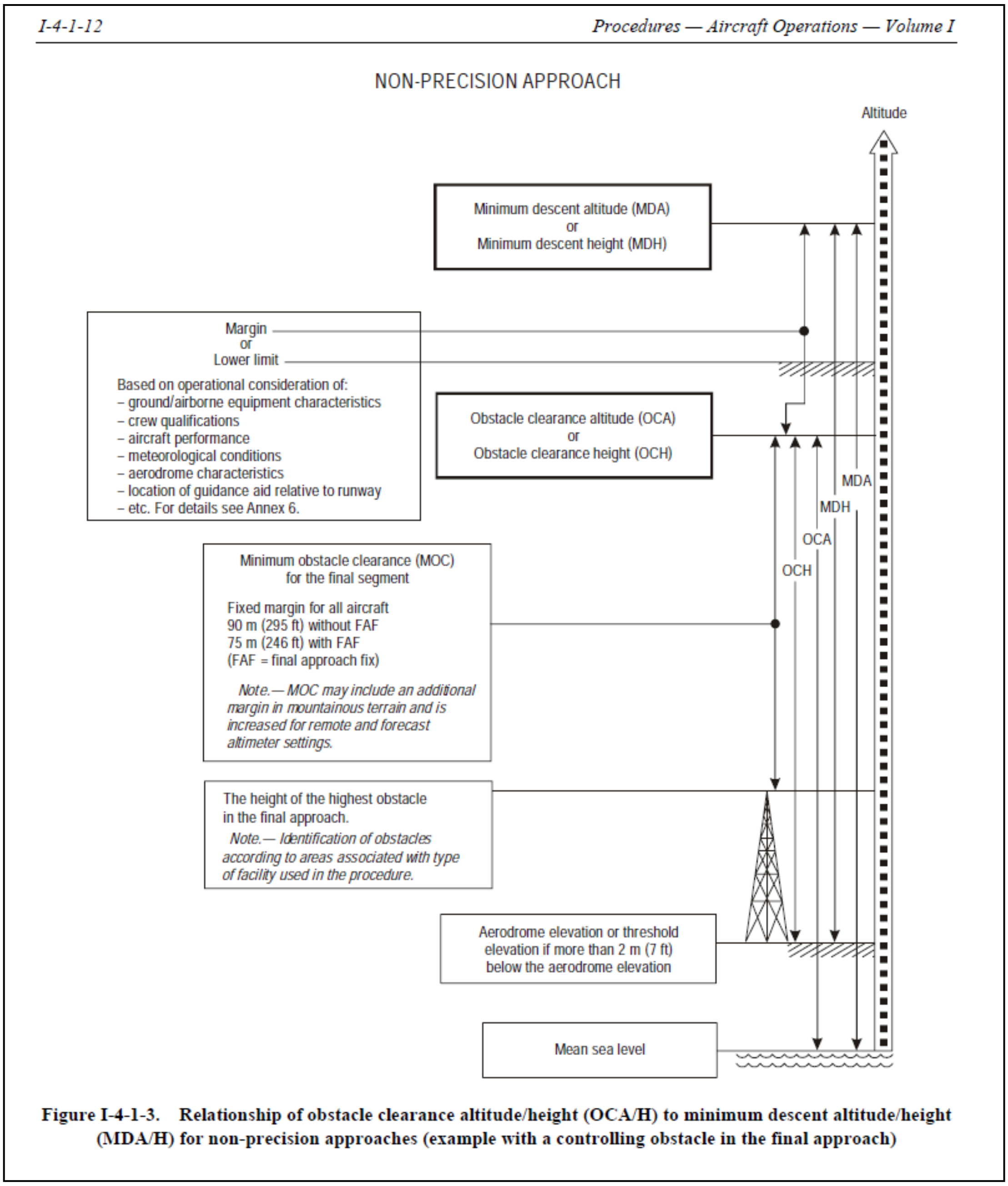
[98] International Civil Aviation Organization. (1998). Human Factors Training Manual (Doc683-AN/950). Montreal, Canada: ICAO.



I-4-1-12 Procedures — Aircraft Operations — Volume I

NON-PRECISION APPROACH

Minimum descent altitude (MDA)
or
Minimum descent height (MDH)

Margin
or
Lower limit

Based on operational consideration of:
- ground/airborne equipment characteristics
- crew qualifications
- aircraft performance
- meteorological conditions
- aerodrome characteristics
- location of guidance aid relative to runway
- etc. For details see Annex 6.

Obstacle clearance altitude (OCA)
or
Obstacle clearance height (OCH)

Minimum obstacle clearance (MOC)
for the final segment

Fixed margin for all aircraft
90 m (295 ft) without FAF
75 m (246 ft) with FAF
(FAF = final approach fix)

Note.— MOC may include an additional margin in mountainous terrain and is increased for remote and forecast altimeter settings.

The height of the highest obstacle in the final approach.

Note.— Identification of obstacles according to areas associated with type of facility used in the procedure.

Aerodrome elevation or threshold elevation if more than 2 m (7 ft) below the aerodrome elevation

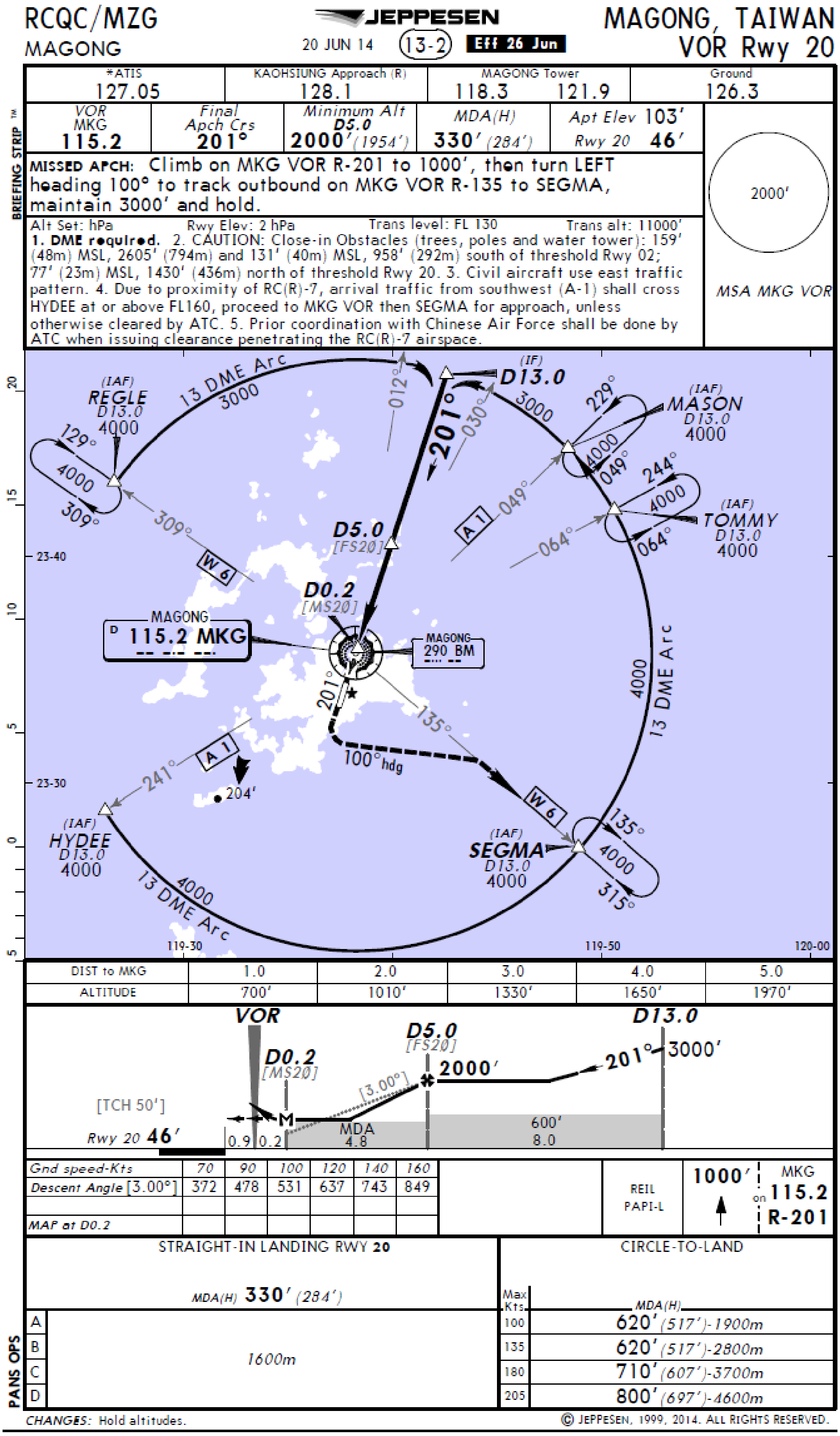
Mean sea level

Figure I-4-1-3. Relationship of obstacle clearance altitude/height (OCA/H) to minimum descent altitude/height (MDA/H) for non-precision approaches (example with a controlling obstacle in the final approach)

Figure 1.18-1 ICAO PANS-OPS Non-Precision Approach OCA/MDA

1.18.4 RCQC VOR RWY20 Aeronautical Chart

TNA provided Jeppesen charts to their flight crew. Figure 1.18-2 is the Jeppesen RCQC VOR RWY20 chart dated 20 JUN 2014.



RCQC/MZG
MAGONG

JEPPESEN
20 JUN 14 (13-2) Eff 26 Jun

MAGONG, TAIWAN
VOR Rwy 20

*ATIS	KAOHSIUNG Approach (R)	MAGONG Tower	Ground
127.05	128.1	118.3 121.9	126.3

VOR MKG	Final Apch Crs	Minimum Alt D5.0	MDA(H)	Apt Elev
115.2	201°	2000′ (1954′)	330′ (284′)	103′ Rwy 20 46′

MISSED APCH: Climb on MKG VOR R-201 to 1000′, then turn LEFT heading 100° to track outbound on MKG VOR R-135 to SEGMA, maintain 3000′ and hold.

Alt Set: hPa Rwy Elev: 2 hPa Trans level: FL 130 Trans alt: 11000′

1. DME required. 2. CAUTION: Close-in Obstacles (trees, poles and water tower): 159′ (48m) MSL, 2605′ (794m) and 131′ (40m) MSL, 958′ (292m) south of threshold Rwy 02; 77′ (23m) MSL, 1430′ (436m) north of threshold Rwy 20. 3. Civil aircraft use east traffic pattern. 4. Due to proximity of RC(R)-7, arrival traffic from southwest (A-1) shall cross HYDEE at or above FL160, proceed to MKG VOR then SEGMA for approach, unless otherwise cleared by ATC. 5. Prior coordination with Chinese Air Force shall be done by ATC when issuing clearance penetrating the RC(R)-7 airspace.

DIST to MKG	1.0	2.0	3.0	4.0	5.0
ALTITUDE	700′	1010′	1330′	1650′	1970′

Gnd speed-Kts	70	90	100	120	140	160
Descent Angle [3.00°]	372	478	531	637	743	849
MAP at D0.2						

REIL
PAPI-L

1000′ on MKG 115.2 R-201

STRAIGHT-IN LANDING RWY 20

MDA(H) 330′ (284′)

A	1600m
B	
C	
D	

CIRCLE-TO-LAND

Max Kts	MDA(H)
100	620′ (517′)-1900m
135	620′ (517′)-2800m
180	710′ (607′)-3700m
205	800′ (697′)-4600m

PANS OPS

CHANGES: Hold altitudes.

Figure 1.18-2 Jeppesen RCQC VOR RWY20 chart

1.18.5 Runway Selection in Magong Airport

According to the air traffic management procedures (ATMP), Chapter 3, 3-5-1 Selection:

a. Selection of runway-in-use:

1. Normally, an aircraft will land and take off into wind unless safety, the runway configuration, meteorological conditions and available instrument approach procedures or air traffic conditions determine that a different direction is preferable. In selecting the runway-in-use, however, the unit providing aerodrome control service shall take into consideration, besides surface wind speed and direction, other relevant factors such as the aerodrome traffic circuits, the length of runways, and the approach and landing aids available.

2. The term "runway-in-use" shall be used to indicate the runway or runways that, at a particular time, are considered by the aerodrome control tower to be the most suitable for use by the types of aircraft expected to land or take off at the aerodrome.

3. If the runway-in-use is not considered suitable for the operation involved, the flight crew may request permission to use another runway and, if circumstances permit, should be cleared accordingly.

b. Except otherwise specified, use the runway most nearly aligned with the wind when 5 knots or more or the "calm wind" runway when less than 5 knots unless use of another runway:

NOTE:

If a pilot prefers to use a runway different from that specified, the pilot is expected to advise ATC.

1. Will be operationally advantageous.

2. Is requested by the pilot.

c. When conducting aircraft operations on other than the advertised runway-in-use, state the runway in use.

Magong Tower Operations Manual, Chapter 3, 3.3 Procedures for runway usage[99]:

3.3.1 For the selection of runway-in-use, according to the provisions of ATMP 3-5-1, use the runway most nearly aligned with the wind when 5 knots or more.

3.3.2 When the Air Force stationed, runway shall be changed for aircraft to land and take off into wind if the tailwind exceeds (not included) to 5 knots. It shall coordinate with the Air Force duty officer before changing runway.

3.3.3 Pilots may request takeoff from or landing on the other direction of runway when the runway is not suitable. Because of fighters on alert, it is prohibited except for special reasons when the Air Force stationed.

3.3.4 Before changing runway, apart from the sudden change in weather, tower shall consider the current traffic and set aside 10 minutes to the flight control and related vehicles to inspect the arresting equipments and the runway conditions. As soon as the flight control and related vehicles finish the inspection and report normal, tower may declare the runway has been changed.

1.18.6 Weather Information and Coding

According to the ATMP, Chapter 2, Section 8 Runway Visibility Reporting – Terminal:

2-8-1 Furnish RVR Values

Where RVR equipment is operational, irrespective of subsequent operation or non-operation of navigational or visual aids for the application of RVR as a takeoff or landing minima, furnish the values for the runway in use in accordance with para 2-8-3, Terminology.

2-8-2 Arrival/Departure Runway Visibility

a. Issue current touchdown RVR for the runway(s) in use:

> *NOTE: RVR is reported just after the visibility group of METAR when RVR near or above threshold being equal or less than 1,500m and the weather minimum will be based on the RVR.*

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[99] Translated from Chinese.

1. *When visibility is 1500 meters or less regardless of the value indicated.*

2. *When RVR indicates a reportable value regardless of the visibility.*

   NOTE: Reportable values are: RVR 2000 meters or less.

b. *Issue both mid-point and rollout RVR when the value of either is less than 600 meters and the touchdown RVR is greater than the mid-point or roll-out RVR.*

c. *Aerodrome control shall issue the current RVR to each aircraft prior to landing or departure in accordance with subpara a. and b.*

ATMP, Chapter 3, 3-10-2 Updating Information on Final Approach:

a. *As soon as possible after transfer from approach control to tower, advise aircraft of the following:*

1. *Runway.*

2. *QNH.*

3. *Significant changes in the wind direction and speed:*

   NOTE: If the controller possesses wind information in the form of components, the significant changes are:

   ① *Mean head-wind component: 10 kts*

   ② *Mean tail-wind component: 2 kts*

   ③ *Mean cross –wind component: 5 kts*

4. *The latest information, if any, on wind shear and/or turbulence in the final approach area.*

5. *Issue the visibility if less than 10km or, when applicable, issue RVR values for the runway to be used.*

b. *During final approach, advise aircraft of the following, without delay:*

1. *The sudden occurrence of hazards (e.g. unauthorized traffic on the runway).*

2. *Significant variations in the current surface wind, expressed in terms of minimum and maximum values.*

3. Significant changes in runway surface conditions.

4. Changes in the operational status of required visual or non-visual aids.

5. Changes in observed RVR value(s) or visibility.

According to the Air Force Meteorological Observation Manual, Chapter 4, Section 5, the timing and provisions for runway visual range observation and reporting were described as follows:

1. Observe and report RVR when the reported prevailing visibility is less than 1,500 m or the RVR value of runway used for landing is less than 1,500 m. The reported RVR value represents the runway visual range of the touchdown zone of runway used for landing
2. RVR reporting scales:
    i. In steps of 25 m when the RVR is less than 400 m.
    ii. In steps of 50 m when it is between 400 m and 800 m.
    iii. In steps of 100 m when the RVR is more than 800 m.
3. Any observed value which does not fit the reporting scale in use shall be rounded down to the nearest lower step in the scale. For example, to report 750 m if observed RVR is 780 m.
4. 50 m should be considered the lower limit and 2,000 m the upper limit for RVR. Outside of these limits, METAR and SPECI should merely indicate that the runway visual range is less than 50 m (M0050) or more than 2,000 m (P2000).
5. If the 1-minute RVR values during the 10-minute period vary from the mean value by more than 50 m or more than 20 percent of the mean value, whichever is greater, the 1-minute mean minimum and the 1-minute mean maximum values should be reported instead of the 10-minute mean value.
6. RVR shall not be reported if RVR instrument of runway used for landing is malfunctioned, or RVR instrument is not installed.

1.18.7 Controlled Flight Into Terrain Accidents

Controlled flight into terrain (CFIT) refers to an unintended inflight collision with terrain, water, or obstacles without any indication of the loss of control of an aircraft. The factors leading to CFIT events are varied. They can include loss of flight crew situational awareness, loss of terrain awareness, non-adherence to standard operating procedures, conduct of improvised approach procedures in instrument meteorological conditions

(IMC) and operations in areas of low cloud base and/or poor visibility.[100]

The Netherlands National Aerospace Laboratory (NLR) examined factors associated with 156 CFIT events involving commercial aircraft operators between 1988 and 1994.[101] The report found that the descent and approach phases of landing accounted for about 70 percent of the accident sample. The report also concluded that on a world-wide basis, there appeared to be a five-fold increase in accident risk for commercial aircraft flying non-precision approaches compared with those flying precision approaches.

In 1993, the Flight Safety Foundation (FSF) organized an international CFIT Task Force that was dedicated to reducing CFIT events. The international CFIT Task Force comprised representatives from aircraft manufacturers, aviation training organizations, aircraft equipment manufacturers, airlines, pilot groups and government and regulatory agencies. The FSF CFIT Task Force concluded that:

- establishing and adhering to adequate standard operating procedures and flight crew decision-making processes improve approach-and-landing safety;
- failure to recognize the need for a missed approach and to execute a missed approach is a major cause of approach-and-landing accidents;
- unsterilized approaches cause approach-and-landing accidents;
- the risk of approach-and-landing accidents increases in operations conducted in low light and poor visibility;
- effective use of radio altimeters will help to prevent approach-and-landing accidents; and
- global sharing of aviation information decreases the risk of approach-and-landing accidents.[102]

The Task Force subsequently developed a data-driven CFIT education and training aid known as the FSF approach and landing accident reduction (ALAR) tool kit. ICAO has recommended that those in positions of

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[100] Australian Transport Safety Bureau. (2007). CFIT: Australia in context 1996-2005 (Aviation Research and Analysis Report B2006/0352). Canberra, ACT: Author.

[101] Khatwa, R., & Roelen, A. L. C. 9(1997). Controlled flight into terrain (CFIT) accidents of air taxi, regional and major operators. (National Aerospace Laboratory NLR TP 977270). Netherlands, NLR.

[102] Flight Safety Foundation. (1996). An analysis of controlled-flight-into-terrain (CFIT) accidents of commercial operators 1988 through 1994. Flight Safety Digest, 15 (4/5), 1-45.

responsibility in civil aviation should apply the recommendations of the CFIT Task Force and make the best use of the education and training material.

The FSF updated its approach and landing accident (ALA) analysis in 2010 to ascertain if the rate of ALAs had reduced and whether the contributing factors for ALAs had changed over time. The original study contained 287 fatal ALA events from 1980 to 1996 whereas the updated study contained 1007 fatal and non-fatal ALAs from 1995 to 2007. A breakdown of the most recent data set indicated that much of the developing world had fatal ALA rates above the world average. The underlying contributing factors for ALAs were largely unchanged since the original study, although there was some shift in the relative rankings of contributing factors. The most frequently cited causal factors in the latest data set was “omission of action/inappropriate action”, followed by “poor professional judgment/airmanship”, and “failure in crew resource management”. Common circumstantial[103] factors included weather, poor visibility, and runway conditions. While CFIT events had reduced they were still in the top ten most frequent ALA accidents.[104]

Standard Operating Procedures

Standard operating procedures (SOPs) are specified in an operations manual to ensure that flight operations are conducted in a consistent and safe manner and are resistant to crew error. Effective crew coordination and crew performance depend upon the crew having a shared mental model of each task. That mental model, in turn, is founded on SOPs. The ALAR briefing note Operating Philosophy described the importance of SOPs as a risk control for minimizing CFIT accidents. The briefing note stated that:

> *Adherence to standard operating procedures (SOPs) is an effective method of preventing approach and landing accidents (ALAs), including those involving controlled flight into terrain (CFIT). Crew resource management (CRM) is not effective without adherence to SOPs.*
>
> *The Flight Safety Foundation Approach-and landing Accident Reduction (ALAR) Task Force found that ‘omission of*

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[103] FSF defined a circumstantial factor as “an event or item that was not directly in the causal chain of events but could have contributed to the accident.”

[104] Flight Safety Foundation. (2010). Killers in aviation: An update. Flight Safety Foundation ALAR Tool Kit Update (pp. 1-24). Alexandria, VA: Author.

> *action/inappropriate action' (i.e., inadvertent deviation from SOPs) was a causal factor in 72 percent of 76 approach-and-landing accidents and serious incidents worldwide in 1984 through 1997.*
>
> *The task force also found that 'deliberate non-adherence to procedures' was a causal factor in 40 percent of the accidents and serious incidents.*

The ALAR briefing note included a standard operating procedures template that was adapted from the FAA Advisory Circular 120-71, standard operating procedures for Flight Deck Crewmembers. The template topics included approach philosophy (including stabilized approaches being standard, limits for stabilized approaches and go-arounds), information needed for each type of approach (including flap/gear extension, standard calls and procedures) and the initiation of go-arounds.

Non-precision Approach Issues

The Flight Safety Foundation ALAR briefing note, Constant-angle Non-precision Approach, identified from training feedback and line-operations experience the factors that reduced the performance of crew conducting non-precision approaches. Some of those factors identified were:

- Late descent preparation;
- Incomplete briefing;
- Inadequate cross-check and backup by the handling pilot/non-handling pilot;
- Late configuration of the aircraft;
- Final approach speed not stabilized at the final approach fix;
- Incorrect identification of the final approach fix; and
- Premature descent to the next step-down altitude (if multiple step-downs) or below the minimum descent altitude.

The briefing note also identified the elements of a successful non-precision approach. Some of the relevant elements were:

- Completing an approach briefing;
- Planning aircraft configuration setup;
- Monitoring descent;
- Managing aircraft energy condition during intermediate approach and final approach;

- Not descending below an altitude before reaching the associated fix;
- Determining the correct angle (vertical speed) during the final descent; and
- Beginning the descent at the correct point.

CFIT Risk Assessment

Risk management is a component of a SMS and encompasses the identification, analysis and assessment of risks and the design and implementation of risk treatments or controls in a structured process. Once controlled, mitigated or treated, risks must continue to be monitored to ensure that the risk treatment process is effective. Risks rarely remain static, and changes in an operational context can result in different risks emerging or a change to the levels of risks. When an operational context is changed, for whatever reason, the risk events that can affect achievement of the changed objectives must be identified, analyzed, evaluated and treated.

An airline CFIT event is almost certain to result in major to catastrophic consequences and the risk of the event will almost certainly be high to extreme. The risk should therefore be assessed, and if identified, it must be managed. The Flight Safety Foundation designed and published CFIT Checklist: Evaluate the Risk and Take Action to evaluate CFIT risk, as part of its international program to reduce CFIT events that present risk to aircraft, flight crews, and passengers. The checklist is currently published in Arabic, Chinese, English, French, Russian and Spanish.

The Flight Safety Foundation intended that the checklist be used to ‘assess CFIT risks for specific flights, identify factors that identify those risks, and enhance pilot awareness of CFIT risk’. The checklist was designed to allow a pilot/operator to assign numerical values to a variety of factors that allow a CFIT risk score to be determined. A significant CFIT risk score can be analyzed to determine strategies for reducing that risk.

The Flight Safety Foundation recommended specific interventions to manage CFIT risk including:

- The use of standard operating procedures, standard call-outs and checklists;
- The content and conduct of descent approach briefings;
- Crew resource management;
- Strategies and procedures for handling interruptions/distractions;
- Procedures for barometric and radio altimeters;

- Descent and approach profile management;
- Terrain awareness;
- The use of stabilized approaches; and
- The use of constant angle non-precision approaches.

There was no evidence that the TNA had conducted any specific CFIT risk assessments, documented the findings, implemented appropriate CFIT risk controls, and confirmed the ongoing effectiveness of those risk CFIT controls.

1.18.8 Interview Summaries

1.18.8.1 UNI Airways B7 647 Flight Crew

The interviewee stated that he had flown B7 647 to Magong before the occurrence. The onboard weather radar indicated that the weather conditions were very bad. He was told to hold in the air about 40 minutes. The aircraft was in cloud most of the time. He requested the runway 02 ILS approach during holding. ATIS reported the weather conditions were above landing minima but he was not approved to continue the approach by the controller. On approach to Magong runway 20, the crew became visual with the runway when they were descending through 1,000 ft. Even though flight conditions were turbulent during the approach, no downdrafts were encountered. The visibility suddenly deteriorated after landing and by the time they reached their parking bay no.2 after vacating the runway, a severe thunderstorm began producing heavy rain showers which prevented the passengers from disembarking. They had to wait for a while before they could disembark. By the time the disembarkation was almost complete, the flight crew saw fire engines standing by near the runway, but they were not aware of the aircraft accident.

Though other pilots once submitted unsatisfactory reports on the weather forecasts for Magong Airport, the interviewee felt that they were accurate enough. He also stated that the VOR signal was good. It might temporarily fail but the indications were accurate.

1.18.8.2 TNA Flight Crew Interview

The investigation team interviewed 15 TNA ATR flight crew after the GE222 occurrence. The interviewees included the assistant vice president of the FOD, the ATR fleet chief pilot, one check pilot, one instructor pilot, 5 captains and 6 first officers. The interviews revealed the following:

Crew Flying Activity

Most interviewees stated that minimum flight crew manpower was employed at TNA and that created high flying activities which were overlooked by senior management. Crewing numbers were reduced in 2014. The number of daily flight sectors had increased considerably and were much higher compared to other domestic operators. Interviewees considered that 4 sectors a day were reasonable, 6 sectors were manageable, but 8 sectors/day were almost unacceptable. With tight daily schedules, there were risks that crews might experience fatigue and distraction.

SOP Compliance

Most interviewees stated that deviations from SOPs mostly occurred when crew made several return trips between the same ports or felt fatigued. The SOP deviations included absence of cross checks, lack of call outs, briefings without using the briefing card, and overlooking some of the procedures, etc.

Some interviewees stated that different captains might react differently when an omission of a standard call out occurred during the daily operation. Some captains might make up the call outs by themselves, while others might overlook it.

Regarding the decision to continue or discontinue an approach, different captains might make different decisions. For example: at a 330 feet MDA, some crew might initiate go around if the runway was not in sight at 400 feet, while some crew might make the decision when the aircraft is at 330 feet. Moreover, a few flight crew might continue to descend below the MDA even if the required visual references had not been obtained. They might continue if they see parts of the runway or approach lighting, or if they can only see the ground.

Understanding of Previous Occurrences

Some interviewees were not aware of the previous GE515 and GE5111 occurrences occurred in 2012 and 2013 respectively.

Comments on Occurrence Flight Crews

Most interviewees stated that the occurrence captain was a very considerate person with good flying technique. Some interviewees indicated that under certain adverse weather conditions, some crew might initiate a missed approach, while the occurrence captain might still land the aircraft because of his proficient skills.

The FOD assistant vice president stated that he was aware of the occurrence captain’s flying behaviors before the occurrence. He stated that he had communicated with senior pilots, including the occurrence captain, about risky landings, and received positive responses.

Most interviewees stated that the occurrence first officer would accommodate the captains' flying habits, and tended not to challenge captains' landing decisions. Many newly employed first officers have a similar attitude. While this situation has improved gradually, it still exists.

1.18.8.3 CAA Principle Operations Inspector

The principle operations inspector (POI) joined the CAA in 1999. He had been responsible for the oversight of TNA's operations since 2008.

The POI generated an annual inspection plan in accordance with the Inspector's Handbook issued by the CAA. However, in practice inspection frequency, timelines and some items may vary in accordance with demands. For example, the working hours spent on Cockpit En-Route inspections are usually higher than the allocated allotment. .

Regarding Cockpit En-Route inspections of TNA's operations, the POI attributed the few findings to the short duration of domestic flights. It constrained the inspectors from going through the process thoroughly. The other reason was that when the inspector was sitting in the cockpit, most pilots will demonstrate their best behavior. However, normal operational practices may not necessarily be the same.

From his viewpoint, with the exception of some newly recruited pilots who had some difficulty in complying with SOPs because they were not yet proficient to cope with the time pressure of domestic short haul flights, most pilots were able to follow company SOPs. He thought that the occurrence flight crew's non-compliances with SOPs was an individual case.

The "air carrier management effectiveness inspections" and the "supervisory inspection of flight safety activities" were the two requisite job functions that he performed every month. Since the CAA does not officially require the POI to hold a formal joint meeting with the operator, he usually took these opportunities to oversee and communicate with TNA.

When technical deficiencies were addressed in the (in-depth) inspection report, he would conduct En-Route inspections or simulator observations as a follow-up to see whether further actions were needed.

He reviewed the company's risk management statistical data provided by the flight operations division. Further discussions were made if certain figures indicated an adverse trend. However, he did not look into the details of how those indexes had been generated and evaluated.

He noted the very few deficiencies in the SOA records, but did not interfere because it was the operator's responsibility to ensure the effectiveness of their own safety management. He said that with the limited time and manpower, inspectors were unable to supervise all aspects of the operation.

He reviewed the FOQA statistical reports every month and would look into the details for those safety related events. He considered that the limited manpower in the TNA FOQA team decreased the performance, effectiveness, and potential safety benefits of the program.

The average monthly flight time for TNA's flight crews were 80 to 90 hours; some of them even exceeded 100 hours. It was relatively high compared to other operators. The POI was aware of the situation, which was associated with a crew shortage and had raised the issue with TNA management. However, the relatively low pilot pay was unfavorable for recruiting so the situation remained unsolved.

With reference to the Safety Management Manual, TNA did not pass the initial acceptance audit and required improvements to be implemented by the end of 2014 for the second audit.

1.18.8.4 CAA Flight Operation Section Manager

The interviewee stated that the scope and depth of the Main Base inspection and the in-depth audit were different than the routine inspection. The inspections were conducted by a task force team with more manpower. Those inspections or audits were followed up by the inspectors assigned to the operator through a computerized FSMIS and an official notice was sent to the operator. The FSMIS data was able to identify the safety trends and warnings which could assist inspectors to better understand and capture unsafe indications and changes.

The CAA required inspectors to conduct a joint meeting with the operator. The manager was not sure about whether there were meeting records or who was responsible for the meeting record. The main purpose was to have an open communication channel between the CAA and the operator. The meeting formalities also depended on the size of the operator.

The interviewee stated that the CAA formed a special SMS task force. That task force examined operators' SMS programs and conducted an initial assessment. Those assessment results were sent to the inspectors assigned to the operator. The interviewee considered those results comprised suggested improvements. The operator SMS implementation is a learning process for both the CAA and the operators, however, the operator needs to understand the program and have the will to improve. This also applied to the SMS safety performance index which the operator was responsible for, not the CAA. The CAA regulations currently required that an operator implement an SMS plan under the State Safety Program. There was no regulatory requirement for an operator to have implemented an SMS at the time of the occurrence. SMS is a continuous improvement process and cannot be achieved overnight.

The interviewee responded to questions about the Cockpit En-Route inspections where almost no findings were recorded. He stated that no findings during the inspections might be due to the accuracy of the inspection process or the technical capability of the inspector. However, there might also be inspector bias, or different inspector might have a different focus during the inspections, and/or the environment might be different for each inspection. Therefore, the interviewee considered it was acceptable that some inspections have fewer findings than others. He stated that the number of the findings was not important. The important thing was that the inspectors report their observations to the CAA. In addition, the CAA only required inspectors to record non-compliances or violations in accordance with the regulations, rather than findings base on an inspector’s personal opinion.

The interviewee stated that not all inspectors were assigned to the Flight Operations Section. The annual inspector performance evaluation was conducted by their designated section chief. However, he was still able to review all inspectors’ performance through the inspection records or when he accompanied the inspectors during inspections.

1.18.8.5 Magong Weather Center

The Weather Forecast Officer in the Meteorological Office

At around 1824 hours, the tower called to ask about visibility because a flight was already holding for 25 minutes and the crew wanted to attempt an approach if visibility permitted; the interviewee answered that the visibility was still 800 meters, but may improve in ten minutes, and would deteriorate once again in 10 to 20 minutes because of another approaching radar echo; therefore, the visibility report would remain 800 meters. The interviewee went outside to perform an actual observation of the weather which indicated that the visibility was not looking good. The interviewee called the weather watch office to inquire about the current visibility. The weather observer then went outside to observe the weather. The interviewee remembered that the weather observer replied that visibility was 1,600 or 2,400 meters. The weather forecast officer told the weather observer to report a special weather report for the improved visibility.

During that period of time, the radar return was green in color with an intensity of 20-25dBz. When the second weather squall arrived, the visibility decreased again.

The Surface Weather Observer in the Weather Watch Office

The interviewee was on the duty shift from 1800 hours to 0800 hours the next day. It was raining excessively heavy when he took over the duty; the rain became light at around 1837 hours, the visibility was about 2,000 meters. At that moment, the reported visibility was 1,600 meters. In order to produce the 1900 hours METAR, an observation was made by going outside the office at 1855 hours but the visibility remained at 1,600 meters. All the weather information that had been collated had to be relayed to the control tower, weather office, and other relevant units. The whole relay operation was completed at 1902 hours. Suddenly, a temporary heavy rain shower arrived, and the interviewee had to go outside to confirm the visibility; at 1904 or 1905 hours, the weather forecast officer called and the observer advised that the visibility had dropped down to 800 meters. The observer was still observing the conditions at the time. It would require three minutes to relay a special weather update. As a result, the updated report was issued at 1910 hours. In order to make reports of prevailing visibility, the AWOS would also have been referenced.

The Weather Watch Office Supervisor

The interviewee began his duty shift at 0800 hours on the day of occurrence. He left the weather watch office at 1730 hours after the termination of the typhoon warning.

Compared with the old system, the new AWOS provided pressure, lightning, and RVR data. Due to the limitations of the RVR equipment, sometimes the displayed data would be different to the manual observations. For example, when rain drops fall on the sensors lenses during heavy rain, or the lenses are not clean, there will be some differences between the automatically generated data and those obtained by manual observation. When these anomalies are found, maintenance personnel will be asked to deal with them, or the system will return to normal after the meteorological office reboots the system. RVR is calculated by using results of a transmissometer with corrections for ambient light. Once the lenses used to measure visibility has been taken care of, the system will operate normally.

On that afternoon, it had happened that the visibility and RVR values reported in the METAR were 800 meters but the RVR values displayed by the AWOS were greater than 2,000 meters. According to the manual, AWOS RVR values should take precedence but the sensitivity of the transmissometers is very high, which results in fluctuating RVR values. Moreover, actual conditions and safety concerns have to be taken into account when AWOS RVR values are higher than the observed visibility. For example, if the visibility observed by the meteorological sergeant is 600 or 800 meters, but the AWOS RVR value indicates 2,000 meters, the meteorological sergeant will perform a manual adjustment instead of using the data from the AWOS. However, according to the prescriptions of observation manual, when RVR values are less than the observed visibility, a ten minute average of such RVR values should be used for editing a METAR/SPECI report. When the visibility is 1,600 meters or less, military flight operations are prohibited, therefore the surface weather observers tend to be conservative when reporting weather information, particularly when the visibility is less than 1,600 meters.

1.18.8.6 Kaohsiung Approach

The Magong Position Controller from 1800 to 1900

The interviewee was on his Magong radar shift from 1800 to 1900 hours. He was responsible for 7 aircraft, of which 4 were holding. The numbers of flights on that day were as usual, but most of the flights had requested changes of heading or altitude due to the bad weather. The radio communications were more frequent than usual but the workload was acceptable.

The flights were waiting for their approach sequences while holding. The first one was B7647, the second one was GE222, the third one was FE3055, and the last one was GE5113. The crews were all eager to know the likelihood of the weather improving. At 1821 hours, the interviewee advised B7647 that thunderstorms were going to last for an hour. Later on when the interviewee obtained the updated wind information from Magong tower, it was broadcasted accordingly. At 1830 hours, B7647 requested the interviewee for the runway 02 ILS approach, which was then relayed to the tower for approval, but confirmation of this request was pending. Given the delays associated with the request, the interviewee informed B7647 of the updated weather received at 1842 hours and that the visibility had improved to 1,600 meters. Upon providing this information, B7647 withdrew their previous request for a change of runway and decided to conduct the runway 20 RNAV approach. After that, GE222 requested the runway 20 VOR approach and was radar vectored for that approach. The interviewee had been relieved from his duty shift before GE222 was established on the inbound course for the approach.

The Magong Position Controller from 1900

The interviewee began his Magong radar duty shift at 1900 hours. GE222 was about 11 nautical miles from the airport and at an altitude of more than 2,000 feet. GE222 did not seem to have any anomaly, and descended normally on the inbound course. By the time the tower relayed the information that GE222 was going around, he saw on the radar that GE222 had passed over MKG VOR at an altitude of 300 feet or so, but soon disappeared from his radar display. The interviewee said it was hard for radar to collect stable and reliable information from aircraft at low altitude or just airborne from Magong Airport. In particular, the TNA ATR aircraft would not be visible on the radar until they reached an altitude of 1,000 feet and above.

The Supervisor

At 1830 hours, the interviewee was asked by the Magong position coordinator to liaise with the duty officer at Magong Air Force Base (AFB) to change the landing runway direction. The request had been made to and coordinated with the Magong tower as usual, but the tower replied that the Magong AFB duty officer rejected the request. The controllers' and coordinators' positions did not have a direct hot line with the duty officer. The coordinator asked the supervisor for help to coordinate the request.

At that time, the visibility of 800 meters was below landing minima for both the runway 20 VOR and RNAV approaches. B7647 had requested the runway 02 ILS approach (which required a change of runway) because the visibility criteria could be met. The interviewee discussed with the duty officer for a very long period and the duty officer disagreed with him for two reasons. The duty officer emphasized that he had already asked the weather watch office to confirm that the weather conditions were suitable for runway 20. The second was the tail wind was too strong to use runway 02. During the coordination, the Magong position coordinator told the supervisor that the visibility had raised to 1,600 meters and that met the standard for runway 20 approaches. Therefore, the B7647 crew decided to request the runway 20 RNAV approach and the coordination ended.

1.18.8.7 The Magong Air Force Base Duty Officer

At 1740 hours, the typhoon warning had been terminated. All typhoon related preventive actions had been cancelled and all combat readiness duties resumed. It was still raining at that moment. The meteorological office issued a hazardous weather forecast valid until 2100 hours. Around 1830 hours, the interviewee received a phone call from the combat information office informing him that the tower had relayed a request to use opposite direction runway. Given that it was against the airport's operational policy, the interviewee asked the combat information duty officer, on his behalf, to advise the tower that he needed time to analyze current conditions and an immediate answer was highly unlikely. As soon as the interviewee hung up the phone, he made the next phone call to the meteorological office to collect the current weather information. At that time, he assumed the request to use the opposite direction runway was due to an emergency. When the interviewee hung up the phone, the Kaohsiung approach supervisor called him about the request for use of the opposite runway. Before making a decision, he and the supervisor were having a discussion, during which the supervisor told him that the aircraft in flight had already cancelled the request. The discussion ended at around 1840 hours.

The interviewee stated that with regard to the request to use the opposite runway direction, the speed and direction of the wind were his main concerns. At military airports, duty officers made decisions regarding runway use. It was a basic principle to take off and land in a headwind.

1.18.8.8 The Magong Tower

The Local Controller from 1800 to 1900

The interviewee was on his duty shift from 1800 to 1900 hours on the day of occurrence. Before 1840 hours, the 800 meters visibility was below the landing minima for runway 20, but met the standard for the runway 02 ILS approach. At that moment, there were 4 or 5 aircraft in that area and the crews had requested Kaohsiung Approach to provide updated weather information. The meteorological office replied that it was not expecting the weather to improve before 1830 hours. Some time later, aircraft in flight requested updated weather information again and the meteorological office revealed that there would be a temporary improvement of the weather, but they had no intention to revise the visibility value - the 800 meters visibility report would remain. The interviewee noticed that the wind for runway 02 provided by the AWOS was not so strong. He felt that the aircraft in flight may like to use runway 02 for landing. Therefore, the wind information for both ends of the runway had been provided to approach control, and also relayed to the aircraft in the air for them to make their own decisions. Flights requested use of opposite direction runway. The final authority for changing the runway in use resided with the Air Force duty officer because Magong is a civil/military joint-use airport. The tower coordinated the request between both parties but the request was not approved. He kept pushing for the change of runway direction. At 1840 hours, the visibility in the weather report was increased to 1,600 meters so the request for using runway 02 was no longer needed.

When military personnel were editing weather reports, it seemed that the

RVR value was manually calibrated. The reported RVR value was often 80 or 90 percent the same as the observed visibility. However, in the tower, the RVR value displayed on the AWOS screen was often greater than 2,000 meters, different from the reported RVR. When in doubt, the tower will use the RVR value reported by the weather watch office. For example, the AWOS RVR showed 2,000 meters while the observed visibility was reported as 800 meters on the occurrence day.

The Local Controller from 1900

The interviewee began his airport duty shift at1900 hours on the day of the occurrence. After fully taking over the shift, he was responsible for two flights, one of which FE082 had received a takeoff clearance, but it taxied very slow due to the bad weather. The interviewee did not have the runway threshold in sight from the tower. Taxiway K3 was visible at best. At about 1901 hours, GE222 had established communication with the tower on a 8 or 9 nautical mile final.

When the interviewee issued the landing clearance, GE222 was on about a 5 or 6 nautical mile final, approaching and descending into the airport. The aircraft stopped descending at an altitude of 300 feet or so. When GE222 reached a one or two nautical mile final, the tower controllers heard their go around call. The interviewee issued the missed approach procedure to GE222, but there was no response.

AWOS RVR was provided to crews during low visibility. According to the controller’s one year experience in the Magong tower, it was quite unlikely for low visibility conditions to occur at Magong Airport. There were previous cases when the weather was good and the visibility was more than 10 kilometers, but the RVR readouts indicated otherwise. The interviewee considered this made no sense at all, then contacted the meteorological units to verify if a malfunction had occurred or the lenses were not clean, and thereafter documented the anomalies. Sometimes such anomalies could be solved by rebooting the system or cleaning the lenses. The meteorological units would inform the tower once the system had returned to normal.

When the interviewee took over his duty position around 1900 hours, the RVR on screen was around 1,600 meters, which coincided with the visibility reported by the METAR. AWOS RVR was not provided to the aircraft on the day of the occurrence because at around 1700 or 1800 hours, the AWOS RVR values were different from the RVR reported in the METAR. The local controller on duty at that time called the tower chief for advice. The chief instructed the controller to trust those professionals in the meteorological units. Therefore, the controller used the RVR value in the weather reports, that is, if the RVR was reported in the weather report, it was provided to the aircraft crews.

The approach visibility minima for runway 20 was 1,600 meters, therefore the interviewee paid more attention to changes in visibility. At 1901 hours the controller received the 1900 hours METAR. At that time the visibility was 1,600 meters, no RVR reported. It was the same as the visibility in the 1840 hours METAR. The QNH changed from 996 to 997 and was provided to the GE222 crew immediately. Given the poor visibility from the tower in the heavy rain, the interviewee continuously paid attention to the relative positions of FE082 and GE222, and monitored the radar and the ground movements all the time. GE222 was on about a 4 or 5 mile final when FE082 was handed over to approach control. The interviewee glanced at the wind speed and direction on the AWOS display once again and found no noticeable changes. While GE222 was on a 3 or 4 mile final, the interviewee could not sight the aircraft in the poor weather; however, he kept an eye on the aircraft altitude and ground speed displayed on the radar to see if there were any flight anomalies or signs of the aircraft executing a missed approach. When the interviewee was checking to see if there were any obvious changes of wind speed and direction, he did remember the fluctuating RVR readouts but could not recall those exact values because his first priority was to maintain aircraft separation and watch those inbound flights.

The Chief

After the new AWOS was commissioned, related chapters in the ATMP manual had explained the system for controllers. The Air Force did not provide any operational manual. The AWOS parameters used mainly in the tower were wind direction, wind speed and RVR. QNH, visibility and ceiling were provided by the weather watch office. Controllers checked the AWOS data on screen when in contact with traffics, and if the weather was becoming more unstable, or during the alternation of the runway, controllers paid more attention to the AWOS.

On the afternoon of the occurrence, the local controller on duty called to express doubt about the RVR because the RVR value was more than 2,000 meters but the RVR reported by the weather center was 800 meters. The local controller mentioned that he had asked the weather forecast officer whether the RVR generated by the AWOS was usable. The weather forecast officer replied it was ok to use those RVR values, but the local controller still had doubts. The interviewee mentioned that, as a manager, he had to consider all the conditions and possibilities. The instrument’s observed value is instantaneous and prone to fluctuation and subject to the influences of the surrounding environment such as spider webs, bird droppings, water vapor, and salt. The interviewee thought about such influences. All operations had to follow the ATMP. The front part of the ATMP 2-8 mentioned that the RVR will only be provided when the lowest takeoff and landing minima are established by RVR values and the equipment is working normally. Instead of using RVR values, the lowest visibility landing minima for runway 20 was 1,600 meters. On the other hand, the lowest landing minima for runway 02 had both RVR and visibility values published. Therefore, considering all these factors and safety concerns, the interviewee told the controller to trust the weather professionals in the airport and use the reported RVR in the weather report for operations.

Chapter 2 Analysis

2.1 General

The captain and the first officer of TransAsia Airways flight GE222 were properly certificated and qualified under Civil Aeronautics Administration (CAA) and company requirements. No evidence indicated any pre-existing medical conditions that might have adversely affected the flight crew's performance during the occurrence flight. The occurrence aircraft was properly certified, equipped, and maintained in accordance with CAA regulations and approved company procedures. No evidence indicated pre-existing engine, system, or structural failures.

This analysis focuses primarily on the flight crew's performance, TransAsia Airways' operational and safety management, and CAA airline safety oversight. The analysis also addresses the roles of some human factors issues in the occurrence, meteorological factors, aerodrome and navigation aids, and aircraft systems.

2.2 Occurrence Scenario

2.2.1 The Approach

Magong Airport was affected by the outer rain bands of Typhoon Matmo around the time of the occurrence flight. When the occurrence flight approached Penghu Island, it was vectored by air traffic control and entered a holding pattern because the visibility at Magong was below the landing minima.

After about 34 minutes holding, the visibility for runway 20 had reportedly improved to 1,600 meters. At 1845, the GE222 flight crew requested the runway 20 very high frequency omni-directional range (VOR) approach. Kaohsiung Approach then issued radar vectors to the crew to establish them on the required flight path and assigned them a lower altitude.

2.2.1.1 Final Approach

The cockpit voice recorder (CVR) indicated that after Kaohsiung Approach cleared GE222 for the Magong runway 20 VOR approach (1845:04.2), the flight crew neither conducted an approach briefing nor did they action the descent/approach checklists as company policy and standard operating procedures required. Even though the flight crew did not formally brief or discuss the details in the approach chart, the first officer did remind the captain of particular limitations, including height and distance requirements. The relevant dialogue is presented in Table

2.2-1:

Table 2.2-1 Flight Crews' dialogue regarding approach chart

Time	Source (CVR)	Context	Pressure ALT (ft.)
18:55:34.9	first officer	v-o-r two zero	2,908
18:55:36.3	captain	oh	2,905
18:55:39.7	first officer	five miles two thousand after passing five miles we can descend three three zero	2,904
18:59:09.9	first officer	sir do we preset next altitude three four zero or four hundred	2,033
18:59:14.2	first officer	preset next altitude four hundred	2,029
18:59:14.3	captain	oh	2,029
18:59:17.3	first officer	descend at five miles four hundred	2,027
18:59:18.3	captain	um okay okay okay four hundred	2,023
18:59:58.8	captain	five miles two thousand um	2,019
19:00:01.2	first officer	can only descend after passing five miles	2,022
19:00:03.4	captain	oh	2,024
19:02:40.7	first officer	oh I will set landing configuration at five miles	1,989
19:02:57.6	first officer	passing five miles	1,931
19:02:58.1	captain	okay flap fifteen	1,925
19:05:37.9	first officer	we will get to zero point two miles	249

The substance of the flight crews' dialogue confirmed critical information on the approach chart, such as "Minimum altitude is 2,000 feet before overflying FAF[105]", "MDA[106] is at 330 feet", and "MAPt[107] is 0.2 NM ahead of Magong VOR station", which revealed that the flight crew had already known what they needed to know for the approach.

When the aircraft was maintaining an altitude of 2,000 feet inbound for

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[105] Final approach fix.

[106] Minimum descent altitude.

[107] Missed approach point.

approach, the first officer obtained permission from the captain to preset the next altitude to 400 feet (1859:15). The aircraft then started to descend (1902:50) with a selected vertical speed of -700 feet/min. Based on weather data and the sound of the windshield wipers increasing in speed on the CVR (1903:36.1), the aircraft probably penetrated heavy thunderstorm rain around then. Three seconds after the “500 feet auto call-out” was annunciated, the selected altitude was reset to 300 feet while the aircraft was descending through 450 feet (1905:12.4). When the aircraft had descended to 344 feet, the selected altitude was reset to 200 feet and the aircraft kept descending (1905:25.7). The sequence of flight crew actions regarding the decision to continue the approach below the MDA is shown in Table 2.2-2. The GE222 approach profile is shown in Figure 2.2-1.

Table 2.2-2 Sequence of flight crew actions regarding the decision to continue the approach below the MDA.

Time	**Source**	**Context**	**Pressure ALT (ft.)**	**Selected Altitude (ft.)**
19:05:09.4	CAM	five hundred	479	400
19:05:11.2	first officer	um	456	
19:05:12.4	captain	um three hundred	450	
19:05:12.6	first officer	alt star three hundred	450	
19:05:15.9	captain	sigh	432	300
19:05:25.7	captain	sigh sigh sigh sigh two hundred	344	
19:05:28			330	200
19:05:35.9	first	alt star	273	
19:05:37.5	captain	um	249	

Below MDA

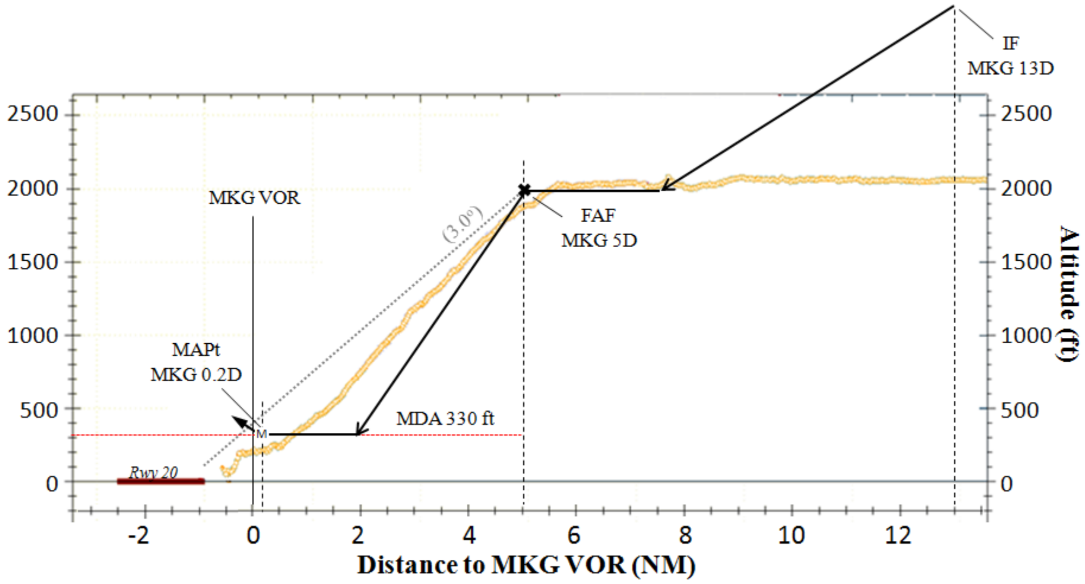

Figure 2.2-1 GE222 approach profile

There was no discussion by the crew on whether the required visual references had been obtained before the captain as the pilot flying (PF) continued to descend the aircraft below the MDA. The first officer, in his capacity as the pilot monitoring (PM) did not object or intervene but rather coordinated with the captain's decision to descend below the MDA in contravention of standard operating procedures (SOPs).

