Aviation Safety Council

Taiwan

Far Eastern Air Transport Flight EF306, Boeing 757-200 / Thai Airways International Public Company Ltd Flight TG659, Boeing 777-300

A TCAS Event in Narrow Collision Avoidance at an Altitude of 34,000 Ft. and 99 NM South of Jeju Island, Korea

On November 16, 2006

Final Report

August 15, 2008

According to Article 5 of the Aviation Occurrence Investigation Act of The Republic of China:

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.

Further, the Section 3.1, Chapter 3, Annex 13 of International Civil Aviation Organization (ICAO):

The sole purpose 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.

Thus, based on both the ICAO Annex 13, as well as the Aviation Occurrence Investigation Act of the Republic of China, this aviation occurrence investigation report shall not be used for any other purpose than to improve safety of the aviation community.

Executive Summary

On Nov. 16, 2006, Far Eastern Air Transport Flight EF306, a Boeing 757-200 type aircraft with registration number B-27015, departed Tao Yuan international airport at 0841 Taipei local time and bound for Jeju International Airport, Korea.

On the way to the destination, about 99 NM south of Jeju Island, over the open sea area during its descent to FL 310 from FL390 following the instruction of the Incheon area control center (Incheon ACC), the Traffic Alert and Collision Avoidance System (TCAS) issued the Traffic Advisory (TA)/Resolution Advisory (RA) warning.

The crew manipulated the aircraft to descend for an avoidance maneuver following the TCAS RA 'DESCEND' warning. During the avoidance maneuver, 4 passengers were seriously injured, 10 passengers and 6 cabin crew sustained minor injury, and the interior of the aircraft sustained minor damage.

According to Article 6 of the ROC Civil Aviation Act, and the content of Annex 13 to the Convention on International Civil Aviation (Chicago Convention), which is administered by the International Civil Aviation Organization (ICAO), the Aviation Safety Council (ASC), an independent agency of the ROC government responsible for civil aviation occurrences investigation, immediately launched a team to conduct the investigation of this occurrence under the concurrence of KARAIB (Korea Aviation & Railway Accident Investigation Board). The investigation team included members from the USA NTSB, KARAIB, Boeing Company, ROC Civil Aeronautical Administration (CAA) and Far Eastern Air Transport (FEA).

After 8 months of factual data collection, the Safety Council published the Factual Data Collection Report on Jul. 31, 2007 and an Interim Flight Safety Bulletin on Aug. 01, 2007.

The analysis portion of the investigation process was commenced immediately after the release of the Factual Data Collection Report. A Preliminary Draft of the investigation final report was sent to the NTSB, USA ARAIB, Korea, CAA, Thailand, CAA, Taiwan and Far Eastern Airways(FEA) for their comments. Based on the comments from the NTSB, ARAIB, CAA, Thailand, Taiwan CAA, and FEA, a final report is prepared and presented.

This final report follows the format of ICAO Annex 13 with a few minor modifications. Firstly, in Chapter 3, Conclusions, the Safety Council decided in their 74th Board meeting that to further emphasize the importance that the purpose of the investigation report is to enhance aviation safety, and not to apportion blame and responsibility, the final report does not directly state the "Probable Causes and Contributing Factors", rather, it will present the findings in three categories: findings related to the probable causes of the occurrence, findings related to risks, and other findings. Secondly, in Chapter

4, in addition to the safety recommendations, the Safety Council also includes the safety actions already taken or in progress by the stakeholders. This modification follows the practices by both the Australian Transport Safety Bureau (ATSB) and Transportation Safety Board (TSB) Canada, as well as follows the guidelines of ICAO Annex 13. The Safety Council decided that this modification would better serve its purpose for the improvement of aviation safety.

Therefore, based upon the analysis by the Safety Council, the following are the key findings of the EF306 occurrence investigation.

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

1. ICN control made a non-standard call and gave a confusing instruction to the EF306 during its descent when passing FL340. EF306 flight crew did not fully comprehend the ATC instructions, failed to confirm the instructions and stopped descending at 33,800 ft. Both parties did not apply standard radiotelephony procedures and phraseologies. These anomalies contributed to the TCAS event between EF306 and TG659. (1.11.1, 2.2.1, 2.3.1)

2. The EF306 flight crew did not complete the TCAS RA standard operation procedures and commenced an excessive high rate descent. The induced negative G-force resulted in the occupants' injury. (1.11.2, 2.2.3.1, 2.4.1)

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 that made this accident more likely; however, they can not be clearly shown to have operated in the accident. They also identify risks that increase the possibility of property damage and personnel injury and death. Further, some of the findings in this category identify risks that are unrelated to the accident, but nonetheless were safety deficiencies that may warrant future safety actions.

1. The EF306 flight crew did not adequately exhibit good CRM performance in this occurrence. (2.2.5)

2. While concentrating on the radar identification of other aircraft, SSRC momentarily missed monitoring the approaching situations developed between EF306 and TG659. (2.3.1)

3. About 20 seconds after stopping descent, the pilot of EF306 notified SSRC of climbing in accordance with TCAS instructions, but descended actually. At that time, SSRC did not provide traffic information but attempted to modify the aircraft flight path instead. SSRC did not comply with ATC TCAS operating procedures. (2.3.1)

4. The human capability of South Sector radar control position could be limited when the control services are performed by only one controller who

is paying attention continuously to a large number of aircraft in a relatively broad service area, particularly during a sudden occurrence of abnormal situation. (2.3.2)

5. Applying RVSM operations, the air traffic on B576 to and from Jeju airport is increasing rapidly. (2.3.3)

6. Most of the injured passenger did not have their seat belts fastened and lost their protection while the fasten seat best sign was still on.(2.5.1)

7. The cabin crewmembers did not provide timely injury information to the flight crew, that would have allowed the flight crew to request sufficient medical assistance before landing. (2.5.4)

8. The controllers did not aware the importance of the number of injuries and the need for more ambulances to meet the flight upon landing. This caused the necessary number of ambulances to arrive at the airport with delay. (2.5.6)

Other findings identify elements that have the potential to enhance aviation safety, resolve an issue of controversy, or clarify an issue of unresolved ambiguity. Some of these findings are of general interest and are not necessarily analytical, but they are often included in ICAO format accident reports for informational, and safety awareness, education, and improvement purposes.

1. The flight crew members were properly certified and qualified in accordance with applicable Civil Aviation Regulations.（2.1）

2. There was no evidence indicated that the flight crew members had any physical or psychological problems, nor any use of alcohol or drugs.（2.1）

3. The aircraft was operated within operational weight and balance limitations. (2.1)

4. There were no adverse weather conditions at the time of the occurrence. (2.1)

5. The TCAS respond maneuver of TG659 flight crew met the standard operational procedures and requirements.(2.2.4)

6. The EF306 flight crew TCAS training materials met the CAA’s training requirements. (2.2.6)

7. It may mislead the flight crew to have abrupt input to the aircraft while they speculate the relative distance according to visual contact of conflicting aircraft. (2.2.7)

8. SSRC and the controller at the Flight Data Control position held the qualifications required for the appropriate control position and the valid air physical examination certificates and did not take drugs or drink alcohol. (2.3.1)

9. The closest distance between EF306 and TG659 met the ICAO radar separation requirement but didn’t meet the minimum radar separation of

10 NM into an actual operation for a safer control. (2.3.1)

10. There was no standard instrument arrival procedures from B576 south of Jeju to Jeju airport. (2.3.3)

11. The data in the Flight Data Recorders of EF306 and TG659 aircraft were in accordance with ICAO Annex 6 Type 1 Flight Data Recorder, and satisfied to record 32 mandatory parameters. (1.11.2)

12. The “seat belt sign” of EF306 was turned “ON” at 02:03:05, and continued remaining “ON” until the aircraft was parked in ramp. (1.11.2.1)

13. According to flight recorders of both the EF306 and TG659 aircraft, the TCAS TA/RA activations, findings indicated as below: (1.11.1.1, 1.11.2.1, 1.11.2.2, 1.11.2.3)

    i. “TA” activated at 02:06:48：

        a. EF306: altitude of 34,052 ft, airspeed 272 knots, ground speed 493 knots, and magnetic heading 11.6 degrees.

        b. TG659: altitude 34,001 ft, airspeed 288 knots, ground speed 421 knots, and magnetic heading 219 degrees

        c. 49 seconds prior to CPA, the relative distance, relative altitude and closure rate of the two aircraft were 12.2 NM, 51 ft (ALT of EF306 was higher than that of TG659), and 910 knots, respectively. (2.4.1, 2.4.2)

    ii. Autopilot disengaged:

        a. The autopilot of EF306 was disengaged at 02:06:56, at an altitude of 33,828 ft, airspeed 274 knots, ground speed 494 knots, and magnetic heading 11.6 degrees. With 41 seconds prior to CPA, the relative distance, relative altitude and closure rate of the two aircraft were 10.05 NM, -171 ft (ALT of EF306 was lower than that of TG659), and 911 knots, respectively.

        b. The autopilot of TG659 was disengaged at 02:07:00, with altitude 33,999 ft, airspeed 288 knots, ground speed 421 knots, and magnetic heading 219 degrees. With 37 seconds prior to CPA, the relative distance, relative altitude and closure rate of the two aircraft were 9.08 NM, -139 ft, and 910 knots, respectively.

    iii. “RA” activated at 02:07:01: (2.4.1)

        a. 35 seconds prior to CPA, the relative distance, relative altitude and closure rate of the two aircraft were 8.82 NM, -128 ft, and 910 knots, respectively.

        b. 29 seconds prior to CPA, the descent rate of EF306 was approaching to a maximum of 12,096 ft/min. The relative distance, relative altitude and closure rate of the two aircraft were 7.41 NM, -812 ft, and 893 knots, respectively.

c. 24 seconds prior to CPA, the “RA Climb” of TG659 was released. The relative distance, relative altitude and closure rate of the two aircraft were 6.13 NM, -1,880 ft, and 914 knots, respectively.

d. At time 02:07:36 was the Closest Point of Approach (CPA). The relative distance, relative altitude and closure rate of the two aircraft were 0.85 NM, -2,611 ft, and 655 knots, respectively.

iv. At time of TCAS RA activation, the closure rate of two aircraft was 910 knots, and the flight crew of EF306 was probably able to see the TG659 on it’s windshield with the size of 0.3 cm. During the activation of “RA Descend” of EF306, the apparent size of the TG659 was expanded to 0.57 cm. TCAS issued the “Adjust Vertical Speed, Adjust” until 02:07:36, then the TG659 performed the climb and right-turn maneuver. The apparent size became larger rapidly (about 0.6 cm ~ 40 cm). The trend moved from the center windshield to the upper-left hand side.

14. If the First Aid Kit contents were labeled in Chinese, it could be more easily to identify by the cabin crewmembers under time pressure. The cabin crewmembers did not follow the bone fracture first aid procedures. (2.5.3)

15. The company’s Cabin Crew Operation Manual and training courses do not provide any guidelines or procedures for crew cooperation, coordination and job allocation to handle a mass of injured passengers and emergency cases. (2.5.4)

16. The cabin crew retrieved the duty free cart back when flight crew gave the start descending signal. This complied with both the company’s and CAA’s regulations. (2.5.5)

17. The TCAS systems installed on both EF306 and TG659 worked properly. (1.16.1, 2.6.2)

18. TCAS simulation program proved that there would be enough vertical separation between two aircraft if EF306 would either have kept the descend rate (-1,920 fpm) at the time (02:06:48) after TA advisory or followed the TCAS RA descent rate (-1,500 fpm) after RA advisory activated at time 02:07:01. (2.6.2)

19. Just after time 02:06:54, EF306 significantly reduced the descent rate which caused the TCAS to activate the Resolution Advisory “Descend, Descend” at 02:07:01. If the pilot didn’t follow RA to react, the collision would potentially happen in 35 seconds. (2.6.2)

Recommendations

Interim Flight Safety Bulletin

Issue No：**ASC- IFSB- 07- 07- 001**

Issue Date：**August 01, 2007**

Occurrence Description:

Recently a scheduled passenger flight descending on the airway to the destination encountered a TCAS warning with an approaching traffic. During the TCAS avoidance maneuvering, four passengers were seriously injured.

Safety Recommendation:

It is recommended that all operators review their training programs to ensure they have contained the necessary training for flight crew to recognize and respond effectively to the TCAS advisory.

Safety Recommendations

To Civil Aviation Safety Authority, Korea

1. Improve the sectorization and staffing standards of Incheon ACC by reviewing traffic density, control workload, and service area with the consideration of abnormal situations.（ASC-ASR-08-08-001）
2. Improve ATC proficiency training on TCAS procedures, communication procedures, phraseology, and language command capability.（ASC-ASR-08-08-002）
3. Review the increase of air traffic on B576 and perform a safety assessment. Establish standard instrument arrival procedures for Jeju airport.（ASC-ASR-08-08-003）
4. Enhance the controller's procedures and training in emergency response to include making sure of the number of injuries on board for preparing the necessary emergency support when receiving the notification of emergency information from the aircraft.（ASC-ASR-08-08-004）

To Far Eastern Air Transport

1. Improve pilot proficiency training on communication procedures, phraseology, and language command capability, especially the reconfirmation of the information issued from ATC.（ASC-ASR-08-08-005）
2. Ensure that flight crews follow the standard TCAS operation procedures, not visually conduct the avoidance maneuverings, and use good CRM practices during TCAS maneuverings. (ASC-ASR-08-08-006)
3. Enhance procedure and training to make sure that cockpit crews and cabin crews communicate and collect sufficient injury information timely, and that they notify the control authorities as soon as possible for airport's

emergency rescue preparation during mass injury situations. （ASC-ASR-08-08-007）

4. Enhance procedure and training regarding cabin chief’s leadership, decision making, communication and cabin crew’s first aid knowledge for emergency response during mass injury situations. (ASC-ASR-08-08-008)

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1 Factual Information

1.1 History of Flight

EF306

On Nov. 16, 2006, Far Eastern Air Transport (FEA) Flight EF306, a Boeing 757 type aircraft with the registration number B-27015, was on a scheduled passenger flight from Taipei Tao Yuan International Airport to Jeju International Airport, Korea. There were 2 flight crew, 6 cabin crew and 129 passengers on board. The CM-1 served as pilot flying (PF) and the CM-2 served as pilot monitoring (PM). The flight was on an instrument flight rules (IFR) flight plan. On the way to the destination, during a descent to FL 310 from FL390 following the instruction of the Incheon area control center (Incheon ACC), the flight was issued a Traffic Alert and Collision Avoidance System (TCAS) Traffic Advisory (TA)/Resolution Advisory (RA) warning. The crew manipulated the aircraft to descend for an avoidance maneuver following the TCAS RA 'DESCEND' warning. During the avoidance maneuver, 4 passengers were seriously injured, 10 passengers and 6 cabin crew sustained minor injuries, and the interior of the aircraft sustained minor damage. The visual meteorological conditions (VMC) prevailed at the time of the occurrence.

The EF306 departed Tao Yuan international airport at 0841 Taipei local time (0041 UTC), at about 0155 UTC, the aircraft was over the ATOTI compulsory reporting point on route B576 and made a position report to the Incheon ACC. The aircraft was instructed to maintain at FL390.

At 02:02:53 UTC[1] the Incheon ACC instructed the aircraft to descend to FL 310 and EF306 flight crew operated the aircraft accordingly. While the aircraft approached to FL 340, the traffic advisory message occurred from the TCAS at 02:06:48. At 02:06:51 the Incheon ACC called "far eastern three zero eight

1 The time is synchronized base on Incheon ACC Radar.

stop uh immediately clear… descend” and at 02:06:56 instructed the TG659 (Thai Airways International Public Company Limited, THAI), a Boeing 777 type aircraft with registration number HS/TKF, turned right heading 270 immediately.

According to the data from Flight Data Recorder (FDR) and the Cockpit Voice Recorder (CVR) on EF306, the TA activated at 02:06:48, the EF306 started level-off at 02:06:56 after the call from Incheon ACC and the aircraft was level at 33,800 ft at 02:06:58. The CM-1 said “now what had happened” at 02:07:01 the TCAS RA “Descend, Descend” occurred and the CM-1 executed the avoidance maneuvering. The aircraft was exposed to negative g for about 4 seconds from 02:07:03 to 02:07:07 and reversed to + 2.48 g in between 2 seconds from 02:07:08 to 02:07:09 and leveled off at 31,000 ft. The maximum negative g was -1.06.

According to CVR and ATC’s（Air Traffic Control） transcript, the CM-2 said “ uh” at 02:07:05 and an unidentified flight crew tried to say something and “ okey keep uh….”, at 02:07:12.9. At 02:07:15 the CM-2 reported Incheon ACC, “incheon control, far eastern three zero six TCAS, TCAS Climb.”. The Incheon ACC replied, “roger, now descend, descend.” at 02:07:19 and the TCAS system issued a corrective RA advisory, “Adjust Vertical Speed, Adjust” almost at the same time frame. At 02:07:22, the CM-2 reported Incheon ACC, “negative, negative, we follow TCAS.” At 02:07:25, cabin crew’s P.A for passengers to fasten seatbelt and remain seated was recorded. At 02:07:34, the CM-2 told the CM-1, “hey, still on the red line” “slow down, don't be so fast, follow that indication”. At 02:07:41.6, the TCAS system issued the advisory of clear of conflict.

At about 02:08:05, the communication was established between cockpit and cabin, the flight crew was told that there was an unconscious passenger. At 02:09:36, the CM-1 reminded the cabin crew to call for any on-board doctor and the cabin crew made the announcement accordingly. At 02:10:35, the CM-1 made a passenger announcement stating the cause of flight disruption.

At 02:11:41, the CM-2 reported the Incheon ACC, “far estern three zero six, we have personnel injured request for uh emergency landing for Jeju Airport”. At 02:11:54, the Incheon ACC replied, “far eastern three zero six roger now direct marin, clear direct marin, say your intention, say again”. At 02:11:59, the CM-2 called the Incheon ACC, “okay clear to marin we are request emergency landing for jeju and need medicine help”.

At 02:16:09, CM-2 requested Jeju approach for an emergency landing and medical help on the initial contact with the Jeju approach. At 02:18:52 and 02:20:41, the Jeju approach broadcast that there was emergency in progress.

At 02:19:48, the CM-2 established contact with the ground handling service station (Jeju operation) and notified it of an emergency situation and requested medical support. At 02:20:51, the Jeju operation called EF306 to verify the status of injured passengers. The CM-2 replied, “maybe I will tell you after landing and now we are proceed descend procedure it is ur there is no time to uh take ready”.

At 02:23:41, EF306 was transferred to the Jeju tower. At the initial contact with the Jeju tower, the CM-2 confirmed Jeju tower that EF306 was in an emergency situation.

At 02:28:14, EF306 landed safely at the Jeju International Airport.

TG659

According to the data from the FDR on TG659 and the crew statement, the TCAS TA activated at 02:06:48 while the altitude was at 34,001 ft. The aural warning “Climb, Climb” was activated at 02:07:01. TG659 began to turn at 02:07:03 and started to climb at 02:07:04. The maximum rate of climb recorded at 02:07:12 was 1,664 fpm. TG659 climbed to the altitude of 34,305 ft from FL340. The aircraft recovered to the assigned altitude and route after clear of the traffic and continued to the destination without any passenger injury and aircraft damage.

1.2 Injuries to Persons

There were 4 serious injuries amoung the 129 passengers and 8 crewmembers aboard. The injury condition is summarized in Table 1.2-1. Figure 1.2-1 showed the aircraft seats and the injury distribution.

Table 1.2-1 Injury table

Injuries	Flight Crew	Cabin Crew	Passengers	Others	Total
Fatal	0	0	0	0	0
Serious	0	0	4	0	4
Minor/None	0/2	6/0	10/115	0/0	16/117
Total	2	6	129	0	137

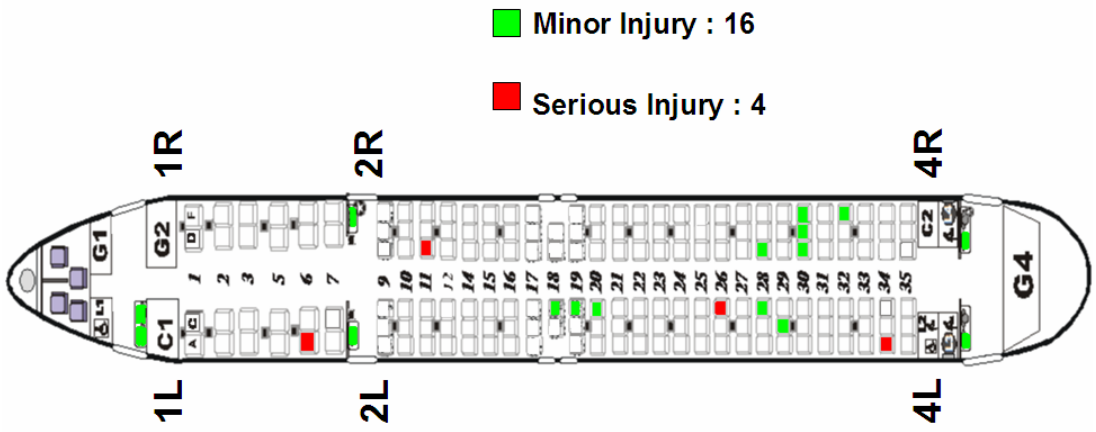

Figure 1.2-1 Injury distribution

1.3 Damage to Aircraft

The aircraft structures of both EF306 and TG659 suffered no substantial damage. Only some minor damage was found in EF306 cabin. This minor damage included:

- Arm-rests of passenger seats (18D, 19C, 29C) were broken.
- Ceiling panels above passenger seat 27A and 33A were out of position and a puncture on ceiling panel above seat 27A was observed.

The maximum upward and downward normal acceleration that the EF306 encountered were +2.48 g[2]'s and -1.06 g's during the escape maneuvering. After landing, for airworthiness release Far Eastern Air Transport performed a series of inspections including "special inspection for severe or unusual turbulence condition occurred for B27015", "Turbulence, stall, buffeting or exceed VMO inspection", and "inspection the area where paint peeling off (right hand upper fuselage skin, STA1000-STA1300)". After completion of these inspections, there was no structure damage found. For detailed inspection and test result, refer to Appendix 1 "B-27015 damage and inspection".

1.4 Other Damage

None.

1.5 Personnel Information

1.5.1 Backgrounds and Experience of Flight Crew Members

1.5.1.1 EF306 CM-1

CM-1, a citizen of the Republic of China, used to serve as a military pilot. He joined FEA in Feb. 1995, served as a first officer of MD-80s aircraft, accomplished the upgrade training, and was promoted to be a captain of the MD-80s type aircraft in Jul., 1997. On Aug. 24 1999 the CM-1 completed

2 A g is a measure of force on a body undergoing acceleration as a multiple of the force imposed by the acceleration of Earth' s gravity.

B-757 type transition training and was appointed as a captain of B-757 type aircraft. His total flight time was 11,682 hours to date of occurrence in which 5,381 hours on B-757 included.

1.5.1.2 EF306 CM-2

CM-2, a citizen of the Republic of China, used to serve as a military pilot. He joined FEA in Oct. 1996, served as a first officer of MD-80s aircraft and accomplished the transition training of B-757 type aircraft on Oct. 09, 1998 as a B-757s first officer. CM-2 was promoted to a captain on Sep. 22, 2000. His total flight time was 9,713 hours to date of occurrence which included 5,895 hours on the B-757.

Table 1.5-1 Basic information on EF306 pilots

Item	CM-1	CM-2
Gender	Male	Male
Age as of occurrence	48	49
Date of joining in FEA	Feb. 03, 1995	Oct. 01, 1996
Title of License	ATPL – AEROPLANE No. 101593	ATPL – AEROPLANE No. 101821
Type rating Expire date	B-757 Jul. 06, 2010	B-757 Jun. 05, 2010
Medical class Expire date	1st class airman Feb. 28, 2007	1st class airman Dec. 31, 2006
Latest flight check	Jul. 02, 2006	Jun. 02, 2006
Total flight time	11,682 hrs 26min.	9,713 hrs 22 min.
Flight time in last 12 months	798 hrs 24 min.	817 hrs 12 min.
Flight time in last 90 days	218 hrs 12 min.	225 hrs 07 min.
Flight time in last 30 days	57 hrs 25 min.	64 hrs 17 min.
Flight time in last 7 days	12 hrs 45 min.	12 hrs 25 min.
B-757 flight time	5,381 hrs 07 min.	5,895 hrs 23 min.
Flight time on the day of occurrence	0	0
Rest time period before occurrence	Over 24 hrs	Over 24 hrs

1.5.1.3 TG659 CM-1

CM-1, a citizen of Thailand, used to serve as a military pilot. He joined THAI in Jul. 1974. CM-1 has been a B-777 captain since Feb. 2003. His total flight time was 24,684 hours to date of occurrence.

1.5.1.4 TG659 CM-2

CM-2, a citizen of Thailand, joined THAI in Feb. 2003. CM-2 has been a first officer on B-777 aircraft since Oct. 2005. His total flight time was 2,470 hours to date of occurrence.

1.5.2 Training and Rating Records of Flight Crew

1.5.2.1 EF306 CM-1

Transition training

CM-1 received B-757 type Captain transition ground school and simulator training from May 01, 1999 to Jun. 21, 1999, accomplished local flight training on Jul. 05, 1999, received route training from Jul. 12 to Aug. 22, 1999 and passed the flight check on Aug. 24.

Recurrent training

Base on the training records provided by FEA, the CM-1 practiced the TCAS RA maneuvering during his simulator training in Jun. 2005 and Jun. 2006. The training comments were “Satisfied” and “Acceptable”. The CRM recurrent training records showed that the CM-1 was capable of conducting the procedures, situational awareness and communications. There were no anomalous comments found in CM-1’s training records.

1.5.2.2 EF306 CM-2

Transition training

The CM-2 received the B-757 type first officer transition training from Jun. 01 to Aug. 15, 1998, completed local flight training on Aug. 31, 1998, received enroute flight training from Sep. 05 to Oct. 06 1998 and passed the flight check on Oct. 09, 1998.

Upgrade training

The CM-2 received B-757 type captain upgrade ground school and simulator training from Feb. 01 to May 09, 2000, completed home base flight training on Jun. 05, 2000, received enroute flight training from Jun. 18 to Sep. 16, 2000and passed the flight check on Sep. 22, 2000.

Recurrent training

Based on the training records provided by FEA, the CM-2 performed the TCAS RA maneuvering during his simulator training in Jun. and Oct. 2005. The training comments were “Satisfied”. The CRM recurrent training comments remarked the CM-2 CRM performance as higher than the standard.

1.5.2.3 TG659 CM-1

Recurrent training

Base on the training records provided by THAI, the CM-1 practiced the TCAS RA maneuvering during his proficiency check on Jun. 28 2006. The comment was “good”.

1.5.2.4 TG659 CM-2

Recurrent training

Base on the training records provided by THAI, the CM-2 received the TCAS RA maneuvering during his proficiency check on Mar. 05 2006. The comment was “Satisfied”.

1.5.3 Flight Crew Members’ Physical Conditions

1.5.3.1 EF306 CM-1

The limitation notes on the CM-1 Airman Medical Certificate issued by CAA indicated: “Holder shall wear correcting glasses for near vision”.

1.5.3.2 EF306 CM-2

The limitation notes on the CM-2 Airman Medical Certificate issued by CAA indicated: “Holder shall wear correcting glasses for near vision”.

1.5.3.3 TG659 CM-1

The limitation notes on the CM-1 Airman Medical Certificate issued by Institute of Aviation, Thailand indicated: “Corrective lenses for near vision are required on duty”.

1.5.3.4 TG659 CM-2

The limitation notes on the CM-2 Airman Medical Certificate issued by Institute of Aviation, Thailand indicated: “No limitation”.

1.5.4 Flight Crew Members’ Activities in 72 Hours prior to the Occurrence

1.5.4.1 EF306 CM-1

1. Nov. 14: The CM-1 flew the EF1254 flight from Cebu, Philippine to Kaohsiung, Taiwan. That flight took off at 0930 and arrived at 1145 local time.
2. Nov. 15: On leave at home.
3. Nov. 16: The CM-1 reached the FEA crew dispatch center at 0620 and flew the EF306 flight.

1.5.4.2 EF306 CM-2

1. Nov. 14: The CM-2 flew G68563B and G68536A flights from Taipei to Angkor, Cambodia round trip. That flight took off from TPE at 1440 and arrived Angkor at 1720, Took off from Angkor, Cambodia at 2330 and arrived Taipei at 0350 on next day in the early morning.
2. Nov. 15: On leave at home.
3. Nov. 16: The CM-2 reached the FEA crew dispatch center at 0620 and flew the EF306 flight.

1.5.4.3 TG659 CM-1

1. Nov. 14: The CM-1 flew the TG658 flight from Bangkok, Thailand to ICN, Korea. That flight departed at 1650 UTC and arrived ICN at 2300 UTC.

2. Nov. 16: The CM-1 flew the TG659 flight from ICN to Bangkok. That flight departed at 0055 UTC.

1.5.4.4 TG659 CM-2

1. Nov. 14: The CM-2 flew the TG658 flight from Bangkok, Thailand to ICN, Korea. That flight departed at 1650 UTC and arrived ICN at 2300 UTC.
2. Nov. 16: The CM-1 flew the TG659 flight from ICN to Bangkok. That flight departed at 0055 UTC.

1.5.5 Incheon ACC Controllers

1.5.5.1 Radar Controller

The radar controller (43 years old), who controlled and communicated with EF306 and TG659, acquired the certificate of air traffic controller[3] on Jan. 14, 1993. He also acquired a rating[4] of “en route control” which allows a person to control in Incheon ACC[5], and “radar en route control” on Mar. 1, 1995.

He had been worked on en route control as a controller in the Air Force from Oct. 1983 to Feb. 28, 1995. When the occurrence occurred, he has been performing en route control in the Incheon ACC since he was employed as a controller by the Ministry of Construction and Transportation on Mar. 1, 1995.

He completed the “practical English for control” course at the Aviation Technical Training Center[6] on May 13, 2000 and finished the “Basic Aviation English” course at the Technical Education Center of Aviation English[7] on Jun. 02, 2006.

He acquired a third class airmen physical certificate[8] which is valid until Jan.

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3 Certificate of airmen according to the article 25 of the Aviation Act.

4 Job rating according to the code 205-4 of the enforcement regulation of Aviation Act.

5 The Ministry of Construction and Transportation took over the en route control authority from the Air Force on Mar. 1. 1995.

6 Belonged to the Korea Airports Corporation, designated as technical education center of air traffic controller by the Ministry of Construction and Transportation (Sep.15.1999).

7 Belonged to the Korea Air Traffic Center, designated as a technical education center of aviation English by the Ministry of Construction and Transportation(Sep.14.2005).

8 Issued by the Aviation specialty doctor according to the code 31 of Aviation Act and the code 95 of the

31, 2007. He did not take medicine or alcohol drinks prior the duty.

He was off duty at 1800 on 16th local time (0900 UTC on 15th), and on duty at 0700 (2200 UTC on 15th) on the day of the occurrence. He had had a rest at 0924-1039 (0024-0139 UTC on 16th) before the occurrence.

1.5.5.2 Flight Data Controller

The controller (30 years old), who was in charge of South Sector Flight Data at the time of occurrence on EF306, acquired a qualification of air traffic controller on Apr. 04, 2001. He also acquired “qualification of flight data position” on Aug. 31, 2006.

He was employed as a controller by the Ministry of Construction and Transportation on Jun. 01, 2001 and he had been in charge of flight data at the Incheon ACC since Aug. 07, 2006.

He completed the “practical English for control” course at the Aviation Technical Training Center on Oct. 18, 2002 and completed the “Professional Aviation English” course at the Technical Education Center of Aviation English on Jan. 13, 2006.

He acquired a third class airmen physical certificate[9] which is valid until Aug. 31, 2007. He did not take medicine or alcohol drinks prior the duty.

1.6 Aircraft Information

1.6.1 Basic Information

EF306

EF306 (B757-27A) is a twinjet transport category airplane. The airplane was certificated as a passenger airplane. It has valid certificates of registration and airworthiness issued by the CAA of Taiwan. The airplane was approved for RVSM (Reduced Vertical Separation Minimum) flights. The basic aircraft information for EF306 was listed as table 1.6-1 below.

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enforcement regulation of the same act above.

9 Issued by the Aviation specialty doctor according to the code 31 of Aviation Act and the code 95 of the enforcement regulation of the same act above.

Table 1.6-1 Basic aircraft information for EF306

Aircraft		
No.	**Item**	**Description**
1	**Nationality**	**R.O.C.**
2	**Nationality mark & registration number**	**B-27015**
3	**Owner**	**Far Eastern Air Transport**
4	**Operator**	**Far Eastern Air Transport**
5	**Registration certificate number**	**88-756**
6	**Airworthiness certificate number**	**95-07-104**
7	**Valid date of airworthiness certificate**	**2007.06.30**
8	**Total flying hours**	**15258 hrs 24 mins**
9	**Total landing cycles**	**15547**
10	**The last letter check**	**A Check**
11	**Date of last letter check**	**2006.11.14**
12	**Flying hours since the last letter check**	**9 hrs 07 mins**
13	**Landing cycles since the last letter check**	**5**
Fuselage		
No.	**Item**	**Description**
1	**Manufacturer**	**The Boeing Company**
2	**Type**	**B757-27A**
3	**Series number**	**29609**
4	**Year of manufacture**	**1999**
5	**Maximum takeoff weight**	**99,791kgs**
Engine		
No.	**Item**	**Description**
1	**Manufacturer**	**Pratt & Whitney**
2	**Type**	**PW 2037**
3	**Series number**	**NO.1: P728717 NO.2: P727291**
4	**Total service time**	**NO.1: 11,239 hrs 04 mins NO.2: 12,837 hrs 59 mins**

TG659

TG659 (B777-300) is a twinjet transport category airplane. The airplane was certificated as a passenger airplane. It has valid certificates of registration and airworthiness issued by the Department of Civil Aviation, Thailand. The airplane was approved for RVSM flights. The basic aircraft information for

TG659 was listed as table 1.6-2 below.

Table 1.6-2 Basic aircraft information for TG659

Aircraft		
No.	**Item**	**Description**
1	**Nationality**	**THAI**
2	**Nationality mark & registration number**	**HS-TKF**
3	**Owner**	**SIAM HIRE PURCHASE LIMITED**
4	**Operator**	**THAI AIRWAYS**
5	**Registration certificate number**	**29/2544**
6	**Airworthiness certificate number**	**43/2549**
7	**Valid date of airworthiness certificate**	**2006.12.08**
8	**Total flying hours**	**21106 Hrs.**
9	**Total landing cycles**	**6172**
10	**The last letter check**	**A-CHECK**
11	**Date of last letter check**	**2006.12.02**
12	**Flying hours since the last letter check**	**176 Hrs.**
13	**Landing cycles since the last letter check**	**39**
Fuselage		
No.	**Item**	**Description**
1	**Manufacturer**	**The Boeing Company**
2	**Type**	**B777-3D7**
3	**Series number**	**29214**
4	**Year of manufacture**	**2000**
5	**Maximum takeoff weight**	**660,000 lbs**
Engine		
No.	**Item**	**Description**
1	**Manufacturer**	**ROLLS-ROYCE**
2	**Type**	**RB211-TRENT892-17**
3	**Series number**	**NO.1: 51072** **NO.2: 51114**
4	**Total service time**	**NO.1: 26044 Hrs** **NO.2: 25863 Hrs**

Both aircraft had position lights on the wing tips and the fuselage tail. They were also fitted with white strobe lights on the wing tips and red strobe lights on the top and bottom of the fuselage.

1.6.2 Maintenance Records

The maintenance records within one month of this occurrence for both aircraft were reviewed and no anomaly found.

1.6.3 Weight and Balance

The maximum takeoff weight of this aircraft was 99,791 kg. The maximum landing weight was 89,812kg. The maximum zero fuel weight was 83,462 kg. The center of gravity at the zero fuel weight was 25.9%MAC. (Table 1.6-3)

Table 1.6-3 Weight and balance data

Zero fuel weight	**74,365 kg**
Takeoff fuel weight	**10,886 kg**
Total takeoff weight	**85,251 kg**
Takeoff center of gravity	**27.9% M.A.C.**
Consumed fuel in flight	**4,899 kg**
Landing weight	**80,352kg**
Landing center of gravity	**26.5% M.A.C.**

1.7 Meteorological Information

The satellite images of MTSAT-1R indicated overcast sky with cloud top less than 30,000 ft in the area of occurrence. From pilot interviews, the weather condition at high altitude over 30,000 ft was good and the visibility was more than 10 km at the time.

1.8 Aids to Navigation

There were no known malfunctions to the aids of navigation involved in this occurrence.

1.9 Communications

The radio communications between Incheon ACC to EF306, TG659 and the other aircrafts were conducted on frequency 124.525 MHz. The transcripts of communications between Incheon ACC to EF306 and TG659 are listed in Attachment 1.

1.10 Airport Information

Not applicable.

1.11 Flight Recorders

1.11.1 Cockpit Voice Recorder

1.11.1.1 EF306

The EF306 was equipped with a Solid-State Cockpit Voice Recorder (SSCVR), model Fairchild A200S, part number 2100-1020-00, and serial number 00449. The total recording of 123 minutes and 38 seconds (recording time 00:35:11 ~ 02:38:49[10]) was downloaded properly. Quality of the recording was good. Time synchronization in detail will be described in section 1.11.3.

The SSCVR recording consisted of four channels of good quality audio information. Channel one captured the audio from the captain's panel, channel 2 captured the audio from the first officer's panel, channel 3 captured the audio from the cockpit area microphone (CAM), and channel 4 captured from passenger public address system. The transcripts started at 01:55:54.6, the time when Incheon ACC controller mentioned "far eastern tree zero seven radar contact maintain tree niner zero". The transcripts included descending from cruising altitude to the end of the flight, only the portion of last 38-minute amongst all SSCVR recordings was prepared as ~~in~~ Attachment 2.

Followings are excerpts from the transcripts during the TCAS activation (39,000 ft ~ clear of conflict of TCAS):

ICN ACC Radar Time	Transcripts	
02:02:53.4	ICN	standby and far eastern tree zero six now descend to flight level tree one zero
02:02:57.9	RDO-2	descend flight level tree one zero far eastern tree zero six
02:03:03.3	CAM	(sounds identified as seat belt sign)
02:06:48.5	CAM	traffic traffic

10 The flight recorder recordings were synchronized by VHF keying before the recorders stopped. The time format for the transcript has been transferred to the Incheon ACC radar UTC time.

02:06:50.8	ICN	Far eastern tree zero eight stop uh immediately clear descend
02:06:55.9	ICN	thai six five niner turn right heading two seven zero two seven zero immediately
02:07:01.6	CAM	descend descend
02:07:01.9	TG659	seven two five two seven zero thai six five nine
02:07:03.7	CAM	(sounds similar to impact)
02:07:07.6	CAM	(sounds similar to impact)
02:07:15.4	RDO-2	incheon control far eastern tree zero six TCAS TCAS climb
02:07:19.2	ICN	roger now descend descend
02:07:19.3	CAM	adjust vertical speed adjust
02:07:22.3	RDO-2	negative negative we follow TCAS
02:07:34.4	CAM-2	喂 還還在紅線上 (*hey still on the red line*)
02:07:36.7	CAM-2	慢 慢 慢 慢 慢 不要這麼快 follow follow follow 那個指示 (*slow down don't be so fast follow that indication*)
02:07:41.6	CAM	clear of conflict
Abbreviation:	ICN：Incheon ACC RDO-2：Radio transmission from CM-2 CAM：Cockpit area microphone TG659：Radio transmission from TG659 CAM-2：CM-2 through cockpit area microphone ( )：Remarks or translation	

1.11.1.2 TG659

The CVR contained the final cockpit voice recording, but did not contain any details of this occurrence.

1.11.2 Flight Data Recorders

1.11.2.1 EF306

The EF306 was equipped with a Solid-State Flight Data Recorder (SSFDR), manufactured by L3 Communication Inc, part number 2100-4043-00, serial number 00595. The total recording of 109 hours, 30 minutes and 46 seconds of data was downloaded successfully.

According to the technical document provided by Boeing[11], totally 235 parameters were recorded in the SSFDR. All the recorded parameters are listed in Attachment 3.

This type of Flight Data Recorder complied with ICAO Annex 6 “Type 1” Flight Data Recorder, and it satisfied to record 32 mandatory parameters.Summary of the SSFDR readout as follows:

1. The occurrence flight started recording at 01:03:04, and continued recording until 02:30:36.
2. The “seat belt sign” recording was “ON” at 02:03:05, continued remaining “ON” until the aircraft was parked in ramp.
3. There are 6 parameters related to TCAS: TCAS Advised Alt Rate (TCASR), TCAS Combined Control (TCASCC), TCAS Down Advisory (TCASDN), TCAS PILOT Select (TCASP), TCAS REPLY Information (TCASRI), and TCAS Vertical Control.
4. During the TCAS activations, the related parameters indicated as below:
    - “TA” activated at 02:06:48 (based on CVR recording), at altitude of 34,052 ft, airspeed 272 knots, ground speed 493 knots, and magnetic heading 11.6 degrees.
    - Autopilot was disengaged at 02:06:56, at an altitude of 33,828 ft, airspeed 274 knots, ground speed 494 knots, and magnetic heading 11.6 degrees.
    - RA command “Descend” was given twice at 02:06:56.2(based on

11 Digital Flight Data Acquisition Unit (757 Databases), Interface Control and Requirements, doc. No.: D226A101-3

CVR)

- TCASDN advisory mode activated from 02:07:01 to 02:07:40. (a) “RA – Descend” 02:07:01 ~ 02:07:18; (b) “ RA Don’t Climb” 02:07:19 ~02:07:40.
- During the activation of TCASDN advisory mode, “TCAS Advised Alt Rate” recording was 1,500 ft/min, and the descend rate[12] was increasing from 336 ft/min to 12,096 ft/min (02:07:01~02:07:08), and decreased from 11,760 ft/min to 2,064 ft/min (02:07:09~02:07:18)
- During the activation of “RA Descend”, altitude loss of 2,112 ft (in 17 seconds); airspeed increased 30 knots (in 17 seconds); vertical acceleration readout between -1.06 g’s and +2.48 g’s (in 4 seconds); pitch angle readout from nose up of 4.4 degrees to nose down of 17.8 degrees (in 7 seconds); roll angle increased from 3.2 degrees to 8.8 degrees (right-wing down, in 12 seconds); and magnetic heading changed from 12.3 degrees to 15.5 degrees (in 14 seconds).
- Relevant parameters (TCAS and flight controls) were tabular listed in Attachment 4.
- Occurrence location at 02:07:01 (126.011 degrees east longitude and 31.957 degrees north latitude), was about 99 NM south of Jeju Island, Korea.
- TCAS resolved at 02:07:41 (Clear of Conflict)

5. The occurrence flight re-engaged autopilot at 02:07:54, with altitude 31,700 ft, airspeed 292 knots, ground speed 493 knots, and magnetic heading 11.6 degrees.

1.11.2.2 TG659

ASC received the SSFDR readout data of the TG659 from Thai Airways on Jan. 04, 2007, that covered the entire flight with 91 parameters. ASC received the FDR raw data on Feb. 27, 2007. According to the technical document provided by Boeing[13], totally 1,606 parameters were recorded in the SSFDR.

This type of Flight Data Recorder complied with ICAO Annex 6 “Type 1” Flight Data Recorder, and it satisfied the requirement to record the 32 mandatory parameters. All the recorded parameters were listed in Attachment 5. Summary of the SSFDR Readout listed as below:

12 The descend rate of EF306 derived by the time differential of altitude, with average-smooth processing.

13 777 Flight Data Recording System Signal Details Document - 1997 Rule - 256 WPS Data Rate, doc. No.: D247W018-9

1. The occurrence flight started recording at 01:07:02, and continued recording until 06:33:58.

2. There were 8 parameters related to TCAS: TCAS Fail, TCAS Up Advisory, TCAS Down Advisory, TCAS Replay, TCAS Combined Control, TCAS Display Sate, TCAS Advisory Alt Rate, and Vertical Speed.

3. During the TCAS activations, the related parameters indicated as follow:

    - “TA” activated at 02:06:48 (based on “TCAS Display State”), at an altitude of 34,001 ft, airspeed 288 knots, ground speed 421 knots, and magnetic heading 219 degrees.

    - Autopilot was disengaged at 02:07:00, with an altitude of 33,999 ft, airspeed 288 knots, ground speed 421 knots, and magnetic heading 219 degrees.

    - TCAS UP Advisory mode activated from 02:07:01 to 02:07:11. (based on “TCAS_UP_ADVISORY”)

    - During the activation of TCAS UP Advisory mode, “TCAS Advisory Alt Rate” recording was 1,500 ft/min, and “Vertical Speed” increased from 64 ft/min to 1,648 ft/min.

    - During the activation of TCAS UP Advisory mode, the TG659 altitude increased 126 ft (in 11 seconds); airspeed decayed 4 knots (in 11 seconds); vertical acceleration readout between +1.0 g’s and +1.24 g’s (in 4 seconds); pitch angle increased from 2.8 degrees to 5.3 degrees (nose up, in 6 seconds); roll angle increased from 0.2 degrees to 19.2 degrees (right-wing down, in 6 seconds); and magnetic heading changed from 219 degrees to 228 degrees (in 11 seconds).

    - Relevant parameters (TCAS and flight controls) were tabular listed in Attachment 6.

    - TCAS resolution time (Clear of Conflict) was not recorded.

4. The occurrence flight re-engaged the autopilot at 02:07:58, with an altitude of 34,025ft, airspeed 289 knots, ground speed 384 knots, and magnetic heading 242 degrees.

All of EF306 CVR transcript, EF306 SSFDR data and TG659 SSFDR data are based on ICN ACC Radar time. Detail SSFDR data are plotted in Attachment 7. Fig.A7-1 to Fig.A7-4 contains the selected parameters of EF306 SSFDR, Fig.A7-5 to Fig.A7-8 contains the selected parameters of TG659 SSFDR.

1.11.3 Time Synchronization

All the time frame of the EF306 CVR transcript, EF306 SSFDR data and

TG659 SSFDR data were synchronized by basing ICN ACC Radar time. Converting relationships as follows:

Radar UTC = EF306 FDR GMT + 6 sec (based on “pressure altitude”)

Radar UTC = TG659 FDR GMT + 5 sec (based on “pressure altitude”)

EF306 CVR Time = EF306 FDR GMT (based on “VHF Key”)

Fig.A7-9 illustrates the related parameters of the altitude, vertical speed, and autopilot during the two TCAS activations of EF306 and TG659. The secondary radar recording rates of EF306 and TG659 were 12.00 $\pm$ 5.37 sec, and 12.06 $\pm$ 2.80sec.

1.12 Damage to Aircraft

EF306 cabin damage is shown in the figures below:

Figure 1.12-1 The broken arm-rests of passenger seats.

Figure 1.12-2 Out of position ceiling panels.

Figure 1.12-3 A puncture on a ceiling panel.

1.13 Medical and Pathological Information

1.13.1 Medical Treatment

The injured passengers and cabin crews were transported to the following nearest hospitals in Korea: Hankuk Hospital, Jeju University Hospital and Halla Hospital. After returning to Taipei, the four seriously injured passengers were sent to Mackay Memorial Hospital and National Taiwan University Hospital in Taipei.

1.13.2 Injury Information

The injury conditions of the four seriously injured passengers were seated respectively at 6A, 11D, 26C and 34A.

1. The passenger seated in 6A suffered from fracture of ribs and clavicle and left hemothorax and was sent to the National Taiwan University hospital after returned from South Korea.
2. The passenger seated in 11D suffered from complicated fracture of left humerus with radial nerve injury, sprains of the right ankle region and fracture of a big toe and was sent to the Mackay Memorial Hospital after returned from South Korea.
3. The passenger seated in 26C suffered from a head injury, intra-cranial hemorrhage (ICH) and subarachnoid hemorrhage (SAH) and was sent to the National Taiwan University hospital, after returned from South Korea.
4. The passenger seated in 34A suffered from fractures of left ribs and hemothorax and was sent to the Mackay Memorial Hospital after returned from South Korea.

The other 10 injured passengers and 6 cabin crews sustained minor injuries, such as contusion, sprain and abrasion.

1.14 Fire

There was no fire in this occurrence.

1.15 Survival Aspects

1.15.1 Cabin Crew Emergency Response

Cabin crew reached the dispatch center 2 hours and 20 minutes before the departure time. A total of 5 cabin crewmembers and 1 purser were assigned as the duty cabin crew. Among them, two other cabin crewmembers held the purser ratings and were assigned at 4L& 4R.

Crew briefing was conducted in a briefing room outside the boarding gate. The contents of crew briefing included NOTAMs, weather, flying time, security code, emergency procedures, incapacitation procedures and ID card.

1.15.1.1 Fasten Seat Belt Sign and Announcement

According to the CVR transcript, the fasten seat belt sign was turned on prior to the occurrence. At 02:07:25, the 4R cabin crew made a PA announcement and asked all passengers to remain seated and to fasten their seat belts. At 02:07:36, the 4R cabin crew used PA to all cabin crew members and asked them to remain seated and to protect themselves from injury.

An announcement was made at 02:17:51 when passing through turbulent air. Most announcements related to the occurrence were conducted in mandarin only. There was one foreign passenger on board. According to the cabin crew interview records, several passengers were injured because their seat belts were unfastened.