When the aircraft had descended to 249 feet, the first officer illustrated the position of the MAPt by saying "*we will get to zero point two miles*". At 1905:44, altitude 219 feet, the captain disengaged the autopilot. Four seconds later, the captain announced "*maintain two hundred*". The captain maintained the aircraft's altitude between approximately 168 and 192 feet in the following 10 seconds (see Table 2.2-3). The flight crew intentionally operated the aircraft below the MDA. They then maintained about 200 feet while attempting to visually sight the runway so they could land the aircraft.

Table 2.2-3 Flight crew's intention to maintain altitude below the MDA during the final approach in instrument meteorological conditions.

Time	Source	Context	Pressure ALT (ft.)	Selected Altitude (ft.)	DME 1* (NM)
19:05:37.9	first officer	we will get to zero point two miles	249	200	
19:05:43			204		0.5
19:05:44.1	CAM	(sound of disengaging autopilot)	219		
19:05:45.8	first officer	disengaged	219		
19:05:47			214		0.3
19:05:48.5	captain	maintain two hundred	208		

* Distance measuring equipment (DME) 1 refer to Magong VOR station, "zero" means the aircraft overflew the station

AP Disengaged

Even though no conversation regarding the MAPt was mentioned on the CVR, the captain asked the first officer "*have you seen the runway*" when the aircraft passed the MAPt (1905:57.8, 0.1 NM behind MAPt). At almost the same time the yaw damper was disengaged without any announcement.

Instead of commencing a missed approach at or prior to the MAPt in accordance with company SOPs, both pilots spent about 13 seconds attempting to locate the runway. During their search for the runway, the heavy thunderstorm rain activity intensified with a maximum rainfall of 1.8 mm per minute. That further reduced the visibility to 500 meters[108]. The UNI Airways flight crew, who had landed a few minutes before the occurrence, stated that there was sudden heavy rainfall with an associated deterioration in visibility. [109] The degraded visibility impeded the GE222 flight crew's ability to visually locate the runway.

From the MAPt, while the autopilot was disengaged, the occurrence aircraft's altitude, course, and attitude started to conspicuously deviate from the intended settings and flight crew's expectations. The flight data

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[108] Refer to section 1.7 Weather Information.

[109] According to section 1.11.3.2, UNI Airways flight B7 647 landed at Magong airport runway 20 at 1857:25 hours. The summary of that flight crew's interview is available in section 1.18.8.1.

recorder (FDR) data (see Table 2.2-4 and Figure 2.2-2) indicated that the aircraft’s heading changed from 207° to 188° as a result of the bank angle changing from approximately wings level to 19° left and then decreasing to 4° left, which was consistent with the aircraft commencing a left turn away from the required approach course. The aircraft also commenced a descent from previously maintained altitude of 200 feet. The aircraft pitch angle decreased from 0.4° nose up to 9° nose down then returned to 5.4° nose down which produced a reduction altitude from 179 feet to 72 feet.

Table 2.2-4 Sequence of flight crew actions and aircraft state during the attempt to visually locate the runway.

Time	**Source: CVR Transcript**	**Selected /Actual ALT (ft.)**	**Selected/ Actual Heading (deg)**	**Pitch (deg)**	**Bank (deg)**	**DME 1 (NM)**
19:05:51		200 / 176	201 / 207.1	-1.0	-0.7	0.2
19:05:55		200 / 180	201 / 206.7	1.2	-1.8	0.1
19:05:57.8	captain: have you seen the runway					
19:05:58		200 / 179	201 / 207.4	0.4	0.7	
19:05:59		200 / 192	201 / 206.4	0.5	-2.5	0
19:06:00		200 / 175	201 / 205.3	1.1	-10.5	
19:06:00.7	first officer: runway					
19:06:01		200 / 167	201 / 203.6	0.3	-15.5	
19:06:01.8	captain: um					
19:06:02		200 / 169	201 / 201.1	0.0	-16.2	
19:06:03		200 / 162	201 / 197.6	0.2	-19.3	0
19:06:04		200 / 157	201 / 195.1	0.6	-18.6	
19:06:04.9	captain: sigh wow ha ha ha					
19:06:05		200 / 166	201 / 193	0.1	-17.2	
19:06:06		200 / 170	201 / 190.2	-1.6	-16.9	
19:06:06.8	first officer: no					
19:06:07		200 / 161	201 / 189.2	-4.1	-13.7	0.1
19:06:07.6	captain: no					
19:06:08		200 / 164	201 / 188.8	-7.7	-10.9	
19:06:09		200 / 131	201 / 189.2	-9.0	-12.3	
19:06:09.8	first officer: no sir					
19:06:10		200 / 99	201 / 189.5	-7.6	-8.8	
19:06:10.4	captain: okay okay okay					
19:06:11		200 / 72	201 / 188.1	-5.4	-3.9	0.3
19:06:11.1	first officer: go around					
19:06:11.4	captain: go around					

Passed MAPt

YD Disengaged

Time	**Source: CVR Transcript**	**Selected /Actual ALT (ft.)**	**Selected/ Actual Heading (deg)**	**Pitch (deg)**	**Bank (deg)**	**DME 1 (NM)**
19:06:12		200 / 47	201 / 186	-1.5	-1.8	
19:06:13		200 / 39	201 / 183.2	2.2	0	
19:06:13.3	CAM: unidentified sound lasting 1.5 seconds					
19:06:14		0 /-48	0 / 180.7	2.9	-2.5	
19:06:15		0 / 43	45 / 180.7	-1.1	-4.6	0.4

Hit Bush

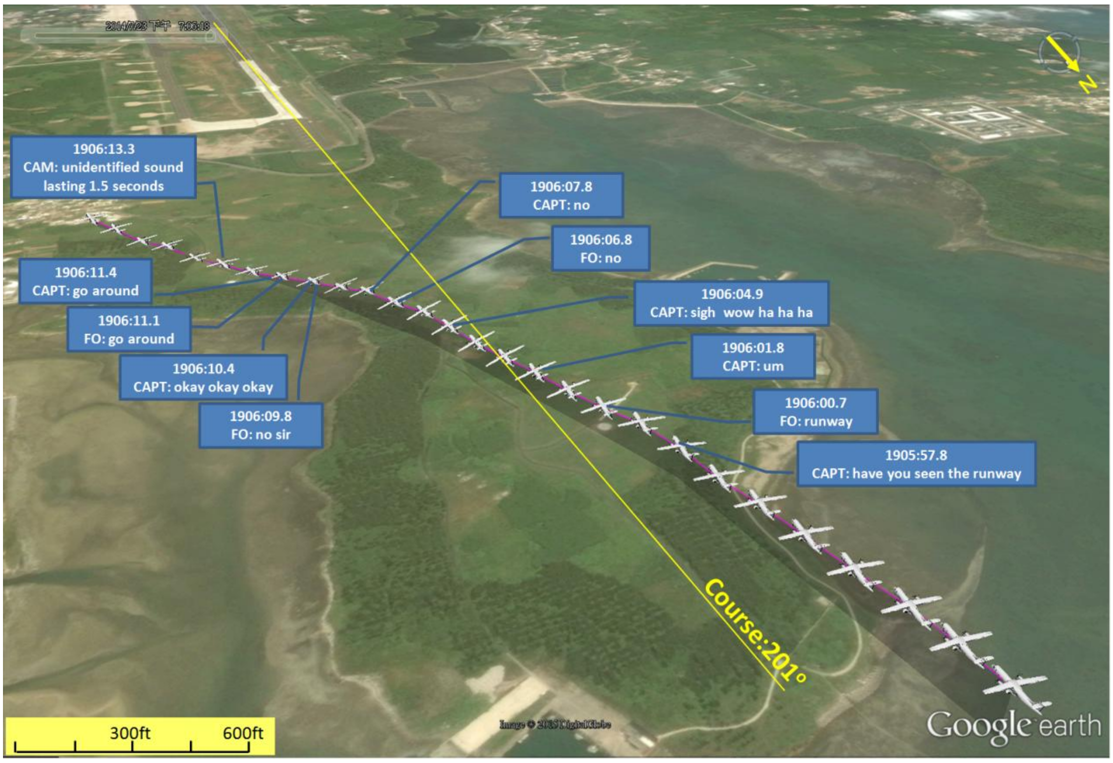

Figure 2.2-2 Aircraft track and altitude deviations as flight crew attempted to visually locate the runway.

The combination of the captain’s left control wheel input and strong right crosswind (32 to 34 kts from 252°) had turned the aircraft to the left, which consequently resulted in the aircraft’s deviating from the required instrument approach course. In addition, the combination of the captain’s forward control column input and the possible effects of moderate turbulence pitched the aircraft nose down with a subsequent loss of altitude below the previously maintained altitude of 200 feet.

The aircraft’s flight profile appeared to continue unchecked during the 10 seconds of flight before the first officer and captain announced their decision to go around at an altitude of 72 feet and 0.5 nautical mile from the MAPt. The CVR indicated that the crew were looking ahead of the aircraft trying to establish visual contact with the ground. The aircraft collided with foliage located 850 meters to the northeast of the runway 20 threshold two seconds after the crew made the go around call.

The captain diverted the aircraft from the published runway 20 VOR non-precision approach procedure by descending below the published MDA before obtaining the required visual references. The aircraft also diverted to the left of the inbound instrument approach track as a result of several factors but the crew did not identify and/or correct that deviation. The first officer did not challenge the captain's violation of the MDA. The crew's decision to continue the approach below the minima provided the crew with no margin for avoidance maneuvering and exponentially increased the risk of controlled flight into terrain (CFIT). The flight crew did not appear to identify the hazards associated with the approach and were therefore not in a position to manage the associated risks.

2.2.2 Post Impact Structural Failure Sequence

According to site survey data, the aircraft subsequently collided with a building on a magnetic heading about 183 degrees, with a nose up, left bank attitude[110]. The top of that building's roof had been damaged by rotating propeller blades.

The aircraft's right wing also collided with the northern wall of the first impacted building. After the first impact, the aircraft's direction of movement was altered to about 170 degrees and it then collided with several other buildings before it finally came to rest. Figure 2.2-3 shows an aerial image of occurrence site superimposed with the main wreckage and final flight trajectory.

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[110] Last recording on the FDR: pitch attitude +12.7 degrees, left bank 4.9 degrees.

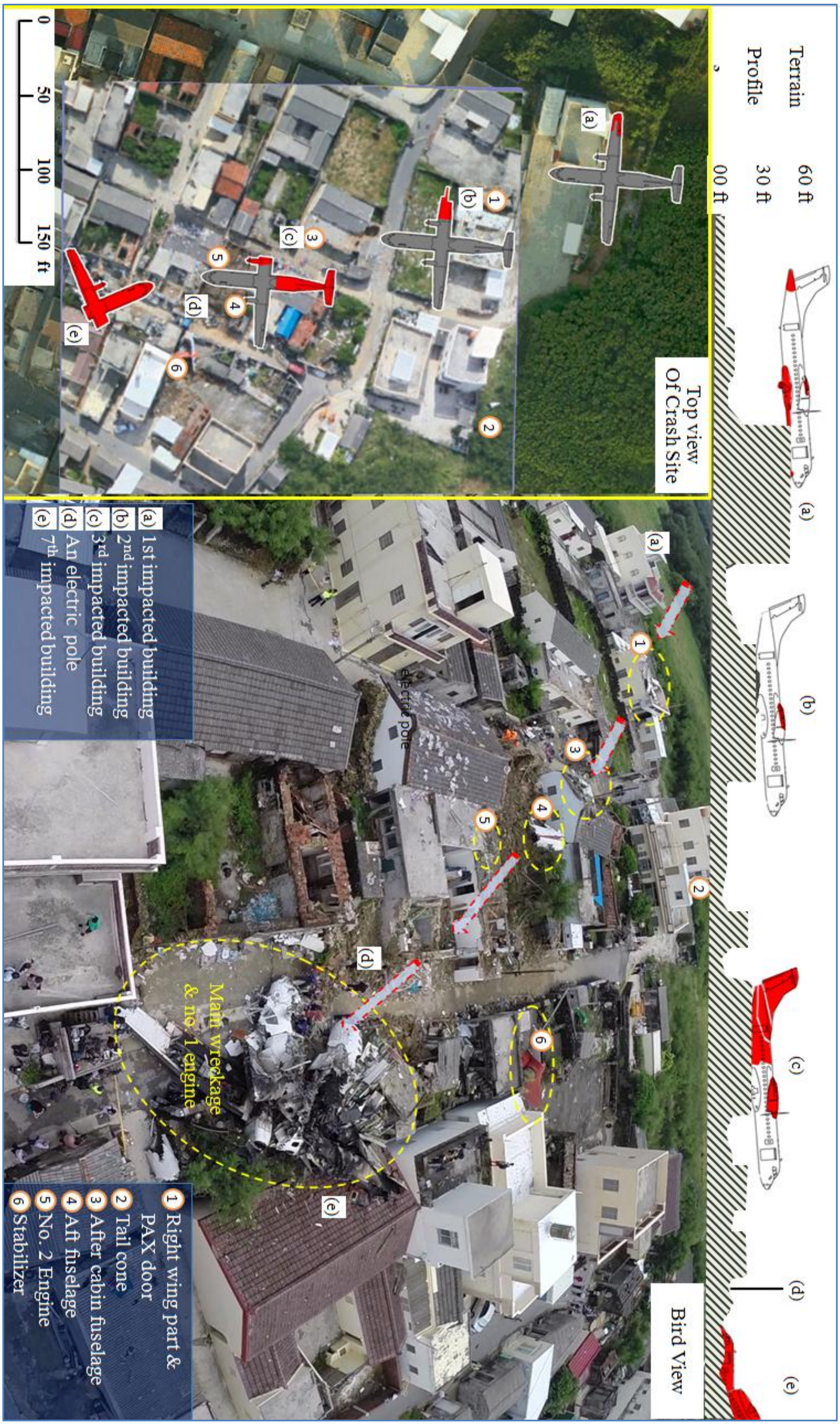

Figure 2.2-3 Aerial image of occurrence site superimposed with the main wreckage and final flight trajectory

2.3 Compliance with Standard Operating Procedures

2.3.1 SOP Non-compliance during the Occurrence Flight

The operator's standard operating procedures (SOPs) provided a framework by which the flight crew were intended to operate the aircraft. The procedures provided guidance to ensure that the flight crew conducted operations in a predictable, uniform and safe manner, and they were therefore an important factor in assuring flight safety. There was, however, significant flight crew non-compliance with those procedures during the descent into Magong. Moreover, the flight crew's non-compliance with the published non-precision instrument approach and missed approach procedures at Magong during flight in instrument meteorological conditions was a primary contributing factor in the events leading up to the occurrence.

The flight crew's compliance with procedures was not at a level to ensure the safe operation of the aircraft. The captain did not conduct an approach briefing before he commenced the descent into Magong. The CVR data revealed that the first officer did not comment on the omission of this procedure, which would have provided the crew with an opportunity to assess the risks for the approach to Magong.[111] The non-compliance with company SOPs continued throughout the descent and approach where the required checklists were not performed.

The Flight Safety Foundation (FSF) approach and landing accident reduction (ALAR) task force found that the conduct of an inadequate approach briefing was a factor in ALAR accidents. The Task Force identified that an approach briefing should contain the following elements:

- Minimum Safe Altitudes;
- Terrain and man-made obstacles;
- Weather conditions and runway conditions;
- Other approach hazards, as applicable;
- Minimums (ceiling and visibility or runway visual range);
- Stabilization height;

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[111] The US Federal Aviation Administration's (FAA) Advisory Circular (AC) 120-74B (dated 30 July 2012), Flightcrew Procedures During Taxi Operations, Appendix 2, contained information regarding effective approach briefings, which can increase crew performance by highlighting those potential areas that need special attention and consideration.

- Final approach descent gradient and vertical speed; and
- Go-around altitude and missed approach initial steps.

While the airline's approach briefing checklist contained most of these elements, the flight crew did not brief any of the items which was contrary to the operator's standard operating procedures. The investigation concluded that because these items were not briefed, the crew did not have an adequate awareness of all the relevant safety factors associated with the approach and landing, thereby progressively increasing the risk of a CFIT event.

The captain then intentionally descended the aircraft below the MDA. The risk of a CFIT event is reduced if an approach is flown no lower than the published MDA of an instrument approach procedure until visual flight can assured and maintained. Continuing the descent below the MDA in instrument meteorological conditions (IMC) in close proximity to terrain meant that the risk of a CFIT event had increased to an unacceptably high level and could not be mitigated. Impact with terrain was almost certain from that point onwards.

Had the flight crew followed the runway 20 VOR approach procedure as published on either the Jeppesen or CAA charts, and not descended below the MDA but conducted a go around in accordance with the published missed approach procedures, the accident would not have occurred. There was no evidence of any inflight emergency that would have warranted the flight crew of the occurrence aircraft to disregard or deviate from the published inflight procedures.

2.3.2 The Phenomenon of SOP Non-compliance in TNA's ATR Fleet

In order to further understand if the numerous and habitual non-compliances with SOPs identified on the occurrence flight were indicative of a systemic problem within the airline's ATR72 fleet or isolated to the occurrence crew, the investigation team conducted various line observations. The findings from those are presented in Table 1.16-1 in section 1.16.4.

The airline observation flights conducted by the investigation team and interviews with members of the airline's flight operations division supported the conclusion that there was a tolerance for non-compliance with procedures within the ATR72 operation. That is, routine violations of procedures were normal. In particular, the flight crew were known to descend below the minima before acquiring the required visual references. If the airline had implemented a line operations safety audit (LOSA) program, it would have readily identified the magnitude and frequency of the systemic routine SOP non-compliance committed by crews at the airline.

In addition, similar findings with reference to TransAsia Airways (TNA) flight crews not complying with SOPs during normal and abnormal operations had been previously identified by Aviation Safety Council (ASC) occurrence investigations.[112] In response, the airline proposed various corrective safety actions, which were reportedly subjected to CAA oversight. However, the safety actions and their subsequent oversight were clearly inadequate and ineffective because the habitual non-compliance with SOPs continued at the airline unabated. The ASC investigations provided further evidence that routine violations were normal practice for the airline's flight crews.

2.3.3 Organizational Factors Related to SOP Non-compliance

Human factors research[113] has indicated that, in addition to individual mental or physiological factors, job and organizational factors may also directly or indirectly lead to SOP non-compliance by front-line personnel. For example, inconsistent SOPs, excessive workload, poor check and training, morale problems, ineffective safety management, and inappropriate operational objectives can contribute to the prevalence of failures to comply with SOPs.

A review of TNA's flight operations and safety management structure and activities, identified several organizational factors related to the prevalence of SOP non-compliance in the ATR72 fleet:

- Functions of the Standards and Training Department;
- Pilot training and checks; and
- High ATR crew flying activity.

2.3.3.1 Functions of Standard and Training Department

The head of the standards and training department was an assistant manager without a flying background. There was no standards pilot for the ATR flight operation to oversee SOP compliance, SOP-related flight

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[112] GE515, ATR-72-500, engine fire during climb, May 2, 2012. GE5111, ATR-72-500, electric smoke after takeoff, July 1, 2013.

[113] 【"Human factors that lead to non-compliance with standard operating procedures" research report by Health and Safety Executive, UK, 2012.】【ICAO Safety Management Manual, the third edition, 2013.】【" A human error approach to aviation accident analysis, Dr. Wiegmann and Shappell, 2003.】

operations quality assurance (FOQA) events handling, and standard operations audits (SOA) monitoring before the GE222 occurrence.

While there was a supervisor for the Standards and Training Section, the high flight times and instructional workload of the check and training pilots assigned to assist him was such that they had insufficient time available to perform support tasks such as reviewing SOPs, training, audits, and operational safety risk assessments. In addition, the shortage of standards pilots may have been another reason why the SOP non-compliances identified by the FOQA program and the conduct of the SOA audit program were not as effective as they could have been.

2.3.3.2 Flight Crew Check and Training

Table 1.16-2 in section 1.16.5 presents the various discrepancies observed during some of the airline’s simulator training sessions. The non-compliance with SOPs which were observed and not corrected indicated a tolerance for or normalization of SOP non-compliance behaviors. This was symptomatic of a complicit and ineffective check and training system with inadequate and ineffective supervision and oversight by flight operations management.

Simulator training is an optimum opportunity for senior instructors and check pilots to model compliant and effective safety behaviors to ensure that crews understand and replicate the required performance standards. Crews under check or training who do not model the required safety behaviors, including compliance with SOPs, should be corrected and given an opportunity to demonstrate the required behaviors. Standardization is a cornerstone for producing safe and proficient crews. However, the airline’s ATR72 check and training system tolerated a lack of crew discipline as demonstrated by the acceptance of operational discrepancies. Furthermore, the CAA had not identified this problem earlier through inspections while the investigation team was able to identify the discrepancies by observing a simulator session. Even under official observation and after the airline had experienced a major aircraft accident, the crews simulator performance indicated significant non-compliance with SOPs.

2.3.3.3 High Flying Activities on ATR Fleet

Most of the ATR pilots who were interviewed and the rostering data had indicated a significant increase in crew flying activities as indicated by increased flight times and flight sectors. From May to July 2014, 57.7% of ATR pilots had accrued over 270 hours flight time which was significantly higher than for the same period and summer peak season in 2013, where only 7.4% and 26.3% of crews respectively had accrued more than 270 hours. The number of daily sectors flown had also increased to a maximum of 8, which many crew found exhausting.

Many of the ATR pilots who were interviewed agreed that most deviations from the SOPs occurred while the crew felt fatigued, particularly when operating flight sectors later in the day. Despite protestations by crew at the time and concern within flight operations, senior management did not conduct a formal risk assessment to inform their decision making process.

The situation presented the risk of increased fatigue and the potential for non-compliance behaviors. However, the company had not implemented a safety management process to assess the safety risks associated with the increase in operational tempo.

2.4 Human Factors Issues and Crew Coordination

2.4.1 Crew Resource Management and Threat and Error Management

Operating a multi-crew aircraft, particularly in high workload situations, requires the two pilots to work in a coordinated manner and effectively communicate with each other. A breakdown in crew coordination or communication can lead to an unequal workload burden between the crew, a loss of cross-checking of information and detection of errors, and/or incorrect or untimely information being communicated.

There were several factors that led to ineffective levels of crew coordination and communication, including the following:

- There was probably a steep trans-cockpit authority gradient, resulting from large differences between the crew in terms of age, experience, and position in TNA;
- Reports that indicated concerns about the captain’s unsafe operational behavior; and
- Reports that the first officer and, the airline’s junior first officers generally, were not naturally assertive.

A steep trans-cockpit authority gradient without appropriate crew resource management (CRM) skills reduced the likelihood that the first officer would voice any concerns that he may have had about the captain’s decisions and actions. It would have also increased the probability that the captain made decisions without consulting the first officer.

The aircraft’s impact with terrain was a direct consequence of the captain descending the aircraft below the published MDA for the runway 20 VOR approach procedure. Moreover, it was also as a result of poor planning by the flight crew and less than effective CRM and threat and error management (TEM). During the landing approach, the actions of the flight crew progressively increased the risk of a CFIT to an extreme level, yet they seemed unaware that the likelihood of impact with terrain was almost certain until less than two seconds before it occurred.

The captain was responsible for the safety of the flight crew, cabin crew, passengers, and aircraft, and had full control of, and authority for, the operation of the aircraft. The first officer had a duty and responsibility to ensure that the flight was operated safely, yet he appeared to either passively condones, or did not question, the unsafe operation of the aircraft during the latter stages of the flight. The crew did not effectively discharge their responsibilities in the operation of the aircraft. Even though the captain was the flying pilot for the sector, the first officer had a responsibility to alert the captain about deviations from standard operating procedures, which resulted in the aircraft being operated in an unsafe manner. The CVR data revealed, however, that the first officer made no significant pro-active contribution to ensure that the aircraft was operated safely during the final stages of the flight.

Effective application of TEM principles can reduce safety risk. Even though the crew had undertaken TEM training, they did not demonstrate an appreciation of the safety risks and how to manage them on the day of the occurrence.

The airline had implemented a TEM training program. The integration of TEM with CRM provided crews with a useful framework to manage threats, errors and undesired aircraft states. However, the systemic safety problems at the airline indicated that their TEM training program was not effective otherwise they might have been more cognizant of the risks confronting the crew on the day of the occurrence. Examples of such risks included:

- The captain was experiencing a moderate level of tiredness, which may have affected his performance during the approach;
- The identification and mitigation of threats were not active components of the operator’s approach briefing model. Therefore, the issues associated with runway use and availability, non-precision approaches, CFIT risk, and the provision of weather information at civil/military joint-use airports were not identified as potential threats;
- Non-compliance with SOPs was a major threat that undermined

safety assurance.

2.4.2 Crew Monitoring and Cross-Checking

Inadequate flight crew monitoring and cross-checking has been identified as an aviation safety problem. To ensure the highest levels of safety, each flight crewmember must carefully monitor the aircraft's flight path and systems, and actively cross-check the actions of other crewmembers. This monitoring function is always essential, and particularly so during approach and landing when CFIT occurrences are most common[114].

During GE222's final approach, several unsafe behaviors regarding crew monitoring and cross-checking were identified. Examples included:

- Contrary to SOPs, the first officer proposed that he conducted the before landing check by himself without a cross-check from the captain, which was approved by the captain. The cross-check function had been intentionally dismissed by the crew despite its safety purpose;
- When the aircraft was overhead the final approach fix, the captain and the first officer did not cross check the aircraft altitude and position;
- When the aircraft was at about 100 feet above MDA, the captain and the first officer did not cross check that the aircraft was approaching the MDA;
- The first officer did not challenge the captain's decision to fly below the MDA, but assisted the captain to do so without hesitation.

Effective crew monitoring and cross-checking can be the last line of defense that prevents an occurrence. However, this monitoring function was ineffective on GE222. The crewmembers did not correct the unsafe behaviors or decisions but rather collaborated together to intentionally conduct an unsafe operation. The behaviors were consistent with what had been identified in previous TNA ATR occurrences, simulator observations and interviews, and indicated a poor safety culture within the ATR fleet.

2.4.3 Overconfidence

Overconfidence is a hazardous attitude that can create an unsafe situation. It is an adverse mental state when an individual overvalues or overestimates personal capability, the capability of others or the capability

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[114] "Crew Resource Management Training", Advisory Circular 120-51E of the FAA, 1/22/2004.

of aircraft/vehicles or equipment[115]. Overconfidence is often coupled with a poor appreciation of safety risk.

Interviews with ATR line pilots indicated that the captain had good flying skills. Some interviewees further stated that the captain had landed safely in adverse weather conditions previously because of his proficiency where some pilots might have initiated a missed approach. The interviews indicated that the captain was quite confident of his flying skills. This might be one of the factors that explained why the captain intentionally flew below the MDA and tried to visually locate the runway while maintaining 200ft.

The TNA flight operations manager was aware of the captain's flying behaviors. However, subsequent discussions with the captain and the issuance of various safety notices regarding SOP compliance were clearly ineffective.

Well-designed SOPs and tasks reduce the risk of non-compliance. However, there are occasions when suitable and appropriate SOPs are not adhered to. Such unacceptable behavior is typically a social or motivational problem and may be a function of implicit organizational incentives. The extent of SOP non-compliance, and the way they are treated by employees and managers, provides a good insight into the overall safety culture in an organization. Proportional and consistent consequences, in accordance with a "Just Culture", need to be implemented to manage flight crew who continue to violate well-designed SOPs and/or engage in unsafe behavior.

2.4.4 Fatigue

Fatigue is a major aviation human factors hazard because it can impair a crew's performance.[116].

To establish the potential presence and influence of fatigue, it is important to:

- Determine if the crew were susceptible to fatigue;
- Evaluate if the crew's presentation, performance and behaviors at the time of the occurrence were consistent with the effects of

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[115] "Department of Defense Human Factors Analysis and Classification System", DOD, USA, January 11, 2005.

[116] "Fatigue Risk Management System Implementation Guide for operators", published by IATA, ICAO and IFALPA, July 2011.

fatigue.[117, 118]

Several contributing factors of fatigue as identified by research[119] were evaluated during the investigation. The captain's medical records and toxicology report did not indicate that he was adversely affected by any medication or physical health problem. The occurrence flight was not at a time that corresponded with a normal individual's circadian low, where human performance was not optimal. The possibility of sleep-related fatigue, including acute sleep disruption, chronic sleep disruption and extended wakefulness, were unable to be assessed because specific information about the captain's wake/sleep cycles in the days before the occurrence were not available.

Both operational crew members' performance metrics produced by the System for Aircrew Fatigue Evaluation (SAFE) biomathematical model indicated that the captain was a little tired and the first officer was not adversely affected by fatigue. However, accurate sleep/wake information for both flight crew members was not available. Therefore, it is important to note that the model used conservative sleep assumptions, which may not have reflected the actual amount of sleep obtained in the period before the occurrence. The SAFE biomathematical model indicated that there were times during the previous two months of rosters for both the captain and first officer where fatigue levels were elevated enough to significantly degrade their operational performance.

The crew were local short-haul regional pilots. Their rosters indicated a common fatigue-producing factor of early starts and/or late finishes, where short-haul pilots tend to progressively lose more sleep throughout a given roster cycle.[120, 121] The fatigue research findings for short-haul airline

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[117] This approach is adopted by several aviation investigation agencies such as NTSB, TSB and ATSB, etc.

[118] 【"Methodology for Investigating Operator Fatigue in a Transportation Accident", NTSB, 2006.】【"Guide to Investigating Sleep-Related Fatigue", TSB, 2014.】

[119] "Methodology for Investigating Operator Fatigue in a Transportation Accident", NTSB, 2006; "Guide to Investigating Sleep-Related Fatigue", TSB, 2014.

[120] Roach, G. D., Sargent, C., Darwent, D., & Dawson, D. (2012). Duty periods with early start times restrict the amount of sleep obtained by short-haul airline pilots. Accident Analysis & Prevention, 45, 22-26.

[121] Drury, D. A., Ferguson, S. A., & Thomas, M. J. (2012). Restricted sleep and negative affective states in commercial pilots during short haul operations. Accident Analysis & Prevention, 45, 80-84.

pilots indicated that approximately 15 minutes of sleep was lost for every hour that the start of duty was advanced prior to 0900 hours. In addition, self-rated fatigue at the start of duty was highest for duty periods that commenced between 0400 and 0500 local time, and lowest for duty periods that commenced between 0900 and 1000 local time. Therefore, it was highly probable that the GE222 flight crew had obtained less sleep throughout their roster cycle than that estimated by the SAFE model.

The operational workload for both crew members was also very high as demonstrated by their flight time and number of sectors flown in the three months before the occurrence. There were also some salient indications recorded on the CVR that suggested the captain was experiencing a higher level of fatigue than that derived from SAFE. The captain stated he was very tired and his yawning was detected by the CVR. In addition, lapses in radio communications with air traffic control (ATC), incorrect VOR approach course selection, incorrect recall of ATC wind information, and incorrect automatic flight control system (AFCS) mode selections, which required the first officer to intervene, were consistent with the captain experiencing lapses of attention, decreased vigilance, and low risk perception.

The fatigue analysis concluded that the captain's performance was probably degraded by fatigue at the time of the occurrence but that the first officer's performance was not adversely affected by fatigue.

Although it was not a requirement, had the airline implemented a data-driven fatigue risk management system (FRMS) or an effective safety management process to manage the flight safety risks associated with fatigue in accordance with the FRMS Implementation Guide for Operators jointly developed by the International Civil Aviation Organization (ICAO), the International Air Transport Association (IATA), and the International Federation of Air Line Pilots' Associations (IFALPA), the fatigue levels and subsequent performance decrements among its ATR crews would have been less acute.

2.5 TNA Safety Management

Effective safety management comprises a systematic approach to managing safety, including the necessary organizational structures, accountabilities, policies and procedures. A safety management system (SMS) is a planned, documented and verifiable method of managing hazards and associated risks.

TNA's SMS was not as effective as it could have been. There were limitations with several of TNA's safety management capabilities and processes related to assuring the safety of its flight operations. The investigation identified reasons for these limitations in terms of:

- Organizational structure, capability and resources;
- Risk management processes;
- FOQA limitations;
- Audits;
- Safety performance monitoring; and
- Safety education.

2.5.1 Organizational Structure, Capability and Resources

Safety committee was responsible for reviewing the overall safety performance of the operations. The safety and security office (SSO) was a committee members and the manager was the Executive Secretary of the committee. However, no staff member from the SSO attended the flight safety action group (FSAG) or any of the other safety action groups (SAGs) except the security safety action group (SSAG). That deprived the SSO of an opportunity to discuss and develop an appreciation of the detailed safety issues confronting each operational department. The safety action group minutes were not an informative source of safety intelligence because they generally contained no safety information of substance, which was perplexing given the safety issues that had been identified in previous and current occurrences.

The SSO had limited resources and capability for the scope of duties they were required to undertake, which included processing safety and security reports, conducting safety and security investigations, SMS implementation, preparing the monthly safety meeting agendas and minutes, FOQA analysis, audits of flight operations, cabin, and ground/airport operations, facilitating and documenting operational safety risk assessments, and conducting safety education and promotion activities. The audit staff had not received sufficient auditor training and the audit checklists did not contain risk assessment items. Furthermore, the CAA had noted in an inspection report that the full capabilities of the FOQA system were not being exploited because of resourcing limitations, thereby depriving the airline of an opportunity to obtain significant insight into its flight operations risks. It was apparent that the SSO was overwhelmed by the volume and complexity of tasks it was required to undertake, which prevented it from implementing an effective SMS.

2.5.2 Hazard Identification and Risk Management

Hazards identification is the first step of the safety risk management. It is a process where organizational hazards are identified and managed so that safety is not compromised.

The investigation evaluated the specific risk factors associated with the occurrence flight using the Flight Safety Foundation CFIT checklist. Based on the information about the adequacy of TNA's corporate culture, flight standards, hazard awareness and training, previous occurrences, line observations, and interviews, the evaluation indicated that the CFIT risk for TNA operating an ATR72 on a non-precision approach into Magong in those weather conditions with crew not complying with SOPs was a 'significant threat'. The assessed risk was at a level such that, to reduce the risk to an acceptable level, improvements were required in TNA's practices, flight standards, training and hazard awareness.

CFIT reduction initiatives have been a significant part of the work conducted by ICAO and the FSF. This collaborative work has resulted in the production of the FSF ALAR Tool Kit. The potential risk of CFIT can be reduced by using current technology and equipment, implementing and complying with effective standard operating procedures and ensuring ongoing compliance with such procedures through an effective flight operations quality assurance program that includes flight data analysis, documented operational risk assessments, regular safety audits, and by developing effective crew decision-making and threat and error management processes. The implementation of an effective data-driven SMS and operational compliance and quality assurance system has the potential to reduce an airline's operational safety risks.

TNA had established and maintained a reactive safety and irregularity reporting system which combined the mandatory and voluntary reporting systems. The voluntary reporting system was operationally and administratively ineffective, which deprived the airline of another opportunity to identify and assess its safety risks. In addition, the airline focused on internal data sources to develop an appreciation of operational risks and did not expand its horizons to external information sources, which deprived it of a further opportunity to learn from other operators' occurrences.

The airline's risk register had not been updated since 2011 and contained no formal proactive CFIT risk assessments. The airline's SMS was not effective or consistent with the guidance provided in the ICAO Safety Management Manual.

2.5.3 TNA FOQA Program

The FOQA program provided a means to identify potential safety risks and mitigate those risks through by modifying the company's risk controls such as standard operating procedures, pilot training programs, and rosters.

According to the UK CAA's Flight Data Monitoring CAP 739, a flight data monitoring program can identify significant changes or deviations from acceptable levels of performance. In addition to being an occurrence investigation tool, FOQA data's primary purpose is to analyze normal operations with a view to identifying or predicting potential risks to flight operations. For example, FOQA will identify ports that are at risk of unstable approaches, problematic instrument approaches, non-compliances with SOPs and so on.

The FOQA Staff

The ICAO DOC 10000, flight data analysis program (FDAP) manual, stated that an airline's FOQA team should have a flight operations specialist and a technical specialist who have in-depth knowledge of company standard operations procedures and aircraft handling characteristics so they can interpret the FOQA data accurately. Those specialists then need to identify operational hazards emerging from the FOQA data analyses. In addition, it is beneficial to utilize an independent non-management pilot as the flight data 'gatekeeper' who can contact and discuss events with the event pilots in a confidential manner to clarify the context of an event on behalf of the safety department.

The TNA FOQA team did not have a flight operations or technical specialist embedded in the SSO. The absence of such specialists made it difficult for the designated FOQA officer to fully understand and analyze the data from an operational perspective. Interviews indicated that the ATR chief pilot usually accompanied the event pilots to review the event. The chief pilot/fleet manager will be able to understand the flight data. However, event flight crew may be reticent to openly discuss the context of a flight data event with a senior management pilot because of potentially adverse consequences, thereby depriving the airline of another opportunity to accurately identify and assess an operational risk.

FOQA Event Handling

SOP non-compliance presents a high level of risk to flight operations and needs to be identified and rectified in a timely manner.

A review of the TNA FOQA data between January and June 2014 indicated that there had been several crew non-compliance events, such as an over-weight landing, late flap setting, unstable approaches, late landing gear retraction, high descent rate below 500 feet and so on. Some event data had been sent to the training department and chief pilot for corrective actions. However, the FOQA events were sometimes not administered in accordance with the company's own procedures and that resulted in the FOQA data not being used to identify and mitigate operational safety risks.

FOQA Trend Analysis

Effective FOQA trend analyses will identify systemic event types.

A review of the TNA FOQA monthly data analysis reports from January 2013 to June 2014 identified recurring flight data events such as long flare, GPWS warning between 500 and 1,000 feet, and heading deviation during landing roll. There was no evidence to indicate that those events or the FOQA trend analysis results were discussed during safety meetings. The SSO issued notices to company flight crew outlining the FOQA data without any technical advisory or explanatory information. In addition, the SSO did not monitor the FOQA trend analysis data so it was not in a position to raise safety issues with the Flight Operation Division if an adverse trend was apparent.

The TNA FOQA program was not used as an effective tool to identify SOP non-compliance events and provide the relevant information to flight operations for training intervention. In addition, the program did not function as required to provide a systematic tool to proactively identify hazards, assess and mitigate the associated risks.

2.5.4 Self-Audit

The CAA's Flight Operations Self-Audit Advisory Circular (AC-120-002A) dated 1 July 2002 defined self-audit as an internal flight operations quality assurance system designed to continuously monitor compliance with regulations, policies, and procedures. The audit was designed to focus on system self-evaluation, analysis, and corrective actions rather than spot checks of outputs. Company self-audits provided an opportunity to identify the frequency and magnitude of non-compliances with standard operating procedures. Moreover, operators were required to conduct special self-audits in response to serious incidents, and other events with the potential to increase risks, such as violations, fleet changes or expansion, and human resource shortages.

TNA self-audit records indicated that there were very few self-audit findings in 2013 and 2014 before the occurrence. The audits were mostly spot checks rather than system audits or system self-evaluations. The self-audits were ineffective because they failed to identify and address those safety deficiencies that had already been identified in previous occurrences and were known by senior flight operations management to be problems, including SOP non-compliance behaviors, lack of standardization in pilot check and training activities, and high crew flying activities on the ATR fleet.

Moreover, there was no evidence that TNA had conducted a special audit after an earlier ATR72 occurrence[122] which also occurred during a time when the ATR72-600 aircraft variant was being introduced into the company's ATR72 fleet for the first time. Furthermore, the TNA annual audit plan had not included an evaluation of responses to those safety issues and/or recommendations which had been identified during previous audits, CAA regulatory inspections, and occurrence investigations. The TNA self-audit program was not consistent with the guidance contained in CAA AC-120-002A.

Standard Operation Audit (SOA)

TNA's SOA program was a component of the flight operations division's self-audit program. The primary function of the SOA was to monitor normal line operations for SOP compliance and to identify safety risks in flight operations. The SOA program also included a flight crew self-evaluation process.

The TNA training for SOA auditors was insufficient and ineffective. Interviews indicated that apart from rudimentary risk management training, there was no additional or specific training and supervision to ensure that the auditors were equipped with the skills required to identify safety risks in flight operations.

Company audit records indicated that from 1 January 2013 to 31 July 2014, TNA staff had conducted 163 SOAs of the ATR fleet. Only 3 of those 163 audits had been identified non-compliances with SOPs. No corrective actions were implemented in response to those audit findings, which had not been captured by the monthly SOA statistics report.

Flight crew self-evaluations were typically not conducted during the SOAs. SOA audits were not conducted as required to ensure that previously issued corrective safety actions had been implemented and were effective. SOA audits were ineffective because they failed to identify and address those safety deficiencies that had already been identified in previous occurrences, FOQA flight data and were known by senior flight

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[122] GE5111 occurrence occurred on 1 July 2013.

operations management to be problems. Furthermore, the monthly SOA statistics report and the 12-month-rolling accumulation statistics were inaccurate and did not reflect SOA audit report findings.

2.5.5 Safety Performance Monitoring

The flight operations division (FOD) had implemented two composite risk indices, the direct risk indicator (DRI) and average risk indicator (ARI), to provide an overall assessment of risk confronting flight operations. However, those risk indices did not accurately reflect the current level of safety risk to TNA flight operations. That is, the risk measures used to monitor safety performance were misleading and not a valid representation of the critical safety risks in flight operations.

The DRI comprised 13 factors, which included items such as SOP non-compliance, fatigue, crew resource management items and so on. The data for these items were extracted from the results of flight crew self-evaluations. However, only 24 crew self-evaluations were obtained as part of the 379 SOA audits which were conducted on the Airbus and ATR fleets from 1 January 2013 to 31 July 2014. In addition, some DRI factors did not reflect the actual situation confronting the ATR fleet. For example, the DRI item pertaining to fleet manpower evaluation was scored to indicate that there were no crew shortages. However, the ATR fleet was short of at least 8 pilots at the time of the occurrence.[123] That is, the DRI was not a valid reflection of actual safety risk because it was calculated using insufficient and/or inaccurate self-evaluation data.

The ARI was calculated using the number of hazards grouped by risk level. The input hazards were established from the brainstorming sessions when the system was first implemented and were revised in accordance with operational data until March 2011. The hazards were not revised or re-evaluated after that time. That is, the ARI input data was not current or informed by recent data from line operations. The ARI had not changed since 2011, which meant that it was not a reliable, valid or meaningful indicator of safety risk at the time of the occurrence.

The airline’s safety performance monitoring system did not provide a current, reliable or valid indication of safety risk in flight operations. Furthermore, the CAA had not identified the accuracy and safety risk level of the airline.

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[123] The pilot to ATR aircraft ratio established by TNA was 6:1. That is, there should have been 60 pilots available to operate the 10 ATR aircraft from May to July 2014. However, there were only 52 pilots at that time.

2.5.6 Safety Education

The TNA SSO had established an internal website for the dissemination of safety information within the company. However, the website was not routinely updated with the latest safety information, including the safety investigation reports and safety lessons from the company's ATR72 occurrences in 2012 and 2013, which were investigated by the ASC. Interviews with ATR flight crew indicated that they were not aware of the contributing factors and safety recommendations related to SOP compliance issued by the ASC in the two occurrence investigation reports.

TNA did not have an effective safety information and education system, which deprived flight crews from further developing an appreciation of the safety risks confronting flight operations, particularly the risks associated with non-compliance with SOPs.

2.6 TNA's SMS Development and CAA Oversight

2.6.1 SMS Implementation Plan

According to the CAA AC 120-32C, local airlines should have implemented a SMS by 31 December 2012.[124]

An SMS implementation plan is the foundation for establishing an effective SMS and was endorsed by CAA AC-120-32C.[125]

TNA had not developed an SMS implementation plan. This led to a disorganized, nonsystematic, and incomplete approach to establishing conforming safety management capabilities and functions and ensuring that those elements were effective. Poor SMS planning resulted in significant deficiencies in senior management engagement, the quality of safety data, the effectiveness of safety meetings, responsiveness to safety recommendations, auditing and risk assessment capabilities, safety performance monitoring, and safety education.

Both ICAO and the FAA advised that a State's civil aviation regulatory authority needs to assess and review an airline's SMS implementation plan

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[124] See CAA Advisory Circular AC-120-32C dated 25 January 2011. CAA AC-120-32D, dated 20 October 2014, extended the SMS implementation date to 31 December 2016.

[125] An SMS implementation plan is a necessary component of the SMS development process. It includes timelines and implementation milestones for the various components or elements. It should also be endorsed by the airline's senior management, including the accountable manager (CEO), and reviewed regularly and updated as required.

for acceptance or approval.[126, 127] The CAA did not require operators to submit their SMS implementation plans for approval. Moreover, the CAA did not consider the absence of an SMS implementation plan at TNA fundamental to SMS oversight. This view deprived the CAA of an opportunity to detect and rectify the manifold deficiencies with TNA's developing SMS at an early stage of the process.

2.6.2 Follow-up Actions of the SMS Assessment

The CAA Operations Inspector's Handbook indicated that the inspectors assigned to TNA were responsible for monitoring the airline's response to SMS deficiencies identified by CAA's SMS assessment project team.

The 24 TNA SMS deficiencies noted by the CAA's SMS assessment project team in 2013, included concerns about the data used for hazard identification, the application of risk management in senior management decision-making, lack of SMS effectiveness evaluation tools and so on. The CAA requested a corrective action plan from the airline but the airline did not submit one. Moreover, the airline's allocated CAA inspectors did not pursue the airline for its corrective actions plan. This resulted in unresolved deficiencies with the airline's SMS.

2.7 CAA Flight Operations Oversight

An air operating certificate (AOC) holder had a clearly defined responsibility under the CAA regulations to ensure the safety of its operations. The regulator, CAA, also had defined responsibilities for overseeing the activities of an AOC holder, through the processes of approving AOC variations and other permissions, as well as conducting surveillance of the activities of the operator.

AOC approval and surveillance processes will have constraints in their ability to detect problems. There is restricted time available for these activities. Regulatory surveillance is also a sampling exercise, and cannot examine every aspect of an operator's activities, nor identify all the limitations associated with these activities. While AOC approval and surveillance processes focus on regulatory requirements, which provide legal checks and a minimum standard of safety, the CAA was also tasked with overseeing airline safety management processes.

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[126] International Civil Aviation Organization. (2012). Safety management manual (3rd Ed.) (DOC 9859-AN/474). Québec, CAN: ICAO.

[127] "Safety management systems for aviation service providers", FAA Advisory Circular No. 120-92B, 1/8/15.

Despite the constraints, the CAA still had significant interactions with TNA, through the conduct of scheduled in-depth and cockpit en-route inspections, monitoring the implementation of corrective actions in response to inspections and safety occurrences, SMS assessment, and other approval activities. As a result of these interactions, the CAA had identified some areas for improvement in TNA's SMS, flight crew training, procedures and practices, and FOQA program. However, it did not detect fundamental problems associated with the airline's risk management of flight operations, such as systemic problems with flight crew not complying with SOPs, lack of standardization in pilot checking and training activities, SSO organizational structure and capability, and demonstrated management commitment to safety.

Given the significance of the problems within TNA, and the amount of interactions CAA had with the airline, it is reasonable to conclude that some of these problems should have been detected by the CAA. In considering the reasons why these problems with TNA were not detected, the investigation identified safety factors in the following areas:

- Consistency of oversight activities with CAA policies, procedures and guidelines;
- Guidance for evaluating management systems;
- Risk assessments for changes in operations;
- Regulatory assessments of safety management systems and the implementation of SMS regulations; and
- Processes for assessing an operator's risk profile.

Assessments of an organization's management systems necessarily involve the use of professional judgement by inspectors. To ensure that such judgements were appropriate, CAA needed to ensure that its inspectors had the appropriate skills to make judgements on management systems, or had an appropriate amount of guidance material to assist them in making these judgements. The CAA only provided limited guidance material to assist inspectors with their evaluations of management systems. While the CAA had formed an SMS project assessment team to assess an airline's SMS implementation progress, the assessment was conducted independent of the CAA inspectors allocated to the airline. It would have been beneficial for the inspectors to be accompanied by the SMS assessment team in routine SMS inspections so that they could develop a better appreciation of the safety challenges confronting the airline.

Although some CAA inspectors probably had sufficient background and skills to conduct assessments in these areas, the guidance provided did not ensure that all of the airline inspectors had these competencies. That is, the CAA had not provided itself with assurance that key components of an operator’s management systems were able to be effectively examined by its inspectors. In the context of TNA, there were limitations in guidance evident in the following areas:

- Evaluating organizational structure and staff resources;
- Evaluating the suitability of key personnel;
- Evaluating organizational change; and
- Evaluating risk management processes.

When assessing an airline’s management systems and capability, CAA inspectors needed to consider whether an organization had an appropriate structure and sufficient personnel to carry out the required functions of the organization. Despite the importance of ensuring an organization had an appropriate number of personnel, and the workload of key personnel was not excessive, CAA provided limited guidance to its inspectors on how to evaluate these requirements.

In terms of the suitability of an organization’s structure, the CAA inspectors’ manuals provided a minimal amount of guidance. Organizations can vary greatly in terms of their size, structure and complexity, and it would be impracticable to provide detailed guidance about every specific situation that CAA inspectors may encounter. However, it would seem practicable to provide case examples of what was and was not considered appropriate, as well as a list of criteria to consider when making evaluations. Such guidelines could be developed based on CAA’s past experience, the experience of other regulatory agencies, discussion with key industry groups, and findings from research into organizational behavior in a variety of fields.

2.7.1 Guidance for Evaluating Organizational Change

TNA was experiencing a period of significant growth and change in operations: the introduction of the ATR72-600 and the general growth in revenue flights. However, the airline was also experiencing a shortage of ATR flight crew and a subsequent significant increase in flight and duty times. There was limited CAA guidance or mechanisms that required inspector’s to review the impact of these events as a whole, or guidance on how to conduct such an evaluation. A series of incremental changes could be made to an organization’s activities, each with the approval of

CAA. Each change by itself may be justified as having minimal impact, but overall may have had a significant impact.

By not making such decisions at the approval stage, the regulator was relying on its surveillance processes to detect and rectify any problems. However, the guidance on examining an organization's change management processes was limited and focused on what changes had occurred rather than the adequacy of an organization's processes to manage the changes.

2.7.2 Guidance for Evaluating Risk Management Processes

SMS require processes for identifying hazards, analysing risks, treating risks and evaluating the effect of treatments or controls. The ability of an operator to develop and implement these processes should be evaluated during the SMS oversight by the CAA. However, there was limited CAA guidance to inspectors allocated to the operator for evaluating the operator's risk management process. Furthermore, although some deficiencies of the risk management processes in TNA were identified during the SMS assessment team's audit, the CAA's SMS oversight to the TNA did not appear to be of sufficient depth to evaluate the quality or effectiveness of the operator's existing processes.

2.7.3 Regulatory Requirements for Safety Management Systems

The CAA's AC-120-32C required that operator implement a SMS by 31 December 2012. The AC is advisory or demonstrative of an acceptable means of compliance with the associated regulations but not the only means. In addition to specific CAA SMS regulations, there were also general regulatory requirements for CAA to ensure that an AOC holder conducted operations safely.

The CAA SMS AC-120-32C contained sufficient scope for the CAA to facilitate safety improvements by operators and to monitor an operator's responses to those requested safety actions. TNAs safety program was a safety management system, albeit ineffective. The CAA had not ensure that the airline responded effectively to the safety deficiencies and corrective actions issued by the CAA, undermined the levels of system safety assurance and facilitated a lack of accountability at the airline.

2.7.4 Processes for Assessing an Operator's Risk Profile

There was no formal safety risk trend indicator system used by the CAA to assess the relative risk level of operators. Rather, the CAA inspectors relied on the risk metrics produced by the operators. In the case of TNA, the airline's risk indices were not current, reliable or valid but the CAA inspectors had limited means to assess the veracity of the airline's risk indices or to calculate an independent safety risk indicator for the airline. Had such a safety risk trend indicator system been in place, it would have identified that the operator was 'high risk' due to a range of issues such as significant expansion of operations, ATR crew shortage, previous serious incidents, unresponsive or ineffective responses to previous ASC safety recommendations, unresponsive or ineffective responses to internal and CAA external audits and inspection corrective actions, ineffective risk management processes and assessments, ineffective safety meetings, questionable senior management commitment to safety, inadequate SSO and flight operations resources, lack of standardization during flight crew check and training activities, non-compliance with procedures and unsafe practices. This would have been a useful tool for triggering the need for additional special audits of the operator.

2.7.5 Previous ASC Investigation

On 20 May 2013, the ASC issued Safety Recommendation ASC-ASR-13-05-014, which recommended that the CAA oversaw TNA's efforts to reinforce the requirement that flight crew comply with standard operating procedures (SOPs), including standard callouts during approach. On 18 September 2013, the CAA replied that TNA would specifically focus on approach operations and standard callouts when conducting an additional SOA. The proposed actions for the Safety Recommendation were accepted.

A review of TNA SOA audit records contained no evidence that TNA had conducted SOAs with a focus on SOP compliance during approach, including standard callouts, as the company had advised the CAA they were going to do. The CAA inspector for TNA did not follow up the implementation of the safety actions which were supposed to be implemented by TNA. The SOP non-compliances identified by the previous occurrence investigation were not corrected and the hazard remained in TNA flight operations practices.

2.7.6 Effectiveness of CAA Inspections

While the regulatory surveillance activities of CAA inspectors assigned to TNA identified some safety deficiencies, the inspections were not as targeted and/or as effective as they could have been. For example, there were major safety events at the airline, including two serious ATR72 occurrences in 2012 and 2013, which should have triggered a special audit by the CAA. Despite the ASC investigation reports had identified crew non-compliance with SOPs and deficiencies with pilot check and training, the CAA did not pursue the matter. Furthermore, identified safety issues were often closed prematurely by CAA inspectors without verifying the implementation or effectiveness of the safety actions implemented by the airline. It wasn’t until after the GE222 fatal accident that the CAA elected to conduct a special audit of the airline, where multiple serious safety deficiencies were identified.

2.7.7 Risk-based Approach to Surveillance

A safety management environment provides for a more dynamic assessment of safety performance. Regulatory oversight surveillance programs generally include mechanisms for calibrating the scope or frequency of surveillance according to actual safety performance. This risk-based approach to surveillance prioritization facilitates the allocation of resources according to areas of greater risk, concern or need. A regulator’s surveillance program should be data-driven so that its resources are focused and prioritized according to areas of highest risk or safety concerns.

In the past, the CAA surveillance methodology focused primarily on determining regulatory compliance using a system of direct inspection of a certificate holder’s aircraft, personnel, records and other systems. The inspectors planned the inspection program based on the inspection job functions and conducted the inspections according to the direction and guidance in the Operations Inspector’s Handbook. With the increasing number of local operators and other regulatory activities, the volume of inspection work increased substantially. Coupled with inspector shortages, that created high CAA inspector workloads, which may had a bearing on the inspectors’ performance.

The introduction of SMS has instigated significant changes for the way civil aviation regulatory authorities assess the safety of operators. While an airline is responsible for implementing effective risk management procedures and practices, the regulator is responsible for ensuring that those procedures and practices are robust, effective and provided for a high degree of safety assurance. Civil aviation regulators cannot abdicate their responsibilities for ensuring the safety of airline operations just because an operator has implemented an SMS.

Civil aviation regulators need to provide safety leadership in an increasingly complex and continuously changing air transportation system. The CAA’s surveillance activities may be more effective if they implement a more targeted risk-based approach to operator safety evaluations. The CAA may refer other civil aviation regulatory agencies to redefine oversight model, transform the internal structure, and revisited future capability needs. The prioritized approach will focus resources on addressing major safety issues within the constraints of limited regulatory resources.

2.8 Meteorological Issues

2.8.1 Rainbands of Typhoon Matmo

Magong Airport was affected by the outer rainbands of Typhoon Matmo at the time of the occurrence. The automated weather observation system (AWOS) and radar data showed that these rainbands were similar to squall lines. The radar images (see Figure 2.8-1) indicated that two waves of rainband passed through Magong Airport before and during the occurrence. The first bow echo affected Magong Airport from 1738 to 1803; the second echo was from 1901 to 1945. These bow echoes may cause significant changes in wind speed and wind direction with associated heavy rain showers.

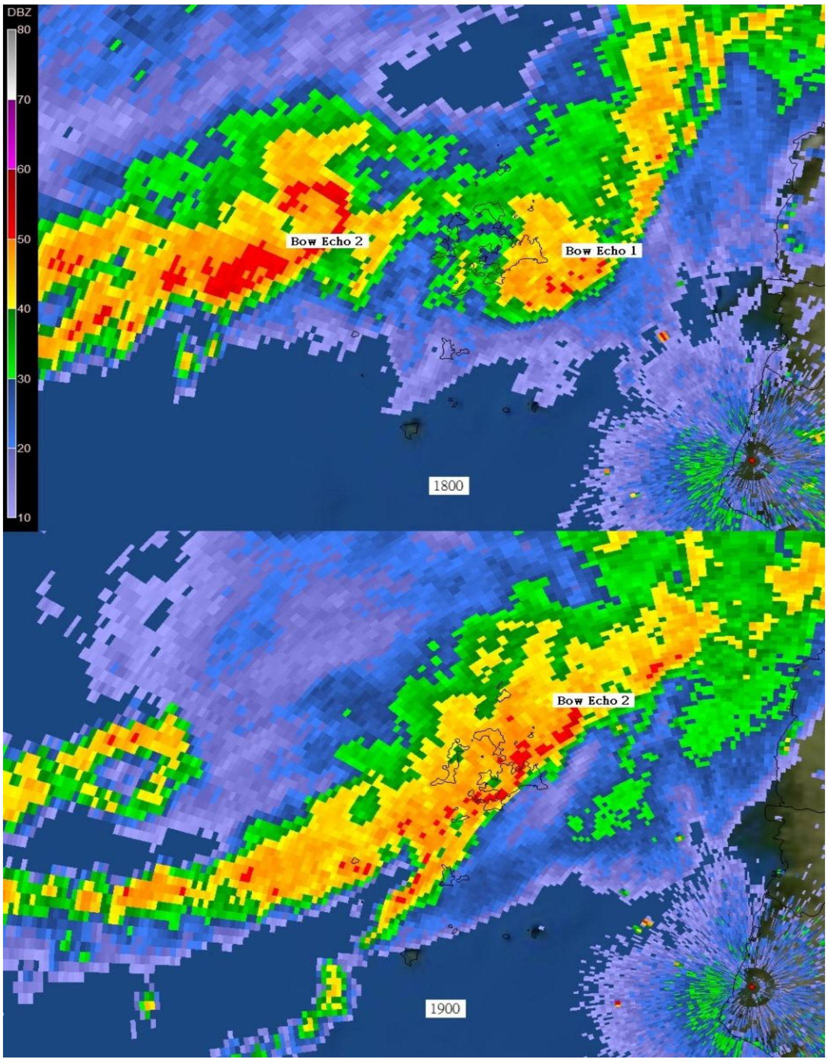

Figure 2.8-1 Rainband activity at Magong before the occurrence.

2.8.2 Surface Weather Observations and Reporting

According to the weather radar information and AWOS data, the rain intensity at Magong Airport from 1803 to 1901 was moderate. The echo intensity was less than 20-25 dBZ and the rain intensity decreased between 1835 and 1900. When the second rainband approached Magong Airport at 1901, the echo intensity was about 50-55 dBZ. The rain then intensified and the runway visual range (RVR) decreased rapidly. Table 2.8-1 shows one-minute mean RVR from 1859 to 1908.

Table 2.8-1 One-minute mean RVR at Magong Airport AWOS N.

Time	1859	1900	1901	1902	1903	1904	1905	1906	1907	1908
RVR (m)	ABV 2000	1800	800	650	600	650	600	500	450	550

The telephone communications recordings indicated that at 1821:59, the tower asked the forecast officer about that visibility. The response indicated that the visibility was improving a little bit but another wave of weather was soon to arrive at the airport where was estimated to become poor. Between 1824 and 1825, the tower asked the forecast officer twice about the visibility, and the forecast officer replied the tower that visibility might improve in ten minutes but would deteriorate once again in 10 to 20 minutes. Therefore, the visibility report would remain 800 meters.

At 1838:35, the forecast officer asked the weather observer about the actual visibility. The forecast officer recalled that the weather observer replied that visibility was about 1,600 or 2,400 meters. The weather observer then reported an improved visibility of 1,600 meters. That visibility report was included in the aerodrome special meteorological reports (SPECI) issues at 1840. The GE222 crew requested the approach to runway 20 at 1843. The AWOS data indicated that between 1900 and 1901 the RVR deteriorated rapidly from 1,800 to 800 meters, which was below the landing minima for the runway 20 VOR approach.

According to the “Air Force Meteorological Observation Manual”, the observation of special weather report shall be completed within three minutes after the weather changed. The manual also instructs that, before conducting visibility observations at night, observers shall spend 3-5 minutes in the darkness to allow their eyes to become adapt to the low light condition. Based on the telephone records, the weather observer had made a phone call to the tower at 1901:01 for the 1900 METAR information. The observer had received two phone calls at 1902:02 and 1904:24 to provide visibility information. After completed the weather observation, the special weather observation report with the visibility decreased to 800 meters was issued at 1910.

2.8.3 RVR Reporting

2.8.3.1 Updating Weather Information to the Aircraft

According to the air traffic management procedures (ATMP), as soon as possible after an aircraft is transferred from approach control, the tower is required to issue the crew with visibility or RVR. In addition, during final approach, the tower is required to advise the crew when there are changes in observed RVR values or visibility. Between 1901 and 1906, the occurrence aircraft was transferred to the Magong tower and was on its final approach to Runway 20. During that period of time, the RVR values started decreased further from 800 meters to 500 meters.

At 1901:13, the GE222 crew contacted the Magong tower controller who confirmed the runway in use and QNH information. The tower controller did not advise the flight crew that the RVR was 800 meters. At 1903:39, the tower controller issued a landing clearance to GE222, and reported wind speed and direction information, but did not advise that the RVR was 600 meters. Had the revised visibility been communicated to the occurrence flight crew, such information might influence the crew’s decision regarding the continuation of the approach.

There was no anomaly of the AWOS RVR recorded at Magong tower and Magong weather center on the occurrence day. At 1804, the weather forecast officer had replied the local controller that the AWOS RVR was serviceable. Compared the AWOS RVR records, AWOS rain gauge records, and information from airport CCTV, the AWOS RVR values on the occurrence day were reasonable and consistent with the changes of the weather.

Interview records indicated that the tower controller did not provide the RVR information to the flight crew was because of the discrepancies between the AWOS RVR data and the RVR reported by the weather observer, which was included in the METARs issued during the hour before the occurrence. The tower controller was concerned about the validity of the AWOS data. After discussion with the tower chief, the tower controller used the visibility and RVR information reported in the applicable METAR/SPECI, which was 1,600 meters.

2.8.3.2 RVR Reporting in METAR/SPECI

Air Force Meteorological Observation Manual stated that the RVR shall be reported whenever the visibility or RVR is less than 1,500 meters.

The 1830 METAR[128] reported that visibility was 800 meters and the RVR was also 800 meters. However, between 1804 and 1859, the 1-minute mean AWOS RVRs recorded were above 2,000 meters. According to the manual, the RVR in the 1830 METAR should be reported as "more than 2,000 meters".

The weather watch office supervisor stated that actual conditions and safety concerns had to be taken into account when AWOS RVR values were higher than the observed visibility. For example, if the visibility observed by the weather observer was 800 meters but the AWOS RVR value indicated 2,000 meters, the RVR would be the observed visibility. When AWOS RVR values were less than the observed visibility, then the weather observer would use the AWOS RVR value for the METAR/SPECI report.

Magong Airport is a civil/military joint-use airport. The Air Force Weather Center didn't provide an AWOS operations manual to the civil Tower when the new AWOS was installed. There was a lack of communication between the civil and military authorities on RVR reporting requirements and practices.

2.8.4 Active Runway Selection

During the time of the occurrence flight, the runway in use at Magong Airport was runway 20 due to the wind speed and direction. The average wind speed for runway 02 decreased to about 5 to 7 knots between 1824 and 1828, which was below the 10 kts tailwind landing limit. At 1827:38, Kaohsiung Approach relayed the wind information for runway 02 to the holding inbound aircraft crews. Some of the crews subsequently requested the runway 02 instrument landing system (ILS) approach.

The use of other direction of runway application procedures for the civil/military joint-use airport indicated that, when the military aircrafts stationed at the airport, the application could only be authorized by the Magong Air Force Base (AFB) duty officer.

At 1833:35, the AFB duty officer received the use of other direction of runway application because three inbound aircraft had requested the runway 02 ILS approach due to runway 20 was no longer suitable given the landing minima visibility requirements. While the decision for the application was still under consideration, the 1840 weather report indicated

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[128] The METAR reported ten-minute mean RVRs. There were only one-minute mean RVRs recorded in AWOS.

that the visibility had improved to 1,600 meters, which met the landing visibility minima requirements for an approach to runway 20. The crews subsequently amended their request and elected to use runway 20.

2.8.5 Coordination at Magong Joint-use Airport

At the time of the occurrence, the mechanisms in place for weather information and runway availability coordination between civil and military personnel at Magong's joint-use airport were less effective than what they could have been. In particular, the inconsistent information or discrepancies regarding airport visibility during the aircraft's approach were unresolved. In addition, the rapidly changing AWOS RVR data was not communicated by the tower controller to the occurrence flight crew. Those inconsistencies meant that there was no collaborative decision-making relationship between the civil air traffic controllers, military weather observer, and flight crew. That resulted in the occurrence flight crew not being fully aware of the rapidly deteriorating RVR while on approach and the high likelihood that the RVR would not be sufficient for landing. Had the local controller provided the flight crew with RVR updates during the approach, it may have placed the crew in a better position to determine the advisability of continuing the approach.

2.9 Atmospheric Environment during Final Approach

2.9.1 The Aircraft Behavior

Based on the FDR data and the technical information provided by the ATR, the vertical speed, control column position, and control wheel position of the occurrence flight after the autopilot was disengaged were calculated. Relevant FDR parameters and the three derived parameters are depicted in Figure 2.9-1. Derived vertical speed is denoted as "VS_SM_5PT", derived control column position and control wheel position are denoted as "CCP_derived" and "CWP_derived", respectively.

The occurrence aircraft's increased rate of descent from 150 ft/min to 1,600 ft/min between 1906:05 and 1906:10 was the result of an elevator control input by the captain. The nose down pitch angle of the aircraft was a maximum of 9 degrees. While descending, the aircraft turned to the left as a result of left aileron input. That is, the aircraft behavior was consistent with the control surface inputs.

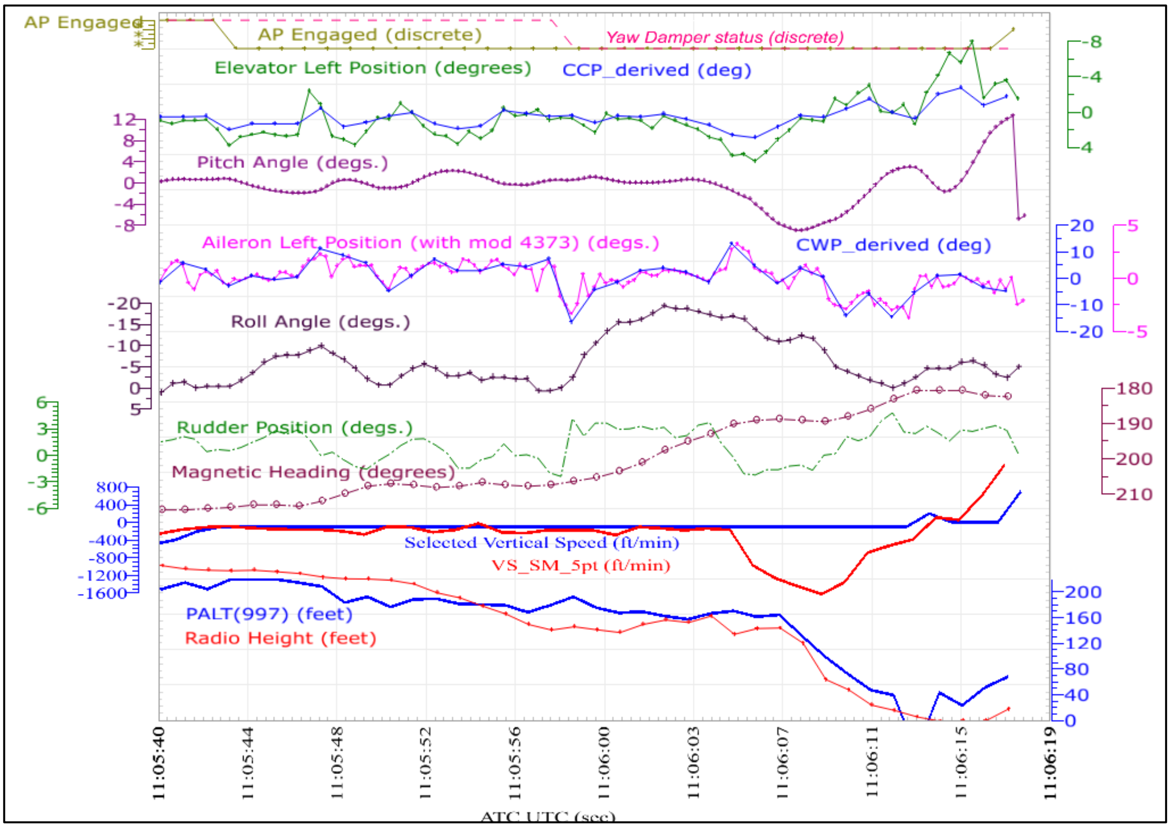

Figure 2.9-1 Relevant FDR and derived parameters

2.9.2 Windshear

An examination of flight data from the occurrence aircraft and from aircraft landing at Magong shortly before the occurrence aircraft indicated no evidence that the occurrence aircraft encountered windshear[129] or microburst[130] activity.

Between 1906:00 and 1906:12, the FDR recorded wind indicated that the headwind decayed from 19 knots to 15 knots. The right crosswind increased from 27 knots to 30 knots. That is, the final approach conditions were not consistent with a windshear encounter.

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[129] According to ICAO Manual on Low-level Wind Shear (DOC 9817), wind shear is defined as the change in wind speed and/or direction in space, including updrafts and downdrafts. Low Level Wind Shear is a rapid change in wind speed and/or direction below 1,600 feet AGL. It can affect the safety of aircraft during takeoff and landing. The manual also indicated that when an aircraft encounters a change in the headwind or tailwind of 15 knots or more, the probability of wind shear is high.

[130] A microburst is a small-scale but violent downburst of a very localized column of sinking air caused by a small and intense downdraft within a thunderstorm.

2.9.3 Turbulence

Turbulence is caused by the relative movement of disturbed air through which an aircraft is flying. Turbulence strength can be divided into three levels: light, moderate, and severe. This section uses two methods to analyze the intensity of turbulence for the occurrence flight, vertical acceleration peak threshold, and Eddy Dissipation Rate (EDR), detail in Table 2.9-1.

Table 2.9-1 Turbulence Strength Levels and Threshold Values

Turbulence strength	**Vertical acceleration peak threshold (FDR 8 Hz)**[131]	**Eddy Dissipation Rate (1 km moving average)**[132]
Light	0.51g's ~ 1.49 g's	0.1 ~ 0.40
Moderate	0.00 g's ~ 0.50 g's 1.50 g's ~ 1.99 g's	0.41 ~ 0.70
Severe	<= 0.00 g's >= 2.00 g's	> = 0.70

Based on the FDR data, the vertical acceleration for the last two minutes of the occurrence flight is shown in Figure 2.9-2. The plot indicated that the vertical acceleration fluctuated between 0.8 and 1.2 g's until 1906:08, the vertical acceleration reached the minimum value of 0.72g's. The decrease of the vertical acceleration probably had a relationship with the pitch down maneuvers of the aircraft. The vertical acceleration then started to increase when the flight crew decided to go around. The vertical acceleration reached the maximum of 1.51 g's at 1906:13, when the aircraft hit the trees.

Stated in the ICAO Annex 3, the EDR is an aircraft-independent measure of turbulence. The relationship between the EDR value and the perception of turbulence is a function of aircraft type, and the mass, altitude, configuration and airspeed of the aircraft. The EDR values of the occurrence flight were calculated and shown in Figure 2.9-2. Similar to the vertical acceleration, the EDR values were less than 0.2 most of the time during the last two minutes of the flight. About 1906:00, the EDR value started to increase and reached the maximum of 0.65 just before the aircraft contacted with the trees.

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[131] Guide to Meteorological Instruments and Methods of Observation, 2010 updated, World Meteorological Organization.

[132] Reference ICAO Annex 3 Meteorological Services for International Air Navigation.

Compare with the FDR data, between 1906:00 and the end of the flight, the occurrence aircraft had large amount of pitch and roll angle changes. The increased vertical acceleration and EDR values probably are cause by the combination of the turbulence and the aircraft maneuver. Based on the values, the turbulence strength of the occurrence flight during the last 2 minutes could be classified as "light to moderate" level.

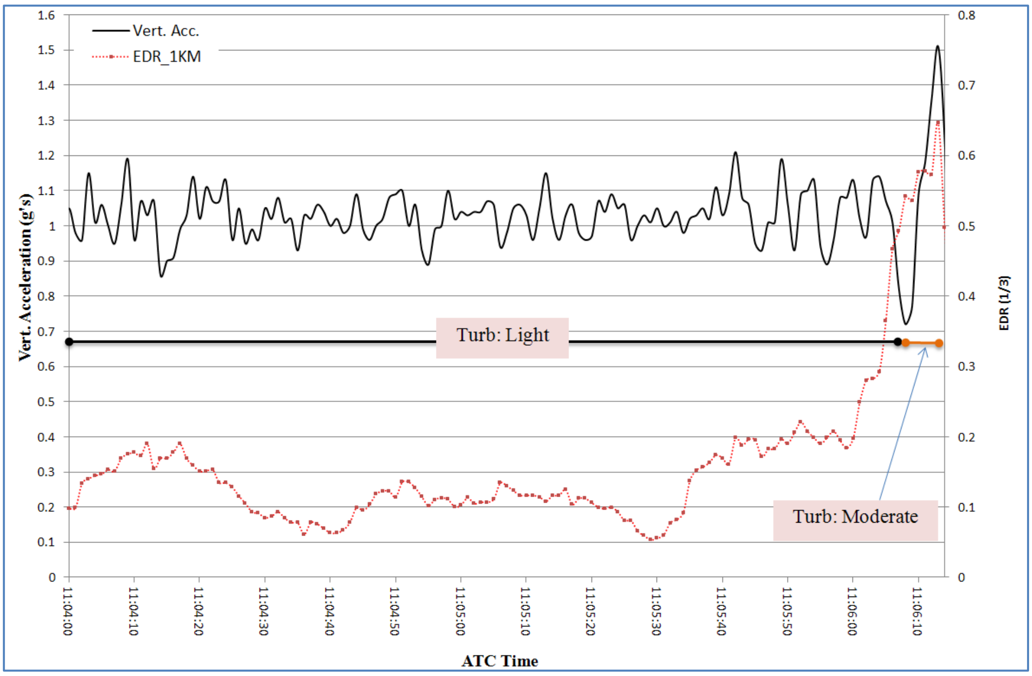

Figure 2.9-2 GE 222 vertical acceleration and calculated EDR (last two minutes)

2.10 Aircraft Systems

2.10.1 Aircraft Airworthiness

The evidence indicated that the occurrence aircraft was dispatched without defects and in compliance with all applicable airworthiness directives and service bulletins. There were no reported anomalies with the aircraft's navigation, autopilot or flight control systems in the six months before the occurrence. The CVR and FDR indicated no aircraft system or powerplant faults during the occurrence flight.

The wreckage examination indicated that the aircraft damage was the result of impact forces. Post-impact examination of primary components, including engines indicated no pre-impact anomalies. Based on the available evidence, there was no pre-existing engine, system, or structural problems with the occurrence aircraft.

2.10.2 Enhanced Ground Proximity Warning System

CVR transcripts, FDR data, and EGPWS computer NVM data indicated that no EGPWS warning activated during the approach before the aircraft collided with terrain.

The function of EGPWS is expected to automatically warn pilots if the aircraft was dangerously approaching to the terrain. However to prevent unwarranted warnings and the available technology used when the EGPWS being designed and developed, those factors limited EGPWS warning envelop boundaries.

The investigation study results indicated that the occurrence aircraft's approach profile was outside the EGPWS terrain warning zone, which meant that the crew did not receive a warning of an impending collision with terrain.

2.10.3 The New EGPWS Computer

During the investigation, the EGPWS manufacturer advised that a software update for newer EGPWS computers would have generated a "Too Low Terrain" warning because of the revised runway field clearance floor and terrain clearance floor envelopes.

The new -022 software was an evolution and is currently not compatible with the current EGPWS fitted on ATR72-500 fleet from a hardware point of view and there is no capability to upgrade existing EGPWS hardware 965-1216-XXX[133] certified on ATR72-500 to new EGPWS hardware that includes the -022 software. The latest version software (-022 and newer) of EGPWS has an improved terrain clearance floor mode and an increased terrain look-up time than the current version (-011).

To install the new EGPWS parts on the ATR72-500 aircraft is different from its original certification, the ATR provided the following response,

The modifications to implement the new EGPWS hardware that includes the -022 software can be developed in two ways:

- *As a type certificate (TC) holder, ATR can initiate a change to the Aircraft type certificate. ATR would have to develop the modification and associated Service Bulletin. In addition, this modification will require certification works to be performed.*
- *Via a supplemental type certificate (STC) which is a national*

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[133] The occurrence aircraft EGPWS hardware was 965-1216-011.

> *aviation authority-approved modification to the existing type certified aircraft. A STC can be developed by an entity other than the aircraft manufacturer i.e. an STC can be developed by the operator or a service provider for an operator and approved by the national aviation authority. As for the modification that can be done by ATR, the STC will require the same certification works to be performed.*

The EGPWS manufacturer's latest generation EGPWS equipment would have provided flight crews with an additional warning if aircraft encountered similar circumstances to the occurrence flight.

2.11 The FDR Recording Parameters Related Issues

The FDR recording contained 35 hours 41 minutes and 7 seconds of data. The total number of recorded parameters was 180. The FDR complied with the requirements of national and international regulations that the recording shall contain at least the last 25 hours of the operation. The number of mandatory recording parameters is 15 (Taiwan CAA) or 16 (ICAO)[134].

The following sections discuss the FDR readout document and TNA's FOQA event settings.

2.11.1 The FDR Readout Document

According to ICAO standards and CAA regulations [135], aircraft manufacturers shall provide the following flight recording system information to an appropriate authority: (a) operating instructions, equipment limitations and installation procedures; (b) origin or source of a flight parameter and its converting equation(s) to engineering units if any; and (c) manufacturer's test reports.

During the investigation, based on ATR's FDR readout document, three types of issues were identified with the non-mandatory FDR parameters:

(1) Erroneous definition for sign convention

The "left roll trim position" and "yaw trim position" contained erroneous definition for sign convention.

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[134] ICAO Annex 6 Part 1- 6.3.2.4 All aeroplanes of a maximum certificated take-off mass of over 5,700 kg, up to and including 27,000 kg, for which the individual certificate of airworthiness is first issued on or after 1 January 1989, shall be equipped with a Type II FDR.

[135] ICAO Annex 6, Annex 8, and CAA 07-02A Aircraft Flight Operation Regulations, Attachment 12.

(2) Mixture of two parameters into one

According to the FDR readout document, “vertical speed” was not recorded and only “selected vertical speed” was available. Investigators found that when the crew engaged vertical speed mode, the “selected vertical speed” parameter would record targeted vertical speed, otherwise current vertical speed was recorded.

(3) Unclear descriptions on several parameters

According to ATR’s FDR readout document, both parameters “DME 1” and “DME 2” were only recording in version 2B, configuration 3 (GE 222 is version 2B, configuration 1). In fact, both “DME 1” and “DME 2” were available and valid parameters. There were some unclear descriptions for the trigger conditions, such as: “yaw damper status.”

Only version 2B configuration 3 of ATRs readout document contained the recording status and modes of the electronic flight instrument system (EFIS), as well as those of the onboard weather radar. If that data had been available, they might have been very helpful to the investigation. After verification, ATR has issued two service bulletins[136], where all ATR72 FDR recording systems can be upgraded from configuration 1 to configuration 3, in order to record more flight parameters.

In summary, certain parameters listed in ATR’s FDR readout document contained unclear or erroneous information in their sign convention and triggering conditions. The parameter “selected vertical speed” was confusing and it had an adverse effect on the efficiency of the occurrence investigation. A reduction in the complexity of ATR’s FDR readout document, by applying the principles of ED-112A[137], would assist future occurrence investigations.

2.11.2 TNA’s FOQA Events Setting

FOQA is a program for the routine collection and analysis of flight data and provides information about the safety risks confronting flight operations. The program can provide objective information to enhance safety, training effectiveness, and operational procedures. The FOQA

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[136] ATR72 Service Bulletins: revision no. 4 of SB no. ATR72-31-1069, revision no. 5 of SB no. ATR72-31-1070 (2013/10/08)

[137] ED-112A Minimum operational performance specification for crash protected airborne recorder systems.

events will be extracted from the raw digital data stream based on parameters, threshold values, and/or routine operational measurements that are specified by the operator. The analysis may focus on events that fall outside normal operating boundaries as determined by the operator's operational standards.

The parameters and threshold values setting of the TNA FOQA program were in accordance with the manufacturer's suggestions. Based on the airline's FOQA system, on the day of occurrence, flight GE 220 triggered three red events: altitude below 500 feet - heading deviation greater than 20 degrees, GPWS warning triggered 24 seconds and level off below 1,400 feet above field elevation (AFE) exceeded 10 seconds. The occurrence flight GE222 triggered two red events: excessive bank angle on final approach below 100 feet AFE, and high rate of descent on approach between 500 and 50 Feet AFE. See Figure 2.11-1 for GE222 and GE220 flight profiles.

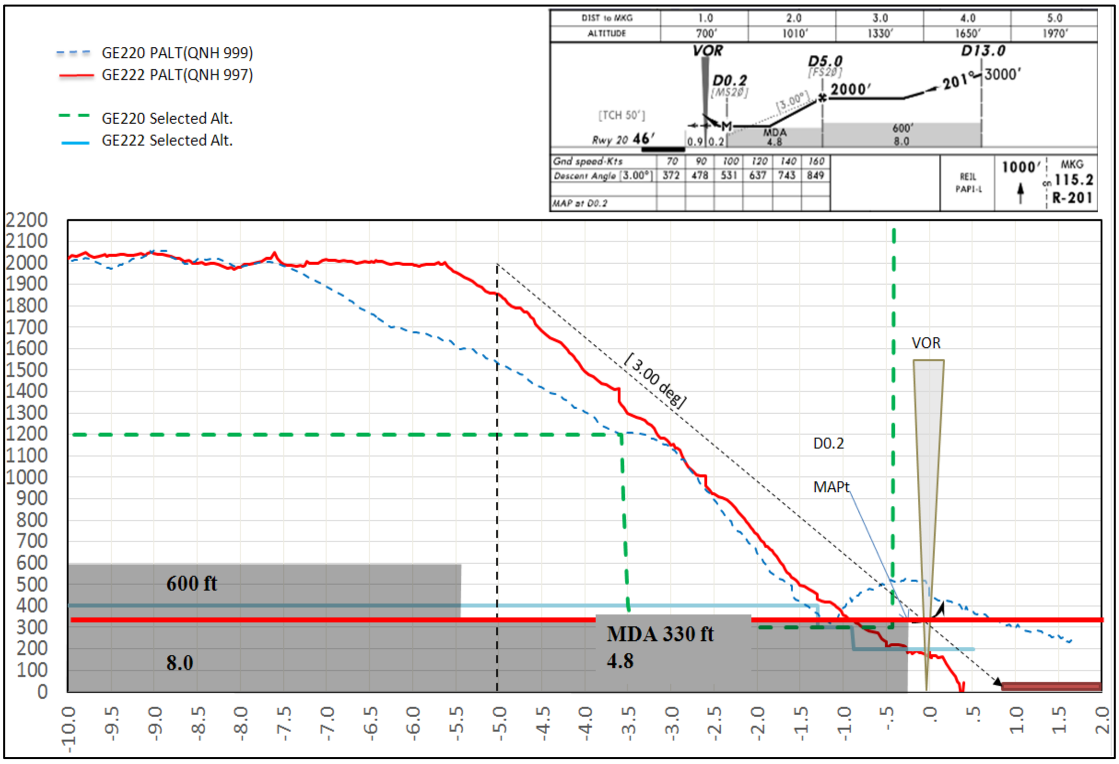

Figure 2.11-1 GE222 and GE220 flight profiles

However, the traditional FOQA program was not configured to be able to readily identify, without further analysis, those events that were indicative of non-compliance with SOPs including violations of approach procedures, such as descent below minimum safe altitudes. No current FOQA system can readily integrate all the required data sources needed to identify some violations of SOPs.

The European Authorities Coordination Group on Flight Data Monitoring (EAFDM)[138] has proposed a set of standard indicators for flight data monitoring events. For example, for CFIT and loss of control in flight (LOC-I) avoidance, EAFDM recommended not only monitoring a triggering altitude and the duration of that alert, but also setting up a severity index that considers the surrounding terrain and pilot maneuvering. In addition, the integration of contextual information with flight data such as time, visibility conditions, local weather conditions, aircraft mass and balance has been proposed. The EAFDM also suggested that the severity index of the events should consider aircraft limitations, flight crew decision-making requirements, crew reaction times to warnings or alerts, compliance with SOPs for go around, aircraft configuration and engine power settings, navigation mode settings and so on.

TNA’s flight operations division and safety and security office need to implement a more advanced FOQA program, with associated training and staff with the required technical expertise to amend system settings and provide more informative data analyses.

2.12 Aerodrome Factors

2.12.1 Approach Lighting System on Runway 20

An approach lighting system allows the flight crew to visually identify the runway environment and align the aircraft with the runway at the prescribed point on an approach.

According to the CAA Civil Aerodrome Design and Operation Guidance section 5.3.4.1[139], where physically practicable, a simple approach lighting system shall be provided to serve a non-precision approach and night operation runway, except when the runway is used only in conditions of good visibility or sufficient guidance is provided by other visual aids.

Magong runway 20 has a non-precision approach and is used for night operations. There is approximately 500 meters of extended space along the runway 20 centerline within the airport area. According to the regulations, a 420 meter simple approach lighting system should be installed to help

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[138] Guidance for National Aviation Authorities Setting up a national Flight Data Monitoring Forum (EAFDM, 2012, Oct.); Developing Standardized FDM-Based Indicators (EAFDM, 2013, Dec.)

[139] The contents in the CAA Aerodrome Design and Operation Guidance are almost identical with the ICAO Annex 14.

pilots visually identify the runway. Runway 20 did not have the required lighting system installed. The CAA advised that the Runway end identification lights (REIL), a flashing white light system, was installed at the runway's threshold as an alternative visual aid to replace the simple approach lighting system.

The intensity of the runway 20 REIL was 22,500 cd whereas a simple approach lighting system was 10,000 cd. The REIL system would have enabled the crew to more easily locate runway 20 visually on approach compared to a simple approach lighting system[140].

However, according to the CAA Civil Aerodrome Design and Operation Guidance 5.3.4.7[141] note 3, at locations where identification of the simple approach lighting system is difficult at night due to surrounding lights, sequence flashing lights installed on the outer portion of the system may resolve this problem.

The illumination or intensity of the sequence flashing lights installed on the outer portion of a simple approach lighting system was higher than the REIL system[142].

The MAPt for the runway 20 VOR approach was about 2,000 meters from the threshold. The visibility landing minima was 1,600 meters. There is a high likelihood that the occurrence flight crew would not have been able to visually identify the runway at the MAPt when the visibility was just above landing minima.

The installation of a simple approach lighting system with the sequence flashing lights on the outer portion would probably increase the likelihood of crews being able to visually locate the runway in degraded visibility in the future.

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[140] The illumination of the REIL on the distance about 2,000 meters (location of the MAPt) from threshold (location of the REIL) is 0.005625. The illumination of the outmost fixed lights (420 meters from threshold) of the simple approach lighting system on the distance of MAPt is 0.004.

[141] Note3— at locations where identification of the simple approaching system is difficult at night due to surrounding lights, sequence flashing lights installed outer portion of system may resolve this problem.

[142] The illumination of the sequence flashing lights installed outer portion of the simple approach lighting system on the MAPt will be 0.009

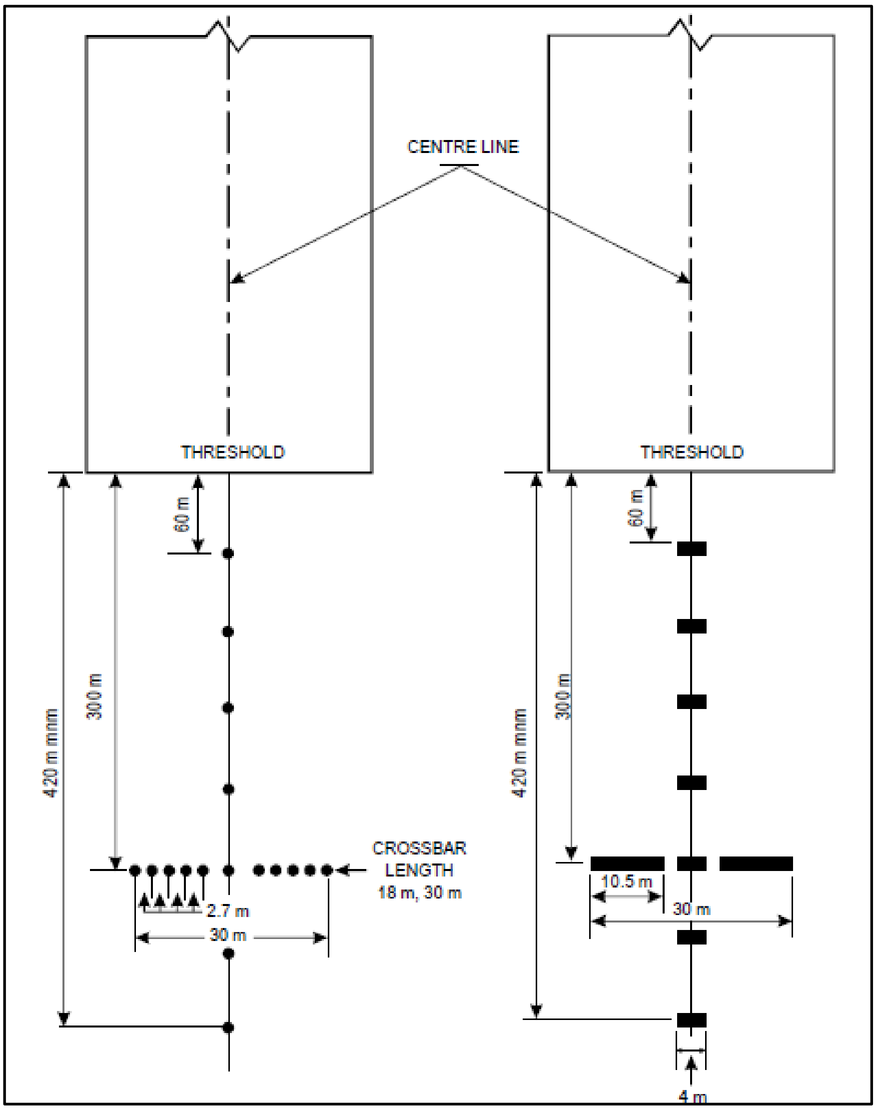

Figure 2.12-1 The typical simple approach lighting system

2.12.2 Determination of Aerodrome Operating Minimum

The runway 20 VOR approach was originally designed under the FAA TERPS standards. In order to comply with the ICAO standards, the CAA decided to adopt ICAO procedures for air navigation services – aircraft operations (PANS-OPS) criteria for the design of instrument flight procedures. After completing the instrument approach charts re-design, a Taipei flight information region (FIR) aeronautical information circular (AIC), dated 13 August, 2010, was issued to explain the differences between TERPS and PANS-OPS, and the different stages of implementing the conversions of charts.

The PANS-OPS criteria used an OCA/H rather than a minimum descent altitude/height (MDA/H), decision altitude/height (DA/H) in the approach charts. Furthermore, in accordance with ICAO DOC 8168 Aircraft Operations, the CAA was not required to issue visibility landing minima.

However, given that operators and the air traffic control system were accustomed to visibility landing minima the CAA still issued visibility landing minima in accordance with the TERPS visibility limitations guidance for instrument approach procedures[143] (refer to Table 2.12-1 Effect of HAT/HAA on Visibility Minimums). Therefore, according to the aeronautical information publication (AIP), the OCH for the runway 20 VOR approach was 284 feet. The visibility landing minima was 1,600 meters after considering the factors associated with a VOR/DME non-precision approach, approach category B, no approach lighting system (NALS), and no vertical guidance.

Table 2.12-1 Effect of HAT/HAA on Visibility Minimums

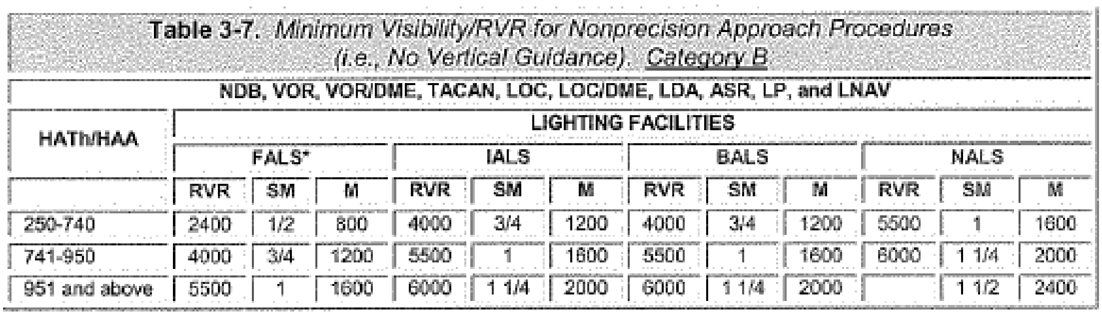

Table 3-7. *Minimum Visibility/RVR for Nonprecision Approach Procedures (i.e., No Vertical Guidance).* Category B

NDB, VOR, VOR/DME, TACAN, LOC, LOC/DME, LDA, ASR, LP, and LNAV

HATh/HAA	LIGHTING FACILITIES											
	FALS*			IALS			BALS			NALS		
	RVR	SM	M	RVR	SM	M	RVR	SM	M	RVR	SM	M
250-740	2400	1/2	800	4000	3/4	1200	4000	3/4	1200	5500	1	1600
741-950	4000	3/4	1200	5500	1	1600	5500	1	1600	6000	1 1/4	2000
951 and above	5500	1	1600	6000	1 1/4	2000	6000	1 1/4	2000		1 1/2	2400

***RVR in feet; SM: Statute Mile; M: Meter**

2.12.3 The Location of Missed Approach Point

According to the AIP, the distance from the runway 20 VOR missed approach point (MAPt) to the runway 20 threshold is 1.1 nautical miles (2,037.2 meters) (see Figure 2.12-2). The distance is longer than the published visibility landing minima of 1,600 meter.

The final approach segment for a non-precision approach procedure begins at the FAF and ends at the MAPt. Approaching aircraft need to descend to and maintain an altitude not below the Obstacle Clearance Altitude/Obstacle Clearance Height (OCA/OCH) and align with the runway. If the runway environment cannot be visually identified at the MAPt, the flight crew should execute the missed approach procedure.

According to ICAO DOC 8168 Volume II Part I section 4, paragraph 6.1.5.2, "*the optimum location of the MAPt is the runway threshold. Where necessary, the MAPt may be moved closer to the FAF…*". In practice, the instrument procedure designer will set the MAPt location with the objective to minimize the OCA/OCH heights.

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[143] FAA Order 8260.3B United States Standard for Terminal Instrument Procedures (TERPS).

The CAA used the PANS_OPS Designer software to calculate the OCA for the runway 20 VOR approach. The CAA advised that the calculations indicated if the MAPt was located at the threshold, the OCA would be 394 feet. If the MAPt was at 1.1 nm from the threshold, the OCA could be lowered to 328 feet. The investigation team asked the CAA to re-calculate the OCA for the runway 20 VOR approach by moving the MAPt to different locations toward the threshold. The results indicated that moving the MAPt to 0.8 nm (1,460 meters) from the threshold, the OCA was 328 feet.

With the same OCA, if the MAPt was set closer to the runway threshold, it would have increased the likelihood of crews being able to visually identify the runway in the future.

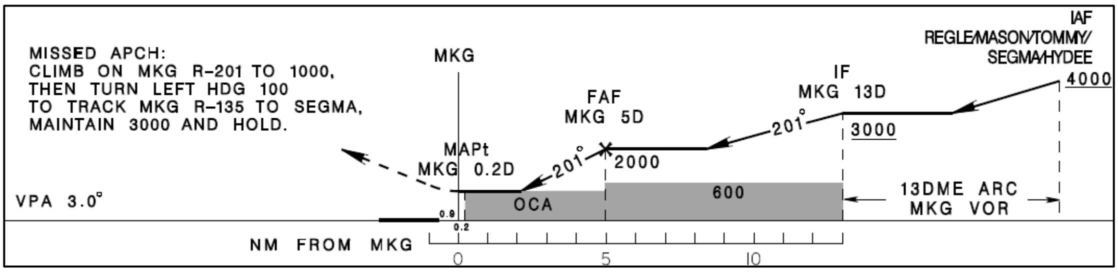

Figure 2.12-2 Magong MAPt location and runway 20 VOR approach procedure

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Chapter 3 Conclusions

In this Chapter, the Aviation Safety Council presents the findings derived from the factual information gathered during the investigation and the analysis of the occurrence. The findings are presented in three categories: **findings related to probable causes**, **findings related to risk**, and **other findings**.

The **findings related to probable causes** identify elements that have been shown to have operated in the occurrence, or almost certainly operated in the occurrence. These findings are associated with unsafe acts, unsafe conditions, or safety deficiencies associated with safety significant events that played a major role in the circumstances leading to the occurrence.

The **findings related to risk** identify elements of risk that have the potential to degrade aviation safety. Some of the findings in this category identify unsafe acts, unsafe conditions, and safety deficiencies including organizational and systemic risks, that made this occurrence more likely; however, they cannot be clearly shown to have operated in the occurrence alone. Furthermore, some of the findings in this category identify risks that are unlikely to be related to the occurrence but, nonetheless, were safety deficiencies that may warrant future safety actions.

Other findings identify elements that have the potential to enhance aviation safety, resolve a controversial issue, or clarify an ambiguity point which remains to be resolved. Some of these findings are of general interests that are often included in the ICAO format accident reports for informational, safety awareness, education, and improvement purposes.