1.15.1.2 Command and Communication among Cockpit and Cabin Crew Members

At 02:08:04, the 4R cabin crew made an interphone call to cockpit crew to ask what happened. Cockpit crew informed the 4R cabin crew that the aircraft encountered a near air miss and asked the cabin crew to report the cabin status. At 02:09:31, the purser informed the cockpit crew of one passenger who lost consciousness. The cockpit crew reminded the purser to ask for on board medical assistance. The above instruction was followed accordingly by the purser. The cockpit crew made a PA announcement later to the passengers that the occurrence occurred due to the conflict avoidance maneuver and apologized to all passengers. At 02:11:25, the cockpit crew instructed the 4R cabin crew to report total numbers of injured passengers. At 02:17:47, one cabin crew got into the cockpit to clean up the mess. At 02:21:47, the 4R cabin crew made a confirmation with the cockpit crew of the required ambulances.

During taxiing in after landing, at 02:29:08, the purser told the flight crew the

total number of injured passengers and recommended to have more ambulances to stand by.

1.15.1.3 First Aid

According to the cabin crew's interview records, the purser &1La noticed a passenger who seemed to be in a coma and laid her down on the floor near 7C seat. After examining her with no symptoms of neck injury, the purser and the other two cabin crew members assisted this injured passenger back to seat and to fasten the seat belt. Purser then informed the cabin situation to the cockpit. Following the cockpit crew recommendation, the purser tried to find doctors on board but failed to find any.

The aircraft was equipped with three First Aid Kits. The three kits were opened and used respectively by 1La, 4L and 4R cabin crew.

The 1La cabin crew used iodine, adhesive bandage and gauze bandage to help injured passengers and prepared ice bags for other injured people. The 2R cabin crew used paper napkins and ice bags to assist some injured passengers. During taxiing in, the 2R cabin crew was seated near 9A seat to assist injured passengers.

During the TCAS avoidance maneuver, the 4L and 2L cabin crew were using the duty free cart on aisle. The duty free cart bounced up and dropped to seats of 28th row with 2 passengers sitting there. The 4L and 2L cabin crew helped the passenger underneath the cart and pushed the duty free cart back. The 4L cabin crew applied the First Aid Kit and took iodine to the passengers.

After the TCAS avoidance maneuver, the 4R cabin crew then made a PA announcement to all cabin crewmembers to start assisting the injured passengers. The 4R cabin crew requested that all injured passengers move to the forward cabin section to centralize human and medical resources.

The 4R cabin crew also opened another First Aid Kit and took iodine, adhesive bandage and gauze bandage to assist the injuries. According to the 4R cabin crew interview records, no oxygen or oral drugs were applied in cabin. At 02:20:16, the 4R cabin crew made a PA announcement and requested injured passengers to identify themselves by pushing their call buttons.

1.15.1.4 Cooperation among Cabin Crew Members

According to the cabin crew interview records, after the TCAS avoidance maneuver the cabin chief instructed the crew members to assist the injured passengers, made PA announcement to find doctors or nurses on board, communicated with cockpit crew, and collected injury information. The majority of PA announcements were made by the 4R cabin crewmember (with cabin chief raging) included: directing passengers and cabin crew to be

seated and fasten their seat belts, instructing the passengers to move to the front section and, announcing disembarking priority. The 4R cabin crewmember also assisted purser in informing the flight crew of the abnormalities and opening 1L door after landing.

AC120-034「Flight operation and cabin safety human factor development guidelines and practice」(Ref. Appendix 2) issued by CAA on 2005.4.1 provided information regarding cabin crew's leadership & decision making ability during emergency response.

1.15.1.5 Cabin Crew Training

There were a total of 14hrs of training courses for the purser. The training curriculum included purser's role and responsibilities, purser mission management, team building and the leadership, cabin operation and service standard, and emergency response command and cabin resources management.

The purser's training records are listed here: (excluding service and annual emergency evacuation training)

Assistance purser	1998.6.22~25	32hrs
CRM	1999.6.8	8hrs
AOR	2001.3.9	3hrs
Purser training	2004.11.11	6hrs
Purser chief leadership	2005.10.4	7hrs

The annual emergency evacuation exercise training records for the entire cabin crew are shown as Table1.15.1:

Table 1.15-1 The annual emergency evacuation exercise training records of the EF306 cabin crew

Cabin crew	Initial training	Latest Recurrent Training
Purser 1R	**1993.7.26**	**2006.06.22**
1La	**1998.12.08**	**2006.06.01**
2L	**1996.12.02**	**2006.05.18**
2R	**2006.10.24**	
4R	**1994.05.03**	**2006.05.07**
4L	**1996.12.02**	**2006.04.06**

1.15.2 Airport Emergency Response Service

According to the CVR transcript, the cockpit crew requested emergency landing to the controller of Incheon ACC at 02:11:41 because of passenger injuries. The cockpit crew repeated this request at 02:11:59 and asked for medical services. The cockpit crew asked for emergency medical services and ambulances again at 02:12:31. CM-1 & 2 asked for doctors to standby on ground at 02:12:44. The controller replied “roger, personal injury”. According to telephone communication records, the controller of Incheon ACC transferred the cockpit crew’s request to Jeju Approach at 02:12:46, and to Jeju tower at 02:12:52.

After flying into the approach control area, the cockpit crew requested emergency landing to the controller of Jeju Approach at 02:16:09 and at 02:16:26 because of passenger injuries. After obtaining the approval of controller, the cockpit crew requested medical services, doctors and ambulances again at 02:16:48. The controller of Jeju Approach replied “roger” at 02:16:58. According to telephone communication records and the situation report of the Jeju airport fire station, the request was transferred to Airport Emergency Service Unit about 02:20:00.

The cockpit crew announced the injury information and requested medicine and ambulance services to their System of Operation Control (SOC) in Jeju Airport at 02:20:03 and repeated it at 02:20:18. The duty person of SOC replied “roger. doctor and ambulance” at 02:20:26 and asked about the injury conditions at 02:20:56. The cockpit crew replied that the cabin crew was counting.

The airport category of rescue and fire fighting in Jeju Airport was 9 according to Airport Operations Manual Para 3.3. There were 1 ambulance, and 5 chemical Fire Fighting Trucks in Jeju Airport. There were one driver, one nurse and one doctor in the ambulance.

After flying into the Jeju tower control area, the controller said that ambulances and fire engine were already standing by at 02:24:05. After landing, one of the cockpit crew said “ambulance there” at 02:28:36. The controller told the cockpit crew taxiing into No.11 parking bay directly and two ambulances were standing by at 02:28:51. During the aircraft taxiing, the cabin crew informed the injury figure was 17-18 to the cockpit crew at 02:29:08 and asked for more ambulances. The cockpit crew relayed this additional request to the controller from 02:29:27 to 02:29:48. The controller replied “copy that”. About one minute later, the tower asked how many ambulances were required. The cockpit crew confirmed 10 ambulances required at 02:31:00. The SOC also asked the same question above from 02:32:58 to 02:33:39. Following the request, 12 more ambulances arrived at 02:35:00, making a total of 13 ambulances were mobilized to the airport in accordance with the agreement with Jeju International Airport.

The doctor, nurse and other medical assistants of the first arrived airport ambulance got into cabin via L2 door by a lift car for medical treatment of patients on board. According to cabin crew interview and a news video clip,

the uninjured passengers disembarked first and the serious injured passengers were transported last in stretchers using a high lift after medical treatment applied in the cabin by the medical staff including the doctor and nurse.

1.16 Tests and Research

1.16.1 TCAS System Operational Test

Far Eastern Transport performed a TCAS system operational test of B-27015 on Dec. 18, 2006 under investigation team surveillance. Refer to Appendix 3 (Special inspection for TCAS system) for the test procedure and records. The test results complied with the maintenance manual specifications.

The TCAS system test of HS-TKF was accomplished on Apr. 08, 2007 by Thai Airways International. Refer to Appendix 4 (HS-TKF: TCAS SYSTEM TEST) for the test procedure and record. The test was under Thai DCA inspector’s surveillance and the results complied with the maintenance manual specifications.

1.17 Organizational and Management Information

None.

1.18 Additional Information

1.18.1 Summary of Interviews

1.18.1.1 Summaries of Interviews with Flight Crew

1.18.1.1.1 EF306 CM-1

The weather condition was good on that day, and the visibility was more than 10km. I contacted Incheon ACC and was instructed to descend to FL310 from FL390 while we were close to the way point Nirat on route B576. The Jeju airport was 90NM from us. We then followed this instruction and started to descend. About 3 minutes after descend, when we were passing through FL347~348, Incheon ACC controller called “Far Eastern 306 Stop Descend”, but he didn’t assign the altitude. Therefore I engaged the altitude hold mode and started to level off. Incheon ACC controller called us “maintain FL340” about 2~3 seconds later and we were at about FL340.

At the time we leveled off, there was a TCAS TA signal on the ND; the scale setting at that moment was 20NM. I’m not sure whether there was a “Traffic, Traffic” aural warning or not. I saw there was one traffic at 34,100 ft on the ND, and I disconnected the Auto Pilot real quick. I noticed that the color of the traffic symbol turned from white to amber then red very quick. When the RA aural warning tone “Descend, Descend” was issued, I followed the TCAS red T-bar on the ADI and pushed down the aircraft smoothly. Afterward the TCAS issued an “Increase Descent” aural warning, at the same time I looked outsight from the left to the right and visual contacted that there was a flying object approaching rapidly in front us. So I pushed down the aircraft hard to avoid the traffic. At that time I neither know what the flying object was nor identify the distance between us. I would guess that the distance is about 2~3 NM base on my experiences. Since it came from the front so I couldn’t recognize its attitude.

When Incheon ACC controller instructed us “stop descend” and “maintain FL340”, I had ever doubted it. But I thought there might be another aircraft passing through FL330 or FL350, so I kept paying attention to the information on the ND and talked about this situation with my F/O. Before TCAS issued the “Descend, Descend” aural warning, I heard Incheon ACC controller instructed the conflicting traffic “descend to FL310”, so I thought there was no problem but the “Descend, Descend” aural warning occurred soon after.

After the traffic was cleared I heard the conflicted traffic asked “what happened” to the Incheon ACC controller, but there was no answer from the

ICN control. F/O and I had asked the same question as well and there was no answer either.

The tone and voice of Incheon ACC controller was very clear, and there was no problem for me to understand their instructions. I didn't observe any mistake or error the Incheon ACC controller made in this flight.

After we cleared traffic and recovered from abnormal condition, I reengaged the autopilot, at the time the altitude was 31,000 ft. I then applied the interphone to contact the purser asked about the situation back there and made the public announcement to the passengers. The purser called back that there were passengers injured and still checked the detailed. So the F/O requested Incheon ACC for an emergency landing to Jeju airport. At the altitude of 15,000 ft, Incheon ACC controller instructed us "direct Marin". When we were handed over to Jeju approach, the controller said "radar not contact" in the beginning and told us "direct Votan". F/O told him "negative, request emergency landing due to passenger injuries", request direct Marin" and got permission presently. During the approach, F/O had informed Incheon ACC, Jeju approach, and our ground-handling agent KAL of the situation onboard and had requested for medical help.

We don't usually use the same parking bay in Jeju airport. On that day, it took 1 minute from exiting the runway to taxing into the bay, so I think it was the closest bay. One ambulance came while the airway was connected. I told them one is not enough and consequently they sent about 10 ambulances. I think the F/O should have issued the situation of 20 people onboard were injured before landing.

After a certain discussion between the purser and ground staff, they decided to evacuate uninjured passengers first, for it was convenient for medical personnel to get into the cabin and carry injured passengers with handbarrow. Since I went to cabin to pacify the passengers, I forgot to turn off the power of two flight recorders until 20~30 minutes after we shutdown the engines.

We probably considered the injured passengers were all traumatic, so we let the uninjured passengers off the board first and then the injured passengers were transported with stretchers. As far as myself, I first went to the cabin try to pacify the passengers and then pulled out the circuit breakers of the FDR and CVR. The time was 30 minutes after engine shut down.

As I know, pilots in our company receive TCAS training at least once every three years. The training syllabus is we have IP instructing the TCAS principle, and then get on the CBT for practice. I think I can acquire enough knowledge about TCAS system from the CBT practices.

According to our training, when TCAS TA is issued, pilot has nothing to do but maintain flying. However, when TCAS RA is issued, pilot should disconnect the autopilot and auto throttle, and follow the Resolution Advisory to take necessary actions. According to my knowledge, the TCAS TA is issued 30~45 seconds prior to collision, and the TCAS RA is issued 25~30 seconds prior to collision.

I had experienced real TCAS TA situation many times before, but this was the

first time I experienced real TCAS RA situation.

1.18.1.1.2 EF306 CM-2

Normally the Incheon ACC controller instructed us to descend from 39,000 ft to 31,000 ft right after we entered the Incheon ACC area, but this time the Incheon ACC issued the descend clearance until we approaching near the top of descend point. The descending was smooth until passing 34,600 ft ~ 34,800 ft, the Incheon ACC called “stop descend”, abruptly; therefore the Captain engaged altitude hold mode at FL340, but I am not sure if we overshoot the altitude or not.

After a while, I saw the TCAS TA symbol showing on the ND. The altitude was showing 341, and then I heard Incheon ACC instructed the conflicting traffic “descend to FL310”. The distance between us was very close even I was still confirming at that moment, the TCAS RA alert had been issued. The pushed down maneuver by the captain was okay in the very beginning. Afterward I was floated from the seat. Since I thought the Captain had pushed down too hard, I reported the speed and attitude of the aircraft to him. I also told him the speed was approaching the red line limit and the pitch attitude on the ADI was lower than TCAS red T-bar as well. Captain recovered the aircraft and reduced pitch angle after my comments. I didn’t visual contact the conflicting traffic during the whole maneuvers.

I reported “Clear of Conflict” to Incheon ACC after we cleared the traffic. Before then, I had heard the conflicting traffic called out “TCAS Climb”. The Captain, the conflicting traffic, and I all had asked “what happened” to Incheon ACC, but the Incheon ACC controller didn’t give any answer.

The Captain then asked the purser about the cabin situation. We were told that many passengers injured back there. The Incheon ACC instructed us turn right, heading 070 and descend to FL150 afterward. I informed him “We have passenger injured, request for medical help” several times but he still let us kept the assigned heading. I concerned about the injured passengers on board and called Incheon ACC again “we have passenger injured, request emergency landing to Jeju airport” and the Incheon ACC cleared us “direct to Marin, descend to FL150”.

We then follow normal procedure to descend and were handed over to JEJU approach at the altitude of 17,000 ft. We continued descend to 15,000 ft and contacted with JEJU approach. The JEJU Rader did not contact us in the beginning, I thought Incheon ACC controller had already cleared us “direct to Marin”, thus I said “request direct to Marin” and maintain at 15,000 ft for a while. After 2~3 minutes, JEJU approach replied “Rader contact” and clear us descend to 4,000 ft. When we were passing through 12,000 ft, the Captain asked me to request JEJU approach for high speed descend, and JEJU approach cleared us heading 330, right turn 080 for ILS landing.

I tried to contact with our ground-handling agent KAL all the way during descending in order to request for medical help and ambulance. Eventually, I

had the contact with them at about 6,000ft ~ 7,000 ft, and was told to park at bay 11.

The Captain selected manual land, and everything was normal during landing. I saw fire trucks and ambulances at the runway end and the first intersection. The tower instructed us taxi to bay 11 via taxiway Bravo, and it took only 2~3 minutes. While we exited runway, the tower asked “how many ambulances do you need?”, and I replied “how many people can one ambulance carry?” the tower answered one ambulance can carry 2 people, I replied that we need 10 accordingly. The arrival of the ambulances was very soon.

On that day, I could clearly receive and understand the ICNs’ instructions. I didn’t observe any mistake or errors made by the Incheon ACC in this flight, and I think his English is good. However, according to my experience, I can’t understand some Korean controllers’ instructions due to their English accent, especially those controllers who work for military airport, so that we have to confirm the clearance repeatedly. And they seldom made the corrections to the wrong read back from the pilots as well.

Regard as the TCAS information on the ND, the approaching traffics is shown as a diamond box in the beginning, the diamond box turned to yellow solid while the TA is issued, and then the symbol will turn to red if RA is issued subsequently. There is a number with “+” or “-” sign beside the symbol which shows the altitude difference to us. There is guidance on the PFD to show you which way to fly. The QRH also states that pilots should “disconnect auto pilot、auto throttle and follow the flight guidance、make visual contact of the approaching traffic.

When TA is issued, pilot should take no action but find out the position of the conflicting traffic. When RA is issued, pilot should immediately follow TCAS indication. Base on my understanding, the TCAS RA is issued 15~20 seconds prior to collision. While TCAS is activated, F/O should call out the speed and altitude of the conflicting traffic. I always follow the call out procedure, however, it happened too soon this time; I could only call out the TA situation but didn’t call out the speed and altitude. After the Captain cleared the traffic, I had reported “TCAS Climb” to the Incheon ACC. That was probably an oral mistake.

As I remember, the company regulated the flight crew receiving the TCAS training once every half-year. The training syllabus is we have CBT class first, and then get on the simulator to practice the specific scenario selected by the instructor pilot.

I had a real TCAS RA experience long time ago, but the circumstance was different from this one.

1.18.1.1.3 TG659 Crew Member

We were level flight at FL340 at that time periods and found there were 3 to 4 traffic showed on the ND and one of it showed about 600 ft higher, 10 NM

from us and was descending. That traffic started level off about 6 to 7 NM, after a moment the ATC instructed us turn immediately and the TCAS RA climb occurred almost in the same time. The TCAS “Traffic”, “Climb” and “Clear Traffic” happened to be occurred but I could not tell the exact time of happening. We did not listen to the communication between the ATC and EF306 since it happened too soon. It took less than 10 seconds from occurrence happened to clear the traffic. We conducted the TCAS proficiency check in simulator once every 6 months in accordance with company Standard Operation Procedures.

1.18.1.2 Summaries of Interview with Incheon ACC Controllers

1.18.1.2.1 Radar Controller

At that time, I was controlling EF306 and TG659 on a South Sector radar control position.

The traffic volume at the time of controlling EF306 and TG659 was normal for the time with about the same number of flights usually I control. I was not overloaded.

After instructing EF306 to descend, I had been monitoring the radar for tracking of some important parts of TG659 which was approaching from the opposite direction although I couldn’t say I tracked it continuously because the control area of South Sector, 300 miles was too wide to monitor all the traffic continuously. And I sensed that at which point two flights would meet.

After instructing EF306 to descend to 31,000 feet, I had been concentrating to identify UNS514T on the radar display for 1 or 1.5 minutes. At the time UNS514T was flying on an altitude of 20,000 feet from Ulsan Airport to Jeongseok Airfield, Jeju, and was lost at the point of about 30 miles ahead MAKET. During this period, I lost the awareness of converging traffic for a minute.

After then, when I became aware of them approaching, EF306 was passing the point of 12 miles from TG659 on an altitude of 34,300 feet. And I thought the situation was a little bit urgent.

I recognized that the altitude of EF306 was 34,300 feet, and momentarily and instinctively I assessed that EF306 was higher than TG659 with an altitude of 34,000 feet. When I said “STOP” to EF306 (“FEA306 Stop … Uh …”), the altitude of EF306 was displayed as 33,800 feet. So I thought that urgent situation was over, and I instructed EF306 to descend more quickly (“Immediately clear … descend”) because it was on the way to descend. And I thought that it would be better for TG659 to turn its heading, so I instructed TG659 as “THA 659 turn right heading 270, 270 immediately.”

I didn’t know whether EF306 responded to the word “Stop” at that time. While I was saying “Stop,” the altitude of EF306 was displayed as 33,900 feet and then as 33,800 feet. Taking into account of radar scan time and the descent rate of EF306, I expected the altitude of EF306 to be lower than 33,800 feet. Then I learned that EF306 responded to the word “stop” and stopped descending at 33,800 feet. It seemed to be the reason why I instructed EF306 to descend fast.

Because radar display showed that EF306 was descending while it was lower than TG659, I instructed EF306 to descend when EF306 said to do TCAS Climb. When EF306 said to do TCAS Climb, I momentarily couldn’t understand it.

There was no CA alert on the radar system. There was no information of CA failure found at that time.

Dealing with this kind of occurrence of conflicting traffic pass through each others’ altitude, I usually apply the minimum of a vertical separation of 1000 feet before at least 10 miles. The standard separation is 5 miles, and the separation standard of facility inner minimum is 10 miles.

According to the transcript, I found out there were about 3 times of pronunciation mistakes while I communicated with EF306. It might be because I was not so concentrated at that time.

Considering the distance between conflicting traffic, I estimated that it would cross the altitude of conflicting traffic. So I instructed EF306 to descend. But FEA might descend slower than they usually did, I think that my judgment at that time was not enough.

1.18.1.2.2 Flight Data Controller

At that time, I was working on a South Sector flight data position.

I didn’t know the situation of the radar controller’s instructing EF306 to descend from 39,000 feet to 31,000 feet at that time because I was doing control transferring work with another control facility. A radar controller is supposed to mark the altitude of directed descent on the strip.

I became aware of the situation of EF306 and TG659 approaching each other when I heard that the control instruction sounded unusual. At that time, the distance between the two flights was about 10 miles. I was watching the situation for some seconds while the altitude of TG659 was becoming to 34,300 feet after TCAS climb and EF306 was descending. They were diverging each other.

After some moments I heard through the speaker that EF306 was on an emergency situation and the radar controller informed me about that. So I notified it to Jeju Approach Control and Jeju Control Tower.

CA was working normally. The CA alert is to be displayed on radar display by

each control sectors, but it can not be heard through the speakers. There was no CA alert when EF306 and TG659 were approaching each other.

I thought that the controller was controlling more than 20 flights at that time, but the record showed that he was controlling 15 flights. Controlling 15 flights can be regarded as “Normal to busy” or “Average to a little busy”, and it occurs 2-4 times almost everyday.

The radar controller reported to the manager about the occurrence of two flights’ approaching and the emergency situation while I was reporting to Jeju Approach Control and Jeju Control Tower about the emergency landing of EF306.

In case of a radar controller can not deliver his duty because of some reason, I can not take his place because I don’t have a radar control rating but a manager or other radar controllers can substitute for him. South Sector flight data controller exchanges control transfer data with Naha, Fukuoka ACC, other Control Sectors in Incheon ACC, and Approach Controls in the service area, and provides a radar controller with the flight data and other data needed to the related flight.

When I looked at the radar display right after receiving control transfer for UNS514T from the Low Central Sector, the altitude of UNS514T was not displayed, and the radar controller asked me what the altitude of the flight is because the altitude was not displayed. After checking its altitude on the flight plan, I told him the altitude. Then the radar controller tried to work on radar identification, and identified it.

1.18.1.2.3 Team leader (Manager)

When I was working on the supervisor position, I heard that TG659 did TCAS Climb through the all frequency speakers installed in the supervisor position. So I caught up on the control situation of south sector through the radar display in the supervisor position, and recognized that EF306 and TG659 were approaching each other in the distance of approximately 10 miles.

It is usually taken for 10 or 12 seconds to solve the separation problem between two aircrafts, so I didn’t change the controller to another person. And I had a standby controller who was at rest behind the south sector controller because of his aroused voice. Then I heard that EF306 requested an emergency landing.

In the mean time, I decided not to change the controller to prevent him from being confused until he finished controlling for EF306. I took the controller out of his duty 5 minutes after the occurrence happened. Through the coordinating committee[14] network, I reported this situation of an emergency landing to Jeju Approach Control and Jeju Control Tower.

14 It is consisted with all approach control and control tower under the jurisdiction of ACC

As the results of after 5 years of operation, the automatic radar system was convinced to be credible, and there were no information about the failure of the conflict alert system at the time. The situation of the day was out of operating limitation of conflict alert system.

At that time, because Data block lead line of all of track on the radar display in Low Central Sector altogether showed different direction, I was concentrating on solving this problem.

At the time of the occurrence, we were controlling 15 flights. Because the South Sector usually control the flights of cruising level flight and rarely controls flights changing altitude for a descending or climbing, the traffic volume at that time was proper.

At that time, there were 30 controllers in the team, and 8 of them were on standby while resting.

1.18.2 TCAS System

The Traffic Alert and Collision Avoidance System II (TCAS II) is an airborne system and operates independently from the ground-based Air Traffic Control (ATC) system. The TCAS II uses active surveillance to alert the pilot to presence of other nearby aircraft which is also equipped with TCAS II. TCAS II issues the “Resolution Advisories” (RAs) when an intruder that is considered to be a collision threat, and “Traffic Advisories” (TAs) when an intruder that may soon cause an RA. The RAs recommends a vertical escape maneuver to help maintain safe vertical separation from the threat aircraft.

1.18.2.1 EF306

The EF306 was equipped with the TCAS II system version 7. The manufacturer is Rockwell Collins Inc.. The type is TTR-920. The part number, serial number and mode S code are 622-8971-022, 5695 and 89907C respectively.

The EF306 flight recorders recoded both TAs and RAs records. Related records from both FDR and CVR were as follows,

- 02:06:48 aural warning “Traffic, Traffic”
- 02:07:01 to 02:07:18 Corrective RA activated “Descend” and aural warning “Descend, Descend” was announced at 02:07:01.6
- 02:07:19 to 02:07:40 Preventive RA activated “Don’t Climb” and aural warning “Adjust Vertical Speed, Adjust” was announced at 02:07:19.3
- 02:07:41 TCAS “Clear of Conflict” and aural message “Clear of Conflict”

The EF306 TCAS related records vs. altitude and time were listed as table 1.18-1 below.

Table 1.18-1 The EF306 TCAS related records vs. altitude and time

RADAR TIME	ALTITUDE (29.92) (FDR)	TCASAR (FDR)	TCASCC (FDR)	TCASDN (FDR)	Traffic Alert (CVR)
(HH:MM:SS)	(FEET)	(FT/MIN)	(discrete)	(discrete)	Aural warning
02:06:43	34220	0	NO ADV.	NO DN ADV.	
02:06:44	34188	0	NO ADV.	NO DN ADV.	
02:06:45	34152	0	NO ADV.	NO DN ADV.	
02:06:46	34120	0	NO ADV.	NO DN ADV.	
02:06:47	34088	0	NO ADV.	NO DN ADV.	
02:06:48	34052	0	NO ADV.	NO DN ADV.	traffic traffic
02:06:49	34020	0	NO ADV.	NO DN ADV.	
02:06:50	33992	0	NO ADV.	NO DN ADV.	
02:06:51	33960	0	NO ADV.	NO DN ADV.	
02:06:52	33928	0	NO ADV.	NO DN ADV.	
02:06:53	33900	0	NO ADV.	NO DN ADV.	
02:06:54	33872	0	NO ADV.	NO DN ADV.	
02:06:55	33844	0	NO ADV.	NO DN ADV.	
02:06:56	33828	0	NO ADV.	NO DN ADV.	
02:06:57	33824	0	NO ADV.	NO DN ADV.	
02:06:58	33828	0	NO ADV.	NO DN ADV.	
02:06:59	33840	0	NO ADV.	NO DN ADV.	
02:07:00	33860	0	NO ADV.	NO DN ADV.	
02:07:01	33868	-1500	DWN ADV COR.	DESCEND	descend descend
02:07:02	33856	-1500	DWN ADV COR.	DESCEND	

RADAR TIME	ALTITUDE (29.92) (FDR)	TCASAR (FDR)	TCASCC (FDR)	TCASDN (FDR)	Traffic Alert (CVR)
02:07:03	33800	-1500	DWN ADV COR.	DESCEND	
02:07:04	33692	-1500	DWN ADV COR.	DESCEND	
02:07:05	33596	-1500	DWN ADV COR.	DESCEND	
02:07:06	33420	-1500	DWN ADV COR.	DESCEND	
02:07:07	33180	-1500	DWN ADV COR.	DESCEND	
02:07:08	33024	-1500	DWN ADV COR.	DESCEND	
02:07:09	32872	-1500	DWN ADV COR.	DESCEND	
02:07:10	32588	-1500	DWN ADV COR.	DESCEND	
02:07:11	32440	-1500	DWN ADV COR.	DESCEND	
02:07:12	32276	-1500	DWN ADV COR.	DESCEND	
02:07:13	32104	-1500	DWN ADV COR.	DESCEND	
02:07:14	31976	-1500	DWN ADV COR.	DESCEND	
02:07:15	31884	-1500	DWN ADV COR.	DESCEND	
02:07:16	31816	-1500	DWN ADV COR.	DESCEND	
02:07:17	31792	-1500	DWN ADV COR.	DESCEND	
02:07:18	31756	-1500	DWN ADV COR.	DESCEND	
02:07:19	31764	0	DWN ADV COR.	DON'T CLIMB	adjust vertical speed adjust
02:07:20	31712	0	DWN ADV COR.	DON'T CLIMB	
02:07:21	31704	0	DWN ADV COR.	DON'T CLIMB	
02:07:22	31676	0	DWN ADV COR.	DON'T CLIMB	
02:07:23	31644	0	DWN ADV COR.	DON'T CLIMB	
02:07:24	31612	0	DWN ADV COR.	DON'T CLIMB	
02:07:25	31604	0	DWN ADV COR.	DON'T CLIMB	

RADAR TIME	ALTITUDE (29.92) (FDR)	TCASAR (FDR)	TCASCC (FDR)	TCASDN (FDR)	Traffic Alert (CVR)
02:07:26	31584	0	DWN ADV COR.	DON'T CLIMB	
02:07:27	31564	0	DWN ADV COR.	DON'T CLIMB	
02:07:28	31552	0	DWN ADV COR.	DON'T CLIMB	
02:07:29	31532	0	DWN ADV COR.	DON'T CLIMB	
02:07:30	31520	0	DWN ADV COR.	DON'T CLIMB	
02:07:31	31524	0	DWN ADV COR.	DON'T CLIMB	
02:07:32	31536	0	DWN ADV COR.	DON'T CLIMB	
02:07:33	31552	0	DWN ADV COR.	DON'T CLIMB	
02:07:34	31572	0	DWN ADV COR.	DON'T CLIMB	
02:07:35	31584	0	DWN ADV COR.	DON'T CLIMB	
02:07:36	31580	0	DWN ADV COR.	DON'T CLIMB	
02:07:37	31576	0	DWN ADV COR.	DON'T CLIMB	
02:07:38	31560	0	DWN ADV COR.	DON'T CLIMB	
02:07:39	31536	0	DWN ADV COR.	DON'T CLIMB	
02:07:40	31516	0	DWN ADV COR.	DON'T CLIMB	
02:07:41	31488	0	CLEAR OF CONFLT	NO DN ADV.	clear of conflict
02:07:42	31476	0	NO ADV.	NO DN ADV.	
02:07:43	31476	0	NO ADV.	NO DN ADV.	
02:07:44	31472	0	NO ADV.	NO DN ADV.	
02:07:45	31472	0	NO ADV.	NO DN ADV.	
02:07:46	31480	0	NO ADV.	NO DN ADV.	

1.18.2.2 TG659

The TG659 was equipped with the Honeywell TCAS II system (Type: TPA-81A , P/N: 066-50000-2721, S/N: 9237, mode S code: 880046).

The TG659 flight recorders (FDR and CVR) should record both TAs and RAs records, however only the FDR data were available. TCAS related records from FDR were as follows,

- 02:06:48 “TA” activated, pressure altitude 34,001 ft.
- 02:07:01 to 02:07:11 Corrective RA activated “Climb”

The TG659 TCAS related records vs. altitude and time were listed as table 1.18-2 below.

Table 1.18-2 The TG659 TCAS related records vs. altitude and time

Radar time	PRESS_ ALT	ADVSR_ALT_RATE	TCAS_COMBND_CNTRL	TCAS_DISPLAY_STATE	TCAS_DOWN_ADVSR	TCAS_UP_ADVSR
FDR time+5sec	(Feet)	(Ft/Min)				
02:06:43	33999	0	No Advisory	No Threat	No Down Advisory	No Up Advisory
02:06:44	33999	0	No Advisory	No Threat	No Down Advisory	No Up Advisory
02:06:45	33999	0	No Advisory	No Threat	No Down Advisory	No Up Advisory
02:06:46	34000	0	No Advisory	No Threat	No Down Advisory	No Up Advisory
02:06:47	34000	0	No Advisory	No Threat	No Down Advisory	No Up Advisory
02:06:48	34001	0	No Advisory	TA	No Down Advisory	No Up Advisory
02:06:49	34002	0	No Advisory	TA	No Down Advisory	No Up Advisory
02:06:50	34001	0	No Advisory	TA	No Down Advisory	No Up Advisory
02:06:51	34002	0	No Advisory	TA	No Down Advisory	No Up Advisory
02:06:52	34001	0	No Advisory	TA	No Down Advisory	No Up Advisory
02:06:53	34002	0	No Advisory	TA	No Down Advisory	No Up Advisory
02:06:54	34001	0	No Advisory	TA	No Down Advisory	No Up Advisory
02:06:55	34000	0	No Advisory	TA	No Down Advisory	No Up Advisory
02:06:56	33999	0	No Advisory	TA	No Down Advisory	No Up Advisory

Radar time	PRESS_ ALT	ADVSR_ALT_RATE	TCAS_COMBND_CNTRL	TCAS_DISPLAY_STATE	TCAS_DOWN_ADVSR	TCAS_UP_ADVSR
FDR time+5sec	(Feet)	(Ft/Min)				
02:06:57	34000	0	No Advisory	TA	No Down Advisory	No Up Advisory
02:06:58	33999	0	No Advisory	TA	No Down Advisory	No Up Advisory
02:06:59	33999	0	No Advisory	TA	No Down Advisory	No Up Advisory
02:07:00	33999	0	No Advisory	TA	No Down Advisory	No Up Advisory
02:07:01	33996	1500	Up Advisory Corrective	RA	No Down Advisory	Climb
02:07:02	33992	1500	Up Advisory Corrective	RA	No Down Advisory	Climb
02:07:03	33988	1500	Up Advisory Corrective	RA	No Down Advisory	Climb
02:07:04	33969	1500	Up Advisory Corrective	RA	No Down Advisory	Climb
02:07:05	33966	1500	Up Advisory Corrective	RA	No Down Advisory	Climb
02:07:06	33980	1500	Up Advisory Corrective	RA	No Down Advisory	Climb
02:07:07	33992	1500	Up Advisory Corrective	RA	No Down Advisory	Climb
02:07:08	34007	1500	Up Advisory Corrective	RA	No Down Advisory	Climb
02:07:09	34033	1500	Up Advisory Corrective	RA	No Down Advisory	Climb
02:07:10	34082	1500	Up Advisory Corrective	RA	No Down Advisory	Climb
02:07:11	34122	1500	Up Advisory Corrective	RA	No Down Advisory	Climb
02:07:12	34156	0	No Advisory	RA	No Down Advisory	No Up Advisory
02:07:13	34191	0	No Advisory	RA	No Down Advisory	No Up Advisory
02:07:14	34223	0	No Advisory	No Threat	No Down Advisory	No Up Advisory

Radar time	PRESS_ ALT	ADVSR_ALT_RATE	TCAS_COMBND_CNTRL	TCAS_DISPLAY_STATE	TCAS_DOWN_ADVSR	TCAS_UP_ADVSR
FDR time+5sec	(Feet)	(Ft/Min)				
02:07:15	34247	0	No Advisory	No Threat	No Down Advisory	No Up Advisory
02:07:16	34266	0	No Advisory	No Threat	No Down Advisory	No Up Advisory
02:07:17	34280	0	No Advisory	No Threat	No Down Advisory	No Up Advisory
02:07:18	34288	0	No Advisory	No Threat	No Down Advisory	No Up Advisory

1.18.3 Incheon ACC Radar Control System

The radar equipment in Incheon ACC including the Radar Data Processing System was made by Lockheed Martin Inc., America. They were made with open type, standard/common products.

The radar of Incheon ACC was equipped with a Conflict Alert function which is a part of the Radar Data Processing System, and its primary parameters comply with the standard of the U.S. Federal Aviation Administration's Order (Order 7110.100) as follows.

Area Type	En route Region	Terminal Region		
	4	3	2 ★	1 ★★
Look-ahead Time (SEC)	120	40	40	40
Minimum Lateral Separation (NM)	2.0	1.25	0.75	0.5
Minimum Vertical Separation (FT)	375	375	275	275
Display Alert Sliding Window M/N Criteria (SCANS) ★★★	3 of 5	3 of 5	3 of 5	3 of 5

★ Approach/Departure Corridor

★★ Runway Vicinity

★★★ Not Area dependent

The performance of Incheon ACC radar system was recorded as normal in daily, weekly, monthly performance monitoring logs. The system provided controllers with visual Conflict Alert (CA) warning, but no aural warning. The CA warning was not observed during the occurrence in the system playback. Neither of the controllers on duty observed the CA warning.

Incheon ACC radar system data for EF306 and TG659 and separation distance measured at primary times, and azimuth of two flights are in

Attachment 8.

1.18.4 Incheon ACC Control Sector Operation

At the time of occurrence, 32 controllers were assigned to the Incheon ACC morning team (B team) and day time team (C team), including an on-the-job training controller, who is in proficiency recurrent training, a supervising controller for trainee controller, and 2 managers. Twenty-eight controllers except the two managers can be assigned in a control position.

The Incheon ACC Sector consists of 10 control sectors such as East Sector and South Sector. and each sector is assigned 1 to 3 controllers, including a radar controller, coordinate controller, and flight data controller. So, 25 controllers are needed when all of sectors are operated at the same time.

At the time of occurrence, “some sectors had to be integrated during duty time for meal and rest. At the time of occurrence, South Sector coordinating control position and flight data control position were integrated, so two controllers were working at the South Sector including radar controller,” as the manager stated.

According to Article 47 of Rules for Operation and Management of Air Traffic Services,[15] the manager on duty can operate the sectors while integrating positions/sectors, considering 1) the complexity and the difficulty of the job, and 2) the special characteristics of each facility.

According to Article 48 of the same rules above, the manager on duty has to supervise controllers on standby in order to 1) provide them sufficient time for a meal, 2) confirm where they are standby for an efficient operation, and 3) provide standby time[16] as a method of improving maximum use and efficiency of the on-duty controllers.

According to the Article 49 of the same rules, on-duty schedule has to be made up on the basis of 1) no consecutive work of more than 5 days, 2) 10 hours of maximum working hour including a standby, and 3) guaranteeing 8 hours of rest after final work. But the on-duty schedule can be changed appropriately considering a working condition, environment, the number of workers and traffic volume of the facility, and the working hour on an on-duty schedule is made up including a standby.

The Incheon ACC regulates the scheduling, operation, and a rotation of a working team by reflecting a standard of Rules for Operation and Management of Air Traffic Services[17] made up by the Aviation Safety

15 the Aviation Safety Authority Notice 2004 (Nov.09.2005).

16 the time when the worker is in standby within a air traffic control facility for a job shift by the basic on-duty schedule.

17 The Korea Air Traffic Center(the name of administrative department where the Incheon ACC is belonged to)

Authority in Article 9 and Article 10 of Rules for Operation and Management of Air Traffic Services.

1.18.5 Minimum Radar Separation

The Article 5-5-4, Paragraph B of Air Traffic Control Procedures and ICAO Doc 4444 8.7.4.1 regulated a minimum radar horizontal separation of two flights as 5 NM, and the Rules for Air Traffic Control Services of the Incheon ACC follows this standard.

According to the statements from the manager and the South Sector radar controller on duty at that time, “the controllers belonged to the Incheon ACC apply a minimum radar separation of 10 NM into an actual control for a safer control despite the standard above”.

1.18.6 History of the Air Traffic Control

The details of air traffic control to the occurrence aircraft below was written based on the records of the recorder in the air traffic control facilities, radar system data, and the data which were recorded in the FDR and CVR of EF306.

1.18.6.1 Incheon Area Control Center

On Nov. 16, 2006, within the flight information region of Korea, the South Sector of the Incheon ACC was in charge of an en route air traffic control for EF306, and the South Sector Radar Controller (hereinafter referred to as “SSRC”) gave the air traffic control instructions to EF306 on a frequency of 124.525 Mhz.

At (01:50:08)[18], EF306[19] contacted Incheon ACC for the first time, reporting “Incheon control good morning, EF306 maintain FL390, 10 DME to ATOTI, squawk 2662”, and SRCC instructed a change of transponder code for a radar contact,[20] telling “EF306 Incheon control, Roger, squawk 4113.”

Instruction.

18 In this section, the time format is Radar Time followed by ACC Time in brackets. Please refer to Attachment 1 for details.

19 The coordinates on the FDR were 29°50′49.6″N, 125°05′25.19″E and the distance was 11 NM to ATOTI.

20 After the Flight Data Processing System of the Incheon ACC assigned it automatically, the controller assigned the change to the flight according to it.

The airplane TG659 which departed Incheon International Airport bounding for Bangkok, Thailand, contacted on a frequency of Incheon ACC South Sector at the point of about 16 NM[21] from Jeju VORTAC (CJU) in the airway of B576 at the time of (01:53:09), reporting “Incheon control TG659, Good morning FL340.” At the time, its distance to Flight 306 was about 216 NM.

At 01:55:54.6(01:55:50), SSRC instructed, “EF307, Radar contact, Maintain 390,” and EF306 read back the instruction, “Maintain 390, EF306.”

At (02:02:43), SSRC instructed Flight 306 to descend, “EF306 now descend to FL 310,” but the response from EF306 was not clear. At 02:02:53.4(02:02:50), SSRC gave a descending instruction to EF306 again, saying “Standby and EF306 now descend to FL310.” EF306 read back the instruction as “Descend to FL 310, EF306.” At that time, the distance between EF306 and TG659 was about 70 NM.

At 02:06:50.8(02:06:45), SSRC instructed EF306, “EF 308 stop uh immediately clear descend.” There was no read-back from EF306 to this instruction. At that time, the altitude passing of EF306 was 34,300 feet, and that of TG659 maintaining was 34,000 feet. The distance between the two airplanes was about 13 NM.

At 02:06:55.9(02:06:50), SSRC instructed TG659 to turn right, “TG659 turn right heading 270, 270 immediately,” and TG659 read back as “725, 270, TG659.” At that time, the distance between the two airplanes was about 12 NM.

According to the radar system data of Incheon ACC, at 02:06:51, the altitude of EF306 was 33,900 feet, and that of TG659 was 34,000 feet. The distance between the two airplanes was about 11.35 NM. At 02:07:03, the altitude of EF306 was 33,800 feet, and that of TG659 was 34,000 feet. The distance between two airplanes was about 8.3 NM.

At 02:07:15.4(02:07:08), EF306 informed SSRC that “Incheon control EF306, TCAS TCAS climb,” and SSRC instructed EF306 as “Roger, now descend, descend.” In response to this instruction, EF306 replied as “Negative, negative we follow TCAS.” At that time, the altitude of EF306 was 31,900 feet and that of TG659 was 34,000 feet. The distance of the two airplanes was about 5 NM.

According to the radar system data of Incheon ACC, at 02:07:28, the altitude of EF306 was 31,600 feet, and that of TG659 was 34,300 feet. The distance between the two airplanes was about 2.86 NM. At 02:07:40, the altitude of EF306 was 31,500 feet, and that of TG659 was 34,200 feet. The distance between two airplanes was about 1.17 NM.

At 02:07:46.4(02:07:42), EF306 notified SSRC that “Incheon control EF306, we are cleared traffic, maintain 310,” and following to this notification, SSRC replied that “EF306, Roger maintain 310.” At 02:07:51, the altitude of EF306

21 The point of 99NM to NIRAT.

was 31,600 feet, and that of TG659 was 34,100 feet. The distance between two airplanes was about 3.93 NM.

At 02:07:59.1(02:07:55), SSRC instructed TG659 as “TG659 maintain FL 340, now direct ATOTI,” and to this instruction, TG659 read back and asked as “Direct ATOTI, TG659. How come you let the things like this occurred, TG659.” To the query of TG659, SSRC instructed TG659 to change the frequency to 134.37 Mhz and explained about the situation.

At 02:09:24.1(02:09:18), SSRC instructed EF306 to turn right, “EF306 turn right heading 070, 070 for descending.” To this instruction, EF306 read back the instruction, and notified that there are some injured people saying as “Turn right 070 for descending, EF306. What's the problem? We have some personal injury.”

At 02:09:44.3(02:09:39), SSRC replied and instructed EF306 to descend as “Roger, EF306 now descend to FL 150.” To this instruction, EF306 read back the instruction as “Descend to FL150. We turn right heading 070, EF306.”

At 02:11:41.1(02:11:37), EF306 requested for an emergency landing, “EF306, we have personal injury, request emergency landing for Jeju airport.” To this request, SSRC instructed EF306 to proceed direct to MARIN[22] and asked the intention of EF306, “EF306, Roger. Now direct MARIN. Clear direct MARIN. Say your intention. Say again.”

At 02:11:59.7(02:11:52), EF306 replied as “O.K, Direct to MARIN. We are request emergency landing for Jeju and need medicine help.” At 02:12:26.6(02:12:22), SSRC asked EF306 that “EF306, Roger. Do you have any need?” To this question, EF306 replied as “Yes, we, we need emer … medicine help and emergency ambulance for help.” To this response of EF306, at 02:12:43, SSRC read back as “okay, do you need ambulance okay.”

At 02:12:44.7(02:12:40), EF306 notified as “We have uh personal injury,” and SSRC replied as “Roger, personal injury.”

At 02:15:49.0(02:15:43), SSRC instructed a control transfer, “EF306 contact Jeju approach 121.2. EF306 good day,” and EF306 read back the instruction as “Incheon 12, … Jeju approach 121.2.” At that time, the position of EF306 was about 39 NM[23] south of Jeju Airport, with altitude of 18,800 feet.

1.18.6.2 Jeju Approach Control

At 02:16:01.9(02:15:56), EF306 contacted Jeju Approach Control for the first time on the frequency 121.2 Mhz, and the approach controller in the Jeju

22 The first approach point of “ILS/DME RWY 06”, Jeju International Airport Flight Procedure.

23 On the basis of YONGDAM VOR/DME(YDM) within Jeju Airport.

Approach Control (hereinafter referred to as “JAAC”) requested EF306 for a radar contact, and said “Uh good morning EF306 Approach, Squawk Ident.” To this request, EF306 replied as “Okay EF306 descend 150. We request emergency landing uh due to personal injury and request medicine help.”

At 02:16:19.8(02:16:14), JAAC instructed, “EF306 unable radar contact. Proceed direct CJU, maintain level 150,” and to this instruction, EF306 requested that “Negative, negative. EF306, we request emergency landing. We have personal injury.” To this request, JAAC instructed as “EF306 unable radar contact, proceed to direct CJU, maintain level 150,” and EF306 requested as “EF306 request direct to MARIN, proceed to direct to MARIN.” At this time, JAAC instructed that “EF306, Proceed direct MARIN.”

At 02:16:48.8(02:16:43), EF306 read back and requested as “Proceed direct MARIN and we have personal injuries, and request un…doctor help, ambulance help.”

At 02:19:20.6(02:19:15), EF306 requested a high speed descent, “Jeju approach, EF306 request high speed descent,” and JAAC approved it.

At 02:19:57.4(02:19:52), JAAC instructed EF306 a radar vector, “EF306 turn left heading 330,” and at 02:20:27.8(02:20:22), JAAC instructed altitude descent to 4,000 feet.

At 02:22:23.8(02:22:18), JAAC issued approach clearance to EF306, “EF306 turn right heading 030, cleared ILS/DME RWY 06 approach, report established, EF306.”

At 02:23:37.5(02:23:32), EF306 reported to JAAC as “Jeju approach, EF306 established.” JAAC transferred the control for Flight 306 to Jeju Control Tower, ” EF306 contact tower 118.1, good day.”

1.18.6.3 Jeju Control Tower

At 02:23:48.8(02:23:44), EF306 contacted Jeju Control Tower for the first time, “Jeju tower, good morning. EF306 approaching 11 DME,” and The local controller (hereinafter referred to as “JTLC”) in Jeju Control Tower issued landing clearance and said “EF306, Tower, cleared to land runway 06, wind 060 at 10.”

At 02:24:00.2(02:23:54), EF306 read back the landing clearance saying “Wind 060 10, EF306. We are emergency landing,” and JTLC replied that “We are copy that, ready for ambulance and fire car.”

At 02:24:11.8(02:24:06), JTLC advised EF306 as “… Welcome, EF306 descend as published. Your altitude so high,” and Flight 306 replied as “Yeh, EF306.”

At 02:28:12(02:28:00), EF306 landed on Runway 06, and JTLC instructed EF306 to taxi.

At 02:29:27.4(02:29:22), while taxing to spot 11, EF306 notified to JTLC saying as “We have almost 20 person injured, 20 person injured,” as JTLC replied “Eh, copy that, parking spot 11.” At 02:29:48.0(02:29:43), Flight 306 stated to JTLC “Need, We need more ambulance.”

At 02:30:44.9(02:30:39), JTLC asked EF306 “How many car do you need ambulance,” and Flight 306 replied as “We have total about 20 person injured. So I don’t know how much cars do we need. But we have 20 person, 20 person injured.” At 02:31:03.4(02:30:58), EF306 said “O.K about 10 ambulance.”

1.18.6.4 Vectoring Procedures

Flight 306 flew along B576 toward Jeju airport after passing Incheon flight information region (ATOTI). When vectoring the aircraft to approach to Jeju airport along B576 descend, ICN ACC used either B576 or RADAR VECTOR, depending on air traffic condition.