3.1 Findings Related to Probable Causes

Flight Operations

1. The flight crew did not comply with the published runway 20 VOR non-precision instrument approach procedures at Magong Airport with respect to the minimum descent altitude (MDA). The captain, as the pilot flying, intentionally descended the aircraft below the published MDA of 330 feet in the instrument meteorological conditions (IMC) without obtaining the required visual references. (1.1, 1.18.1.4, 2.2.1.1, 2.3.1)
2. The aircraft maintained an altitude between 168 and 192 feet before and just after overflying the missed approach point (MAPt). Both pilots spent about 13 seconds attempting to visually locate the runway environment, rather than commencing a missed approach at or prior to the MAPt as required by the published procedures. (1.1, 2.2.1.1)

3. As the aircraft descended below the minimum descent altitude (MDA), it diverted to the left of the inbound instrument approach track and its rate of descent increased as a result of the flying pilot’s control inputs and meteorological conditions. The aircraft’s hazardous flight path was not detected and corrected by the crew in due time to avoid the collision with the terrain, suggesting that the crew lost situational awareness about the aircraft’s position during the latter stages of the approach. (1.1, 1.11.4.2, 2.2.1.1, 2.9)
4. During the final approach, the heavy rain and associated thunderstorm activity intensified producing a maximum rainfall of 1.8 mm per minute. The runway visual range (RVR) subsequently reduced to approximately 500 meters. The degraded visibility significantly reduced the likelihood that the flight crew could have acquired the visual references to the runway environment during the approach. (1.7, 2.2.1.1, 2.8)
5. Flight crew coordination, communication, and threat and error management were less than effective. That compromised the safety of the flight. The first officer did not comment about or challenge the fact that the captain had intentionally descended the aircraft below the published minimum descent altitude (MDA). Rather, the first officer collaborated with the captain’s intentional descent below the MDA. In addition, the first officer did not detect the aircraft had deviated from the published inbound instrument approach track or identify that those factors increased the risk of a controlled flight into terrain (CFIT) event. (1.1, 1.18.7, 2.2.1.1, 2.3.1, 2.4.1, 2.4.2, Appendix 3)
6. None of the flight crew recognized the need for a missed approach until the aircraft reached the point (72 feet, 0.5 nautical mile beyond the missed approach point) where collision with the terrain became unavoidable. (1.1, 1.18.1.4, 2.2.1.1)
7. The aircraft was under the control of the flight crew when it collided with foliage 850 meters northeast of the runway 20 threshold, two seconds after the go around decision had been made. The aircraft sustained significant damage and subsequently collided with buildings in a residential area. Due to the high impact forces and post-impact fire, the crew and most passengers perished. (1.11.4.2, 1.12.1, 1.13, 2.2.1.1)
8. According to the flight recorders data, non-compliance with standard operating procedures (SOPs) was a repeated practice during the occurrence flight. The crew’s recurring non-compliance with SOPs constituted an operating culture in which high risk practices were

routine and considered normal. (1.18.1.4, 2.3.1)

9. The non-compliance with standard operating procedures (SOPs) breached the obstacle clearances of the published procedure, bypassed the safety criteria and risk controls considered in the design of the published procedures, and increased the risk of a controlled flight into terrain (CFIT) event. (1.18.7, 2.2.1.1, 2.3.1)

Weather

10. Magong Airport was affected by the outer rainbands of Typhoon Matmo at the time of the occurrence. The meteorological conditions included thunderstorm activities of heavy rain, significant changes in visibility, and changes in wind direction and speed. (1.7, 2.2.1, 2.8)

3.2 Findings Related to Risk

Flight Operations

1. The captain did not conduct a descent and approach briefing as required by standard operating procedures (SOPs). The first officer did not question the omission of that required briefing. That deprived the crew of an opportunity to assess and manage the operational risks associated with the approach and landing. (1.1, 1.18.1.4, 2.2.1.1, 2.3.1, Appendix 3)

2. The captain was likely overconfident in his flying skills. That might lead to his decision to continue the approach below the minimum descent altitude (MDA) without an appreciation of the safety risks associated with that decision. (1.18.8.2, 2.4.3)

3. The results of the fatigue analysis indicated that, at the time of the occurrence, the captain's performance was probably degraded by his fatigue accumulated from the multiple sectors/day flown and flight and duty times during the months preceding the occurrence. (1.5.5, 1.17.3.2.1, 2.3.3.3, 2.4.4)

4. The TransAsia Airways observation flights conducted by the investigation team and the interviews with members of the airline's flight operations division show prevalent tolerance for non-compliance with procedures within the airline's ATR fleet. (1.16.4, 1.18.8.2, 2.3.3)

5. The non-compliances with standard operating procedures (SOPs) during the TransAsia Airways' ATR simulator training sessions were observed by the investigation team but not corrected by the instructors. The tolerance for or normalization of SOPs non-compliance behaviors

was symptomatic of an ineffective check and training system with inadequate supervision by the airline’s flight operations management. (1.16.5, 2.3.3.2)

6. The non-compliance with standard operating procedures (SOPs) was not restricted to the occurrence flight but was recurring, as identified by previous TransAsia Airways ATR occurrence investigations, line observations, simulator observations, internal and external audits or inspections, and interviews with TransAsia Airways flight operations personnel, including managers. The non-compliant behaviors were an enduring, systemic problem and formed a poor safety culture within the airline’s ATR fleet. (1.16.4, 1.16.5, 1.17.1.1, 1.17.8.2.1, 1.17.10, 1.18.8.2, 2.3.2, 2.4.2)

Airline Safety Management

7. The TransAsia Airways’ inadequate risk management processes and assessments, ineffective safety meetings, unreliable and invalid safety risk indices, questionable senior management commitment to safety, inadequate safety promotion activities, underdeveloped flight operations quality assurance (FOQA) system, and inadequate safety and security office and flight operations resources and capabilities constituted an ineffective safety management system (SMS). (1.17.4, 1.17.5, 1.17.6, 1.17.7, 1.17.9, 1.17.10, 2.3.3.1,2.3.33, 2.5)
8. The safety risks associated with change within the TransAsia Airways were not assessed and mitigated. For example, the company did not assess or mitigate the safety risks associated with the increase in ATR operational tempo as a result of the recent increase in ATR fleet size and crew shortage that, in turn, elevated crew flying activities and the potential safety risks associated with crew fatigue. (1.17.3.2.1, 2.3.3.3)
9. Findings regarding non-compliance with standard operating procedures (SOPs) during operations by the TransAsia Airways’ ATR crews had been identified by previous Aviation Safety Council occurrence investigations. The proposed corrective safety actions were not implemented by the airline. (1.17.10, 2.3.2, 2.7.5)
10. TransAsia Airways self-audits were mostly spot checks rather than system audits or system self-evaluations. The self-audits failed to assess and address those safety deficiencies, including standard operating procedures non-compliance behaviors, lack of standardization in pilot check and training activities, and high crew flying activities on the ATR fleet. Such deficiencies had been pointed

out in previous occurrences and audits and were considered by senior flight operations managers as problems. (1.17.8, 2.5.4)

11. The TransAsia Airways annual audit plan did not include an evaluation of the implementation and/or effectiveness of corrective actions in response to the safety issues identified in previous audits, regulatory inspection findings, or safety occurrence investigation recommendations. The airline’s self-audit program was not consistent with the guidance contained in AC-120-002A. (1.17.8, 2.5.4)
12. The TransAsia Airways had not developed a safety management system (SMS) implementation plan. This led to a disorganized, nonsystematic, incomplete and ineffective implementation, which made it difficult to establish robust and resilient safety management capabilities and functions. (1.17.2, 2.6.1)
13. The Civil Aeronautics Administration’s (CAA) safety management system (SMS) assessment team had identified TransAsia Airways’ SMS deficiencies, but TransAsia Airways failed to respond to the CAA’s corrective actions request. That deprived the airline of an opportunity to improve the level of safety assurance in its operations. (1.17.2, 2.6.2)
14. The TransAsia Airways did not implement a data-driven fatigue risk management system (FRMS) or alternative measures to manage the operational safety risks associated with crew fatigue due to fleet expansion and other operational factors. (1.17.3.2.1, 2.4.4)
15. The ATR flight operation did not include in its team a standards pilot to oversee standard operating procedures (SOPs) compliance, SOP-related flight operations quality assurance (FOQA) events handling, and standard operations audit (SOA) monitoring before the GE222 occurrence. (1.17.3.1, 1.17.6.3, 2.3.3.1, 2.5.3)
16. The safety and security office, due to resource and capability limitations, was unable to effectively accomplish the duties they were required to undertake. (1.17.4.2, 2.5.1)
17. The safety and security office staff was not included in the flight safety action group. That deprived the airline of an opportunity to identify, analyze and mitigate flight safety risks more effectively in the flight operations. (1.17.4.1.1, 2.5.1)
18. The TransAsia Airways’ safety management system was overly dependent on its internal reactive safety and irregularity reporting system to develop full awareness of the airline’s safety risks. It did

not take advantage of the instructive material from external safety information sources. That limited the capability of the system to identify and assess safety risks. (1.17.5, 1.17.7.1, 2.5.2)

19. The TransAsia Airways' flight operations quality assurance (FOQA) settings and analysis capabilities were unable to readily identify those events involving standard operating procedures (SOPs) non-compliance during approach and likely other stages of flight. The FOQA events were not analyzed sufficiently or effectively, leaving some safety issues in flight operations unidentified and uncorrected. Some problems with crew performance and reductions in safety indicated in the FOQA trend analyses were not investigated further. Clearly, the airline's FOQA program was not used to facilitate proactive operational safety risk assessments. (1.17.6, 2.5.3)

Civil Aeronautics Administration

20. The Civil Aeronautics Administration's oversight of TransAsia Airways did not identify and/or correct some crucial operational safety deficiencies, including crew non-compliance with procedures, non-standard training practices, and unsatisfactory safety management practices. (1.17.1, 1.17.2.2, 2.7)
21. To develop and maintain a safety management system (SMS) implementation plan at TransAsia Airways was not enforced by the Civil Aeronautics Administration. That deprived the regulator of an opportunity to assess and ensure that the airline had the capability to implement a resilient SMS. (1.17.2.2, 2.6.1)
22. Issues regarding the TransAsia Airways' crew non-compliance with standard operating procedures (SOPs) and deficiencies with pilot check and training had previously been identified by the Aviation Safety Council investigation reports. However, the Civil Aeronautics Administration (CAA) did not monitor whether the operator has implemented the recommended corrective actions; correlatively, the CAA failed to ensure the proper measures for risk reduction have been adopted. (1.17.10, 2.7.6)
23. The Civil Aeronautics Administration provided limited guidance to its inspectors to enable them to effectively and consistently evaluate the key aspects of operators' management systems. These aspects included evaluating organizational structure and staff resources, the suitability of key personnel, organizational change, and risk management processes. (1.17.1, 2.7)
24. The Civil Aeronautics Administration did not have a systematic

process for determining the relative risk levels of airline operators. (1.17.1, 2.7)

Air Traffic Service and Military

25. The runway visual range (RVR) reported in the Magong aerodrome routine meteorological reports (METAR) and the aerodrome special meteorological reports (SPECI) was not in accordance with the requirements documented in the Air Force Meteorological Observation Manual. (1.7.2, 1.18.6, 2.8.3.2)
26. The discrepancies between the reported runway visual range (RVR) and automated weather observation system (AWOS) RVR confused the tower controllers about the reliability of the AWOS RVR data. (1.18.8.8, 2.8.3.1)
27. During the final approach, the runway 20 runway visual range (RVR) values decreased from 1,600 meters to 800 meters and then to a low of about 500 meters. The RVR information was not communicated to the occurrence flight crew by air traffic control. Such information might influence the crew's decision regarding the continuation of the approach. (1.7.4, 2.8.3.1)

3.3 Other Findings

1. The flight crew were properly certificated and qualified in accordance with the Civil Aeronautics Administration and company requirements. No evidence indicated any pre-existing medical conditions that might have adversely affected the flight crew's performance during the occurrence flight. (1.5, 1.13, 2.1)
2. The airworthiness and maintenance of the occurrence aircraft were in compliance with the extant civil aviation regulations. There were no aircraft, engine, or system malfunctions that would have prevented normal operation of the aircraft. (1.12, 2.1)
3. All available evidence, including extensive simulations, indicated that the enhanced ground proximity warning system (EGPWS) functioned as designed. (1.6.3, 1.16.1, 1.16.2, 2.10.2)
4. The enhanced ground proximity warning system (EGPWS) manufacturer's latest generation EGPWS equipment would have provided flight crews with an additional warning if aircraft encountered similar circumstances to the occurrence flight. Installing the latest EGPWS equipment on the occurrence aircraft would have required approved modifications. (1.6.3, 1.16.2, 2.10.3)

5. According to the Civil Aeronautics Administration (CAA) regulations, a 420 meter simple approach lighting system should have been installed to help pilots visually identify runway 20. The CAA advised that the Runway End Identification Lights, a flashing white light system, was installed at the runway's threshold as an alternative visual aid to replace the simple approach lighting system. (1.10.2, 2.12.1)
6. From the perspective of flight operations, the location of the runway 20 VOR missed approach point (MAPt) was not in an optimal position. With the same Obstacle Clearance Altitude, if the MAPt had been set closer to the runway threshold, it would have increased the likelihood of flight crews to visually locate the runway. (1.18.3, 1.18.4, 2.12.3)
7. During holding, the occurrence flight crew requested the runway 02 instrument landing system (ILS) approach after receiving the weather information that the average wind speed for runway 02 had decreased to below the tailwind landing limit. While the decision for the use of the reciprocal runway was still under consideration by the Magong Air Force Base duty officer, the weather report indicated that the visibility had improved to 1,600 meters, which met the landing visibility minimal requirement for an approach to runway 20. The flight crew subsequently amended their request and elected to use runway 20. (1.1, 1.18.5, 2.8.4)
8. At the time of the occurrence, the weather information exchange and runway availability coordination between civil and military personnel at Magong's joint-use airport could have been more efficient. (1.18.8.6, 1.18.8.7, 2.8)
9. ATR's flight data recorder (FDR) readout document contained unclear information. That affected the efficiency of the occurrence investigation. (1.11.2, 2.11.1)

Chapter 4 Safety Recommendations

4.1 Recommendations

<u>To TransAsia Airways</u>

1. Implement effective safety actions to rectify the multiple safety deficiencies previously identified by the Aviation Safety Council investigations, internal and external Civil Aeronautics Administration audit and inspection findings, and deficiencies noted in this report to reduce the imminent safety risks confronting the airline. (ASC-ASR-16-01-010)
2. Conduct a thorough review of the airline's safety management system and flight crew training programs, including crew resource management and threat and error management, internal auditor training, safety management system (SMS) training and devise systematic measures to ensure:
   - Flight crew check and training are standardized;
   - All flight crews comply with standard operating procedures (SOPs);
   - Staff who conduct audits receive appropriate professional auditor training;
   - All operational and senior management staff receive SMS training, including thorough risk assessment and management training; and
   - Proportional and consistent rules, in accordance with a "Just Culture", are implemented to prevent flight crew from violating the well-designed SOPs and/or being engaged in unsafe behavior.

   (ASC-ASR-16-01-011)
3. Conduct a rigorous review of the safety management system (SMS) to rectify the significant deficiencies in:
   - Planning;
   - Organizational structure, capability and resources;
   - Risk management processes and outputs;
   - Flight operations quality assurance (FOQA) limitations and operations, including inadequate data analysis capabilities;

- Safety meetings;
- Self-audits;
- Safety performance monitoring, including risk indices;
- Safety education; and
- Senior management commitment to safety.

(ASC-ASR-16-01-012)

4. Rectify the human resources deficits in the flight operations division and the safety and security office, including:
   - Crew shortages;
   - Inadequate support staff in the Flight Standards and Training Department, including insufficient standards pilots and crew to conduct operational safety risk assessments; and
   - Safety management staff with the required expertise in flight operations, safety and flight data analytics, safety risk assessment and management, human factors, and safety investigations.

   (ASC-ASR-16-01-013)

5. Review and improve the airline’s internal compliance oversight and auditing system and implement an effective corporate compliance and quality assurance system to ensure that oversight activities provide the required level of safety assurance and accountability. (ASC-ASR-16-01-014)

6. Implement an effective safety management process, such as a data-driven fatigue risk management system (FRMS), to manage the flight safety risks associated with crew fatigue. (ASC-ASR-16-01-015)

7. Provide flight crew with adequate fatigue management education and training, including the provision of effective strategies to manage fatigue and performance during operations. (ASC-ASR-16-01-016)

8. Implement an effective change management system as a part of the airline’s safety management system (SMS) to ensure that risk assessment and mitigation activities are formally conducted and documented before significant operational changes are implemented, such as the introduction of new aircraft types or variants, increased operational tempo, opening new ports, and so on.

(ASC-ASR-16-01-017)

9. Implement a more advanced flight operations quality assurance (FOQA) program with adequate training and technical support for the FOQA staff to ensure that they can exploit the analytical capabilities of the program. As such, the FOQA staff can more effectively identify and manage the operational safety risks confronting flight operations. (ASC-ASR-16-01-018)

10. Implement an effective standard operating procedures (SOPs) compliance monitoring system, such as the line operations safety audit (LOSA) program, to help identifying threats to operational safety and to minimize the associated risks. The system should adopt a data-driven method to assess the level of organizational resilience to systemic threats and can detect issues such as habitual non-compliance with SOPs. (ASC-ASR-16-01-019)

<u>To Civil Aeronautics Administration</u>

1. Strengthen surveillance on TransAsia Airways to assess crew's discipline and compliance with standard operating procedures (SOPs). (ASC-ASR-16-01-020)

2. Implement a more robust process to identify safety-related shortcomings in operators' operations, within an appropriate timescale, to ensure that the operators meet and maintain the required standards. (ASC-ASR-16-01-021)

3. Provide inspectors with detailed guidance on how to evaluate the effectiveness of an operator's safety management system (SMS), including:

   - Risk assessment and management practices;
   - Change management practices;
   - Flight operations quality assurance (FOQA) system and associated data analytics; and
   - Safety performance monitoring.

   (ASC-ASR-16-01-022)

4. Provide inspectors with comprehensive training and development to ensure that they can conduct risk-based surveillance and operational oversight activities effectively. (ASC-ASR-16-01-023)

5. Enhance inspector supervision and performance evaluation to ensure

all inspectors conduct surveillance activities effectively and are able to identify and communicate critical safety issues to their supervisors. (ASC-ASR-16-01-024)

6. Enhance the oversight of operators transitioning from traditional safety management to safety management systems. (ASC-ASR-16-01-025)
7. Develop a systematic process for determining the relative risk levels of airline operators. (ASC-ASR-16-01-026)
8. Review the current regulatory oversight surveillance program with a view to implementing a more targeted risk-based approach for operator safety evaluations. (ASC-ASR-16-01-027)
9. Ensure all safety recommendations issued by the occurrence investigation agency are implemented by the operators. (ASC-ASR-16-01-028)
10. Develop detailed guidance for operators to implement effective fatigue risk management processes and training. (ASC-ASR-16-01-029)
11. Review runway approach lighting systems in accordance with their existing radio navigation and landing aids to ensure that adequate guidance is available for pilots to identify the visual references to the runway environment, particularly in poor visibility condition or at night. (ASC-ASR-16-01-030)
12. Review the design procedures for determining the location of missed approach point with the intention of increasing the likelihood of pilots to locate the runway without compromising the required obstacle clearance altitude. (ASC-ASR-16-01-031)
13. Request tower controllers to advise the flight crews of aircraft on final approach of the updated information in accordance with the provisions of the air traffic management procedures (ATMP). (ASC-ASR-16-01-032)
14. Coordinate with Air Force Command Headquarters to review and improve the weather information exchange and runway availability coordination between civil air traffic control and military personnel at Magong Airport. (ASC-ASR-16-01-033)

To ATR-GIE Avions de Transport Régional

1. Evaluate the feasibility of a modification to allow the new enhanced ground proximity warning system (EGPWS) to be fitted on

all ATR72-500 aircraft. (ASC-ASR-16-01-034)

2. Review the flight data recorder (FDR) readout document for any erroneous information and provide timely revisions of the manual to assist airline operators and aviation occurrence investigation agencies. (ASC-ASR-16-01-035)

To Air Force Command Headquarters, Ministry of National Defense

1. Coordinate with the Civil Aeronautics Administration to ensure the reliability and validity of automated weather observation system (AWOS) runway visual range (RVR) sensors and their data. (ASC-ASR-16-01-036)
2. Conduct the runway visual range (RVR) reporting operations and requirements in accordance with the provisions of the Air Force Meteorological Observation Manual. (ASC-ASR-16-01-037)
3. Coordinate with the Civil Aeronautics Administration to review and improve the weather information exchange and runway availability coordination between civil air traffic control and military personnel at Magong Airport. (ASC-ASR-16-01-038)

4.2 Safety Actions Accomplished

4.2.1 Civil Aeronautics Administration

On 6 October 2015, Civil Aeronautics Administration provided the safety actions accomplished or being accomplished after the GE222 occurrence. Those actions were not verified by the Aviation Safety Council. The information is in the“Appendix 5-4 Comments on ASC’s Final Draft Report from Civil Aeronautics Administration.”

4.2.2 TransAsia Airways

On 18 December 2015, TransAsia Airways provided the safety actions accomplished or being accomplished after the GE222 occurrence. Those actions were not verified by the Aviation Safety Council. The information is in the“Appendix 5-5 Comments on ASC’s Final Draft Report from TransAsia Airways.”

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Appendix 1　Sequence of ATS Weather Communications

Time	Event
1700	MZG (Magong) METAR at 1700 (ATIS I): wind from 200 degrees at 18 knots gusting to 28 knots, visibility 2,400 meters in thunderstorm rain, thunderstorm overhead.
1724:23	The military MZG weather forecast officer (WFO) informed the Air Force Base (AFB) duty officer that the typhoon warning for Magong Airport will be terminated at 1730. However, a hazardous weather forecast will be issued from 1730 to 1930.
1728:58	GE222 flight crew acknowledged thunderstorm overhead Magong Airport from KHH Ground controller and proceeded to depart.
1740	MZG SPECI at 1740 (ATIS K): wind from 190 degrees at 21 knots gusting to 31 knots, visibility 800 meters in thunderstorm rain, thunderstorm overhead.
1741:03	Military MZG weather watch office (WWO) informed MZG tower of 1740 SPECI.
1742:42	GE222 flight crew acknowledged that the weather at Magong Airport was below landing minima from KHH Ground controller and proceeded to depart.
1743:26	The MZG WFO informed MZG tower that the termination time for the typhoon warning will be amended to 1740. However, a hazardous weather forecast will be issued from 1740 to 1940.
1745:35	The MZG WFO informed the MZG WWO that the typhoon warning will be terminated at 1740. A hazardous weather forecast will then be issued from 1740 to 1940. The military MZG weather observer (WO) informed the MZG WFO that the visibility was less than 1,200 meters. The MZG WFO replied to report what the actual weather was.
1750:51	The MZG WFO informed the AFB duty officer that the termination time for the typhoon warning will be amended to 1740. A hazardous weather forecast will then be issued till 1940.
1753:54	MZG tower asked the MZG WFO if the visibility will soon increase to 1,600 meters. The MZG WFO advised that the visibility will not increase.
1756:28	The KHH approach controller informed the GE222 flight crew that the weather for Magong Airport was below landing minima and instructed them to join the SEGMA holding pattern.

1756:56	The KHH approach controller broadcasted a hazardous weather forecast report for Magong Airport.
1759:36	MZG WWO informed MZG tower of the 1800 MZG METAR.
1800	MZG METAR at 1800 (ATIS L): wind from 220 degrees at 17 knots gusting to 27 knots, visibility 800 meters in heavy thunderstorm rain, thunderstorm overhead.
1803:52	The KHH approach controller informed the GE222 flight crew that the current ATIS was Lima (L).
1804:10	MZG local controller called the MZG WFO to ask if the automated weather observing system (AWOS) runway visual range (RVR) readout was correct and usable because the MZG WWO had said that the METAR/SPECI RVR value referred to the AWOS, which required manual adjustment. The MZG WFO confirmed that the AWOS was serviceable.
1816:50	The GE222 flight crew requested weather information for Magong Airport.
1816:55	KHH Approach asked MZG Tower if the weather at MZG was going to improve.
1817:21	MZG Tower asked the MZG WFO if the weather was going to improve. The MZG WFO replied “standby”.
1818:27	MZG WFO contacted MZG Tower and advised that the rain would last for about 1 hour and the visibility would not improve.
1818:53	MZG WFO then contacted MZG WWO. MZG WO told the MZF WFO that visibility was improving but that another wave of weather would soon arrive. The WFO replied that the current visibility remained applicable.
1820:26	MZG Tower informed KHH Approach that the thunderstorm would probably continue for another hour and visibility would not change. KHH Approach then asked MZG Tower to ask about the visibility again.
1821:42	KHH Approach controller broadcasted thunderstorm will probably continue for another hour.

1821:59	MZG Tower asked the MZG WFO about visibility again and the WFO replied that the visibility was improving a little bit but that another wave of weather would soon arrive. Visibility was estimated to deteriorate significantly. The visibility report would not change. MZG Tower then asked about the likelihood of the visibility improving before the next wave of weather to which the WFO replied it's about right now. The WFO then inquired of the aircraft's position and MZG Tower replied that the aircraft was holding over the airport.
1824:00	KHH Approach informed MZG Tower that the GE222 crew had asked if there was any temporary break in the MZG weather. MZG Tower replied that the MZG WFO had advised that the weather was improving a little bit but that another wave of weather would soon arrive and the situation would deteriorate.
1824:30	MZG Tower asked the MZG WFO when the visibility would improve. The WFO replied that the visibility might improve in ten minutes but it would then deteriorate once again in another 10 to 20 minutes.
1824:56	MZG Tower informed KHH Approach that MZG visibility might improve in ten minutes but would then deteriorate once again in another 10 to 20 minutes. KHH Approach then asked about the current MZG ceiling and visibility values.
1825:27	MZG Tower asked the MZG WFO to estimate what the visibility might rise to. The WFO replied that visibility might improve a little bit but the visibility report of 800 meters would not be changed because the visibility will soon deteriorate again. MZG Tower then asked the WFO for changes in wind information to which the WFO replied that the current wind for runway 20 was 17 knots gusting to 27 knots but would reduce to 12-15 knots in a few minutes.
1826:42	MZG Tower informed KHH Approach that MZG visibility might improve a little bit but the MZG visibility report would not be changed. MZG Tower then advised that the average wind speed was 17 knots maximum 27 knots, runway 02 instant wind was 210 degrees at 5 knots maximum 11 knots, runway 20 instant wind was 190 degrees at 11 knots maximum 15 knots.
1827:00	MZG WFO informed the MZG WWO of the weather information provided to MZG Tower a moment ago and that some aircraft were holding over the airport because of visibility.
1827:24	GE222 flight crew changed radio frequency to MZG Tower and requested weather information.

1827:38	MZG Tower replied that the forecast visibility will remain at 800 meters and the 10 minute average wind was 220 degrees at 17 knots maximum 27 knots; runway 02 instant wind was 210 degrees at 6 knots maximum 11 knots, runway 20 instant wind was 200 degrees at 12 knots maximum 16 knots.
1827:39	KHH Approach controller broadcasted that the runway 02 wind was 210 degrees at 5 knots maximum 11 knots, runway 20 wind was 190 degrees at 11 knots maximum 15 knots, with a visibility of 800 meters but would improve, however, no adjustment would be issued.
1829	Uni Airways B7647 and GE222 flight crews both requested radar vectors for the runway 02 ILS approach.
1829:44	KHH Approach coordinator asked MZG Tower to apply to the military to use the different runway.
1829:58	MZG Tower informed the military flight control office (FCO) that there were 3 or 4 aircraft requesting a different runway at MZG because of visibility.
1830	MZG METAR at 1830 (ATIS M): wind from 200 degrees at 14 knots gusting to 24 knots, visibility 800 meters in heavy thunderstorm rain, thunderstorm overhead.
1830:19	MZG WWO informed MZG Tower of the 1830 METAR.
1831:05	The FCO informed the combat information office (CIO) that there were 3 or 4 aircraft requesting a different runway at MZG due to visibility.
1833:35	The CIO informed the MZG AFB duty officer that there were 3 aircraft requesting a different runway due to visibility. The runway in use was runway 20. The AFB duty officer asked if there was a visibility or equipment problem and wanted to know the real reason.
1833:41	The KHH Approach coordinator asked MZG Tower to expedite the application for a change of runway with the military.
1834:55	The AFB duty officer called the military MZG Weather Center and asked for the current visibility and the reply was 800 meters. The AFB duty officer then asked for the wind and ceiling information. He was informed that the wind was from 200 degrees at 14 knots gusting to 24 knots, ceiling at 600 feet. The AFB duty officer then said it was OK to use runway 20.

1834:56	The FCO asked MZG Tower if the aircraft requested a different runway because of the visibility. MZG Tower replied it's due to visibility because the minima for the runway 02 ILS approach included a visibility of 750 meters. The visibility minima for the runway 20 VOR approach was 1,600 meters.
1835:09	B7647 requested MZG METAR.
1836:05	The CIO told the AFB duty officer that MZG Tower said that the visibility minima for runway 02 was lower so they requested different runway. The AFB duty officer replied that he had just obtained the visibility information from the Weather Center and a visibility of 800 meters was in line with the provisions.
1836:21	KHH approach controller advised MZG ATIS information 'Mike' (M), visibility 800 meters in thunderstorm shower, thunderstorm overhead, clouds few 200 feet scattered 600 feet few CB 1,200 feet broken 1,600 feet.
1836:27	KHH Approach coordinator asked MZG Tower for the phone number of the Magong AFB duty officer after MZG tower advised that the duty officer had not yet approved the application for a change of runway.
1836:51	B7647 requested radar vectors for the runway 02 ILS approach.
1836:55	KHH approach controller advised that the change of runway application was still in process.
1837:15	The FCO told MZG Tower that the AFB duty officer thought that weather was consistent with runway 20 approach minima. MZG Tower replied that the visibility was 800 meters and therefore only the runway 02 approach minima were applicable.
1837:24	KHH approach inquired about the change of runway application again but MZG Tower replied it was still under coordination.
1837:45-1849:32	KHH approach supervisor called the MZG AFB duty officer to request a different runway for landing. (At 1843:20, the KHH Approach supervisor was told that runway 20 met the approach standard and the application was cancelled).

1838:35	The MZG WFO called the WO to inquire about the actual visibility. The WFO then asked the WO to report the improved visibility first and then to report another one when the weather deteriorated. (The communications recording had been interrupted and the middle part of the call was not recorded. From the post-occurrence WFO interview, the WFO called to inquire about the current visibility. The WO then went outside to observe the weather without hanging up the phone. The WFO recalled that the WO replied that the visibility was somewhere between 1,600 to 2,400 meters).
1838:49	The WFO informed MZG Tower that the WWO was still observing the weather and would increase the reported visibility.
1839:26	The WWO advised the meteorological office (MO) to report a visibility of 1,600 to 2,400 meters. The MO replied that another wave of weather would soon arrive and the visibility would deteriorate. The WWO asked the MO to report a visibility of 1,600 meters first because the landing minimum was 1,600 meters.
1840	MZG SPECI at 1840 (ATIS N): wind from 190 degrees at 13 knots gusting to 24 knots, visibility 1,600 meters in thunderstorm rain, thunderstorm overhead.
1840:14	The WFO informed MZG Tower that the visibility had increased to 1,600 meters.
1840:58	MZG Tower asked the WWO when the SPECI with a visibility of 1,600 meters would be issued. The answer was 1840.
1841:00	MZG Tower informed the KHH Approach coordinator that a visibility of 1,600 meters will be issued now.
1842:04	MZG tower informed KHH Approach that the MZG SPECI with a visibility of 1,600 meters will be in effect at 1840 with thunderstorm overhead continuing to 1940.
1842:25	The KHH Approach controller informed B7647 that the visibility at Magong Airport was now 1,600 meters and asked for his intentions.
1842:32	WWO informed MZG Tower of the 1840 SPECI.
1843:08	B7647 requested an approach to runway 20.
1843:34	MZG Tower informed KHH Approach of the 1840 SPECI.
1844:59	GE222 flight crew requested the runway 20 VOR approach.
1845:32	The KHH Approach controller cleared B7647 for the runway 20 RNAV approach.
1846:00	FE3055 requested the runway 20 VOR approach.

1848:08	KHH Approach controller advised B7647 that Kaohsiung QNH was 1000 and Magong QNH was 996.
1848:45	GE5133 requested the runway 20 VOR approach.
1852:02	KHH Approach controller instructed B7647 to contact MZG Tower after B7647 was established on the final approach course.
1853:03	MZG Tower provided B7647 with wind and QNH information and cleared them to land.
1855:09	KHH Approach controller cleared GE222 for the runway 20 VOR approach.
1856:16	KHH Approach controller advised GE222 Kaohsiung QNH was 1000 and Magong QNH was 996.
1858	B7647 landed at MZG.
1900	MZG METAR at 1900 (ATIS O): wind from 220 degrees at 11 knots gusting to 21 knots, visibility 1,600 meters in thunderstorm rain, thunderstorm overhead.
1901:01	WWO informed MZG Tower of the 1900 METAR.
1901:04	KHH Approach controller instructed GE222 to contact MZG tower after GE222 was established on the final approach course.
1901:13	GE222 crew contacted MZG tower and the tower controller advised QNH 997.
1902:02	The MO contacted the WWO about the coding of the MZG visibility.
1902:05	MZG Tower controller cleared FE082 for takeoff.
1903:39	MZG Tower controller informed GE222 that the wind was 250 degrees at 19 knots and cleared them to land.
1904:04	MZG Tower controller instructed FE082 to contact Kaohsiung Approach.
1904:24	WFO asked the WWO about MZG the visibility at MZG and the reply was 800 meters.
1905:05	MZG Tower informed KHH Approach of the new METAR with information ‘Oscar’ (O). Visibility was not changed.
1906:15	GE222 crew informed the MZG Tower controller that they were going around.
1906:21	MZG Tower informed KHH Approach that GE222 was going around.
1910	MZG SPECI at 1910 (ATIS P): wind from 230 degrees at 23 knots gusting to 33 knots, visibility 800 meters in heavy thunderstorm rain, thunderstorm overhead.
1913:38	WWO informed MZG Tower of the 1910 SPECI.

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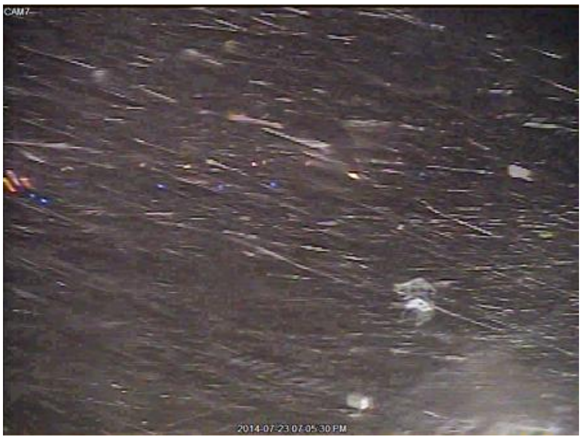
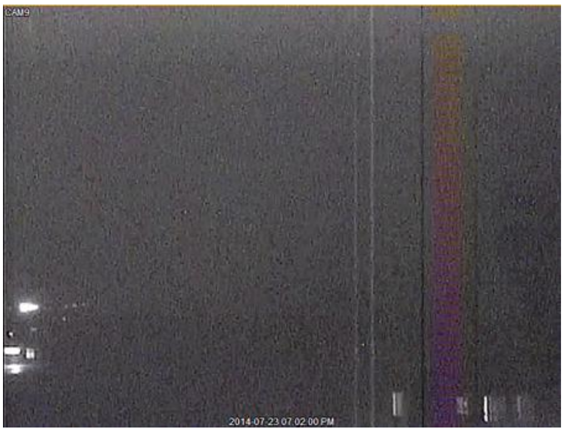
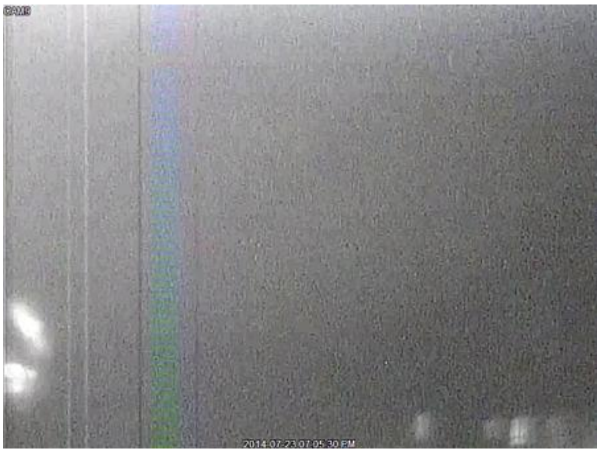
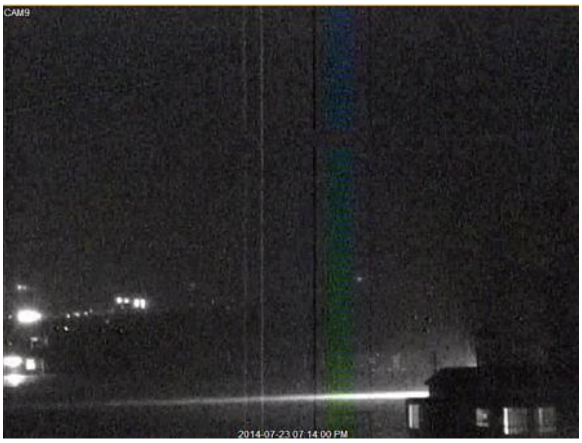
Appendix 2 The Photos Extracted from Airport CCTV Camera

No. 7 18:30.00	No. 7 18:40.18
	
No. 7 18:58.11	No. 7 18:59.00
	
No. 7 19:01.00	No. 7 19:02.09
	

No. 7　19:03.01	No. 7　19:05.30
	
No. 7　19:07.01	No. 7　19:09.33
	
No. 7　19:13.03	No. 7　19:22
	

No. 9　18:30.00	No. 9　18:40.00
 	
No. 9　18:50.05	No. 9　18:59.01
 	
No. 9　19:01.00	No. 9　19:02.00
 	

No. 9　19:03.00	No. 9　19:05.30
	
No. 9　19:07.00	No. 9　19:09.34
	
No. 9　19:14.00	No. 9　19:20.00
	

Appendix 3　CVR Transcripts

RDO	: Radio transmission from occurrence aircraft
CAM	: Cockpit area microphone voice or sound source
INT	: Interphone
PA	: Cabin announcement
	(RDO, CAM, INT, PA)-1 : Voice identified as captain
	(RDO, CAM, INT, PA)-2 : Voice identified as first officer
	(RDO, CAM, INT, PA)-3 : Voice identified as cabin crew 1
	(RDO, CAM, INT, PA)-4 : Voice identified as cabin crew 2
APP	: Kaohsiung approach
TWR_M	: Magong Tower
TWR_K	: Kaohsiung Tower
B7 647	: Communication from B7 647
OTH	: Communication from other flights
GC	: Ground crew
…	: Unintelligible
( )	: Remarks
[ ]	: Translation
*	: Communication not related to operation / expletive words

hh	mm	ss	Source	Context
17	39	09.4		(GE 222 CVR 紀錄開始) *[GE 222 CVR recording begins]*
1739:09.4 ~ 1906:18.9				
17	39	09.4	CAM-2	oil pressure rising n-h forty five starter light off
17	39	17.5	INT-1	可以拆外電源後推煞車鬆向東 *[you may disconnect gpu parking brake release clear to push back facing east]*
17	39	19.6	GC	…頭朝東 *[... facing east]*
17	39	20.8	CAM-2	i-t-t drop … normal start
17	39	32.7	CAM-2	四洞分 *[time forty]*

hh	mm	ss	Source	Context
17	39	34.1	CAM-1	嗯 好 *[um okay]*
17	39	35.3	INT-1	開二號解鎖 *[release number two]*
17	39	36.6	GC	okay 二號解鎖 *[okay number two released]*
17	39	38.2	CAM	(客艙呼叫聲響) *[sound of cabin call]*
17	39	38.9	INT-3	cabin is ready
17	39	41.4	INT-2	好 謝謝 *[okay thank you]*
17	39	42.4	CAM-1	嗯(um)
17	39	43.0	CAM-2	ready 了 好快啊 *[ready so fast]*
17	39	44.2	CAM-1	嗯好*[um okay]*
17	39	45.8	CAM-2	oil pressure rising i-t-t rising n-p rising
17	39	50.2	CAM	(single chime)
17	39	52.1	CAM-2	oil pressure rising n-h forty five starter light off
17	40	04.5	CAM-2	i-t-t drop and stable normal start
17	40	08.8	CAM-1	after start check
17	40	10.5	CAM-2	after start check down to the line packs and bleeds one and two
17	40	12.3	CAM-1	on
17	40	13.5	CAM-2	prop brake
17	40	14.1	CAM-1	released
17	40	14.7	CAM-2	a-d-u heading lo bank
17	40	16.2	CAM-1	check
17	40	16.3	CAM-2	幺幺拐 拐千 flaps *[one one seven seven thousand flaps]*
17	40	17.4	CAM-1	fifteen
17	40	18.1	CAM-2	anti skid test
17	40	18.6	CAM-1	check
17	40	19.1	CAM-2	radar
17	40	19.6	CAM-1	standby

hh	mm	ss	Source	Context
17	40	20.2	CAM-2	after start checklist down to the line complete
17	40	25.0	CAM-1	(咳嗽聲)*[sound of coughing]*
17	40	26.7	CAM-1	(咳嗽聲)*[sound of coughing]*
17	40	35.6	CAM-1	(咳嗽聲)*[sound of coughing]*
17	40	37.5	CAM-2	single channel
17	40	42.1	RDO-2	transasia two two two request taxi
17	40	43.0	GC	教官請煞車 *[sir parking brake please]*
17	40	45.0	INT-1	煞好請撤離 *[parking brake set and you may disconnect]*
17	40	45.7	GC	byebye…
17	40	46.5	GND	transasia two two two taxi via golf sierra foxtrot holding point runway two seven
17	40	51.3	RDO-2	taxi via golf sierra foxtrot holding point runway two seven transasia two two two
17	40	55.2	CAM-2	golf sierra foxtrot 兩拐許可滑出了 *[golf sierra foxtrot two seven cleared to taxi]*
17	40	57.4	CAM-1	嗯(um)
17	40	58.2	GC	okay 教官撤離掰 *[okay sir you're disconnected bye]*
17	40	58.4	CAM-2	after start below the line con lever one and two
17	40	59.2	INT-1	好掰*[okay bye]*
17	41	02.6	CAM-1	嗯 standby *[um standby]*
17	41	04.8	CAM-2	hydraulic pressure normal
17	41	05.9	CAM-1	uh normal
17	41	07.2	CAM-2	taxi golf sierra foxtrot 兩拐*[two seven]* gear pin inside after start check complete right side clear
17	41	11.3	CAM-1	好*[okay]*
17	41	15.4	CAM-1	taxi check please
17	41	16.7	CAM-2	taxi check taxi light
17	41	17.9	CAM-1	on
17	41	18.2	CAM-2	com hatch
17	41	19.0	CAM-1	closed

hh	mm	ss	Source	Context
17	41	19.7	CAM-2	brakes test
17	41	20.4	CAM-1	normal
17	41	20.7	CAM-2	right side checked oxygen probes wind heating
17	41	22.4	CAM-1	on
17	41	23.1	CAM-2	flight instruments
17	41	23.6	CAM-1	check normal
17	41	24.5	CAM-2	right side checked takeoff config test
17	41	27.4	CAM-2	m-p-c 四六點三 set *[m-p-c four six point three set]*
17	41	29.9	CAM-2	takeoff briefing sosan one tango
17	41	32.5	CAM-1	嗯(um) taxi checklist complete
17	42	29.0	GND	transasia two two two ground
17	42	31.6	RDO-2	transasia two two two
17	42	33.2	GND	transasia two two two now magong airdrome on is below landing minimum say intention
17	42	40.1	CAM-1	uh hold on seg segma hold on mason
17	42	42.5	RDO-2	hold on segma
17	42	44.7	CAM-1	mason
17	42	45.1	RDO-2	oh mason transasia two two two
17	42	47.8	GND	transasia two two two roger
17	42	59.5	GND	transasia two two two holding request approved and contact tower one one eight decimal seven
17	43	05.6	RDO-2	contact tower transasia two two two
17	43	08.9	CAM	嘟 (無線電波道切換提醒聲響) *[sound of radio frequency switching]*
17	43	12.2	RDO-2	kaohsiung tower good afternoon transasia two two two taxi on sierra
17	43	16.8	TWR_K	transasia two two two kaohsiung tower roger
17	43	27.0	TWR_K	transasia two two two runway two seven wind two zero zero degree one four knots gusting two five knots cleared for takeoff
17	43	34.7	INT-1	cabin crew cleared for departure
17	43	35.7	RDO-2	cleared for departure transasia two two two
17	43	37.5	CAM-2	兩洞洞十四 gust 兩五 *[two zero zero fourteen gust two five]*

hh	mm	ss	Source	Context
17	43	39.8	CAM-1	(咳嗽聲)*[sound of coughing]*
17	43	39.9	PA-3	(客艙廣播至 1743:49.8) *[cabin passenger announcement until 1743:49.8]*
17	43	40.1	CAM-2	許可起飛 *[cleared for takeoff]*
17	43	49.4	CAM-1	flight control check
17	43	50.1	CAM-2	left side spoiler light on
17	43	52.5	CAM-2	right side spoiler check spoiler up
17	43	54.0	CAM-1	欸 嗯 沒看到 喔好好 晚一點 *[hey um haven't seen it uh ok ok later]*
17	43	56.8	CAM-2	flight control left side spoiler light on
17	43	57.8	CAM-1	un light on
17	44	00.4	CAM-2	complete before takeoff checklist runway 兩拐*[two seven]* verify
17	44	03.9	CAM-1	兩拐*[two seven]*
17	44	04.4	CAM-2	flight controls
17	44	05.2	CAM-1	normal
17	44	05.8	CAM-2	right side checked c-cas
17	44	06.9	CAM-1	takeoff inhibit
17	44	08.4	CAM-2	transponder
17	44	09.4	CAM-1	altitude
17	44	09.7	CAM-2	么么拐 lights *[one one seven lights]*
17	44	11.0	CAM-1	on
17	44	11.5	CAM-2	cabin crew
17	44	12.1	CAM-1	advised
17	44	12.8	CAM-2	b air flow
17	44	13.4	CAM-1	normal
17	44	13.9	CAM-2	rudder cam
17	44	14.7	CAM-1	center
17	44	15.3	CAM-2	heading course
17	44	16.1	CAM-1	…
17	44	18.3	CAM-2	… set takeoff clearance received before takeoff checklist complete

hh	mm	ss	Source	Context
17	44	23.5	CAM-1	check
17	44	25.0	CAM-2	final runway clear
17	44	28.5	CAM-2	四十四分 *[time forty four]*
17	44	35.1	CAM	(發動機轉速提高聲響) *[sound of engine rotational speed increasing]*
17	44	35.4	CAM-1	唉嘿　嗯 *[uh hey　um]*
17	44	36.1	CAM-2	timing
17	44	39.8	CAM-2	a-t-p-s armed
17	44	40.8	CAM-1	notch check …
17	44	42.3	CAM-2	power set engine instrument check
17	44	44.2	CAM-1	(咳嗽聲)*[sound of coughing]*
17	44	45.4	CAM-2	normal
17	44	46.3	CAM-1	等一下*[later]*
17	44	47.2	CAM-2	seventy
17	44	48.0	CAM-1	check i have control
17	44	49.1	CAM-2	you have control engine instrument check
17	44	51.4	CAM-1	check
17	44	53.1	CAM-2	normal
17	44	53.9	CAM-1	check
17	44	57.9	CAM-2	v one v r
17	44	58.9	CAM-1	rotate
17	45	03.1	CAM-2	positive climb
17	45	03.8	CAM-1	gear up yaw damper on
17	45	04.6	CAM-2	gear up yaw damper on
17	45	07.9	CAM	(pitch trim 聲響) *[sound of pitch trim]*
17	45	08.2	CAM-1	啊*[ah]* autopilot on
17	45	09.4	CAM-2	autopilot on
17	45	17.2	CAM-2	加速高度 *[acceleration altitude]*
17	45	21.5	CAM-1	nav on
17	45	22.9	CAM-2	check

hh	mm	ss	Source	Context
17	45	28.8	TWR_K	transasia two two two contact departure one two four decimal seven
17	45	32.2	RDO-2	contact departure one two four decimal seven transasia two two two good day
17	45	36.3	CAM	嘟 (無線電波道切換提醒聲響) *[sound of radio frequency switching]*
17	45	40.1	RDO-2	kaohsiung approach good evening transasia two two two passing one thousand two hundred sigang one sosan one tango departure
17	45	44.0	CAM	(pitch trim 聲響) *[sound of pitch trim]*
17	45	46.7	CAM-1	嗯(um) roger
17	45	47.1	APP	transasia two two two kaohsiung approach roger climb and maintain seven thousand
17	45	50.9	RDO-2	climb maintain seven thousand transasia two two two
17	45	52.9	CAM-2	拐千爬高保持 *[climb and maintain seven thousand]*
17	45	53.9	CAM-1	check
17	45	54.3	CAM	(pitch trim 聲響) *[sound of pitch trim]*
17	45	55.1	CAM-2	flap zero set after takeoff checklist
17	45	56.5	CAM-1	嗯(um)
17	45	57.2	CAM-2	gears up flap zero power management climb con lever auto n-p … taxi lights off anti icing off seat belts on bleed and air flow high approach brief uh after takeoff checklist complete
17	46	16.5	APP	transasia two two two squawk ident
17	46	20.4	RDO-2	ident passing one thousand niner hundred transasia two two two
17	46	25.1	APP	two two roger now radar contact two miles west of the airport climb and maintain seven thousand
17	46	29.9	RDO-2	climb and maintain seven thousand transasia two two two
17	46	32.9	CAM-2	爬高保持拐千嗯 *[climb and maintain seven thousand]*
17	46	34.4	CAM-1	嗯(um)
17	46	37.3	CAM-1	嗯(um)

hh	mm	ss	Source	Context
17	46	50.1	OTH	(復興 2082 與 ATC 對話) *[communication between GE 2082 and ATC]*
17	46	54.4	APP	(與復興 2082 對話) *[communication with GE 2082]*
17	47	00.3	OTH	(復興 2082 與 ATC 對話) *[communication between GE 2082 and ATC]*
17	47	04.5	APP	(與復興 2082 對話) *[communication with GE 2082]*
17	47	06.3	CAM-2	喔 sosan approach 航向三么洞 *[ah sosan approach heading three one zero]*
17	47	09.0	OTH	(復興 2082 與 ATC 對話) *[communication between GE 2082 and ATC]*
17	47	12.4	APP	two two two direct magong v-o-r
17	47	15.2	RDO-2	roger direct to magong v-o-r transasia two two two
17	47	18.0	APP	(與港龍 432 對話) *[communication with KA 432]*
17	47	19.4	CAM-2	好馬公 v-o-r *[okay magong v-o-r]*
17	47	21.0	CAM-1	check
17	47	21.5	OTH	(港龍 432 與 ATC 對話) *[communication between KA 432 and ATC]*
17	47	23.1	CAM-2	…
17	47	24.0	CAM-1	好*[okay]*
17	47	28.0	CAM-1	mason 啊 … 洞四九 *[mason ah … zero four nine]*
17	48	04.6	CAM-1	那 有沒有 mason 啊 *[that is mason there ah]*
17	48	07.1	CAM-2	好教官加一個 mason *[okay sir insert mason]*
17	48	09.8	CAM-1	magong
17	48	10.8	CAM-2	好 先 magong *[okay magong first]*
17	48	12.0	CAM-1	m-a-s-o-n 嗯(um)
17	48	19.0	APP	(與復興 2082 對話) *[communication with GE 2082]*

hh	mm	ss	Source	Context
17	48	22.9	OTH	(復興 2082 與 ATC 對話) *[communication between GE 2082 and ATC]*
17	49	01.5	CAM	嘟嘟 (客艙安全帶提示聲響) *[sound of seat belt reminder]*
17	49	17.2	APP	(與復興 2082 對話) *[communication with GE 2082]*
17	49	26.8	OTH	(復興 2082 與 ATC 對話) *[communication between GE 2082 and ATC]*
17	49	33.1	APP	transasia two two two traffic at your two o-clock five miles southeast bound same company a-t-r leaving eight thousand four hundred to eight thousand
17	49	43.2	RDO-2	information looking transasia two two two
17	49	44.8	CAM	(高度提示聲響) *[sound of altitude alert]*
17	49	46.4	CAM-1	(咳嗽聲)*[sound of coughing]*
17	49	46.9	CAM	(高度提示聲響) *[sound of altitude alert]*
17	49	47.1	CAM-2	one thousand to go
17	49	47.9	CAM-1	check
17	49	49.5	CAM-2	兩點鐘五浬八千四下到八千 *[two o'clock five miles eight thousand four hundred descending to eight thousand]*
17	49	54.5	CAM	(不明聲響數聲至 1750:00.7) *[some unidentified sound until 1750:00.7]*
17	50	00.9	PA-4	(客艙廣播至 1752:48.9) *[cabin announcement until 1752:48.9]*
17	50	12.6	APP	(與復興 2082 對話) *[communication with GE 2082]*
17	50	16.1	OTH	(復興 2082 與 ATC 對話) *[communication between GE 2082 and ATC]*
17	50	37.4	APP	(與復興 2082 對話) *[communication with GE 2082]*
17	50	40.6	OTH	(復興 2082 與 ATC 對話) *[communication between GE 2082 and ATC]*
17	50	50.7	CAM-2	altitude star

hh	mm	ss	Source	Context
17	50	52.0	CAM-1	對七千 *[yes seven thousand]*
17	51	01.8	CAM-2	altitude check 拐千*[seven thousand]*
17	51	06.8	CAM-1	check
17	51	27.4	CAM-1	cruise check
17	51	28.1	CAM-2	cruise check power management
17	51	29.0	CAM-1	cruise
17	51	29.6	CAM-2	altimeter 九九九*[nine nine nine]*
17	51	30.7	CAM-1	九九九*[nine nine nine]* set
17	51	32.1	CAM-2	altitude 拐千*[seven thousand]*
17	51	33.1	CAM-1	check
17	51	33.3	CAM-2	速度么九四加速中*[airspeed one nine four and increasing]* cruise check complete
17	51	35.1	CAM-1	check 好*[okay]*
17	51	36.6	CAM-2	我聽 a-tis *[let me listen to a-tis]*
17	51	37.7	CAM	(ATIS information kilo)
17	51	55.5	APP	(與復興 2082 對話) *[communication with GE 2082]*
17	51	58.6	OTH	(復興 2082 與 ATC 對話) *[communication between GE 2082 and ATC]*
17	52	45.2	CAM-1	… check 那 broken 是 broken 是多少 *[... check that broken how high is the broken]*
17	52	46.2	CAM	(嘟) *[toot]*
17	52	47.9	CAM-2	六百*[six hundred]*
17	52	48.7	CAM-1	六百喔*[six hundred uh]*
17	52	49.5	CAM-2	對*[yes]*
17	52	50.3	CAM-2	scatter 兩百 broken 六百 few c-b 是一千二 overcast 是一千六 *[scatter two hundred broken six hundred few c-b at one thousand two hundred overcast at one thousand six hundred]*
17	52	53.9	CAM-1	喔*[oh]*

hh	mm	ss	Source	Context
17	52	54.6	CAM-2	然後二十四度二十二　九九三 *[then twenty four degree twenty two nine nine three]*
17	52	56.4	CAM-1	喔*[oh]*
17	52	57.4	CAM-2	能見度在八百呎*[visibility eight hundred feet]* r-a thunder visibility thunderstorm
17	52	59.2	CAM-1	喔*[oh]*
17	53	01.6	CAM-1	喔*[oh]*
17	53	01.9	CAM-2	below minimum　幺九洞二十一 gust 三兩 *[below minimum one nine zero twenty one gust three two]*
17	53	05.5	CAM-1	喔*[oh]*
17	53	10.1	CAM-1	啊 (咳嗽聲)*[ah] [sound of coughing]*
17	53	19.4	APP	(與復興 2082 對話) *[communication with GE 2082]*
17	53	22.4	OTH	(復興 2082 與 ATC 對話) *[communication between GE 2082 and ATC]*
17	53	25.3	APP	(與復興 2082 對話) *[communication with GE 2082]*
17	53	26.4	CAM	(客艙安全帶提示聲響) *[sound of seat belt reminder]*
17	53	33.1	OTH	(復興 2082 與 ATC 對話) *[communication between GE 2082 and ATC]*
17	53	33.8	PA-4	(客艙廣播至 1753:54.9) *[cabin announcement until 1753:54.9]*
17	54	17.9	OTH	(國泰航機對話) *[communication between Cathay Pacific aircraft]*
17	54	25.3	OTH	(廈航 863 與 ATC 對話) *[communication between MF 863 and ATC]*
17	54	33.0	APP	(與廈航 863 對話) *[communication with MF 863]*
17	54	44.8	OTH	(廈航 863 與 ATC 對話) *[communication between MF 863 and ATC]*
17	54	58.1	CAM-1	(打哈欠聲) *[sound of yawning]*