Also, in order for Jeju Approach Control to control the inbound traffic to Jeju airport flying along B576 and A586 in the south of Jeju, there were no NON-RADAR flight procedures such as standard instrument arrival procedure including a feeder route from both air ways to Initial Approach Fix except approach procedure using radar vectoring.

According to air traffic data on the day of occurrence provided by Air Traffic Center (Incheon ACC), 258 aircraft flew B576 between Jeju VORTAC and NIRAT, and at the time of flight 306 occurrence, SSRC was controlling 13 aircraft including flight 306 on the same frequency.

1.18.7 Related Documentation

1.18.7.1 Flight Operations Manual

Base on the Flight Operations Manual, version 22, issued by FEA at Oct. 16, 2006, the related information is summarized below:

4.3訓練種類（Types of Training）：

4.3.1機種新進訓練（Initial）：

指對新進副駕駛員所實施之機種訓練。

4.3.2機種轉換訓練（Transition）：

指對曾任職於其他機型相同職務之駕駛員所實施之訓練。

4.3.3升等訓練（Upgrade）：

指對副駕駛員升任正駕駛員之訓練。

4.3.4定期複訓（Recurrent）：

指對已任職之駕駛員，為保持其熟練程度所實施之定期訓練。

4.3.5恢復資格訓練（Re-qualification）：

指供持有某機型檢定申請人，因故喪失該機型資格，重新取得該機型檢定證之訓練。訓練之能量應是其資格喪失期間之長短決定之。

4.3.6機種差異訓練（Difference Training）：

指公司引進現有機隊之同型機，針對飛機設備之改變導致飛行操作產生差異時，提供該機型駕駛員施予相關差異部分之訓練。

4.3.7緊急撤離裝備訓練（Emergency Evacuation Equipment）：

應就各型航空器指派其每一飛航組員，於飛航緊急情況或緊急撤離時擔任必要任務，其任務包括緊急及救生裝備之使用，並應於年度訓練計畫中施以訓練及定期演練。

4.3.8零飛時訓練（Zero Flight Time, ZFT）

4.5 機型資格規定

4.5.2複訓/考驗(Recurrent Training/Check)

4.5.1.2正駕駛員右座派飛訓練：

正駕駛員於每年模擬機複訓時實施，並於複訓後次月在實機上實施。

4.8組員資源管理（Crew Resource Management, CRM）：

依據『國籍航空公司組員資源管理訓練實施要點』辦理之。

4.8.1組員資源管理訓練之目的為提升人機介面與人際互動之績效，有效運用所有可用資源，包括人力硬體及資訊等項目，以預防事故發生，確保飛航安全。

4.8.2組員資源管理訓練應涵蓋組員之狀況警覺、溝通技巧、團隊合作、任務配置及決心下達等項目。

4.8.3依據CAR05-09B之規定，就航務處實施CRM之訓練對象應包括飛航組員、航空器簽派人員等。

4.8.4組員資源管理訓練主體包括初訓、複訓及持續強化等項目。

4.8.4.1組員資源管理初訓：

- 促使組員認知溝通與決策、人際關係、組員協調及領導等飛航安全間之關聯性，以灌輸組員資源管理之觀念。
- 課程依上項目標，明確定義及發展組員資源管理之觀念，並與組員所遭遇之問題作直接聯結，建立共同觀念架構及用語，以確保組員對相關問題能有效溝通。

4.8.4.2組員資源管理複訓：

- 依CAR之規定飛航組員至少每年乙次，其他人員至少每二年乙次。
- 駕駛員之複訓除於課堂強化組員資源管理觀念外，並應於模擬機或飛行訓練儀進行組員資源管理－線上導向飛行訓練（Crew Resource Management－Line Oriented Flight Training, CRM－LOFT）

4.8.4.3組員資源管理持續強化：

- 組員資源管理訓練應融入各項訓練中，日常運作亦應強調其觀念，使組員資源管理成為組織文化中之一部分。

4.8.4.4組員資源管理－線上導向飛行訓練，應以現任線上組員為對象，訓練活動則以完整之組員搭配進行，並包含對人員行為表現之回饋。

本訓練配合飛航組員之年度複訓實施。

4.8.5組員資源管理訓練必要時得配合配合特殊需求實施專案，或與相關人員進行練合訓練完成之。

4.8.6組員資源管理訓練執行準則：

- 各級管理階層應明確支持組員資源管理理念，並積極提供

訓練所需資訊。

- 航務手冊與訓練手冊應於政策及程序上，提供必要指導，以宣揚組員資源管理理念。
- 於飛航手冊中，應清楚強調「鼓勵適當的質疑」，且任一飛航組員對另一飛航組員之決策或行動提出質疑時，不會出現負面效果或影響。
- 訓練計畫設計前應對相關人員進行調查研究，以確認組員資源管理訓練實施之範圍及程度。
- 訓練計畫執行前，應讓相關人員對整體訓練計畫有所瞭解，避免對訓練重點或執行方面產生誤解。
- 組員資源管理訓練應適時反應組織本身之特性及需要，以增加組員對於訓練所感受之關聯性
- 相關訓練計畫應持續作有系統之效果評估，以確認計畫目標有效達成，並作為各項訓練計畫修正及改善之依據。
- 訓練計畫之教師、督導及課程規劃等人員，應接受相關之專業訓練，使人員具備訓練執行及評估之技能。

※本公司配合年度航路考驗實施飛航駕駛員資源管理（CRM）評鑑資料，如附表4-A。

8.1通則

8.1.11 GPWS/EGPWS, TCAS

8.1.11.2 TCAS/TCAS II：

當有TA警告時，PF應立即以目視尋找該航機，而PM則應注意機內TCAS顯示器並隨時告知PF該航機的相關位置、距離及高度以確保適當隔離。

當有RA警告時，PF應立即飛離危險區域，同時依FOM12.10標準術語通知航管；若航管指示與RA警告不符合時，應不予理會航管指示。PM應幫助PF交互檢查座艙儀表以確保離開危險區域。

遭遇RA狀況，落地後應填寫Captain Report。

12.8緊急醫療救助(Medical Emergency)

12.8.3乘客醫療救護：

遇乘客發生事故需要醫療救護時，客艙組員醫急救須知程序處理後，儘速告訴機長。

12.8.3.1乘客一般醫療救護：

經客艙組員告知機長，乘客僅需一般醫療救護時，機長依下列事項通知聯管部：

A.目的地機場之ETA。

B.姓名、年齡、性別和體重。

C.症狀。

D.所需相關支援。

12.8.3.2乘客緊急醫療救護：

經客艙組員告知機長，乘客需要緊急醫療救護時，除按上述程序通報外，應優先考量轉降，儘速就醫。

12.10 TCAS空中接近之通報：

當駕駛員依飛機上TCAS裝備RA指示改變時，僅可依RA提供方式爬昇或下降避讓，同時通知航管並於落地後填寫機長報告。空中接近通報術語如下表：

a.依RA指示爬昇（下降）時	*TCAS Climb (or Descent)*
b.衝突清除時，告知ATC	*Returning To (Altitude)*

航機資訊：

a.告知航機資訊	*1.Traffic (Information)* *2.No Reported Traffic*
b.收到航機資訊	*1.Looking Out* *2.Traffic In Sight* *3.Negative Contact*

1.18.7.2 Flight Operations Training Manual, FOTM

Based on the Flight Operations Training Manual, version 16, issued by FEA on May 16, 2006, the related information is summarized below:

4.5.1節：

機種地面學科訓練課程內容及時數分配表中之飛航訓練學科課程中，針對新訓人員列有2小時之學科課程。

4.5.3節訓練主題中TCAS之訓練主題為：

a. Control and Indicators

b. Transponder/TCAS Control Panels

c. Dual Mode-s/TCAS Transponder Control Panel

d. Flat Panel, VSI/TCAS Indicator

6.4.1節：

6.4.1.2節：

學科定期複訓課目主題內容中律定TCAS II之訓練每三年實施一次。

6.4.4正駕駛員右座訓練：

6.4.4.1模擬機訓練：

配合模擬機年度複訓，正駕駛員每年實施一次，練習右座起落及不正常程序。

6.4.4.2航路訓練：

正駕駛員每年實施乙次右座航路訓練，由教師駕駛員以上人員帶飛，練習右座起落及正常程序。

1.18.7.3 Pilot Training Manual

Base on the Pilot Training Manual, version 7, issued by FEA on Sep. 19, 2006, the related information is summarized below:

- *2.1.2節模擬器訓練內容中，第2.1.2.2.5節、2.1.2.2.8節及2.1.2.2.9中之模擬器訓練課目中列有TCAS Avoidance operation及Recovery之課目。*

- *2.2節年度複訓與考驗內容中列有TCAS訓練課目（以Video方式實施）*
- *3.2節對TCAS訓練之要求標準為：裝備使用操作熟練、狀況警覺、TA/RA改正動作與判斷正確。*
- *4.5.6節內容：*

4.5.6 Traffic Alert and Collision Avoidance

課 目	Traffic Alert and Collision Avoidance
目 的	訓練人員運用 TCAS 裝備，對接近之航空器增進危害警覺，並採取適當避讓操作，以維飛行安全。
要求標準與重點	1.系統裝備了解與環境警覺性(SA)。 2.狀況判斷與避讓操作。 3.組員合作與交互檢查。

操作程序	PF	PM
1.Traffic Advisory (TA)	當航空器接近進入隔離許可範圍內，TCAS 顯示音頻與目視符號，應立即執行下列程序：	
TA 改正程序	1.依 TCAS 顯示方位，搜尋相關航機。 2.報出相關航跡位置方位。 3.如判定無相關危害： 保持原航行操作。 4.如判定隔離不足或有危害： (1)視需要避讓。 (2)通過後 Call Out "Clear"，轉向攔截回正常航線。	1.(同左) 2.(同左) 3.保持目視相關航機，通過後呼叫"**Clear**"。 4.(1)呼叫航管，要求避讓航向。 (2)保持目視相關航機，通過後呼叫"**Clear**"。 (3)呼叫航管，恢復正常航線。

2.Resolution Advisory procedures (RA)	航機與相關接近之航空器安全隔離不足，TCAS 立即顯示音頻警告及俯仰改正指示(EADI 顯示紅色框區或 VSI 顯示 Red Band)，必須立即依指示操作避讓。(飛行人員應依程序 Follow RA 顯示操作，除非有危害飛機安全或目視確認原航道絕對安全。)	
RA 改正程序(All RAs are Inhibited below 1000' Radio Altitude)	1.Call Out "**TCAS Climb /Descend**"	1.Check & Advise ATC "**TCAS Climb / Descend**"
	2."**A/P – Disengage**" "**A/T – Disengage**"	2. Verify
	3.Pitich Control Follow RA 指示(Throttle 依 RA 指示操作增減，保持 EADI 小飛機於紅色區外或 VSI 升降率指示於 Red band 外。)	3.加強對外目視報告相關航機及 (1)Pitch UP/DN – xx (2)VSI – xxx UP/DN (3)SPD – xxx
	4.相關航機危害解除： (1) Advise ATC (2)柔和改正回原航行計畫	4.Advise ATC "**Clear of Conflect / Returning to "xxx**"
	5.A/P – A/T – ON	5. "**TCAS Climb or descent completed FLxxx, Resumed OWN navigation**"

1.18.7.4 Flight Crew Operations Manual

Base on the Flight Crew Operations Manual, version 24, issued by the Boeing Company on May 03, 2006, the related information is summarized below:

- Chapter 10.10.42: TCAS HIS Symbology are shown in the Table below:

B-27015 through B-27021

Symbol	Name	Applicable Mode(s)	Remarks
■ ↑ -03	TCAS resolution advisory (RA), relative altitude (R)	MAP CTR MAP APP VOR	These symbols are displayed only when the EFIS control panel traffic (TFC) switch is selected on. Refer to Chapter 15, Warning Systems. The arrow indicates traffic climbing or descending at a rate greater than or equal to 500 fpm. At rates less than 500 fpm, the arrow is not displayed. The number and associated signs indicate altitude of traffic in hundreds of feet relative to the airplane. The number is below the traffic symbol when the traffic is below, and above the traffic symbol when the traffic is above the airplane. Absence of the number implies altitude unknown.
+02 ● ↓	TCAS traffic advisory (TA), relative altitude (A)		
♦ ↓ -05	TCAS proximate traffic, relative altitude (W)		
+09 ◇ ↑	TCAS other traffic, relative altitude (W)		
RA 5.3 +03 ↑ TA 8.9 -12 ↑	TCAS no bearing message (RA–R, TA–A)	MAP CTR MAP APP VOR	Message provides traffic type, range in NM, altitude and vertical direction.
TRAFFIC	TCAS traffic alert message (RA–R, TA–A)	All	Displayed whenever a TCAS RA or TA is active. EFIS control panel TFC switch does not have to be selected on.

1.18.7.5 Quick Reference Handbook (QRH)

- Chapter MAN: Section 0, MAN1.8, Traffic Avoidance

Traffic Avoidance

The following is accomplished immediately by recall whenever a TCAS traffic advisory (TA) or resolution advisory (RA) occurs.

WARNING: Comply with the RA if there is a conflict between the RA and air traffic control.

WARNING: Once an RA has been issued, safe separation could be compromised if current vertical speed is changed, except as necessary to comply with the RA. This is because TCAS II–to–TCAS II coordination may be in progress with the intruder aircraft, and any change in vertical speed that does not comply with the RA may negate the effectiveness of the other aircraft's compliance with the RA.

Note: If stick shaker or initial buffet occurs during the maneuver, immediately accomplish the APPROACH TO STALL RECOVERY procedure.

Note: If high speed buffet occurs during the maneuver, relax pitch force as necessary to reduce buffet, but continue the maneuver.

Note: Do not use flight director commands until clear of conflict.

For TA:

Pilot Flying	Pilot Monitoring
Look for traffic using traffic display as a guide. Call out any conflicting traffic.	
If traffic is sighted, maneuver as required.	

For RA, except a climb in landing configuration:

WARNING: A DESCEND (fly down) RA issued below 1,000 feet AGL should not be followed.

Pilot Flying	Pilot Monitoring
If maneuvering is required, disengage the autopilot and autothrottle. Smoothly adjust pitch and thrust to satisfy the RA command. Follow the planned lateral flight path unless visual contact with the conflicting traffic requires other action.	
Attempt to establish visual contact. Call out any conflicting traffic.	

1.18.7.6 Flight Crew Training Manual

Base on the Flight Crew Training Manual, version 5, issued by Boeing Company at Oct. 31, 2006, the related information include 7.18,7.19 and 7.20 is summarized below:

Airspeed

Airspeed changes very slowly because of small changes in thrust and drag. Anticipate thrust changes and apply them at the first indication of change on the airspeed indicator or speed tape (as installed). An increase in thrust is required as bank angle increases.

Note: If the command speed is set to target speed on the MCP, the airspeed fast/slow indicator (as installed) on the attitude display indicates thrust change required.

Rollout

Roll out at the same rate as used during normal turns. Normally rollout should begin 15° to 20° prior to the desired heading. A decrease in pitch is required as the bank angle is decreased to maintain constant altitude. A decrease in thrust is required to maintain constant airspeed.

Terrain Avoidance

The Ground Proximity Warning System (GPWS) PULL UP Warning occurs when an unsafe distance or closure rate is detected with terrain below the airplane. The Look-ahead terrain alerting (as installed) also provides an aural warning when an unsafe distance is detected from terrain ahead of the airplane. Immediately accomplish the Terrain Avoidance maneuver found in the non-normal maneuvers section in the QRH.

Do not attempt to engage the autopilot and/or autothrottle until terrain clearance is assured.

Traffic Alert and Collision Avoidance System (TCAS)

TCAS is designed to enhance crew awareness of nearby traffic and issue advisories for timely visual acquisition or appropriate vertical flight path maneuvers to avoid potential collisions. It is intended as a backup to visual collision avoidance, application of right-of-way rules and ATC separation.

Use of TA/RA, TA Only, and Transponder Only Modes

TCAS operation should be initiated just before takeoff and continued until just after landing. Whenever practical, the system should be operated in the TA/RA mode to maximize system benefits. Operations in the Traffic Advisory (TA) Only or TCAS Off (Transponder Only) modes, to prevent nuisance advisories and display clutter, should be in accordance with operator policy.

The responsibility for avoiding collisions still remains with the flight crew and ATC. Pilots should not become preoccupied with TCAS advisories and displays at the expense of basic airplane control, normal visual lookout and other crew duties.

Traffic Advisory (TA)

A Traffic Advisory (TA) occurs when nearby traffic meets system minimum separation criteria, and is indicated aurally and visually on the TCAS traffic display. A goal of the TA is to alert the pilot of the possibility of an RA. If a TA is received, immediately accomplish the Traffic Avoidance maneuver in the QRH.

Maneuvers based solely on a TA may result in reduced separation and are not recommended.

The TA ONLY mode may be appropriate under the following circumstances:

- during takeoff toward known nearby traffic (in visual contact) which would cause an unwanted RA during initial climb
- during closely spaced parallel runway approaches
- when flying in known close proximity to other airplanes
- in circumstances identified by the operator as having a verified and significant potential for unwanted or undesirable RAs
- engine out operation.

Resolution Advisory (RA)

When TCAS determines that separation from approaching traffic may not be sufficient, TCAS issues a Resolution Advisory (RA) aural warning and a pitch command. Maneuvering is required if any portion of the airplane symbol is within the red region on the attitude indicator. Flight crews should follow RA commands using established procedures unless doing so would jeopardize the safe operation of the airplane or positive visual contact confirms that there is a safer course of action. If a RA is received, immediately accomplish the Traffic Avoidance maneuver in the QRH.

Resolution advisories are known to occur more frequently at locations where traffic frequently converges (e.g. waypoints). This is especially true in RVSM airspace. Climb or descent profiles should not be modified in anticipation of avoiding an RA unless specifically requested by ATC.

RA maneuvers require only small pitch attitude changes which should be accomplished smoothly and without delay. Properly executed, the RA maneuver is mild and does not require large or abrupt control movements. Remember that the passengers and flight attendants may not all be seated during this maneuver. The flight director is not affected by TCAS guidance. Therefore, when complying with an RA, flight director commands may be followed only if they result in a vertical speed that satisfies the RA command.

During the RA maneuver, the aircrew attempts to establish visual contact with the target. However, visual perception of the encounter can be misleading, particularly at night. The traffic acquired visually may not be the same traffic causing the RA.

Pilots should maintain situational awareness since TCAS may issue RAs in conflict with terrain considerations, such as during approaches into rising terrain or during an obstacle limited climb. Continue to follow the planned lateral flight path unless visual contact with the conflicting traffic requires other action. Windshear, GPWS, and stall warnings take precedence over TCAS advisories. Stick shaker must be respected at all times. Complying with RAs may result in brief exceedance of altitude and/or placard limits. However, even at the limits of the operating envelope, in most cases sufficient performance is available to safely maneuver the airplane. Smoothly and expeditiously return to appropriate altitudes and speeds when clear of conflict. Maneuvering opposite to an RA command is not recommended since TCAS may be coordinating maneuvers with other airplanes.

Upset Recovery

For detailed information regarding the nature of upsets, aerodynamic principles, recommended training and other related information, refer to the Airplane Upset Recovery Training Aid available through your operator.

An upset can generally be defined as unintentionally exceeding the following conditions:

- pitch attitude greater than 25 degrees nose up, or
- pitch attitude greater than 10 degrees nose down, or
- bank angle greater than 45 degrees, or
- within above parameters but flying at airspeeds inappropriate for the conditions.

General

Though flight crews in line operation rarely, if ever, encounter an upset situation, understanding how to apply aerodynamic fundamentals in such a situation helps them control the airplane. Several techniques are available for recovering from an upset. In most situations, if a technique is effective, it is not recommended that pilots use additional techniques. Several of these techniques are discussed in the example scenarios below:

- stall recovery
- nose high, wings level
- nose low, wings level
- high bank angles

1.18.7.7 B-757 Fleet Flight Crew Recurrent Training Guideline

The TCAS II system introduction (Ref. Appendix 5) is part of the FEA B-757

Fleet flight crew recurrent training material (Ref. Appendix 6). It was a 50 minute syllabus.

1.18.7.8 The Related TCAS System Documents

- Introduction to TCAS II Version 7－FAA (Appendix 5)
- B-757 Fleet flight crew recurrent training material－FEA (Appendix 6)
- AC90-48C Pilot' Role in Collision Avoidance－FAA (Appendix 7)
- TCAS/ACAS II(Change 7) Pilot's Guide－Honeywell (Appendix 8)
- AC-120-019 TCAS/ACAS operational approval–CAA (Appendix 9)
- AC120-55B Air carrier operational approval and use of TCAS II－FAA. (Appendix 10)

2 Analysis

2.1 General

The EF306 and TG659 flight crew members were properly certificated and qualified in accordance with the applicable Civil Aviation Regulations. The flight crew's duty and rest periods were normal within the 72 hours prior to the occurrence. There was no evidence indicated the flight crew members had any physical or psychological problems, nor any use of alcohol or drugs.

The aircraft were equipped, maintained and operated in accordance with each own states' regulations. Also the aircraft were operated within operational weight and balance limitations. Based on the meteorological information contained in Section 1.7, there were no adverse weather conditions at the time of the occurrence.

2.2 Flight Operations

2.2.1 Communication between EF306 and ICN

Paragraph 13.4.6 of FAT FOM states: "The flight crew shall reconfirm the unclear or doubt information received from ATC".

According to the CVR, ICN mistakenly called Far Eastern 306 for Far Eastern 307 at 01:55:54 and mistakenly called China Eastern 579 for China Eastern 5053 at 02:01:25 but corrected by China Eastern 579. ICN mistakenly called Far Eastern 306 for Far Eastern 308 again at 02:06:50. It showed that the ICN did not adequately use the correct flight numbers in that area. The flight crew should correct the incorrect call sign from ATC immediately after the mistaken call.

At the moment of ICN instructing: "Far Eastern 308 stop uh immediately clear

and descend" at 02:06:50 and then calling TG659 turn right to heading 270, the EF306 CM-1 leveled off the aircraft and asked: "What had happened?" This shows that the EF306 flight crew assertively leveled the aircraft at FL340 without totally comprehending the instruction from ICN.

The radio frequency of EF306 might be occupied by other ATC calls during the ICN issued the instruction at 02:06:50 with TCAS "Descend, Descend" message announced in the cockpit, so that the EF306 flight crew could not communicate with ATC and assertively leveled off the aircraft at FL340. The EF306 flight crew should have maintained the original descent profile and reconfirm the instruction from ATC.

2.2.2 Flight Path Analysis of EF306

According to the radar and FDR data, EF306 was on route B-576 at FL390 and started northbound, descending to FL310 after the ICN issued the clearance at 02:02:53. At 02:06:50, EF306 passed FL340 with 493 Knots ground speed and with approximately 1,900 feet per minute descent rate, away from the TG659 about 11.62 NM. The TG659 was on route B-576 but southbound and maintained level flight at FL340 with 421 knots ground speed. The closure rate between the two aircraft was about 0.25NM/sec[24]. At the 02:02:53, EF306 stopped descent and leveled off the aircraft at about 33,800 feet due to ICN called: "Far Eastern 308 Stop uh immediately clear and descend".

Had EF306 kept its original descent profile, the EF306 would have passed 33,700 feet at 02:07:01(the "Descend, Descend" message issued in the cockpit), with a distance about 8.82 NM to TG659 and 128 feet below TG659. If both of the aircraft kept the planned flight profile, (Ref. to 2.6.1) they would have passed 36 seconds later with the TA caution message only.

The CVR, FDR data and the flight crew interview notes revealed that the flight crew started level off the aircraft at 02:06:50 right after the instruction call from ICN, though the EF306 flight crew did not quite comprehend the instruction from ICN. If ICN did not called out "Far Eastern 308 stop uh immediately clear descend", both of the aircraft would have TA messages only at about 02:06:48, the flight crew of both aircraft only needed to keep monitoring the anomaly. It is concluded that ICN made a non standard call to EF306 during its descent when passing FL340.

24 (493+421) / 3,600 = 0.25 NM/sec

2.2.3 TCAS Operations by Flight Crew

2.2.3.1 EF306

The paragraph 8.1 of FAT FOM define whenever the TA occurred, the PF shall scans outside of the aircraft for traffic, focusing in the direction advised by the PM, the PM shall call out the intruder's clock position, relative altitude and distance. The QRH for this type aircraft states that the flight crew shall look for traffic using traffic display as a guide, and call out any conflicting traffic. According to the CVR and FDR data, the TA was announced at 02:06:48, the distance between two aircraft was approximately 12.2 NM and for 12 seconds till RA announced. There was no TCAS related communications between PF and PM in this period except level off the aircraft at FL340. This showed that the EF306 flight crew did not complete the TCAS TA standard operation procedures.

The detailed QRH TCAS RA procedures are as follows:

PF:

1. *If maneuvering is required, disengage the autopilot and auto throttle; smoothly adjust pitch and thrust to satisfy the RA command. Follow the planned lateral flight path unless visual contact with the conflicting traffic requires other action.*
2. *Attempt to establish visual contact. Call out any conflicting traffic.*

PM:

Attempt to establish visual contact. Call out any conflicting traffic.

Based on the data on CVR and FDR, the EF306 RA alert (Descent) announced at 02:07:01, PF started to push down the column at the time of 02:07:03 with the maximum vertical acceleration of -1.06 g at 02:07:07. The pitch angle changed from +4° to -18° in 4 seconds with the change rate of 5.5 deg/sec. The maximum momentary descent rate was 12,000 ft/min. The distance to TG659 was 9 NM while the RA announced at 02:07:01 and the closure rate was 0.25NM/Sec. The distance between two aircraft six seconds later (at the time of 02:07:07) was 7.41 NM. This showed that the abrupt control input to the aircraft was not necessary at that moment.

Page 6-7 of TCAS/ACASⅡ（Change 7）Pilot's Guide(Att. 8) define: "Mach No.)X1,000= Vertical speed change in feet per second for a 1° pitch change", "A prompt, smooth pitch change of 2° to 6° should be sufficient to resolve nearly all conflicts". At the time of RA announced on EF306, the Mach number was approximately 0.80. Even if the aircraft was pushed down with minimum pitch angle (2°), the anticipate aircraft descend rate would be approximately 1,600 ft/min and the altitude would reach about 33,500 feet in 10 seconds. This reconfirms that the large abrupt control was not necessary in this avoidance maneuver.

2.2.3.2 TG659

The interview notes showed that the flight crew already detected that there was a descending traffic approaching them beyond 10 NM. The FDR data verified that TA announced at 02:06:48 with 12.2 NM distance apart from the traffic. The FDR data showed the RA alert (Climb) announced at 02:07:00, the AP disengaged at 02:07:02, and the aircraft started climbing at 1,600 ft/min with maximum pitch up angle of 5.3° and maximum vertical acceleration of 1.24 g. The aircraft also turned right to heading 270 with 19° bank angle. This proved the TCAS RA avoidance maneuver of TG659 flight crew met the standard operational procedures and related requirements.

2.2.4 FAT Crew Resource Management

The integrated information of FAT FOM, FOTM, FCOM, PTM and FCTM indicate that once a TA has been issued, the flight crew should remind themselves of the TCAS procedures. The PF should look for the threatening traffic immediately. The PM should monitor the TCAS display and inform PF the position, distance and altitude of the other aircraft to keep distance from the other aircraft. The PF are responsible for the aircraft control, situation awareness and making final decision. The PM should keep closely monitor the TCAS display; call out any updated information, radio communication and cross check the PF operations. Once a RA has been issued, the PF should looks inside the aircraft, call out “TCAS Climb/Descend” and disengage A/P and A/T, smoothly adjust pitch and thrust to satisfy the RA command and maneuver immediately until clear of conflict. The PM should monitor and verify all required action to have been completed until clear of conflict, and inform ATC when time permits.

The EF306 flight crew did not call out the related messages while the TA announced in the cockpit, did not exchange and cross check the related message, did not follow the related operational procedure while the RA was issued and mistakenly informed “TCAS Descend” as “TCAS Climb” to ATC.

The flight crew should understand the basic concepts of TCAS logic, theory and the cockpit display, should immediately detect the approaching traffic, and execute the defined CRM procedures and exhibit situation awareness. The EF306 flight crew did not use good CRM procedures in this event.

2.2.5 FAT TCAS Training Program

The TCAS flight crew training program should include theory and simulator practice. The flight crew should have an understanding of how TCAS works. This includes an understanding of the alert thresholds, expected response to TAs and RAs, proper use of TCAS displayed information, phraseology and

system limitations. The simulator practices should include the proper reaction to a TA, the response to an RA requiring prompt and appropriate reactions from the aircrew involved.

A review of the FOM revealed that the related TCAS training was stated in the initial pilot training program, recurrent training program, line and route check program and CRM training program. The related training materials, including descriptions of the general concept of TCAS, TCAS system function, advisory thresholds, limitations, expected flight crew response and maneuver to TA and RA met the Taiwan CAA's AC120-019 requirements. It is concluded that all the training programs would satisfy the TCAS avoidance maneuvers of flight crew.

2.2.6 Visual Perception

The EF306 flight crew interview records indicated: "I followed the TCAS red T-bar on the ADI and pushed down the aircraft smoothly. Afterwards the TCAS issued an "Increase Descent" aural warning. At the same time the pilot flying, PF, looked outside from the left to the right and visually contacted that there was a flying object approaching rapidly in front of him. So the pilot, PF, pushed down the aircraft hard to avoid the traffic. According to the FDR, the PF started to push down at 02:07:03 and a maximum negative g occurred at 02:07:07.

The FDR and RDR data revealed that the distance between EF306 and TG659 were 9 NM apart at 02:07:01 and the approaching rate was about 0.25NM/sec. The visual closure rate was extremely fast when EF306 visually contacted the TG659.

The appendix 1 of FAA's AC90-48C "pilot Role in Collision Avoidance" (Appendix 7) shows: A 40 ft x 11 ft aircraft approaching from half mile away will have an apparent size about 3 cm wide. If this object is 10 miles away, the size you see in the cockpit will be 0.2 cm. Based on the description above, a 200 ft x 60 ft Boeing 777 aircraft, away from half mile, will be in a size of 15 cm x 6 cm, or away from 10 miles, in a size of 1.0 cm.

The apparent size of an aircraft varies in the form of an exponential function while the two aircraft are approaching; a more detail description is in Attachment 9. The closure rate and apparent size of the TG659 views from EF306 cockpit with respect to the time to CPA[25] is shown in Figure 2.2-1. Based on the results of Figure 2.2-1, the apparent size of TG659 at the time of 02:07:01(RA warning issued) was about 0.3 centimeter and almost the same at the time of 02:07:07(the time of max. negative g). This means that the PF's visual contact dose not agree with the data of Figure 2.2-1.

25 Closest point of approach at 020736~37.

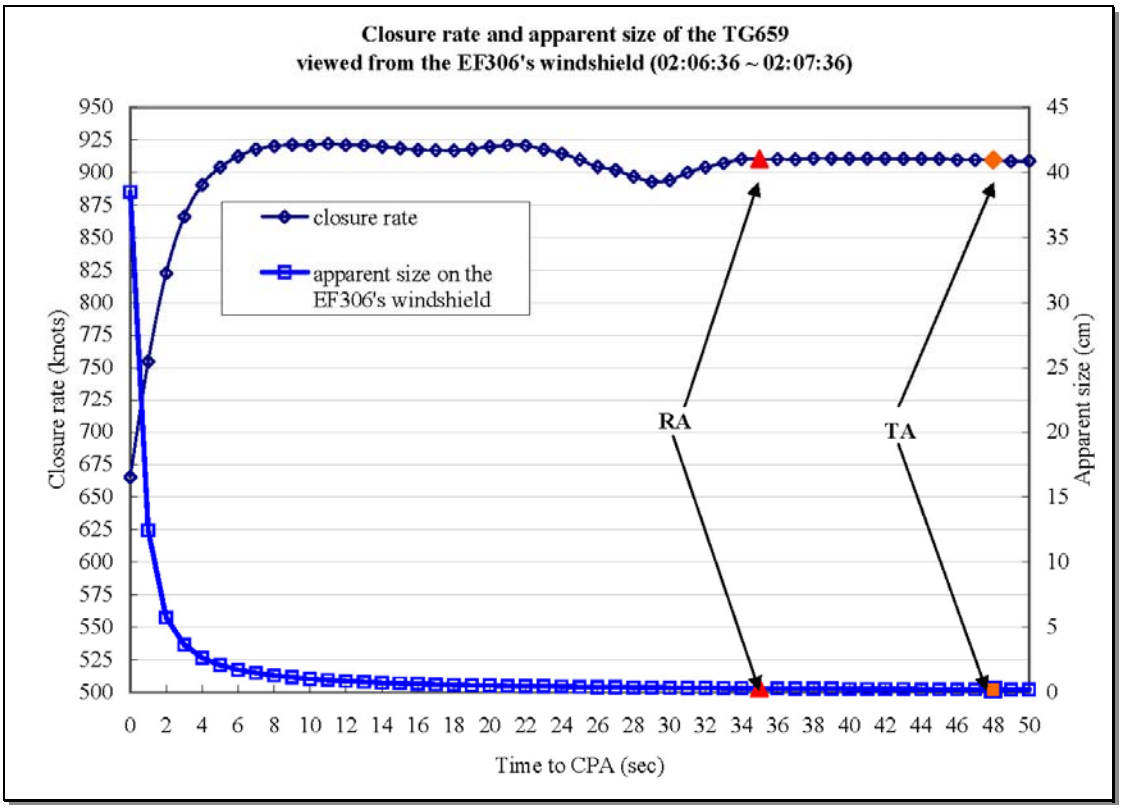

Figure 2.2-1 The apparent size of TG659 from EF306 cockpit

The FAA's AC90-48C also indicates: Based upon the "see and avoid principle" it takes approximate 12.5 seconds to initiate the traffic avoidance maneuver after visual contact with threatening approaching traffic. The EF306 RA announced 36 seconds prior to the CPA in this event. The threatening traffic was 9 NM ahead. If the EF306 initiated the avoidance maneuver 12.5 seconds later, there were still about 24 seconds prior to the CPA; the apparent size of TG659 based on Figure 2.2-1 is about 0.4 centimeter. This again means that the abrupt TCAS avoidance maneuver was not necessary. Page 6-8, TCAS/ACASⅡ (Change7) Pilot's Guide （Appendix 8） emphasizes when RA is announced, the PF shall look inside the aircraft to determine the commanded vertical speed required and change the pitch of the aircraft on the attitude indicator to the computed target attitude which will yield the commanded vertical speed. The PM shall continue to scan the outside of the aircraft for traffic, to back up the PF to insure the required performance and notify ATC when practical. Page 7-20, FCOM also indicated that visual avoidance maneuvers could mislead the flight crews into making abrupt input to the aircraft.

From the analysis above, it is concluded that conducting the avoidance maneuver visually, rather than by relying on the TCAS display probably will mislead the pilot into performing an abrupt input to the aircraft.

2.3 Air Traffic Control Factors

2.3.1 Air Traffic Control of EF306

At this section, the ACC time in Attachment 1 is used for analysis. During the period of 4 minutes after instructing EF306 to descend to 31,000 feet, while concentrating on radar identification of UNS514T which was flying along A586, SSRC missed the converging situation of EF306 and TG659 for a while. Soon after, he recognized that the two aircraft were approaching at a distance of about 13NM as shown in the radar display[26] of Figure 2.3-1. He stated that at the time, “I thought it was a little urgent.” after recognizing that EF306 was passing 34,300 feet and TG659 was cruising at 34,000 feet from the opposite direction.

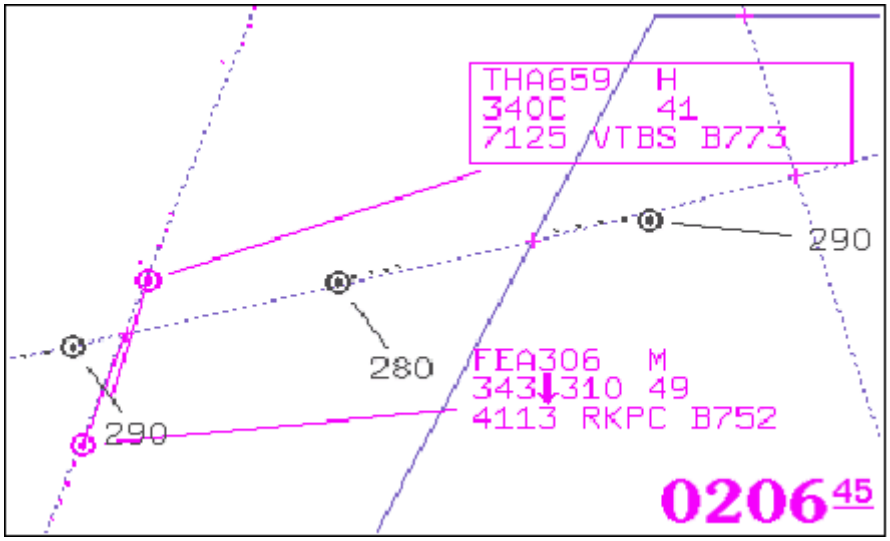

Figure 2.3-1 Radar display at 02:06:45

At this time, in order to separate the two aircraft, SSRC instructed EF306 “far eastern tree zero eight stop uh immediately clear descend” and TG659 to turn to the right quickly saying that “thai six five niner turn right heading two seven zero two seven zero immediately”.

In response to this control instruction, EF306 did not read back the instruction and stopped descent momentarily as shown in Figure 2.3-3, 4, 5 and 6 because EF306 misunderstood the instruction to stop at 34,000 feet. EF306 flight crew stated that they did not perceive the latter half of the instruction to descend immediately, and TG659 turned to the right after reading back the instruction.

26 The Incheon ACC radar display used for this analysis are printed each every 5 seconds, and the radar data updates every 12 seconds at 02:06:39, 02:06:51, 02:07:03 and 02:07:15, etc.

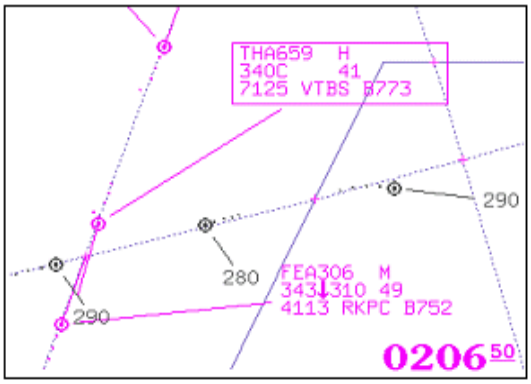

Figure 2.3-2 Radar display at 02:06:50

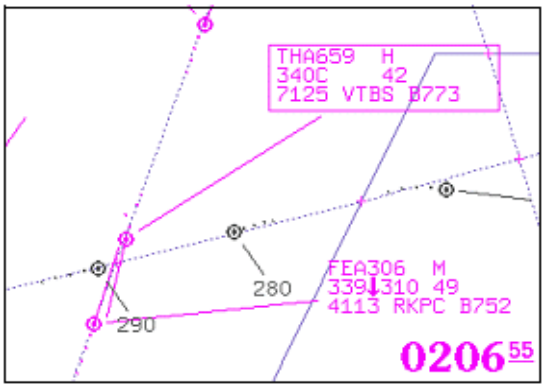

Figure 2.3-3 Radar display at 02:06:55

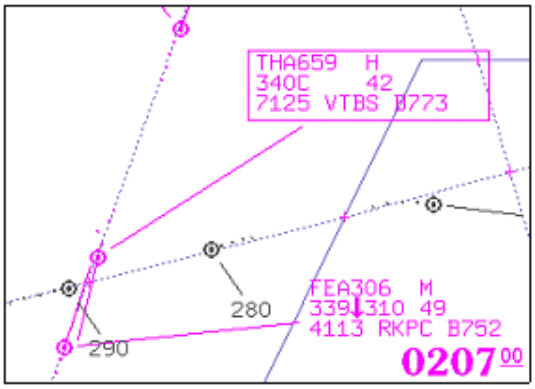

Figure 2.3-4 Radar display at 02:07:00

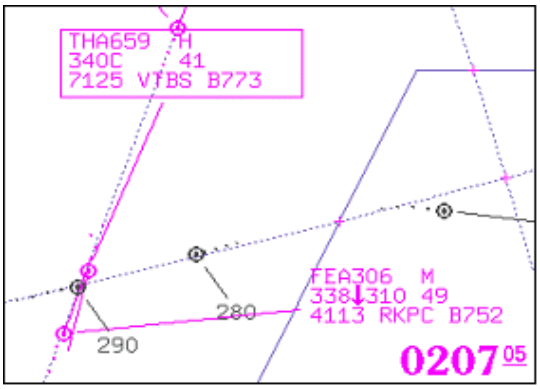

Figure 2.3-5 Radar display at 02:07:05

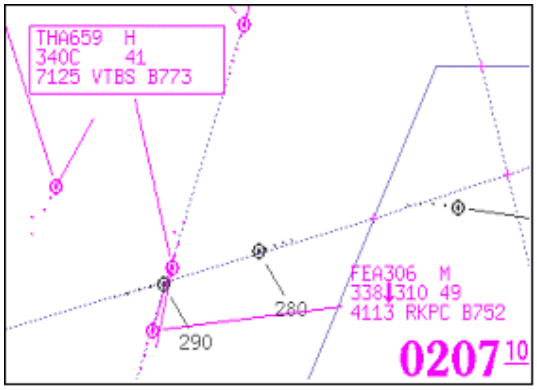

Figure 2.3-6 Radar display at 02:07:10

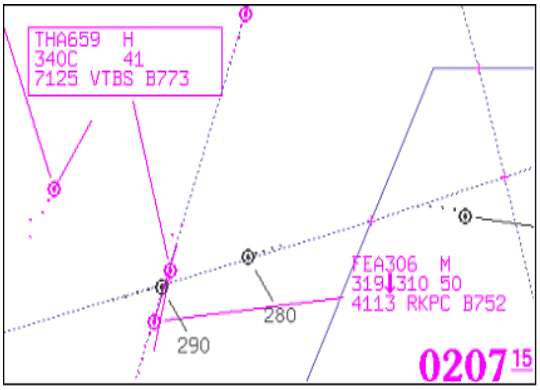

Figure 2.3-7 Radar display at 02:07:15

SSRC stated that he thought that the urgent situation had been over because the altitude of EF306 was displayed as 33,800 feet while he was instructing

“stop uh”. With his instinctive and instant judgment that the altitude of EF306 was 300 feet higher than TG659 at the time when he gave an instruction to EF306. He promptly instructed EF306, “immediately clear descend” because he believed that EF306 was descending at the moment.

But, in the situation of figure 2.3-1 and 2.3-2, considering the altitude of EF306 indicating continuously 34,300 feet in radar display when SSRC instructed that “immediately clear descend” following after “far eastern tree zero eight stop uh…” it seems that the altitude of EF306 was not displayed as 33,800 feet while SSRC was issuing these instructions.

By recognizing the situation of approaching traffics at about the same altitude after loosing the flying status of two aircraft for a while, SSRC believed it was the urgent situation. Observing the displayed altitude of two aircraft, SSRC instructed “stop” to EF306 which was relatively higher than TG659. Soon after, reminding that EF306 was descending, he thought that it would be better to make EF306 keep descending. Thus it is concluded that SSRC issued two different control instructions “stop” and “descend” in succession.

In this situation, SSRC did not use correct aircraft call sign. Moreover he did not issue clearly the subsequent control instruction distinguishing it from the preceding one, such as using the term “Correction” when the subsequent control instruction needs to be different from the preceding one. Therefore it is concluded that the controller’s intention was not delivered correctly to EF306 because of the controller’s misuse of control phraseologies and aircraft call signs, and the controller’s incorrect control instructions.

Because EF306 could not perceive the latter half of the instruction while concentrating on the TCAS warning (Traffic, Traffic) which announced about 2 seconds before SSRC’s descent instruction, it is concluded that EF306 could not even read back or ask a question for confirmation[27] about unclear control instruction. SSRC also did not ask the flight why[28] EF306 did not read back his instruction.

About 20 seconds after receiving SSRC’s control instruction (far eastern tree zero eight stop…descend.), EF306 notified SSRC that “INCHEON CONTROL FEA306, TCAS TCAS CLIMB”. To the contrary of reporting SSRC to climb, in fact flight 306 was descending in conforming to TCAS. At the time, the altitude of EF306 was displayed 200 feet lower than that of TG659 as shown in Figure 2.3-6 and SSRC instructed EF306 that “roger now descend descend”. In response to this instruction, EF306 replied that “negative negative we follow TCAS”. SSRC did not provide traffic information but attempted to modify the aircraft flight path instead, after EF306 had reported a maneuver induced by a TCAS RA[29]. It is concluded that SSRC applied TCAS/ATC related procedures inappropriately.

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27 Reference to ICAO Doc 4444 4.5.7.5.1

28 Reference to ICAO Doc 4444 4.5.7.5.2

29 Reference to ICAO Doc 4444 15.7.3.2

Considering that the altitude of EF306 was 31,900 feet and the altitude of TG659 was 34,000 feet at this time as shown in Figure 2.3-7, it is analyzed that the vertical separation of 2,100 feet and the lateral separation more than about 5 NM have been established. Based on the FDR data, the horizontal and vertical distances between EF306 and TG659 were 9.79-7.09 NM and 176-983 feet respectively from 02:06:57 to 02:07:08. There were 0.85 NM, and 2,611 ft at 02:07:36 (Closest Point of Approach). Therefore, the closest point of EF306 and TG659 met the ICAO radar separation minimum but didn't meet the minimum radar separation of 10 NM into an actual control for a safer control despite required separation standard.

Based on the facts that SSRC could not either provide the air traffic control service in advance[30] to keep the distance well enough to maintain separation, or expedite the descent of EF306 by providing the information of the opposite traffic. The SSRC did not deliver his intention correctly to the TG659 by not employing the correct air traffic control phraseology under the situation of closing traffics of urgent and instruct TG659, which was cruising at FL340, to turn to the right all of a sudden without giving sufficient explanation or providing traffic information as well. It is concluded that SSRC didn't provide traffic information in time despite the standard separation was maintained through out the event.

The reason SSRC not providing air traffic control services as required is that SSRC did not monitor the altitude status of EF306, and did not recognize the converging situation of these two aircraft in time. The reasons for this are listed as follows. SSRC was communicating continuously with 8 aircraft during about 4 minutes before EF306 and TG659 were approaching each other. And SSRC concentrated his view for about one minute on radar identifying an aircraft in the north-east area of his sector. In addition, he was responsible for ATC services in an area of jurisdiction as broad as 300 NM from south to north.

2.3.2 Control Position Operation

Incheon ACC South Sector consisted of the en route control position, the coordination control position and the flight data control position but was operating in combining the coordination control position and the flight data control position at the time of this occurrence. The controller who was on duty at flight data control position held "Qualification of Flight Data Control" but did not hold the rating of en route control or radar en route control, and SSRC had en route control experience for more than 20 years.

In spite of having much experience in the en route control, during about 4 minutes after instructing EF306 to descend, SSRC concentrated for about 1 minute on radar identification of UNS514T which was flying along A586. During that period of time, SSRC could not allocate his attentions

30 Reference to ICAO Doc 4444 4.5.1.5

appropriately to aircraft under his control, and for this reason, SSRC could not recognize that EF306 and TG659 were converging for a while.

The reason that he could not allocate his attention appropriately for a while in the situation of controlling 13 aircraft at the time might be the lack of his personal control capability or the human error. Considering that the human capability can be limited when services are provided by only one controller paying attention continuously to lots of aircraft in a relatively broad area, and particularly that the sudden occurrence of abnormal situation requires capability beyond the acceptable range of human performance, it is concluded that intrinsic unsafe factors which could lead to another occurrences are inevitable in this situation of a sudden abnormality.

In order to recognize the limit of human capability or the possibility of human error, it is concluded that management should reconsider a Team Resource Management plan, including adjustments of area of jurisdiction or more reasonable manpower arrangements.

2.3.3 Airway and Arrival Flight Procedure

There were no standard arrival procedures along B576 from south of Jeju to Jeju airport. Thus when Incheon ACC vectored the EF306 toward the south of Mt. Halla where is the radar blind airspace of Jeju Approach Control and completed the radio transfers, the Jeju Approach was not able to vector the aircraft immediately although the flight had requested an emergency landing. By applying the procedural control , the Jeju Approach Control did not provide the aircraft in emergency a track as short as possible.

B576 which is used by aircraft en route to and from Korea, Taiwan and China is applying RVSM operations, and is also used for aircraft approaching to and departing from Jeju airport. Therefore the risk of aviation safety particularly when the traffic density is increasing requires a comprehensive review very soon. If situations justify the requirements, the authority concerned should establish standard arrival routes for Jeju airport, or consider establishing a new ATS in parallel with B576.

2.3.4 Radar Control System

Radar Data Processor (RDP) system of Incheon ACC manufactured by Lockheed Martin(USA) has been operated since 2001 with Micro-EARTS (MICROPROCESSOR ENROUTE AUTOMATED RADAR TRACKING SYSTEM) program which is adopted by FAA. Thus the Conflict Alert (CA) detection standard of RDP system is operating in conformity to the standards of FAA. In case of detecting the potential collision of aircraft within 375 feet in vertical and 2 NM in lateral within the time period of 120 seconds, the CA system will alert the controllers visually and audibly.