hh	mm	ss	Source	Context
17	55	04.1	CAM-1	嗯九九六嘛喔 *[um nine nine six right]*
17	55	05.2	OTH	(復興 2093 與 ATC 對話) *[communication between GE 2093 and ATC]*
17	55	06.5	CAM-2	九九三 *[nine nine three]*
17	55	07.2	CAM-1	九九三啊 *[nine nine three ah]*
17	55	12.4	APP	(與復興 2093 對話) *[communication with GE 2093]*
17	55	16.6	OTH	(復興 2093 與 ATC 對話) *[communication between GE 2093 and ATC]*
17	55	19.9	APP	transasia two two two contact kaohsiung approach one two eight decimal one good day
17	55	23.4	RDO-2	contact kaohsiung approach one two eight decimal one good day transasia two two two
17	55	26.8	CAM	嘟 (無線電波道切換提醒聲響) *[sound of radio frequency switching]*
17	55	27.0	APP	(與立榮 647 對話) *[communication with B7 647]*
17	55	36.4	RDO-2	kaohsiung approach good evening transasia two two two south east four two d-m-e direct to magong v-o-r maintain seven thousand information kilo
17	55	49.2	APP	uh transasia two two two kaohsiung approach roger now direct segma initially
17	55	56.7	CAM-2	check squawk
17	55	57.5	APP	transasia two two two kaohsiung
17	55	59.4	RDO-2	uh transasia two two two direct to segma trans two two two
17	56	04.8	CAM-2	segma
17	56	06.0	OTH	(立榮 647 與 ATC 對話) *[communication between B7 647 and ATC]*
17	55	09.6	APP	(與立榮 647 對話) *[communication with B7 647]*
17	56	11.3	CAM-2	e-g-m-a
17	56	14.4	CAM-2	g

hh	mm	ss	Source	Context
17	56	15.5	OTH	(立榮 647 與 ATC 對話) *[communication between B7 647 and ATC]*
17	56	17.1	CAM-2	喔*[oh]*
17	56	18.0	APP	transasia two two two for your information magong airport now below landing minimum
17	56	23.4	RDO-2	copy that request hold at segma transasia two two two
17	56	27.9	APP	transasia two two two roger maintain seven thousand direct segma join holding pattern report join
17	56	34.5	RDO-2	maintain seven thousand direct to segma and join holding pattern report join transasia two two two
17	56	41.6	CAM-2	好*[okay]* segma report
17	56	42.8	CAM-1	segma 么三五*[one three five]*
17	56	46.3	CAM-2	么三五*[one three five]*
17	56	48.7	CAM-1	哇*[wow]*
17	56	50.2	CAM-2	教官我們右偏了喔 *[sir we are deviating to the right oh]*
17	56	50.7	APP	復興兩兩兩遠東三洞伍伍高雄 *[kaohsiung approach call GE 222 and FE 3055]*
17	56	56.8	APP	最新的顯著危害天氣在馬公機場接下來的兩小時能見度大約是么千兩百公尺有　有雷雨有霧裂雲兩百 *[latest sigmet forcasts magong airport visibility 1,200 meters thunderstorm fog scatter 200 for the next two-hour]*
17	57	09.7	CAM-2	喔*[oh]*
17	57	11.4	RDO-2	復興兩兩兩抄收 *[GE222 copy that]*
17	57	12.9	APP	謝謝各位 *[thanks all]*
17	57	14.8	CAM-2	兩個小時能見度一千二 有雷雨 有霧 *[visibility 1,200 meters thunderstorm fog for two-hour]*
17	57	19.1	CAM-1	喔*[oh]*
17	57	19.8	CAM-2	然後裂雲 這個 scatter 兩百 *[then scatter scatter 200]*
17	57	25.5	CAM-1	一千二　我們要一千六

hh	mm	ss	Source	Context
				[one thousand two hundred we need one thousand six hundred]
17	57	27.7	CAM-2	報告教官 是 *[affirmative sir]*
17	57	34.3	APP	(與立榮 895 對話) *[communication with B7 895]*
17	57	43.5	OTH	(立榮 647 與 ATC 對話) *[communication between B7 647 and ATC]*
17	57	48.6	APP	(與立榮 647 對話) *[communication with B7 647]*
17	57	52.3	OTH	(立榮 647 與 ATC 對話) *[communication between B7 647 and ATC]*
17	58	01.6	APP	(與立榮航機對話) *[communication with Uni Air flight]*
17	58	08.8	OTH	(其他航機對話) *[communication with other aircraft]*
17	58	13.8	CAM-1	看起來好像還好 *[seems to be ok]*
17	58	14.1	APP	(與遠東 3055 對話) *[communication with FE 3055]*
17	58	17.5	CAM-2	就是那 那一塊啊 *[that that's the one]*
17	58	17.7	CAM-1	欸 欸*[hey hey]*
17	58	19.7	APP	(與遠東 3055 對話) *[communication with FE 3055]*
17	58	19.9	CAM-2	紅色的很糟 後面好像還好 *[the red one is much worse looks ok behind it]*
17	58	29.1	CAM-1	segma
17	58	29.4	APP	(與華信 786 對話) *[communication with AE 786]*
17	58	31.5	OTH	(華信 786 與 ATC 對話) *[communication between AE 786 and ATC]*
17	58	36.2	APP	(與華信 786 對話) *[communication with AE 786]*
17	58	41.7	OTH	(華信 786 與 ATC 對話)

hh	mm	ss	Source	Context
				[communication between AE 786 and ATC]
17	58	42.7	CAM-2	segma 是飛 *[to sigma via where]*
17	58	43.6	APP	(與華信 786 對話) *[communication with AE 786]*
17	58	47.5	CAM-2	一分鐘我們是要跟他申請　要不要十浬 *[we request one minute　or ten miles]*
17	58	50.6	OTH	(華信 786 與 ATC 對話) *[communication between AE 786 and ATC]*
17	58	52.5	CAM-1	嗯嗯*[um um]*
17	58	53.7	CAM-2	啊*[ah]*
17	58	54.2	CAM-1	沒關係等一下他 *[it is okay　let's wait awhile for him]*
17	58	55.2	APP	(與華信 786 對話) *[communication with AE 786]*
17	58	55.6	CAM-2	好*[okay]*
17	58	58.5	CAM-1	啊直接加入 *[ah direct entry]*
17	58	59.4	OTH	(華信 786 與 ATC 對話) *[communication between AE 786 and ATC]*
17	59	00.4	CAM-2	教官我們加入是　是那個 *[sir which　which one for us to direct to]*
17	59	03.1	CAM-1	直接加入　我知道　你 … *[direct entry　I know　you]*
17	59	05.3	CAM-2	知道 *[I see]*
17	59	05.5	CAM-1	holding 待命邊啊*[join holding pattern]*
17	59	06.7	CAM-2	知道 holding 是要 hold 一分鐘還是 hold 距離 *[I know it's holding　but to hold by leg length in one minute or by distance]*
17	59	09.0	CAM-1	hold 啊 hold 距離 (*hold ah hold by distance]*
17	59	10.4	CAM-2	hold 距離 那我跟他申請 *[hold by distance　I would request from ATC]*
17	59	13.7	CAM-1	喔五浬*[oh five miles]*

hh	mm	ss	Source	Context
17	59	14.4	CAM-2	五浬　好*[five miles　roger]*
17	59	23.1	CAM-1	segma 十三*[thirteen]*
17	59	25.6	CAM-1	等一下再申請 *[request later]*
17	59	26.7	CAM-2	喔喔 (笑聲) *[oh oh laughing]*
17	59	27.0	APP	(與立榮 647 對話) *[communication with B7 647]*
17	59	30.2	OTH	(立榮 647 與 ATC 對話) *[communication between B7 647 and ATC]*
17	59	34.2	APP	(與立榮 647 對話) *[communication with B7 647]*
17	59	37.2	OTH	(立榮 647 與 ATC 對話) *[communication between B7 647 and ATC]*
17	59	38.0	CAM-2	等一下*[later]*
17	59	38.1	OTH	(華信 786 與 ATC 對話) *[communication between B7 647 and ATC]*
17	59	41.2	CAM-2	... 應該就是這一條 thunderstorm 過來就好了 *[... these squall line thunderstorms should be the one would be great if they move this way]*
17	59	42.0	APP	(與華信 786 對話) *[communication with AE 786]*
17	59	46.2	CAM-1	喔*[oh]*
17	59	47.1	CAM-2	現在是吹西南風 吹過去 *[now wind from southwest　blows them over]*
17	59	47.1	OTH	(華信 786 與 ATC 對話) *[communication between AE 786 and ATC]*
17	59	50.9	APP	(與華信 786 對話) *[communication with AE 786]*
17	59	56.1	APP	(與華信 786 對話) *[communication with AE 786]*
18	00	04.4	APP	(與立榮 895 對話) *[communication with B7 895]*
18	00	16.6	CAM-1	mason mason mason
18	00	20.4	APP	(與立榮 647 對話)

hh	mm	ss	Source	Context
				[communication with B7 647]
18	00	24.0	OTH	(立榮 647 與 ATC 對話) *[communication between B7 647 and ATC]*
18	00	28.3	CAM-1	四九*[four nine]*
18	00	30.9	CAM-1	唉 (咳嗽聲)*[sigh [sound of coughing]]*
18	00	36.3	CAM-1	請求在 mason 待命喔 *[request holding at mason]*
18	00	37.9	APP	(與遠東 3055 對話) *[communication with FE 3055]*
18	00	39.5	CAM-2	好*[okay]*
18	00	41.2	CAM-1	等一下喔*[later]*
18	00	45.1	CAM-2	等一會你說要我我再 我再講好了 *[later when you ask me to I will tell them]*
18	00	46.4	CAM-1	好*[okay]*
18	00	46.8	APP	(與遠東 3055 對話) *[communication with FE 3055]*
18	00	55.6	APP	(與遠東 3055 對話) *[communication with FE 3055]*
18	00	58.4	CAM	嘟 (無線電波道切換提醒聲響) *[sound of radio frequency switching]*
18	01	00.9	CAM	(ATIS information lima)
18	01	08.1	APP	(與其他航機對話) *[communication with other aircraft]*
18	01	10.8	CAM-2	在換天氣了 *[weather is changing]*
18	01	11.8	APP	(與華信 786 對話) *[communication with AE 786]*
18	01	16.5	OTH	(華信 786 與 ATC 對話) *[communication between AE 786 and ATC]*
18	01	19.5	APP	(與華信 786 對話) *[communication with AE 786]*
18	01	20.3	APP	(與遠東 3055 對話) *[communication with FE 3055]*
18	01	49.1	APP	(與立榮 6295 對話) *[communication with B7 6295]*

hh	**mm**	**ss**	**Source**	**Context**
18	01	53.4	CAM-1	好 我們請求請求定向 mason mason 待命 *[okay we request request direct to mason to hold at mason]*
18	01	55.0	APP	(與遠東 3055 對話) *[communication with FE 3055]*
18	01	57.1	CAM-2	好 定向五浬 *[okay direct course by five miles]*
18	02	00.0	CAM-1	欸對 *[um yes]*
18	02	02.0	RDO-2	transasia two two two request direct to mason and join holding pattern at five mile leg
18	02	10.5	APP	confirm far eastern tree zero five five
18	02	12.3	RDO-2	negative transasia two two two
18	02	14.4	APP	transasia two two two roger approved as requested maintain seven thousand
18	02	18.2	RDO-2	maintain seven thousand direct to mason transasia two two two
18	02	20.5	CAM	(ATIS information lima)
18	02	25.8	APP	(與其他航機對話) *[communication with other aircraft]*
18	02	39.5	APP	(與立榮 647 對話) *[communication with B7 647]*
18	02	44.1	OTH	(立榮 647 與 ATC 對話) *[communication between B7 647 and ATC]*
18	03	00.3	CAM-2	好 *[okay]* information lima
18	03	02.4	CAM	嘟(無線電波道切換提醒聲響) *[sound of radio frequency switching]*
18	03	03.2	CAM-2	lima 還是一樣 能見度八百 *[still lima visibility eight hundred]*
18	03	05.0	OTH	(華信 786 與 ATC 對話) *[communication between AE 786 and ATC]*
18	03	11.6	APP	(與華信 786 對話) *[communication with AE 786]*
18	03	15.0	OTH	(華信 786 與 ATC 對話) *[communication between AE 786 and ATC]*
18	03	17.5	APP	(與華信 786 對話)

hh	mm	ss	Source	Context
				[communication with AE 786]
18	03	19.6	OTH	(華信 786 與 ATC 對話) *[communication between AE 786 and ATC]*
18	03	21.9	APP	(與立榮 6295 對話) *[communication with B7 6295]*
18	03	29.0	APP	(與立榮 6295 對話) *[communication with B7 6295]*
18	03	39.4	APP	(與立榮 647 對話) *[communication with B7 647]*
18	03	44.1	OTH	(立榮 647 與 ATC 對話) *[communication between B7 647 and ATC]*
18	03	46.7	APP	(與立榮 647 對話) *[communication with B7 647]*
18	03	50.3	OTH	(立榮 647 與 ATC 對話) *[communication between B7 647 and ATC]*
18	03	52.4	APP	transasia two two two information lima
18	03	54.6	RDO-2	good day information lima transasia two two two 謝謝 *[thank you]*
18	03	58.9	CAM-2	lima
18	03	59.7	CAM-1	喔 lima *[oh lima]*
18	04	01.3	OTH	(復興 2093 與 ATC 對話) *[communication between GE 2093 and ATC]*
18	04	05.6	APP	(與復興 2093 對話) *[communication with GE 2093]*
18	04	05.7	CAM-1	(咳嗽聲)*[sound of coughing]*
18	04	10.7	OTH	(復興 2093 與 ATC 對話) *[communication between GE 2093 and ATC]*
18	04	14.3	APP	transasia two two two descend and maintain six thousand transasia two two two
18	04	14.4	CAM-1	嘿呀*[hey yes]*
18	04	18.9	RDO-2	descend and maintain six thousand transasia two two two
18	04	20.6	PA-1	各位女士各位先生 下午好 這是機長報告 歡迎您搭乘本班機從高雄到澎湖 目前通過台南外海飛行高度七千英呎 平均速度每小時 嗯 三百公里

hh	mm	ss	Source	Context
				因為馬公 現在目前的天氣是低於起降　我們預計在馬公的北面待命 有進一步的天氣消息我們會再向您報告　祝您身體 身體健康　謝謝 *[ladies and gentlemen good afternoon this is captain speaking welcome onboard our flilght from kaohsiung to penghu we are now flying over tainan at an altitude of seven thousand feet with an average speed of um three hundred kilometers per hour due to current weather condition magong is below landing minimum we will be holding at the north of magong and I will keep you updated on further weather information wish you a good day thank you]*
18	04	24.7	CAM	(高度提示聲響) *[sound of altitude alert]*
18	04	26.4	CAM-2	one thousand to go
18	04	29.5	APP	(與其他航機對話) *[communication with other aircraft]*
18	04	55.9	APP	(與立榮 647 對話) *[communication with B7 647]*
18	04	57.7	CAM-2	航向保持六千 …速度在一百八 *[remain heading maintain six thousand… speed one eighty]*
18	04	58.6	OTH	(立榮 647 與 ATC 對話) *[communication between B7 647 and ATC]*
18	05	01.1	CAM-1	好*[okay]*
18	05	01.8	CAM-2	no change
18	05	03.7	CAM-1	yah i have control
18	05	04.5	CAM-2	you have control
18	05	05.0	APP	(與立榮 647 對話) *[communication with B7 647]*
18	05	08.1	OTH	(立榮 647 與 ATC 對話) *[communication between B7 647 and ATC]*
18	05	13.3	APP	(與立榮 647 對話) *[communication with B7 647]*
18	05	15.3	OTH	(立榮 647 與 ATC 對話) *[communication between B7 647 and ATC]*
18	05	18.8	APP	(與立榮 6295 對話) *[communication with B7 6295]*

hh	mm	ss	Source	Context
18	05	23.5	CAM-1	兩兩九 啊 平行 平行加入好了喔 *[two two nine uh parallel parallel entry]*
18	05	25.2	OTH	(立榮 6295 與 ATC 對話) *[communication between B7 6295 and ATC]*
18	05	31.7	CAM-2	兩兩九*[two two nine]*
18	05	31.9	APP	(與立榮 6295 對話) *[communication with B7 6295]*
18	05	38.0	OTH	(立榮 6295 與 ATC 對話) *[communication between B7 6295 and ATC]*
18	05	46.9	OTH	(立榮 786 與 ATC 對話) *[communication between B7 786 and ATC]*
18	05	51.5	APP	(與立榮 786 對話) *[communication with B7 786]*
18	05	54.4	OTH	(立榮 786 與 ATC 對話) *[communication between B7 786 and ATC]*
18	05	57.2	CAM	(高度提示聲響) *[sound of altitude alert]*
18	05	59.7	PA-1	cabin crew turbulence
18	06	01.4	OTH	(復興 2093 與 ATC 對話) *[communication between GE 2093 and ATC]*
18	06	04.9	APP	(與復興 2093 對話) *[communication with GE 2093]*
18	06	07.5	OTH	(復興 2093 與 ATC 對話) *[communication between GE 2093 and ATC]*
18	06	08.5	PA-4	(客艙廣播至 1806:30.1) *[cabin announcement until 1806:30.1]*
18	06	11.5	CAM-2	這個 有紫色的 *[this one it has purple color]*
18	06	13.5	CAM-1	欸奇怪怎麼 看起來沒看到東西啊 *[hey it is strange and didn't seem to have this within]*
18	06	16.8	CAM-2	對啊*[right]*
18	06	19.3	CAM-2	altitude star
18	06	20.5	CAM-1	check set
18	06	24.2	OTH	(華信 786 與 ATC 對話) *[communication between AE 786 and ATC]*

hh	mm	ss	Source	Context
18	06	27.8	APP	(與華信 786 對話) *[communication with AE 786]*
18	06	30.8	OTH	(華信 786 與 ATC 對話) *[communication between AE 786 and ATC]*
18	06	38.7	CAM-2	altitude capture 六千 *[six thousand]*
18	06	41.0	CAM-1	check
18	06	47.2	CAM	(不明聲響) *[unidentified sound]*
18	06	50.7	CAM-1	欸 (咳嗽聲)*[um [sound of coughing]]*
18	07	04.2	OTH	(華信 786 與 ATC 對話) *[communication between AE 786 and ATC]*
18	07	08.4	APP	(與華信 786 對話) *[communication with AE 786]*
18	07	10.9	OTH	(華信 786 與 ATC 對話) *[communication between AE 786 and ATC]*
18	07	12.4	APP	(與華信 786 對話) *[communication with AE 786]*
18	07	17.8	OTH	(華信 786 與 ATC 對話) *[communication between AE 786 and ATC]*
18	07	21.5	APP	(與華信 786 對話) *[communication with AE 786]*
18	07	24.1	OTH	(華信 786 與 ATC 對話) *[communication between AE 786 and ATC]*
18	07	29.8	APP	(與立榮 647 對話) *[communication with B7 647]*
18	07	33.0	OTH	(立榮 647 與 ATC 對話) *[communication between B7 647 and ATC]*
18	07	36.3	APP	(與立榮 647 對話) *[communication with B7 647]*
18	07	55.1	CAM-1	嗯*[um]*
18	08	06.1	APP	(與遠東 3055 對話) *[communication with FE 3055]*
18	08	32.6	CAM-1	(咳嗽聲)*[sound of coughing]*
18	08	38.0	CAM-1	剛剛看 mason 還不錯 怎麼* 吹過來了 *[mason was looking good moments ago what the * it*

hh	mm	ss	Source	Context
				was blown to here]
18	08	41.2	CAM-2	風吹進來嘛 *[wind blows it here]*
18	08	42.1	CAM-1	喔*[oh]*
18	09	01.4	APP	(與立榮 692 對話) *[communication with B7 692]*
18	09	05.3	OTH	(立榮 692 與 ATC 對話) *[communication between B7 692 and ATC]*
18	09	08.3	APP	(與立榮 692 對話) *[communication with B7 692]*
18	09	11.3	OTH	(立榮 692 與 ATC 對話) *[communication between B7 692 and ATC]*
18	09	14.8	APP	(與立榮 692 對話) *[communication with B7 692]*
18	09	19.0	OTH	(立榮 692 與 ATC 對話) *[communication between B7 692 and ATC]*
18	09	31.6	CAM-2	喔兩兩九*[oh two two nine]*
18	09	32.7	CAM-1	喔來我們請求那個航向三兩洞加入那個馬公的兩洞么的十三浬 待命 好就 *[oh let us request heading three two zero to join the holding pattern of one three miles from magong two zero one okay]*
18	09	39.1	CAM-2	okay
18	09	40.5	APP	(與遠東 3055 對話) *[communication with FE 3055]*
18	09	46.5	RDO-2	transasia two two two request heading tree two zero and join correction tree one zero turn left heading and join magong two zero one one tree d-m-e
18	09	50.3	CAM-1	tree one zero
18	10	01.5	APP	transasia two two two approved as requested
18	10	05.0	CAM-2	三么洞*[three one zero]*
18	10	05.1	APP	(與遠東 3055 對話) *[communication with FE 3055]*
18	10	06.7	CAM-1	三么洞*[three one zero]*
18	10	15.2	CAM-2	啊*[uh]*
18	10	15.8	APP	(與遠東 3055 對話)

hh	mm	ss	Source	Context
				[communication with FE 3055]
18	10	17.7	CAM-1	啊啊 * 我好累啊 *[uh uh I am so * tired]*
18	10	28.4	CAM-2	教官那要在這邊做 *[sir are we holding here]*
18	10	30.4	CAM-1	對*[yes]*
18	10	30.9	CAM-2	right orbit 還是 left orbit *[right orbit or left orbit]*
18	10	32.5	CAM-1	沒有沒有 那個 這麼做 做做 右轉的 待命航線 *[no not that this will do do right orbit holding pattern]*
18	10	37.3	CAM-2	okay
18	10	38.2	APP	(與立榮 692 對話) *[communication with B7 692]*
18	10	40.5	CAM-2	兩洞么 *[two zero one]*
18	10	44.2	OTH	(立榮 692 與 ATC 對話) *[communication between B7 692 and ATC]*
18	10	51.1	RDO-2	transasia two two two ah request magong two zero one one tree d-m-e right pattern
18	10	59.7	APP	transasia two two two approved as requested
18	11	02.0	RDO-2	thank you
18	11	03.0	CAM-1	唉*[sigh]*
18	11	04.5	APP	(與復興 2093 對話) *[communication with GE 2093]*
18	11	08.3	OTH	(復興 2093 與 ATC 對話) *[communication between GE 2093 and ATC]*
18	11	11.6	CAM-2	噢加入我跟他報 *[oh established I will report to him]*
18	11	13.4	CAM-1	好*[okay]*
18	11	16.7	RDO-2	transasia two two two join uh holding pattern request five mile leg
18	11	17.7	CAM-1	嗯*[um]*
18	11	21.3	APP	transasia two two two approved as requested
18	11	23.5	CAM-1	對*[yes]*

hh	mm	ss	Source	Context
18	11	23.9	RDO-2	thank you transasia two two two
18	11	25.4	APP	(與其他航機對話) *[communications with other aircraft]*
18	11	25.4	CAM-2	好*[okay]*
18	11	36.6	CAM-1	嗯*[um]*
18	11	42.1	CAM-1	噢 一下子就吹掉 *[oh blown away immediately]*
18	11	46.0	CAM-2	嗯*[um]*
18	11	47.4	APP	(與其他航機對話) *[communication with other aircraft]*
18	11	50.7	CAM-2	五浬的 leg *[five mile leg]*
18	11	52.1	CAM-1	唉*[sigh]*
18	11	53.7	APP	(與遠東 3055 對話) *[communication with FE 3055]*
18	12	08.5	CAM-1	啊 十三浬三千 五浬的兩千 *[ah thirteen miles three thousand five miles two thousand]*
18	12	13.1	CAM-2	么八 么八也是五浬 *[one eight one eight reaches five miles too]*
18	12	15.0	CAM-1	嗯 嗯啊*[um um]*
18	12	16.3	CAM-2	沒有我說我們 holding 的話是 十 十八浬的時候再右轉回來 *[no I said if we're holding we have to turn inbound at one one eight miles]*
18	12	16.5	APP	(與復興 5133 對話) *[communication with GE 5133]*
18	12	24.9	CAM-1	唉 兩洞么噢 *[sigh two zero one]*
18	12	27.9	CAM-2	course 是兩洞么 *[course is two zero one]*
18	12	29.1	CAM-1	好 洞兩 這是洞兩么的噢 *[okay zero two this is zero two one]*
18	12	31.7	CAM-2	教官 我現在先設 兩洞么 因為我們現在是風修嘛噢

hh	mm	ss	Source	Context
				[sir I will initially set two zero one because we need this wind correction]
18	12	34.5	CAM-1	好*[okay]*
18	12	35.2	CAM-2	我們現在做風修啊 *[we can have this wind correction now]*
18	12	39.3	CAM-1	欸*[um]*
18	12	43.4	CAM-1	喔這樣喔*[oh I see]*
18	12	54.0	CAM-2	等一下要轉到　多少　兩三么吧　風那麼大 *[later we need to turn to how much two three one wind is so strong]*
18	13	04.3	CAM-1	嗯*[um]*
18	13	12.2	CAM-2	好教官五浬到 *[okay sir here comes the five miles]*
18	13	14.2	CAM-1	好*[okay]*
18	13	25.7	APP	(與立榮 6295 對話) *[communication with B7 6295]*
18	13	34.7	APP	(與立榮 6295 對話) *[communication with B7 6295]*
18	13	38.1	CAM-2	兩三么　我看看 *[two three one let me see]*
18	13	50.2	APP	(與遠東 3055 對話) *[communication with FE 3055]*
18	14	12.8	APP	(與華信 786 對話) *[communication with AE 786]*
18	14	24.0	OTH	(華信 786 與 ATC 對話) *[communication between AE 786 and ATC]*
18	14	29.5	APP	(與華信 786 對話) *[communication with AE 786]*
18	14	31.4	OTH	(華信 786 與 ATC 對話) *[communication between AE 786 and ATC]*
18	14	36.4	APP	(與復興 2093 對話) *[communication with GE 2093]*
18	14	40.9	OTH	(復興 2093 與 ATC 對話) *[communication between GE 2093 and ATC]*
18	14	43.6	APP	(與立榮 6295 對話)

hh	mm	ss	Source	Context
				[communication with B7 6295]
18	14	53.9	CAM-1	看一下*[take a look]*
18	15	02.6	CAM-2	快要 嗯 thunderstorm 快要吹過來了 *[coming um thunderstorm is gonna be blown toward us]*
18	15	06.0	CAM-1	喔*[oh]*
18	15	06.6	CAM-2	對啊所以馬公 可能我們就第一架下去了 *[yes so magong we may the first one for the approach]*
18	15	12.3	CAM-1	嗯啊*[um uh]*
18	15	13.9	OTH	(華信 786 與 ATC 對話) *[communication between AE 786 and ATC]*
18	15	19.7	APP	(與華信 786 對話) *[communication with AE 786]*
18	15	25.6	OTH	(華信 786 與 ATC 對話) *[communication between AE 786 and ATC]*
18	15	34.0	APP	(與復興 5133 對話) *[communication with GE 5133]*
18	15	37.0	OTH	(長榮航機間通話) *[communication between BR flights]*
18	15	41.5	OTH	(其他航機通聯) *[other aircraft communication]*
18	15	48.2	OTH	(其他航機通聯) *[other aircraft communication]*
18	15	52.8	OTH	(其他航機通聯) *[other aircraft communication]*
18	15	57.9	CAM-1	躲它一下好了 *[better evade it]*
18	15	58.3	OTH	(其他航機通聯) *[other aircraft communication]*
18	15	59.9	CAM-2	抄收*[copy that]*
18	16	01.4	APP	(與立榮 786 對話) *[communication with B7 786]*
18	16	03.2	CAM-2	那我們剛好跟他錯開啊 右邊這一塊剛好錯開 *[then we happen to circumvent it happens to circumvent the right side one]*

hh	mm	ss	Source	Context
18	16	07.1	CAM-1	喔*[oh]*
18	16	07.8	CAM-2	對啊*[yes]*
18	16	18.4	APP	(與遠東 3055 對話) *[communication with FE 3055]*
18	16	20.5	OTH	(長榮 758 與 ATC 對話) *[communication between BR 758 and ATC]*
18	16	22.2	APP	(與遠東 3055 對話) *[communication with FE 3055]*
18	16	28.6	APP	(與遠東 3055 對話) *[communication with FE 3055]*
18	16	36.5	CAM-1	來問一下天氣有沒有轉好　我們請求繼續進場 *[ask whether the weather is getting better　we request to continue the approach]*
18	16	41.5	CAM-1	有沒有 tempo 喔 *[any tempo]*
18	16	42.8	APP	(與華信 786 對話) *[communication with AE 786]*
18	16	43.5	CAM-2	好*[okay]*
18	16	46.5	OTH	(華信 786 與 ATC 對話) *[communication between AE 786 and ATC]*
18	16	50.4	RDO-2	高雄復興兩兩兩　嗯　check　馬公天氣是否好轉可以的話我們就申請進場 *[kaohsiung transasia two two two　um is　magong weather getting better and if yes we will request for approach]*
18	16	54.4	CAM-1	tempo 的天氣 *[tempo weather]*
18	16	55.9	APP	好的我幫你申我幫你詢問一下 *[okay i will apply for　I will inquire about it for you]*
18	16	58.1	CAM-1	短暫的好天氣 *[temporary good weather]*
18	17	00.5	CAM-2	好*[okay]*
18	17	15.4	APP	(與遠東 3055 對話) *[communication with FE 3055]*
18	17	20.4	OTH	(長榮 758 與 ATC 對話) *[communication between BR 758 and ATC]*

hh	mm	ss	Source	Context
18	17	29.9	CAM-2	好教官十三浬到　我們 要再轉一個 holding 喔 *[okay sir here is the one three miles　we are going to turn for another holding orbit]*
18	17	35.1	CAM-1	對啊那呢要轉 那就左轉喔 *[yes then if turn needed　turn left]*
18	17	38.3	CAM-2	左轉 orbit *[left turn orbit]*
18	17	39.6	CAM-1	好*[okay]*
18	17	40.8	RDO-2	transasia two two two request left turn orbit one orbit
18	17	45.3	APP	transasia two two two approved as requested
18	17	48.1	RDO-2	left turn one orbit transasia two two two
18	17	50.2	CAM-2	好左轉 one orbit *[okay left turn one orbit]*
18	17	56.4	CAM-1	看樣子啊 看 看起來都已經好了 *[it seems to　look　look like it is clear]*
18	17	58.8	CAM-2	要過了啊 *[it is passing over]*
18	17	59.9	APP	(與遠東 3055 對話) *[communication with FE 3055]*
18	18	04.1	CAM-2	教官我聽一下好了 *[sir I will listen to it]*
18	18	05.4	CAM-1	好*[okay]*
18	18	06.5	CAM	嘟 (無線電波道切換提醒聲響) *[sound of radio frequency switching]*
18	18	06.6	CAM	(ATIS information lima)
18	18	08.1	APP	(與遠東 3055 對話) *[communication with FE 3055]*
18	18	12.3	CAM-2	還是 lima 沒變 *[still lima]*
18	18	16.3	APP	(與遠東 3055 對話) *[communication with FE 3055]*
18	18	20.9	CAM	嘟 (無線電波道切換提醒聲響) *[sound of radio frequency switching]*
18	18	21.7	CAM-2	教官 lima 沒變 *[sir still lima]*

hh	mm	ss	Source	Context
18	18	23.1	CAM-1	喔喔*[oh oh]*
18	18	24.4	CAM-2	嗯討厭耶*[um annoying]*
18	18	40.5	B7 647	approach 立榮 嗯 六四拐請問現在要往 馬公的航機有幾架在待命 *[approach glory um six four seven how many aircraft to magong are holdind now]*
18	18	46.1	APP	有四架 包含您是四架 您是第一架 *[there are four including you and you are the first]*
18	18	49.5	B7 647	了解*[roger]*
18	18	51.4	APP	教官請問您的意向 *[sir say your intention please]*
18	18	54.0	B7 647	要等你們給我們天氣我們再做判斷 *[we will make our decision after the weather you provide us]*
18	18	56.8	APP	好的我們已經請塔台去 詢問了謝謝 *[okay we already have the tower to inquire about it thank you]*
18	19	00.4	CAM-2	天氣 天氣都不好 (笑聲) *[weather weather is not good [laughing]]*
18	19	00.5	B7 647	謝謝*[thank you]*
18	19	21.3	APP	(與華信 786 對話) *[communication with AE 786]*
18	19	25.1	OTH	(華信 786 與 ATC 對話) *[communication between AE 786 and ATC]*
18	19	29.4	APP	(與華信 786 對話) *[communication between AE 786 and ATC]*
18	19	32.4	OTH	(華信 786 與 ATC 對話)
18	19	35.5	APP	(與華信 786 對話) *[communication with AE 786]*
18	19	44.4	CAM-2	那要轉多少 *[to which shall we switch to]*
18	19	46.3	CAM	嘟 (無線電波道切換提醒聲響) *[sound of radio frequency switching]*
18	19	46.9	CAM-2	好*[okay]*
18	19	47.6	CAM-1	守聽一下*[listening watch for awhile]*

hh	mm	ss	Source	Context
18	19	48.6	CAM-2	okay
18	19	52.3	APP	(與遠東 3055 對話) *[communication with FE 3055]*
18	19	57.1	CAM-1	唉*[sigh]*
18	19	58.2	APP	(與遠東 3055 對話) *[communication with FE 3055]*
18	20	14.5	APP	(與遠東 3055 對話) *[communication with FE 3055]*
18	20	35.5	CAM-1	那就這樣亂轉喔 躲天氣就亂轉囉 *[then we're turning randomly turn randomly to dodge the weather]*
18	20	39.1	CAM-2	反正 orbit 就是我們的啊 這個空域都是我們的啊 *[anyway the orbit is ours this whole area is ours]*
18	20	42.0	CAM-1	好*[okay]*
18	20	51.1	CAM-1	看樣子是蠻好的*[looks pretty good]*
18	20	54.5	CAM-2	嗯*[um]*
18	20	59.5	CAM-1	嗯好*[um okay]*
18	20	59.9	APP	(與復興 5133 對話) *[communication with GE 5133]*
18	21	01.7	CAM-2	快過完了啊 那個 thunderstorm 就快過完了 *[almost completely passing through the thunderstorm is about to pass over soon]*
18	21	04.7	CAM-1	對啊*[yes]*
18	21	12.8	APP	(與華信 786 對話) *[communication with AE 786]*
18	21	17.5	CAM-2	繼續跟他要嗎 繼續跟他要 orbit 喔 *[keep requesting keep requesting orbit]*
18	21	18.0	OTH	(華信 786 與 ATC 對話) *[communication between AE 786 and ATC]*
18	21	23.1	CAM-1	嗯對*[um yes]*
18	21	25.9	RDO-2	transasia two two two ah request left orbit at two zero one radial one tree d-m-e
18	21	33.3	APP	confirm transasia two two two
18	21	34.8	RDO-2	affirmative
18	21	35.7	APP	transasia two two two approved as requested

hh	mm	ss	Source	Context
18	21	37.6	RDO-2	thank you transasia two two two
18	21	39.1	CAM-2	好 我們就在這邊么三 么三 么 么三浬 *[okay we will remain here at one three one three one one three miles]*
18	21	39.2	APP	立榮六四拐高雄 *[glory six four seven kaohsiung]*
18	21	41.4	B7 647	嗯請講*[um go ahead]*
18	21	42.4	APP	教官塔臺報告雷雨大概還要持續一個小時 嗯能見度我們還在詢問 *[sir tower reported that thunderstorm will probably continue for another hour and we are still requesting the visibility]*
18	21	50.0	B7 647	好謝謝 *[okay thank you]*
18	21	51.3	APP	復興兩兩兩教官 confirm 你抄收 *[transasia two two two sir confirm you copy that]*
18	21	54.3	RDO-2	抄收復興兩兩兩 *[roger transasia two two two]*
18	21	56.8	CAM-2	唉一個小時 *[sigh one hour]*
18	21	57.4	APP	(與遠東 3055 對話) *[communication with FE 3055]*
18	21	59.7	APP	(與復興 5133 對話) *[communication with GE 5133]*
18	22	05.9	APP	(與復興 5133 對話) *[communication with GE 5133]*
18	22	10.8	APP	(與復興 5133 對話) *[communication with GE 5133]*
18	22	11.7	APP	(與遠東 3055 對話) *[communication with FE 3055]*
18	22	15.9	APP	(與遠東 3055 對話) *[communication with FE 3055]*
18	22	20.0	CAM-2	好 … 那我們轉囉 orbit *[okay… then we have to turn orbit]*
18	22	22.1	CAM-1	好*[okay]*
18	22	30.1	RDO-1	嗯復興兩兩兩請問有沒有短暫的好天氣

hh	mm	ss	Source	Context
				[um transasia two two two is there any temporary good weather]
18	22	34.9	APP	教官我們正在問如果有我們馬上跟您報 *[sir we are waiting for an answer we will let you know immediately if there is any]*
18	22	38.1	RDO-1	好謝謝*[okay thank you]*
18	22	39.2	APP	不客氣*[you are welcome]*
18	22	58.4	CAM-1	唉唉唉*[sigh sigh sigh]*
18	23	31.7	CAM-1	唉唉唉*[sigh sigh sigh]*
18	23	48.1	CAM-2	那我看一下距離喔 *[let me check the distance]*
18	24	07.1	CAM-2	對啊應該都已經開了啊 *[yes it should be clear]*
18	24	08.9	CAM-1	嘿壓*[hey yes]*
18	24	09.1	CAM-2	*怎麼又來了 *[* here it comes again]*
18	24	33.3	CAM-1	唉(咳嗽聲)*[sigh [sound of coughing]]*
18	24	44.1	CAM-1	沒有了嗎*[gone yet]*
18	24	45.7	CAM-2	沒有了*[it's gone]*
18	24	48.3	CAM-1	應該好了*[should be good now]*
18	24	51.7	CAM-1	唉唷*[sigh]*
18	25	06.6	CAM-2	唉*[sigh]*
18	25	17.3	APP	(與其他航機對話) *[communication with other aircraft]*
18	25	21.5	APP	(與其他航機對話) *[communication with other aircraft]*
18	25	25.1	APP	(與遠東 3055 對話) *[communication with FE 3055]*
18	25	30.4	CAM-2	(笑聲) …拐千隨便你了 (笑聲) *[[laughing] ... seven thousand and all up to you [laughing]]*
18	25	36.3	APP	(與其他航機對話) *[communication with other aircraft]*
18	25	57.4	CAM-1	唉 … 好了 *[sigh ... all right]*

hh	mm	ss	Source	Context
18	26	25.4	CAM-1	…
18	27	04.4	CAM-2	要接上嗎 *[contact him or not]*
18	27	05.6	CAM-1	啊　等一下喔 *[ah wait a second]*
18	27	07.3	CAM-2	好*[okay]*
18	27	12.1	CAM-2	還是要問馬公 tower *[or ask magong tower]*
18	27	19.3	CAM-1	好我來問他 *[okay let me ask him]*
18	27	20.2	CAM-2	好教官*[okay sir]*
18	27	23.9	RDO-1	馬公塔台復興兩兩兩 請問有沒有短暫好天氣　我們看起來還不錯啊 *[magong tower transasia two two two　is the weather temporarily in good conditon　it looks fine from our perspective]*
18	27	38.2	TWR_M	復興兩兩兩塔台　欸教官我們剛剛在跟天氣室作天氣的確認 目前的預報是 數 能見度的數值應該會維持八百　那地面風的狀況 十分鐘平均風力是風向風速是兩兩洞的么拐浬　最大兩拐浬 洞兩跑道頭的即時風向風速是兩么洞的六浬 最大么么浬　兩洞頭的即時風速是兩洞洞的么兩浬最大么六浬 *[transasia two two two tower　sir we just confirmed with the forecast office and the forecast now visibility will remain at eight hundred　and as for ground wind average ten minutes wind two two zero degrees one seven knots maximum two seven knots　runway zero two wind two one zero degrees six knots maximum one one knots runway two zero wind two zero zero degrees one two knots maximum one six knots]*
18	27	38.4	APP	高雄 approach 廣播 馬公預報長報告十到 十 二十分鐘 能見度會好一點但是… 洞兩跑道的風會兩么洞風的五浬 最大風么么浬 兩洞跑道的風么九洞風的么么浬 最大風么五浬 confirm 抄收 立榮六四拐 *[kaohsiung approach broadcasts magong forecast chief reported that visibility will improve in the next ten to　ten twenty minutes but...　runway zero two wind two one zero degrees five knots maximum*

hh	mm	ss	Source	Context
				one one knots runway two zero wind one nine zero degrees one one knots maximum one five knots confirm you copy it glory six four seven]
18	28	05.0	APP	glory six four seven 高雄 *[kaohsiung]*
18	28	07.5	B7 647	六四拐回答 請問洞兩的跑道 洞兩的跑道風向風速再報一次 *[glory six four seven can you repeat runway zero two wind information at runway zero two]*
18	28	12.0	APP	洞兩跑道風 兩么洞風五浬最大么么浬 兩洞跑道風么九洞風么么浬最大么五浬 *[runway zero two wind two one zero degrees five knots maximum one one knots runway two zero wind one nine zero degrees one one knots maximum one five knots]*
18	28	18.6	RDO-1	抄收謝謝 *[roger thank you]*
18	28	20.2	TWR_M	教官不會 *[you are welcome sir]*
18	28	21.9	CAM-2	好教官切過去囉 *[okay sir I will switch over now]*
18	28	22.5	B7 647	那他現在能見度 他沒有報能見度嗎 *[what about the visibility didn't he report the visibility]*
18	28	24.3	CAM	嘟 (無線電波道切換提醒聲響) *[sound of radio frequency switching]*
18	28	25.6	APP	他們 預報長說不會調整數值 但是他說天氣會好一點點 *[they the forecast chief said they will not issue any adjustment but he said the weather will get better a little bit]*
18	28	25.9	CAM-2	都在八百 *[remain at eight hundred]*
18	28	32.2	B7 647	那現在數值多少 *[what about now]*
18	28	34.0	CAM-2	八百 *[eight hundred]*
18	28	34.2	APP	現在 我幫你查一下 *[now let me check for you]*
18	28	37.1	CAM-2	還是八百 *[still eight hundred]*

hh	mm	ss	Source	Context
18	28	42.6	APP	立榮六四拐 教官 現在 馬公的 metar 報告能見度是八百公尺 *[glory six four seven sir right now magong metar visibility eight hundred meters]*
18	28	58.1	RDO-1	approach 兩兩兩 請問那個洞兩跑道的 跑道頭風向風速 *[approach two two two may we request wind information at runway zero two]*
18	29	04.8	APP	嗯 洞兩 洞兩的風兩么洞風的五浬 最大么么浬 兩洞跑道么九洞風么么浬 最大么五浬 *[um zero two zero two wind two one zero degrees five knots maximum one one knots runway two zero wind one nine zero degrees one one knots maximum one five knots]*
18	29	15.2	CAM-1	抄收了嗎 洞兩跑道 *[copy yet runway zero two]*
18	29	18.0	RDO-2	please say again 復興兩兩兩 *[transasia two two two]*
18	29	20.6	APP	transasia two two two runway zero two wind two one zero degrees five knots maximum one one knots runway two zero wind one niner zero degrees one one knots maximum one five knots
18	29	32.4	RDO-2	copy standby transasia two two two
18	29	34.7	CAM-2	那我猜一下 i-l-s 洞兩的能見度 *[let me guess the visibility at i-l-s zero two]*
18	29	38.3	B7 647	高雄 approach glory 六四拐 請求雷達引導 i-l-s 洞兩跑道進場 *[kaohsiung approach glory six four seven request radar vector for i-l-s runway zero two approach]*
18	29	39.4	CAM-1	那就可以 *[then it works]*
18	29	39.8	CAM-2	能見度八百可以 洞兩可以 *[visibility eight hundred is good for zero two]*
18	29	44.3	CAM-2	真敢 * 他們要下了 *[how dare * they are going to descend]*
18	29	44.8	APP	我幫你申請一下 *[I will apply for you]*
18	29	46.4	CAM-2	被他們搶了 教官那我們也要喔

hh	mm	ss	Source	Context
				[they run in front of us sir we would request the same]
18	29	46.7	B7 647	好*[okay]*
18	29	48.3	CAM-1	好*[okay]*
18	29	50.3	RDO-2	高雄*[kaohsiung]* transasia two two two request radar vector to i-l-s runway zero two
18	29	55.4	APP	transasia two two two roger standby for coordination with magong tower
18	29	59.8	RDO-2	thank you standby transasia two two two continue left orbit
18	30	03.4	CAM-1	(咳嗽聲)*[sound of coughing]*
18	30	03.5	APP	roger
18	30	04.6	CAM-2	教官我們繼續轉 orbit 吧 *[sir let us continue the orbit]*
18	30	06.3	CAM-1	好*[okay]*
18	30	08.1	CAM-2	他在聯絡塔台幫我們帶 *[he is contacting tower to assist us]*
18	30	10.2	CAM-1	好的*[okay]*
18	30	11.0	CAM-2	兩么洞五浬 maximum 么么 尾風沒超限 *[two one zero five knots maximum one one under tail wind limit]*
18	30	14.5	CAM-1	好*[okay]*
18	30	15.1	CAM-2	能見度八百 i-l-s 洞兩可以下 *[visibility eight hundred i-l-s zero two is good]*
18	30	17.5	CAM-1	好*[okay]*
18	30	35.1	CAM-2	(咳嗽聲)*[sound of coughing]*
18	30	38.3	CAM-1	請求航向么八洞向南飛 *[request heading one eight zero to south]*
18	30	41.9	RDO-2	transasia two two two request heading one eight zero and to south
18	30	46.9	APP	transasia two two two roger approved as requested and heading one eight zero
18	30	51.1	RDO-2	heading one eight zero transasia two two two
18	30	53.6	CAM-2	航向么八洞許可 *[heading one eight zero approved]*
18	30	54.8	CAM-1	好的*[okay]*

hh	mm	ss	Source	Context
18	30	56.6	CAM-1	嗯 落地是 ... *[um and for landing...]*
18	30	58.7	CAM-2	一樣 落地是用洞八么三三六六么　我們現在尾風不加了 *[same　use zero eight one three three six six one for landing　we have tail wind now so no more addition]*
18	31	03.6	CAM-1	好*[okay]*
18	31	37.8	CAM-1	請求么六洞 唉 *[request one six zero　sigh]*
18	31	39.7	CAM-2	么六洞*[one six zero]*
18	31	40.6	CAM-1	嘿么六洞*[hey one six zero]*
18	31	42.1	RDO-2	transasia two two two request heading turn left one six zero
18	31	46.9	APP	transasia two two two heading one six zero approved
18	31	49.5	RDO-2	one six zero thank you transasia two two two
18	31	52.3	APP	transasia two two two any deviation is approved maintain ah maintain six thousand
18	31	57.6	RDO-2	maintain six thousand thank you transasia two two two
18	32	00.2	APP	welcome sir
18	32	01.3	CAM-2	好 隨便我們飛啦 六千保持就好了 *[okay it is all up to us now as long as maintaining six thousand]*
18	32	03.9	CAM-1	好*[okay]*
18	32	07.2	CAM-2	教官打一個 q-c 洞兩 a 下去了 *[sir I just keyed in q-c zero two a]*
18	32	09.3	CAM-1	好*[okay]*
18	32	12.8	CAM-1	好 航向么八洞啊 *[okay heading one eight zero]*
18	32	14.4	CAM-2	隨便　他說隨便了 *[up to us　he said up to us]*
18	32	15.2	CAM-1	隨便 隨便喔 *[up to us　up to us]*
18	32	16.5	CAM-2	他說隨便了 any deviation (笑聲) *[he said up to us any deviation [laughing]]*
18	32	19.7	CAM-1	(咳嗽聲)*[sound of coughing]*

hh	mm	ss	Source	Context
18	32	21.1	CAM-1	a-d-m …
18	32	22.9	CAM-2	啊 *[uh]*
18	32	23.2	CAM-1	他說怎麼樣 *[what did he say]*
18	32	24.0	CAM-2	他說*[he said]* any deviation
18	32	25.4	CAM-1	any deviation…
18	32	26.3	CAM-2	any deviation approved maintain six thousand 就是隨便我們了*[it means it is all up to us]*
18	32	27.2	CAM-1	喔喔喔　好好好　okay 好 *[oh oh oh okay okay okay okay okay]*
18	32	32.4	CAM-2	因為他也懶得管了　反正現在這個空域沒有飛機了 *[because they do not care and there is no other aircraft in this area anyway]*
18	32	35.4	CAM-1	喔 *[oh]*
18	32	39.6	CAM-1	唉*[sigh]*
18	32	57.9	CAM-2	教官現在變成那個風是小了嘛 *[sir the wind becomes mild]*
18	33	00.2	CAM-1	嘿啊*[yes]*
18	33	00.9	CAM-2	對啊變成五浬了嘛 *[yes it becomes five knots]*
18	33	02.6	CAM-1	嘿啊*[yes]*
18	33	02.7	CAM-2	maximum 十一啊 剛還在十七 gust 兩拐啊 *[maximum one one it was one seven gusting two seven]*
18	33	06.0	CAM-1	喔*[oh]*
18	33	06.6	CAM-2	現在風都變小了 *[now wind is getting mild]*
18	33	08.0	CAM-1	喔*[oh]*
18	33	33.7	B7 647	kaohsiung approach glory six four seven how about the weather … how about situation
18	33	39.4	APP	立榮六四拐教官還在詢問耶 *[glory six four seven sir we are still requesting]*
18	33	42.2	B7 647	嗯 okay

hh	mm	ss	Source	Context
				[um okay]
18	33	48.1	CAM-2	風有了能見度八百　應該就可以了 *[we have the wind info and visibility eight hundred that should be good]*
18	34	00.7	CAM-2	(咳嗽聲)*[sound of coughing]*
18	34	06.1	CAM-1	洞兩兩喔 … *[zero two two ....]*
18	34	07.3	CAM-2	洞兩兩么洞九么 *[zero two two one zero nine one]*
18	34	14.0	CAM-1	是剛剛 現在到哪裡去了 *[yes moments ago　where is it now]*
18	34	23.7	CAM-2	教官要放大一點看嗎 *[sir do you want to increase the range]*
18	34	25.7	CAM-1	啊*[uh]*
18	34	26.5	CAM-2	嗯嗯我說 *[um um I mean]*
18	34	27.3	CAM-1	哇* 這邊還有一架 * 拿四千的 *[wow * here is another one * at four thousand]*
18	34	29.5	CAM-2	四千的　我說 range range 要不要放大一點 我看一下我們在哪裡 *[four thousand　I mean range　can we increase it a bit　let me see where we are]*
18	34	35.6	CAM-2	對啊*[yes]*
18	34	36.7	CAM-1	嘿啊*[hey yes]*
18	34	40.5	CAM-2	教官我這邊可以參考好了 *[sir you can use my side for reference]*
18	34	42.1	CAM-1	好 好*[okay okay]*
18	34	44.3	CAM-2	對*[yes]*
18	34	48.6	CAM-1	好*[okay]*
18	34	51.3	CAM-1	現在* 看一下地圖就知道啊 *[now * you will know if you check the map]*
18	34	54.1	CAM-2	教官等於是馬公在我們的右手邊啊 *[sir magong is at our right hand side]*
18	34	57.6	CAM-1	喔*[oh]*
18	34	58.5	CAM-2	現在應該是 嗯差不多將近兩拐洞要九點鐘方向了

hh	mm	ss	Source	Context
				馬公 v-o-r *[now it shall be um roughly two seven zero at our nine o'clock direction magong v-o-r]*
18	35	04.7	CAM-1	喔*[oh]*
18	35	10.0	B7 647	高雄立榮六四拐 請問三洞分的馬公 那個 metar 是多少 *[kaohsiung glory six four seven what is the magong metar at time three zero]*
18	35	18.3	APP	我幫你詢問一下 *[I will inquire about it for you]*
18	35	19.9	B7 647	好*[okay]*
18	35	25.1	CAM-2	還沒有放嘛 *[not updated yet]*
18	35	26.0	CAM-1	嗯*[um]*
18	35	30.6	CAM	嘟 (無線電波道切換提醒聲響) *[sound of radio frequency switching]*
18	35	30.7	CAM	(ATIS information lima)
18	35	37.9	CAM	嘟 (無線電波道切換提醒聲響) *[sound of radio frequency switching]*
18	35	38.4	CAM-2	還沒變*[no change yet]*
18	35	52.8	CAM-2	所以它是往外飛 它飛外圍 *[so it is flying outbound at outer area]*
18	35	55.6	CAM-1	喔*[oh]*
18	35	56.2	CAM-2	我們在內圈啊 可是它高度比我們低 *[we are at inner area but it's altitude is lower than us]*
18	35	58.7	CAM-1	欸*[hey]*
18	36	14.3	CAM-1	才剛過馬公 v-o-r *[just passing magong v-o-r]*
18	36	16.0	CAM-2	欸 馬公 v-o-r 已經 現在在我們的 兩洞 一九洞 *[hey magong v-o-r is at our two zero one nine zero direction]*
18	36	22.1	APP	立榮六四拐教官 現在 information 是 mike 報告啊 mike 報 能見度是八百公尺 有雷雨雷陣雨嗯雷雨當嗯然後還是雷雨當空的 稀雲是兩百疏雲是六百 稀雲的 c b 是么千兩百 嗯裂雲是么千的六百