Unlike TCAS which communicates every second, this CA alert based on the data which are calculated and anticipated on the basis of the signal received according to Scan Rate (one cycle per 12 seconds) of the ACC radar.

In addition to the dimensional and time parameters, the CA alert can only be triggered provided such situations are detected at least three times in five continuous radar scans.

As a result of analyzing the data of EF306 and TG659 as Attachment 10 and according to the standards above, the radar system was operating normally but CA was not announced because the RDP didn’t produce CA since the condition triggering the CA were not met.

2.4 Flight Path Analysis

According to the factual information on section 1.11, ASC obtained the flight paths of the EF306 and TG659 from the flight data recorders and the surveillance radars. Figure 2.4-1 indicates the superposing flight paths and radar tracks during the TCAS activation. The radar tracks of EF306 and TG659 are respectively plotted by the symbols of ◆ and ★. Two types of flight paths were recovered. One was from FDR recorded position (latitude, longitude), sourced from Inertial Reference Unit (IRU). The other was from the Integrating flight path, based on recorded parameters (time, pressure altitude, ground speed, drift angle, heading) by integrating the flight paths of the EF306 (blue line) and TG659 (brown line). The initial position was based on radar data at the time of 02:00:02[31].

Figure 2.4-1 indicates that radar tracks and flight paths are well matched (02:00:02 ~ 02:10:00). But the radar track of TG659 had two bad data points (02: 07:28.2, 07:07:39.1). During the TG659 performing the climbing and right-turning, the two aircraft became very close, which probably caused the primary surveillance radar echo strength and slant range to be detected with noise and error.

2.4.1 Relative distance of the two aircraft during TCAS activation

Figure 2.4-2 includes the vertical speed, relative distance and relative altitude variation during the TCAS activation with relevant CVR transcripts. Table 2.4-1 lists those parameters, plotted in Figure 2.4-2, and described the derivative parameters with relative distance and bearing angle.

At the initial TCAS TA activation time (49 seconds prior to CPA), the relative distance and relative altitude of the two aircraft were 12.2 NM and 51 ft (positive value means the EF306 was at higher altitude). As EF306 disengaged the autopilot (41 seconds prior to CPA), the relative distance and relative altitude of the two aircraft were 10.05 NM and -171 ft (negative value means the altitude of the EF306 was lower than that of TG659).

At the initial TCAS RA activation time (36 seconds prior to CPA), the relative distance and relative altitude of the two aircraft were 8.82 NM and -128 ft, respectively. During the “RA Descend” activation, the descent rate of the EF306 reached to the maximum 12,096 ft/min (02:07:08, 29 seconds prior to CPA), and the relative distance and relative altitude of the two aircraft were 7.09 NM and -983 ft, respectively.

31 02:00:02: EF306 (E125.6391670, N31.0583330), TG659 EF306 (E126.3988890, N32.8644440)

During the “RA Climb” de-activation (25 seconds prior to CPA), the TG659 climbed with climb rate up to 1,664 ft/min. The relative distance and relative altitude of the two aircraft were 6.13 NM and -1,880 ft, respectively. At 02:07:36 (CPA), the closest distance and relative altitude were 0.85 NM, and -2,611 ft, respectively.

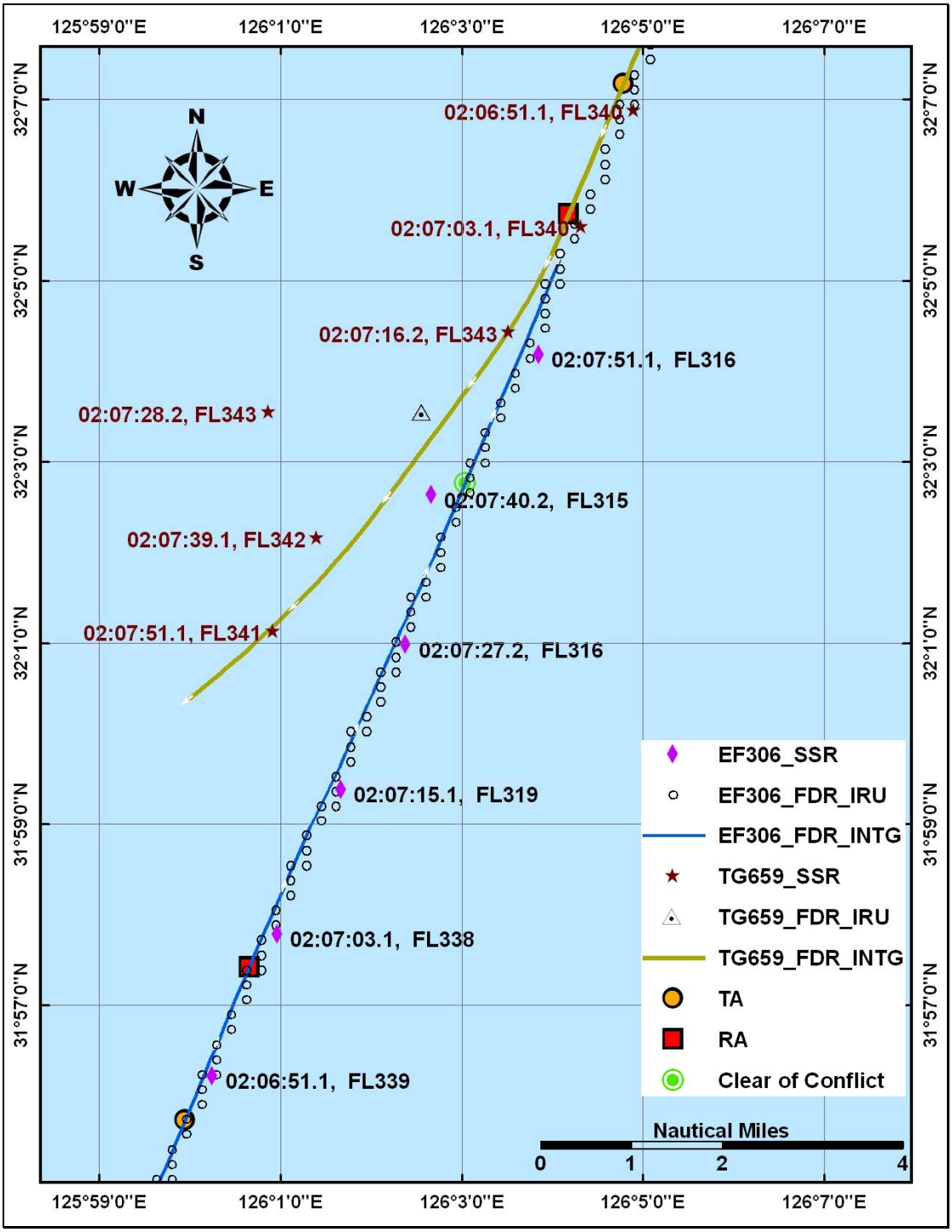

Figure 2.4-1 Superposition of the radar tracks and flight paths

In summary, TG659 followed the TCAS RA command to climb. However, the EF306 descended by using both of visual contact and TCAS RA command.

The flight crew performed an excessive descent rate during the first 8 seconds. That kind of maneuver induced a negative G-force and resulted in occupants' injury. At 02:07:08, the vertical separation was -983 ft. If the two aircraft fully followed the TCAS RA instructions and performed with the recommended vertical speed of RA (i.e. vertical speed between 0 ft/min and 1500 ft/min), there would be no collision hazard.

Table 2.4-1 The variation of vertical speed, relative distance, relative altitude, and bearing angle with respect to CVR transcripts

Time	Radar	VSPD	VSPD	Rel.	Rel.	Bearing	Radar	CVR Transcripts
to CPA	UTC	EF306	TG659	Dist.	Alt.	Angle	UTC	
(sec)	(hh:mm:ss)	(ft/min)	(ft/min)	(NM)	(ft)	(deg)	(ss.0)	
455	02:00:02	60	-16	112.89	5008	12		
284	02:02:53	0	0	70.73	5002	13	53.4	ICN: standby and far eastern tree zero six now descend to flight level tree one zero
279	02:02:58	0	0	69.43	5006	13	57.9	EF306 RDO-2: descend flight level tree one zero far eastern tree zero six
274	02:03:03	0	0	68.35	5003	13	03.3	EF306 CAM: (sounds identified as seat belt sign)
49	02:06:48	-1920	0	12.20	51	11	48.5	EF306 CAM: traffic traffic
48	02:06:49	-1920	16	11.94	18	11		
47	02:06:50	-1920	0	11.62	-9	11		
46	02:06:51	-1824	0	11.35	-42	11	50.8	ICN: Far eastern tree zero eight stop uh immediately clear descend
45	02:06:52	-1776	-16	11.09	-73	11		
44	02:06:53	-1776	-16	10.91	-102	11		
43	02:06:54	-1584	-32	10.64	-129	11		
42	02:06:55	-1248	-32	10.38	-156	11		

41	02:06:56	-864	-32	10.05	-171	11	55.9	ICN: thai six five niner turn right heading two seven zero two seven zero immediately
40	02:06:57	-384	-16	9.79	-176	11		
39	02:06:58	192	-16	9.67	-171	11		
38	02:06:59	480	-16	9.35	-159	11		
37	02:07:00	384	-16	9.08	-139	11		
36	02:07:01	-336	-32	8.82	-128	11	01.6	EF306 CAM: descend descend
							01.9	TG659: seven two five two seven zero thai six five nine
35	02:07:02	-1776	-64	8.64	-136	11		
34	02:07:03	-3168	-32	8.38	-188	11		
33	02:07:04	-5376	64	8.11	-277	11		
32	02:07:05	-8112	256	7.79	-370	11		
31	02:07:06	-9312	480	7.52	-560	11		
30	02:07:07	-9840	736	7.41	-812	11		
29	02:07:08	-12096	1008	7.09	-983	11		
28	02:07:09	-11760	1312	6.82	-1161	10		
27	02:07:10	-10848	1536	6.56	-1494	9		
26	02:07:11	-11040	1648	6.39	-1682	8		
25	02:07:12	-10752	1664	6.13	-1880	7		
24	02:07:13	-8448	1600	5.87	-2087	6	12.9	EF306 CAM-2: 可以 keep 嗯 (*ok keep um*)
23	02:07:14	-7488	1472	5.55	-2247	6		
22	02:07:15	-5808	1296	5.29	-2363	6	15.4	EF306 RDO-2: incheon control far eastern tree zero six TCAS TCAS

								climb
21	02:07:16	-4176	1088	5.13	-2450	6		
20	02:07:17	-2544	880	4.87	-2488	6		
19	02:07:18	-2064	688	4.61	-2532	6		
18	02:07:19	-1344	528	4.30	-2531	5	19.2	ICN: roger now descend descend
17							19.3	EF306 CAM: adjust vertical speed adjust
16	02:07:20	-1392	368	4.04	-2592	5		
15	02:07:21	-1344	224	3.78	-2601	4		
14	02:07:22	-1824	96	3.63	-2629	3	22.3	EF306 RDO-2: negative negative we follow TCAS
13	02:07:23	-1296	-16	3.37	-2658	2		
12	02:07:24	-1440	-112	3.07	-2686	1		
11	02:07:25	-1344	-192	2.81	-2690	-1		EF306 P-3: 各位貴賓 請儘速留在座位上並將安全帶扣好 (ladies and gentlemen please remain in seat and fasten your seatbelt as soon as possible)
10	02:07:26	-1104	-256	2.55	-2704	-3		
9	02:07:27	-960	-320	2.43	-2718	-5		
8	02:07:28	-1008	-384	2.17	-2724	-7		
7	02:07:29	-720	-432	1.91	-2735	-10		
6	02:07:30	-336	-496	1.66	-2736	-14		
5	02:07:31	0	-560	1.41	-2719	-20		
4	02:07:32	480	-592	1.17	-2692	-27		
3	02:07:33	768	-576	1.14	-2649	-37		

2	02:07:34	672	-464	0.95	-2611	-51	34.4	EF306 CAM-2: 喂 還還在紅線上 (hey still on the red line)
1	02:07:35	480	-304	0.91	-2602	-69		
0	02:07:36	96	-208	0.85	-2611	-87	36.4	EF306 PA-3: 這時候都不要離開座位 先把安全帶扣好 保護好自己 (do not leave your seat for this moment buckles up first and protect yourself)
							36.7	EF306 CAM-2: 慢 慢 慢 慢 慢 不要這麼快 follow follow follow 那個指示 (slow down don't be so fast follow that indication)
	02:07:37	-432	-160	0.87	-2617	-103		
	02:07:38	-816	-176	1.11	-2635	-115		
	02:07:39	-1104	-224	1.20	-2656	-123		
	02:07:40	-1200	-304	1.35	-2670	-130		
	02:07:41	-1008	-384	1.66	-2691	-134	40.9	速度快到了 (*the speed is about there*)
							41.6	EF306 CAM: clear of conflict
	02:07:42	-768	-448	1.85	-2691	-138		
	02:07:43	-528	-496	2.06	-2681	-140		
	02:07:44	-96	-528	2.30	-2675	-143		
	02:07:45	96	-544	2.50	-2666	-145		
	02:07:46	288	-576	2.72	-2649	-146	46.4	EF306 RDO-2: incheon control far eastern tree zero six we are clear traffic maintain flight level tree one zero

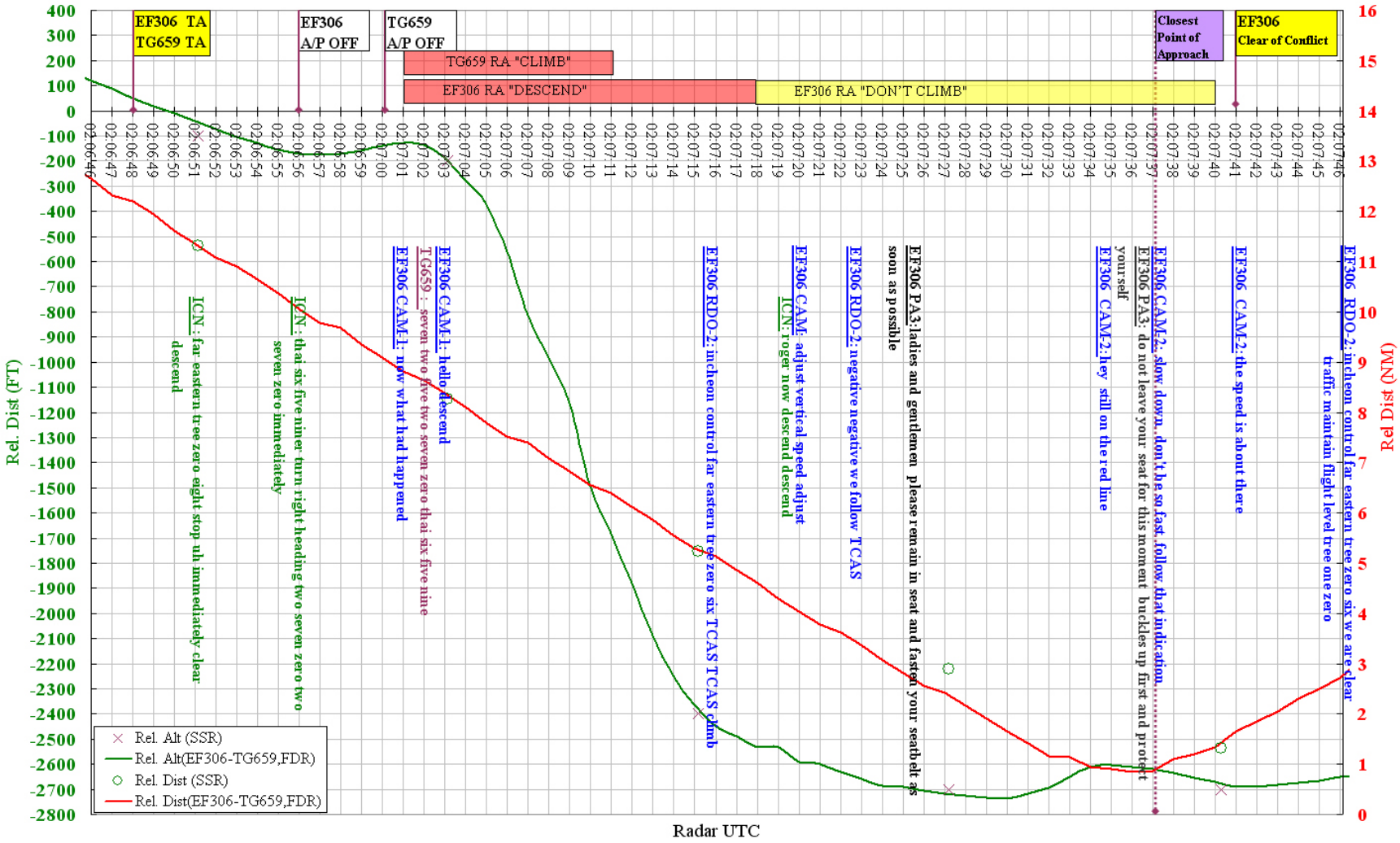

Figure 2.4-2 The variation of vertical speed, relevant CVR transcripts, relative distance and altitude during the TCAS activation

2.5 Survival factors

2.5.1 Injury to Passengers

Before the aircraft started to descend, the fasten seat belt sign was turned on by the flight crew. Cabin crew accomplished the automatic decent announcement to the passengers. In the meantime, cabin crews were clearing up passengers' tableware and starting to sell the duty-free goods in the aisle. Some passengers left their seats to use the lavatories or purchase duty-free goods.

According to the cabin crew's interview records, when the occurrence happened, the cabin crewmembers were bringing the duty free cart back to the galley. Initially, the aircraft jerked slightly, and then followed by severe movement. The passengers who left their seats or were in their seats without fastening their seat belts, the duty-free cart, and the unfixed cabin equipment were all bounced up and down.

Six cabin crewmembers and 14 passengers suffered injury in the occurrence. Four of the injured passengers sustained serious injury and other 10 passengers and 6 cabin crewmembers suffered minor injury, such as contusions, sprains and abrasions.

The four seriously injured passengers are described as below：

1. The female passenger seated in 26C with her seat belt unfastened was preparing to purchase duty-free goods. Due to the severe moving up and down of the aircraft, the passenger was bounced up several times and suffered from head injury, intra-cranial hemorrhage (ICH). In addition, she encountered an impact from a flying duty-free cart that bounced to ceiling. Her injuries resulted in coma.

2. The male passenger seated in 11D, just walked out of the lavatory. He was bounced up and also encountered impact by the duty-free cart. He received a complicated fracture of left humerus with radial nerve injury, sprains of right ankle region and fracture of big toe.

3. The male passenger seated in 34A did not fasten his seat belt because he just returned to his seat from the lavatory. This passenger suffered from fracture of left ribs and hemothorax.

4. The female passenger seated in 6A suffered from fracture of ribs and clavicle and left hemothorax. While the aircraft was moving violently, she encountered an impact with the ceiling and seat arm and caused a serious injury.

The rest of injured passengers sustained minor injury, their seat belts were not fastened.

When the occurrence happened, some passengers were bounced up to the cabin ceiling and dropped to the seat back, handrail, or cabin equipment. It is concluded that most of the passenger did not have their seat belts fastened and lost their protection while the fasten seat belt sign was still on.

2.5.2 Injury to Cabin Crew

All cabin crewmembers' injuries were minor, such as contusions, sprains and abrasions. Their injuries were due to the bounced up and down of the aircraft. The cabin crewmembers were providing services to passengers in cabin and did not have time or equipment to protect themselves from the occurrence because it happened suddenly.

2.5.3 First Aid

All cabin crewmembers completed their basic First Aid training courses. The company's Cabin Crew Operation Manual contains the first aid procedures.

After the occurrence, the fact that the cabin chief used PA to seek medical assistance and used the extra cabin crew as resources complied with the company's Cabin Crew Operation Manual 5.6.1 and CRM principles.

However, the cabin crewmembers were unable to comply with the company's Cabin Crew Operation Manual 5.6.1.2 regarding the mass injury status. The general guidelines of First Aid states that cabin crew shall document the injury report for the further understanding of the ground medical personnel.

There were three First Aid Kits on board. The three kits were opened respectively and used for minor injury passengers. According to the interview records, some cabin crew noted that some contents like calamine, gauze bandage, adhesive plaster, bandage compress, triangular bandage and wire splint were not used. If all contents were labeled both in Chinese and in English that would be more easy to be identified under time pressure.

After the emergency decent terminated, one cabin crew used PA to request all injured passengers (except the passenger with leg injury) to move to the L2 door section to centralize resources. This complied with the company's Cabin Crew Operation Manual procedures. However, the cabin crew did not follow the bone fracture first aid procedures.

2.5.4 Command and Corporation between Cabin Crews

The company's Cabin Crew Operation Manual 1.1.3.2 describes the cabin chief's duties and responsibilities that include: supervision of overall cabin safety, command and coordination with cabin crew during abnormal situations.

The company cabin chief training program also include training regarding cabin chief's role and responsibility, duty management, teambuilding and leadership, cabin operation and quality of service, emergency response and command procedures and CRM.

According to the crew interview records, cabin crew did not receive any formal information regarding the occurrence nature, nor emergency job allocation instructions from the cabin chief.

Except the cabin chief, there were two cabin crewmembers, sitting at 4L & 4R, who also have cabin chief ratings in this flight. After the occurrence, the 4R cabin crew inquired abnormal information, verified with flight crew, informed the injury passengers to move to forward section to centralize medical resources. This complied with the Cabin Crew Operation Manual 1.3.3, aircraft command and communication procedures.

Because the cabin crew did not prioritize their handling procedures, it would led to a failure to feed back timely injury information to the flight crew. The flight crew needed this information to determine the number of the ambulances required after landing.

AC120-034 Flight Operation and Cabin Safety Human Factors Guidelines and Operation Procedures published by Taiwan's CAA on 2005.4.1 reiterate: *Leadership and prioritizing actions to be taken are two of the main responsibilities of cabin crew in an emergency. These are responsibilities that could benefit from training in leadership and decision-making. Cabin crew training in these areas could emphasize their leadership role in aircraft cabins in an emergency. Relevant policies could be designed to reinforce their full responsibility for safety and emergency duties in the aircraft cabin and encourage them to undertake this responsibility to the maximum extent possible.* To enhance cooperation and coordination between cabin crew, the company needs to establish clear policy and procedures regarding job allocation, duty responsibility and relative training procedures including what to do, when to do it, how to do it and by whom it should be done. The main job functions of an efficient group leader should include team building, specific goal and objective, coordination and control group activities, time and workload management, emergency response, listening and adherence to group opinions.

The company's Cabin Crew Operation Manual oand training courses do not provide any guidelines or procedures of crew cooperation and coordination and job allocation including detail procedures as what to do, when to do, how to do and by whom to handle the mass injured passengers in emergency cases.

2.5.5 Termination of Duty Free Sales

The company's Cabin Crew Operation Manual 2.5.4 describes that the duty free sales should be stopped when descending started due to safety reasons.

The company's Cabin Crew Operation Manual 2.5.2 describes that all carts should be properly stored and locked, aisle path cleared and lavatories emptied before door closing on ground, during taxiing, taking off and landing. The CAA Inspector Manual requires inspectors to check all cabin crew execute safety check items during the approaching and landing phase.

The cabin crew retrieved the duty free cart back when flight crew gave the start descending signal. This complied with both the company's and CAA's regulations.

2.5.6 Emergency Response to Occurrence Aircraft

EF 306 requested medical assistance, such as emergency ambulance while declaring emergency landing to the controllers of ICN ACC, Jeju Approach Control and Jeju Control Tower. But EF 306 did not mention the number of injuries and the nature of emergency landing before landing to Jeju airport. And the controllers also did not confirm this information until EF306 landed.

Therefore, while entering to apron after landing, EF306 notified Jeju Control Tower the number of injured persons (WE HAVE 20 PERSON INJURIES) and required ambulances (WE NEED MORE AMBULANCE). At that time, the airport authority realized that the number of stand-by ambulance was not enough, and called for help from the contracted hospitals in the city of Jeju according to the emergency plan of Jeju airport. Thus it is concluded that the required number of ambulances was mobilized with some delay depending on the location of the contracted hospitals.

ICAO Annex14, Chapter 9, Emergency and Other Services states the requirements of fire engines by the category of aerodrome, but there is no described standard for the ambulances. It is considered as worldwide practice that there are few ambulances standing-by at the airport but with the system of mobilizing medical support and ambulance under the contract in nearby hospital. Thus if the pilot can inform the ATC the type and number of injured passengers in advance, the emergency care service to the injuries could be more timely.

The controllers, upon receiving the notification of emergency information from the aircraft, should confirm or request the correct information regarding the number of injuries according to the regulations of Air Traffic Control Procedure 10-1-2 and 10-2-1. It is concluded that the controllers did not make an effort to recognize the scope of the situation.

2.6 TCAS System

2.6.1 TCAS System Analysis

This analysis is to make sure that the TCAS system installed on B-27015 (EF306) was functioned normally. To achieve this goal, the Safety Council used the TSIM[32], a simulation of the CAS (Collision Avoidance System) logic based directly on the TCAS II CRS (CAS Requirements Specification), to verify the TCAS information in FDR/CVR data of the two aircraft. The TSIM is a verified implementation of the CAS specifications defined in Volume II of RTCA/DO-185A. TSIM can be useful in the design and test of other TCAS implementations[33]. In addition to test the occurrence data, we also used TSIM to simulate some flying conditions to find out some possible scenarios. All scenarios are listed as follows:

- Scenario 1 simulated this occurrence (with FDR/CVR data of EF306/TG659) to compare the function of onboard TCAS system with designed requirements.
- Scenario 2 simulated the situation if IACC did not provide the instruction to EF306 at 02:06:51, EF306 continued descending and TG659 continued his level flight.
- Scenario 3 simulated the situation if EF306 followed the TCAS descend rate (-1500 fpm) to see the vertical separation of EF306 and TG659.
- Scenario 4 simulated the situation if EF306 did not descent after TCAS RA to see the encounter status.

Scenario 1:

The Safety Council used FDR data such as the airspeed/ground speed, altitude, track angle and vertical speed of EF306/TG659 to input to TSIM and set the encounter geometry. The simulated TSIM result is the expected output data which would be further used to compare with the occurrence recorded data of TCAS in TA/RA. The conditions and test results of this scenario as follows.

Initial conditions:

According to Recorders Group's data at radar time 02:06:43[34], the altitude, vertical speed and position of EF306 and TG659 were as follows,

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32 The TSIM used in this simulation was the version 7, CPS 1-112E, dated 02/06/2007.

33 Refer to FAA Technical Standard Order, TSO-C119b, TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEM (TCAS) AIRBORNE EQUIPMENT, TCAS II dated 12/18/1998.

34 All time using in this section was referred to Incheon Area Control Center radar time (IACC).

	Altitude	Vertical speed	Latitude	Longitude
EF306	34,220 ft	-20,16 fpm	N31.918237deg	E125.994631deg
TG639	33,999 ft	0 fpm	N32.128746deg	E126.083656deg

The initial range between EF306 and TG659 was 13.33 nm. The ground speed of EF306 was 492 knots and the TG659 was 421 knots. The vertical acceleration data input to TSIM was derived from FDR pressure altitude data.

In addition to the initial data, we also input the vertical acceleration and ground speed at each second to the TSIM. With this setup, the output of TSIM simulation is as follows,

- The Traffic Advisory occurred at time 02:06:48,
- The Descend RA “Descend, Descend” occurred at time 02:07:01,
- The Reduce Descend RA “Adjust Vertical Speed, Adjust” occurred at time 02:07:13,
- The RA Removed “Clear of Conflict” occurred at time 02:07:41,
- The closest relative range was 0.877 nm at time 02:07:36 and the altitude separation was approximately 2,600 ft.

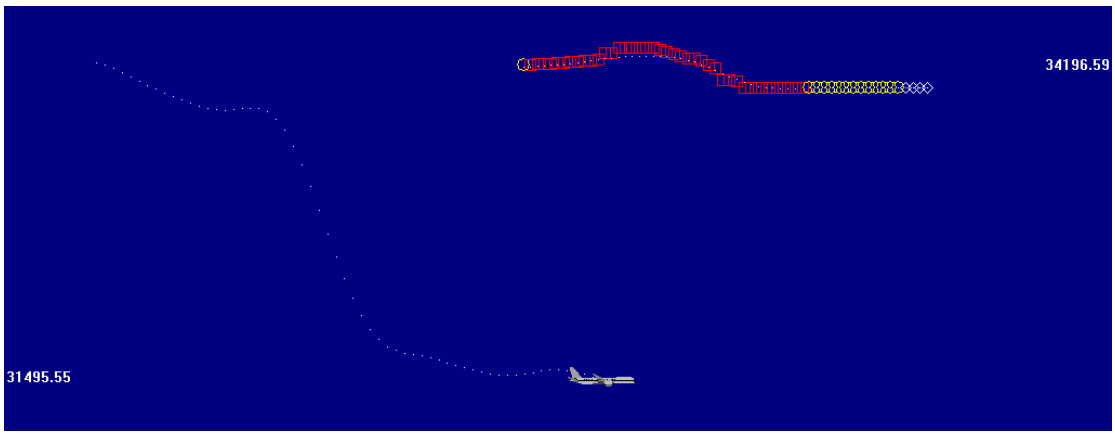

Figure 2.6-1 Side view of Scenario 1 on TSIM

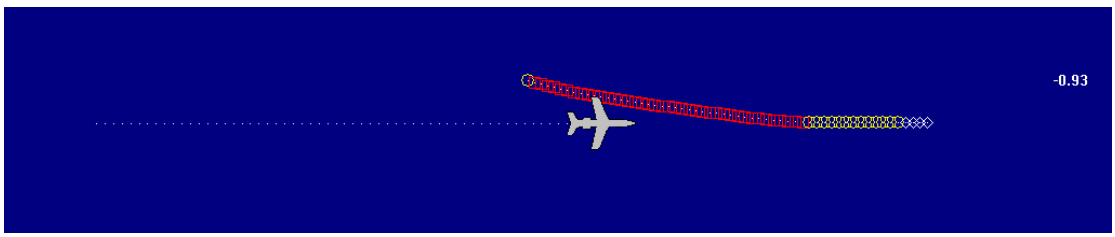

Figure 2.6-2 Top view of Scenario 1 on TSIM

Above mentioned data were compared to the TCAS advisory recorded on the EF306 FDR/CVR data as follows,

TCAS Advisory	TCAS message	Time of TSIM output	Time of EF306 recorded
Traffic Advisory	Traffic traffic	02:06:48	02:06:48
Descend RA	Descend descend	02:07:01	02:07:01
Reduced Descend RA	Adjust vertical speed adjust	02:07:13	02:07:19
RA removed	Clear of conflict	02:07:41	02:07:41

By comparison, the time of the Traffic Advisory, RA Descend and RA Removed message of EF306 were the same as the time of TSIM output data. The EF306 system delivered these three messages as the system design specified. However the Reduced Descend RA seemed to be too late as the design specification. Further checking the vertical speed (referred to Figure A7-9) during descent phase, we would find that the vertical speed was over 10,000 fpm from time 02:07:07 to time 02:07:12. According to the Minimum Operational Performance Standards for TCAS II, RTCA/DO-185A, Surveillance tracking requirements of CAS is designed to track aircraft with vertical rates up to maximum 10,000 fpm. The excessive vertical speed may cause the TCAS to lose tracking and to reveal this symptom.

Scenario 2:

With the same initial data, we input the vertical acceleration for each second from time 02:06:43 to 02:06:48. After 02:06:48, both aircraft would keep their vertical speed (-1,920 fpm for EF306) at that time. This scenario simulated that EF306 kept the descent rate of the time after TA “Traffic, Traffic”. With this setup, the output of TSIM simulation as follows,

- The Traffic Advisory occurred at time 02:06:48, but thereafter, there was no more TCAS warning.
- The closest relative range was 0.263 nm at time 02:07:36 and the altitude separation was approximately 1,450 ft.

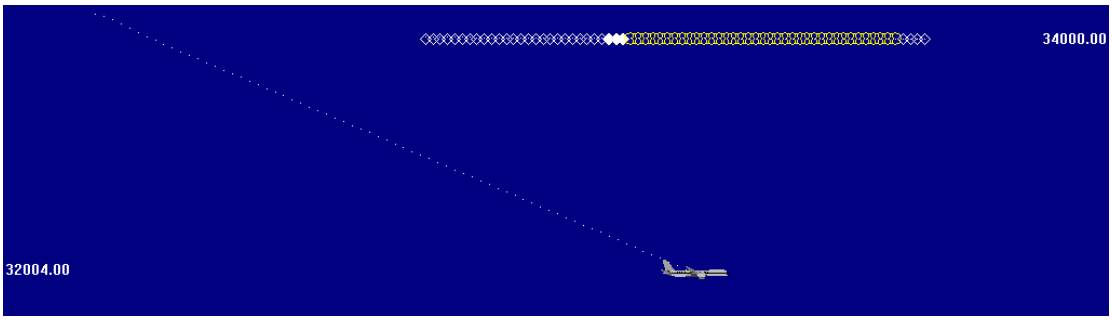

Figure 2.6-3 Side view of Scenario 2 on TSIM

Scenario 3:

With the same initial data, we input the vertical acceleration for each second from time 02:06:43 to 02:07:01. After 02:07:01, the TG659 situation was the same as scenario 1, but EF306 used the TCAS system RA vertical speed (-1,500 fpm). This scenario was to simulate that the EF306 followed the RA descent instruction with descent rate of -1,500fpm. With this setup, the output of TSIM simulation as follows,

- The Traffic Advisory occurred at time 02:06:48.
- The Descend RA “Descend, Descend” occurred at time 02:07:00
- The Reduce Descend RA “Adjust Vertical Speed, Adjust” occurred at time 02:07:22.
- The RA Removed “Clear of Conflict” occurred at time 02:07:40
- The closest relative range was 0.320 nm at that time 02:07:35 and the altitude separation was approximately 1,000 ft. Referred to Figure 2.6-4.

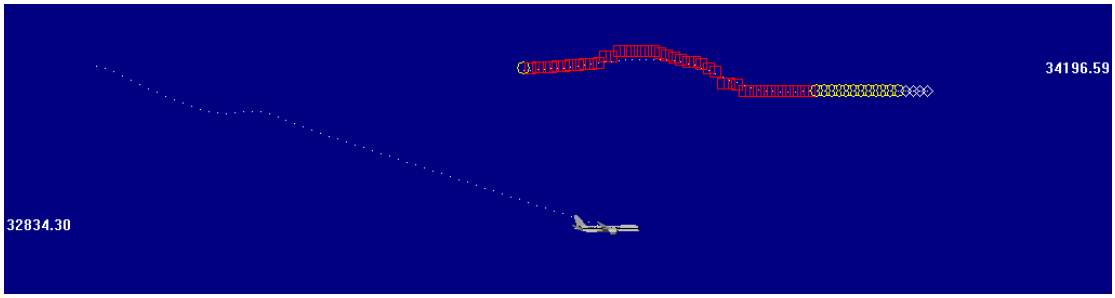

Figure 2.6-4 Side view of Scenario 3 on TSIM

Scenario 4:

With the same initial data, we input the vertical acceleration for each second from time 02:06:43 to 02:06:54. After 02:06:54, both aircraft hold their altitude and heading. This scenario was to simulate that the EF306 stopped descending, maintained altitude approximately 33,850 ft and disregarded all TCAS warning. With this setup, the output of TSIM simulation as follows,

- The Traffic Advisory occurred at time 02:06:48.

- The Descend RA “Descend, Descend” occurred at time 02:07:00
- The Increase Descend RA “Increase Descent, Increase Descent” occurred at time 02:07:29.
- The RA Removed “Clear of Conflict” occurred at time 02:07:38
- The closest relative range was 0.116 nm at time of 02:07:35 and the altitude separation was approximately 150 ft.

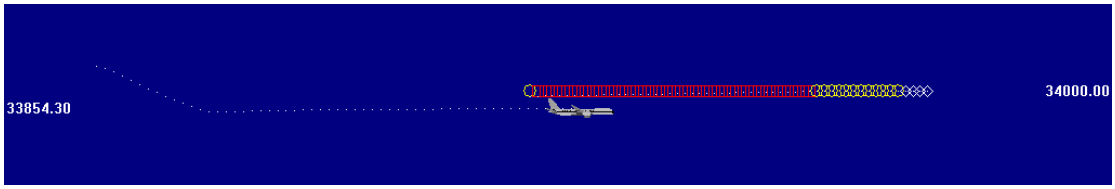

Figure 2.6-5 Side view of Scenario 4 on TSIM

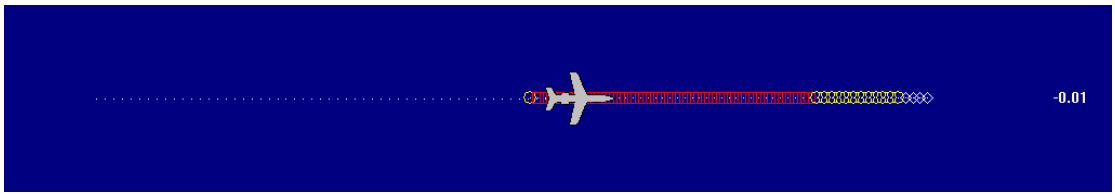

Figure 2.6-6 Top view of Scenario 4 on TSIM

2.6.2 Conclusion of the TCAS System Analysis

The TCAS system installed on EF306 was functioned normally. The very high descent rate over 10,000 fpm might caused TCAS to lose tracking of target aircraft and created “Reduced Descent RA” 6 seconds late. Simulations showed that there was still enough vertical separation between two aircraft, if EF306 would either keep the descend rate (-1,920 fpm) at the time (02:06:48) after TA advisory or follow the TCAS RA descent rate (-1,500 fpm) after RA advisory activated at time 02:07:01. Just after time 02:06:54, the EF306 significantly reduced the descent rate which caused the TCAS to activate the Resolution Advisory “Descend, Descend”. If the EF306 stopped descending, held the altitude and did not follow TCAS RA, the EF306 might keep moving to TG659 at relative close range of 0.116 nm and a vertical separation of merely 150 ft.

3 Conclusion

There are three different categories of findings as the result of this investigation; **findings related to probable causes**, **findings related to risks**, and **other findings**:

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

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 that made this accident more likely; however, they cannot be clearly shown to have operated in the accident. They also identify risks that increase the possibility of property damage and personnel injury and death. Further, some of the findings in this category identify risks that are unrelated to the accident, but nonetheless were safety deficiencies that may warrant future safety actions.

Other findings identify elements that have the potential to enhance aviation safety, resolve an issue of controversy, or clarify an issue of unresolved ambiguity. Some of these findings are of general interest and are not necessarily analytical, but they are often included in ICAO format accident reports for informational, and safety awareness, education, and improvement purposes.

3.1 Findings Related to Probable Causes

1. ICN control made a non-standard call to the EF306 during its descent when passing FL340. EF306 flight crew did not fully comprehend the ATC instructions, failed to confirm the instructions and stopped descending at 33,800 ft. Both parties did not apply standard

radiotelephony procedures and phraseologies. These anomalies contributed to the TCAS event between EF306 and TG659. (1.11.1, 2.2.1, 2.3.1)

2. The EF306 flight crew did not complete the TCAS RA standard operation procedures and commenced an excessive high rate descent. The induced negative G-force resulted in the occupants' injury. (1.11.2, 2.2.3.1, 2.4.1)

3.2 Findings Related to Risk

1. The EF306 flight crew did not adequately exhibit good CRM performance in this occurrence. (2.2.5)

2. While concentrating on the radar identification of other aircraft, South Sector radar control (SSRC) momentarily missed monitoring the approaching situations developed between EF306 and TG659. (2.3.1)

3. About 20 seconds after stopping the descent, the pilot of EF306 notified SSRC of climbing in accordance with TCAS instructions, but descended actually. At that time, SSRC did not provide traffic information but attempted to modify the aircraft flight path instead. SSRC did not comply with ATC TCAS operating procedures. (2.3.1)

4. The human capability of SSRC position could be limited when the control services are performed by only one controller who is paying attention continuously to a large number of aircraft in a relatively broad service area, particularly during a sudden occurrence of abnormal situation. (2.3.2)

5. Applying RVSM operations, the air traffic on B576 to and from Jeju airport is increasing rapidly. (2.3.3)

6. Most of the injured passengers lost their protection because their seat belts were not fastened while the fasten seat best sign was still on.(2.5.1)

7. The cabin crewmembers did not provide timely injury information to the flight crew, that would have allowed the flight crew to request sufficient medical assistance before landing. (2.5.4)

8. The controllers did not aware the importance of the number of injuries and the need for more ambulances to meet the flight upon landing. This caused the necessary number of ambulances to arrive at the airport with delay. (2.5.6)

3.3 Other Finding

1. The flight crew members were properly certified and qualified in accordance with applicable Civil Aviation Regulations.（2.1）
2. There was no evidence indicated that the flight crew members had any physical or psychological problems, nor any use of alcohol or drugs.（2.1）
3. The aircraft was operated within operational weight and balance limitations. (2.1)
4. There were no adverse weather conditions at the time of the occurrence. (2.1)
5. The TCAS respond maneuver of TG659 flight crew met the standard operational procedures and requirements.(2.2.4)
6. The EF306 flight crew TCAS training materials met the CAA's training requirements. (2.2.6)
7. It may mislead the flight crew to have abrupt input to the aircraft while they speculate the relative distance according to visual contact of conflicting aircraft. (2.2.7)
8. SSRC and the controller at the Flight Data Control position held the qualifications required for the appropriate control position and the valid air physical examination certificates and did not take drugs or drink alcohol. (2.3.1)
9. The closest distance between EF306 and TG659 met the ICAO radar separation requirement but didn't meet the minimum radar separation of 10 NM into an actual operation for a safer control. (2.3.1)
10. There was no standard instrument arrival procedure from B576 south of Jeju to Jeju airport. (2.3.3)
11. The data in the Flight Data Recorders of EF306 and TG659 aircraft were in accordance with ICAO Annex 6 Type 1 Flight Data Recorder, and satisfied to record 32 mandatory parameters. (1.11.2)
12. The "seat belt sign" of EF306 was turned "ON" at top of descent (02:03:05), and continued remaining "ON" until the aircraft was parked in ramp. (1.11.2.1)
13. According to flight recorders of both the EF306 and TG659 aircraft, the TCAS TA/RA activations, findings indicated as below: (1.11.1.1, 1.11.2.1, 1.11.2.2, 1.11.2.3)

    i. "TA" activated at 02:06:48：

    a. EF306: altitude of 34,052 ft, airspeed 272 knots, ground speed 493 knots, and magnetic heading 11.6 degrees.

    b. TG659: altitude 34,001 ft, airspeed 288 knots, ground speed 421

knots, and magnetic heading 219 degrees

c. 49 seconds prior to CPA, the relative distance, relative altitude and closure rate of the two aircraft were 12.2 NM, 51 ft (ALT of EF306 was higher than that of TG659), and 910 knots, respectively. (2.4.1, 2.4.2)

ii. Autopilot disengaged:

a. The autopilot of EF306 was disengaged at 02:06:56, at an altitude of 33,828 ft, airspeed 274 knots, ground speed 494 knots, and magnetic heading 11.6 degrees. With 41 seconds prior to CPA, the relative distance, relative altitude and closure rate of the two aircraft were 10.05 NM, -171 ft (ALT of EF306 was lower than that of TG659), and 911 knots, respectively.

b. The autopilot of TG659 was disengaged at 02:07:00, with altitude 33,999 ft, airspeed 288 knots, ground speed 421 knots, and magnetic heading 219 degrees. With 37 seconds prior to CPA, the relative distance, relative altitude and closure rate of the two aircraft were 9.08 NM, -139 ft, and 910 knots, respectively.

iii. “RA” activated at 02:07:01: (2.4.1)

a. 35 seconds prior to CPA, the relative distance, relative altitude and closure rate of the two aircraft were 8.82 NM, -128 ft, and 910 knots, respectively.

b. 29 seconds prior to CPA, the descent rate of EF306 was approaching to a maximum of 12,096 ft/min. The relative distance, relative altitude and closure rate of the two aircraft were 7.41 NM, -812 ft, and 893 knots, respectively.

c. 24 seconds prior to CPA, the “RA Climb” of TG659 was released. The relative distance, relative altitude and closure rate of the two aircraft were 6.13 NM, -1,880 ft, and 914 knots, respectively.

d. At time 02:07:36 was the Closest Point of Approach (CPA). The relative distance, relative altitude and closure rate of the two aircraft were 0.85 NM, -2,611 ft, and 655 knots, respectively.

iv. At time of TCAS RA activation, the closure rate of two aircraft was 910 knots, and the flight crew of EF306 was probably able to see the TG659 on it’s windshield with the size of 0.3 cm. During the activation of “RA Descend” of EF306, the apparent size of the TG659 was expanded to 0.57 cm. TCAS issued the “Adjust Vertical Speed, Adjust” until 02:07:36, then the TG659 performed the climb and right-turn maneuver. The apparent size became larger rapidly (about 0.6 cm ~ 40 cm). The trend moved from the center windshield to the upper-left hand side.

14. If the First Aid Kit contents were labeled in Chinese, it could be more easily to identify by the cabin crewmembers under time pressure. The cabin crewmembers did not follow the bone fracture first aid procedures.

(2.5.3)

15. The Far Eastern Airways Company's Cabin Crew Operation Manual and training courses do not provide any guidelines or procedures for crew cooperation, coordination and job allocation to handle a mass of injured passengers and emergency cases. (2.5.4)

16. The EF306 cabin crew retrieved the duty free cart back when flight crew gave the start descending signal. This complied with both the company's and CAA's regulations. (2.5.5)

17. The TCAS systems installed on both EF306 and TG659 worked properly. (1.16.1, 2.6.2)

18. TCAS simulation program proved that there would be enough vertical separation between two aircraft if EF306 would either have kept the descend rate (-1,920 fpm) at the time (02:06:48) after TA advisory or followed the TCAS RA descent rate (-1,500 fpm) after RA advisory activated at time 02:07:01. (2.6.2)

19. Just after time 02:06:54, EF306 significantly reduced the descent rate which caused the TCAS to activate the Resolution Advisory "Descend, Descend" at 02:07:01. If the pilot didn't follow RA to react, the collision would potentially happen in 35 seconds. (2.6.2)

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4 Safety Recommendations

4.1 Recommendations

4.1.1 Interim Flight Safety Bulletin

Issue No：ASC- IFSB- 07- 07- 001
Issue Date：August 01, 2007

Occurrence Description:

Recently a scheduled passenger flight descending on the airway to the destination encountered a TCAS warning with an approaching traffic. During the TCAS avoidance maneuvering, four passengers were seriously injured.

Safety Recommendation:

It is recommended that all operators review their training programs to ensure they have contained the necessary training for flight crew to recognize and respond effectively to the TCAS advisory.

4.1.2 Safety Recommendations

To Civil Aviation Safety Authority, Korea

1. Improve the sectorization and staffing standards of Incheon ACC by reviewing traffic density, control workload, and service area with the

consideration of abnormal situations.（ASC-ASR-08-08-001）

2. Improve ATC proficiency training on TCAS procedures, communication procedures, phraseology, and language command capability.（ASC-ASR-08-08-002）

3. Review the increase of air traffic on B576 and perform a safety assessment. Establish standard instrument arrival procedures for Jeju airport.（ASC-ASR-08-08-003）

4. Enhance the controller's procedures and training in emergency response to include making sure of the number of injuries on board for preparing the necessary emergency support when receiving the notification of emergency information from the aircraft.（ASC-ASR-08-08-004）

To Far Eastern Air Transport

1. Improve pilot's proficiency training on communication procedures, phraseology, and language command capability, especially the reconfirmation of the information issued from ATC.（ASC-ASR-08-08-005）

2. Ensure that pilot follow the standard TCAS operation procedures, not to visually conduct the avoidance maneuverings, and use good CRM practices during TCAS maneuverings. (ASC-ASR-08-08-006)

3. Enhance procedures and training to make sure that cockpit crews and cabin crews communicate and collect sufficient injury information timely, and that they notify the control authorities as soon as possible for airport's emergency rescue preparation during mass injury situations.（ASC-ASR-08-08-007）

4. Enhance procedures and training regarding cabin chief's leadership, decision making, communication and cabin crew's first aid knowledge for emergency response during mass injury situations. (ASC-ASR-08-08-008)

4.2 Safety Actions Accomplished or Being Accomplished

Far Eastern Air Transport

1. Far Eastern Air Transport (FAT) Flight Operations Division has already addressed this subject both in IP Meeting and the Flight Safety Meeting on March 19, 2008, during which all the IP (Instructor Pilot) and PIC (Pilot In Command) are requested to have their crew member to communicate in accordance with standard callouts during simulator training and line operations.

2. FAT Flight Operations Division has already included the TCAS and CRM subjects into the Pilot Recurrent Training of the first half year (Jan, to Jun.) of 2008. As from Dec. 24, 2007 to March 2008, four groups have been

trained. The training will be completed by May 31. 2008.

3. FAT has already arranged the Jointed Annual Recurrent Training for both cockpit crew and cabin crew from April 3. 2008 to June 21. 2008. Nine groups of crew members will be participating the training and will be complete by the end of June. The content of the training includes: Handling, Situation Awareness and Responses, Communication between Cockpit and Cabin, Communication between Cockpit and Control Authorities in In-flight Massive Injury Cases. The training insures that the airport authorities will be able to prepare the emergency rescue timely by means of the injury information from the crew. The related procedures will be amended into the CCOM and FOM.

4. FAT has arranged the Jointed Annual Recurrent Training for both cockpit and cabin crew members from April 3rd till June 21st of the year 2008. Nine groups of crew members will be participating the training, In the subjects regarding in-flight first aid, abnormal situation handling, emergency procedures and evacuation for Force Landing and Ditching drills will emphasize more in how to dealing with massive amount of injuries and adding the enhanced leadership, decision making, communication for Cabin Chief, and in-flight first aid, and other emergency response on board for all cabin crew. The related procedures will be amended into the CCOM.

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Attachment 1 Transcriptions of Incheon ACC Communications

Legend:

Radar Time : Incheon ACC radar time from the EF306 CVR Transcripts

ACC Time : The time recorded in Incheon ACC communications

EF306 : Radio transmission from occurrence aircraft

TG659 : Thai Airways flight 659

ACC : Incheon ACC controller 1

ACC-2 : Incheon ACC controller 2

ACC-3 : Incheon ACC controller 3

- : The time not presented on EF306 CVR Transcripts

… : Unintelligible words

ICER41, UNS514T, CE579, KE691, CE5053, KE1803, AI310, AAR363, KE887 stand for other flights appeared in the recording

Used frequency : 124.525Mhz(ACC south sector)

Radar Time (UTC)	ACC Time (UTC)	SOURCE	CONTENT
-	01:50:08	EF306	INCHEON CONTROL GOOD MORNING. EF306 MAINTAIN FLIGHT LEVEL 390, 10 DME TO A TI SQUAWK 2662
-	01:50:18	ACC	EF306 INCHEON CONTROL, ROGER, SQUAWK 4113

-	01:50:24	EF306	SQUAWK 4113. EF306
-	01:53:09	TG659	INCHEON CONTROL TG659, GOOD MORNING, FLIGHT LEVEL 340
-	01:53:14	ACC	TG659 MAINTAIN 340. REQUEST ESTIMATE ATOTI
-	01:53:18	TG659	MAINTAIN 340, ESTIMATE ATOTI 0225, TG659
-	01:53:23	ACC	ROGER. 0225
01:55:54.6	01:55:50	ACC	EF307, RADAR CONTACT. MAINTAIN 390
01:55:59.7	01:55:55	EF306	MAINTAIN 390, EF306
-	02:02:43	ACC	EF306 NOW DESCEND TO FLIGHT LEVEL 310
-	02:02:47	EF306	……
02:02:53.4	02:02:50	ACC	STANDBY AND EF306 NOW DESCEND TO FLIGHT LEVEL 310
02:02:57.9	02:02:53	EF306	DESCEND TO FLIGHT LEVEL 310 EF306
-	02:02:53	ICER41	ICER41 CONFIRM THAT THE POTAK OR TOPAX?
-	02:03:02	ACC	AFFIRMATIVE ICER41 CLEAR DIRECT TOPAX
02:03:05.4	02:03:03	UNS514T	INCHEON CONTROL UNS514T MAINTAIN FLIGHT LEVEL …
-	02:03:06	ICER41	ICER41 CLEAR DIRECT TOPAX THEN AS FILED
02:03:12.6	02:03:09	ACC	UNS514T MAINTAIN UH …… STAND BY
02:03:21.2	02:03:18	ACC	UNS514T MAINTAIN FLIGHT LEVEL 160
-	02:03:22	UNS514T	ROGER LEAVING FLIGHT LEVEL 200 FLIGHT LEVEL 160 UNS514T
02:03:32.9	02:03:30	ACC	CE579 NOW DIRECT CHILE JULIET

			UNIFORM
02:03:36.8	02:03:34	CE579	OKAY DIRECT TO CHILE JULIET UNIFORM CE579 THANK YOU
-	02:03:42	ACC	KE691 RADAR SERVICE TERMINATED CONTACT NAHA CONTROL 127.5 GOOD DAY
-	02:03:47	CE579	…FLIGHT LEVEL 270 OVER SADLI SQUAWK 5005
02:03:56.4	02:03:54	ACC	5053 STAND BY
02:03:59.9	02:03:56	ACC	KE691 RADAR SERVICE TERMINATED CONTACT NAHA CONTROL 127.5
02:04:05.0	02:04:02	KE691	CONTACT NAHA 127.5 KE691 GOOD DAY
02:04:09.8	02:04:07	ACC	CE5053 INCHEON RADIO CHECK
02:04:13.3	02:04:10	CE5053	AHH READ FIVE TO FIVE
02:04:15.1	02:04:12	ACC	ROGER RESET SQUAWK 4105
02:04:18.8	02:04:16	CE5053	SQUAWK 4105 CE5053
02:04:22.6	02:04:20	KE1803	INCHEON CONTROL KE1803 REQUEST DESCENT TURBULENCE
02:04:27.8	02:04:25	ACC	1803 DESCEND TO FLIGHT LEVEL 180
02:04:32.1	02:04:29	KE1803	180 KE1803
02:04:36.3	02:04:33	ACC	UNS514T REQUEST YOUR POSITION
02:04:40.4	02:04:38	UNS514T	UH…… NOW POSITION THIRTEEN MILES NORTH OF MARKET
02:04:46.3	02:04:44	ACC	ROGER. UNS514T NOW RADAR CONTACT LOST IDENT
-	02:04:49	AI310	01 SQUAWK 3543
-	02:04:54	UNS514T	IDENT SAY AGAIN UNS514T
02:04:59.7	02:04:57	ACC	IDENT
02:05:02.7	02:05:00	UNS514T	IDENT 514T
02:05:03.7	02:05:01	ACC	OKAY NOW RADAR CONTACT UNS514T
02:05:07.6	02:05:05	UNS514T	ROGER THANK YOU UNS514T
02:05:12.0	02:05:09	AI310	INCHEON GOOD MORNING AI310

02:05:15.0	02:05:12	ACC	AI310 SQUAWK 4120
02:05:19.0	02:05:16	AI310	4120 AI310
02:05:21.2	02:05:18	ACC	CE5053 RADAR CONTACT CLEAR DIRECT CHILE JULIET UNIFORM
02:05:25.6	02:05:23	CE5053	DIRECT CHILE JULIET UNIFORM CE5053
02:05:56.5	02:05:53	ACC	UNS514T CONTACT JEJU APPROACH 121.2 GOOD DAY
02:06:01.8	02:05:58	UNS514T	1212 UNS514T GOOD DAY
02:06:21.0	02:06:17	ACC	AAR363 RADAR SERVICE TERMINATED CONTACT SANGHAI CONTROL 132 DECIMAL 4
02:06:26.1	02:06:22	AAR363	132 DECIMAL 4 AAR363
02:06:29.4	02:06:26	ACC	AFFIRMATIVE
02:06:30.5	02:06:27	ACC	KE887 CLIMB TO FLIGHT LEVEL 350
02:06:34.4	02:06:31	KE887	CLIMB FLIGHT LEVEL 350 KE887
02:06:50.8	02:06:45	ACC	EF 308 STOP.... AHA... IMMEDIATELY CLEAR AND DESCEND
02:06:55.9	02:06:50	ACC	TG659 TURN RIGHT HEADING 270, 270 IMMEDIATELY
-	02:06:56	TG659	725, 270, TG659.
02:07:15.4	02:07:08	EF306	OKAY. INCHEON CONTROL EF306, TCAS TCAS CLIMB
02:07:19.2	02:07:14	ACC	ROGER, NOW DESCEND, DESCEND
02:07:22.3	02:07:17	EF306	NEGATIVE, NEGATIVE WE FOLLOW TCAS
02:07:46.4	02:07:42	FEA306	INCHEON CONTROL FEA306, WE ARE CLEARED TRAFFIC, MAINTAIN FLIGHT LEVEL 310
02:07:53.6	02:07:49	ACC	FEA306 ROGER, MAINTAIN 310
02:07:57.3	02:07:52	FEA306	ROGER, FEA306.
02:07:59.1	02:07:55	ACC	THA659 MAINTAIN FLIGHT LEVEL 340, NOW DIRECT ATOTI

02:08:05.3	02:08:00	THA659	DIRECT ATOTI, THA659. HOW COME YOU LET THE THINGS LIKE THIS OCCURRED. THA659.
02:08:11.2	02:08:06	ACC	ROGER, THANK YOU.
02:08:12.8	02:08:08	TG659	HOW COME! WE LIKE TO KNOW THAT YOU LET THE THINGS LIKE THIS HAPPEN? WE HAVE TO DESCEND. I HAD TCAS CLIMB.
02:08:20.7	02:08:17	ACC	TG659, ROGER.
02:08:24.2	02:08:20	TG659	NO WE'D LIKE TO KNOW THAT HOW COME YOU LET THING LIKE THIS HAPPEN?
02:08:29.2	02:08:25	ACC	OKAY, STAND BY
02:09:24.1	02:09:18	ACC	EF306, TURN RIGHT HEADING 070, 070 FOR DESCENDING
02:09:30.8	02:09:26	EF306	TURN RIGHT 070 FOR DESCENDING EF306. WHAT'S THE PROBLEM. WE HAVE SOME PERSONAL INJURY.
02:09:44.3	02:09:39	ACC	ROGER. EF306 NOW DESCEND TO FLIGHT LEVEL 150
02:09:50.2	02:09:45	EF306	DESCEND TO FLIGHT LEVEL 150. WE ARE TURN RIGHT HEADING 070, EF306.
02:10:34.6	02:10:31	EF306	CONFIRM HEADING 070, DESCEND FLIGHT LEVEL 250
02:10:42.0	02:10:38	ACC	EF306, HEADING 070 DESCEND TO FLIGHT LEVEL 150
02:10:46.5	02:10:41	EF306	DESCEND TO FLIGHT LEVEL 150, EF306. HEADING 070.
02:11:33.2	02:11:28	EF306	INCHEON CONTROL DUE TO… AH
02:11:39.4	02:11:35	ACC	SAY AGAIN CALL SIGN.
02:11:41.1	02:11:37	EF306	EF306, WE HAVE PERSONAL INJURY. REQUEST FOR EMERGENCY LANDING FOR JEJU AIRPORT.

02:11:53.5	02:11:49	ACC	EF306 ROGER. NOW DIRECT MARIN. CLEAR DIRECT MARIN. SAY YOUR INTENTION. SAY AGAIN.
02:11:59.7	02:11:52	EF306	OKAY, DIRECT TO MARIN. WE REQUEST EMERGENCY LANDING FOR JEJU AND WE NEED MEDICINE HELP
02:12:08.9	02:12:04	ACC	AH, 306 ROGER, STAND BY. DO YOU HAVE ……
02:12:26.6	02:12:22	ACC	EF306, ROGER. DO YOU HAVE ANY NEED? DO YOU NEED ANY?
02:12:31.8	02:12:27	EF306	YES WE NEED EMER..... MEDICINE HELP AND EMERGENCY AMBULANCE FOR HELP
02:12:41.5	02:12:37	ACC	OKAY, DO YOU NEED AMBULANCE OKAY. I.....
02:12:44.7	02:12:40	EF306	WE HAVE PERSONAL INJURY.
02:12:48.2	02:12:44	ACC	ROGER, PERSONAL INJURY.
02:12:50.1	02:12:47	EF306	AFFIRM
02:13:08.2	02:13:03	TG659	INCHEON TG659.
02:13:10.5	02:13:06	ACC-2	TG659, GO AHEAD.
02:13:12.2	02:13:08	TG659	IF YOU WANT TO KNOW THE REASON WHY YOU LED THE AIRCRAFT WITH US ANOTHER ONE NEAR MISS THAT WE HAPPENED TCAS CLIMB.
02:13:22.8	02:13:18	ACC-2	TG659, ROGER.
02:13:24.9	02:13:20	TG659	NO, WE'D LIKE TO KNOW THE REASON. NOT ROGER. WE'D LIKE TO KNOW THE REASON WHY YOU LET THINGS LIKE THAT HAPPEN.
02:13:29.8	02:13:25	ACC-2	OKAY, I KNOW. STAND BY.
02:13:36.4	02:13:30	ACC-2	TG659, WE HAVE TRAFFIC. SO TCAS CLIMB. DO YOU UNDERSTAND?

02:13:44.5	02:13:40	TG659	TG659, WE HAD TCAS CLIMB. THE OTHER TRAFFIC MAINTAINING WRONG ALTITUDE.
02:15:49.0	02:15:43	ACC-2	EF306 CONTACT JEJU APPROACH 121.2. EF306 GOOD DAY.
02:15:54.2	02:15:49	EF306	INCHEON 12 … JEJU APPROACH 121.2 EF306
02:15:59.2	02:15:53	ACC-2	AFFIRMATIVE.
02:16:00.4	02:15:55	EF306	GOOD DAY

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Attachment 2　EF306 CVR Transcripts

Legend:

RDO　: Radio transmission from occurrence aircraft

CAM　: Cockpit area microphone voice or sound source

PA　: Passenger public address system

-1: Voice identified as Captain

-2: Voice identified as First Officer

-3: Voice identified as Flight Attendant

-4: Voice identified as Flight Attendant

-5: Voice identified as Flight Attendant

-6: Voice identified as Flight Attendant

-7: Voice identified as Flight Attendant

-8: Voice identified as Flight Attendant

-?: Unidentifiable voice

ICN　: Incheon ACC controller

APP　: Jeju approach

TWR　: Jeju tower

TG659　: Thai Airways flight 659

ATIS　: Radio transmission from automatic terminal information service

SOC　: System operation control

…　: Unintelligible words

*　: Communication not related to operation

（ ）　: Remarks or translation

CI160, CE5045, AC139, AAR363, CRK308, KE1803, KE887, KE865, CE579, 514T, CE5053, KE691, AI310, AC363, MU5043, GL52, MU5041, CA139, SK105, CA8123, CX417, KE1217, JE109, KE1214, KE734, AK9142 stand for other flights appeared in the recording

Radar Time *	SOURCE	**CONTENT**
00:35:11.0		(recording started)
01:55:54.6	ICN	far eastern tree zero seven radar contact maintain tree niner zero
01:55:59.7	RDO-2	maintain flight tree niner zero far eastern tree zero six
01:56:03.1	ICN	(conversation with CI160)
01:56:12.2	ICN	(conversation with CI160)
01:56:23.4	CI160	(conversation with ICN)
01:56:26.4	ICN	(conversation with CI160)
01:56:33.1	CI160	(conversation with ICN)
01:56:36.1	ICN	(conversation with CE5045)
01:56:39.4	CE5045	(conversation with ICN)
01:56:44.1	AC139	(conversation with ICN)
01:56:52.1	ICN	(conversation with AC139)
01:56:58.1	AC139	(conversation with ICN)
01:57:01.3	ICN	(conversation with AAR363)
01:57:05.7	AAR363	(conversation with ICN)
01:57:10.5	ICN	(conversation with AAR363)
01:57:17.2	AAR363	(conversation with ICN)
01:57:28.0	AC139	(conversation with ICN)
01:57:34.3	ICN	(conversation with AC139)
01:57:38.8	AC139	(conversation with ICN)
01:58:12.2	CRK308	(conversation with ICN)
01:58:21.1	ICN	(conversation with CRK308)
01:58:24.5	CRK308	(conversation with ICN)
01:58:27.0	KE1803	(conversation with ICN)

* Correlated to Incheon ACC radar time.

Radar Time *	SOURCE	**CONTENT**
01:58:31.5	ICN	(conversation with KE1803)
01:58:36.8	AAR363	(conversation with ICN)
01:58:44.2	ICN	(conversation with AAR363)
01:58:48.1	AAR363	(conversation with ICN)
01:58:49.0	ICN	(conversation with CRK308)
01:58:59.4	CRK308	(conversation with ICN)
01:59:05.3	ICN	(conversation with CRK308)
01:59:08.8	CRK308	(conversation with ICN)
01:59:11.3	ICN	(conversation with CRK308)
01:59:16.8	CRK308	(conversation with ICN)
01:59:31.6	ICN	(conversation with CRK308)
01:59:39.3	CRK308	(conversation with ICN)
01:59:40.8	ICN	(conversation with CRK308)
01:59:43.8	CRK308	(conversation with ICN)
01:59:46.0	ICN	(conversation with CRK308)
02:00:17.9	KE887	(conversation with ICN)
02:00:37.4	ICN	(conversation with KE887)
02:00:40.2	KE887	(conversation with ICN)
02:00:42.8	ICN	(conversation with KE887)
02:00:53.1	ICN	(conversation with KE865)
02:00:59.1	KE865	(conversation with ICN)
02:01:13.9	CE579	(conversation with ICN)
02:01:25.0	ICN	china eastern five zero five tree incheon control squawk four one zero five
02:01:34.8	CE579	uh we are call sign is china eastern five seven nine flight level tree seven zero
02:01:40.5	ICN	uh five seven niner standby
02:01:47.0	ICN	(conversation with CE579)
02:01:49.7	CE579	(conversation with ICN)
02:02:00.2	-?	…
02:02:05.5	ICN	(conversation with CE579)
02:02:11.2	CE579	(conversation with ICN)
02:02:19.6	-?	…

Radar Time *	SOURCE	**CONTENT**
02:02:37.1	CE579	(conversation with ICN)
02:02:53.4	ICN	standby and far eastern tree zero six now descend to flight level tree one zero
02:02:57.9	RDO-2	descend flight level tree one zero far eastern tree zero six
02:03:01.8	CAM-2	tree one zero
02:03:02.7	CAM-1	set
02:03:03.3	CAM	(sounds identified as seat belt sign)
02:03:05.4	514T	incheon … five one four tango maintain flight level two zero zero
02:03:09.7	ATIS	jeju international airport information … i-l-s d-m-e runway …
02:03:12.6	ICN	… five one four tango maintain uh standby
02:03:21.2	ICN	… five one four tango maintain flight level one six zero
02:03:32.9	ICN	(conversation with CE579)
02:03:36.8	CE579	(conversation with ICN)
02:03:46.7	CE5053	(conversation with ICN)
02:03:56.4	ICN	(conversation with CE5053)
02:03:59.9	ICN	(conversation with KE691)
02:04:05.0	KE691	(conversation with ICN)
02:04:09.8	ICN	(conversation with CE5053)
02:04:13.3	CE5053	(conversation with ICN)
02:04:15.1	ICN	(conversation with CE5053)
02:04:18.8	CE5053	(conversation with ICN)
02:04:22.6	KE1803	(conversation with ICN)
02:04:27.8	ICN	(conversation with KE1803)
02:04:32.1	KE1803	(conversation with ICN)
02:04:36.3	ICN	university five one four tango request your position
02:04:40.4	-?	…
02:04:46.3	-?	roger
02:04:48.7	-?	…
02:04:59.7	ICN	ident
02:05:02.7	514T	ident … five one four tango
02:05:03.7	ICN	okay now radar contact university five one four tango

Radar Time *	SOURCE	**CONTENT**
02:05:07.6	514T	roger … five one four tango
02:05:12.0	AI310	(conversation with ICN)
02:05:15.0	ICN	(conversation with AI310)
02:05:16.7		(ATIS terminated)
02:05:19.0	AI310	(conversation with ICN)
02:05:21.2	ICN	(conversation with CE5053)
02:05:25.6	CE5053	(conversation with ICN)
02:05:56.5	ICN	university five one four tango contact jeju approach one two one decimal two good day
02:06:01.8	514T	one two one two … five one four tango good day
02:06:21.0	ICN	(conversation with AC363)
02:06:26.1	AC363	(conversation with ICN)
02:06:29.4	ICN	(conversation with AC363)
02:06:30.5	ICN	(conversation with KE887)
02:06:34.4	KE887	(conversation with ICN)
02:06:48.5	CAM	traffic traffic
02:06:50.8	ICN	far eastern tree zero eight stop uh immediately clear descend
02:06:55.9	ICN	thai six five niner turn right heading two seven zero two seven zero immediately
02:07:00.8	CAM-1	現在是怎麼樣 (*now what had happened*)
02:07:01.6	CAM	descend descend
02:07:01.9	TG659	seven two five two seven zero thai six five nine
02:07:02.4	CAM-1	喂 descend (*hello descend*)
02:07:03.7	CAM	(sounds similar to impact)
02:07:03.9	CAM-1	descend
02:07:04.7	CAM-2	啊 啊 (*uh uh*)
02:07:05.9	MU5043	(conversation with ICN)
02:07:07.3	CAM-?	哎 (*alas*)
02:07:07.6	CAM	(sounds similar to impact)
02:07:12.9	CAM-2	可以 keep 嗯 (*ok keep um*)
02:07:15.4	RDO-2	incheon control far eastern tree zero six TCAS TCAS climb
02:07:19.2	ICN	roger now descend descend

Radar Time *	SOURCE	**CONTENT**
02:07:19.3	CAM	adjust vertical speed adjust
02:07:22.3	RDO-2	negative negative we follow TCAS
02:07:25.3	PA-3	各位貴賓 請儘速留在座位上並將安全帶扣好 (*ladies and gentlemen please remain in seat and fasten your seatbelt as soon as possible*)
02:07:29.0	PA-3	請儘速留在座位上把安全帶扣好 (*please remain in seat and fasten your seatbelt as soon as possible*)
02:07:30.2	MU5043	(conversation with ICN)
02:07:34.4	CAM-2	喂 還還在紅線上 (*hey still on the red line*)
02:07:36.4	PA-3	這時候都不要離開座位 先把安全帶扣好 保護好自己 (*do not leave your seat for this moment buckles up first and protect yourself*)
02:07:36.7	CAM-2	慢 慢 慢 慢 慢 不要這麼快 follow follow follow 那個指示（*slow down don't be so fast follow that indication*）
02:07:40.0	MU5043	(conversation with ICN)
02:07:40.9	CAM-?	速度快到了(*the speed is about there*)
02:07:41.6	CAM	clear of conflict
02:07:43.4	ICN	(conversation with MU5043)
02:07:46.4	RDO-2	incheon control far eastern tree zero six we are clear traffic maintain flight level tree one zero
02:07:53.1	CAM-2	喂 把它弄到 tree one zero (*hey setting it to three one zero*)
02:07:53.6	ICN	far far eastern tree zero six roger maintain tree one zero
02:07:57.3	RDO-2	roger far eastern tree zero six
02:07:59.1	ICN	thai six five niner maintain flight level tree four zero now direct atoti
02:08:03.8	CAM-2	現在廣播一下吧 (*now please make a PA*)
02:08:04.8	CAM-3	喂 教官 (*hello sir*)
02:08:05.3	TG659	direct atoti thai six five niner how come you let the things like this uh occurred thai six five niner
02:08:05.9	CAM-1	有沒有怎麼樣 (*what was the situation back there*)
02:08:06.7	CAM-3	我們後面散的亂七八糟了 (*there is really messy back here*)
02:08:08.7	CAM-1	好好好我會寫報告 剛剛那個飛機接近 (*okay I will write a report it happen to be a traffic getting close just a moment ago*)

Radar Time *	SOURCE	**CONTENT**
02:08:11.2	ICN	roger thank you
02:08:12.1	CAM-3	okay
02:08:12.8	TG659	how come i like to know that you let the thing like this happen we had the TCAS r-a TCAS climb
02:08:13.1	CAM-1	你們乘客的情況怎麼樣 等一下再報告一下 (*what was the passenger's situation let me know later on*)
02:08:16.8	CAM-3	教官 現在 現在過了吧 過了吧 (*sir were we passed now*)
02:08:18.1	CAM-4	教官有人昏倒了 商務艙有人昏倒了 (*sir there is a passenger in business class passed out*)
02:08:18.2	CAM-1	呃 現在已經過了 (*uh now it was passed by*)
02:08:20.7	ICN	uh thai six five niner roger
02:08:21.3	CAM-1	okay 好 (*okay*)
02:08:22.3	PA-3	來協助一下受傷旅客 (*here to assist the injury passengers*)
02:08:22.4	CAM-2	商務艙有人昏倒 (*there is a passenger in business class passed out*)
02:08:24.2	TG659	no I'd like to know that how come you let the things like this happened
02:08:29.2	ICN	okay standby
02:08:30.8	CAM-2	* …
02:08:33.1	CAM-1	你跟他講一下 (*you go ahead to tell him*)
02:08:33.3	CAM-2	洞兩洞八 (*zero two zero eight*)
02:08:37.9	CAM-2	這個這個他們一定會查 (*they definitely are going to investigate it*)
02:08:39.0	MU5043	(conversation with ICN)
02:08:44.0	ICN	(conversation with MU5043)
02:08:48.3	MU5043	(conversation with ICN)
02:08:48.6	CAM-1	我剛剛都看到了 (*I have it all in sight*)
02:08:50.1	CAM-2	我也看到啦 (*so do I*)
02:08:50.2	CAM-1	一百呎 (one *hundred feet*)
02:08:52.0	CAM-2	怎麼一下子突然推那麼多 推的很多 (*how come to push it so hard push it too much*)
02:08:56.1	CAM-1	因為已經 已經已經紅點了 一百呎 (*because it already*

Radar Time *	SOURCE	**CONTENT**
		turn to red one hundred feet)
02:08:57.9	CAM-2	平的 都是 他兩個都平的 * (*it's flat both of them were flat*)
02:09:00.9	CAM-1	一百呎 所以我* 急著 * TCAS descend 我急著 (*one hundred feet so I am in the hurry TCAS descent I am in the hurry to*)
02:09:03.3	CAM-2	嗯 我們我們現在現在先用 autopilot on 然後 VNAV 飛 嗯 (*um now we engage the autopilot first and applied VNAV flight mode*)
02:09:06.9	CAM-1	autopilot
02:09:07.4	CAM-2	嗯 (*um*)
02:09:08.1	CAM-1	三萬一 (*thirty one thousand*)
02:09:09.1	CAM-2	三萬一 (*thirty one thousand*)
02:09:13.4	CAM	(sounds identified as cockpit to cabin call)
02:09:13.6	CAM-2	*
02:09:23.0	CAM	(sounds identified as cockpit to cabin call)
02:09:24.1	ICN	far eastern tree zero six turn right heading zero seven zero zero seven zero for descending
02:09:26.0	CAM	(unidentified sounds)
02:09:27.1	CAM-5	... 教官 (*sir*)
02:09:29.2	CAM-1	回報一下 回報一下 (*report back report back*)
02:09:30.0	CAM-5	教官 (*sir*)
02:09:30.8	RDO-2	turn right zero seven zero for descending uh far eastern tree zero six uh what's the problem we have uh personal injury
02:09:31.1	CAM-5	不好意思喔 有一個 其實大家都還好 可是有一個太太她昏倒了 (*excuse me everybody is fine as a matter of fact but one lady passed out*)
02:09:35.6	CAM-1	有沒有醫師 (*is there any doctor on board*)
02:09:36.5	CAM-5	昏在走道上 我我現在要廣播 因為我剛才先去看後面一下 我現在先廣播一下喔 教官 現在氣流都還好了吧 (*passed out on the aisle I gona make a broadcast because I just took a look from back there I am going to make a broadcast how is the turbulence now sir*)
02:09:44.1	CAM-1	嗯 現在還好 剛才是飛機接近 我等一下會廣播 (*um now is fine we just had a traffic getting close I will make a PA later*)

Radar Time *	SOURCE	**CONTENT**
02:09:44.3	ICN	roger far eastern tree zero six now descend to flight level one five zero
02:09:50.2	RDO-2	descend to flight level one five zero we are turn right zero seven zero far eastern tree zero six
02:09:51.3	PA-5	各位貴賓...醫生還是護士 因為前面有一位客人需要協助 如果有醫生護士麻煩請跟我們連絡 謝謝 (*ladies and gentlemen… doctor or nurse…..we have a passenger in the front need medical help if there is any doctor or nurse on board please contact to us thank you*)
02:10:00.0	CAM-2	哎 (*alas*)
02:10:00.5	CAM-1	多少 (*what it was*)
02:10:00.6	CAM-2	zero seven two five
02:10:02.0	CAM-2	我再 confirm (*I will confirm it again*)
02:10:02.7	CAM-1	我的…夾子都飛掉了 (*my clip board is flied off*)
02:10:04.2	CAM-2	我也飛掉了 (*me too*)
02:10:05.3	ICN	(conversation with AI310)
02:10:10.7	CAM-5	* 麻煩你來前面一下好不好 謝謝 (*please move forward thank you*)
02:10:13.3	ICN	(conversation with AI310)
02:10:16.1	AI310	(conversation with ICN)
02:10:17.2	ICN	(conversation with AI310)
02:10:22.7	AI310	(conversation with ICN)
02:10:25.6	ICN	(conversation with CE5045)
02:10:26.1	CAM-1	你飛 我廣播一下 （*you have control I make PA*）
02:10:29.7	CE5045	(conversation with ICN)
02:10:30.0	CAM-2	我要你先 … (*I want you…*)
02:10:34.5	PA-1	嗯 各位貴賓大家早 這是機長廣播 嗯 剛剛由於韓國它的航管單位的關係 嗯 剛造成有飛機接近的現象 為了躲避與其它航機的碰撞關係 所以採取必要的緊急措施 嗯造成嗯上下一片混亂感到非常抱歉 目前都已經恢復到正常的情況 嗯 謝謝各位的諒解 我們會在落地之後再把這個報告再反應給相關的單位 感到非常抱歉 (*good morning ladies and gentlemen this is captain speaking we just had a traffic getting close because the traffic control had some problem we have to take a necessary emergency action to get rid of it we are sorry to the messy and your inconvenient now the aircraft is recover to the normal*

Radar Time *	SOURCE	**CONTENT**
		condition thanks for your understanding and we are going to file a report after landing thank you)
02:10:34.6	RDO-2	incheon control far eastern tree zero six we are confirm heading zero seven zero descend flight level two five zero
02:10:42.0	ICN	far eastern tree zero six heading zero seven zero descend to level one five zero
02:10:46.5	RDO-2	descend to flight one five zero far eastern tree zero six heading zero seven zero
02:10:51.0	ICN	(conversation with GL52)
02:10:55.3	-?	哦 拐五五拐 (*wow seven five five seven*)
02:10:55.4	GL52	(conversation with ICN)
02:10:58.2	-?	么三洞 (*one three zero*)
02:11:03.7	-?	嗯 再說一遍 (*em repeat it again*)
02:11:06.9	-?	嗯 么三洞 一二三四五 (*em one three zero one two three four five*)
02:11:19.0	CAM	(sounds identified as cabin to cockpit call)
02:11:20.1	-?	拐五五拐 (*seven five five seven*)
02:11:20.8	CAM-1	請說 (*speaking please*)
02:11:21.4	CAM-3	教官 現在有人有人骨折 然後有人臉整個都撞撞流血了 (*sir we got passengers bones broken and face bleeding due to impact*)
02:11:22.2	-?	(unidentified sounds)
02:11:25.4	CAM-2	我我們知道 你去統計看有幾個人 (*we know please go ahead to count how many passengers got injured*)
02:11:27.6	CAM-3	好 我我們可以請求就是緊緊急落地這樣子 (*okay could we applied for emergency landing*)
02:11:30.7	CAM-2	對的 我們會的 (*sure we will do that*)
02:11:31.6	CAM-3	好好 (*okay okay*)
02:11:33.2	RDO-1	incheon control due to uh
02:11:36.6	RDO-1	uh
02:11:37.3	CAM-2	passenger injured

Radar Time *	SOURCE	**CONTENT**
02:11:38.8	PA-3	各位貴賓 如果現在您有受傷的情況的旅客 請您現在我們統一將您的座位 都換在第二個艙門 我們統一集中 幫您照顧跟救護 我們飛機上有急救箱 我們現在會幫您做初步的處理 (*ladies and gentlemen if you are the injured passengers we are planning to rearrange all you seat forward to the second door for the medical care purpose we got first aid kit on board and ready to take the preliminary medical care*)
02:11:39.1	CAM-?	…
02:11:39.4	ICN	say your call sign
02:11:41.1	RDO-2	far eastern tree zero six we have personal injuries request for uh emergency landing for jeju airport
02:11:53.5	ICN	far eastern tree zero six roger now direct marin clear direct marin say your intention say again
02:11:53.8	PA-3	我們飛機現在也會提前降落在濟州島 到濟州島之後 我們會請求救護車協助 (*we are now going to landing in jeju island in advance the emergency ambulance will be ready after arrival*)
02:11:59.7	RDO-2	okay clear to marin we are request emergency landing for jeju and need medicine help
02:12:01.0	PA-3	各位你有目前有撞傷受傷的旅客 我們統一幫您的座位換到第二排的座位 我們統一幫您照顧 謝謝 (*ladies and gentlemen if you are the injury passengers we are planning to rearrange all you seat forward to the second door for the medical care purpose thank you*)
02:12:04.2	CAM-1	你你你跟他講 (*you tell him*)
02:12:08.9	ICN	uh tree zero six roger standby do you have …
02:12:13.2	CAM-1	你說我們有傷患 因為剛剛有飛機接近 你跟他講了嗎 (*tell him we got passengers injured on board due to traffic closing did you*)
02:12:14.7	CAM-2	對對對 我跟他講了 (*right I did*)
02:12:16.7	MU5041	(conversation with ICN)
02:12:19.1	CAM-2	定向 定向那個 marin (*direct direct to marin*)
02:12:21.1	ICN	(conversation with MU5041)
02:12:24.6	CAM-2	我去 我去拿箱子 (*I go I got to take my suitcase*)
02:12:26.6	ICN	far eastern tree zero six roger do you have any need do you need any
02:12:28.2	CAM-1	我來 我來 (*I have control I have control*)

Radar Time *	SOURCE	**CONTENT**
02:12:31.8	RDO-2	yeah yes we we need uh emerge uh medicine help and emergency uh ambulance for help
02:12:33.2	CAM-1	我們需要救護車 (*we need ambulance*)
02:12:41.5	-?	(unidentified sounds)
02:12:44.7	RDO-2	we need doctor we have uh personal injury
02:12:48.2	ICN	uh roger personal injury
02:12:50.1	RDO-2	affirm
02:12:55.5	CAM-2	我已經跟他報 emergency landing (*I already request for emergency landing*)
02:12:57.8	CAM-2	* 這這這些不管了 因為一定有 有骨折的 我拿一下箱子 (*I do not care that because must be somebody got bones broken I got to take my suitcase*)
02:12:57.9	CAM-1	對 (*right)*
02:13:03.6	CAM-2	喂 你的後 後面等一下要收一下 (*hey your back it need to have a clean up later on*)
02:13:08.2	THI659	incheon thai six five niner
02:13:10.5	ICN	thai six five niner go ahead
02:13:12.2	THI659	if you want to know the reason why you let uh the aircraft between us and another one near miss here we have the TCAS climb
02:13:15.0	CAM-1	嗯 跟 operation 講 (*um talk to the operation*)
02:13:22.8	ICN	thai six five niner roger
02:13:24.9	THI659	no we'd like to know the reason not roger we'd like to know the reason why you let the things like that happened
02:13:28.4	RDO-2	jeju uh operation uh good morning far eastern tree zero six
02:13:29.8	ICN	okay i know standby
02:13:36.4	ICN	thai six five niner we have traffic on uh so we have with the TCAS climb do you understand
02:13:44.5	THI659	thai six five niner we have TCAS climb the other traffic maintaining wrong altitude
02:13:54.9	CAM-2	他 他沒有隔離 * (*he did not provide the separation*)
02:13:56.8	MU5043	(conversation with ICN)
02:13:59.3	RDO-2	okay jeju operation good morning far eastern tree zero six

Radar Time *	SOURCE	**CONTENT**
02:14:01.1	ICN	(conversation with MU5043)
02:14:05.6	CAM-2	等一下問後面有幾個人受傷 (*ask how many people back there got injured later*)
02:14:07.4	MU5043	(conversation with ICN)
02:14:09.9	CAM-1	他們現在在忙 (*they are busy now*)
02:14:11.7	CAM	(sounds identified as cockpit to cabin call)
02:14:16.8	CAM-4	喂 我是* (*hello I am **)
02:14:17.4	ICN	(conversation with MU5041)
02:14:17.8	CAM-1	幾個人受傷 (*how many injury passengers*)
02:14:18.8	CAM-4	嗯 現在還不知道耶 教官 我們先忙完… 然後… (*um do not know yet sir let us deal with the business…..and….*)
02:14:21.0	MU5041	(conversation with ICN)
02:14:22.8	CAM-1	嗯 大概再 (*um about another*)
02:14:25.1	CAM-6	我* 我搭機組員 你跟我說 (*I am * I am the off duty crew member you talk to me*)
02:14:26.4	KE1803	(conversation with ICN)
02:14:28.0	CAM-2	okay 我們三洞分到 現在是十二度 等一下告訴我們一下人數 受傷的人數好不好 跟後面統計 (*okay we are about to arrive at three zero minutes the temperature is twelve degree please let us know how many people got injured later on count at the back*)
02:14:29.5	CAM-5	教官 我現在… (*sir I am now…*)
02:14:30.2	ICN	(conversation with KE1803)
02:14:31.7	CAM-5	好好好 我好好好 (*okay I okay*)
02:14:33.4	KE1803	(conversation with ICN)
02:14:34.0	CAM-5	好的 (*okay*)
02:14:35.7	ICN	(conversation with CA139)
02:14:37.3	RDO-2	jeju operation good morning far eastern tree zero six
02:14:38.7	CA139	(conversation with ICN)
02:14:43.6	ICN	(conversation with MU5041)
02:14:48.6	MU5041	(conversation with ICN)
02:14:56.5	CAM-1	他先叫我們保持高度 保持高度… (*he instructed me maintain altitude at first maintain altitude….*)

Radar Time *	SOURCE	**CONTENT**
02:14:58.5	CAM-2	來不及了啦 (*but we could not make it*)
02:14:58.8	SK105	(conversation with ICN)
02:14:59.3	CAM-1	來不及就 你你就根本就沒辦法 * 一定要在*下 而且 * (*could not make it you you have no choice should be down and*)
02:14:59.7	CAM-2	再加一點 再加一點 加一點 再加一點 (*increase a little*)
02:15:05.1	CAM-2	他是保持三四洞 我們也在三四洞 (*they maintain at three four zero we are at three four zero too*)
02:15:06.2	ICN	(conversation with SK105)
02:15:08.3	CAM-1	我們是下降中 (*we are descending*)
02:15:09.4	CAM-2	對 下降中 (*right descending*)
02:15:09.9	SK105	(conversation with ICN)
02:15:13.1	ICN	(conversation with MU5041)
02:15:16.8	MU5041	(conversation with ICN)
02:15:19.6	CAM-1	等一下 autoland (*engage autoland later on*)
02:15:21.0	CAM-2	autoland
02:15:22.8	CAM-2	我們現在不要再亂 (*we have to keep stable now*)
02:15:23.9	ICN	(conversation with MU5041)
02:15:24.1	CAM-2	…下降 下降檢查 先先做… (*…descent descent check do it first…*)
02:15:25.8	CA8123	(conversation with ICN)
02:15:28.3	ICN	(conversation with CA8123)
02:15:30.2	CAM-1	descend checklist
02:15:31.0	CA8123	(conversation with ICN)
02:15:31.7	CAM-2	pressurization
02:15:32.6	CAM-1	set
02:15:33.5	CAM-2	landing data
02:15:33.6	CX417	(conversation with ICN)
02:15:34.6	CAM-1	one two four one six four two zero four
02:15:36.8	CAM-2	recall
02:15:37.5	CAM-1	check
02:15:37.6	ICN	(conversation with CX417)
02:15:39.1	CAM-2	autobrake

Radar Time *	SOURCE	**CONTENT**
02:15:39.2	CAM-1	two
02:15:40.5	CX417	(conversation with ICN)
02:15:41.7	CAM-2	descend checklist complete
02:15:42.8	CAM-1	啊 手套都不見了 (*uh the gloves are gone*)
02:15:47.5	CAM-1	喂 你後面 (*hay behind you*)
02:15:49.0	ICN	far eastern tree zero six contact jeju approach one two one point two far eastern tree zero six good day
02:15:54.2	RDO-2	incheon one two uh correct jeju approach one two one two far eastern tree zero six
02:15:59.2	ICN	affirmative
02:16:00.4	RDO-2	good day
02:16:01.9	RDO-2	jeju approach good morning far eastern tree zero six
02:16:06.0	APP	uh good morning far eastern tree zero six approach squwak ident
02:16:09.6	RDO-2	okay far eastern tree zero six descend one five zero we request emergency landing uh due to the personal injury and request the medicine help
02:16:19.8	APP	uh far eastern tree zero six unable radar contact proceed direct charlie juliet uniform maintain level one five zero
02:16:26.8	RDO-2	uh negative negative far eastern tree zero six we request emergency landing we have personal injuries
02:16:34.6	APP	far eastern tree zero six unable radar contact uh proceed direct charlie juliet uniform maintain level one five zero
02:16:40.2	RDO-2	far eastern tree zero six request direct marin far eastern tree zero six request direct marin
02:16:45.2	APP	far eastern tree zero six proceed direct marin
02:16:48.8	RDO-2	proceed to marin and we have uh personal injuries request uh medicine or doctor help and emer uh ambulance help
02:16:58.6	APP	uh roger
02:17:02.0	CAM-1	one five zero request continue descend
02:17:03.1	CAM-2	yes 他 他沒有 okay (*yes he he was not okay*)
02:17:06.5	RDO-2	far eastern tree zero six maintain flight level one five zero request continue descend
02:17:10.9	APP	far eastern tree zero six standby descend level one five zero proceed direct marin

Radar Time *	SOURCE	**CONTENT**
02:17:15.1	RDO-2	okay proceed marin maintain flight level one five zero far eastern tree zero six we have uh information foxtrot
02:17:21.6	APP	uh roger
02:17:23.3	APP	(conversation with unidentified aircraft)
02:17:31.8	-?	(conversation with APP)
02:17:34.7	APP	(conversation with KE1217)
02:17:38.1	CAM	(sounds identified as cockpit to cabin call)
02:17:41.7	CAM-1	哈囉 (*hello*)
02:17:43.6	KE1217	(conversation with APP)
02:17:43.6	CAM-1	他們現在忙 不要不要管他 (*they are busy now do not bother them*)
02:17:44.7	CAM-2	那我們 他們有沒一個有空 (*now we do they have any one available*)
02:17:46.8	CAM-5	*
02:17:47.7	CAM-2	*你們有一沒一個人可以進來幫我們後面收拾一下 (*do you have anyone available to clean up back here*)
02:17:50.6	APP	korea one eight zero tree stop descend one two thousand
02:17:51.1	PA	各位貴賓 我們正經過一段不穩定的氣流 為了您的安全 請您留在座位上 並將安全帶扣好 謝謝 (*ladies and gentlemen we are now passing the unstable turbulence area please remain in seat and fasten your seatbelt for you own safety thank you*)
02:17:52.4	CAM-5	好那你 *你幫他 教官說幫他進來盤子收一收 (*okay you * you help him please help to clean up the cockpit*)
02:17:53.8	KE1803	(conversation with APP)
02:17:56.5	CAM-4	好 好 (*okay okay*)
02:18:00.6	APP	(conversation with unidentified aircraft)
02:18:02.3	CAM-1	把它收一收好了 那個報紙… (*clean it up that newspaper…..*)
02:18:03.1	-?	(conversation with APP)
02:18:05.3	PA	ladies and gentleman we are now encontering some pumping air for your safety please remain seated and fasten your seat belt for security thank you
02:18:05.6	CAM	(unidentified sounds)
02:18:07.5	APP	(conversation with KE1217)

Radar Time *	SOURCE	**CONTENT**
02:18:11.0	KE1217	(conversation with APP)
02:18:12.7	APP	(conversation with JE109)
02:18:15.5	CAM-2	沒有還是受傷 (*uninjured or injured*)
02:18:17.4	JE109	(conversation with APP)
02:18:17.6	CAM-5	沒有 (*no*)
02:18:18.2	CAM-1	啊 (*uh*)
02:18:18.6	CAM-5	有 * 在前面 (*yes * in the front*)
02:18:20.2	CAM-1	*啊 (**uh*)
02:18:20.8	CAM-6	* 在走道…(* *at the aisle…*)
02:18:23.4	CAM-1	喔 (*uh*)
02:18:23.5	APP	far eastern tree zero six descend to uh seven thousand
02:18:27.9	RDO-2	descend to seven thousand far eastern tree zero six
02:18:30.6	CAM-2	seven thousand
02:18:34.0	APP	(conversation with JE109)
02:18:36.2	CAM-1	seven thousand set
02:18:37.6	JE109	(conversation with APP)
02:18:39.6	CAM-1	approach check please
02:18:41.3	CAM-2	okay one zero two
02:18:44.1	CAM-1	one zero two four
02:18:45.1	CAM-2	one zero two four
02:18:46.3	CAM-1	descent checklist
02:18:47.6	CAM-2	okay decent checklist 已經做 complete approach checklist altimeter (*okay decent checklist had been done complete approach checklist altimeter*)
02:18:50.1	CAM-1	approach checklist
02:18:51.5	CAM-2	altimeter
02:18:51.9	APP	jeju all aircraft this is jeju approach emergency landing in progress maintain radio silence
02:18:52.4	CAM-1	one zero two four
02:18:55.6	CAM-2	approach checklist complete
02:18:56.3	CAM-1	等一下不... 不管啦 你 你你先去忙你們的 (*wait a moment forget it you you go to take care of your own job first*)

Radar Time *	SOURCE	**CONTENT**
02:18:59.3	CAM-1	有沒有很嚴重的 (*anyone got serious injured*)
02:19:00.6	CAM-4	有 暈倒了 (*yah one passed out*)
02:19:16.8	CAM-1	high speed
02:19:19.6	CAM	(unidentified sounds)
02:19:20.6	RDO-2	jeju approach far eastern tree zero six request high speed descend
02:19:24.4	APP	far eastern tree zero six high speed descend approved
02:19:26.9	RDO-2	high speed descend approved far eastern tree zero six
02:19:33.8	-?	(conversation with unidentified aircraft)
02:19:39.2	APP	(conversation with APP)
02:19:42.6	-?	(conversation with unidentified aircraft)
02:19:48.3	RDO-2	okay opera uh jeju operation good morning far eastern tree zero six
02:19:53.3	SOC	far eastern tree zero six go ahead
02:19:55.4	RDO-2	okay e-t-a zero two tree zero request parking bay
02:19:57.4	APP	far eastern tree zero six turn left heading tree tree zero
02:20:00.2	SOC	zero two tree zero spot one one
02:20:01.4	RDO-1	turn left tree tree zero far eastern tree zero six
02:20:03.3	RDO-2	spot one one far eastern tree zero six we have personal injuries uh we uh need uh medicine help and ambulance
02:20:16.0	PA-3	各位貴賓 現在我們要統計所有飛機上面 不管是您有受輕傷或是重傷的旅客 如果您有受傷的話 請您將您的服務鈴按著 我們 座艙長要來統計所有受傷的人數 好不好 以及受傷乘客受傷的情況 (*ladies and gentlemen now we are going to count the injury passenger if you are the one please press and hold the service bell the purser is going to count the wound passengers and the status of the wound passengers*)
02:20:16.4	SOC	far eastern tree zero six say again
02:20:18.7	RDO-2	we have personal injuries request doctor and ambulance help
02:20:26.4	SOC	roger doctor and ambulance
02:20:27.8	APP	far eastern tree zero six descend to four thousand
02:20:30.8	RDO-2	descend to four thousand far eastern tree zero six
02:20:31.0	CAM	(sounds identified as service bell call)
02:20:32.8	CAM-1	four thousand check

Radar Time *	SOURCE	**CONTENT**
02:20:34.0	CAM-2	我幫你打延長線了喔 (*I already input the final inbound course in for you*)
02:20:34.3	CAM	(sounds identified as service bell call)
02:20:38.2	CAM	(sounds identified as service bell call)
02:20:38.4	CAM-1	execute
02:20:39.4	CAM-2	洞六五 (*zero six five*)
02:20:40.4	CAM	(sounds identified as service bell call)
02:20:41.1	APP	attention all aircraft this is jeju approach uh emergency landing in progress maintain radio silence
02:20:43.5	CAM	(sounds identified as service bell call)
02:20:44.1	CAM-1	ten thousand feet
02:20:45.5	CAM-1	有報過了 報過了 (*I did report it already I did*)
02:20:49.2	PA	各位貴賓 我們還有幾分鐘就可以在濟州島機場降落了 請您現在將椅背扶正 安全帶扣好 謝謝 (*ladies and gentlemen we are going to land at jeju airport in the few minutes please remain in your seat erect your seat back and fasten your seatbelt thank you*)
02:20:50.5	SOC	far eastern tree zero six
02:20:53.7	RDO-2	go ahead far eastern tree zero six
02:20:56.7	SOC	could you tell me the status of patient now
02:21:00.3	PA	ladies and gentlemen we will be landing at jeju international airport please fasten your seat belt fasten and straighten your seat lift the window shade thank you
02:21:00.9	RDO-2	okay uh we are not include just check now uh wait a moment
02:21:07.8	-?	…
02:21:14.4	RDO-2	may be i will tell you after landing and now we are proceed descent procedures it is uh there is no time to uh take ready
02:21:32.5	SOC	roger
02:21:42.0	CAM-2	喔 先打兩響 (*uh twice first*)
02:21:42.8	CAM	(sounds identified as seat belt sign) [approaching signal]
02:21:44.7	CAM	(sounds identified as cabin to cockpit call)
02:21:46.5	CAM-2	請說 (*speaking please*)
02:21:47.1	CAM-3	教官 請問救護車叫了嗎 (*did we request the ambulance*