hh	mm	ss	Source	Context
				[glory six four seven now information mike information mike visibility eight hundred meters thunderstorm thundershower um still thunderstorm overhead clouds few two hundred meters scattered six hundred few c-b one thousand two hundred um broken one thousand six hundred]
18	36	47.8	B7 647	請問馬公有宣布關場嘛 *[is magong airport close]*
18	36	50.4	APP	嗯我們沒有關場 *[um we are not close]*
18	36	51.3	B7 647	okay 好雷達引導的 i-l-s 洞兩跑道 準備進場 *[okay good radar vector i-l-s runway zero two prepare for approach]*
18	36	54.6	CAM-2	風向啊 *[wind direction]*
18	36	55.3	APP	好的教官我們 因為現在馬公是使用兩洞跑道 那如果使用洞兩跑道的話需要由馬基隊同意 我們已經幫您申請了 但是他們還在申請當中 請您稍待一下 *[okay sir we because we are using runway two zero now and if you prefer runway zero two an approval from magong military office is required we have applied it for you but it is still in process please wait]*
18	37	08.3	B7 647	了解 *[roger]*
18	37	10.3	CAM-2	我跟他說同樣喔 *[I will tell him the same thing]*
18	37	12.7	CAM-1	嗯不用 我們已經知道了 嘿 我們剛剛已經跟他講了 *[no we don’t have to we know it already hey we just told him]*
18	37	13.5	CAM-2	不要講了*[no need to tell them]*
18	37	16.0	CAM-2	好好好*[okay okay okay]*
18	37	17.6	CAM-2	馬基隊是不是就是空軍那個啊 *[doesn’t magong military office belong to air force]*
18	37	19.7	CAM-1	嘿呀 馬公基地 *[hey magong military office]*
18	37	21.6	CAM-2	喔 馬基隊 哈哈哈哈

hh	mm	ss	Source	Context
				[oh magong military office ha ha ha ha]
18	37	23.9	CAM-1	基勤中隊 *[air force base duty team]*
18	37	25.0	CAM-2	嘿嘿嘿嘿 (笑聲) *[hey hey hey hey] [laugh]*
18	37	26.5	CAM-1	他們要去換那個 *[they are going to change that]*
18	37	28.3	CAM-2	網子還是甚麼 *[a net or something]*
18	37	29.6	CAM-1	對啊*[yes]*
18	37	30.0	CAM-2	可是這種天氣*戰機也會起來才怪咧 對不對 *他們根本不肯 不會起來啊 *[but in this kind of weather condition * fighters are not going to get airborne right * they are not willing to get airborne at all]*
18	37	54.8	APP	立榮六四拐教官請您稍待 現在塔台已經跟馬基隊提出三次申請了 請您稍待一下 *[glory six four seven please standby we have made three requests to magong military office already please wait]*
18	38	01.9	CAM-2	教官好像這邊比較好 隨便我們飛了(笑聲) *[sir looks like here is better any deviation as we like]*
18	38	02.4	B7 647	了解謝謝 *[roger thank you]*
18	38	31.7	APP	(與復興 5133 對話) *[communication with GE 5133]*
18	38	35.0	OTH	(復興 5133 與 ATC 對話) *[communication between GE 5133 and ATC]*
18	38	43.3	CAM-2	five one tree tree
18	38	59.9	CAM-2	*
18	39	00.5	OTH	(復興 5084 與 ATC 對話) *[communication between GE 5084 and ATC]*
18	39	06.1	CAM-2	唉唷*[ouch]*
18	39	06.5	APP	(與復興 5084 對話) *[communication with GE 5084]*

hh	mm	ss	Source	Context
18	39	13.5	OTH	(復興5084與ATC對話) *[communication between GE 5084 and ATC]*
18	39	17.3	APP	(與復興5084對話) *[communication with GE 5084]*
18	39	23.1	OTH	(復興5084與ATC對話) *[communication between GE 5084 and ATC]*
18	39	28.1	APP	(與復興5084對話) *[communication with GE 5084]*
18	39	33.8	OTH	(復興5084與ATC對話) *[communication between GE 5084 and ATC]*
18	39	38.6	CAM-2	我跟他check一下q-n-h　剛剛是給他報一千 *[I will check q-n-h with him　he reported one zero zero zero moments ago]*
18	39	42.7	RDO-2	transasia two two two check magong q-n-h
18	39	45.8	APP	transasia two two two kaohsiung q-n-h one zero zero zero and magong q-n-h uh magong q-n-h niner niner five
18	39	54.9	CAM-1	喔*[oh]*
18	39	55.2	RDO-2	q-n-h one zero zero zero magong airport niner niner five transasia two two two thank you
18	40	00.6	CAM-2	好么洞洞洞 *[okay one zero zero zero]*
18	40	04.0	CAM-2	馬公九九五唉 *[magong nine nine five sigh]*
18	40	13.7	CAM-2	三　油量三　三六四 *[three　fuel quantity three　three six four]*
18	40	19.4	CAM-1	唉*[sigh]*
18	40	29.8	CAM-2	三七三唉 *[three seven three　sigh]*
18	40	40.3	APP	(與復興5084對話) *[communication with GE 5084]*
18	40	43.8	OTH	(復興5084與ATC對話) *[communication between GE 5084 and ATC]*
18	40	48.4	APP	(與復興5084對話) *[communication with GE 5084]*
18	40	52.9	OTH	(復興5084與ATC對話)

hh	mm	ss	Source	Context
				[communication between GE 5084 and ATC]
18	41	08.0	CAM-1	唉*[sigh]*
18	41	13.4	OTH	(復興 5084 與 ATC 對話) *[communication between GE 5084 and ATC]*
18	41	18.6	APP	(與復興 5084 對話) *[communication with GE 5084]*
18	41	21.3	OTH	(復興 5084 與 ATC 對話) *[communication between GE 5084 and ATC]*
18	42	28.3	APP	glory six four seven now magong runway two zero visibility one thousand six hundred meters however still thunderstorm overhead say intention
18	42	41.0	CAM-2	*一千六變我們兩洞可以下去了 *[* one thousand six hundred we now can use two zero]*
18	42	42.1	B7 647	standby
18	42	43.1	APP	roger
18	42	44.4	APP	transasia two two two say intention
18	42	46.6	CAM-1	ahhh
18	42	47.9	RDO-1	request runway zero two i-l-s approach
18	42	54.0	APP	confirm transasia two two two request runway zero two
18	42	57.5	RDO-1	affirm transasia two two two request runway zero two for i-l-s approach
18	43	01.8	APP	transasia two two two roger standby coordination with the military office
18	43	06.7	RDO-1	okay
18	43	07.9	CAM-2	如果兩洞的話就不用了 *[do not need that if using two zero]*
18	43	09.3	B7 647	okay glory six four seven request runway two zero approach
18	43	13.7	APP	glory six four seven roger cancel holding clearance and fly heading … cancel holding clearance heading two eight zero radar vector v-o-r
18	43	25.5	B7 647	confirm left turn or right turn
18	43	27.8	APP	right turn
18	43	29.2	B7 647	okay right turn heading two eight zero glory six four seven

hh	mm	ss	Source	Context
18	43	43.8	APP	(與復興 5084 對話) *[communication with GE 5084]*
18	43	48.0	OTH	(復興 5084 與 ATC 對話) *[communication between GE 5084 and ATC]*
18	43	51.9	APP	glory six four seven descend and maintain two thousand
18	43	54.7	B7 647	descend and maintain two thousand glory six four seven
18	43	55.6	CAM	(pitch trim 聲響) *[sound of pitch trim]*
18	43	59.3	CAM-1	哇那要等它落地了* *[wow then we have to wait until it lands *]*
18	44	01.5	CAM-2	它是要用兩洞的 我們洞兩要等那個馬基隊的 *[it will use two zero, we have to wait for the approval from magong military office to use zero two]*
18	44	05.4	APP	glory six four seven continue right turn heading tree four zero
18	44	09.2	B7 647	right turn tree four zero request direct to pinit
18	44	13.7	APP	glory six four seven roger maintain four thousand direct to uh correction maintain four thousand heading two eight zero standby pinit
18	44	22.4	B7 647	… four thousand uh heading tree four zero
18	44	28.2	APP	heading two eight zero thank you glory six four seven
18	44	30.5	OTH	(其他航機與 ATC 對話) *[communication between other aircraft and ATC]*
18	44	31.9	OTH	(復興 5084 與 ATC 對話) *[communication between GE 5084 and ATC]*
18	44	35.6	APP	(與復興 5084 對話) *[communication with GE 5084]*
18	44	37.9	OTH	(復興 5084 與 ATC 對話) *[communication between GE 5084 and ATC]*
18	44	49.2	CAM-1	嗯*[um]*
18	44	52.5	RDO-1	transasia two two two confirm ah number two
18	44	56.5	APP	transasia two two two affirm ah number two say intention
18	45	00.5	RDO-1	roger request runway two zero for v-o-r approach

hh	mm	ss	Source	Context
18	45	04.2	APP	transasia two two two roger ah fly heading ah zero two ah tree six zero radar vector v-o-r approach
18	45	10.7	RDO-2	right turn heading tree six zero radar vector v-o-r runway two zero transasia two two two
18	45	14.7	CAM-2	右轉航向 三六洞 *[turn right heading three six zero]*
18	45	17.9	CAM-1	嗯*[sigh]*
18	45	19.0	CAM-2	唉 v-o-r 洞 兩洞 *[sigh v-o-r zero two zero]*
18	45	21.6	CAM-1	roger
18	45	22.9	CAM-2	兩洞么*[two zero one]*
18	45	26.7	APP	glory six four seven now information november and direct to pinit
18	45	31.1	B7 647	direct to pinit glory six four seven
18	45	33.7	APP	glory six four seven one six mile from uh pinit cleared r-nav runway two zero approach
18	45	35.1	CAM-1	uh 先不要下降 … *[uh do not descend yet]*
18	45	36.9	CAM-2	我知道…*[I know…]*
18	45	39.0	B7 647	clear for r-nav runway two zero approach glory six four seven
18	45	44.6	APP	transasia two two two continue maintain six thousand heading tree six zero radar vector v-o-r
18	45	50.8	RDO-2	clear maintain present maintain six thousand heading three six zero transasia two two two
18	45	52.5	CAM-1	嗯唉*[um sigh]*
18	45	55.6	CAM-1	(咳嗽聲)*[sound of coughing]*
18	45	57.0	APP	(與遠東 3055 對話) *[communication with FE 3055]*
18	45	02.5	CAM-2	…
18	46	03.9	APP	(與遠東 3055 對話) *[communication with FE 3055]*
18	46	05.8	CAM-1	所以叫他下兩千他還不下啊 *[so tell them to descend to two thousand but they have not done so]*
18	46	08.4	CAM-2	對啊*[yes]*

hh	mm	ss	Source	Context
18	46	09.3	CAM-1	唉呀呀阿*[ohoh]*
18	46	10.8	CAM-2	受不了他*[cannot stand him]*
18	46	11.9	OTH	(復興 5084 與 ATC 對話) *[communication between GE 5084 and ATC]*
18	46	16.5	APP	(與復興 5084 對話) *[communication with GE 5084]*
18	46	20.8	OTH	(復興 5084 與 ATC 對話) *[communication between GE 5084 and ATC]*
18	46	30.9	CAM-1	那請求航向洞三洞 *[request heading zero three zero]*
18	46	32.1	APP	(與復興 5133 對話) *[communication with GE 5133]*
18	46	41.8	CAM-1	算了*[forget about it]*
18	46	42.0	OTH	(復興 5133 與 ATC 對話) *[communication between GE 5133 and ATC]*
18	46	43.6	CAM-2	不用噢*[no]*
18	46	44.5	CAM-1	不用*[no]*
18	46	50.5	CAM-2	他們到底　前面的那架立榮真的是 * 很慢耶 *[they… that Uni Air flight ahead of us is so * slow]*
18	46	56.5	CAM-1	…
18	46	57.6	CAM-2	叫他們下 給他們帶了 *　還那邊慢吞吞的 不懂耶 *[cleared them for descend, and vectored them, I don't understand why they are so slow]*
18	47	03.2	CAM-1	現在…叫它下兩千啊 *[now …. cleared it to descend to two thousand]*
18	47	04.5	B7 647	kaohsiung approach glory six four seven due to weather request direct to mause
18	47	08.7	CAM-2	* r-nav 啊 *[* r-nav]*
18	47	09.1	APP	glory six four seven can you accept after one zero mile for mause
18	47	17.6	B7 647	affirm glory six four seven
18	47	19.0	CAM-2	五浬後給他們 *[approve them after five miles]*

hh	mm	ss	Source	Context
18	47	19.6	APP	… glory six four seven roger continue present heading descend and maintain tree thousand radar vector to mause
18	47	27.2	B7 647	present heading three thousand ah standby at mause glory six four seven
18	47	33.6	CAM-2	他們要飛十浬去 mause *[they need to fly ten miles to mause]*
18	47	51.4	CAM-2	有帶開一點 *[vectored them further away]*
18	47	52.2	CAM-1	唉*[sigh]*
18	48	04.6	CAM-2	okay …
18	48	05.3	B7 647	kaohsiung approach glory six four seven confirm local q-n-h
18	48	08.3	CAM-2	他把它關掉 *[he turned it off]*
18	48	09.4	APP	glory six four seven kaohsiung q-n-h one zero zero zero magong q-n-h niner niner six
18	48	17.7	B7 647	niner niner six one zero zero zero glory six four seven
18	48	18.3	CAM	(客艙呼叫聲響) *[sound of cabin call]*
18	48	21.1	CAM-1	好等一下航向洞四洞啊 *[okay later heading zero four zero]*
18	48	21.8	APP	transasia two two two turn right heading zero two zero descend and maintain five thousand
18	48	27.3	CAM-1	等一下 zero four zero 嗯 (later zero four zero um)
18	48	29.1	RDO-2	right turn heading zero two zero and request heading zero four zero descend and maintain five thousand transasia two two two
18	48	36.4	APP	transasia two two two heading zero four zero approved maintain five thousand
18	48	40.4	RDO-2	heading zero four zero five thousand transasia two two two
18	48	40.5	CAM	(高度提示聲響) *[sound of altitude alert]*
18	48	43.1	APP	(與復興 5133 對話) *[communication with GE 5133]*

hh	mm	ss	Source	Context
18	48	43.2	CAM-2	好我們進去 *[okay let us go in]*
18	48	50.3	APP	(與復興 5133 對話) *[communication with GE 5133]*
18	49	06.9	OTH	(復興 5084 與 ATC 對話) *[communication between GE 5084 and ATC]*
18	49	11.3	APP	(與復興 5084 對話) *[communication with GE 5084]*
18	49	17.8	OTH	(復興 5084 與 ATC 對話) *[communication between GE 5084 and ATC]*
18	49	21.6	B7 647	kaohsiung approach glory six four seven due to weather request left turn direct to mause
18	49	26.3	APP	glory six four zero direct to mause approved and position six miles from mause cleared r-nav runway two zero approach
18	49	33.5	B7 647	cleared for r-nav runway two zero approach glory six four seven
18	50	11.2	CAM-1	好 heading zero two zero … zero tree zero 好了 *[okay heading zero two zero … do zero tree zero]*
18	50	16.9	CAM-2	洞三洞*[zero three zero]*
18	50	17.5	CAM-1	好洞三洞 *[okay zero three zero]*
18	50	19.2	RDO-2	transasia two two two request turn left heading zero tree zero
18	50	22.8	APP	transasia two two two heading zero tree zero approved and descend and maintain four thousand
18	50	27.1	RDO-2	heading zero tree zero descend and maintain four thousand transasia two two two
18	50	30.9	CAM-2	好四千洞三洞 *[okay four thousand zero three zero]*
18	50	31.9	APP	(與遠東 3055 對話) *[communication with FE 3055]*
18	50	37.5	CAM-1	嗯唉*[um sigh]*
18	50	38.4	APP	(與復興 5133 對話) *[communication with GE 5133]*
18	50	58.9	CAM	(高度提示聲響) *[sound of altitude alert]*

hh	mm	ss	Source	Context
18	50	59.2	CAM-2	oh one thousand to go
18	51	01.0	CAM-1	唉嗯*[um sigh]*
18	51	08.3	OTH	(華信 1831 與 ATC 對話) *[communication between AE 1831 and ATC]*
18	51	13.9	APP	(與華信 1831 對話) *[communication with AE 1831]*
18	51	17.6	OTH	(華信 1831 與 ATC 對話) *[communication between AE 1831 and ATC]*
18	51	26.3	OTH	(華信 1831 與 ATC 對話) *[communication between AE 1831 and ATC]*
18	51	33.0	OTH	(華信 1831 與 ATC 對話) *[communication between AE 1831 and ATC]*
18	51	37.6	APP	(與華信 1831 對話) *[communication with AE 1831]*
18	51	41.0	OTH	(華信 1831 與 ATC 對話) *[communication between AE 1831 and ATC]*
18	51	44.4	APP	(與華信 1831 對話) *[communication with AE 1831]*
18	51	50.4	OTH	(華信 1831 與 ATC 對話) *[communication between AE 1831 and ATC]*
18	51	53.1	APP	another traffic say again
18	51	58.6	APP	are there any traffic calling kaohsiung
18	52	03.0	B7 647	kaohsiung approach glory six four seven established final
18	52	06.2	APP	glory six four seven contact magong tower one one eight decimal tree see you
18	52	09.1	B7 647	contact tower see you glory six four seven
18	52	11.7	APP	transasia two two two turn left heading two niner zero
18	52	14.3	RDO-2	turn left heading two niner zero transasia two two two
18	52	17.3	CAM-2	兩 左轉航向兩 兩九洞 *[two left heading two two nine zero]*
18	52	18.9	CAM-1	好 嗯*[okay um]*
18	52	22.6	CAM-1	up five mile up five mile
18	52	25.2	CAM-2	five mile
18	52	25.8	CAM-1	喔 up up five mile 五浬以後

hh	mm	ss	Source	Context
				[oh up up five mile after five miles]
18	52	27.3	CAM-2	okay
18	52	29.1	RDO-2	transasia two two two request another five mile and turn left heading two niner zero
18	52	34.3	APP	transasia two two two approved as requested descend and maintain tree thousand
18	52	37.7	RDO-2	descend maintain tree thousand approved five mile two niner zero transasia two two two
18	52	42.5	CAM-2	好現在保持三千 五浬後 兩九洞 *[okay now maintain three thousand after five miles two nine zero]*
18	52	44.2	CAM-1	嗯*[um]*
18	52	45.7	APP	(與復興 5133 對話) *[communication with GE 5133]*
18	52	50.2	CAM	(不明聲響) *[unidentified sound]*
18	52	54.7	APP	(與復興 5133 對話) *[communication with GE 5133]*
18	52	58.3	CAM	(高度提示聲響) *[sound of altitude alert]*
18	53	00.6	CAM-2	one thousand to go
18	53	19.1	CAM-2	教官這是 basic mode *[sir this is basic mode]*
18	53	21.1	CAM-1	喔 唉*[oh sigh]*
18	53	24.0	CAM-2	okay 謝謝 *[okay thank you]*
18	53	25.9	APP	(與遠東 3055 對話) *[communication with FE 3055]*
18	54	02.4	CAM	(安全帶提示聲響) *[sound of seat belt reminder]*
18	54	04.5	CAM-1	heading two nine zero 哦 *[heading two nine zero oh]*
18	54	06.2	CAM-2	對 *[yes]* two nine zero
18	54	06.3	APP	(與其他航機對話) *[communication with other aircraft]*
18	54	08.8	PA-3	(客艙廣播至 1854:52.3)

hh	mm	ss	Source	Context
				[cabin announcement until 1854:52.3]
18	54	44.1	CAM-1	我要兩四洞 *[I want two four zero]*
18	54	46.5	CAM-2	…
18	54	47.4	CAM-1	heading 兩四洞喔 *[heading two four zero]*
18	54	47.4	RDO-2	transasia two two two request left turn heading two four zero
18	54	51.1	APP	transasia two two two heading two four zero approved
18	54	53.2	RDO-2	heading two four zero transasia two two two
18	54	55.0	CAM-2	兩四洞許可了 *[two four zero approved]*
18	54	56.5	CAM-1	唉*[sigh]*
18	54	56.6	CAM-2	altitude check 三千*[three thousand]*
18	55	04.4	CAM-1	唉*[sigh]*
18	55	05.4	CAM-2	剛剛這一塊 吹過去馬公都開啦 *[if this patch we just saw is blown away then magong is clear]*
18	55	09.7	APP	transasia two two two position two five miles northeast of magong airdrome turn left heading two three zero descend and maintain two thousand till establish final approach course cleared v-o-r runway two zero approach
18	55	19.9	RDO-2	turn left heading two three zero descend maintain two thousand until establish cleared v-o-r runway two zero approach transasia two two two
18	55	27.7	CAM	(高度提示聲響) *[sound of altitude alert]*
18	55	28.0	APP	(與遠東 3055 對話) *[communication with FE 3055]*
18	55	30.4	CAM-2	one thousand to go
18	55	31.9	CAM-2	兩三洞攔上許可 *[two three zero cleared for approach]*
18	55	34.9	CAM-2	v-o-r 兩洞*[v-o-r two zero]*
18	55	36.3	CAM-1	喔*[oh]*
18	55	39.7	CAM-2	五浬兩千　通過五浬可以下降 三三零 *[five miles two thousand after passing five miles we*

hh	mm	ss	Source	Context
				can descend three three zero]
18	55	42.5	APP	(與遠東 3055 對話) *[communication with FE 3055]*
18	55	58.6	CAM-1	唉*[sigh]*
18	56	08.6	RDO-2	transasia two two two check q-n-h for approach
18	56	12.8	APP	transasia two two two say again
18	56	14.7	RDO-2	哦教官我們 check q-n-h *[oh sir we would like to check q-n-h]*
18	56	17.2	APP	嗯復興兩兩兩教官 roger 高雄高度表么洞洞洞 馬公高度表九九六 *[um transasia two two two sir roger kaohsiung q-n-h one zero zero zero magong q-n-h niner niner six]*
18	56	23.2	RDO-2	好么洞洞洞九九六謝謝 復興兩兩兩 *[okay one zero zero zero niner niner six thank you transasia two two two]*
18	56	27.3	APP	教官不要客氣攔上報告 *[you are welcome sir report when established]*
18	56	29.8	RDO-2	攔上報告 *[report when established]*
18	56	31.1	CAM-2	好九九六攔上報告 *[okay niner niner six report when established]*
18	56	33.1	CAM-1	嗯*[um]*
18	56	34.5	CAM-2	耶教官不是 *[yay sir negative]*
18	56	39.9	APP	(與遠東 3055 對話) *[communication with FE 3055]*
18	56	45.4	APP	(與復興 5133 對話) *[communication with GE 5133]*
18	56	51.6	OTH	(立榮 8297 與 ATC 對話) *[communication with B7 8297]*
18	56	59.6	CAM-1	唉嗯 *[sigh um]*
18	57	00.7	APP	(與立榮 8297 對話) *[communication with B7 8297]*
18	57	02.9	CAM	(高度提示聲響) *[sound of altitude alert]*

hh	mm	ss	Source	Context
18	57	04.0	OTH	(立榮 8297 與 ATC 對話) *[communication between B7 8297 and ATC]*
18	57	08.2	CAM-2	altitude star
18	57	09.1	CAM-1	check
18	57	25.2	CAM-2	alt captured 兩千*[two thousand]*
18	57	26.8	CAM-1	check
18	56	31.3	CAM-1	唉嗯*[sigh um]*
18	57	37.6	CAM-1	(咳嗽聲)*[sound of coughing]*
18	57	54.0	APP	(與復興 5133 對話) *[communication with GE 5133]*
18	58	34.6	CAM-1	… nav 嘛 *[… nav]*
18	58	34.5	CAM-2	兩洞么 *[two zero one]*
18	58	40.5	OTH	(立榮 8297 與 ATC 對話) *[communication between B7 8297 and ATC]*
18	58	44.2	APP	(與立榮 8297 對話) *[communication with B7 8297]*
18	58	47.2	OTH	(立榮 8297 與 ATC 對話) *[communication between B7 8297 and ATC]*
18	58	49.6	APP	(與遠東 3055 對話) *[communication with FE 3055]*
18	58	57.4	CAM-2	我們 course 兩洞么 *[our course is two zero one]*
18	59	58.6	CAM-1	嗯 course 兩洞么啊 *[um course two zero one]*
18	59	01.5	CAM-2	yes sir
18	59	03.3	CAM	(安全帶提示聲響) *[sound of seatbelt reminder]*
18	59	09.9	CAM-2	教官 preset 下一個三四零嘛 還四百 *[sir do we preset next altitude three four zero or four hundred]*
18	59	13.5	CAM-1	啊*[uh]*
18	59	14.2	CAM-2	preset 下一個高度四百 *[preset next altitude four hundred]*

hh	mm	ss	Source	Context
18	59	14.3	CAM-1	喔*[oh]*
18	59	15.7	CAM-2	五浬 *[five miles]*
18	59	15.8	CAM-1	…個高度　嗯 *[… altitude　um]*
18	59	17.3	CAM-2	五浬才可以下　四百 *[descend at five miles　four hundred]*
18	59	18.3	CAM-1	嗯好好好　四百 *[um okay okay okay four hundred]*
18	59	19.9	APP	(與遠東 3055 對話) *[communication with FE 3055]*
18	59	43.2	APP	(與遠東 3055 對話) *[communication with FE 3055]*
18	59	50.4	APP	(與遠東 3055 對話) *[communication with FE 3055]*
18	59	58.8	CAM-1	五浬兩千 嗯 *[five miles two thousand um]*
19	00	01.2	CAM-2	通過五浬才可以下 *[can only descend after passing five miles]*
19	00	03.4	CAM-1	喔*[oh]*
19	00	04.1	CAM-2	好*[okay]*
19	00	11.4	CAM-2	風怎麼那麼大啊 唉 *[how come the wind is so strong　sigh]*
19	00	15.5	CAM-2	兩四拐三十五 歪著飛不進去 (笑聲) *[two four seven thirty five　we can not land it with crabbing] [laughing]*
19	00	20.7	CAM-1	啊…就這樣 *[uh…. that is it]*
19	00	20.8	OTH	(其他航機與 ATC 對話) *[communication between other aircraft and ATC]*
19	00	21.9	APP	station calling say again
19	00	23.6	CAM-2	風那麼大　原則飛不進去啦 *[wind is too strong to make the landing in principle]*
19	00	25.6	CAM-1	嘿*[hey]*
19	00	26.9	APP	(與立榮航機對話)

hh	mm	ss	Source	Context
				[communication with Uni Air flight]
19	00	34.3	CAM-2	噢喔教 …來了 *[uh uh sir ….. alive]*
19	00	36.5	CAM-1	來了嗎　對啊 *[is it alive　yes]*
19	00	55.7	CAM-1	嗯*[um]*
19	01	01.5	CAM-2	v-o-r star runway heading
19	01	03.2	CAM-1	嗯嗯嗯*[um um um]*
19	01	03.4	RDO-2	transasia two two two established
19	01	05.8	APP	two two two contact tower one one eight decimal three good day
19	01	08.4	RDO-2	contact tower good day transasia two two two 謝謝喔 *[thank you]*
19	01	11.2	APP	good day
19	01	12.1	CAM	嘟 (無線電波道切換提醒聲響) *[sound of radio frequency switching]*
19	01	13.2	RDO-2	magong tower good evening transasia two two two eight miles for v-o-r runway two zero
19	01	19.9	TWR_M	transasia two two two good evening magong tower runway two zero q-n-h niner niner seven continue approach
19	01	26.7	RDO-2	runway two zero q-n-h niner niner seven continue transasia two two two
19	01	31.3	CAM-2	九九拐兩洞繼續進場 *[nine nine seven two zero continue approach]*
19	01	32.8	CAM-1	Roger
19	01	38.8	CAM-1	啊雷達關了喔 *[uh is radar off yet]*
19	01	39.9	CAM-2	好教官雷達關 *[okay sir radar off]*
19	01	53.8	TWR_M	(與遠東 082 對話) *[communication with FE 082]*
19	01	57.7	OTH	(遠東 082 與 ATC 對話) *[communication between FE 082 and ATC]*
19	02	00.0	TWR_M	(與遠東 082 對話) *[communication with FE 082]*

hh	mm	ss	Source	Context
19	02	02.5	OTH	(遠東 082 與 ATC 對話) *[communication between FE 082 and ATC]*
19	02	05.7	TWR_M	(與遠東 082 對話) *[communication with FE 082]*
19	02	12.3	OTH	(遠東 082 與 ATC 對話) *[communication between FE 082 and ATC]*
19	02	14.9	CAM-2	啊么四浬么么八 *[uh one four knots one one eight]*
19	02	18.0	CAM-1	么么八啊 *[one one eight]*
19	02	18.9	CAM-2	我先加十浬　因為兩洞 *[I will add ten knots due to two zero]*
19	02	21.1	CAM-1	喔*[oh]*
19	02	26.1	CAM-1	嗯*[um]*
19	02	36.2	CAM-2	嗯　我 *[um　i]*
19	02	37.8	PA-1	組員準備落地 *[cabin crew prepare for landing]*
19	02	39.0	CAM-1	嗯*[um]*
19	02	40.7	CAM-2	噢我五浬放外型 *[oh I will set landing configuration at five miles]*
19	02	48.7	PA-3	(客艙廣播至 1902:59.2) *[cabin announcement until 1902:59.2]*
19	02	57.6	CAM-2	剛好通過五浬 *[passing five miles]*
19	02	58.1	CAM-1	好 flap fifteen *[okay flap fifteen]*
19	02	59.8	CAM-2	speed check
19	03	05.1	CAM	(pitch trim 聲響) *[sound of pitch trim]*
19	03	05.6	OTH	(遠東 082 與 ATC 對話) *[communication between FE 082 and ATC]*
19	03	07.8	TWR_M	(與遠東 082 對話) *[communication with FE 082]*
19	03	08.1	CAM	(pitch trim 聲響)

hh	mm	ss	Source	Context
				[sound of pitch trim]
19	03	21.1	CAM-1	嗯 嗯 嗯*[um um um]*
19	03	27.3	CAM-2	flap fifteen set
19	03	28.3	CAM-1	好*[okay]*
19	03	29.9	CAM-1	…
19	03	31.0	CAM-2	speed check
19	03	31.9	CAM	(起落架艙門開啟聲響) *[sound of gear doors open]*
19	03	32.7	CAM	(客艙播放音樂) *[cabin music starts]*
19	03	36.1	CAM	(疑似雨刷加速聲響) (*sound similar to wiper speeding up]*
19	03	38.7	TWR_M	transasia two two two runway two zero wind two five zero degree one niner knots cleared to land
19	03	44.8	RDO-2	copy runway two zero runway two zero wind copy cleared to land transasia two two two
19	03	45.5	CAM	(高度提示聲響) *[sound of altitude alert]*
19	03	50.6	CAM-2	啊許可落地 *[uh cleared to land]*
19	03	51.2	CAM-1	flap thirty
19	03	52.3	CAM-2	speed check gear down …
19	03	54.4	CAM-2	好教官我做你飛 *[okay sir I will monitor and you have control]*
19	03	56.0	CAM-1	好*[okay]*
19	03	57.0	CAM-2	before landing check landing gear down three green flaps thirty thirty t-l-u … on control auto 一百*[one hundred]* power management takeoff lights on icing a-o-a light off runway 兩洞*[two zero]* verify landing clearance received before landing complete
19	03	58.8	CAM	(pitch trim 聲響) *[sound of pitch trim]*
19	03	04.7	TWR_M	(與遠東 082 對話) *[communication with FE082]*
19	04	07.8	CAM-1	兩九洞風啊*[wind two niner zero]*
19	04	09.3	CAM-2	兩五洞*[two five zero]*

hh	mm	ss	Source	Context
19	04	10.2	CAM-1	兩五洞*[two five zero]*
19	04	10.8	CAM-2	對*[yes]*
19	04	12.5	CAM-2	one thousand stable continue
19	04	14.0	CAM-1	check
19	04	26.4	CAM-1	(打噴嚏聲) *[sneezing]*
19	04	35.3	CAM-1	…
19	04	41.0	CAM-1	啊嗯*[uh um]*
19	05	09.4	CAM	five hundred
19	05	11.2	CAM-2	嗯*[um]*
19	05	12.4	CAM-1	嗯三百*[um three hundred]*
19	05	12.6	CAM-2	alt star 三百 *[alt star three hundred]*
19	05	15.9	CAM-1	唉*[sigh]*
19	05	25.7	CAM-1	唉唉唉唉 兩百 *[sigh sigh sigh sigh two hundred]*
19	05	35.9	CAM-2	alt star
19	05	37.5	CAM-1	嗯*[um]*
19	05	37.9	CAM-2	我們要到零點二浬 *[we will get to zero point two miles]*
19	05	38.1	CAM-1	…
19	05	39.7	CAM-1	好*[okay]*
19	05	40.5	CAM-2	一點五*[one point five]*
19	05	42.6	CAM	(pitch trim 聲響) *[sound of pitch trim]*
19	05	43.5	CAM-1	嗯*[um]*
19	05	44.1	CAM	(自動駕駛解除聲響) *[sound of disengaging autopilot]*
19	05	45.8	CAM-2	disengaged
19	05	46.8	CAM-1	好*[okay]*
19	05	48.5	CAM-1	保持兩百啊 *[maintain two hundred]*
19	05	57.8	CAM-1	看到跑道了嗎 *[have you seen the runway]*

hh	mm	ss	Source	Context
19	06	00.7	CAM-2	跑道*[runway]*
19	06	01.8	CAM-1	嗯*[um]*
19	06	04.9	CAM-1	唉 哇哈哈哈 *[sigh wow ha ha ha]*
19	06	06.8	CAM-2	沒有*[no]*
19	06	07.6	CAM-1	沒有*[no]*
19	06	09.8	CAM-2	教官沒有 *[no sir]*
19	06	10.4	CAM-1	好 好 okay *[okay okay okay]*
19	06	11.1	CAM-2	go around
19	06	11.4	CAM-1	go around
19	06	13.3	CAM	(不明聲響持續 1.5 秒) (*unidentified sound lasting 1.5 seconds]*
19	06	15.8	RDO-2	go around go around
19	06	17.2	TWR_M	roger
19	06	18.0	CAM	(不明聲響) *[unidentified sound]*
19	06	18.9		CVR 錄音終止 *[CVR recording ends]*

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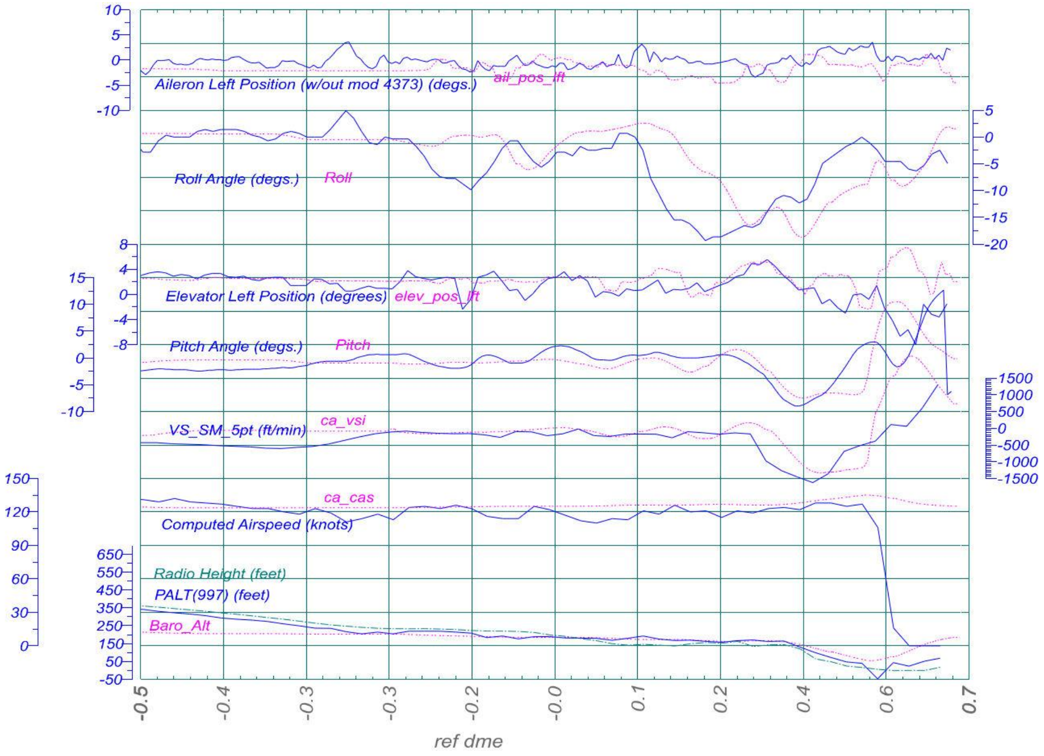
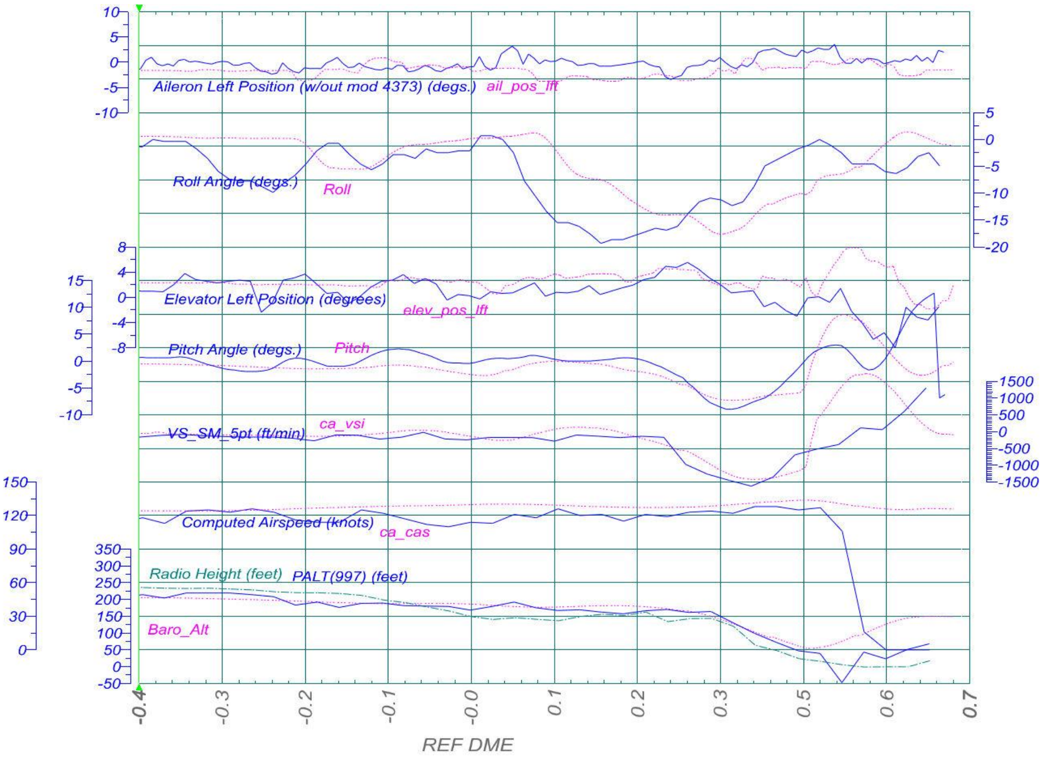
Appendix 4 ATR Full Flight Simulation – Descent Rates

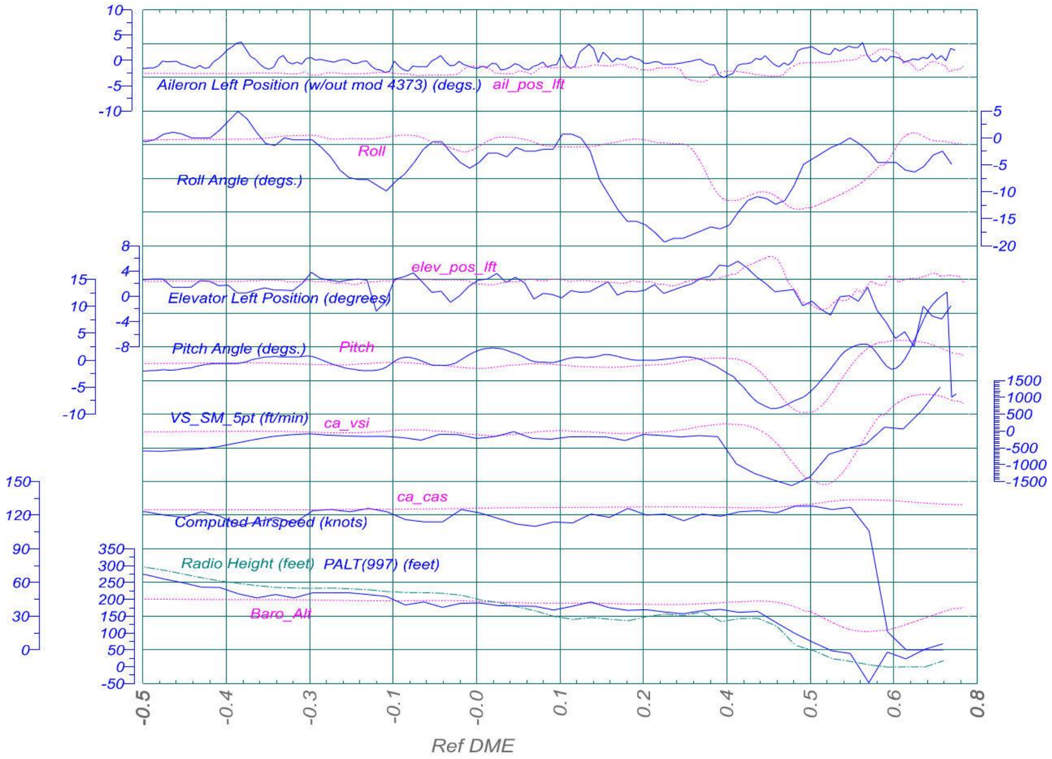
ATR Full Flight Simulation Result (2014/11/05 CASE 1)



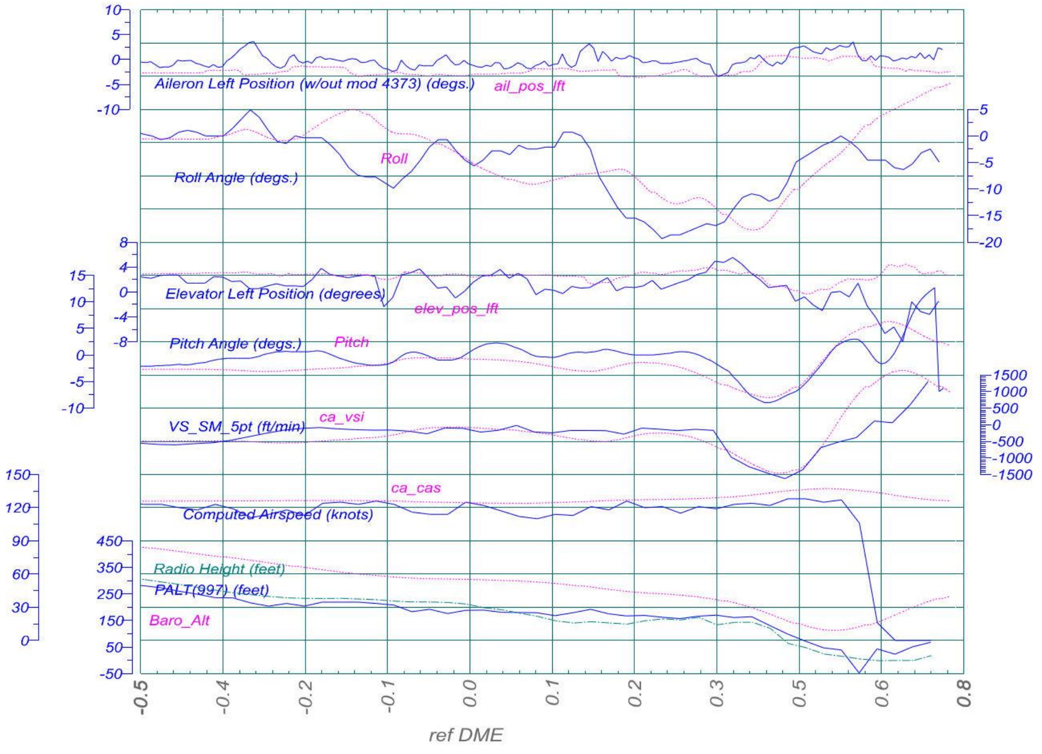
ATR Full Flight Simulation Result (2014/11/05 CASE 2)



ATR Full Flight Simulation Result (2014/11/06 CASE 1)



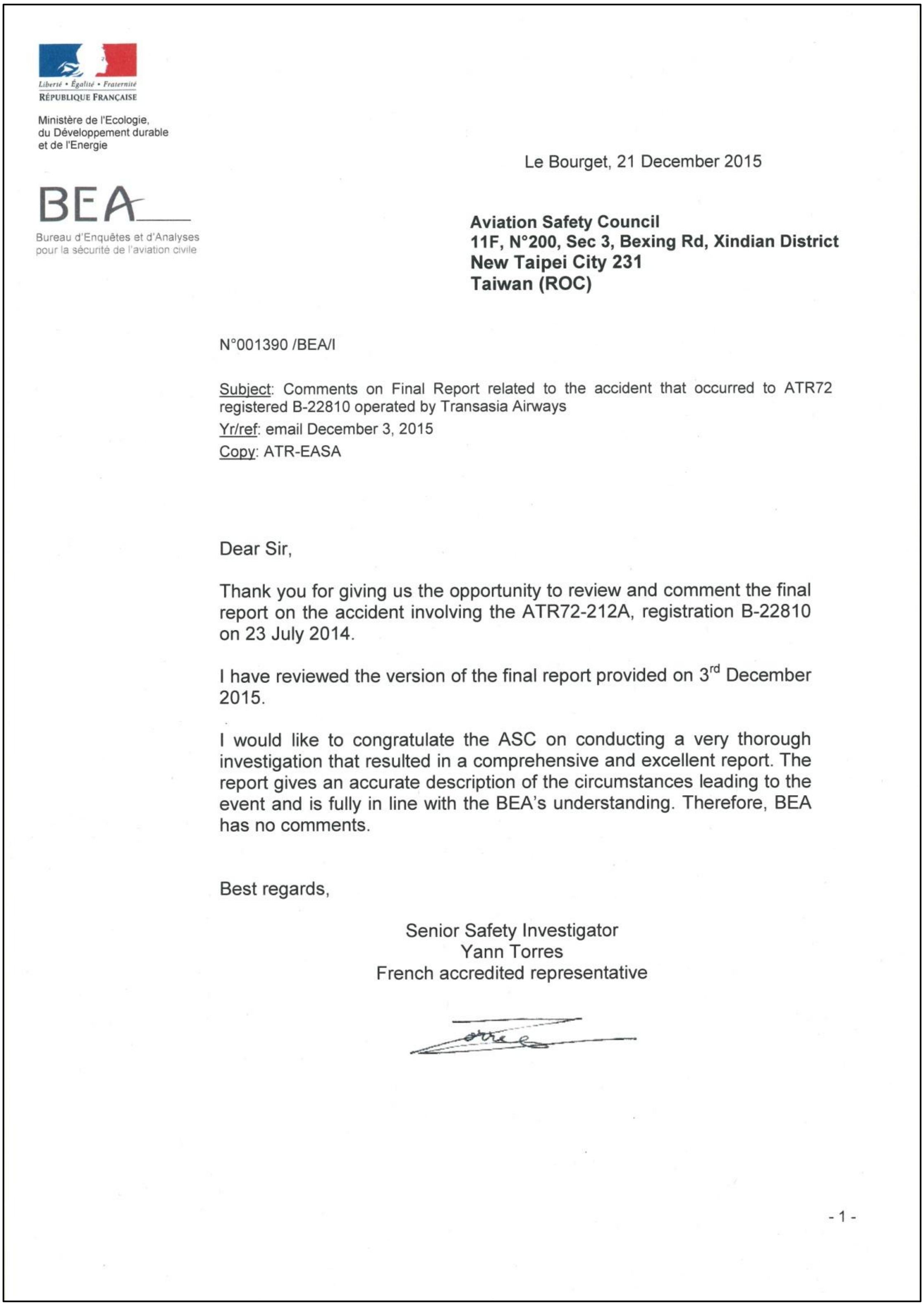
ATR Full Flight Simulation Result (2014/11/06 CASE 2)



Appendix 5 Comments on ASC's Final Draft Report

Appendix 5-1	Comments on ASC's Final Draft Report from BEA (Bureau d'Enquêtes et d'Analyses, France)
Appendix 5-2	Comments on ASC's Final Draft Report from TSB (Transportation Safety Board, Canada)
Appendix 5-3	Comments on ASC's Final Draft Report from NTSB (National Transportation Safety Board, USA)
Appendix 5-4	Comments on ASC's Final Draft Report from CAA (Civil Aeronautics Administration, Taiwan)
Appendix 5-5	Comments on ASC's Final Draft Report from TNA (TransAsia Airways)

Appendix 5-1 Comments on ASC's Final Draft Report from BEA



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et de l'Energie

BEA
Bureau d'Enquêtes et d'Analyses
pour la sécurité de l'aviation civile

Le Bourget, 21 December 2015

Aviation Safety Council
11F, N°200, Sec 3, Bexing Rd, Xindian District
New Taipei City 231
Taiwan (ROC)

N°001390 /BEA/I

Subject: Comments on Final Report related to the accident that occurred to ATR72 registered B-22810 operated by Transasia Airways
Yr/ref: email December 3, 2015
Copy: ATR-EASA

Dear Sir,

Thank you for giving us the opportunity to review and comment the final report on the accident involving the ATR72-212A, registration B-22810 on 23 July 2014.

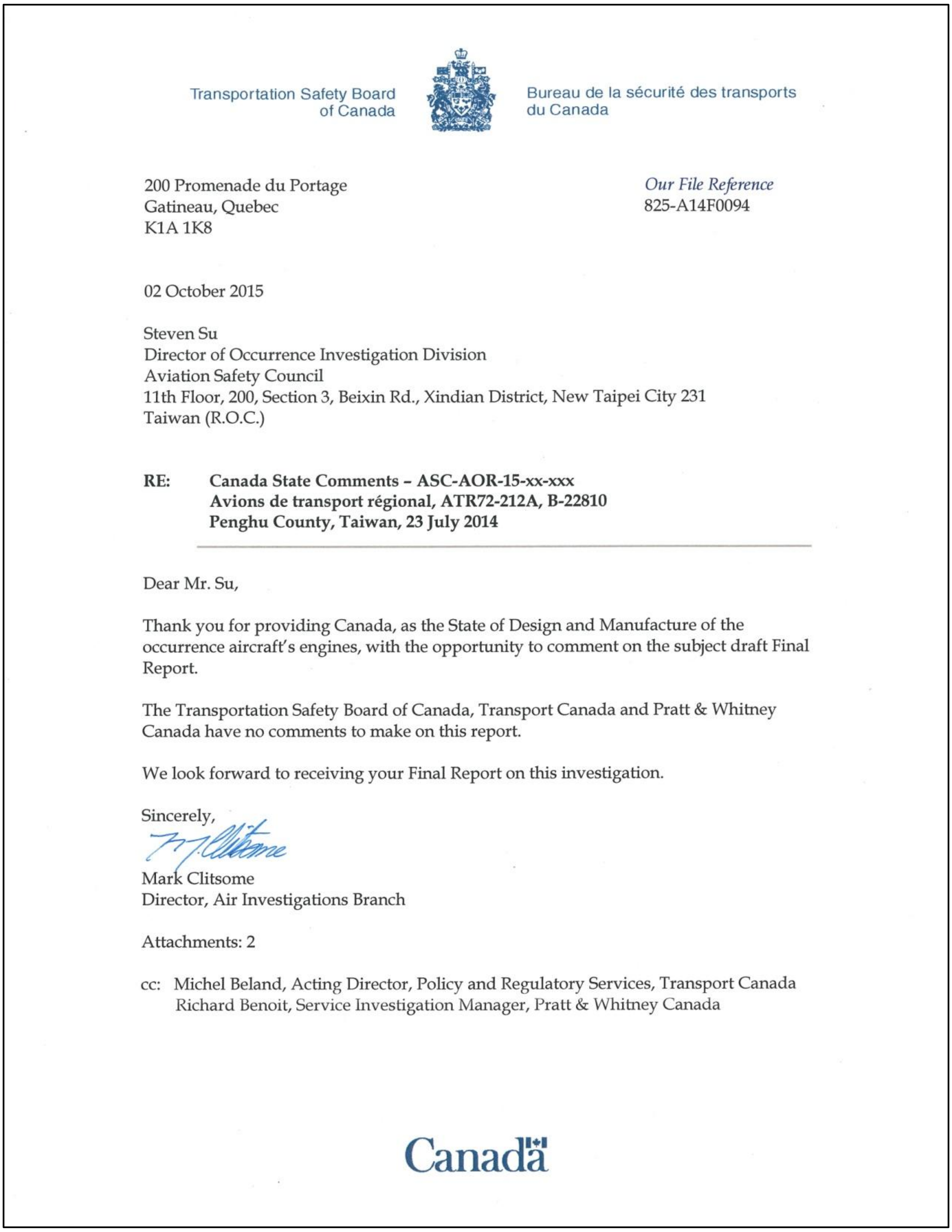
I have reviewed the version of the final report provided on 3rd December 2015.