Radar Time *	SOURCE	**CONTENT**
		sir)
02:21:48.4	CAM-2	叫了 (*yes I did*)
02:21:48.8	CAM-3	謝謝 謝謝 (*thanks thanks*)
02:21:49.0	CAM-2	我們醫護人員也叫了 (*we requested the medical person too*)
02:21:50.6	CAM-3	謝謝 謝謝 (*thanks*)
02:21:53.3	CAM-1	麻煩了 (*we are in trouble*)
02:21:54.4	APP	(conversation with KE1217)
02:21:57.5	CAM-2	嗨 先想想看 等一下要寫報告 (*hay thinking ahead we are going to write the report*)
02:21:58.5	KE1217	(conversation with APP)
02:21:59.8	APP	(conversation with KE1217)
02:22:02.0	KE1217	(conversation with APP)
02:22:02.4	CAM-2	呃 三萬四 他是三萬四 我們在三萬四 洞兩洞拐 三萬四 遇到同向飛機 對向飛機 (*uh thirty four thousand we were at thirty four thousand zero two zero seven had a traffic at thirty four thousand heading to us*)
02:22:04.6	APP	(conversation with KE1217)
02:22:07.1	KE1217	(conversation with APP)
02:22:07.8	PA-3	請所有旅客先坐在座位上 我們優先讓那些受傷的旅客 讓醫護人員進來幫他們協助 以及救護車準備好了 讓那些需要急著救救護車的旅客 要讓先行離機 感謝各位合合作喔 (*please remain in seat first let the medical person get in and help the wounded passengers the ambulances are ready please let the passengers who need the ambulance get off first thanks for your cooperation*)
02:22:13.9	CAM-1	你跟他講了救護車來了嗎 (*did you tell him is the ambulance coming*)
02:22:15.9	CAM-2	都 都叫了 (*yes I did*)
02:22:19.0	CAM-2	等一下塔台我會再講一下 (*I will talk to tower again later*)
02:22:21.7	CAM-1	flaps one
02:22:22.9	CAM-2	flaps one
02:22:23.8	APP	far eastern tree zero six turn right heading zero tree zero clear i-l-s d-m-e runway six approach report established
02:22:29.4	RDO-2	okay ... turn zero tree zero uh clear i-l-s runway zero six approach report established far eastern tree zero six

Radar Time *	SOURCE	**CONTENT**
02:22:40.6	APP	far eastern tree zero six descend to two thousand seven hundred
02:22:43.9	RDO-2	descend two thousand seven hundred far eastern tree zero six
02:22:46.1	CAM-2	two thousand seven
02:22:48.5	CAM-2	gear down
02:22:48.9	CAM-1	gear down
02:22:49.0	CAM-2	…
02:22:50.2	CAM-2	gear down 是吧 (*gear down is that right*)
02:22:50.9	CAM-1	down
02:22:51.2	CAM	(sounds identified as gear down)
02:22:53.3	APP	(conversation with unidentified aircraft)
02:22:57.5	CAM-1	flap five
02:22:58.9	CAM-2	five
02:22:59.2	CAM	(unidentified sounds)
02:22:59.7	-?	(conversation with APP)
02:23:02.5	APP	(conversation with unidentified aircraft)
02:23:05.5	CAM-2	both capture
02:23:05.9	-?	(conversation with APP)
02:23:06.8	-?	…
02:23:08.7	KE1214	(conversation with APP)
02:23:09.4	CAM-2	十一號 bay 喔 (*bay eleven*)
02:23:10.8	CAM-1	十一號 bay (*bay eleven*)
02:23:13.9	-?	…
02:23:15.2	APP	(conversation with KE1214)
02:23:19.0	KE1214	(conversation with APP)
02:23:23.8	APP	(conversation with unidentified aircraft)
02:23:28.0	-?	(conversation with APP)
02:23:30.4	APP	(conversation with KE1217)
02:23:34.7	KE1217	(conversation with APP)
02:23:37.5	RDO-2	uh jeju approach far eastern tree zero six established
02:23:41.3	APP	far eastern tree zero six contact tower one eighteen one good day

Radar Time *	SOURCE	**CONTENT**
02:23:44.2	RDO-2	contact tower one eighteen one far eastern tree zero six
02:23:48.8	RDO-2	uh jeju uh tower good morning far eastern tree zero six approach one one d-m-e
02:23:54.3	TWR	far eastern tree zero six tower clear to land runway zero six wind zero six zero at one zero
02:24:00.2	RDO-2	wind zero six zero six zero uh one zero far eastern zero six we are emergency landing
02:24:05.8	TWR	do you copy that there are ready for ambulance and fire car
02:24:09.4	RDO-2	okay thank you far eastern tree zero six
02:24:11.8	TWR	welcome tree zero six descend as published …
02:24:15.7	RDO-2	oh yeah far eastern tree zero six
02:24:17.8	CAM-1	剛這句話講甚麼 (*what did he say just now*)
02:24:20.1	CAM-2	descend as published uh descend as 那個 (*descend as published uh descend as the*)
02:24:28.7	CAM-2	他有 ambulance 那個 uh fire truck 他有 (*they got ambulance uh and the fire truck*)
02:24:37.6	CAM-2	因為我剛剛懶得再跟他講 因為要講 所以我就要 報 emergency landing 最快 因為你不報 emergency 他不會給你優先嘛 還給你帶走 (*I just reluctant to tell them again request for emergency is the fastest way if you did not do that they would not give you the priority even extend your landing pattern sometimes*)
02:24:38.6	KE734	(conversation with SOC)
02:24:46.4	CAM-2	我報了 他才會轉轉向 marin (*I did it so they cleared us direct to marin*)
02:24:46.9	SOC	(conversation with KE734)
02:24:48.5	KE734	(conversation with SOC)
02:24:54.1	SOC	(conversation with KE734)
02:24:55.9	AK9142	(conversation with TWR)
02:24:57.9	TWR	(conversation with AK9142)
02:25:00.1	CAM-2	這個 那個 FOQAs 喔 可能讀 不好看 因為你 降降到十幾 十幾這個 (*this the FOQAs readout probably not going well because you descend to ten somehow ten somehow*)
02:25:00.4	AK9142	(conversation with TWR)
02:25:07.5	CAM-1	啊 (*uh*)

Radar Time *	SOURCE	**CONTENT**
02:25:07.7	CAM-2	fo fo 那個 FOQAs 一定不好看 (*fo fo that FOQAs readout is not going well for sure*)
02:25:09.9	CAM-1	十幾浬 (*ten somewhat knots*)
02:25:10.7	CAM-2	不是 我說那個這個那個 altitude 的 (*no I meant that the altitude*)
02:25:14.0	CAM-1	twenty
02:25:15.5	CAM-1	twenty
02:25:16.5	CAM-2	flap twenty
02:25:16.6	CAM	(sounds identified as lower flap level)
02:25:18.3	CAM-2	呃 速度 (*uh speed*)
02:25:22.0	CAM-2	下去再說 (*talk to you after we land*)
02:25:23.4	CAM-2	速度 (*speed*)
02:25:27.3	CAM-1	么四四 唉 (*one four four uh*)
02:25:32.1	CAM	(sounds identified as pulling speedbrake level)
02:25:32.6	CAM-2	等一下落地 我在座艙 你到後面 ...關完車你到後面去看看 我在這邊好了 我留在這邊 去看看他們怎麼樣 (*after landing I remain in cockpit and you walk to the cabin you walk to the cabin and take a look see what happened back there after engine shut down I remain in the cockpit*)
02:25:39.4	CAM-2	land tree
02:25:40.4	CAM-1	Thirty
02:25:41.7	CAM	(sounds identified as lower flap level)
02:25:41.8	CAM-2	thirty
02:25:43.3	CAM-2	Auto land 喔 (*auto land uh*)
02:25:44.3	CAM-2	我來我來唸 (*I will read for you*)
02:25:46.3	CAM-1	還是自己飛好了 (*I would like to take manual control*)
02:25:47.6	CAM-2	對 land tree 了 (*yep land tree uh*)
02:25:48.6	CAM	(unidentified sounds)
02:25:48.7	CAM-2	好 landing checklist (*okay landing checklist*)
02:25:50.4	CAM-1	speed brake
02:25:51.0	CAM-2	armed
02:25:51.3	CAM-1	check
02:25:51.8	CAM-2	landing gear

Radar Time *	SOURCE	**CONTENT**
02:25:52.9	CAM-1	down
02:25:53.3	CAM-2	flap
02:25:53.7	CAM-1	thirty
02:25:54.2	CAM-2	landing checklist complete clear to land
02:25:55.2	CAM-1	roger
02:25:56.4	CAM-2	洞么洞十浬喔 洞六洞 呃 洞六洞十浬 (*zero one zero ten nautical miles zero six zero uh zero six zero ten nautical miles*)
02:26:01.3	CAM	(unidentified sounds)
02:26:02.6	CAM	(unidentified sounds)
02:26:04.2	CAM-2	對么 么三洞 (*yep one one three zero*)
02:26:10.5	CAM-2	autoland 不加速度 對不對 (*do not add speed in auto land mode right*)
02:26:13.2	CAM-1	我自己飛 我自己飛 (*manual control manual control*)
02:26:14.1	CAM-2	好 (*okay*)
02:26:35.8	CAM-2	你要 你要出去報告 等一下我再跟 跟你講一下 我們再討論一下 (*you got you got to go out and report it let's discuss later*)
02:26:41.3	CAM-2	one thousand stable
02:26:42.7	CAM-1	continue
02:27:08.3	CAM-1	那個要不要 要不要把它拉下來 (*I am wondering….I am wondering should we pull it down or not*)
02:27:11.9	CAM-1	我們這邊也沒有這個能量 (*we do not have the capabilities here*)
02:27:13.5	CAM-2	沒 這邊沒有 (*no we do not have*)
02:27:15.5	KE1217	(conversation with TWR)
02:27:21.4	TWR	(conversation with KE1217)
02:27:23.7	-?	…
02:27:24.8	CAM-2	那邊對 對面是 (*there the opposite plane is*)
02:27:25.7	KE1217	(conversation with TWR)
02:27:25.8	CAM	five hundred
02:27:26.8	CAM-2	stable
02:27:27.4	CAM-1	continue
02:27:28.9	CAM-2	呃 等一下落 對面是泰航的 泰航也在 一直在問為什麼

Radar Time *	SOURCE	**CONTENT**
		(*uh land later the thai was heading to us they were keep asking why*)
02:27:32.3	-?	…
02:27:33.5	CAM-1	泰航 跟我們對頭的耶 (*the thai was the one heading to us*)
02:27:34.5	-?	…
02:27:35.1	CAM-2	泰航 泰航也一直在問嘛 (*the thai was keep asking too*)
02:27:36.7	-?	…
02:27:39.4	CAM-2	好 不要講了 (*okay stop talking that*)
02:27:39.5	CAM-1	泰航也沒講甚麼話 (*the thai did not say much*)
02:27:40.6	CAM-2	有 他有 他有講 (*no they did*)
02:27:45.9	CAM-2	approach minimum
02:27:46.9	CAM-1	check
02:27:48.0	CAM-2	auto pilot auto throttle disconnect
02:27:54.6	CAM-2	…
02:27:54.9	CAM	minimums
02:27:55.8	CAM-1	land
02:27:56.4	CAM-2	check
02:28:01.0	CAM	one hundred
02:28:05.9	CAM	fifty
02:28:06.7	CAM	forty
02:28:07.9	CAM	thirty
02:28:09.1	CAM	twenty
02:28:10.6	CAM	ten
02:28:14.7	CAM-2	speed brake up
02:28:16.1	CAM	(sounds identified as reverse level unlocked)
02:28:17.1	CAM	(sounds identified as reverse activated)
02:28:19.8	CAM-2	reverse two green
02:28:21.1	CAM-1	車子都來了 (*all the vehicles are here*)
02:28:21.9	CAM-2	epr one zero two one zero tree
02:28:24.4	CAM	(sounds identified as reposition reverse level to idle)
02:28:31.2	CAM-2	eighty knots
02:28:32.3	CAM-1	我們要救護車 不是要消防車耶 (*we need ambulances*

Radar Time *	SOURCE	**CONTENT**
		not fire trucks)
02:28:34.9	CAM-2	沒有我是… (*no I am…*)
02:28:36.2	TWR	far eastern tree zero six turn right bravo
02:28:36.3	CAM-2	救護車有來喔 (*the ambulance is here*)
02:28:39.1	RDO-2	turn right bravo far eastern tree zero six
02:28:44.5	RDO-2	far eastern tree zero six uh we don't need the fire truck and we are taxi to parking bay uh one one
02:28:51.6	TWR	okay clear to parking bay one one and ready two [or to] ambulance
02:28:54.9	RDO-2	uh far eastern tree zero six
02:28:58.2	CAM-1	幾個人也不知道 (*we do not know how many people*)
02:29:00.0	CAM-2	不知道 現在我們沒… (*I do not know now we do not havet….*)
02:29:00.9	CAM-1	start a-p-u
02:29:02.4	CAM-2	a-p-u
02:29:02.7	CAM	(sounds identified as starting a-p-u)
02:29:04.9	CAM	(sounds identified as cabin to cockpit call)
02:29:05.3	CAM	(unidentified sounds)
02:29:05.5	CAM-5	教官 教官 (*sir sir*)
02:29:06.9	CAM	(unidentified sounds)
02:29:07.5	PA	各位貴賓 我們現在已經降落 在飛機 在飛機 機還沒有完全停 (*ladies and gentlemen we are now landed before the airplane full stop…*)
02:29:07.8	CAM-1	嗨 (*hai*)
02:29:08.3	CAM-5	大概有十七八個受傷吧 這不包括組員 然後因為有一個人他 有一個人他 有一個人說他手斷了 還有一個人肋骨痛 (*there are about seventeen to eighteen injury passengers not including crew members one passenger said that his arm was broken and another one said he had aches in his ribs*)
02:29:17.8	CAM-1	好 我們叫救護車了 現在我 (*okay we had already requested for ambulances now I*)
02:29:19.9	CAM-5	多多叫幾部好了 沒有沒有 我看叫幾部就好了 然後大部分可以走啦 只是因為有些… (*request more no no I think several is enough most of the injury passengers can walk by themselves only because some….*)

Radar Time *	SOURCE	**CONTENT**
02:29:21.5	CAM-1	okay 好 (*okay*)
02:29:22.7	RDO-2	tower far eastern tree zero six
02:29:25.5	TWR	tree zero six your parking bay one one in used
02:29:27.4	RDO-2	yeah yes sir we have almost twenty person injured we are twenty person injured
02:29:29.8	PA-7	各位貴賓 現在已經降落在濟州 在還沒完全停妥以前 請您一定要留在座位上 在飛機完全停妥之後 我們盡快讓傷者先行離機 謝謝您的合作 (*ladies and gentlemen we have landed at jeju please remain seated until the airplane full stop we will let the wound passengers off the airplane as soon as possible thanks for your cooperation*)
02:29:30.0	CAM-1	要 要 要好幾部救護車 (*need several ambulances*)
02:29:37.7	TWR	tree zero six pardon your radio say again
02:29:41.0	RDO-2	we have twenty person injured
02:29:44.7	TWR	uh copy that the parking at one one
02:29:48.0	RDO-2	need we need uh more ambulance
02:29:52.1	TWR	copy that
02:29:56.2	PA-5	各位旅客 呃 請先檢查您的貴重物品 像護照啊 這些東西要 嗯 那其餘的如果眼鏡這些東西 我們會一併 清艙的時候我們一併收齊 然後在下飛機拿給你們 謝謝 (*ladies and gentlemen please check your valuable belonging like passport etc. the rest like glasses we will pick it up for you during the cabin cleaning process and hand it to you afterward thank you*)
02:30:00.5	CAM-2	okay speed brake down autobrake off flaps up both weather radar off a-p-u start after landing check completed
02:30:08.6	CAM-2	其他的先不動 等一下再弄 (*do not move the others we are doing it later*)
02:30:13.0	CAM-3	有客人說 對 他的 ipod 不見了 他的 (*one passenger report that he lost his ipod*)
02:30:15.1	CAM-5	… ipod
02:30:21.2	PA-3	各位貴賓您好 剛才有許多旅客反應 他的隨身個人小物品目前是遺失了 好 如果您可以尋找先尋找 如果沒有尋找到的話 我們等會統一做客艙的清潔 會將所有撿到的物品呢 統一集中來再交還給各位貴賓 好 謝謝 (*ladies and gentlemen we had been told that many passengers lost*

Radar Time *	SOURCE	**CONTENT**
		their personal belongings if you could find it that's fine if you can not find it we will pick it up for you at cabin cleaning process and hand it to you afterward)
02:30:37.1	CAM-1	收起來 (*take it*)
02:30:38.6	CAM	(sound similar to single chime)
02:30:40.6	TWR	far eastern tree zero six tower
02:30:42.7	RDO-2	go ahead far eastern tree zero six
02:30:42.8	CAM-3	…
02:30:44.7	CAM-5	…
02:30:44.9	TWR	uh do you how many car do you need ambulance
02:30:48.6	RDO-2	we have ... about twenty person injuries so uh I don't know how much uh car do we we need but we have twenty person twenty person injured
02:30:55.0	CAM-1	嘿 你那個跟業務聯絡了嗎 業務人呢人勒 (*hai did you contact the agent where is he*)
02:30:59.6	-?	…
02:31:00.2	TWR	okay two … two zero person
02:31:00.4	CAM-1	那個 有二十個人受傷 (*that there are twenty injury passengers*)
02:31:03.0	-?	…
02:31:03.4	RDO-2	okay uh about ten ambulance
02:31:03.6	CAM-2	二十個人受傷 (*twenty injury passengers*)
02:31:04.6	CAM-1	對 我們要救護車 (*correct we need ambulances*)
02:31:06.2	-?	…
02:31:06.7	CAM-2	救護車現在在下面啦 (*now the ambulance is down there*)
02:31:07.7	CAM-1	你跟那個聯繫一下 救護車一部不夠啦 要 很多人受傷啦 (*you tell them that one ambulance is not enough we got many injury passengers*)
02:31:09.0	TWR	(conversation with KE1217)
02:31:13.4	KE1217	(conversation with TWR)
02:31:14.6	CAM-1	shut down checklist
02:31:16.1	CAM-2	okay hydraulic panel
02:31:18.6	CAM-1	set

Radar Time *	SOURCE	**CONTENT**
02:31:19.0	CAM-2	fuel pump
02:31:19.3	CAM-1	off
02:31:19.9	CAM-2	parking brake
02:31:21.7	CAM-1	off
02:31:22.7	CAM-2	fuel control switches
02:31:23.9	CAM-1	cut off
02:31:24.7	CAM-2	shut down check complete sir
02:31:32.4	CAM-2	哦 你先去後面看 我來開 我來跟他連絡 我來我來動其它 我正常 很好 (*uh you go to cabin I'll take care of the communication and the others I am fine*)
02:31:35.5	CAM-1	跟他聯繫一下（contact to him）
02:31:37.4	CAM-2	我來聯繫 如果有什麼事 我跟你報告 (*I'll take care of the communication I'll report to you if needed*)
02:32:10.8	PA-5	各位貴賓 麻煩先請讓受傷的 (*ladies and gentlemen please let the wound passengers…*)
02:32:13.5	-?	…
02:32:14.4	CAM-2	(sounds similar to sigh)
02:32:15.1	CAM-?	…
02:32:23.1	JE109	(conversation with TWR)
02:32:27.2	TWR	(conversation with JE109)
02:32:30.4	JE109	(conversation with TWR)
02:32:33.2	CAM-8	doctor 沒看到 doctor (*doctor I do not see doctor*)
02:32:36.6	CAM-5	喂 喂 喂 那那個 那那個 那個 那個 受傷的可不可以叫他們出來 (*hello….that….would you let the wound passengers out…*)
02:32:45.7	CAM-3	…
02:32:47.0	CAM-?	這邊有 (*here they are*)
02:32:53.3	SOC	far eastern tree zero six korea air operation
02:32:55.2	CAM-?	喂喂喂 (*hello*)
02:32:55.9	RDO-2	go ahead far eastern tree zero six
02:32:58.5	SOC	how many passenger ...
02:33:00.3	CAM-?	…
02:33:00.6	RDO-2	we have about twenty person injuries and need ten ambulance and

Radar Time *	SOURCE	**CONTENT**
02:33:07.0	CAM-1	…他們… (…*they*…)
02:33:07.8	CAM-3	對 (*right*)
02:33:10.5	CAM-?	正常 (*normal*)
02:33:13.0	CAM-5	好好好 (*okay*)
02:33:14.2	SOC	you need ten ambulance
02:33:14.3	PA-5	真的很抱歉 呃 沒有受傷的旅客 先先行離機 那受傷的旅客 等待醫生護士 請留在座位上稍候 造成不便 敬請見諒 謝謝您的合作 (*we are sorry for the uninjured passengers please move forward and off the plane for the injury passengers please remain in the seat the medical person will help you later*)
02:33:16.3	RDO-2	affirm uh we have about twenty person injuries
02:33:24.9	SOC	passenger how many
02:33:27.7	RDO-2	two zero twenty person
02:33:28.8	CAM	(sounds identified cockpit to cabin call)
02:33:30.9	SOC	roger
02:33:32.1	RDO-2	and landing time is two eight diagonal tree two fuel remaining one tree point zero
02:33:39.4	SOC	roger thank you
02:38:49.0		(recording ending)

Attachment 3 EF306 SSFDR Parameter List

no.	Parameter Name	Units	no.	Parameter Name	Units
1	Super Frame Raw Param	DIS	121	IRS SELECT SW-CAPT	DIS
2	A/C NUMBER	DIS	122	ISOLATION VALVE	DIS
3	A/C TYPE	DIS	123	L BLEED DUCT PRESS	PSI
4	A/P CMD ENGA	DIS	124	L HYD SYS LO PRESS	DIS
5	A/P CWS ENGA	DIS	125	L NAV MODE OPER	DIS
6	A/P ENGAGE DETENT	DIS	126	L T/R DEPLOYED	DIS
7	A/T DISCONNECT	DIS	127	L YAW DAMPER	DIS
8	A/T ENGAGE	DIS	128	L.E. SLATS EXTEND	DIS
9	A/T G/A MODE ANNUN	DIS	129	L.E. SLATS FAIL	DIS
10	ACMS S/W P/N CODE	DIS	130	L.E. SLATS PART EXTEND	DIS
11	ADC SELECT SW-CAPT	DIS	131	L.E. SLATS RETRACTED	DIS
12	AILERON POSN-OUTER	deg	132	LAND 2 GREEN	DIS
13	AIR/GROUND	DIS	133	LAND 3 GREEN	DIS
14	ALL GEAR DOWN & LOCK	DIS	134	LATERAL ACCELERATION	G
15	ALT FLAPS	DIS	135	LDG GEAR LEVER	DIS
16	ALT HOLD MODE OPER	DIS	136	LE SLATS ASYM	DIS
17	ALT MODE OPER	DIS	137	LOC MODE OPER	DIS
18	ALT SLATS	DIS	138	LOCALIZER DEV	DDM
19	ALTITUDE (29.92)	ft	139	LOCALIZER_dot	dot
20	ANGLE OF ATTACK	deg	140	LONGITUDINAL ACCEL	g
21	ANTI-SKID	DIS	141	LOW FUEL QTY	DIS
22	APCC	DIS	142	MACH	DIS
23	APCM	DIS	143	MACH LIMIT OPER	DIS
24	APLC	DIS	144	MACH MODE OPER	DIS
25	APLM	DIS	145	MACH SPEED TRIM	DIS
26	APPR MODE OPER	DIS	146	MAG HEADING	deg
27	APRM	DIS	147	MAG/TRUE DATA	DIS
28	APU BLEED VALVE	DIS	148	MAIN/ALT BRAKE SEL	DIS

29	APU MAN RECORD	DIS	149	MANDATORY S/W P/N CODE	DIS
30	ATD	DIS	150	MANUAL TRIM NOSE DOWN	DIS
31	ATE	DIS	151	MANUAL TRIM NOSE UP	DIS
32	ATT HOLD MODE OPER	DIS	152	MANUFACTURER CODE	DIS
33	ATTH	DIS	153	MASTER CAUTION LIGHT	DIS
34	AUTO SPEEDBRAKE		154	MASTER WARNING	DIS
35	AUTOTRIM DOWN	DIS	155	MIDDLE MARKER	DIS
36	AUTOTRIM UP	DIS	156	MIN SPEED	DIS
37	AZIMUTH	DDM	157	MINIMUMS	DIS
38	B/CRS MODE OPER	DIS	158	MLS CHANNEL	DIS
39	BRAKE PRES ALT	PSI	159	MLS/ILS SOURCE SEL	DIS
40	BRAKE PRES MAIN	PSI	160	OUTER MARKER	DIS
41	C HYD SYS LO PRESS	DIS	161	PASS OXYGEN ON	DIS
42	CAPTAIN PVD ON	0-,1-	162	PERF MAN RECORD	DIS
43	CCP_SYNCHO	DIS	163	PILOT SL	DIS
44	CLB MODE OPER	DIS	164	Pitch Angle	deg
45	COMBINED CONT	DIS	165	PRES POSN LAT	deg
46	COMPUTED AIRSPEED	KNOTS	166	PRES POSN LONG	deg
47	CON MODE OPER	DIS	167	PULL UP	DIS
48	Control Column Pos.	deg	168	PVD ENABLE	DIS
49	CONTROL COLUMN POSN	deg	169	R BLEED DUCT PRESS	PSI
50	CONTROL WHEEL POSN	deg	170	R HYD SYS LO PRESS	DIS
51	COWL ANTI-ICE	DIS	171	R T/R DEPLOYED	DIS
52	CRZ MODE OPER	DIS	172	R YAW DAMPER	DIS
53	CUSTOMER UNIQUE FRAME	DIS	173	RADIO HEIGHT	ft
54	DME DISTANCE	NM	174	RALT	ft
55	DRIFT ANGLE	deg	175	RATING 1 OPER	DIS
56	ECS MAN RECORD	DIS	176	RATING 2 OPER	DIS
57	ECS PACK H/L	DIS	177	REPLY INFORMATION	DIS
58	ECS PACK ON/OFF	DIS	178	ROLL ANGLE	deg
59	EFIS SELECT SW-CAPT	DIS	179	ROLLOUT MODE OPER	DIS
60	EICAS SELECT SW	DIS	180	RUDDER PEDAL POSITION	deg

61	ELEC MAN RECORD	DIS	181	RUDDER POSITION	deg
62	ELEVATION	DDM	182	S/F CYCLE COUNT	DIS
63	ELEVATOR POSN	deg	183	SEAT BELT SIGN	discrete
64	ENG EGT	deg C	184	SHUTOFF VALVE	DIS
65	ENG EPR COMMAND	RATIO	185	GPWS:SINK RATE	DIS
66	ENG EPR LIMIT	RATIO	186	SPARE	DIS
67	ENG EPR-ACTUAL	RATIO	187	SPARE DISC	DIS
68	ENG FUEL FLOW	PPH	188	SPD BRK HDL POSN	%
69	ENG N1-ACTUAL	%RPM	189	SPD LIMIT	DIS
70	ENG N2-ACTUAL	%RPM	190	SPOILER PNLS FAIL	DIS
71	ENG N3-ACTUAL	%RPM	191	STAB POSITION	deg
72	ENG OIL QTY	US PINT	192	STAB TRIM FAULT	DIS
73	EPR BUG DRIVE	%	193	STAB TRIM MODULE	DIS
74	EPR TARGET-FMC	%	194	STBY TRIM NOSE DOWN	DIS
75	EQUIV PLA	deg	195	STBY TRIM NOSE UP	DIS
76	EVENT MARKER (RESV)	DIS	196	STICK SHAKER	DIS
77	F/O PVD ON	0-,1-	197	SYNC WORD	DIS
78	FDEP DAY	DIS	198	T.E. FLAP ASYM	DIS
79	FDEP DEPART	DIS	199	T/L RSLVR ANGLE	deg
80	FDEP DEST	DIS	200	T/O MODE OPER	DIS
81	FDEP FLT NUMBER	DIS	201	T/O MODE OPER-P	DIS
82	FDEP LEG NUMBER	DIS	202	T/O MODE OPER-R	DIS
83	FDEP MONTH	DIS	203	T/R INTRANSIT	DIS
84	FL CH MODE OPER	DIS	204	TCASAR	FT/MIN
85	FLAP HANDLE POSN	deg	205	TCASCC	DIS
86	FLAP LIMIT	DIS	206	TCASDN	DIS
87	FLAP POSITION	deg	207	TCASP	DIS
88	FLARE OPER	DIS	208	TCASRI	DIS
89	FLARE RETARD MODE	DIS	209	TCAS VERTICAL CONTROL	DIS
90	FLEET IDENT	DIS	210	GPWS:TERRAIN	DIS
91	FLT DIR ON-CAPT	DIS	211	GPWS:TERRAIN PULL UP	DIS
92	FLT DIR ON-F/O	DIS	212	THROTTLE HLD ANNUN	DIS
93	FMA FAULT 1 (CWS)	DIS	213	THRUST MODE OPER	DIS

94	FMA FAULT 2 (PTCH)	DIS	214	TMC V-NAV OPER	DIS
95	FMA FAULT 3 (ROLL)	DIS	215	TMC VALID	DIS
96	FMC SELECT SW	DIS	216	TOO LOW FLAP	DIS
97	FMC/IRU DATA SOURCE	DIS	217	TOO LOW GEAR	DIS
98	FRAME 1/FRAME 2 SEL	DIS	218	TOO LOW TERRAIN	DIS
99	FRAME COUNTER	DIS	219	TOTAL AIR TEMP	deg C
100	FUEL QTY IND SYS	DIS	220	TRIM DOWN CMD	DIS
101	G/A MODE OPER	DIS	221	TRIM UP CMD	DIS
102	G/A MODE OPER-P	DIS	222	TRUE HEADING	deg
103	G/A MODE OPER-R	DIS	223	UP ADVISORY	DIS
104	G/S MODE OPER	DIS	224	V NAV MODE OPER	DIS
105	GLIDESLOPE	DIS	225	V/S MODE	DIS
106	GLIDESLOPE DEV	DDM	226	VENDOR STATUS & DATA	DIS
107	GMT	DIS	227	VERTICAL ACCELERATION	g
108	GPWS-1	DIS	228	VHF KEYING	DIS
109	GROSS WEIGHT	LBS	229	VOR FREQUENCY	MHz
110	GROUNDSPEED	KNOTS	230	WIND DIRECTION TRUE	deg
111	HDG HOLD MODE OPER	DIS	231	WIND SPEED	KNOTS
112	HDG SEL MODE OPER	DIS	232	WINDSHEAR	DIS
113	HFKEYING	DIS	233	WINDSHEAR CAUTION	DIS
114	HYD MAN RECORD	DIS	234	WING ANTI-ICE	DIS
115	IAS	DIS	235	YAW DAMPER ENGAGE	DIS
116	IAS LIMIT OPER	DIS			
117	IAS MODE OPER	DIS			
118	IDLE THRUST OPER	DIS			
119	ILS FREQUENCY	MHz			
120	INNER MARKER	DIS			

Attachment 4 EF306 Relevant Tabular Parameters List (TCAS and Flight Controls)

Radar UTC	A/P CMD	ALTITUDE (29.92)	COMPUTED AIRSPEED	GSPD	Pitch Angle	Roll Angle	SEAT BELT	TCASDN	Vertical Speed	CCP	CWP	AILERON-L	AILERON-R	ELEVATOR-L	ELEVATOR-R	RUDDER PEDAL Pos.	RUDDER POS
FDR+6sec	C ENGA	(ft)	(kts)	(kts)	(deg)	(deg)	SIGN		(FT/MIN)	(deg)	(deg)	(deg)	(deg)	(deg)	(deg)	(deg)	(deg)
02:06:55	ENGAGE	33844	274	494	1	0		NO DN ADV.	-1248	1.8	3.5	0.3		-0.26		1.3	0.2
02:06:56	Not ENG.	33828	274	494	2	0.4		NO DN ADV.	-864	1	2.9		-0.3		0.26	1.3	0.2
02:06:57	Not ENG.	33824	274	494	2	1.1	On	NO DN ADV.	-384	1.2	2.9	0.4		-0.44		1.3	0.2
02:06:58	Not ENG.	33828	273	494	3	2.1		NO DN ADV.	192	1.3	3.2		-0.4		0.26	1.3	0.2
02:06:59	Not ENG.	33840	272	493	4	2.5		NO DN ADV.	480	0.7	4.5	0.8		-0.79		1.3	0.2
02:07:00	Not ENG.	33860	272	493	4	3.2		NO DN ADV.	384	-0.1	6.6		-1.3		-2.02	1.3	0.2
02:07:01	Not ENG.	33868	272	493	4	3.2	On	DESCEND	-336	-1.5	3.8	0.5		-3.43		1.3	0.2
02:07:02	Not ENG.	33856	272	493	2	2.5		DESCEND	-1776	-1.8	2		0.1		-3.87	1.3	0.2
02:07:03	Not ENG.	33800	272	494	-1	2.5		DESCEND	-3168	-3.8	2	0.3		-7.47		1.3	0.2
02:07:04	Not ENG.	33692	272	493	-6	2.5		DESCEND	-5376	-3.5	0.2		0.6		-8.26	1.3	-0.3
02:07:05	Not ENG.	33596	274	491	-11	2.5	On	DESCEND	-8112	-2	-1.2	-0.3		-5.27		1.3	-0.3
02:07:06	Not ENG.	33420	276	490	-12	2.8		DESCEND	-9312	-4.1	-1.8		0.9		-9.4	1.2	-0.3
02:07:07	Not ENG.	33180	278	486	-18	3.5		DESCEND	-9840	-1.1	-0.6	-0.3		0.88		1.3	-0.3
02:07:08	Not ENG.	33024	283	487	-17	4.6		DESCEND	-12096	3.8	1.4		0.2		3.96	-1.1	-0.3
02:07:09	Not ENG.	32872	286	494	-9	4.9	On	DESCEND	-11760	-2.9	0.5	0.2		-6.94		-8.8	0.2
02:07:10	Not ENG.	32588	288	500	-11	4.2		DESCEND	-10848	0.8	1.4		-0.8		1.76	-7.5	0.5
02:07:11	Not ENG.	32440	292	504	-13	6		DESCEND	-11040	2.4	7.2	2		0.44		-5.8	1.1
02:07:12	Not ENG.	32276	296	511	-9	8.8		DESCEND	-10752	0.6	11.5		-3.4		-0.44	1.2	1
02:07:13	Not ENG.	32104	300	517	-8	8.1	On	DESCEND	-8448	1.3	16	4.4		0.35		1.2	0.5
02:07:14	Not ENG.	31976	302	521	-6	3.9		DESCEND	-7488	1.9	11.7		-1.5		1.58	1.2	0.2
02:07:15	Not ENG.	31884	302	525	-4	1.1		DESCEND	-5808	2	7.5	1.7		0.79		1.3	0.2
02:07:16	Not ENG.	31816	302	526	-1	-1.1		DESCEND	-4176	1.5	4.6		0.2		0.53	1.3	0.2
02:07:17	Not ENG.	31792	302	525	2	-3.5	On	DESCEND	-2544	-0.1	1.5	-0.3		-2.29		1.3	0.2
02:07:18	Not ENG.	31756	300	524	2	-5.6		DESCEND	-2064	0.5	-5.7		2.3		-0.35	1.2	0.2

02:07:19	Not ENG.	31764	300	523	2	-3.9		DON'T CLIMB	-1344	-0.6	-0.2	-0.4		-2.55		1.2	0.2
02:07:20	Not ENG.	31712	301	523	2	-2.1		DON'T CLIMB	-1392	-2.8	0.8		0.7		-3.6	1.2	0.2
02:07:21	Not ENG.	31704	301	523	-2	-1.4	On	DON'T CLIMB	-1344	-0.6	0.8	0.2		-2.37		1.2	-0.3
02:07:22	Not ENG.	31676	302	523	-1	-0.7		DON'T CLIMB	-1824	-0.9	0.8		0.6		-1.49	1.2	0.2
02:07:23	Not ENG.	31644	304	524	-1	-0.4		DON'T CLIMB	-1296	-0.4	0.6	-0.3		-1.58		1.2	0.2
02:07:24	Not ENG.	31612	306	525	0	0.4		DON'T CLIMB	-1440	0.2	0.3		0.7		-0.44	1.2	0.2
02:07:25	Not ENG.	31604	306	525	1	1.1	On	DON'T CLIMB	-1344	0.2	1.1	1.8		-1.23		1.2	0.2
02:07:26	Not ENG.	31584	307	525	2	2.1		DON'T CLIMB	-1104	-1.2	13.7		-3.1		-2.64	1.2	0.2
02:07:27	Not ENG.	31564	306	525	1	-0.7		DON'T CLIMB	-960	-1	8.2	1.7		-2.55		1.2	0.2
02:07:28	Not ENG.	31552	308	524	1	-2.8		DON'T CLIMB	-1008	-1.3	5.4		-0.2		-2.64	1.2	0.2
02:07:29	Not ENG.	31532	308	524	0	-3.9	On	DON'T CLIMB	-720	-0.5	2.9	0.4		-1.76		1.2	0.2
02:07:30	Not ENG.	31520	308	524	1	-3.9		DON'T CLIMB	-336	-0.3	3.2		0.2		-0.53	1.2	0.2
02:07:31	Not ENG.	31524	309	523	2	-3.5		DON'T CLIMB	0	0.4	3.8	0.8		-0.7		1.2	0.2
02:07:32	Not ENG.	31536	308	521	3	-2.8		DON'T CLIMB	480	0.5	5.1		-0.3		-0.35	1.2	0.2
02:07:33	Not ENG.	31552	307	519	5	-2.5	On	DON'T CLIMB	768	-1	8.8	2.2		-2.72		1.2	0.2
02:07:34	Not ENG.	31572	306	517	4	-3.2		DON'T CLIMB	672	-1.3	6.6		-0.4		-2.72	1.2	0.2
02:07:35	Not ENG.	31584	305	516	3	-4.2		DON'T CLIMB	480	-2	1.7	0.2		-3.78		1.2	0.2
02:07:36	Not ENG.	31580	305	515	1	-4.2		DON'T CLIMB	96	-1.8	1.4		0.6		-3.34	1.2	0.2
02:07:37	Not ENG.	31576	304	515	0	-3.9	On	DON'T CLIMB	-432	-1.4	0.8	-0.3		-2.72		1.2	-0.2
02:07:38	Not ENG.	31560	305	515	0	-3.2		DON'T CLIMB	-816	-1.2	0.5		0.7		-2.11	1.2	0.2
02:07:39	Not ENG.	31536	306	514	0	-2.5		DON'T CLIMB	-1104	-0.8	0.2	-0.3		-2.02		1.2	0.2
02:07:40	Not ENG.	31516	306	514	0	-2.1		DON'T CLIMB	-1200	-1	0.8		0.7		-2.11	1.2	0.2
02:07:41	Not ENG.	31488	306	514	0	-1.4	On	NO DN ADV.	-1008	-0.9	0.5	-0.3		-1.85		1.2	0.2
02:07:42	Not ENG.	31476	306	514	0	-0.4		NO DN ADV.	-768	0	1.4		0.2		-0.35	1.2	0.2

Attachment 5 TG659 SSFDR Parameter List

no.	Parameter Name	Units	no.	Parameter Name	Units
1	28VAC STBY BUS STATUS	DIS	801	L ADF FAIL	DIS
2	AC STBY BUS STATUS	DIS	802	L ADF FREQ LSP	kHz
3	ACCEL DATA SUSPECT	DIS	803	L ADF FREQ LSP + 1	kHz
4	ADC DATA SUSPECT	DIS	804	L ADF FREQ LSP + 2	kHz
5	ADFS BCRS MODE ARMED	DIS	805	L ADF FREQ MSP	kHz
6	ADIRS ALL DATA FAULTED E	DIS	806	L AFDC WATCHDOG FAULT	DIS
7	ADIRS LATITUDE LSP	deg	807	L AOA CASE HEAT VLD	DIS
8	ADIRS LATITUDE MSP	deg	808	L AOA VANE HEAT VLD	DIS
9	ADIRS LONGITUDE LSP	deg	809	L APPROACH MODE CAT	DIS
10	ADIRS LONGITUDE MSP	deg	810	L ASG CARDFILE FAIL E	DIS
11	ADIRU IRU DATA INVALID E	DIS	811	L BLEED VALVE POSN	DIS
12	AFDC TEST	DIS	812	L CTAI SW POSN	DIS
13	AFDS FLARE MODE ARMED	DIS	813	L DME FAIL	DIS
14	AFDS GS MODE ARMED	DIS	814	L ELEC GEN ADV	DIS
15	AFDS LNAV ARMED	DIS	815	L ENG 1 PER N1 VIB	DIS
16	AFDS LOC MODE ARMED	DIS	816	L ENG 1 PER N2 VIB	DIS
17	AFDS PITCH EN MODE	DIS	817	L ENG 1 PER N3 VIB	DIS
18	AFDS PITCH MODE FAIL	DIS	818	L ENG ALT MODE	DIS
19	AFDS ROLL EN MODE	DIS	819	L ENG ALT MODE MAN SEL	DIS
20	AFDS ROLL MODE FAIL	DIS	820	L ENG AT APP IDLE	DIS
21	AFDS ROLLOUT MODE ARMED	DIS	821	L ENG AVM FAIL	DIS
22	AFDS STATUS C AFDC	DIS	822	L ENG BLEED VLV OFF	DIS
23	AFDS STATUS L AFDC	DIS	823	L ENG BROADBAND VIB	DIS
24	AFDS STATUS R AFDC	DIS	824	L ENG BURNER PRESS	DIS
25	AFDS VNAV MODE ARMED	DIS	825	L ENG CH A IN CONTROL	DIS
26	AFT CARGO SMOKE WARN E	DIS	826	L ENG CH B IN CONTROL	DIS
27	AFT CSDS FAIL E	DIS	827	L ENG CMD THRUST EPR	DIS
28	AFT FUEL XFEED VLV CLSD	DIS	828	L ENG COMP INLET TEMP	deg C

29	AFT FUEL XFEED VLV OPEN	DIS	829	L ENG COMPUTED THRUST	LBF
30	AFT OUTFLO VLV PCT OPN L	%	830	L ENG CTRL ADVISORY	DIS
31	AFT OUTFLO VLV PCT OPN R	%	831	L ENG CTRL STATUS	DIS
32	AFT OUTFLO VLV SEL MAN L	DIS	832	L ENG EEC CNTRL STATUS	DIS
33	AFT OUTFLO VLV SEL MAN R	DIS	833	L ENG EGT RED EXCEED	DIS
34	AIL TRIM SW L WNG DN	DIS	834	L ENG EGT STRT RED EXCED	DIS
35	AIL TRIM SW R WNG DN	DIS	835	L ENG EPR	DIS
36	AIRCRAFT OVERSPEED WARN	DIS	836	L ENG EXHAUST GAS TEMP	deg C
37	AIRPLANE ON STBY PWR	DIS	837	L ENG FAIL WARN	DIS
38	ALT EXTEN SYS ARM 1	DIS	838	L ENG FANCASE OVHT E	DIS
39	ALT EXTEN SYS ARM 2	DIS	839	L ENG FIRE WARN PA	DIS
40	ALTITUDE ALERT CAUT E	DIS	840	L ENG FIRE WARN PB	DIS
41	AP BAP BKDRV ENGAGE C	DIS	841	L ENG FUEL FILT STATUS	DIS
42	AP BAP BKDRV ENGAGE L	DIS	842	L ENG FUEL FLOW RATE	PPH
43	AP BAP BKDRV ENGAGE R	DIS	843	L ENG N1 RED EXCEED	DIS
44	AP BKDRV STATUS L	DIS	844	L ENG N1 RPM	%RPM
45	AP BKDRV STATUS R	DIS	845	L ENG N1N2N3 FROM TACH	DIS
46	AP BKDRV WHL ENG A L	DIS	846	L ENG N2 RED EXCEED	DIS
47	AP BKDRV WHL ENG A R	DIS	847	L ENG N2 RPM	%RPM
48	AP BKDRV WHL ENG B L	DIS	848	L ENG N3 RED EXCEED	DIS
49	AP BKDRV WHL ENG B R	DIS	849	L ENG N3 RPM	%RPM
50	AP COL BKDRV CMD C	Inches	850	L ENG OIL DEBRIS STATUS	DIS
51	AP COL BKDRV CMD L	Inches	851	L ENG OIL FILT ADVISORY	DIS
52	AP COL BKDRV CMD R	Inches	852	L ENG OIL FILT STATUS	DIS
53	AP DISCONNECT BATTERY PA	DIS	853	L ENG OIL P LO RED EXCD	DIS
54	AP DISCONNECT BATTERY PB	DIS	854	L ENG OIL PRESS	PSID
55	AP DISCONNECT MAN E	DIS	855	L ENG OIL PRESS CAUT	DIS
56	AP DISCONNECT NORM	DIS	856	L ENG OIL QUANTITY	Quarts
57	AP DISCONNECT NORM E	DIS	857	L ENG OIL T HI RED EXCD	DIS
58	AP FC C FAIL C AFDC	DIS	858	L ENG OIL TEMP	deg C

59	AP FC L FAIL L AFDC	DIS	859	L ENG OVHT CAUT E	DIS
60	AP FC R FAIL R AFDC	DIS	860	L ENG START AIR VLV POSN	DIS
61	AP FLT DIR PITCH VAL C	DIS	861	L ENG STATOR VANE ANGLE	deg
62	AP FLT DIR PITCH VAL L	DIS	862	L ENG SURGE DETECTED	DIS
63	AP FLT DIR PITCH VAL R	DIS	863	L ENG THR LIM BY REV	DIS
64	AP FLT DIR ROLL VAL C	DIS	864	L ENG THROT RATE CMD	deg/s
65	AP FLT DIR ROLL VAL L	DIS	865	L ENG THRUST CALC FAIL	DIS
66	AP FLT DIR ROLL VAL R	DIS	866	L ENG THRUST LEVER ANGLE	deg
67	AP OVERSPEED PROT ACT	DIS	867	L ENG THRUST NOT CALC	DIS
68	AP PITCH CMD C	g	868	L ENG TR ANY SENSOR FAIL	DIS
69	AP PITCH CMD L	g	869	L ENG TR DEPLOYED	DIS
70	AP PITCH CMD R	g	870	L ENG TR IN TRANSIT	DIS
71	AP PITCH FD CMD C	deg	871	L ENG TR LT SLV LOCKED	DIS
72	AP PITCH FD CMD L	deg	872	L ENG TR RT SLV LOCKED	DIS
73	AP PITCH FD CMD R	deg	873	L ENG VIB AMB EXCEED	DIS
74	AP PITCH ROLL ENGAGE C	DIS	874	L ENG VIB RED EXCEED	DIS
75	AP PITCH ROLL ENGAGE L	DIS	875	L FU JETSN NOZL VLV CMD	DIS
76	AP PITCH ROLL ENGAGE R	DIS	876	L FUEL JET PMP LOW PRESS	DIS
77	AP ROLL CMD C	deg	877	L GLS CHANNEL	DIS
78	AP ROLL CMD L	deg	878	L GLS CHANNEL	DIS
79	AP ROLL CMD R	deg	879	L GLS CHANNEL	DIS
80	AP ROLL FD CMD C	deg	880	L GPS LATITUDE LSP	deg
81	AP ROLL FD CMD L	deg	881	L GPS LATITUDE MSP	deg
82	AP ROLL FD CMD R	deg	882	L GPS LONGITUDE LSP	deg
83	AP RUD PDL BKDRV CMD C	deg	883	L GPS LONGITUDE MSP	deg
84	AP RUD PDL BKDRV CMD L	deg	884	L GPS OPERATIONAL MODE	DIS
85	AP RUD PDL BKDRV CMD R	deg	885	L GS ANT STATUS L AFDC	DIS
86	AP STALL PROT ACT	DIS	886	L HI STAGE BLD VLV POSN	DIS
87	AP SYS C1 INCOMP DATA C	DIS	887	L ICE DETECTOR FAIL	DIS
88	AP SYS L INCOMP DATA L	DIS	888	L ILS FREQ	MHz
89	AP SYS R INCOMP DATA R	DIS	889	L ILS FREQ	MHz