I would like to congratulate the ASC on conducting a very thorough investigation that resulted in a comprehensive and excellent report. The report gives an accurate description of the circumstances leading to the event and is fully in line with the BEA's understanding. Therefore, BEA has no comments.

Best regards,

Senior Safety Investigator
Yann Torres
French accredited representative

Appendix 5-2 Comments on ASC's Final Draft Report from TSB



Transportation Safety Board
of Canada

Bureau de la sécurité des transports
du Canada

200 Promenade du Portage
Gatineau, Quebec
K1A 1K8

Our File Reference
825-A14F0094

02 October 2015

Steven Su
Director of Occurrence Investigation Division
Aviation Safety Council
11th Floor, 200, Section 3, Beixin Rd., Xindian District, New Taipei City 231
Taiwan (R.O.C.)

RE: Canada State Comments – ASC-AOR-15-xx-xxx
Avions de transport régional, ATR72-212A, B-22810
Penghu County, Taiwan, 23 July 2014

Dear Mr. Su,

Thank you for providing Canada, as the State of Design and Manufacture of the occurrence aircraft's engines, with the opportunity to comment on the subject draft Final Report.

The Transportation Safety Board of Canada, Transport Canada and Pratt & Whitney Canada have no comments to make on this report.

We look forward to receiving your Final Report on this investigation.

Sincerely,

M. Clitsome

Mark Clitsome
Director, Air Investigations Branch

Attachments: 2

cc: Michel Beland, Acting Director, Policy and Regulatory Services, Transport Canada
Richard Benoit, Service Investigation Manager, Pratt & Whitney Canada

Canada

Appendix 5-3 Comments on ASC’s Final Draft Report from NTSB

::RE: TransAsia Airways GE222 investigation final draft report 60 days review

RE: TransAsia Airways GE222 investigation final draft report 60 days review

寄件者：**Magladry Steve** <maglads@ntsb.gov> ;
收件者：wang <wang@asc.gov.tw> ;
副　本：Deforge Carolyn < @ntsb.gov> ; Warren Scott < @ntsb.gov> ;
時　間：Thu, 13 Aug 2015 15:07:31 +0000

Dear Mr. Wang,

Thank you for the opportunity to review the draft report. We only have two minor typographical comments:

Page 17 – First full paragraph.

If the terrain penetrates the Caution envelope boundary, an aural message "TERRIN AHEAD. TERRAIN AHEAD" is generated with the red "GPWS" alerts illuminated on each pilot’s instrument panel. Should be TERRAIN.

Page 123 – First full paragraph.

The report found that the descent and approach phases of landing accounted for about 70 per cent of the accident sample. Should be percent.

Best Regards,

Steve

Steven Magladry
Aircraft Systems Investigator
Aviation Engineering Division, AS-40
National Transportation Safety Board

Appendix 5-4 Comments on ASC's Final Draft Report from CAA Taiwan

GE222 Accident Investigation Submission

ASC Accident File:ASC-AOR-16-01-002

Operator: TransAsia Airways

Model: ATR-72

Aircraft Number: B-22810

Location of Accident: Magong Airport (RCQC)

Date of Accident: July 23, 2014

Civil Aeronautical Administration, MOTC

Jan. 27, 2016

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Issue 3 - Location of Missed Approach Point...P.308

Issue 4- Approach Lighting System …………P.313

Foreword

In accordance with International Civil Aviation Organization (ICAO) Annex 13, Aircraft Accident and Incident Investigation, the Civil Aeronautics Administration (CAA) is providing this submission that details its review of the ASC’s draft factual report related to the accident of TransAsia Flight GE222

The sole objective of the investigation of an accident or incident shall be the prevention of accidents and incidents, based on the credible information provided in the investigation report by the authority of investigation. ICAO Doc 9756 Part 4 “Manual of Aircraft Accident and Incident Investigation” Appendix 1 to Chapter 1- 2.2 「The analysis part should contain an evaluation of the evidence presented in the factual information part and should discuss the circumstances and events that existed or may have existed. The reasoning must be logical and may lead to the formulation of hypotheses which are then discussed and tested against the evidence. Any hypothesis which is not supported by the evidence should be eliminated; it is then important to clearly state the reasons why a particular hypothesis was rejected. When a hypothesis is not based on fact but is an expression of opinion, this should be clearly indicated. As well, the justification for sustaining the validity of a hypothesis should be stated and reference should be made to the supporting evidence. Contradictory evidence must be dealt with openly and effectively. Cause related conditions and events should be identified and discussed. The discussion in the analysis should support the findings and the immediate and systemic causes and/or contributing factors of the accident.」 Therefore, the investigation report shall provide clear information and indisputable evidence.

The CAA appreciates the opportunity to provide comments on the ASC’s draft report. The CAA staff of subject-matter experts in the areas of Flight Standards, Air Traffic Control (ATC) and Instrument Approach (IAP)

Design and Lighting participated in the investigative activities as a Party to the ASC investigation. After reviewing the investigation report, the CAA has identified issues in the Factual, Analysis, Conclusions and Safety Recommendations sections that require correction, clarification, or the inclusion of additional information. Furthermore, the CAA is very concerned that some pertinent factual information was not fully developed; and that the report contains statements and information, as well as Findings and Conclusions, that are factually incorrect or without merit and relevance to this accident. Additionally, the draft report contains several Safety Recommendation that are not supported by factual evidence and, if implemented, would result in a degradation in aviation safety.

It is apparent from the several discussions presented in the Factual Report that the ASC investigator(s) do not have the expertise in the areas of Safety Management System, flight safety oversight and surveillance, Air Traffic Control, Instrument Approach Procedure (IAP) design and lighting. For instance, the ASC was critical of the CAA regarding its oversight of the SMS program, especially at TransAsia Airways. Without proper expertise in the relevant area during investigation, the information provided in the report may not reflect the truth of matters.

The objective of the investigation of an accident or incident shall be the prevention of accidents and incidents by investigating all the facts, conditions and circumstances available to identify the causes and contributing factors. The investigation must be objective and without bias, and the information that is developed must be thoroughly researched by subject matter experts to determine if any element of the respective issue is causal or contributory to the accident. The CAA is very concerned that despite it’s best effort to provide expertise to the ASC, the information presented in various sections of the ASC report may have been mis-stated, misinterpreted or factually incorrect, and not based on regulatory requirements or industry standards and practices. The CAA strongly disagrees with the ASC’s analysis and conclusions regarding the CAA’s oversight of air carriers, instrument approach procedure design, flight operations training and the analysis of SMS. Therefore, the CAA respectfully submits the following information to provide clarification, and to correct the factual record with a comprehensive and corrected description of the misinformation and the issues that are of concern for the CAA.

1. Issue 1 -Flight Operation and SMS

1.1 Introductions

This unfortunate accident that happened on July 23, 2014 was a typical CFIT (Controlled Flight Into Terrain) in an adverse weather condition. Many previous similar accidents that have occurred worldwide were because the flight crew failed to follow the respective air carrier policies or procedures, and/or the Federal regulations. In these accidents, the regulatory authority was not held responsible, nor found to be the cause/contributing factors for the accident flight crews' improper actions.

It is apparent, with regard to the analysis of SMS in the draft report, the ASC does not fully understand that the CAA advisory circular AC 120-32C and the revised issuance of AC 120-32D is not enforceable by regulation, but rather, as the name implies, 「… sufficient understanding on SMS concepts and the development of management policies and processes to implement and maintain an SMS that meets ICAO and CAA requirements.」 In addition, the stated purpose of the AC is to provide 「… an acceptable means, but not the only means, to show compliance with Article 9 of "Aircraft Flight Operation Regulations" or Article 27 of "Regulations for Repair Station Certification and Management" for establishing and implementing a safety management system.」

In addition, it is apparent the ASC has confused the regulatory requirement of air carriers implementing an SMS program with the information presented in the Advisory Circular, which indicates that air carriers should set target of implementation of an SMS program by 2012. The ASC inadequately described the efforts of the CAA to assist the air carriers. They also failed to provide important information, such as the fact that the CAA performed two "SMS Assessment Projects" to determine the status of the implementation of SMS programs in the various air carriers regulated by the CAA. The assessments lead to the CAA identifying issues that the air carriers were having regarding the implementation of the SMS program, and as a result, the CAA conducted an SMS Conference.

1.2. Factual Information

1.2.1 The CAA has conducted an SMS assessment project for 6 civil air transportation operators and 2 repair stations by the end of 2013. The objectives of the project were:

- To review/ensure SMS implementation of the certificate holders (operators and repair stations) in consistence with the ICAO requirement, CAA regulations and policy;
- To adjust the CAA promoting strategies and assist the certificate holders to implement the SMS effectively in accordance with the data collected from the assessment project; and
- All deficiencies identified during the assessment would not be categorized as finding or concern in the CAA FSMIS, but the CAA will notify the concerned certificate holder to improve its SMS implementation plan and to comply with the regulations and the CAA policy within the SMS implementation timeline.

1.2.2 After the assessment project, the CAA held an SMS conference for senior managers of operators and repair stations on December 4, 2013. Several promoting strategies delivered by the CAA representatives in the conference are summarized as follows:

- From the SMS assessment project in 2013, the CAA identified that some operators did not develop a SMS implementation plan, and therefore suggested all operators should establish a SMS implementation plan accordingly;
- The AC 120-32D will be published before 2014 and will be based on the 3rd edition of the ICAO Doc 9859;

- The timeline of SMS implementation will be extended to the end of 2016;
- SMS training course will be provided for the operators and repair stations before 2014.

1.2.3 Based on the CAA's SMS Assessment Project, the CAA understand that it is necessary to further extend SMS implementation program to the end of 2016, which will comply with the 3rd edition of ICAO Doc9859 Safety Management Manual (SMM), published on May 8, 2013 with numerous updates. Due to the changes in the SMM and the fact that ICAO was intending to publish a new Annex (identified as Annex 19), the CAA waited until the Annex was published to update AC 120-32C, so that the new information could be incorporated into a revised AC, identified as 120-32D.

1.3 Analysis

1.3.1 CAA's clarification

The ASC has asserted in the report and concluded based on its analysis that the CAA was responsible for the accident flight crew's intentional non-compliance with both the air carrier policies and procedures, and the CAA regulations, because the ASC believes the CAA's oversight of training and line operations was inadequate. It is also apparent that the ASC made these conclusions based on the ASC findings of deficiencies and procedural non-compliance by flight crews during their "observations" of training sessions as part of their investigative activities.

This conclusion may not accurately represent the TransAsia Airways training program, or the oversight by the CAA since the ASC's observations were very limited and only a “snap-shot” of a continual program.

The discussion in this report of the CAA’s SMS by the ASC indicates that the ASC may not fully understand the CAA’s efforts in developing the SMS and in the incorporation of SMS into an air carrier. Unfortunately, the way it is described in the report suggests that the SMS program would have been functional immediately; and that the accident would not have occurred if the CAA inspectors had received training or had better guidance information; and had TransAsia Airways submitted an implementation plan.

Therefore, the CAA believes it is necessary to provide appropriate information in order to clarify some points in this report, especially those areas involving the CAA oversight and SMS program.

1.3.2 The CAA recommended changes to the ASC Report

1.3.2.1 Chapter 3.2 Findings Related to Risks

- **Item 20.** *Refer to investigation report chapter 3.2.20*

  The Civil Aeronautics Administration’s oversight of TransAsia Airways did not identify and/or correct some crucial operational safety deficiencies, including crew non-compliance with procedures, non-standard training practices, and unsatisfactory safety management practices.

  Reason to change:

  1. The CAA's oversight activities follow international standards and recommended practices to oversee air carriers. Practically, it is not possible to observe all the operational flights, and it is

difficult to identify particular flight crew who may not follow SOPs during which a CAA inspector is not present in the cockpit.

2. There is difference between the case of the accident flight crews' intention to violate discipline and non-compliance of SOP of Standard Call Out. ASC is too subjective to describe CAA’s oversight as not able to identify correct.
3. The paragraph 2.7.3 in ASC report” ……The CAA had not ensure that the airline responded effectively to the safety deficiencies and corrective actions issued by the CAA…….” shows ASC agree the CAA’s inspection still identified some safety deficiencies.

Recommend to amend as:

The Civil Aeronautics Administration’s oversight of TransAsia Airways did not promptly identify the deficiencies of crew non-compliance with procedures and non-standard training practices.

(Relocate to 3.3)

- **Item 21**. *Refer to investigation report chapter 3.2.21*

To develop and maintain a safety management system (SMS) implementation plan at TransAsia Airways was not enforced by the Civil Aeronautics Administration. That deprived the regulator of an opportunity to assess and ensure that the airline had the capability to implement a resilient SMS.

Reason to change:

1. ICAO Annex 19 was published in 2013 and defines the SMS implementation program into 4 different phases, which require 5 years to accomplish. The CAA regulations and Advisory Circular

comply with ICAO requirement to set the target date of SMS accomplishment on Dec 31, 2016.

2. Most of airlines are required to implement the SMS by the other authorities at the stage of implementation plan, the implementation stage are required in Taiwan like China Airline and EVA Air.
3. TNA do have the SMS implementation instead of " not develop the implementation plan of SMS " TNA submitted its SMS implementation plan in 2013 , however it was uncompleted . the CAA raise the 24 items to recommend TNA improving the SMS system including Hazzard identification , risk management and decision making for top manager and lack of assessment tool for evaluating the effectiveness of SMS. The CAA has requested the TNA to improve the deficiencies and corrected according CAA recommendation, TNA was not complete the corrective action. There are difference between " not develop the SMS implementation plan " and " not complete the implementation plan"

Recommend to amend as:

Although CAA had demanded TNA to develop and maintain a safety management system (SMS) implementation plan，TNA has not complete the implementation of SMS, that made the regulator cannot completely evaluate the SMS, which is still established by TNA.

- **Item 22.** *Refer to investigation report chapter 3.2.22*

Issues regarding the TransAsia Airways' crew non-compliance with standard operating procedures (SOPs) and deficiencies with pilot check and training had previously been identified by the Aviation Safety Council investigation reports. However, the Civil

Aeronautics Administration (CAA) did not monitor whether the operator has implemented the recommended corrective actions; correlatively, the CAA failed to ensure the proper measures for risk reduction have been adopted.

Reason to change:

1. The CAA follows the procedure and regulations of Aviation Occurrence Investigation Act to process the safety recommendations identified in the previous ASC occurrence report which required corrective actions: the process was closed after it had been confirmed and accepted by the ASC.
2. The ASC should review the proper corrective actions that had been accepted and closed, which indicate that the CAA had increased surveillance activities and dispatch inspectors abroad to monitor the corrective actions regarding the TransAsia Airways flight crews' non-compliance of SOP(including Standard Call Out), training and check programs.
3. ASC should rethink the relevance between the recommendations that had been closed(including the TransAsia Airways flight crews' non-compliance of SOP and training and check programs) and the accident flight crews' non-compliance of the minimum descent altitude.

Recommend to amend as:

The Civil Aeronautics Administration should have monitored and ensured the implementation of recommended corrective actions and adoption of proper measures regarding issues that had previously been identified by the Aviation Safety Council investigation reports, including TransAsia Airways’ crew non-compliance with standard operating procedures (SOPs) and deficiencies with pilot check and training. **(Relocate to 3.3)**

- **Item 23.** *Refer to investigation report chapter 3.2.23*

The Civil Aeronautics Administration provided limited guidance to its inspectors to enable them to effectively and consistently evaluate the key aspects of the operators' management systems. These aspects included evaluating organizational structure and staff resources, the suitability of key personnel, organizational change, and risk management processes.

Reason to change:

1. The CAA has developed SMS programs and checklists in the Operations Inspectors Handbook. The AC-120-32D issued by CAA and ICAO Doc.9859 could be the guidance of inspectors.
2. CAA's foreign consultants had gave SMS training course to inspectors. The inspectors has also took courses yearly.
3. The evaluations and recommendations to TransAsia Airways' implantation of SMS before the accident shows the appropriate capability of inspectors.

Recommend to amend as:

The Civil Aeronautics Administration should provide the last updated documents to its inspectors to enable them to effectively and consistently evaluate the key aspects of operators' management systems. These aspects included evaluating organizational structure and staff resources, the suitability of key personnel, organizational change, and risk management processes. **(Relocate to 3.3)**

- **Item 24.** *Refer to investigation report chapter 3.2.24*

The Civil Aeronautics Administration did not have a systematic process for determining the relative risk levels of airline

operators.

Reason to change:

1. In accordance with the risk management and safety assurance in the SSP, the CAA collects the deficiencies from oversight activities, compulsory reports, violation events, surveillance data, and in-depth inspection as basis to form the airline risks level assessment. In addition, the FSD review the surveillance results both quarterly and annually in order to adjust surveillance next quarter / year as necessary.
2. The factual information in the report includes the interview record of the POI of TransAsia Airways and his surveillance results, and does not represent a comprehensive picture of the CAA regulations and oversight. ASC would not conclude a description of” The Civil Aeronautics Administration did not have a systematic process” if had a more comprehensively understanding on CAA’s surveillance laws and system.

Recommend to amend as:

The Civil Aeronautics Administration should develop constantly a systematic process for determining the relative risk levels of airline operators. **(Relocate to 3.3)**.

1.3.2.2 Chapter 4.1 Safety Recommendations from CAA

- **Item 2:** *Refer to investigation report chapter 4.1*

Implement a more robust process to identify safety-related shortcomings in operators’ operations, within an appropriate timescale, to ensure that the operators meet and maintain the

required standards.

Recommend to delete and the reason to delete:

1. CAA had set the phases of SMS's promotion and operation in its related rules and guidance foucument.
2. CAA recommend operators to implement SMS from Jan 01, 2009 and to accomplish the 4 phases of implementation before Dec 31, 2016 according to ICAO requirement. CAA Advisory Circular AC 120-32 provides information and instruction of SMS implementation, which has been amended up to 4th edition.
3. To understand and help operators to implant and operate SMS and assist them to utilize SMS as a tool of safety management. The CAA SMS assessment project team assessed, identified and notified the issues of the operators and repair station in compliance with SMS. The CAA holds conferences to communicate with senior management of operators, to assure the effectiveness of SMS implementation.
4. CAA arranged SMS training courses for operators in both Aug & Sep 2014 and in Sep & Oct 2015 to assist them in implement of SMS according the assessment.
5. CAA also issued the AC 120-050 "Evaluate operators' FOQA application" and AC 120-049 "Safety performance Indicator "as a guide to implant and operate SMS for operators effectively.

- **Item 3、4 :** *Refer to investigation report chapter 4.1*

3. Provide inspectors with detailed guidance on how to evaluate the effectiveness of an operator's safety management system (SMS), including:

- **Risk assessment and management practices;**
- **Change management practices;**

- **Flight operations quality assurance (FOQA) system and associated data analytics; and**
- **Safety performance monitoring.**

4. **Provide inspectors with comprehensive training and development to ensure that they can conduct risk-based surveillance and operational oversight activities effectively.**

Recommend to integrate and the reason to integrate:

1. The CAA has developed SMS programs and checklists in the Operations Inspectors Handbook. The AC-120-32D issued by CAA and ICAO Doc.9859 could be the guidance of inspectors.
2. CAA's foreign consultants had gave SMS training course to inspectors. The inspectors has also took courses yearly.
3. The evaluations and recommendations to TransAsia Airways' implantation of SMS before the accident shows the appropriate capability of inspectors.

Recommend to integrate as:

Constantly provide inspectors with updated guidance to its inspectors on how to evaluate the effectiveness of an operator's safety management system (SMS) including Risk assessment and management、Change management practices、Flight operations quality assurance (FOQA) system and associated data analytics and Safety performance monitoring, to ensure that they can conduct risk-based surveillance and operational oversight activities effectively and identity the operators' risk level of safety.

- **Item 5 :** *Refer to investigation report chapter 4.1*

Enhance inspector supervision and performance monitoring to ensure all inspectors conduct surveillance activities effectively and are able to identify and communicate critical safety issues to their supervisors.

Recommend to delete and the reason to delete:

CAA had enacted *Executive Procedures Governing Flight Safety Inspection and Flight Inspection of CAA, MOTC*, and established job function of Air Carrier Management Effectiveness in the Operations Inspectors Handbook as a guidance document, thus the inspectors can follow to train, dispatch, oversight and check.

- **Item 6、7、8 :** *Refer to investigation report chapter 4.1*

6. Enhance the oversight of operators transitioning from traditional safety management to safety management systems.
7. Develop a systematic process for determining the relative risk levels of airline operators.
8. Review the current regulatory oversight surveillance program with a view to implementing a more targeted risk-based approach for operator safety evaluations

Recommend to integrate and the reason to integrate:

1. In accordance with the risk management and safety assurance in the SSP, the CAA collects the deficiencies from oversight activities, compulsory reports, violation events, surveillance data, and in-depth inspection as basis to form the airline risks level assessment. In addition, the FSD review the surveillance results both quarterly and annually in order to adjust surveillance next quarter / year as necessary.
2. The factual information in the report includes the interview record of the POI of TransAsia Airways and his surveillance results, and does not represent a comprehensive picture of the CAA regulations and oversight. ASC would not conclude a description of” The Civil Aeronautics Administration did not have a systematic process” if had a more comprehensively

understanding on CAA’s surveillance laws and system.

Recommend to integrate as:

Enhance the oversight of operators transitioning from traditional safety management to safety management systems. After operators implement SMS, establish a relative safety management mechanism for operators.

- **Item 9 :** *Refer to investigation report chapter 4.1*

Ensure all safety recommendations issued by the occurrence investigation agency are implemented by the operators.

Recommend to delete and the reason to delete:

1. The CAA follows the procedure and regulations of Aviation Occurrence Investigation Act to process the safety recommendations identified in the previous ASC occurrence report which required corrective actions: the process was closed after it had been confirmed and accepted by the ASC.
2. The ASC should review the proper corrective actions that had been accepted and closed, which indicate that the CAA had increased surveillance activities and dispatch inspectors abroad to monitor the corrective actions regarding the TransAsia Airways flight crews' non-compliance of SOP(including Standard Call Out), training and check programs.

- **Item 10 :** *Refer to investigation report chapter 4.1*

Develop detailed guidance for operators to implement effective fatigue risk management processes and training.

Reason to change:

1. CAA has established the regulation with respect to flight time, duty time and rest time limitation.
2. Refer to FAA's Advisory Circular, CAA also issued the Advisory Circular AC F120-103 Fatigue Risk Management Systems for Aviation Safety related to FRMS.

Recommend to amend as:

Encourage the operators self-evaluate and develop policy of fatigue risk management in order to reduce fatigue factor.

1.4 Conclusions

1.4.1 The ASC investigation indicates the cause of this accident was the result of controlled flight into terrain, that is, an airworthy aircraft under the control of the flight crew was flown unintentionally into terrain with limited awareness by the crew of the aircraft's proximity to terrain. The crew continued the approach below the minimum descent altitude (MDA) when they were not visual with the runway environment contrary to standard operating procedures.

1.4.2 The actions of the accident Captain were personally systemic and, regardless of the quality of TransAsia's pilot training program or the oversight by the CAA, the accident Captain was not going to comply with the policies, procedures or regulations. This type of hazardous attitude is characterized as "Anti-Authority" and is described in the FAA Advisory Circular (AC) 60-22, titled "Aeronautical Decision Making (ADM). The CAA had no way knowing that the accident Captain exhibited an "anti-authority" attitude and a complete disregard for policies, procedures or regulations.

1.4.3 The progress of ICAO developing aviation safety management standard is based on the lesson learns from the accumulated accidents and incidents. The evolution is from early stage of Accident Prevention Program、Self-Audit program until to the latest stage of Safety Management System. All the programs or system can meet the requirements of safety operation.

1.4.4 Once again, the incorporation of a Safety Management System (SMS) into an air carrier is both a challenging and dynamic process. The amount of time and resources that are necessary to develop an effective program, implement the program so that it is supported by 100 percent of the employees are considerable, and then oversee a program for which the air carrier has primary responsibility. The CAA originally issued Advisory AC 120-32C as a guidance document to assist air carriers in the development of their respective SMS program. And like its predecessor, AC120-32D it is not enforceable by regulation, but rather, as the name implies, it is an “Advisory Circular” which provides “… sufficient understanding on SMS concepts and the development of management policies and processes to implement and maintain an SMS that meets ICAO and CAA requirements.” Due to the nature of complexity, the Federal Aviation Administration (FAA) still has not developed a regulatory requirement for U.S. air carriers to have an SMS program.

1.4.5 With reference to the CAA oversight in the ASC report, to some extent the ASC chose to focus critically on the CAA’s procedures and methodologies, that unfortunately and unfairly portray a picture of incompetence by the regulatory authority. Unfortunately, the ASC concluded that CAA inspector surveillance and oversight was “inadequate” or “ineffective” because of their lack of training or limited guidance. In fact, the CAA Operations Inspector Handbook showed that there is a substantial amount of guidance information in the form of policies, procedures, and examples for inspectors to perform air carrier surveillance, which includes pilot training and proficiency checks, en-route flight checks, and SMS implementation and oversight. However, it is not logical or possible for the CAA to have inspectors continually observing all training sessions, in-flight operations or management functions.

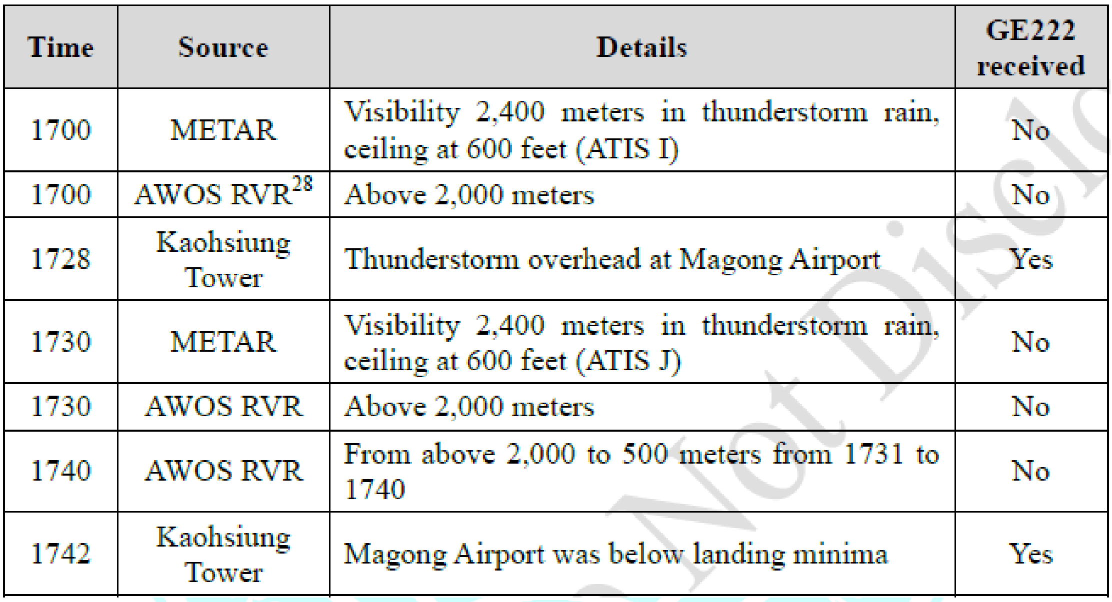
2. Issue 2 - RVR Information

2.1 Introduction

2.1.1

In the ASC report, Section 1.7.4, Table 1.7-1 shows AWOS, visibility, RVR and other weather information. The rightmost column indicates whether the weather information was received by GE222 or not.

Table 1.7-1 Summarized weather information



Time	Source	Details	GE222 received
1700	METAR	Visibility 2,400 meters in thunderstorm rain, ceiling at 600 feet (ATIS I)	No
1700	AWOS RVR[28]	Above 2,000 meters	No
1728	Kaohsiung Tower	Thunderstorm overhead at Magong Airport	Yes
1730	METAR	Visibility 2,400 meters in thunderstorm rain, ceiling at 600 feet (ATIS J)	No
1730	AWOS RVR	Above 2,000 meters	No
1740	AWOS RVR	From above 2,000 to 500 meters from 1731 to 1740	No
1742	Kaohsiung Tower	Magong Airport was below landing minima	Yes

2.1.2

In the ASC report, Section 3.2, Item 27. "During the final approach, the runway 20 RVR values decreased from 1,600 meters to 800 meters and then to a low of about 500 meters. The RVR information was not communicated to the occurrence flight crew by air traffic control. Such information might influence the crew's decision regarding the continuation of the approach."

2.2 Factual Information

2.2.1 Weather information ATC provided

When GE222 established contact with Magong tower, ATC provided the necessary information to flight crew according to the Air Traffic Management Procedure (ATMP). When the QNH changed, ATC updated the QNH to flight crew immediately.

2.2.2 The relative regulation in ATMP

2.2.2.1 ATMP 2-8-1 FURNISH RVR VALUES

Where RVR equipment is operational, irrespective of subsequent operation or non-operation of navigational or visual aids for the application of RVR as a takeoff or landing minima, furnish the values for the runway in use in accordance with para 2-8-3, TERMINOLOGY.

2.2.2.2. ATMP 2-8-2 Arrival/Departure Runway Visibility

Reference to ASC report, section 1.18.6 for details

2.2.2.3. ATMP 3-10-2 Updating Information on Final Approach

Reference to ASC report, section 1.18.6 for details

2.3 Analysis

2.3.1 Table 1.7-1

2.3.1.1

The website of ASC did not publish the Table 1.7-1 in factual report.

2.3.1.2

According to ATMP and the requirement of flight operation, not all the information on table 1.7-1 are necessary and mandatory needed to rely to GE222. For example, GE222 did not obtain the METAR and RVR of AWOS of Magong airport at 17:00L, because at that time GE222 still at Kaohsiung airport and did not take off yet. GE222 did not be received the RVR information when the value was more than 2000 meters, because according to ATMP ATC do not need to provide the RVR when the value is more than 2000 meters.

2.3.2 Reliability of RVR

Reference to the ASC report, section 3.2 item 26 “The discrepancies between the reported runway visual range (RVR) and automated weather observation system (AWOS) RVR confused the tower controllers about the reliability of the AWOS RVR data. (1.18.8.8, 2.8.3.1) “, therefore, the controller did not provide the unreliable RVR value that day.

2.3.3 Essential weather information provided to flight crew

2.3.3.1 VOR Runway 20 is Non-Precision Approach procedure, and its landing minimum is based on visibility rather than RVR.

2.3.3.2 Flight crew were provided the visibility information from automatic terminal information system (ATIS) “N” and “O”. The visibility of ATIS “N” and “O” were the same as 1600M.

2.3.3.3 After GE222 contacted with tower (at 1901L), reported visibility was not changed till 1910L.

2.3.4. Comments from the CAA

2.3.4.1 Table 1.7-1 do not explain and elaborate the relationship between the weather information and if the GE222 should obtain the weather information or not. The table just shows “yes” or “no”. It might misleading the reader that ATC did not provide the weather information to GE222 on purpose. The appendix 1 of the report already has a table for showing all weather information. CAA suggest the table 1.7-1 should be removed.

2.3.4.2 Controllers furnish RVR values to the crew when the takeoff or landing minima is based on RVR value, and the landing minima of Magong runway 20 VOR approach is based on “prevailing visibility”. While the aircraft was in the final approach segment, Magong tower already updated all the visibility values to the crew.

2.3.4.3 The ASC suggests that the tower should have provided the unreliable RVR information to the occurrence flight crew. The ASC thought that data might influence the crew's decision regarding the continuation of the approach. In CAA's point of view, it is not well-founded and unacceptable. The weather information is for reference. During the approach segment, flight crew should execute the miss approach procedure when the altitude reached MDA if they did not have the visual reference of runway rather than spending 13 seconds searching for the runway when the altitude was lower than MDA.

2.3.4.4 This issue should not be classified as a risk because controllers provide the weather information in accordance with regulation.

2.4. Conclusions

Refer to section 3.2 item 26 "The discrepancies between the reported runway visual range (RVR) and automated weather observation system (AWOS) RVR confused the tower controllers about the reliability of the AWOS RVR data"; the controller did not provide the weather information to the flight crew in accordance with ATMP due to ATC considered the RVR were unreliable.

3 Issue 3 – Location of Missed Approach Point

3.1 Introduction

In the ASC report sections 2.12.3 "With the same minimum OCA, if the MAPt was set closer to the runway threshold, it would have increased the likelihood of crews being able to visually identify the runway in the future."

I. In the ASC report section 3.3 "The location of the runway 20 VOR missed approach point (MAPt) was not in an optimal position. With the same Obstacle Clearance Altitude, if the MAPt had been set closer to the runway threshold, it would have increased the likelihood of flight crews to visually locate the runway."

3.2 Factual Information

3.2.1 On July 23, 2014, TransAsia flight 222(GE222) crashed short of runway 20 at Magong Airport during VOR approach following the request for go-around at 1906 local time. According to the ASC report, the aircraft's altitude was 176ft by 1905L when passing Missed Approach Point (MAPt). It is also identified in the analysis section of the ASC report that the crew were aware of MDA at 330 feet for the VOR RWY20 approach procedure and the captain had diverted the aircraft from the published runway 20 VOR non-precision approach procedure by descending below the published MDA before obtaining the required visual references. (*Refer to investigation report section 2.2.1.1*)

3.2.2 The VOR RWY20 approach procedure was designed by the CAA in accordance with ICAO PANS-OPS (Document 8168) Volume II instrument flight procedure designing criteria. The MAPt is 1.1 nautical mile from runway 20 threshold. Obstacle clearance

Altitude/Height (OCA/H) is 330/284 feet with visibility of 1600 meter for category A and B aircraft.

3.3 Analysis

3.3.1 International Practices

According to ICAO PANS-OPS, the instrument flight procedure design focuses on the clearance between aircraft and obstacles (Ref. Vol II 1.3). In all types of approach procedures, the location of MAPt is merely part of the designing process, and has no relationship with visibility requirement.

Based on various locations of MAPt, the same approach procedure may yield different assessment result. The procedure designer may have considerations to finalize the design parameters. ICAO has the recommendation to place the MAPt at runway threshold. However, ICAO also identified that, when necessary, the MAPt may be moved toward Final Approach Fix (FAF) (Ref. Doc. 8168 Vol II Part I Section 4).

According to both ICAO PANS-OPS and Annex 6, visibility is established based on the obstacle clearance height (OCH) derived from the obstacle evaluation with considerations of aircraft performance, crew training, etc.

When an aircraft has descended below the MDA/H, the instrument flight procedure can no longer provide the minimum obstacle clearance (MOC) required, and thus cannot be provide for safety between obstacles. The proper obstacle clearance in such cases will be for the pilot to assume responsibility to maintain the required visual reference.

3.3.2 CAA’s approach

The CAA conducts instrument flight procedure design in accordance with provisions in ICAO PANS-OPS. However, the current visibility requirement was established mainly based on FAA FO 8260.3B Terminal Instrument Procedures (TERPS). Nonetheless, the CAA would like to point out that different States, operators or chart vendors may adopt different set of rules to determine the actual value of visibility.

3.3.3 Comments from the CAA

3.3.3.1 The assumption of “moving the MAPt would have increased the likelihood of flight crews to visually locate the runway” is not proper in this case. It is apparent from the factual information that the accident flight crew was not aware of their position relative to the airport and runway 20 during the execution of the VOR approach. This is exemplified by the flight crews’ discussions recorded on the CVR. The ASC report also shows, the flight crew failed to maintain the proper inbound heading and deviated significantly to the left of course, they flew beyond both published MAPt (1.1 nautical mile from runway threshold) and the ASC proposed MAPt (0.8 nautical mile from the runway threshold) location with altitude below MDA, but still had no airport environment or runway in sight. This precludes the ASC assumption of moving the MAPt in the Finding and Recommendation sections.

3.3.3.2 The VOR RWY20 approach in Magong airport meets the criteria specified of ICAO DOC 8168; and Approach visibility minima is not a valid parameter for designing an instrument approach procedure.

3.3.3.3 The FAA Aeronautical Information Manual related to flight operations, clearly addresses to pilots “The MAPt on a non-precision instrument approach procedure is not designed for consideration of beginning descent but based on terrain, obstructions, NAVAID location and possibly air traffic considerations.

3.3.3.4 The ASC's recommendations aims at improving safety, but recommending to move all the MAPt closer to the runway threshold may as well lead to a crew identifying the runway at the MAPt and attempting to land, increasing the potential risk of overshooting the runway. The CAA strongly recommends the ASC to reconsider the negative implication very carefully.

3.4 Conclusions

3.4.1 It is demonstrated that the ASC's recommendation of moving the location of MAPt to increase the likelihood of sighting runway environment in this case is not valid.

3.4.2 It is international common practice that visibility plays no roles in the instrument flight procedure design activity. The ASC's recommendation will impose a peculiar local requirement to the CAA's instrument flight procedure design activity that is different from any other countries, which has very high probability to introduce new risk or to lead to significant liability consequence in the future. The CAA cannot assure if such peculiar recommendation would bring in any unknown hazard.

3.4.3 The CAA has tried the best to deliver the above actual international regulations and common practice to the ASC during the investigation(Table 3-1). The CAA has also invited reputable international accident investigation expert to examine the argument proposed by the CAA, which reflects the true rationale behind the provisions. The CAA has also delivered various procedures from other States demonstrating the location of MAPt has no relationship with the visibility.

Table 3-1 International Examples for MAPt-Threshold distance greater than visibility minimum in VOR approach procedures.

Airport	Procedure	MAPt-THR distance	Visibility minimum
Haneda, Japan	VOR RWY 34L	1.2NM(2225m)	1500m
Kagoshima, Japan	VOR DME RWY 32	2.5 NM (4630m)	1500m
Kansai, Japan	VOR RWY 06R	1.1 NM (2037m)	1500m
Brussels, Belgium	VOR RWY 25	1.0 NM (1825m)	1600m
Barcelona GRO, Spain	VOR RWY 20	1.1 NM (2037m)	1500m
Willington, New Zealand	VOR DME RWY 16	1.9 NM (3519m)	1500m
Nuremburg, Germany	VOR RWY 10	1.0 NM (1825m)	1500m
Tahiti, French Polynesia	VOR Z RWY 22	1.6 NM (2963m)	1500m

3.4.4 Therefore the ASC assumption of moving the MAPt does not apply and should be removed from the Finding and Recommendation sections.

4 Issue 4- Approach Lighting System

4.1 Introduction

II. In the ASC report, section 3.3 item 5. “According to the Civil Aeronautics Administration (CAA) regulations, a 420 meter simple approach lighting system should have been installed to help pilots visually identify runway 20. The CAA advised that the Runway End Identification Lights, a flashing white light system, was installed at the runway’s threshold as an alternative visual aid to replace the simple approach lighting system.”

III. Also in the ASC report, section 4.1 item 11: “Review runway approach lighting systems in accordance with their existing radio navigation and landing aids to ensure that adequate guidance is available for pilots to identify the visual references to the runway environment, particularly in poor visibility condition or at night.”

4.2 Factual Information

4.2.1 In the CAA’s Civil Aerodrome Design and Operations Specifications, section 5.3.4.1.B. “*Where physically practicable, a simple approach lighting system shall be provided to serve a non-precision approach runway, **except when** the runway is used only in conditions of good visibility or **sufficient guidance is provided by other visual aids**.*”

4.2.2 Runway end identifier lights (REIL) were installed on both sides of the runway 20 threshold of Magong airport. The REIL provided a rapid and positive identification of the end of the runway. The system comprised of synchronized unidirectional flashing lights. These lights were directed towards the approach area. The REIL had three intensity settings and can be seen by flight crew at an approximate range of 3 miles during daylight and 20 miles at night.

4.2.3 Runway 20 was equipped with a precision approach path indicator (PAPI) positioned 320 meters facing forward of the runway threshold. It provide visual guidance of landing approach path (approx. 3 degrees). The PAPI can be seen by flight crew at an approximate range of 5 miles during daytime and 25 miles at nighttime.

4.3 Analysis

4.3.1 According to FAA standards, REIL can be seen at minimum of 3 nautical miles (NM) during the daytime and 20 NM at nighttime, and a PAPI can been seen between 5 and 25 NM depending on daytime/nighttime. Consider, the visibility minimum in the VOR procedure is 1600 meters, the aforementioned visual aids are more than adequate to provide sufficient visual guidance for pilots to identify the runway environment. Which is comply the requirement from the CAA’s Civil Aerodrome Design and Operations Specifications “***when sufficient guidance is provided by other visual aids***.”

4.3.2 The runway identification lights (REIL) of Magong airport's runway 20 has been setting up for more than 10 years and without any operation issues. Taking into account that other flights before and after GE222 landed safely, proved the REIL do provide enough visual guidance.

4.3.3 There are lot of airports in the world using same facilities as Magong runway 20. A short list as Table 4-1.

Table 4-1 Airports using VOR Approach Procedure and REIL as Visual Guidance

Airports	Procedure	Visibility (Meters)
Fresno Yosemite International Airport (KFAT)	VOR DME RWY 11L	2200
Richmond International Airport (KRIC)	VOR RWY 20	2000
Charleston International Airport (KCHS)	VOR DME RWY 3	**1600**
McGhee Tyson Airport (KTYS)	VOR RWY 23L	**1600**
Waco Regional Airport (KACT)	VOR RWY 14	2000
Mobile Downtown Airport (KBFM)	VOR RWY 14	2800

4.4 Conclusions

To operate in coordination with related navigation aids, instrument flight procedures and flight operations restrictions, the runway identification lights (REIL) of Magong airport's runway 20 are compliant with the CAA related regulations. As severe weather is often accompanied by thunderstorms, low clouds, strong winds, etc. (as in this case, for example), there is no factual information that can be corroborated that setting up a 420 meters simple approach runway lights can enhance the runway identification in case of severe weather. The safe operation of aircraft approach in severe weather, is dependent upon flight crews visually identifying the runway; or else they should perform the missed approach procedure at (or before) the missed approach point.

Safety Actions Accomplished or Being Accomplished of Civil Aeronautics Administration

Flight Standards Division

No.	Recommendations	Status	Safety Actions
1	Strengthen surveillance on TransAsia Airways to assess crew's discipline and compliance with standard operating procedures (SOPs).	Accomplished	CAA's definite supervisory actions after TransAsia Airways GE-222 accident: 1. After the accidents of GE-222, CAA implement the in depth inspection of the Airlines, and formulate the short-term, mid-term and long-term targets to improve flight safety. 2. The in depth inspection found 24 deficiencies which includes safety management, FOQA, training and check standardization, CRM, fatigue, dispatch etc. CAA required TransAsia to set up plans of improvement. TransAsia made improvement from those deficiencies within allotted date (see attachment 1). 3. Review the adverse weather operation to improve the procedures(see attachment 2). 4. Enhance the operation inspection, the inspectors had launched 929 inspections since 23RD JUL,2014 until 31st AUG, 2015 and found deficiencies which improved afterwards, the improvement were recheck and confirmed by CAA inspectors(see attachment 3). 5. Targets of flight safety of TransAsia: (1) Short-term A. Complete ATR-72 fleet's engine system special inspection. B. Complete ATR-72 fleet 55 pilots oral test and proficiency check. 10 pilots didn't pass oral test and 3 pilots proficiency check didn't pass, but all passed recheck after remedial training. C. 150 cockpit enroute inspections and proficiency check found normal. D. Enhance pilots'schedule and flight time monitoring(see attachment 4).

No.	Recommendations	Status	Safety Actions
			(2) Mid-term A. Implement A330 and A320/321 pilot's oral test and proficiency check, with the result: 3 of 102 pilots take oral retest and 2 pilots take remedial training after recheck, the pilot proficiency check will finish before 31st DEC,2015. B. Enhance the mechanism to effectively control of mechanical troubles and arranged the main base inspection to verify the implementation. C. SMS implementation, is now in the phase 3 of the plan, and CAA will continue to monitor the implementation accordingly. D. To coordinate with Flight Safety Foundation action team to evaluate safety management of TransAsia Airways, list the priorities of safety related issues and continue to improve those. (3) Long-term(before 31st DEC,2016) A. Complete SMS implementation. B. Supervise the airlines SMS plan. C. Develp the methods of airlines management. 6. Works of supervise: (1) Oversee the management of organization and improve the proficiency of employees. (2) Supervise the improvement of safety related issues according the targets. 7. Reviews: (1) Except the deficiencies found in the in-depth inspection and targets of safety improvement required by CAA, the recommendations made by ASC , action team and authority of aircraft manufacture are also included in the measure of improvement. (2) Though the TransAsia Airways has improved it's flight safety by measures in all aspect, but leave of employees and

No.	Recommendations	Status	Safety Actions
			change of management still a major concern. The airlines is one of the major domestic carriers, suggest not to increase flight either domestic or international due to the manpower issue. The application of emergency medical service flight will be review and restricted as well. (3) CAA required TransAsia Airways to take actions to improve flight safety after accident. The immediate action to improve were the knowledge and skills, it has been effective improvement and will continue to enhance the performance. As to the organization, company culture, employees etc. are the human factors which is a long-term issues to improve, CAA will continue to oversee performance of the airlines. Due the CAA oversight activities are continuously and persistently, suggest to close the 1st and 2nd ASC recommendations to CAA.
2	Implement a more robust process to identify safety-related shortcomings in operators' operations, within an appropriate timescale, to ensure that the operators meet and maintain the required standards.		Suggest to close recommendation, the statement same as aforementioned.
5	Enhance inspector supervision and performance evaluation to ensure all inspectors conduct surveillance activities effectively and are able to identify and		CAA Flight Standards Division holds Operations Section and Airworthiness Inspection Section meeting and Airlines group report meeting monthly. The details of Section meeting includes policies proclaiming 、operations and airworthiness inspection work reporting and inspectors performance review, special items

No.	Recommendations	Status	Safety Actions
	communicate critical safety issues to their supervisors.		of inspection and jobs emphasis in coming months. Airlines groups meeting details includes POI work reports and reviews (includes airlines events or deficiencies improvement), emphasis of inspection, recommendations. The interim review meeting of airlines performance are also included.

Air Traffic Services Division

No.	Recommendations	Status	Safety Actions
11	Review runway approach lighting systems in accordance with their existing radio navigation and landing aids to ensure that adequate guidance is available for pilots to identify the visual references to the runway environment, particularly in poor visibility condition or at night.	Accomplished	The simple approach lighting system of runway 20 of Magong airport was commissioned on March 18, 2015. And the instrument landing system(ILS) of runway 20 was commissioned on June 25, 2015. After the aforementioned facilities are commissioned, the runway operational visibility limitation, has been upgraded from previously 1600 meters down to 1200 meters.

Air Navigation and Weather Services

No.	Recommendations	Status	Safety Actions
11	Review runway approach lighting systems in accordance with their existing radio navigation and landing aids to ensure that adequate guidance is available for pilots to identify the visual references to the runway environment, particularly in poor visibility condition or	Accomplished	20 跑道原已設有目視輔助設施跑道識別燈(REIL)使跑道頭更加明顯，符合儀器進場程序需求。另為提昇飛航服務品質，飛航服務總臺已於104年3月18日完成增設馬公機場20跑道簡式進場燈系統。

No.	Recommendations	Status	Safety Actions
	at night.		
13	Request tower controllers to advise the flight crews of aircraft on final approach of the updated information in accordance with the provisions of the air traffic management procedures (ATMP).	Accomplished	1. 飛航服務總臺於103年7月31日以航業一字第1030007601號函予各航管單位，重申提供即時天氣資料予航空器駕駛員之相關航管作業事宜。 2. 飛航服務總臺將本案納入103及104年度航管訓練教材，宣導天氣資訊之重要性及航空器緊急情況之之應變處置。 3. 飛航服務總臺飛航航管員席位查核重點項目原即列有「天氣資料之更新」，以口頭方式通知各航管單位加強查核有關天氣資訊更新之作業。 4. 飛航服務總臺於103年12月23日以航業一字第1035016256號函予各航管單位，宣導有關人工錄製ATIS、天氣資料提供及事件通報程序等相關注意事項。
14	Coordinate with Air Force Command Headquarters to review and improve the weather information exchange and runway availability coordination between civil air traffic control and military personnel at Magong Airport.	Accomplished	1. 飛航服務總臺於103年8月21日邀集空軍單位召開「戰航管工作協議書研討會」，並持續數月與空軍氣象聯隊及空軍第四四三聯隊就相關工作協議書進行研討及修訂。 2. 有關天氣資訊之交換 (1)「空軍氣象聯隊第七基地天氣中心/民用航空局飛航服務總臺高雄近場管制塔臺馬公機場管制臺工作協議書」於104年1月1日完成修訂(附件3-6)，明訂雙方工作項目，以完善馬公機場軍民用航空器飛航所須天氣資料之提供作業，使雙方工作人員於作業時能密切協調配合，確保飛航安全。 (2) 飛航服務總臺於103年12月17日派員至空軍氣象聯隊第七基地天氣中心，就天氣資訊之交換進行交流與研討，瞭解守視室(天氣觀測室)之觀測、發報作業，並與該中心呂副主任前往本總臺馬公塔臺了解管制員天氣資訊接收、使用情形，研議於塔臺設置該中心守視室氣象報文之即時顯示器，以加速機場天氣

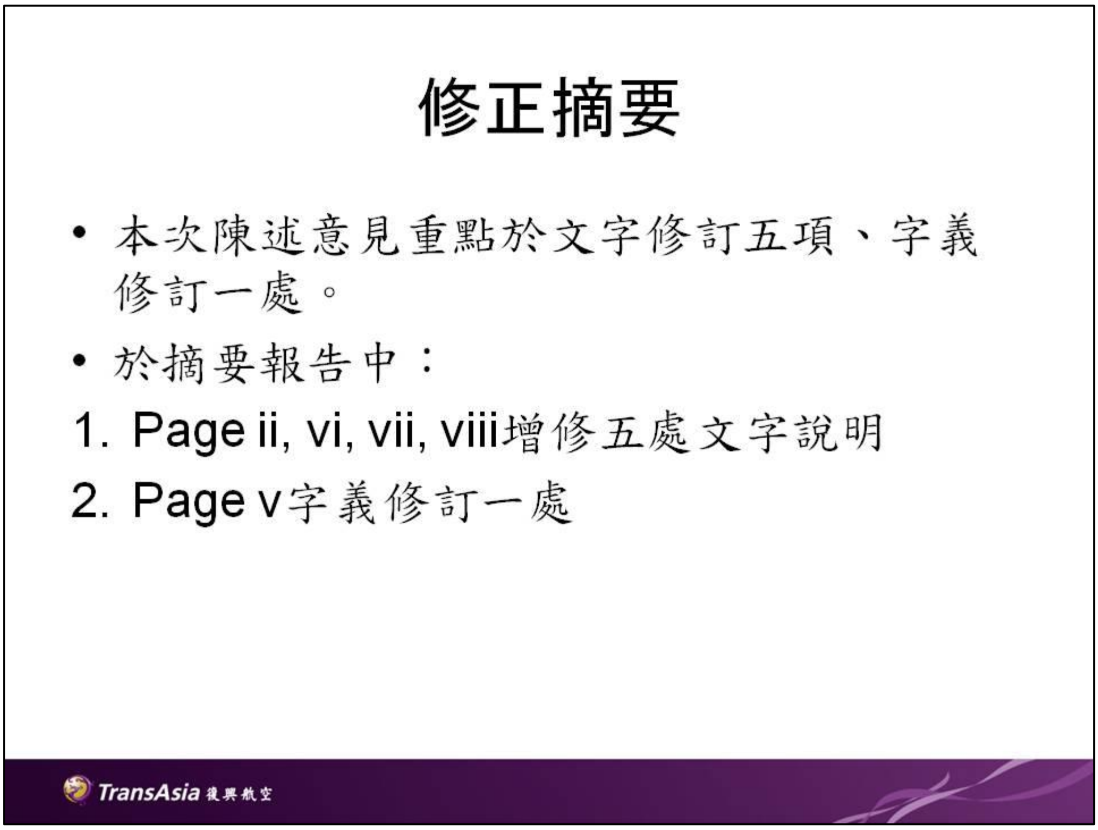
No.	Recommendations	Status	Safety Actions
			報告之傳送。 (3) 飛航服務總臺復於104年3月5日邀集空軍氣象聯隊召開「軍方提供第七基地天氣中心守視室至馬公塔臺光纖研商會議」，討論本案進行方式。後因國防部資訊安全規定，無法於馬公塔臺設置氣象報文即時顯示器，爰該中心改為透過塔臺 AWOS 顯示器畫面下方欄直接顯示氣象報文，即時提供，並於104年4月10日完成，以減輕航管與氣象雙方作業負擔。 3. 有關使用跑道之協調 (1)「空軍第四四三聯隊/空軍戰術管制聯隊/空軍通信航管資訊聯隊/民用航空局飛航服務總臺　有關馬公基地工作協議書」針對「跑道使用選擇」及作業方式持續溝通協調，飛航服務總臺爰分別於103年9月25日及103年11月14日邀集空軍單位召開會議確認文字。 (2) 飛航服務總臺與軍方經數月之溝通協調後，於104年1月1日完成「空軍第四四三戰術戰鬥機聯隊/空軍戰術管制聯隊/空軍通信航管資訊聯隊/民用航空局飛航服務總臺/有關馬公基地工作協議書」修訂，律訂天駒部隊(每年4至9月)進駐馬公基地期間，有關跑道使用選擇及使用另一方向跑道作業程序，並由飛管每日通知塔臺當日上警戒時間及下警戒時間，及遇颱風來襲戰機返臺防颱，飛管通知塔臺撤離及恢復馬公基地警戒時間。 (3) 飛航服務總臺於104年3月5日以航業一字第1045002186號函請民航局協助於飛航指南新增馬公機場跑道使用相關資訊，內容如次：「每年4月1日至9月30日間，除因天氣因素、載重或緊急狀況等特殊情況外，避免申請與航管指定跑道方向不同之跑道」，該項資訊已自104年3月11日起生效。本(104)年遇民航機申請不同方向跑道起降，雙

No.	Recommendations	Status	Safety Actions
			方依規範作業，協調順暢。 (4) 飛航服務總臺透過天駒部隊進駐前座談會、進駐座談會，及進駐期間各項協調會議，與天駒部隊持續溝通有關更換跑道之協調作業，目前執行情況良好。 (5) 飛航服務總臺馬公塔臺與空軍司令部人員分別於104年6月24及7月13日進行交流，就本(104)年度天駒部隊及馬基隊進駐期間更換跑道、戰機放行及訓練、異常狀況處理等作業交換意見，雙方均表示協調聯繫良好。

Appendix 5-5 Comments on ASC's Final Draft Report from TransAsia Airways

復興航空 TransAsia

GE222 事件
復興航空陳述意見

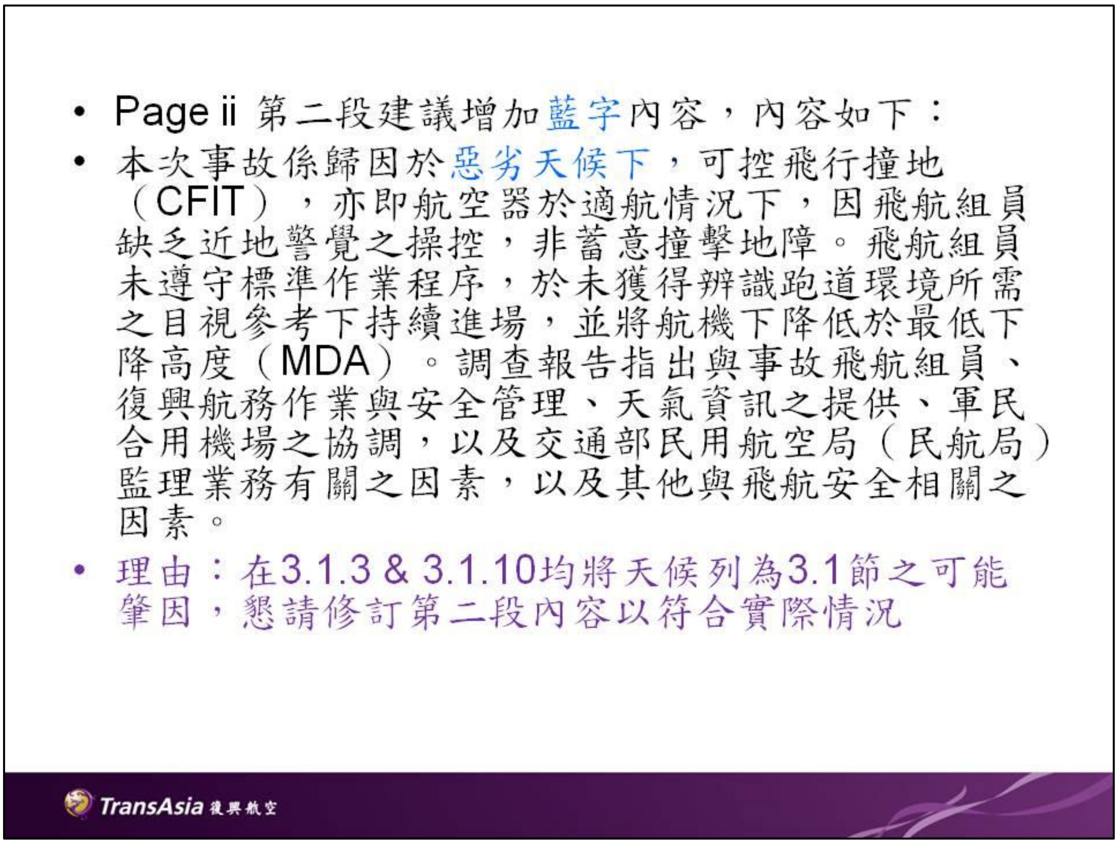


修正摘要

- 本次陳述意見重點於文字修訂五項、字義修訂一處。
- 於摘要報告中：

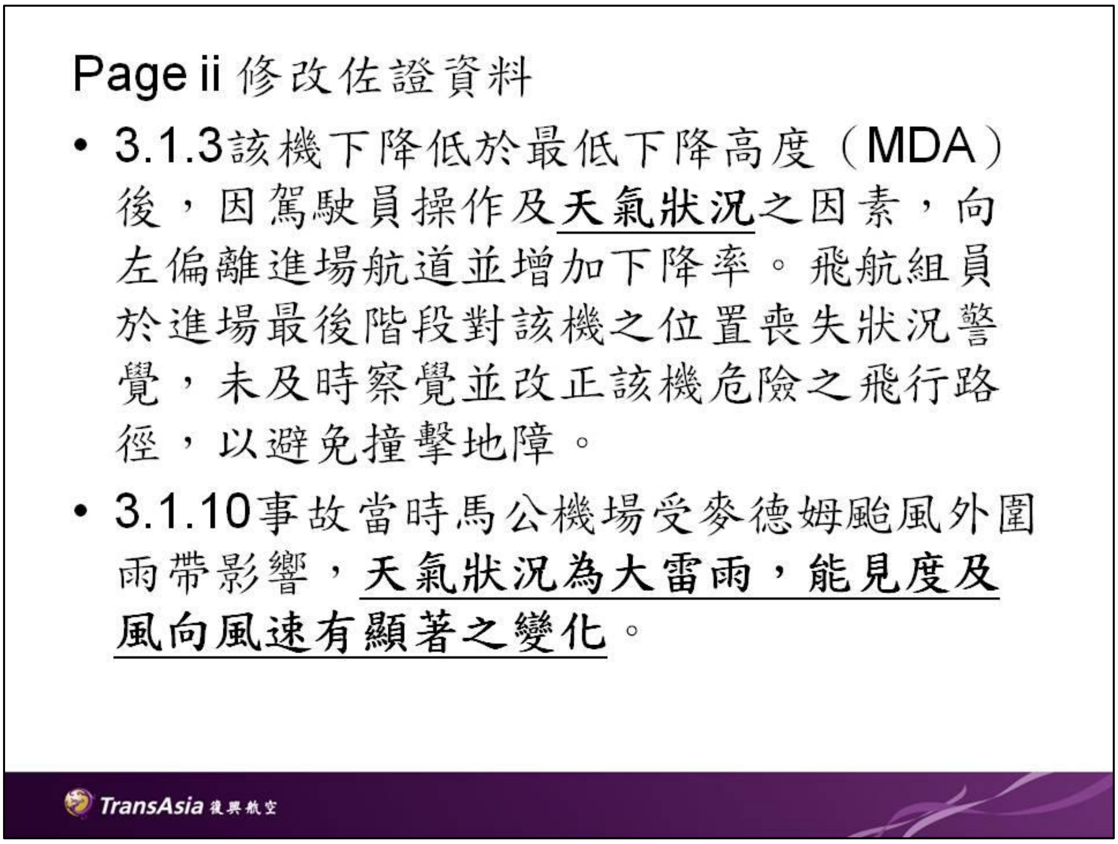
1. Page ii, vi, vii, viii增修五處文字說明
2. Page v字義修訂一處

TransAsia 復興航空



- Page ii 第二段建議增加藍字內容，內容如下：
- 本次事故係歸因於惡劣天候下，可控飛行撞地（CFIT），亦即航空器於適航情況下，因飛航組員缺乏近地警覺之操控，非蓄意撞擊地障。飛航組員未遵守標準作業程序，於未獲得辨識跑道環境所需之目視參考下持續進場，並將航機下降低於最低下降高度（MDA）。調查報告指出與事故飛航組員、復興航務作業與安全管理、天氣資訊之提供、軍民合用機場之協調，以及交通部民用航空局（民航局）監理業務有關之因素，以及其他與飛航安全相關之因素。
- 理由：在3.1.3 & 3.1.10均將天候列為3.1節之可能肇因，懇請修訂第二段內容以符合實際情況

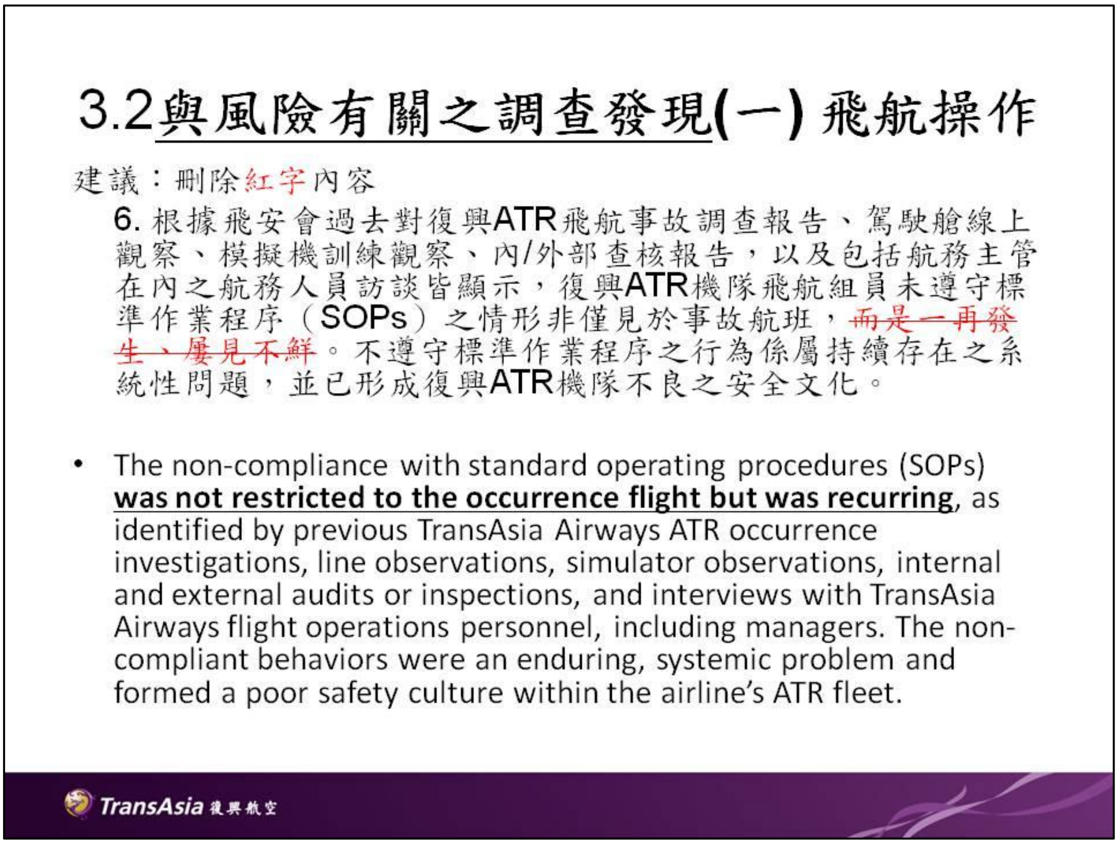
TransAsia 復興航空



Page ii 修改佐證資料

- 3.1.3該機下降低於最低下降高度（MDA）後，因駕駛員操作及**天氣狀況**之因素，向左偏離進場航道並增加下降率。飛航組員於進場最後階段對該機之位置喪失狀況警覺，未及時察覺並改正該機危險之飛行路徑，以避免撞擊地障。
- 3.1.10事故當時馬公機場受麥德姆颱風外圍雨帶影響，**天氣狀況為大雷雨，能見度及風向風速有顯著之變化**。

TransAsia 復興航空



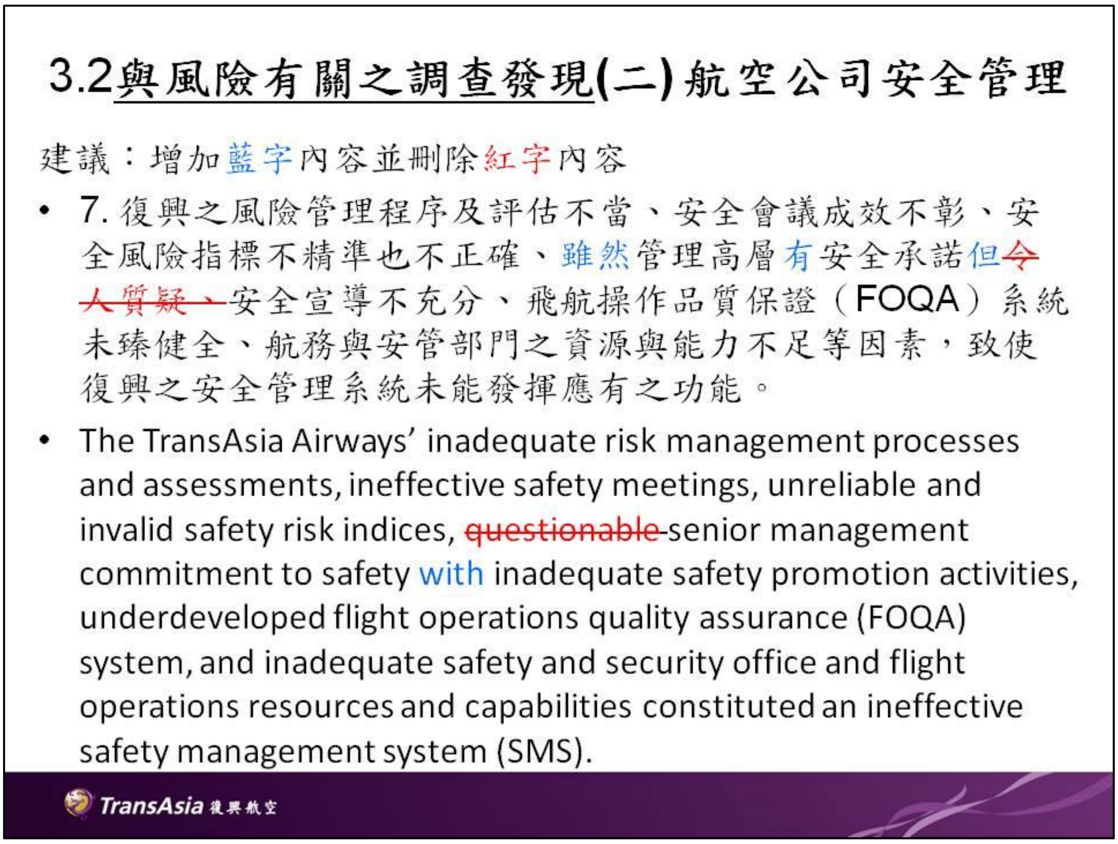
3.2與風險有關之調查發現(一) 飛航操作

建議：刪除紅字內容

6. 根據飛安會過去對復興ATR飛航事故調查報告、駕駛艙線上觀察、模擬機訓練觀察、內/外部查核報告，以及包括航務主管在內之航務人員訪談皆顯示，復興ATR機隊飛航組員未遵守標準作業程序（SOPs）之情形非僅見於事故航班，~~而是一再發生、屢見不鮮~~。不遵守標準作業程序之行為係屬持續存在之系統性問題，並已形成復興ATR機隊不良之安全文化。

- The non-compliance with standard operating procedures (SOPs) **was not restricted to the occurrence flight but was recurring**, as identified by previous TransAsia Airways ATR occurrence investigations, line observations, simulator observations, internal and external audits or inspections, and interviews with TransAsia Airways flight operations personnel, including managers. The non-compliant behaviors were an enduring, systemic problem and formed a poor safety culture within the airline's ATR fleet.

TransAsia 復興航空

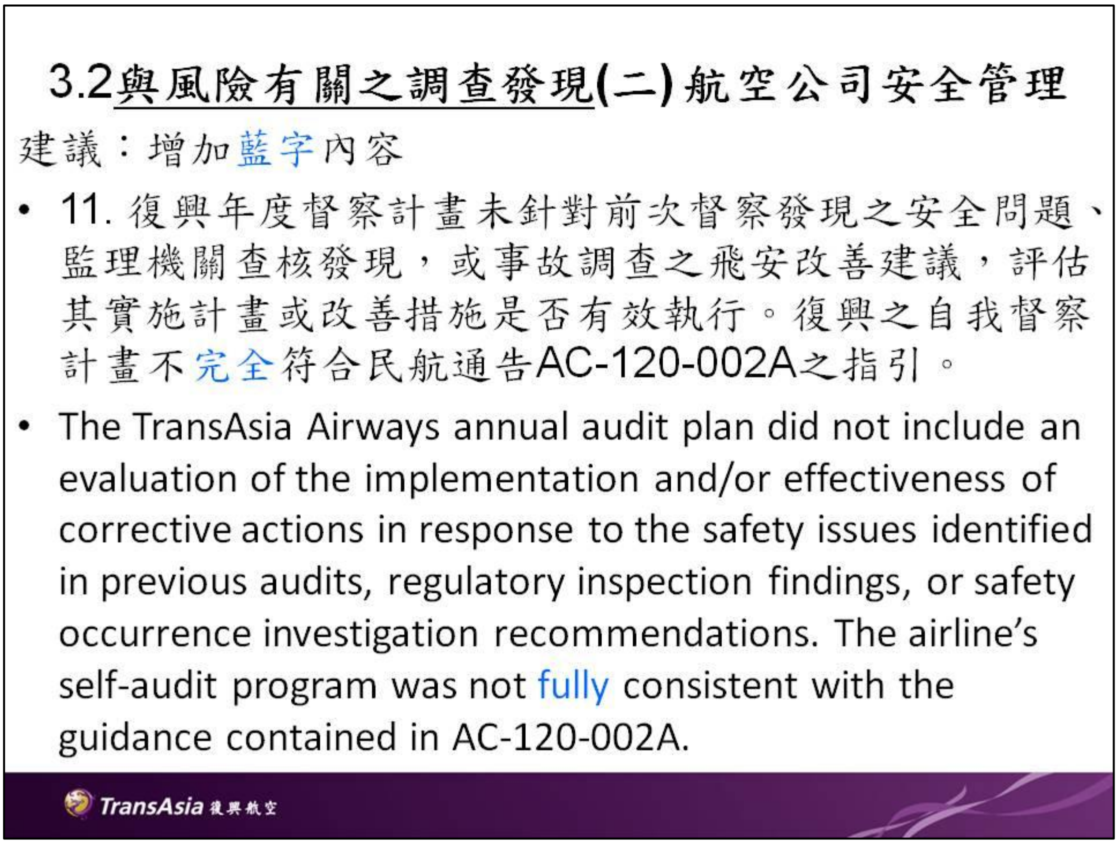


3.2與風險有關之調查發現(二)航空公司安全管理

建議：增加藍字內容並刪除紅字內容

- 7. 復興之風險管理程序及評估不當、安全會議成效不彰、安全風險指標不精準也不正確、雖然管理高層有安全承諾但~~令人質疑、~~安全宣導不充分、飛航操作品質保證（FOQA）系統未臻健全、航務與安管部門之資源與能力不足等因素，致使復興之安全管理系統未能發揮應有之功能。
- The TransAsia Airways' inadequate risk management processes and assessments, ineffective safety meetings, unreliable and invalid safety risk indices, ~~questionable~~ senior management commitment to safety with inadequate safety promotion activities, underdeveloped flight operations quality assurance (FOQA) system, and inadequate safety and security office and flight operations resources and capabilities constituted an ineffective safety management system (SMS).

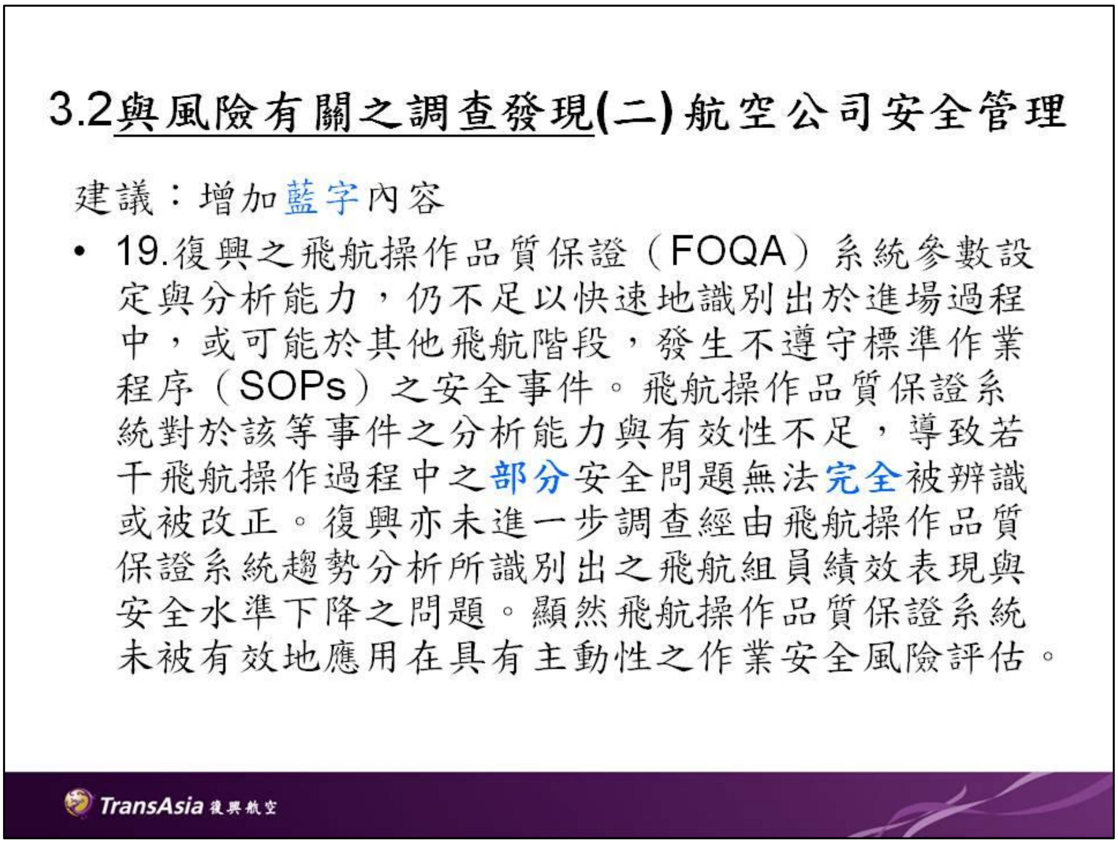
TransAsia 復興航空



3.2與風險有關之調查發現(二)航空公司安全管理

建議：增加藍字內容

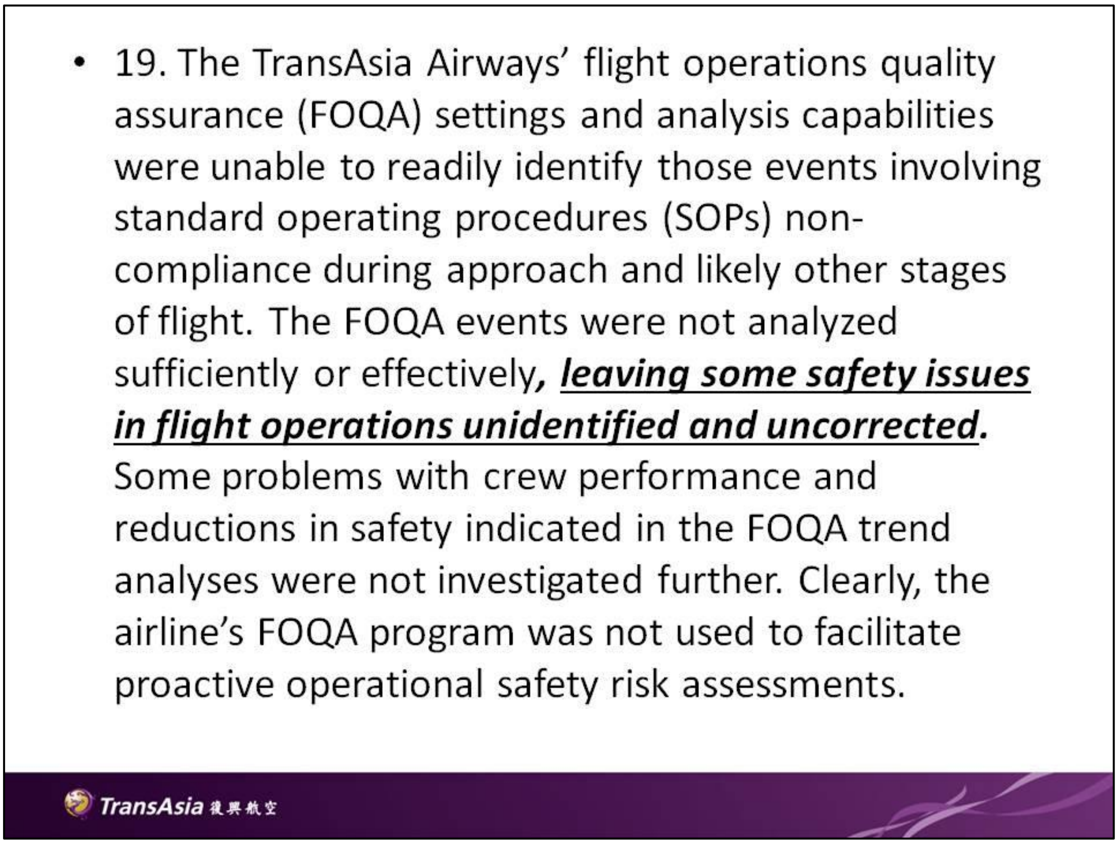
- 11. 復興年度督察計畫未針對前次督察發現之安全問題、監理機關查核發現，或事故調查之飛安改善建議，評估其實施計畫或改善措施是否有效執行。復興之自我督察計畫不完全符合民航通告AC-120-002A之指引。
- The TransAsia Airways annual audit plan did not include an evaluation of the implementation and/or effectiveness of corrective actions in response to the safety issues identified in previous audits, regulatory inspection findings, or safety occurrence investigation recommendations. The airline's self-audit program was not fully consistent with the guidance contained in AC-120-002A.



3.2與風險有關之調查發現(二)航空公司安全管理

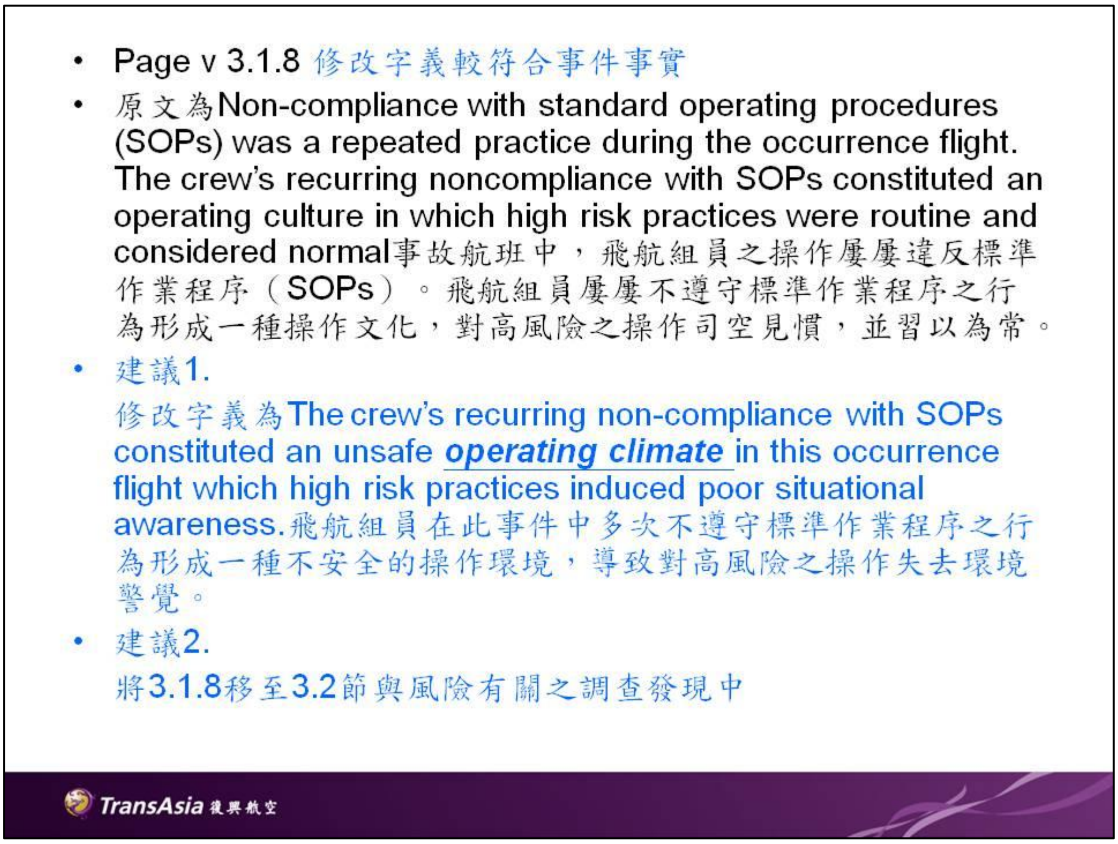
建議：增加藍字內容

- 19.復興之飛航操作品質保證（FOQA）系統參數設定與分析能力，仍不足以快速地識別出於進場過程中，或可能於其他飛航階段，發生不遵守標準作業程序（SOPs）之安全事件。飛航操作品質保證系統對於該等事件之分析能力與有效性不足，導致若干飛航操作過程中之部分安全問題無法完全被辨識或被改正。復興亦未進一步調查經由飛航操作品質保證系統趨勢分析所識別出之飛航組員績效表現與安全水準下降之問題。顯然飛航操作品質保證系統未被有效地應用在具有主動性之作業安全風險評估。



- 19. The TransAsia Airways' flight operations quality assurance (FOQA) settings and analysis capabilities were unable to readily identify those events involving standard operating procedures (SOPs) non-compliance during approach and likely other stages of flight. The FOQA events were not analyzed sufficiently or effectively, ***leaving some safety issues in flight operations unidentified and uncorrected.*** Some problems with crew performance and reductions in safety indicated in the FOQA trend analyses were not investigated further. Clearly, the airline's FOQA program was not used to facilitate proactive operational safety risk assessments.

TransAsia 復興航空

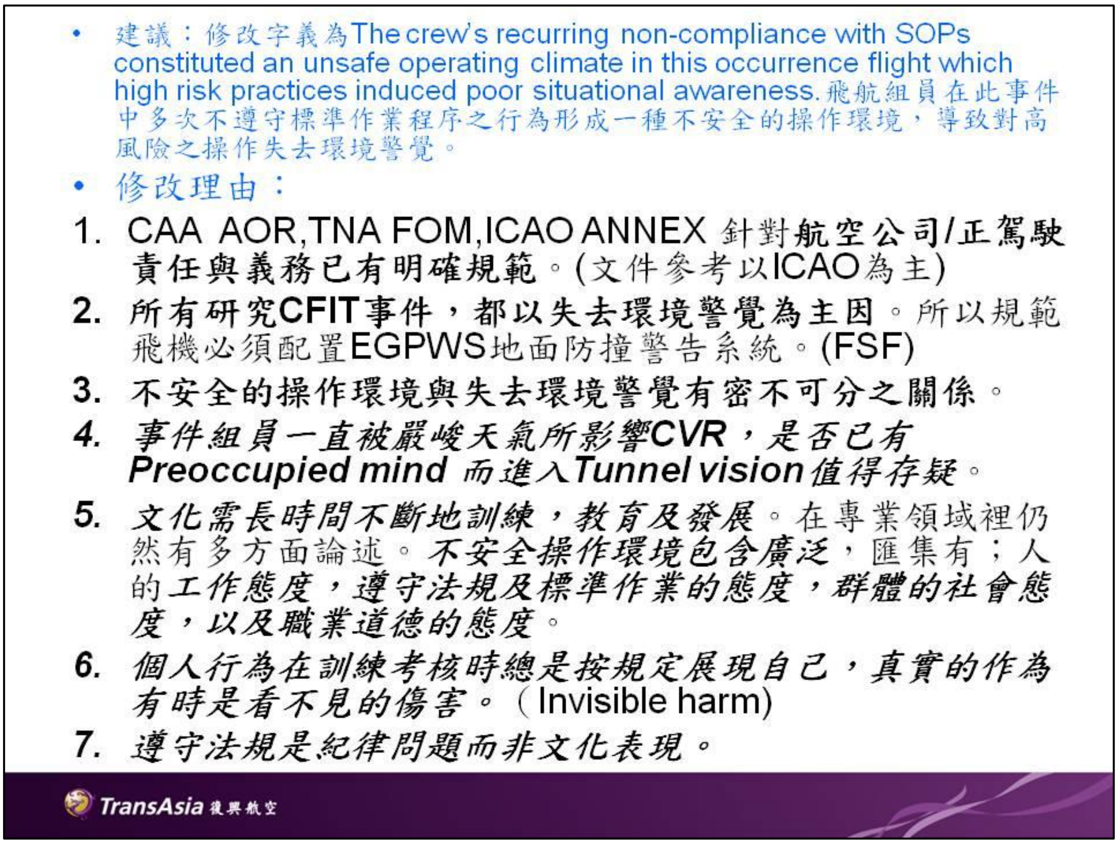


- Page v 3.1.8 修改字義較符合事件事實
- 原文為Non-compliance with standard operating procedures (SOPs) was a repeated practice during the occurrence flight. The crew's recurring noncompliance with SOPs constituted an operating culture in which high risk practices were routine and considered normal事故航班中，飛航組員之操作屢屢違反標準作業程序（SOPs）。飛航組員屢屢不遵守標準作業程序之行為形成一種操作文化，對高風險之操作司空見慣，並習以為常。
- 建議1.

  修改字義為The crew's recurring non-compliance with SOPs constituted an unsafe ***operating climate*** in this occurrence flight which high risk practices induced poor situational awareness.飛航組員在此事件中多次不遵守標準作業程序之行為形成一種不安全的操作環境，導致對高風險之操作失去環境警覺。
- 建議2.

  將3.1.8移至3.2節與風險有關之調查發現中

TransAsia 復興航空



- 建議：修改字義為The crew's recurring non-compliance with SOPs constituted an unsafe operating climate in this occurrence flight which high risk practices induced poor situational awareness. 飛航組員在此事件中多次不遵守標準作業程序之行為形成一種不安全的操作環境，導致對高風險之操作失去環境警覺。
- 修改理由：

1. CAA AOR,TNA FOM,ICAO ANNEX 針對**航空公司/正駕駛責任與義務已有明確規範**。(文件參考以ICAO為主)
2. **所有研究CFIT事件，都以失去環境警覺為主因**。所以規範飛機必須配置EGPWS地面防撞警告系統。(FSF)
3. **不安全的操作環境與失去環境警覺有密不可分之關係**。
4. ***事件組員一直被嚴峻天氣所影響CVR，是否已有 Preoccupied mind 而進入Tunnel vision 值得存疑***。
5. ***文化需長時間不斷地訓練，教育及發展***。在專業領域裡仍然有多方面論述。***不安全操作環境包含廣泛***，匯集有；***人的工作態度，遵守法規及標準作業的態度，群體的社會態度，以及職業道德的態度***。
6. ***個人行為在訓練考核時總是按規定展現自己，真實的作為有時是看不見的傷害***。（Invisible harm)
7. ***遵守法規是紀律問題而非文化表現。***

TransAsia 復興航空

FAA Safety Briefing：

Positive Flight Attitude by FAA Susan

Be AWARE請注意

The airplane's physical attitude is relatively easy to understand. The pilot's mental attitude is more complicated. Attitude can be defined as a complex mental state involving beliefs, feelings, values, and dispositions to act in certain ways. One of the trickiest aspects of mental attitude is that the beliefs, feelings, and values driving our disposition to act in certain ways are often as invisible to us as water is to a fish.

Assuming that safety is one of your primary aviation values, there are things you can do to become more aware of factors that contribute to a positive flight attitude in both senses of the term. These include: Aircraft – Weather – Airspace –Risk Factors – External Pressures.

飛機的姿態很容易理解
飛行員心理的態度卻是錯綜複雜，因為信仰，感情，價值等，面對問題也會有不知不覺程度的影響。常常這種影響卻是不容易察覺。

姿態
VS
態度

Editor : Susan Parson is a special assistant in the FAA Flight Standards Service and editor of FAA Safety Briefing. She is an active general aviation pilot and flight instructor

TransAsia 復興航空

As explained in the ***FAA's Risk Management Handbook (FAA-H-8083-2),*** the PAVE checklist is a methodical way to increase your awareness of hazards that might pose a risk for your flight:

- **P** – Although the "P" is primarily intended to spur thinking about hazards associated with the pilot (fatigue, illness, stress, lack of proficiency), it can also represent hazards that might arise from passengers, e.g., distraction to pilot.
- **A** – Use this part of the PAVE checklist to identify hazards related to the aircraft you are flying. Does it have known mechanical issues?
- **V** – Derived from "enVironment," this part of the checklist reminds you to identify hazards arising from weather, airspace, terrain, and airports.
- **E** – External pressures (discussed below) often pose the most insidious dangers to a pilot. Awareness of these pressures is vital to safety of flight.

外界壓力

常常是致使飛行員不知不覺的對危險
喪失警覺，而對壓力的警覺
卻是保障飛安的生命

External Pressures

I speak from personal experience when I say that external pressures can pose the greatest hazard to safety awareness and, as the definition for attitude states, the "disposition to act in certain ways." A pilot who recognizes a hazard will likely have the disposition to act in a safety-conscious manner. When a hazard goes unnoticed, however, the pilot may instead be disposed to act in ways that, if an accident occurs, inspire fellow aviators to roll their eyes over the "stupidity" of his or her behavior. Because they often arise from those unconscious but powerful beliefs, feelings, and values that we all hold, external pressures can have truly treacherous effects on pilot judgment.

飛行員若是了解危害，自然會產生安全意識的態度。
一旦危害不被意識到，飛行員所造成的意外很容易讓專家們認為他/她們的行為愚蠢。這些主要是因為他們不自覺但強而有力的信仰，心理狀態，價值觀等，讓飛行員做了信以為真的判斷。

No one ever intends to have an accident and many accidents result from poor judgment.

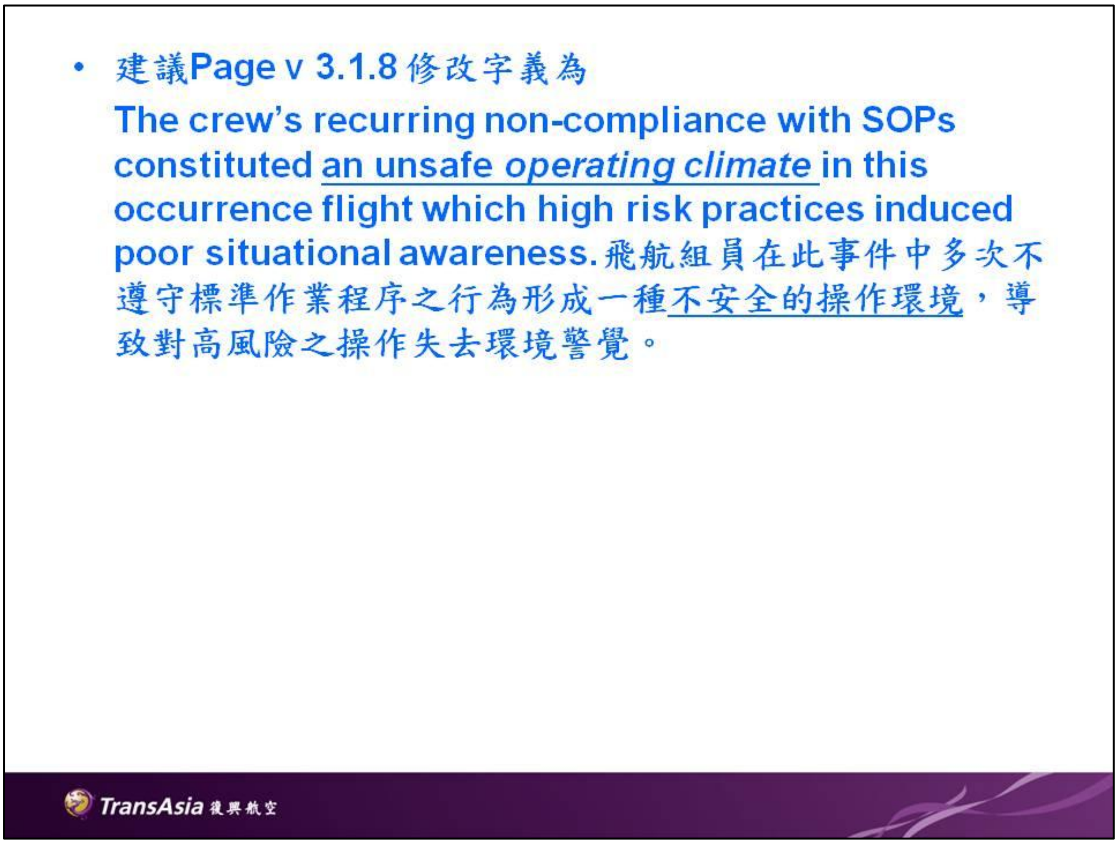
For example, ***a pilot flying several trips throughout the day*** grows steadily behind schedule due to late arriving passengers or other delays. Before the last flight of the day, the weather starts to deteriorate, but the pilot thinks one more short flight can be squeezed in. It is only 10 minutes to the next stop. But by the time the cargo is loaded and the flight begun, the pilot cannot see the horizon while flying out over the tundra. The pilot decides to forge on since he told the village agent he was coming and flies into poor visibility. The pilot never reaches the destination and searchers find the aircraft crashed on the tundra.

In this scenario, a chain of events results in the pilot making a poor decision. First, the pilot exerts pressure on himself to complete the flight, and then proceeds into weather conditions that do not allow a change in course. In many such cases, the flight ends in controlled flight into terrain (CFIT).

結　語

1. 嚴峻天氣
2. 社會風氣壓力
3. 夜間非精確性進場
4. 組員的安全態度
5. 組員對危害辨識警覺能力不足
6. 組員對辨識壓力及管理的警覺不夠

形成為不安全的操作環境



- 建議Page v 3.1.8 修改字義為
  The crew’s recurring non-compliance with SOPs constituted an unsafe *operating climate* in this occurrence flight which high risk practices induced poor situational awareness. 飛航組員在此事件中多次不遵守標準作業程序之行為形成一種不安全的操作環境，導致對高風險之操作失去環境警覺。

Safety Actions Accomplished or Being Accomplished of TransAsia Airways

No.	Recommendations	Status	Safety Actions
1	Implement effective safety actions to rectify the multiple safety deficiencies previously identified by the Aviation Safety Council investigations, internal and external Civil Aeronautics Administration audit and inspection findings, and deficiencies noted in this report to reduce the imminent safety risks confronting the airline.	Accomplished	1. 針對查核缺點航務處均改善並回覆。 2. SOA 針對進場操作程序及標準呼叫列入觀察項目(如附件)
2	Conduct a thorough review of the airline's safety management system and flight crew training programs, including crew resource management and threat and error management, internal auditor training, safety management system (SMS) training and devise systematic measures to ensure:		
	● Flight crew check and training are standardized;	Accomplished	1. 訓練依 FTMM 第 34 版規劃，考驗依教師手冊考驗標準執行。 2. 2014/10 改版修訂 FTMM(飛航訓練管理手冊)使訓練符合法規，經報民航局核准後實施。 3. 2014/10 修訂教師手冊，使 IP/CP 對訓練及考核標準有所遵循。
	● All flight crews comply with standard operating procedures (SOPs);	Accomplished	1. 檢視各機型 SOP 內容，使一致化，例 ATR 增加 STANDARD CALL OUT、MEMORY、ABNORMAL/EMERGENCY 等章節。 2. SOP 修訂完成，所有飛航組員均安排上課，以便熟悉修訂內

No.	Recommendations	Status	Safety Actions
			容。 3. 在適職性考驗及加強全員SOP督考中，全面檢視對SOP之遵守。
	● Staff who conduct audits receive appropriate professional auditor training;	Accomplished	1. 執行自我督察人員訓練時數由原先7小時增加至50小時，以增加執行人員適職性。 2. E-IOSA稽核員訓練已於12月7日至10日由IATA授權機構ARGUS/PRO執行，並完成25員合格E-IOSA稽核員認證。 3. 預劃105年1月執行稽核員職能強化訓練，以提升稽核深度與稽核品質。
	● All operational and senior management staff receive SMS training, including thorough risk assessment and management training; and	Accomplished	高階主管的安全管理訓練已於例行性的安全委員會中實施二次，並記錄在案。
	● Proportional and consistent rules, in accordance with a "Just Culture", are implemented to prevent flight crew from violating the well-designed SOPs and/or being engaged in unsafe behavior.	Accomplished	對於蓄意違反SOP的飛航組員，經調查屬實後，按公司規定加強懲處並施以再訓練課程，期藉以提醒所有飛航組員務必遵守SOP飛行。
3	Conduct a rigorous review of the safety management system (SMS) to rectify the significant deficiencies in: ● Planning; ● Organizational structure, capability and resources; ● Risk management processes and outputs; ● Flight operations quality assurance (FOQA) limitations and	Accomplished	針對民航局102年5月20日SMS評估所見，經民航局民國103年11月4日標準一字第1035015287號函(本公司收文時間103年11月05日)函文，合併前述二、三、四項函文 於深度檢查項目中列管。本編號各項改善均已於本公司SMM3-2 TR001版完成修訂列入執行，並於104年6月11日報局核備。

No.	Recommendations	Status	Safety Actions
	operations, including inadequate data analysis capabilities; ● Safety meetings; ● Self-audits; ● Safety performance monitoring, including risk indices; ● Safety education; and ● Senior management commitment to safety.		
4	Rectify the human resources deficits in the flight operations division and the safety and security office, including:		
	● Crew shortages;	Accomplished	本公司已於本年招募機師 33 員補充人力需求，ATR 人力除新招募 6 員外，ATR500 汰除後人力亦轉換為 ATR600。
	● Inadequate support staff in the Flight Standards and Training Department, including insufficient standards pilots and crew to conduct operational safety risk assessments; and	Accomplished	航務處於 2015 年 5 月組織調整，將標訓發展部分為訓練標考部及計畫發展部；增設訓練標考部各機型標考主任，負責考核標準化業務；各機隊增設技術機師協助處理機師相關業務。
	● Safety management staff with the required expertise in flight operations, safety and flight data analytics, safety risk assessment and management, human factors, and safety investigations.	Accomplished	1. 於 104 年 7 月於企業安全處下增設資料分析部，含部門主管 1 員及工程師 3 員，FOQA 工程師及相關人員已於 103 年 11 月報到，AIRBUS 及 Teledyne 公司並於 104 年 11 月派員至本公司實施為期一個月的訓練以提升 FOQA 工程師的判讀能力及實務操作經驗並符合民航法規要求。 2. FOQA 相關機制已參酌 ICAO DOC10000 重新撰擬，並納入航務處訓練標考部各機型標考主任(STANDARD PILOT)與企

No.	Recommendations	Status	Safety Actions
			安處共同分析研討。
5	Review and improve the airline's internal compliance oversight and auditing system and implement an effective corporate compliance and quality assurance system to ensure that oversight activities provide the required level of safety assurance and accountability.	Being Accomplished	1. 已於104年7月20日核定於企業安全處增設品質保證管理部，統合本公司品保系統與查核系統整體業務，並於104年8月與稽核室及機務品保處完成稽核範圍及權責劃分。 2. 已於104年10月完成SMS與QMS系統整合規劃工作，並建立Quality Assurance Program(QAP)，將品質保證稽核範圍涵蓋公司各航空運作相關部門，以支持Safety Assurance，達成安全目標。 3. 於104年12月修訂SMS手冊安全保證章節，並增訂品質保證實施辦法為附錄，以為品質保證稽核作業依據。
6	Implement an effective safety management process, such as a data-driven fatigue risk management system (FRMS), to manage the flight safety risks associated with crew fatigue.	Accomplished	1. 為避免組員疲勞，已將國內線每日8次起降修正為6次，後續待人力充足將修訂為4-6次，以避免組員工作疲勞。 2. 已完成FRMS導入計畫，分階段於105年實施。
7	Provide flight crew with adequate fatigue management education and training, including the provision of effective strategies to manage fatigue and performance during operations.	Accomplished	1. 宣導方式告知祖員身體不適，不可勉強飛行。 2. 外站(高雄)以刷卡方式管制組員，按時進駐休息。
8	Implement an effective change management system as a part of the airline's safety management system (SMS) to ensure that risk assessment and mitigation activities are formally conducted and documented before significant operational changes are implemented, such as the introduction of new	Accomplished	SMS改變管理項目，本公司已於SMM3-2 TR001版完成修訂，並已於104年6月11日核備後執行。

No.	Recommendations	Status	Safety Actions
	aircraft types or variants, increased operational tempo, opening new ports, and so on.		
9	Implement a more advanced flight operations quality assurance (FOQA) program with adequate training and technical support for the FOQA staff to ensure that they can exploit the analytical capabilities of the program. As such, the FOQA staff can more effectively identify and manage the operational safety risks confronting flight operations.	Accomplished	配合組織編制 103/10/1 日發布，航務處新設標訓組，FOQA 審查會成員改以安管處與標訓組成員審查，以增進其品質監控。綜合民航局意見，配合全公司安全管理系統之重新檢討，已於 103 年 11 月完成修正 FOQA 運作機制，並修訂於【安全管理手冊】第四章，於 104.03.01 完成手冊 FOQA 章節修訂，104 年 3 月 16 日奉核。FOQA 人員訓練除由原有具資格人員施訓外，另 AIRBUS 原廠於 104 年 11 月派員至本公司實施為期一個月的 FOQA 訓練。
10	Implement an effective standard operating procedures (SOPs) compliance monitoring system, such as the line operations safety audit (LOSA) program, to help identifying threats to operational safety and to minimize the associated risks. The system should adopt a data-driven method to assess the level of organizational resilience to systemic threats and can detect issues such as habitual non-compliance with SOPs.	Being Accomplished	1. 目前用加強督考方式(適職性考驗、主管督考、SOA)確保組員遵守 SOP 操作。 2. 將以本公司 SOA 為藍本，發展本公司的類 LOSA 作業。