90	AP WHL BKDRV CMD C	deg	890	L INBD AILERON POSN CA	Inches
91	AP WHL BKDRV CMD L	deg	891	L INBD AILERON POSN CA	Inches
92	AP WHL BKDRV CMD R	deg	892	L INBD AILERON POSN CA S	Inches
93	AP WHL BKDRV VL4 BAP A L	DIS	893	L INBD DISPLAY MODE	DIS
94	AP WHL BKDRV VL4 BAP A R	DIS	894	L INBD ELEV POSN CA	Inches
95	AP WHL BKDRV VL4 BAP B L	DIS	895	L INBD ELEV POSN CA	Inches
96	AP WHL BKDRV VL4 BAP B R	DIS	896	L INBD ELEV POSN CA S	Inches
97	AP YAW CMD C	deg	897	L INBD FLAPERON POSN RA	Inches
98	AP YAW CMD L	deg	898	L INBD FLAPERON POSN RA	Inches
99	AP YAW CMD R	deg	899	L INBD FLAPERON POSN RAS	Inches
100	AP YAW ENGAGE C	DIS	900	L ISOLATION VLV CLOSED	DIS
101	AP YAW ENGAGE L	DIS	901	L JETSN ISOL VLV CLSD	DIS
102	AP YAW ENGAGE R	DIS	902	L JETSN ISOL VLV OPEN	DIS
103	APU AC XFER BUS FREQ	Hz	903	L JETSN NOZZLE VLV CLSD	DIS
104	APU AC XFER BUS LOAD	%	904	L JETSN NOZZLE VLV OPEN	DIS
105	APU AC XFER BUS VOLTAGE	Volts	905	L LE SLAT POSN 1	deg
106	APU BATTERY FAIL	DIS	906	L LE SLAT POSN 2	deg
107	APU BATTERY VOLTAGE	Volts	907	L LOC ANT STATUS L AFDC	DIS
108	APU BTL PRESS LOW PA	DIS	908	L MAIN GEAR DN AND LOCK	DIS
109	APU BTL PRESS LOW PB	DIS	909	L MAIN GEAR UP AND STOW	DIS
110	APU COMP INLET TEMP	deg C	910	L MLS CHANNEL	DIS
111	APU EGT RED EXCEED	DIS	911	L MLS CHANNEL	DIS
112	APU ELEC GEN ADV	DIS	912	L MLS CHANNEL	DIS
113	APU EXHAUST GAS TEMP	deg C	913	L MN AFT FU PMP CMD	DIS
114	APU FIRE WARN PA	DIS	914	L MN AFT FU PMP LO PRESS	DIS
115	APU FIRE WARN PB	DIS	915	L MN FWD FU PMP CMD	DIS
116	APU FUEL FLOW CMD	pph	916	L MN FWD FU PMP LO PRESS	DIS
117	APU FUEL PMP LOW PRESS	DIS	917	L OUTBD AILERON POSN L2A	Inches

118	APU FUEL SOV CLSD	DIS	918	L OUTBD AILERON POSN L2A	Inches
119	APU FUEL SOV OPEN	DIS	919	L OUTBD AILERON POSN L2S	Inches
120	APU HIGH OIL TEMP CAUT	DIS	920	L OUTBD DISPLAY MODE	DIS
121	APU INLET DOOR POSN	DIS	921	L OUTBD ELEV POSN L1A	Inches
122	APU ISOLATION VLV CLOSED	DIS	922	L OUTBD ELEV POSN L1A	Inches
123	APU LIMIT CAUTION	DIS	923	L OUTBD ELEV POSN L1A S	Inches
124	APU LOW OIL PRESS CAUT	DIS	924	L OUTBD FLAPERON POS L1A	Inches
125	APU OIL PRESS	PSIg	925	L OUTBD FLAPERON POS L1A	Inches
126	APU OIL QUANTITY	Quarts	926	L OUTBD FLAPERON POS L1S	Inches
127	APU OIL TEMP	deg C	927	L OVRD FU PMP LOW PRESS	DIS
128	APU RPM	% RPM	928	L PFC BUS ACT FAULT	DIS
129	APU RPM RED EXCEED	DIS	929	L PFC CHANNEL STAT	DIS
130	APU SHUTDOWN ADVISORY	DIS	930	L PFC DATA SUSPECT	DIS
131	APU START SW POSN	DIS	931	L PFC WATCHDOG FAULT	DIS
132	AT EN MODE	DIS	932	L PITOT STAT PRB HT VLD	DIS
133	AT SERVO1 ANN	DIS	933	L PSA CB 1 POSN	DIS
134	AT SERVO2 ANN	DIS	934	L PSA CB 10 POSN	DIS
135	ATC BLOCK DISPLAYED	DIS	935	L PSA CB 11 POSN	DIS
136	ATC COMM MED1 UPLNK RCVD	DIS	936	L PSA CB 12 POSN	DIS
137	ATC COMM MED2 UPLNK RCVD	DIS	937	L PSA CB 13 POSN	DIS
138	AUTO SLAT ACTIVIATED 1	DIS	938	L PSA CB 14 POSN	DIS
139	AUTO SLAT ACTIVIATED 2	DIS	939	L PSA CB 15 POSN	DIS
140	AUTO THROT SW SEL ON L	DIS	940	L PSA CB 16 POSN	DIS
141	AUTO THROT SW SEL ON R	DIS	941	L PSA CB 17 POSN	DIS
142	AUTOPILOT CAUTION	DIS	942	L PSA CB 2 POSN	DIS
143	AUTOPILOT CAUTION E	DIS	943	L PSA CB 3 POSN	DIS
144	AUTOPILOT ENGAGED	DIS	944	L PSA CB 4 POSN	DIS
145	AUTOSPDBRK RET LIM SW	DIS	945	L PSA CB 5 POSN	DIS
146	AUTOTHROTTLE DISC E	DIS	946	L PSA CB 6 POSN	DIS

147	BARO PRESS ALT	FEET	947	L PSA CB 7 POSN	DIS
148	BARO PRESS ALT	FEET	948	L PSA CB 8 POSN	DIS
149	BAT BUS SECT 2 STATUS	DIS	949	L PSA CB 9 POSN	DIS
150	BAT BUS STATUS	DIS	950	L RAD ALTIMETER FAULT	DIS
151	BATTERY SW POSN	DIS	951	L RAD TUNE INPUT	DIS
152	BNK ANG PROT CMD C	deg	952	L RAD TUNE INPUT	DIS
153	BNK ANG PROT CMD L	deg	953	L RAD TUNE INPUT	DIS
154	BNK ANG PROT CMD R	deg	954	L RAD TUNE INPUT	DIS
155	BNK ANG PROT INOP STAT C	DIS	955	L RAD TUNE INPUT	DIS
156	BNK ANG PROT INOP STAT L	DIS	956	L SATCOM CM ALRT CHM	DIS
157	BNK ANG PROT INOP STAT R	DIS	957	L SATCOM CM ALRT NO CHM	DIS
158	BODY BLEED LOSS E	DIS	958	L SATCOM FD VOI CH1 CONN	DIS
159	BRAKE PRESS AUTOBRAKE	PSIg	959	L SATCOM FD VOI CH2 CONN	DIS
160	BRAKE PRESS L ALT	PSIg	960	L SATCOM LOG ON2 GND STA	DIS
161	BRAKE PRESS L NORM	PSIg	961	L SATCOM NO VOICE	DIS
162	BRAKE PRESS R ALT	PSIg	962	L TAT PROBE HEAT ON	DIS
163	BRAKE PRESS R NORM	PSIg	963	L TAT PROBE HEAT VALID	DIS
164	BRAKE SOURCE ADV PA	DIS	964	L TE FLAP POSN 1	deg
165	BRAKE SOURCE ADV PB	DIS	965	L TE FLAP POSN 1	deg
166	C ACE BUS ACT FAULT	DIS	966	L TE FLAP POSN 1	deg
167	C ACE IN DIRECT MODE PA	DIS	967	L TE FLAP POSN 1	deg
168	C ACE IN DIRECT MODE PB	DIS	968	L TE FLAP POSN 1	deg
169	C ACE PWR SUPP FAIL PA	DIS	969	L TE FLAP POSN 1	deg
170	C ACE PWR SUPP FAIL PB	DIS	970	L TE FLAP POSN 1	deg
171	C ACS FAIL	DIS	971	L TE FLAP POSN 1	deg
172	C AFDC WATCHDOG FAULT	DIS	972	L TE FLAP POSN 1 SEN	Volts
173	C APPROACH MODE CAT	DIS	973	L TE FLAP POSN 2	deg
174	C GLS CHANNEL	DIS	974	L TE FLAP POSN 2	deg
175	C GLS CHANNEL	DIS	975	L TE FLAP POSN 2	deg
176	C GLS CHANNEL	DIS	976	L TE FLAP POSN 2	deg
177	C GS ANT STATUS C AFDC	DIS	977	L TE FLAP POSN 2	deg
178	C ILS FREQ	MHz	978	L TE FLAP POSN 2	deg

179	C ILS FREQ	MHz	979	L TE FLAP POSN 2	deg
180	C ISOLATION VLV CLOSED	DIS	980	L TE FLAP POSN 2	deg
181	C LOC ANT STATUS C AFDC	DIS	981	L TE FLAP POSN 2 SEN	Volts
182	C MLS CHANNEL	DIS	982	L VOR FAIL	DIS
183	C MLS CHANNEL	DIS	983	L VOR FREQ	MHz
184	C MLS CHANNEL	DIS	984	L VOR SELECTED COURSE	deg
185	C PFC BUS ACT FAULT	DIS	985	L1 ACE BUS ACT FAULT	DIS
186	C PFC CHANNEL STAT	DIS	986	L1 ACE IN DIRECT MODE PA	DIS
187	C PFC DATA SUSPECT	DIS	987	L1 ACE IN DIRECT MODE PB	DIS
188	C PFC WATCHDOG FAULT	DIS	988	L1 ACE PWR SUPP FAIL PA	DIS
189	C PITOT STAT PRB HE VLD	DIS	989	L1 ACE PWR SUPP FAIL PB	DIS
190	C PSA CB 1 POSN	DIS	990	L2 ACE BUS ACT FAULT	DIS
191	C PSA CB 10 POSN	DIS	991	L2 ACE IN DIRECT MODE PA	DIS
192	C PSA CB 11 POSN	DIS	992	L2 ACE IN DIRECT MODE PB	DIS
193	C PSA CB 12 POSN	DIS	993	L2 ACE PWR SUPP FAIL PA	DIS
194	C PSA CB 13 POSN	DIS	994	L2 ACE PWR SUPP FAIL PB	DIS
195	C PSA CB 14 POSN	DIS	995	LAND 2 ON PFD	DIS
196	C PSA CB 15 POSN	DIS	996	LAND 3 ON PFD	DIS
197	C PSA CB 16 POSN	DIS	997	LAND GEAR LEVER DOWN	DIS
198	C PSA CB 17 POSN	DIS	998	LAND GEAR LEVER UP	DIS
199	C PSA CB 2 POSN	DIS	999	LANDING ALT MAN E	DIS
200	C PSA CB 3 POSN	DIS	1000	LAT ACCEL	g
201	C PSA CB 4 POSN	DIS	1001	LAT ACCEL	g
202	C PSA CB 5 POSN	DIS	1002	LAT ACCEL	g
203	C PSA CB 6 POSN	DIS	1003	LAT ACCEL	g
204	C PSA CB 7 POSN	DIS	1004	LAT DEV VALIDITY C	DIS
205	C PSA CB 8 POSN	DIS	1005	LAT DEV VALIDITY L	DIS
206	C PSA CB 9 POSN	DIS	1006	LAT DEV VALIDITY R	DIS
207	C RAD ALTIMETER FAULT	DIS	1007	LATERAL DEVIATION C	DDM
208	C1 BUS DC VOLTAGE	Volts	1008	LATERAL DEVIATION L	DDM
209	C2 BUS DC VOLTAGE	Volts	1009	LATERAL DEVIATION R	DDM
210	CABIN ALT AUTO FAIL E	DIS	1010	LAV SMOKE WARN E	DIS

211	CABIN ALTITUDE	FEET	1011	LIB AILERN CMD CPFC 2 CA	Inches
212	CABIN PRESS WARN	DIS	1012	LIB AILERN CMD LPFC 2 CA	Inches
213	CAPT ADIRS SW SEL ALT	DIS	1013	LIB AILERN CMD RPFC 2 CA	Inches
214	CAPT AP EN SW SEL EN	DIS	1014	LIB AILRN BYPAS STATE CA	DIS
215	CAPT COL FORCE C	lbs	1015	LIB ELEV BYPASS STATE CA	DIS
216	CAPT COL FORCE C SENSOR	lbs	1016	LIB ELEV CMD CPRC 2 CA	Inches
217	CAPT COL FORCE L1	lbs	1017	LIB ELEV CMD LPRC 2 CA	Inches
218	CAPT COL FORCE L1 SENSOR	lbs	1018	LIB ELEV CMD RPRC 2 CA	Inches
219	CAPT COLUMN FORCE 4 FDR	lbs	1019	LIB FLPRN BYPAS STATE RA	DIS
220	CAPT CTRL COL POSN C	deg	1020	LIB FLPRN CMD CPFC 2 L1A	Inches
221	CAPT CTRL COL POSN C	deg	1021	LIB FLPRN CMD LPFC 2 L1A	Inches
222	CAPT CTRL COL POSN C S	Inches	1022	LIB FLPRN CMD RPFC 2 L1A	Inches
223	CAPT CTRL COL POSN C S	Inches	1023	LL REST BLT PRESS LOW	DIS
224	CAPT CTRL COL POSN L1	deg	1024	LL REST SMOKE WARN E	DIS
225	CAPT CTRL COL POSN L1 S	Inches	1025	LOB AILRN BYPAS STAT L2A	DIS
226	CAPT CTRL COL POSN R	deg	1026	LOB AILRN CMD CPFC 2 L2A	Inches
227	CAPT CTRL COL POSN R S	Inches	1027	LOB AILRN CMD LPFC 2 L2A	Inches
228	CAPT CTRL WHEEL POSN C	deg	1028	LOB AILRN CMD RPFC 2 L2A	Inches
229	CAPT CTRL WHEEL POSN C	deg	1029	LOB ELEV BYPAS STATE L1A	DIS
230	CAPT CTRL WHEEL POSN C	deg	1030	LOB ELEV CMD CPFC 2 L1A	Inches
231	CAPT CTRL WHEEL POSN C	deg	1031	LOB ELEV CMD LPFC 2 L1A	Inches
232	CAPT CTRL WHEEL POSN L1	deg	1032	LOB ELEV CMD RPFC 2 L1A	Inches
233	CAPT CTRL WHEEL POSN L1	deg	1033	LOB FLPRN BYPAS STAT L1A	DIS
234	CAPT CTRL WHEEL POSN R	deg	1034	LOB FLPRN CMD CPFC 2	Inches

				RA	
235	CAPT CTRL WHEEL POSN R	deg	1035	LOB FLPRN CMD LPFC 2 RA	Inches
236	CAPT CTRL WHL POSN C S	Inches	1036	LOB FLPRN CMD RPFC 2 RA	Inches
237	CAPT CTRL WHL POSN C S	Inches	1037	LOC ANTENNA FAIL C	DIS
238	CAPT CTRL WHL POSN L1 S	Inches	1038	LOC ANTENNA FAIL L	DIS
239	CAPT CTRL WHL POSN R S	Inches	1039	LOC ANTENNA FAIL R	DIS
240	CAPT DISP ARPT SEL	DIS	1040	LOC DEV OR AZ CH CAPT	DIS
241	CAPT DISP POS SEL	DIS	1041	LOC TEST TUNE INHIBIT C	DIS
242	CAPT DISP RTE DATA SEL	DIS	1042	LOC TEST TUNE INHIBIT L	DIS
243	CAPT DISP STA SEL	DIS	1043	LOC TEST TUNE INHIBIT R	DIS
244	CAPT DISP WPT SEL	DIS	1044	LONG ACCEL	g
245	CAPT EFIS ADF L SEL	DIS	1045	LONG ACCEL	g
246	CAPT EFIS ADF R SEL	DIS	1046	LONG ACCEL	g
247	CAPT EFIS VOR L SEL	DIS	1047	LONG ACCEL	g
248	CAPT EFIS VOR R SEL	DIS	1048	LOW FUEL INDICATION	DIS
249	CAPT FD BARS CH	DIS	1049	LOW FUEL PRESS L	DIS
250	CAPT FD SW SEL ON	DIS	1050	LOW FUEL PRESS R	DIS
251	CAPT FD SW SEL ON FPV	DIS	1051	LOWER DISPLAY MODE	DIS
252	CAPT FLT INST BUS STATUS	DIS	1052	LWR RUDDER CMD CPFC 2 RA	Inches
253	CAPT NAV SW SEL CDU	DIS	1053	LWR RUDDER CMD LPFC 2 RA	Inches
254	CAPT PVD ADVISORY	DIS	1054	LWR RUDDER CMD RPFC 2 RA	Inches
255	CAPT PVD ON	DIS	1055	LWR RUDDER POSN RA	Inches
256	CAPT RUDDER PEDAL FORCE	lbs	1056	LWR RUDDER POSN RA	Inches
257	CAPT SEL BARO SETTING	In Hg	1057	LWR RUDDER POSN RA IN	Inches
258	CAPT SEL DH BARO	Feet	1058	LWR RUDR BLKING STATE RA	DIS
259	CAPT SEL DH RA	Feet	1059	LWR RUDR BYPASS STATE RA	DIS
260	CARGO 1A BTL PRESS LOW	DIS	1060	MACH NUMBER	DIS
261	CARGO 1B BTL PRESS LOW	DIS	1061	MAG HEADING SUSPECT	DIS
262	CARGO 2A BTL PRESS LOW	DIS	1062	MAGNETIC HEADING	deg
263	CARGO 2B BTL PRESS LOW	DIS	1063	MAIN BATTERY FAIL	DIS

264	CARGO 2C BTL PRESS LOW	DIS	1064	MAIN BATTERY VOLTAGE	VDC
265	CLOCK TIME	DIS	1065	MANIFOLD PRESS L	PSIg
266	COMM MED1 UPLINK RCVD	DIS	1066	MANIFOLD PRESS R	PSIg
267	COMM MED2 UPLINK RCVD	DIS	1067	MARKER BEACON FAIL L VOR	DIS
268	COMM UPLINK RCVD FMC	DIS	1068	MARKER BEACON FAIL R VOR	DIS
269	COMPUTED AIRSPEED	Knots	1069	MARKER BEACON INNER	DIS
270	CONFIG DOORS WARN	DIS	1070	MARKER BEACON MIDDLE	DIS
271	CONFIG FLAPS WARN	DIS	1071	MARKER BEACON OUTER	DIS
272	CONFIG GEAR STRG WARN	DIS	1072	MASTER WARN LT CAPT	DIS
273	CONFIG GEAR WARN	DIS	1073	MASTER WARN LT FO	DIS
274	CONFIG PRKG BRAKE WARN	DIS	1074	MCP LANE STATUS C AFDC	DIS
275	CONFIG RUDDER WARN	DIS	1075	MCP LANE STATUS L AFDC	DIS
276	CONFIG SPOILERS WARN	DIS	1076	MCP LANE STATUS R AFDC	DIS
277	CONFIG STAB WARN	DIS	1077	MCP SPD DISPLAY BLANK	DIS
278	CPT DSP CTRL SW SEL ALT	DIS	1078	MD CREW REST SMOKE WARN	DIS
279	CPT STAB TRIM ASW DN L1	DIS	1079	MID RUDDER POSN L1A	Inches
280	CPT STAB TRIM ASW DN L1	DIS	1080	MID RUDDER POSN L1A	Inches
281	CPT STAB TRIM ASW UP L1	DIS	1081	MID RUDDER POSN L1A IN	Inches
282	CPT STAB TRIM ASW UP L1	DIS	1082	MID RUDDR CMD CPFC 2 L1A	Inches
283	CPT STAB TRIM CSW DN C	DIS	1083	MID RUDDR CMD LPFC 2 L1A	Inches
284	CPT STAB TRIM CSW DN C	DIS	1084	MID RUDDR CMD RPFC 2 L1A	Inches
285	CPT STAB TRIM CSW UP C	DIS	1085	MID RUDR BLKING STAT L1A	DIS
286	CPT STAB TRIM CSW UP C	DIS	1086	MID RUDR BYPASS STAT L1A	DIS
287	CREW ALERT MON LVL A	DIS	1087	MLS ANT 1 SEL CMD ACK C	DIS
288	CREW ALERT MON LVL C	DIS	1088	MLS ANT 1 SEL CMD ACK L	DIS
289	CREW ALERT MON LVL W	DIS	1089	MLS ANT 1 SEL CMD ACK R	DIS
290	CTR DSP CTRL SW SEL ALT	DIS	1090	MLS ANT SOURCE C	DIS

291	CTR TNK L FU PMP CMD	DIS	1091	MLS ANT SOURCE L	DIS
292	CTR TNK R FU PMP CMD	DIS	1092	MLS ANT SOURCE R	DIS
293	CTRL WHEEL FORCE 4 FDR	lbs	1093	MLS MODE C	DIS
294	CTRL WHEEL FORCE C	lbs	1094	MLS MODE L	DIS
295	CTRL WHEEL FORCE C SEN	lbs	1095	MLS MODE R	DIS
296	CTRL WHEEL FORCE L2	lbs	1096	MMR STANDBY MODE C	DIS
297	CTRL WHEEL FORCE L2 SEN	lbs	1097	MMR STANDBY MODE L	DIS
298	CURS PRES L INBD DISPLAY	DIS	1098	MMR STANDBY MODE R	DIS
299	CURS PRES LOWER DISPLAY	DIS	1099	MODAL SUPS ACCEL L	g
300	CURS PRES R INBD DISPLAY	DIS	1100	MODAL SUPS ACCEL R	g
301	DAT SRC ADIRS PG1	DIS	1101	MODE SW1 SEL FPA	DIS
302	DAT SRC ADIRS PG2	DIS	1102	MODE SW2 SEL HDG	DIS
303	DAT SRC ADIRS PG3	DIS	1103	MODE SW3 SEL MACH	DIS
304	DAT SRC ADIRS PG4	DIS	1104	NACELLE ANTI ICE ON L	DIS
305	DAT SRC ADIRS PG5	DIS	1105	NACELLE ANTI ICE ON R	DIS
306	DAT SRC ADIRS PG6	DIS	1106	NO AUTOLAND ON PFD	DIS
307	DAT SRC ADIRS PG7	DIS	1107	NO LAND 3 ADV C AFDC	DIS
308	DAT SRC ADIRS PG8	DIS	1108	NO LAND 3 ADV L AFDC	DIS
309	DAT SRC AFDC PG1	DIS	1109	NO LAND 3 ADV R AFDC	DIS
310	DAT SRC AFDC PG2	DIS	1110	NO LAND 3 CAUT C AFDC	DIS
311	DAT SRC AOA L PG	DIS	1111	NO LAND 3 CAUT L AFDC	DIS
312	DAT SRC AOA R PG	DIS	1112	NO LAND 3 CAUT R AFDC	DIS
313	DAT SRC APU GCU PG	DIS	1113	NORM HDG REF SEL	DIS
314	DAT SRC APUC PG	DIS	1114	NOSE GEAR DN AND LOCK	DIS
315	DAT SRC C PFC PG	DIS	1115	NOSE GEAR UP AND STOW	DIS
316	DAT SRC C1 HYDIM PG	DIS	1116	PACK MASS FLOW RATE L	lbs/m
317	DAT SRC C2 HYDIM PG	DIS	1117	PACK MASS FLOW RATE R	lbs/m
318	DAT SRC CAB DEPEND PG	DIS	1118	PACK OVERHEAT L	DIS
319	DAT SRC CPT DISP ACS PG	DIS	1119	PACK OVERHEAT R	DIS
320	DAT SRC CPT DISP AFDC PG	DIS	1120	PACK VALVE POSN L	DIS
321	DAT SRC CPT DISP ALTI PG	DIS	1121	PACK VALVE POSN R	DIS
322	DAT SRC CPT DISP EFIS PG	DIS	1122	PARKING BRAKE SET	DIS
323	DAT SRC CPT DISP ENG PG	DIS	1123	PFC 2NDARY MD EN STAT	DIS

				C	
324	DAT SRC CPT DISP FD PG	DIS	1124	PFC 2NDARY MD EN STAT L	DIS
325	DAT SRC CPT DISP RA PG	DIS	1125	PFC 2NDARY MD EN STAT R	DIS
326	DAT SRC CTR LWR DISP PG	DIS	1126	PFC AUTOSPDBRK EXTND C	DIS
327	DAT SRC CTR UPR DISP PG	DIS	1127	PFC AUTOSPDBRK EXTND L	DIS
328	DAT SRC EICAS PG	DIS	1128	PFC AUTOSPDBRK EXTND R	DIS
329	DAT SRC ELMS110 PG	DIS	1129	PFC DISC SW POSN C	DIS
330	DAT SRC ELMS210 PG	DIS	1130	PFC DISC SW POSN L1	DIS
331	DAT SRC ELMS310 PG	DIS	1131	PFC DISC SW POSN L2	DIS
332	DAT SRC FMC PERF PG1	DIS	1132	PFC DISC SW POSN R	DIS
333	DAT SRC FMC PERF PG2	DIS	1133	PFD AFDC ALT ENGAGE	DIS
334	DAT SRC FMC PG1	DIS	1134	PFD AFDC PTH ENGAGE	DIS
335	DAT SRC FMC PG2	DIS	1135	PFD AFDC SPD ENGAGE	DIS
336	DAT SRC FMC PG3	DIS	1136	PITCH ATTITUDE	deg
337	DAT SRC FMC PG4	DIS	1137	PITCH ATTITUDE	deg
338	DAT SRC FMC PG5	DIS	1138	PITCH ATTITUDE	deg
339	DAT SRC FMC PG6	DIS	1139	PITCH ATTITUDE	deg
340	DAT SRC FMC PG7	DIS	1140	PITCH RATE	deg/S
341	DAT SRC FMC PG8	DIS	1141	PITCH TRIM REF SPD C	Knots
342	DAT SRC FMC TMC PG1	DIS	1142	PITCH TRIM REF SPD L	Knots
343	DAT SRC FMC TMC PG2	DIS	1143	PITCH TRIM REF SPD R	Knots
344	DAT SRC FMC TMC PG3	DIS	1144	PITCH TRM ARM LVR ACT PA	DIS
345	DAT SRC FO DISP EFIS PG	DIS	1145	PITCH TRM ARM LVR ACT PB	DIS
346	DAT SRC FQIS PG	DIS	1146	PITCH TRM ARM LVR PDN PA	DIS
347	DAT SRC FSEU1 PG	DIS	1147	PITCH TRM ARM LVR PDN PB	DIS
348	DAT SRC FSEU2 PG	DIS	1148	PITCH TRM ARM LVR PUP PA	DIS
349	DAT SRC GCU1 PG	DIS	1149	PITCH TRM ARM LVR PUP PB	DIS
350	DAT SRC GCU2 PG	DIS	1150	PRE WINDSHEAR WARN	DIS
351	DAT SRC L ACIPS PG	DIS	1151	PRECOOLER TEMP L	deg F

352	DAT SRC L ASCPC PG	DIS	1152	PRECOOLER TEMP R	deg F
353	DAT SRC L AVM PG	DIS	1153	PRINTER MED1 UPLINK RCVD	DIS
354	DAT SRC L CTC PG	DIS	1154	PRINTER MED2 UPLINK RCVD	DIS
355	DAT SRC L ENG PG1	DIS	1155	PTCH TRM CTRL LVR ACT PA	DIS
356	DAT SRC L ENG PG10	DIS	1156	PTCH TRM CTRL LVR ACT PB	DIS
357	DAT SRC L ENG PG11	DIS	1157	PTCH TRM CTRL LVR PDN PA	DIS
358	DAT SRC L ENG PG2	DIS	1158	PTCH TRM CTRL LVR PDN PB	DIS
359	DAT SRC L ENG PG3	DIS	1159	PTCH TRM CTRL LVR PUP PA	DIS
360	DAT SRC L ENG PG5	DIS	1160	PTCH TRM CTRL LVR PUP PB	DIS
361	DAT SRC L ENG PG6	DIS	1161	R 28VDC BUS STATUS	DIS
362	DAT SRC L ENG PG7	DIS	1162	R 28VDC BUS VOLTAGE	VDC
363	DAT SRC L ENG PG8	DIS	1163	R AC MAIN BUS STSTUS	DIS
364	DAT SRC L ENG PG9	DIS	1164	R AC XFER BUS FREQ	Hz
365	DAT SRC L HYDIM PG	DIS	1165	R AC XFER BUS LOAD	%
366	DAT SRC L PFC PG	DIS	1166	R AC XFER BUS STATUS	DIS
367	DAT SRC LIB DISP PG	DIS	1167	R AC XFER BUS VOLTAGE	VAC
368	DAT SRC LOB DISP PG	DIS	1168	R ACE BUS ACT FAULT	DIS
369	DAT SRC MCP PG1	DIS	1169	R ACE IN DIRECT MODE PA	DIS
370	DAT SRC MCP PG2	DIS	1170	R ACE IN DIRECT MODE PB	DIS
371	DAT SRC OPAS PG	DIS	1171	R ACE PWR SUPP FAIL PA	DIS
372	DAT SRC PSEU PG	DIS	1172	R ACE PWR SUPP FAIL PB	DIS
373	DAT SRC PSEU1 PG	DIS	1173	R ACS FAIL	DIS
374	DAT SRC PSEU2 PG	DIS	1174	R ADF BEARING	deg
375	DAT SRC R ACIPS PG	DIS	1175	R ADF FAIL	DIS
376	DAT SRC R ASCPC PG	DIS	1176	R ADF FREQ LSP	kHz
377	DAT SRC R AVM PG	DIS	1177	R ADF FREQ LSP + 1	kHz
378	DAT SRC R CTC PG	DIS	1178	R ADF FREQ LSP + 2	kHz
379	DAT SRC R ENG PG1	DIS	1179	R ADF FREQ MSP	kHz
380	DAT SRC R ENG PG10	DIS	1180	R AFDC WATCHDOG FAULT	DIS

381	DAT SRC R ENG PG11	DIS	1181	R AOA CASE HEAT VLD	DIS
382	DAT SRC R ENG PG2	DIS	1182	R AOA VANE HEAT VLD	DIS
383	DAT SRC R ENG PG3	DIS	1183	R APPROACH MODE CAT	DIS
384	DAT SRC R ENG PG5	DIS	1184	R ASG CARDFILE FAIL E	DIS
385	DAT SRC R ENG PG6	DIS	1185	R BLEED VALVE POSN	DIS
386	DAT SRC R ENG PG7	DIS	1186	R CTAI SW POSN	DIS
387	DAT SRC R ENG PG8	DIS	1187	R DME FAIL	DIS
388	DAT SRC R ENG PG9	DIS	1188	R ELEC GEN ADV	DIS
389	DAT SRC R HYDIM PG	DIS	1189	R ENG 1 PER N1 VIB	DIS
390	DAT SRC R PFC PG	DIS	1190	R ENG 1 PER N2 VIB	DIS
391	DAT SRC RIB DISP PG	DIS	1191	R ENG 1 PER N3 VIB	DIS
392	DAT SRC ROB DISP PG	DIS	1192	R ENG ALT MODE	DIS
393	DAT SRC RTP PG	DIS	1193	R ENG ALT MODE MAN SEL	DIS
394	DAT SRC TCAS DISP ST PG	DIS	1194	R ENG AT APP IDLE	DIS
395	DAT SRC VOR MB L CAB PG	DIS	1195	R ENG AVM FAIL	DIS
396	DAT SRC WES PG2	DIS	1196	R ENG BLEED VLV OFF	DIS
397	DAT SRC WES PG3	DIS	1197	R ENG BROADBAND VIB	DIS
398	DATA LINK MODE C	DIS	1198	R ENG BURNER PRESS	DIS
399	DATA LINK MODE L	DIS	1199	R ENG CH A IN CONTROL	DIS
400	DATA LINK MODE R	DIS	1200	R ENG CH B IN CONTROL	DIS
401	DATA LINK STATUS C	DIS	1201	R ENG CMD THRUST EPR	DIS
402	DATA LINK STATUS L	DIS	1202	R ENG COMP INLET TEMP	deg C
403	DATA LINK STATUS R	DIS	1203	R ENG COMPUTED THRUST	LBF
404	DATE DAY	DIS	1204	R ENG CTRL ADVISORY	DIS
405	DATE MONTH	DIS	1205	R ENG CTRL STATUS	DIS
406	DATE YEAR	DIS	1206	R ENG EEC CNTRL STATUS	DIS
407	DC STANDBY BUS FAIL	DIS	1207	R ENG EGT RED EXCEED	DIS
408	DEFAULT ENG SELECTED	DIS	1208	R ENG EGT STRT RED EXCED	DIS
409	DELTA VOTED THRUST C	lbs	1209	R ENG EPR	DIS
410	DELTA VOTED THRUST L	lbs	1210	R ENG EXHAUST GAS TEMP	deg C
411	DELTA VOTED THRUST R	lbs	1211	R ENG FAIL WARN	DIS
412	DFDAF SENDING	DIS	1212	R ENG FANCASE OVHT E	DIS

413	DFDAF WORDS IN XMIT BUFF	DIS	1213	R ENG FIRE WARN PA	DIS
414	DFDAF XMIT PATTERN ADV	DIS	1214	R ENG FIRE WARN PB	DIS
415	DFDAF XMIT PATTERN LOC	DIS	1215	R ENG FUEL FILT STATUS	DIS
416	DFDAF XMIT PATTERN RET	DIS	1216	R ENG FUEL FLOW RATE	PPH
417	DH DISPLAY BLANK CAPT	DIS	1217	R ENG N1 RED EXCEED	DIS
418	DH DISPLAY BLANK FO	DIS	1218	R ENG N1 RPM	%RPM
419	DIRECT MD EN STAT C	DIS	1219	R ENG N1N2N3 FROM TACH	DIS
420	DIRECT MD EN STAT L1	DIS	1220	R ENG N2 RED EXCEED	DIS
421	DIRECT MD EN STAT L2	DIS	1221	R ENG N2 RPM	%RPM
422	DIRECT MD EN STAT R	DIS	1222	R ENG N3 RED EXCEED	DIS
423	DISPLAY BARO DH CAPT	DIS	1223	R ENG N3 RPM	%RPM
424	DISPLAY BARO DH FO	DIS	1224	R ENG OIL DEBRIS STATUS	DIS
425	DISPLAY RA DH CAPT	DIS	1225	R ENG OIL FILT ADVISORY	DIS
426	DISPLAY RA DH FO	DIS	1226	R ENG OIL FILT STATUS	DIS
427	DISPLAYED HEADING	deg	1227	R ENG OIL P LO RED EXCD	DIS
428	DME DISTANCE CH1	N Miles	1228	R ENG OIL PRESS	PSID
429	DME DISTANCE CH2	N Miles	1229	R ENG OIL PRESS CAUT	DIS
430	DME DISTANCE CH3	N Miles	1230	R ENG OIL QUANTITY	Quarts
431	DME DISTANCE CH4	N Miles	1231	R ENG OIL T HI RED EXCD	DIS
432	DME DISTANCE CH5	N Miles	1232	R ENG OIL TEMP	deg C
433	DME FREQ CH1 LSB	MHz	1233	R ENG OVHT CAUT E	DIS
434	DME FREQ CH1 MSB	MHz	1234	R ENG START AIR VLV POSN	DIS
435	DME FREQ CH2 LSB	MHz	1235	R ENG STATOR VANE ANGLE	deg
436	DME FREQ CH2 MSB	MHz	1236	R ENG SURGE DETECTED	DIS
437	DME FREQ CH3 LSB	MHz	1237	R ENG THR LIM BY REV	DIS
438	DME FREQ CH3 MSB	MHz	1238	R ENG THROT RATE CMD	deg/s
439	DME FREQ CH4 LSB	MHz	1239	R ENG THRUST CALC FAIL	DIS
440	DME FREQ CH4 MSB	MHz	1240	R ENG THRUST LEVER ANGLE	deg
441	DR1 OHEAD CMPT SMK WARN	DIS	1241	R ENG THRUST NOT CALC	DIS
442	DR1 OHEAD REST SMK WARN	DIS	1242	R ENG TR ANY SENSOR FAIL	DIS

443	DR2 OHEAD CMPT SMK WARN	DIS	1243	R ENG TR DEPLOYED	DIS
444	DR2 OHEAD REST SMK WARN	DIS	1244	R ENG TR IN TRANSIT	DIS
445	DR3 OHEAD CMPT SMK WARN	DIS	1245	R ENG TR LT SLV LOCKED	DIS
446	DR3 OHEAD REST SMK WARN	DIS	1246	R ENG TR RT SLV LOCKED	DIS
447	DR4 OHEAD CMPT SMK WARN	DIS	1247	R ENG VIB AMB EXCEED	DIS
448	DR4 OHEAD REST SMK WARN	DIS	1248	R ENG VIB RED EXCEED	DIS
449	DR5 OHEAD CMPT SMK WARN	DIS	1249	R FU JETSN NOZL VLV CMD	DIS
450	DR5 OHEAD REST SMK WARN	DIS	1250	R FUEL JET PMP LOW PRESS	DIS
451	DRIFT ANGLE	deg	1251	R GLS CHANNEL	DIS
452	ECS BLOCK DISPLAYED	DIS	1252	R GLS CHANNEL	DIS
453	EE BAY SMOKE WARN	DIS	1253	R GLS CHANNEL	DIS
454	EGPSW TERRAIN INOP STATE	DIS	1254	R GPS LATITUDE LSP	deg
455	EGPWS CAUTION TERRAIN	DIS	1255	R GPS LATITUDE MSP	deg
456	EGPWS FUTURE DISC 1	DIS	1256	R GPS LONGITUDE LSP	deg
457	EGPWS FUTURE DISC 2	DIS	1257	R GPS LONGITUDE MSP	deg
458	EGPWS OBST AHEAD PULL UP	DIS	1258	R GPS OPERATIONAL MODE	DIS
459	EGPWS OBSTACLE CAUTION	DIS	1259	R GS ANT STATUS L AFDC	DIS
460	EGPWS OBSTACLE ENABLED	DIS	1260	R HI STAGE BLD VLV POSN	DIS
461	EGPWS OBSTACLE WARN	DIS	1261	R ICE DETECTOR FAIL	DIS
462	EGPWS TERRAIN AHEAD	DIS	1262	R ILS FREQ	MHz
463	EGPWS TERRAIN AMBER	DIS	1263	R ILS FREQ	MHz
464	EGPWS TERRAIN DISP CAPT	DIS	1264	R INBD AILERON POSN RA	Inches
465	EGPWS TERRAIN DISP FO	DIS	1265	R INBD AILERON POSN RA	Inches
466	EGPWS TERRAIN NOT AVAIL	DIS	1266	R INBD AILERON POSN RA S	Inches
467	EGPWS TERRAIN OVERRIDE	DIS	1267	R INBD DISPLAY MODE	DIS
468	EGPWS TERRAIN RED	DIS	1268	R INBD ELEV POSN RA	Inches
469	EGPWS WINDSHEAR C	DIS	1269	R INBD ELEV POSN RA	Inches

470	EGPWS WINDSHEAR W	DIS	1270	R INBD ELEV POSN RA S	Inches
471	EICAS SPARE NO 1	DIS	1271	R INBD FLAPERON POSN L2A	Inches
472	EICAS SPARE NO 2	DIS	1272	R INBD FLAPERON POSN L2A	Inches
473	EICAS SPARE NO 3	DIS	1273	R INBD FLAPERON POSN L2S	Inches
474	ELEV FEEL ACT 1 POSN L2	Inches	1274	R ISOLATION VLV CLOSED	DIS
475	ELEV FEEL ACT 2 POSN C	Inches	1275	R JETSN ISOL VLV CLSD	DIS
476	EMERG PWR OFF CMD GRP1	DIS	1276	R JETSN ISOL VLV OPEN	DIS
477	EMERG PWR OFF CMD GRP2	DIS	1277	R JETSN NOZZLE VLV CLSD	DIS
478	EMERGENCY LIGHTS ARM	DIS	1278	R JETSN NOZZLE VLV OPEN	DIS
479	ENG AUTOSTART SW POSN	DIS	1279	R LE SLAT POSN 1	deg
480	ENG FIRE BTTL 1 DISC PA	DIS	1280	R LE SLAT POSN 2	deg
481	ENG FIRE BTTL 1 DISC PB	DIS	1281	R LOC ANT STATUS R AFDC	DIS
482	ENG FIRE BTTL 2 DISC PA	DIS	1282	R MAIN GEAR DN AND LOCK	DIS
483	ENG FIRE BTTL 2 DISC PB	DIS	1283	R MAIN GEAR UP AND STOW	DIS
484	ENG OUT COMP INOP STAT C	DIS	1284	R MLS CHANNEL	DIS
485	ENG OUT COMP INOP STAT L	DIS	1285	R MLS CHANNEL	DIS
486	ENG OUT COMP INOP STAT R	DIS	1286	R MLS CHANNEL	DIS
487	ENG TARGET THRUST EPR	DIS	1287	R MN AFT FU PMP CMD	DIS
488	EVENT MARKER	DIS	1288	R MN AFT FU PMP LO PRESS	DIS
489	FD CREW REST SMOKE WARN	DIS	1289	R MN FWD FU PMP CMD	DIS
490	FLAP DRIVE FAIL 1	DIS	1290	R MN FWD FU PMP LO PRESS	DIS
491	FLAP DRIVE FAIL 2	DIS	1291	R OUTBD AILERON POSN L1A	Inches
492	FLAP HANDLE POSN A 1	deg	1292	R OUTBD AILERON POSN L1A	Inches
493	FLAP HANDLE POSN A 1	deg	1293	R OUTBD AILERON POSN L1S	Inches
494	FLAP HANDLE POSN A 1	deg	1294	R OUTBD DISPLAY MODE	DIS

495	FLAP HANDLE POSN A 1	deg	1295	R OUTBD ELEV POSN L2A	Inches
496	FLAP HANDLE POSN A 1	deg	1296	R OUTBD ELEV POSN L2A	Inches
497	FLAP HANDLE POSN A 1	deg	1297	R OUTBD ELEV POSN L2A S	Inches
498	FLAP HANDLE POSN A 1	deg	1298	R OUTBD FLAPERON POS CA	Inches
499	FLAP HANDLE POSN A 1	deg	1299	R OUTBD FLAPERON POS CA	Inches
500	FLAP HANDLE POSN A 1	deg	1300	R OUTBD FLAPERON POS CAS	Inches
501	FLAP HANDLE POSN A 1 V	Volts	1301	R OVRD FU PMP LOW PRESS	DIS
502	FLAP HANDLE POSN A 2	deg	1302	R PFC BUS ACT FAULT	DIS
503	FLAP HANDLE POSN A 2	deg	1303	R PFC CHANNEL STAT	DIS
504	FLAP HANDLE POSN A 2	deg	1304	R PFC DATA SUSPECT	DIS
505	FLAP HANDLE POSN A 2	deg	1305	R PFC WATCHDOG FAULT	DIS
506	FLAP HANDLE POSN A 2	deg	1306	R PITOT STAT PRB HT VLD	DIS
507	FLAP HANDLE POSN A 2	deg	1307	R PSA CB 1 POSN	DIS
508	FLAP HANDLE POSN A 2	deg	1308	R PSA CB 10 POSN	DIS
509	FLAP HANDLE POSN A 2	deg	1309	R PSA CB 11 POSN	DIS
510	FLAP HANDLE POSN A 2	deg	1310	R PSA CB 12 POSN	DIS
511	FLAP HANDLE POSN A 2 V	Volts	1311	R PSA CB 13 POSN	DIS
512	FLAP HANDLE POSN B 1	deg	1312	R PSA CB 14 POSN	DIS
513	FLAP HANDLE POSN B 1	deg	1313	R PSA CB 15 POSN	DIS
514	FLAP HANDLE POSN B 1	deg	1314	R PSA CB 16 POSN	DIS
515	FLAP HANDLE POSN B 1	deg	1315	R PSA CB 17 POSN	DIS
516	FLAP HANDLE POSN B 1	deg	1316	R PSA CB 2 POSN	DIS
517	FLAP HANDLE POSN B 1	deg	1317	R PSA CB 3 POSN	DIS
518	FLAP HANDLE POSN B 1	deg	1318	R PSA CB 4 POSN	DIS
519	FLAP HANDLE POSN B 1	deg	1319	R PSA CB 5 POSN	DIS
520	FLAP HANDLE POSN B 1	deg	1320	R PSA CB 6 POSN	DIS
521	FLAP HANDLE POSN B 1 V	Volts	1321	R PSA CB 7 POSN	DIS
522	FLAP HANDLE POSN B 2	deg	1322	R PSA CB 8 POSN	DIS
523	FLAP HANDLE POSN B 2	deg	1323	R PSA CB 9 POSN	DIS
524	FLAP HANDLE POSN B 2	deg	1324	R RAD ALTIMETER FAULT	DIS
525	FLAP HANDLE POSN B 2	deg	1325	R RAD TUNE INPUT	DIS
526	FLAP HANDLE POSN B 2	deg	1326	R RAD TUNE INPUT	DIS

527	FLAP HANDLE POSN B 2	deg	1327	R RAD TUNE INPUT	DIS
528	FLAP HANDLE POSN B 2	deg	1328	R RAD TUNE INPUT	DIS
529	FLAP HANDLE POSN B 2	deg	1329	R RAD TUNE INPUT	DIS
530	FLAP HANDLE POSN B 2	deg	1330	R SATCOM CM ALRT CHM	DIS
531	FLAP HANDLE POSN B 2 V	Volts	1331	R SATCOM CM ALRT NO CHM	DIS
532	FLAP LOAD RELIEF 1	DIS	1332	R SATCOM FD VOI CH1 CONN	DIS
533	FLAP LOAD RELIEF 2	DIS	1333	R SATCOM FD VOI CH2 CONN	DIS
534	FLAPS 2ND SYS FAIL 1	DIS	1334	R SATCOM LOG ON2 GND STA	DIS
535	FLAPS 2ND SYS FAIL 2	DIS	1335	R SATCOM NO VOICE	DIS
536	FLAPS IN CMDED POSN 1	DIS	1336	R TAT PROBE HEAT ON	DIS
537	FLAPS IN CMDED POSN 2	DIS	1337	R TAT PROBE HEAT VALID	DIS
538	FLAPS PRI SYS FAIL 1	DIS	1338	R TE FLAP POSN 1	deg
539	FLAPS PRI SYS FAIL 2	DIS	1339	R TE FLAP POSN 1	deg
540	FLIGHT PHASE	DIS	1340	R TE FLAP POSN 1	deg
541	FLT CRIT BUS VOLTAGE C	Volts DC	1341	R TE FLAP POSN 1	deg
542	FLT CRIT BUS VOLTAGE L	Volts DC	1342	R TE FLAP POSN 1	deg
543	FLT CRIT BUS VOLTAGE R	Volts DC	1343	R TE FLAP POSN 1	deg
544	FLT DIR ENGAGED	DIS	1344	R TE FLAP POSN 1	deg
545	FMC ACT NAV PERF	Meters	1345	R TE FLAP POSN 1	deg
546	FMC ACT NAV PERF	Meters	1346	R TE FLAP POSN 1 SEN	Volts
547	FMC ACT NAV PERF INVALID	DIS	1347	R TE FLAP POSN 2	deg
548	FMC ALTITUDE TARGET	Feet	1348	R TE FLAP POSN 2	deg
549	FMC CAS TARGET	Knots	1349	R TE FLAP POSN 2	deg
550	FMC CENTER OF GRAVITY	%MAC	1350	R TE FLAP POSN 2	deg
551	FMC CLIMBOUT SPEED	Knots	1351	R TE FLAP POSN 2	deg
552	FMC DECISION SPEED	Knots	1352	R TE FLAP POSN 2	deg
553	FMC DESIRED TRACK	deg	1353	R TE FLAP POSN 2	deg
554	FMC ENG TARGET THRST EPR	DIS	1354	R TE FLAP POSN 2	deg
555	FMC FLAP EXTEND SPEED	Knots	1355	R TE FLAP POSN 2 SEN	Volts
556	FMC FLAP RETRACT SPEED	Knots	1356	R VOR FAIL	DIS
557	FMC FLAPS UP MAX SPEED	Knots	1357	R VOR FREQ	MHz
558	FMC GROSS WEIGHT	lbs	1358	R VOR SELECTED	deg

				COURSE	
559	FMC LATITUDE LSP	deg	1359	RAD ALT CH CAPT	DIS
560	FMC LATITUDE MSP	deg	1360	RADIO ALTITUDE C	Feet
561	FMC LONGITUDE LSP	deg	1361	RADIO ALTITUDE L	Feet
562	FMC LONGITUDE MSP	deg	1362	RADIO ALTITUDE R	Feet
563	FMC MACH TARGET	DIS	1363	RAT AC XFER BUS VOLTAGE	VAC
564	FMC MAG TRACK	deg	1364	RAT DEPLOYMENT FAULT	DIS
565	FMC MIN MANUEVER SPEED	Knots	1365	RAT HYDRAULIC PRESS	PSI
566	FMC NAV MODE	DIS	1366	RAT UNLOCKED	DIS
567	FMC REQD NAV PERF	NM	1367	RIB AILERN CMD CPFC 2 RA	Inches
568	FMC REQD NAV PERF	NM	1368	RIB AILERN CMD LPFC 2 RA	Inches
569	FMC RNP EXCEED ADVISORY	DIS	1369	RIB AILERN CMD RPFC 2 RA	Inches
570	FMC RNP EXCEED CAUTION	DIS	1370	RIB AILRN BYPASS STAT RA	DIS
571	FMC ROTATION SPEED	Knots	1371	RIB ELEV BYPASS STATE RA	DIS
572	FMC SELECTED REF SPEED	Knots	1372	RIB ELEV CMD CPFC 2 RA	Inches
573	FMC SW SEL AUTO	DIS	1373	RIB ELEV CMD LPFC 2 RA	Inches
574	FMC SW SEL L	DIS	1374	RIB ELEV CMD RPFC 2 RA	Inches
575	FMC SW SEL R	DIS	1375	RIB FLPRN BYPAS STAT L2A	DIS
576	FMC TRUE TRACK	degs	1376	RIB FLPRN CMD CPRC 2 L2A	Inches
577	FO ADIRS SW SEL ALT	DIS	1377	RIB FLPRN CMD LPRC 2 L2A	Inches
578	FO AP EN SW SEL EN	DIS	1378	RIB FLPRN CMD RPRC 2 L2A	Inches
579	FO COL FORCE L2	lbs	1379	ROB AILRN BYPAS STAT L1A	DIS
580	FO COL FORCE L2 SEN	lbs	1380	ROB AILRN CMD CPFC 2 L1A	Inches
581	FO COL FORCE R	lbs	1381	ROB AILRN CMD LPFC 2 L1A	Inches
582	FO COL FORCE R SEN	lbs	1382	ROB AILRN CMD RPFC 2 L1A	Inches
583	FO COLUMN FORCE 4 FDR	lbs	1383	ROB ELEV BYPAS STATE L2A	DIS
584	FO CTRL COL POSN L2	deg	1384	ROB ELEV CMD CPFC 2	Inches

				L2A	
585	FO CTRL COL POSN L2 SEN	Inches	1385	ROB ELEV CMD LPFC 2 L2A	Inches
586	FO CTRL COL POSN R	deg	1386	ROB ELEV CMD RPFC 2 L2A	Inches
587	FO CTRL COL POSN R SEN	Inches	1387	ROB FLAPRN CMD CPFC 2 CA	Inches
588	FO CTRL WHEEL POSN C	deg	1388	ROB FLAPRN CMD LPFC 2 CA	Inches
589	FO CTRL WHEEL POSN C	deg	1389	ROB FLAPRN CMD RPFC 2 CA	Inches
590	FO CTRL WHEEL POSN C	deg	1390	ROB FLPRN BYPAS STATE CA	DIS
591	FO CTRL WHEEL POSN C	deg	1391	ROLL ATTITUDE	deg
592	FO CTRL WHEEL POSN C S	Inches	1392	ROLL ATTITUDE	deg
593	FO CTRL WHEEL POSN C S	Inches	1393	ROLL RATE	deg/S
594	FO CTRL WHEEL POSN L2	deg	1394	RUDDER PEDAL POSN CA	deg
595	FO CTRL WHEEL POSN L2	deg	1395	RUDDER PEDAL POSN CA	deg
596	FO CTRL WHEEL POSN L2 S	Inches	1396	RUDDER PEDAL POSN CA S	Inches
597	FO CTRL WHEEL POSN R	deg	1397	RUDDER PEDAL POSN L1A	deg
598	FO CTRL WHEEL POSN R	deg	1398	RUDDER PEDAL POSN L1A	deg
599	FO CTRL WHEEL POSN R S	Inches	1399	RUDDER PEDAL POSN L1A S	Inches
600	FO DISP ARPT SEL	DIS	1400	RUDDER PEDAL POSN L2A	deg
601	FO DISP POS SEL	DIS	1401	RUDDER PEDAL POSN L2A	deg
602	FO DISP RTE DATA SEL	DIS	1402	RUDDER PEDAL POSN L2A S	Inches
603	FO DISP STA SEL	DIS	1403	RUDDER PEDAL POSN RA	deg
604	FO DISP WPT SEL	DIS	1404	RUDDER PEDAL POSN RA	deg
605	FO DSP CTRL SW SEL ALT	DIS	1405	RUDDER PEDAL POSN RA S	Inches
606	FO EFIS ADF L SEL	DIS	1406	RUDDER TRIM BRAKE	DIS
607	FO EFIS ADF R SEL	DIS	1407	RUDDER TRIM LEFT L1	DIS
608	FO EFIS VOR L SEL	DIS	1408	RUDDER TRIM POSN	Inches
609	FO EFIS VOR R SEL	DIS	1409	RUDDER TRIM PTC L1	DIS
610	FO FD SW SEL ON	DIS	1410	RUDDER TRIM RATE	DIS
611	FO FD SW SEL ON FPV	DIS	1411	RUDDER TRIM RIGHT L1	DIS
612	FO FLT INST BUS STATUS	DIS	1412	S/F CYCLE COUNT	DIS

613	FO NAV SW SEL CDU	DIS	1413	SEL ALTITUDE	Feet
614	FO PVD ADVISORY	DIS	1414	SEL FLIGHT PATH	deg
615	FO PVD ON	DIS	1415	SEL HEADING	deg
616	FO RUDDER PEDAL FORCE	lbs	1416	SEL LANDING MODE STAT C	DIS
617	FO SEL BARO SETTING	DIS	1417	SEL LANDING MODE STAT L	DIS
618	FO SEL DH BARO	DIS	1418	SEL LANDING MODE STAT R	DIS
619	FO SEL DH RA	DIS	1419	SEL MACH	DIS
620	FO STAB TRIM ASW DN L2	DIS	1420	SEL RUNWAY HEADING C	deg
621	FO STAB TRIM ASW DN L2	DIS	1421	SEL RUNWAY HEADING L	deg
622	FO STAB TRIM ASW UP L2	DIS	1422	SEL RUNWAY HEADING R	deg
623	FO STAB TRIM ASW UP L2	DIS	1423	SEL SPEED	Knots
624	FO STAB TRIM CSW DN R	DIS	1424	SEL TRACK	deg
625	FO STAB TRIM CSW DN R	DIS	1425	SEL VERT SPEED	ft/min
626	FO STAB TRIM CSW UP R	DIS	1426	SLAT DRIVE FAIL 1	DIS
627	FO STAB TRIM CSW UP R	DIS	1427	SLAT DRIVE FAIL 2	DIS
628	FQIS WTR DETECT CENTER L	DIS	1428	SLATS 2ND SYS FAIL 1	DIS
629	FQIS WTR DETECT CENTER R	DIS	1429	SLATS 2ND SYS FAIL 2	DIS
630	FQIS WTR DETECT L MAIN	DIS	1430	SLATS IN CMDED POSN 1	DIS
631	FQIS WTR DETECT R MAIN	DIS	1431	SLATS IN CMDED POSN 2	DIS
632	FRAME COUNTER	DIS	1432	SLATS PRI SYS FAIL 1	DIS
633	FSEU 1 FAIL	DIS	1433	SLATS PRI SYS FAIL 2	DIS
634	FSEU 1 IN CONTROL	DIS	1434	SPD BRK HANDL POSN CA	deg
635	FSEU 1 LANE FAULT	DIS	1435	SPD BRK HANDL POSN CA	deg
636	FSEU 2 FAIL	DIS	1436	SPD BRK HANDL POSN CA	deg
637	FSEU 2 IN CONTROL	DIS	1437	SPD BRK HANDL POSN CA S	deg
638	FSEU 2 LANE FAULT	DIS	1438	SPD BRK HANDL POSN L1A	deg
639	FUEL CUTOFF LVR L PA	DIS	1439	SPD BRK HANDL POSN L1A	deg
640	FUEL CUTOFF LVR L PB	DIS	1440	SPD BRK HANDL POSN L1A	deg
641	FUEL CUTOFF LVR R PA	DIS	1441	SPD BRK HANDL POSN L1A S	deg

642	FUEL CUTOFF LVR R PB	DIS	1442	SPD BRK HANDL POSN L2A	deg
643	FUEL DENS CENTER	ppg	1443	SPD BRK HANDL POSN L2A	deg
644	FUEL DENS L MAIN	ppg	1444	SPD BRK HANDL POSN L2A	deg
645	FUEL DENS R MAIIN	ppg	1445	SPD BRK HANDL POSN L2A S	deg
646	FUEL IMBALANCE	DIS	1446	SPD BRK HANDL POSN RA	deg
647	FUEL JETSN ARM	DIS	1447	SPD BRK HANDL POSN RA	deg
648	FUEL QTY BLOCK DISPLAYED	DIS	1448	SPD BRK HANDL POSN RA	deg
649	FUEL QUAN CENTER	lbs	1449	SPD BRK HANDL POSN RA S	deg
650	FUEL QUAN IND SYS FAIL	DIS	1450	SPEEDBRAKE EXT CAUT E	DIS
651	FUEL QUAN L MAIN	lbs	1451	SPLR 1 SERV LOOP FAULT	DIS
652	FUEL QUAN R MAIN	lbs	1452	SPLR 10 SERV LOOP FAULT	DIS
653	FUEL QUAN TOTAL	lbs	1453	SPLR 12 SERV LOOP FAULT	DIS
654	FUEL SPAR VLV POSN L	DIS	1454	SPLR 13 SERV LOOP FAULT	DIS
655	FUEL SPAR VLV POSN R	DIS	1455	SPLR 14 SERV LOOP FAULT	DIS
656	FUEL TEMP L MAIN	deg C	1456	SPLR 2 SERV LOOP FAULT	DIS
657	FUEL UNITS STATUS	DIS	1457	SPLR 3 SERV LOOP FAULT	DIS
658	FUEL VALVE SOLENOID L	DIS	1458	SPLR 5 SERV LOOP FAULT	DIS
659	FUEL VALVE SOLENOID R	DIS	1459	SPLR 6 SERV LOOP FAULT	DIS
660	FWD CARGO SMOKE WARN E	DIS	1460	SPLR 7 SERV LOOP FAULT	DIS
661	FWD CSDS FAIL E	DIS	1461	SPLR 8 SERV LOOP FAULT	DIS
662	FWD FUEL XFEED VLV CLSD	DIS	1462	SPLR 9 SERV LOOP FAULT	DIS
663	FWD FUEL XFEED VLV OPEN	DIS	1463	SPOILER NO 1 POSN	Inches
664	FWD OUTFLO VLV PCT OPN L	%	1464	SPOILER NO 1 POSN	Inches
665	FWD OUTFLO VLV PCT OPN R	%	1465	SPOILER NO 1 POSN IN	Inches
666	FWD OUTFLO VLV SEL MAN L	DIS	1466	SPOILER NO 10 POSN	Inches
667	FWD OUTFLO VLV SEL MAN R	DIS	1467	SPOILER NO 10 POSN	Inches

668	GEAR DISAGREE	DIS	1468	SPOILER NO 10 POSN IN	Inches
669	GLS MODE C	DIS	1469	SPOILER NO 11 POSN	Inches
670	GLS MODE L	DIS	1470	SPOILER NO 11 POSN	Inches
671	GLS MODE R	DIS	1471	SPOILER NO 11 POSN IN	Inches
672	GMT BNR HOURS	Hours	1472	SPOILER NO 12 POSN	Inches
673	GMT BNR MINUTES	Minutes	1473	SPOILER NO 12 POSN	Inches
674	GMT BNR SECONDS	Seconds	1474	SPOILER NO 12 POSN IN	Inches
675	GND BUS FAULT ADV E	DIS	1475	SPOILER NO 13 POSN	Inches
676	GNSS MODE C	DIS	1476	SPOILER NO 13 POSN	Inches
677	GNSS MODE L	DIS	1477	SPOILER NO 13 POSN IN	Inches
678	GNSS MODE R	DIS	1478	SPOILER NO 14 POSN	Inches
679	GPWS DON'T SINK	DIS	1479	SPOILER NO 14 POSN	Inches
680	GPWS FAIL	DIS	1480	SPOILER NO 14 POSN IN	Inches
681	GPWS GLIDESLOPE	DIS	1481	SPOILER NO 2 POSN	Inches
682	GPWS GLIDESLOPE ALERT	DIS	1482	SPOILER NO 2 POSN	Inches
683	GPWS GLIDESLOPE CANCEL	DIS	1483	SPOILER NO 2 POSN IN	Inches
684	GPWS MINIMUMS	DIS	1484	SPOILER NO 3 POSN	Inches
685	GPWS PULL UP	DIS	1485	SPOILER NO 3 POSN	Inches
686	GPWS SINK RATE	DIS	1486	SPOILER NO 3 POSN IN	Inches
687	GPWS SYSTEM INOP	DIS	1487	SPOILER NO 4 POSN	Inches
688	GPWS TERRAIN	DIS	1488	SPOILER NO 4 POSN	Inches
689	GPWS TERRAIN PULL UP	DIS	1489	SPOILER NO 4 POSN IN	Inches
690	GPWS TOO LOW FLAPS	DIS	1490	SPOILER NO 5 POSN	Inches
691	GPWS TOO LOW GEAR	DIS	1491	SPOILER NO 5 POSN	Inches
692	GPWS TOO LOW TERRAIN	DIS	1492	SPOILER NO 5 POSN IN	Inches
693	GPWS WARN	DIS	1493	SPOILER NO 6 POSN	Inches
694	GPWS WINDSHEAR CAUTION	DIS	1494	SPOILER NO 6 POSN	Inches
695	GPWS WINDSHEAR INOP	DIS	1495	SPOILER NO 6 POSN IN	Inches
696	GPWS WINDSHEAR WARN	DIS	1496	SPOILER NO 7 POSN	Inches
697	GROUNDSPEED	Knots	1497	SPOILER NO 7 POSN	Inches
698	GS ANTENNA FAIL C	DIS	1498	SPOILER NO 7 POSN IN	Inches
699	GS ANTENNA FAIL L	DIS	1499	SPOILER NO 8 POSN	Inches
700	GS ANTENNA FAIL R	DIS	1500	SPOILER NO 8 POSN	Inches

701	GS DEV OR ELEV CH CAPT	DIS	1501	SPOILER NO 8 POSN IN	Inches
702	GS TEST TUNE INHIBIT C	DIS	1502	SPOILER NO 9 POSN	Inches
703	GS TEST TUNE INHIBIT L	DIS	1503	SPOILER NO 9 POSN	Inches
704	GS TEST TUNE INHIBIT R	DIS	1504	SPOILER NO 9 POSN IN	Inches
705	GSRS V FIN LWR DELTA P	psid	1505	STALL PROT CMD C PFC	g
706	GSRS V FIN UPR DELTA P	psid	1506	STALL PROT CMD L PFC	g
707	HF 1 KEYED PA	DIS	1507	STALL PROT CMD R PFC	g
708	HF 1 KEYED PB	DIS	1508	STATIC AIR TEMP	deg C
709	HF 1 SELECTED FREQ LSP	MHz	1509	STATIC PRESSURE	Mb
710	HF 1 SELECTED FREQ LSP+1	MHz	1510	STBY IINVERTER STATUS	DIS
711	HF 1 SELECTED FREQ MSP	MHz	1511	STICK SHAKER L	DIS
712	HF 2 KEYED PA	DIS	1512	STICK SHAKER R	DIS
713	HF 2 KEYED PB	DIS	1513	SYNC WORD	DIS
714	HF 2 SELECTED FREQ LSP	MHz	1514	TAC DISABLE SW POSN	DIS
715	HF 2 SELECTED FREQ LSP+1	MHz	1515	TAIL SKID ADVISORY E	DIS
716	HF 2 SELECTED FREQ MSP	MHz	1516	TAIL STRIKE CAUTION E	DIS
717	HORIZ STAB POSN C	DIS	1517	TCAS ADVISORY ALTE RATE	Feet
718	HORIZ STAB POSN C S	DIS	1518	TCAS ALTITUDE RPTG	DIS
719	HORIZ STAB POSN L1	DIS	1519	TCAS ALTITUDE SEL	DIS
720	HORIZ STAB POSN L1 S	DIS	1520	TCAS COMBINED CONTROL	DIS
721	HORIZ STAB POSN R	DIS	1521	TCAS DISPLAY STATE	DIS
722	HORIZ STAB POSN R S	DIS	1522	TCAS DOWN ADVISORY	DIS
723	HOT BAT BUS STATUS	DIS	1523	TCAS FAIL	DIS
724	HUD ACT FAULT	DIS	1524	TCAS REPLY	DIS
725	HUD ACTIVE MODE	DIS	1525	TCAS SENSE LEVEL CMD	DIS
726	HUD AIII CAPABILITY	DIS	1526	TCAS SENSE LEVEL MAN	DIS
727	HUD ALERT AMBER	DIS	1527	TCAS SPI	DIS
728	HUD ALERT LATCH	DIS	1528	TCAS SYSTEM STAT	DIS
729	HUD ALERT VOICE CALLOUT	DIS	1529	TCAS UP ADVISORY	DIS
730	HUD ARM MODE	DIS	1530	TCAS VERTICAL CONTROL	DIS
731	HUD BIT FAULT	DIS	1531	TOTAL AIR TEMP	deg C
732	HUD COMBINER POSITION	DIS	1532	TOTAL PRESSURE	Mb

733	HUD DISPLAY MODE	DIS	1533	TRUE HDG REF SEL	DIS
734	HUD EXCESS DEVIATION	DIS	1534	TRUE HEADING	deg
735	HUD FLASHBOX	DIS	1535	TUNING INP BUS INACT C	DIS
736	HUD FLIGHT PATH X POSN	DI	1536	TUNING INP BUS INACT L	DIS
737	HUD FLIGHT PATH Y POSN	DI	1537	TUNING INP BUS INACT R	DIS
738	HUD GUIDANCE CUE X POSN	DI	1538	UNSCHED STAB TRUM WARN C	DIS
739	HUD GUIDANCE CUE Y POSN	DI	1539	UNSCHED STAB TRUM WARN L	DIS
740	HUD GUIDANCE STATUS	DIS	1540	UNSCHED STAB TRUM WARN R	DIS
741	HUD MODE FAULT FIELD 1	DIS	1541	UPPER DISPLAY MODE	DIS
742	HUD MODE FAULT FIELD 2	DIS	1542	UPR RUD BLKING STATE CA	DIS
743	HUD MODE FAULT FIELD 3	DIS	1543	UPR RUD BYPASS STATE CA	DIS
744	HUD MULTI WARN	DIS	1544	UPR RUDDER CMD CPFC 2 CA	Inches
745	HUD NO AIII ADV	DIS	1545	UPR RUDDER CMD LPFC 2 CA	Inches
746	HUD OVERRIDE	DIS	1546	UPR RUDDER CMD RPFC 2 CA	Inches
747	HUD PFD WARNING	DIS	1547	UPR RUDDER POSN CA	Inches
748	HUD SPARE DIS 1	DIS	1548	UPR RUDDER POSN CA	Inches
749	HUD SPARE DIS 10	DIS	1549	UPR RUDDER POSN CA IN	Inches
750	HUD SPARE DIS 2	DIS	1550	VERSION NUMBER LSP	DIS
751	HUD SPARE DIS 3	DIS	1551	VERSION NUMBER MSP	DIS
752	HUD SPARE DIS 4	DIS	1552	VERT ACCEL	g's
753	HUD SPARE DIS 5	DIS	1553	VERT ACCEL	g's
754	HUD SPARE DIS 6	DIS	1554	VERT ACCEL	g's
755	HUD SPARE DIS 7	DIS	1555	VERT ACCEL	g's
756	HUD SPARE DIS 8	DIS	1556	VERT ACCEL	g's
757	HUD SPARE DIS 9	DIS	1557	VERT ACCEL	g's
758	HUD SYS FAIL ADVISORY	DIS	1558	VERT ACCEL	g's
759	HUD SYSTEM STATUS	DIS	1559	VERT ACCEL	g's
760	HUD TAILSTRIKE	DIS	1560	VERT DEV VALIDITY C	DIS
761	HUD TOUCHDOWN	DIS	1561	VERT DEV VALIDITY L	DIS
762	HUD VALIDITY	DIS	1562	VERT DEV VALIDITY R	DIS

763	HYD LOW PRESS WARN C1	DIS	1563	VERTICAL DEVIATION C	DDM
764	HYD LOW PRESS WARN C2	DIS	1564	VERTICAL DEVIATION L	DDM
765	HYD LOW PRESS WARN L	DIS	1565	VERTICAL DEVIATION R	DDM
766	HYD LOW PRESS WARN R	DIS	1566	VERTICAL SPEED	Ft/min
767	HYD RESERVOIR QUAN C2	%	1567	VHF 1 KEYED PA	DIS
768	HYD RESERVOIR QUAN L	%	1568	VHF 1 KEYED PB	DIS
769	HYD RESERVOIR QUAN R	%	1569	VHF 1 SEL FREQ LSP	MHz
770	HYDRAULIC PRESS C	psi	1570	VHF 1 SEL FREQ MSP	MHz
771	HYDRAULIC PRESS L	psi	1571	VHF 2 KEYED PA	DIS
772	HYDRAULIC PRESS R	psi	1572	VHF 2 KEYED PB	DIS
773	ICAO ID CODE LSP	DIS	1573	VHF 2 SEL FREQ LSP	MHz
774	ICAO ID CODE MSP	DIS	1574	VHF 2 SEL FREQ MSP	MHz
775	ICE DETECTED COWL L	DIS	1575	VHF 3 KEYED PA	DIS
776	ICE DETECTED COWL R	DIS	1576	VHF 3 KEYED PB	DIS
777	ICE DETECTED WING L	DIS	1577	VHF 3 SEL FREQ LSP	MHz
778	ICE DETECTED WING R	DIS	1578	VHF 3 SEL FREQ MSP	MHz
779	ICE DETECTORS FAIL ADV E	DIS	1579	VOR BEARING L	deg
780	ILS MODE C	DIS	1580	VOR BEARING R	deg
781	ILS MODE L	DIS	1581	WHEEL WELL FIRE WARN E	DIS
782	ILS MODE R	DIS	1582	WIND DIRECTION	deg
783	INDICATED AOA L	deg	1583	WIND SPEED	Knots
784	INDICATED AOA R	deg	1584	WING ANTI ICE L ON	DIS
785	INERT REF DATA SUSPECT	DIS	1585	WING ANTI ICE R ON	DIS
786	INTERMEDIATE DUCT PRES L	psig	1586	WNDSHEAR ALRT SYS FAIL E	DIS
787	INTERMEDIATE DUCT PRES R	psig	1587	WT ON WHEELS L MAIN	DIS
788	IOM1 FAULTED	DIS	1588	WT ON WHEELS L MAIN	DIS
789	IOM2 FAULTED	DIS	1589	WT ON WHEELS L MAIN	DIS
790	IOM3 FAULTED	DIS	1590	WT ON WHEELS L MAIN	DIS
791	IOM4 FAULTED	DIS	1591	WT ON WHEELS NOSE	DIS
792	L 28VDC BUS STATUS	DIS	1592	WT ON WHEELS NOSE	DIS
793	L 28VDC BUS VOLTAGE	VDC	1593	WT ON WHEELS NOSE	DIS
794	L AC MAIN BUS STATUS	DIS	1594	WT ON WHEELS NOSE	DIS
795	L AC XFER BUS FREQ	Hz	1595	WT ON WHEELS R MAIN	DIS

796	L AC XFER BUS LOAD	%	1596	WT ON WHEELS R MAIN	DIS
797	L AC XFER BUS STATUS	DIS	1597	WT ON WHEELS R MAIN	DIS
798	L AC XFER BUS VOLTAGE	VAC	1598	WT ON WHEELS R MAIN	DIS
799	L ACS FAIL	DIS	1599	WTAI SW POSN	DIS
800	L ADF BEARING	deg	1600	XFMR RECT C1 STATUS	DIS
			1601	XFMR RECT C2 STATUS	DIS
			1602	XFMR RECT L STATUS	DIS
			1603	XFMR RECT R STATUS	DIS
			1604	YAW DAMPER CMD C	deg
			1605	YAW DAMPER CMD L	deg
			1606	YAW DAMPER CMD R	deg

Attachment 6 TG659 Relevant Tabular Parameters List (TCAS and Flight Controls)

Radar time	Pressure	Computed	ROLL	PITCH	MAG_HEADING	TCAS Display	TCAS_UP	Vertical	A/P PITCH	A/P PTCH/RLL	A/P ROLL	A/P ROLL	AIL_LIB	AIL_ROB	ELEV_LIB	ELEV_ROB	TLA
fdr+5sec	Altitude	Airspeed	(Degrees)	(Degrees)	(Degrees)	State	Advisory	Speed	F/D CMD	CMD	CMD	F/D CMD	ACTUAT POSN	ACTUAT POSN	ACTUAT POSN	ACTUAT POSN	-LEFT
	(Feet)	(Knots)	-0.4	2.8	219			(Ft/Min)	(DEG)	-CPFC	(DEG)	(DEG)	(IN-LVDT)	(IN-LVDT)	(IN-LVDT)	(IN-LVDT)	(DEG)
02:06:55	34000	288	-0.4	2.8		TA	-	-32	0	ENGAGED	0.3	0	-0.1		0	0	58.7
02:06:56	33999	288	-0.4	2.6	219	TA	-	-32		ENGAGED	0.2			-0.1	0	0	58.7
02:06:57	34000	288	-0.4	2.8		TA	-	-16	0	ENGAGED	0.4	0	-0.1		0	0	58.7
02:06:58	33999	288	-0.4	2.6	219	TA	-	-16		ENGAGED	0.3			-0.1	0	0	58.7
02:06:59	33999	288	0.2	2.8		TA	-	-16	0	ENGAGED	7.9	0.2	-0.1		0	0	58.7
02:07:00	33999	288	4.2	2.8	219	TA	-	-16		-	15.7			-0.1	0	0	58.7
02:07:01	33996	288	9.8	2.8		RA	Climb	-32	0	-	14.1	0.4	-0.1		0	0	58.7
02:07:02	33992	288	14.2	2.8	220	RA	Climb	-64		-	4.7			-0.1	0	0	58.7
02:07:03	33988	288	17.1	3.5		RA	Climb	-32	-0.2	-	6.3	-1.2	-0.1		0	0.1	58.7
02:07:04	33969	287	19.2	3.9	223	RA	Climb	64		-	-0.4			-0.1	0.2	0.2	58.7
02:07:05	33966	287	18.6	4		RA	Climb	256	-0.9	-	-3.1	-2.6	-0.1		0.2	0.1	58.7
02:07:06	33980	287	18.5	4.4	224	RA	Climb	480		-	1.5			-0.1	0.1	0.1	59.4
02:07:07	33992	286	19	4.9		RA	Climb	736	-1.6	-	0.4	-2.5	-0.1		0.2	0.2	60.1
02:07:08	34007	286	19.2	5.3	226	RA	Climb	1008		-	-0.4			-0.1	0.1	0.1	61.2
02:07:09	34033	285	18.5	5.1		RA	Climb	1312	-2.3	-	-3.3	-2.5	-0.1		0.1	0	61.9
02:07:10	34082	284	17.2	4.9	228	RA	Climb	1536		-	-4.3			-0.1	0	0	62.9
02:07:11	34122	284	15.5	4.7		RA	Climb	1648	-2.6	-	-5	-0.9	-0.1		0	0	63.6
02:07:12	34156	284	13.4	4.6	229	RA	-	1664		-	-5.1			-0.1	0	0	64
02:07:13	34191	283	11.4	4.2		RA	-	1600	-2.8	-	-3.6	1.6	-0.1		-0.1	0	64.7
02:07:14	34223	283	9.8	3.9	229	-	-	1472		-	-2.9			-0.1	-0.1	-0.1	65
02:07:15	34247	283	8.4	3.5		-	-	1296	-2.8	-	-2.6	3.3	-0.1		-0.1	-0.1	65

02:07:16	34266	282	6.9	3.3	230	-	-	1088		-	-4			-0.1	0	-0.1	65.4
02:07:17	34280	282	5.3	3.3		-	-	880	-2.3	-	-1.6	5.3	-0.1		0	0	65.4
02:07:18	34288	282	4.4	3.2	230	-	-	688		-	-2			-0.1	0	0	65.7
02:07:19	34295	282	3.3	2.8		-	-	528	-2.1	-	-3.8	6.5	-0.1		0	-0.1	65.7
02:07:20	34304	282	1.8	2.8	230	-	-	368		-	-3.3			-0.1	0	0	65.7
02:07:21	34305	282	0.4	2.6		-	-	224	-1.8	-	-2.3	7.6	-0.1		0	0	66.1
02:07:22	34305	282	-0.7	2.6	230	-	-	96		-	-2			-0.1	0	0	66.1
02:07:23	34302	283	-1.8	2.5		-	-	-16	-1.6	-	-1.5	8.6	-0.1		0	0	66.1
02:07:24	34298	283	-2.3	2.5	230	-	-	-112		-	-0.5			-0.1	0	0	66.1
02:07:25	34294	283	-2.6	2.3		-	-	-192	-1.6	-	0.1	9.8	-0.1		0	0	66.1
02:07:26	34288	284	-2.6	2.3	230	-	-	-256		-	1.8			-0.1	0	0	66.1
02:07:27	34282	284	-1.8	2.3		-	-	-320	-1.6	-	4.8	10	-0.1		0	0	65.7
02:07:28	34276	284	0.2	2.1	230	-	-	-384		-	6.2			-0.1	0	0	64.7
02:07:29	34267	285	2.3	2.1		-	-	-432	-1.4	-	5.5	7.9	-0.1		0	0	63.3
02:07:30	34256	285	4.6	1.9	230	-	-	-496		-	5.3			-0.1	0	0	61.9
02:07:31	34243	285	6.2	1.9		-	-	-560	-1.4	-	1.8	5.5	-0.1		0	0	60.5
02:07:32	34228	285	7.7	2.5	231	-	-	-592		-	6.3			-0.1	0.1	0.1	60.1
02:07:33	34201	286	10.2	2.8		-	-	-576	-1.8	-	4.6	3.3	-0.1		0.1	0.1	59.4
02:07:34	34183	286	11.8	2.8	232	-	-	-464		-	2.4			-0.1	0	0	59.4
02:07:35	34186	286	12.1	2.6		-	-	-304	-1.9	-	-0.4	1.6	-0.1		0	0	59.4
02:07:36	34191	286	12.3	2.6	233	-	-	-208		-	0.3			-0.1	0	0	59.4
02:07:37	34193	286	12.5	2.5		-	-	-160	-1.9	-	1.7	1.4	-0.1		0	0	59.4
02:07:38	34195	286	13	2.3	233	-	-	-176		-	2			-0.1	0	0	59.4
02:07:39	34192	286	13.7	2.3		-	-	-224	-1.6	-	2.4	0.9	-0.1		0	0	59.1
02:07:40	34186	286	14.2	2.1	235	-	-	-304		-	1.3			-0.1	0	0	59.1
02:07:41	34179	286	14.6	2.1		-	-	-384	-1.4	-	0.1	0.2	-0.1		0	0	58.7
02:07:42	34167	286				-	-	-448		-	0			-0.1	0	0	58.4

Attachment 7 Detail SSFDR Data Plots

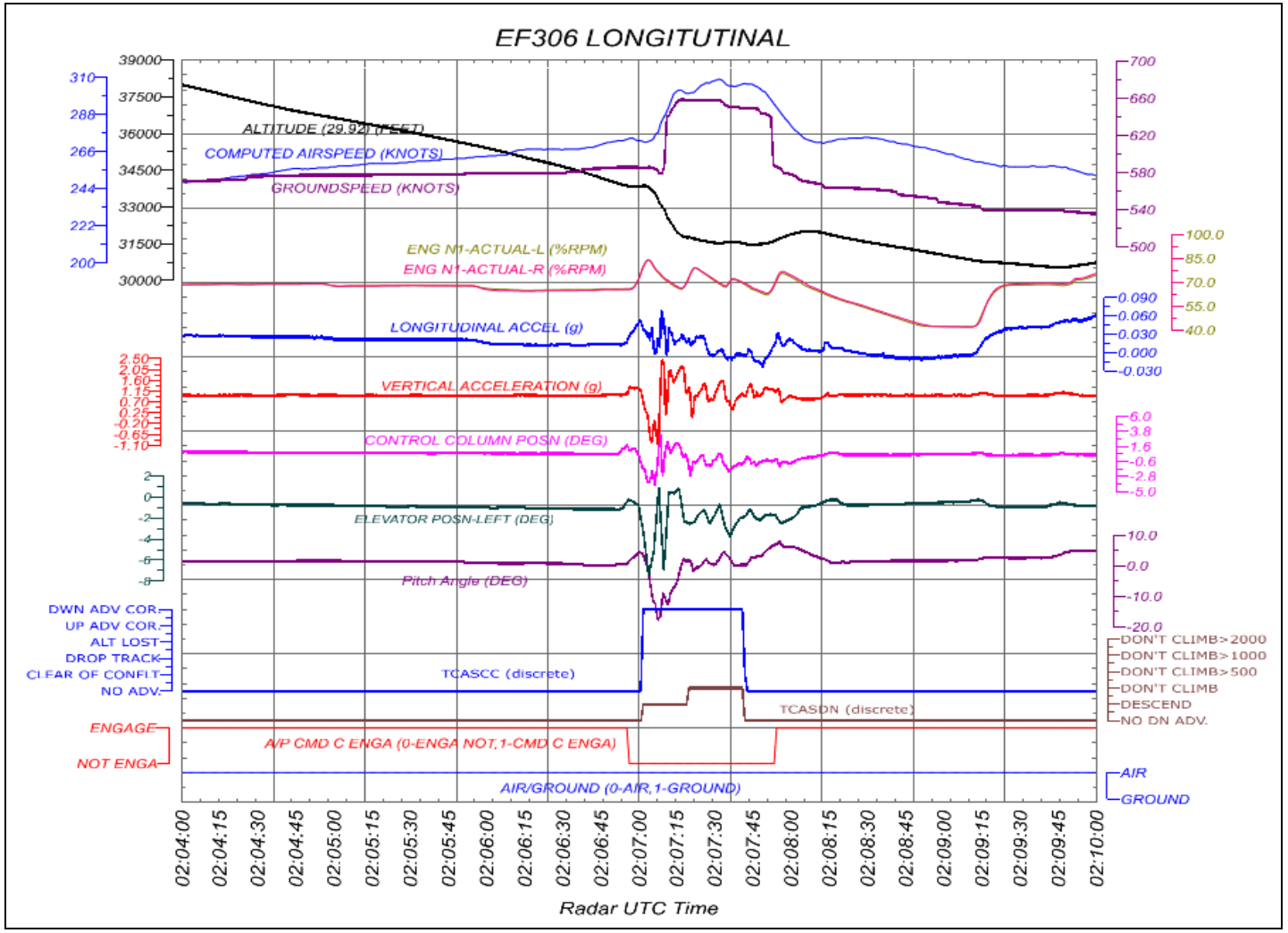

Figure A7-1 EF306 SSFDR data plot (longitude axis, 02:04 ~ 02:10)

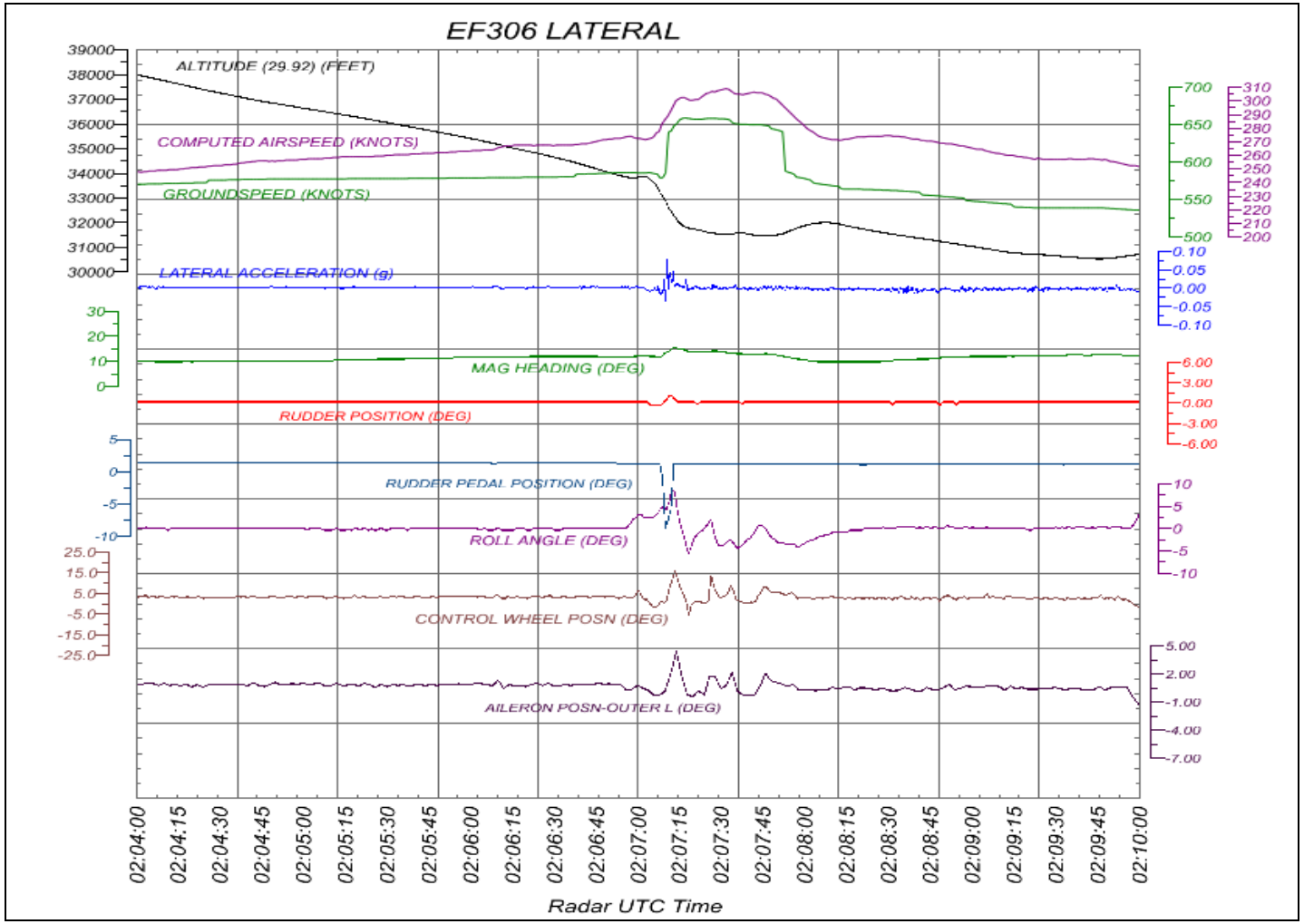

Figure A7-2 EF306 SSFDR data plot (lateral axis, 02:04 ~ 02:10)

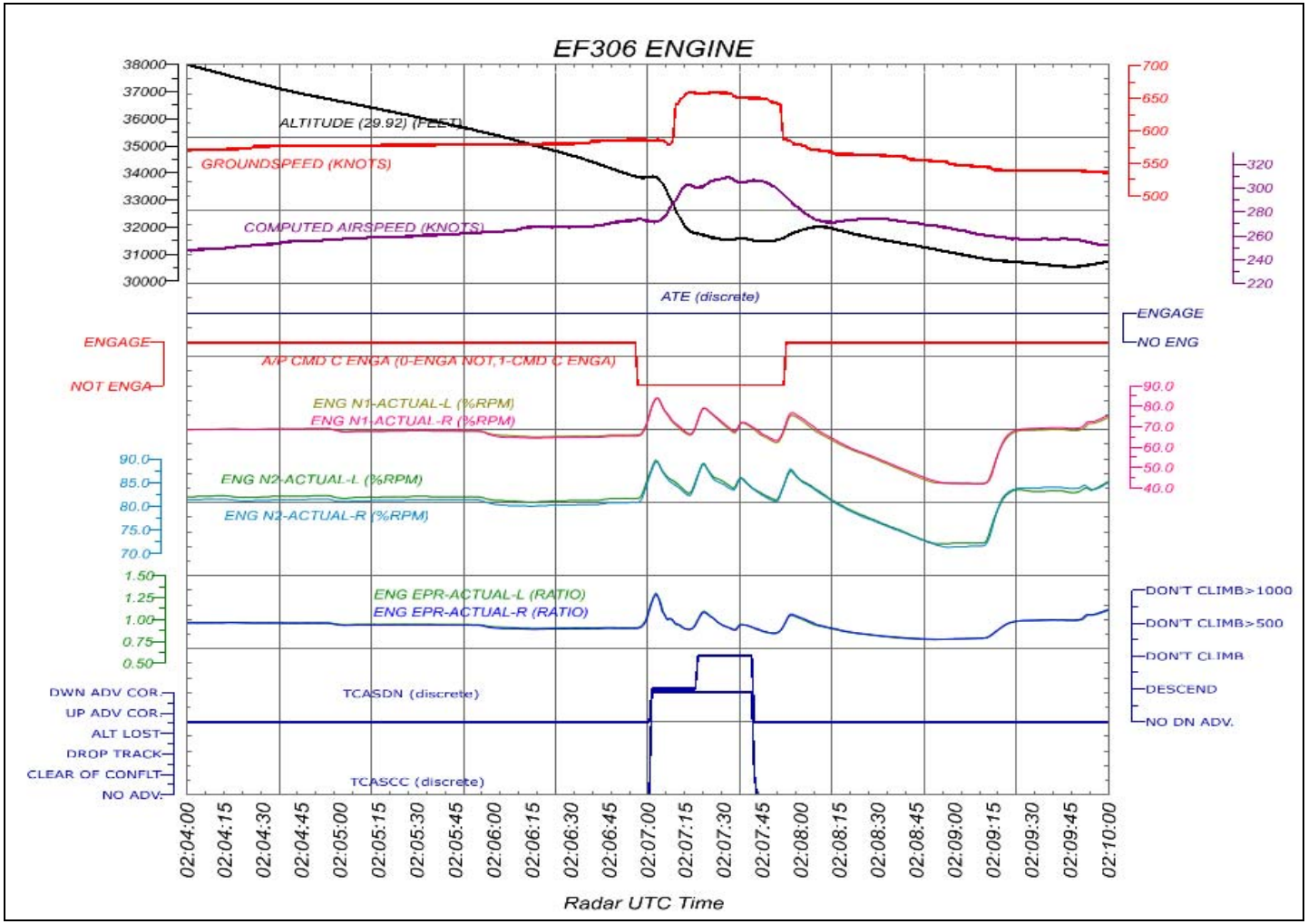

Figure A7-3 EF306 SSFDR data plot (engine related, 02:04 ~ 02:10)

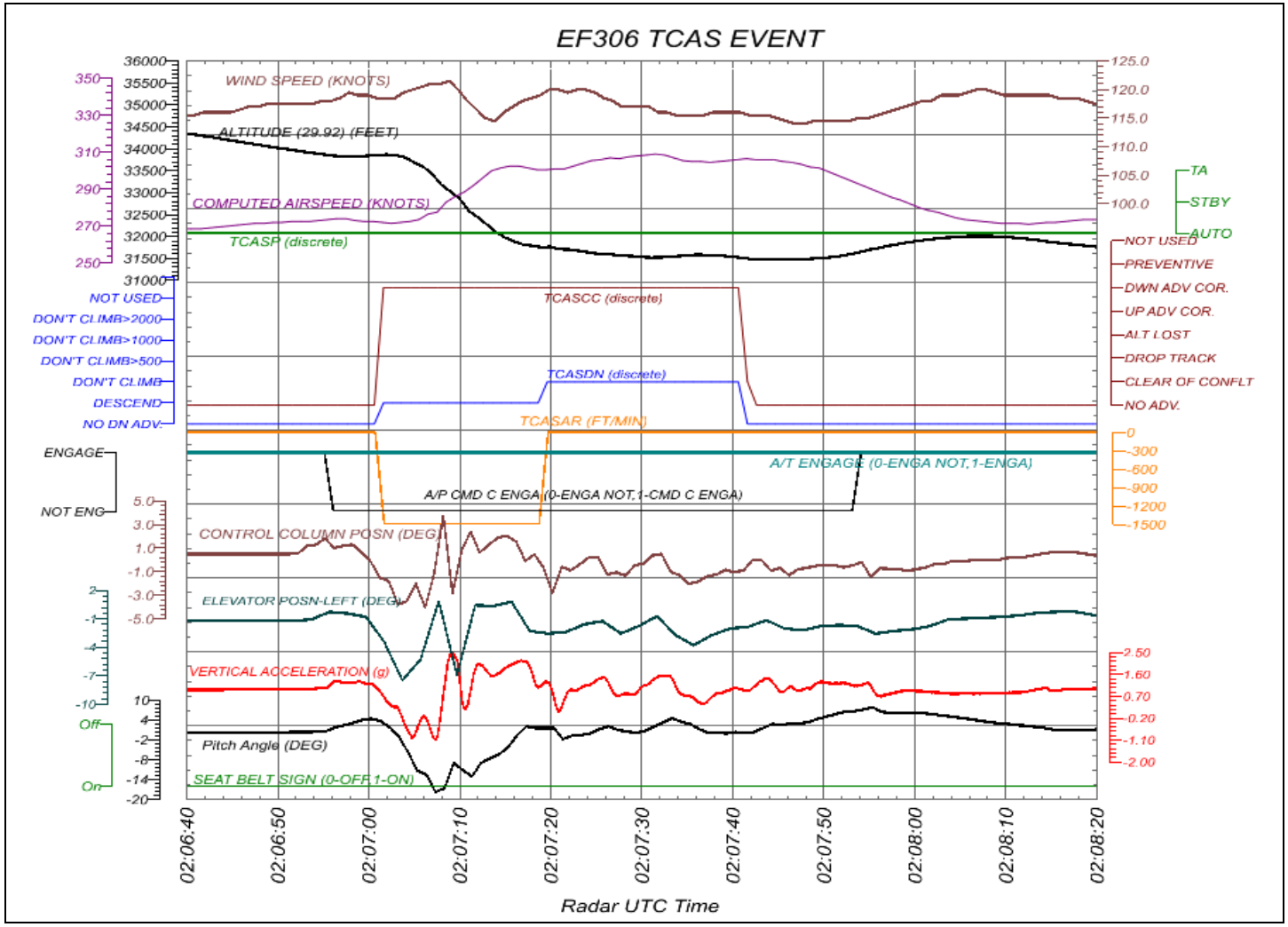

Figure A7-4 EF306 SSFDR TCAS related parameters plot (02:06:40 ~ 02:08:20)

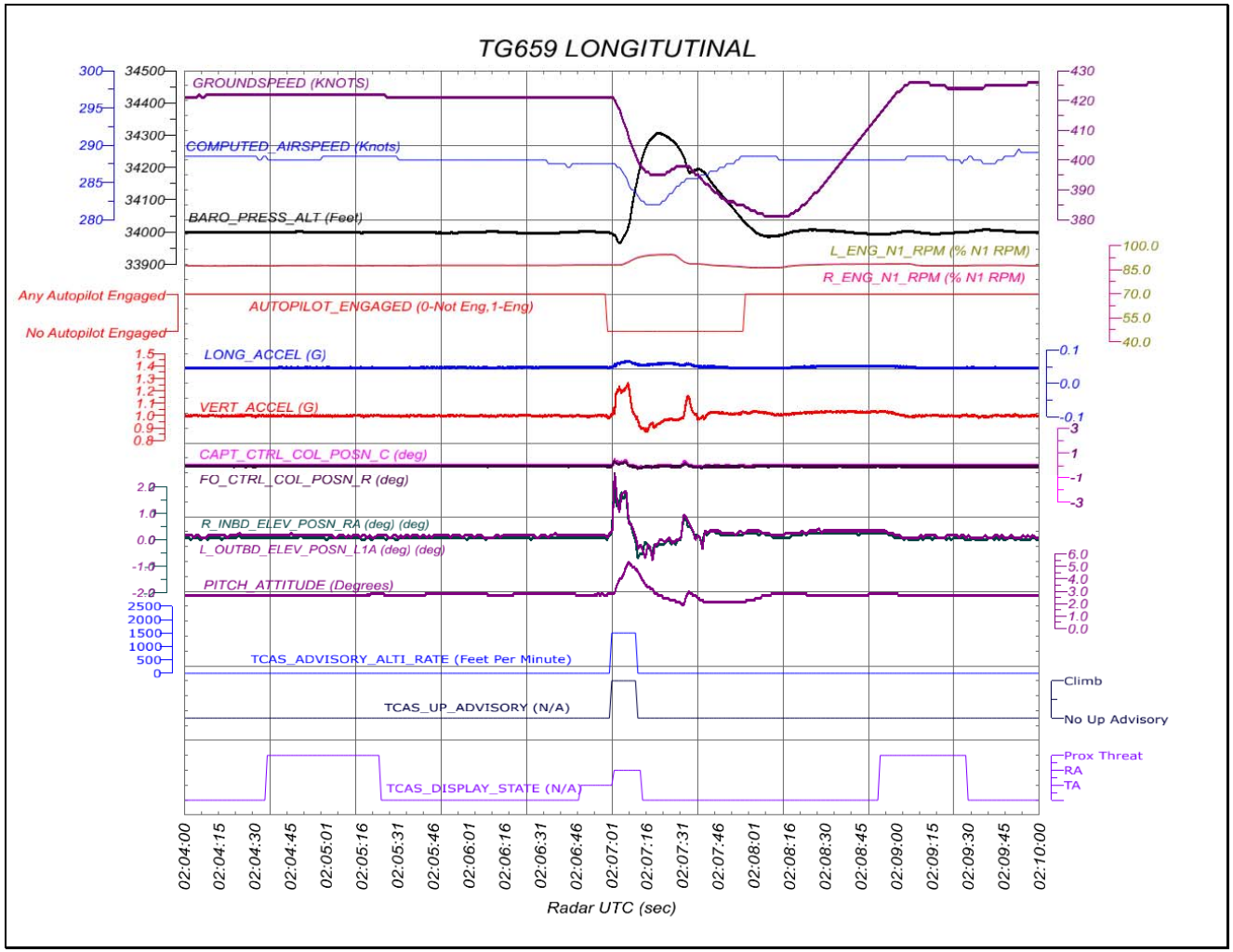

Figure A7-5 TG659 SSFDR data plot (longitude axis, 02:04 ~ 02:10)

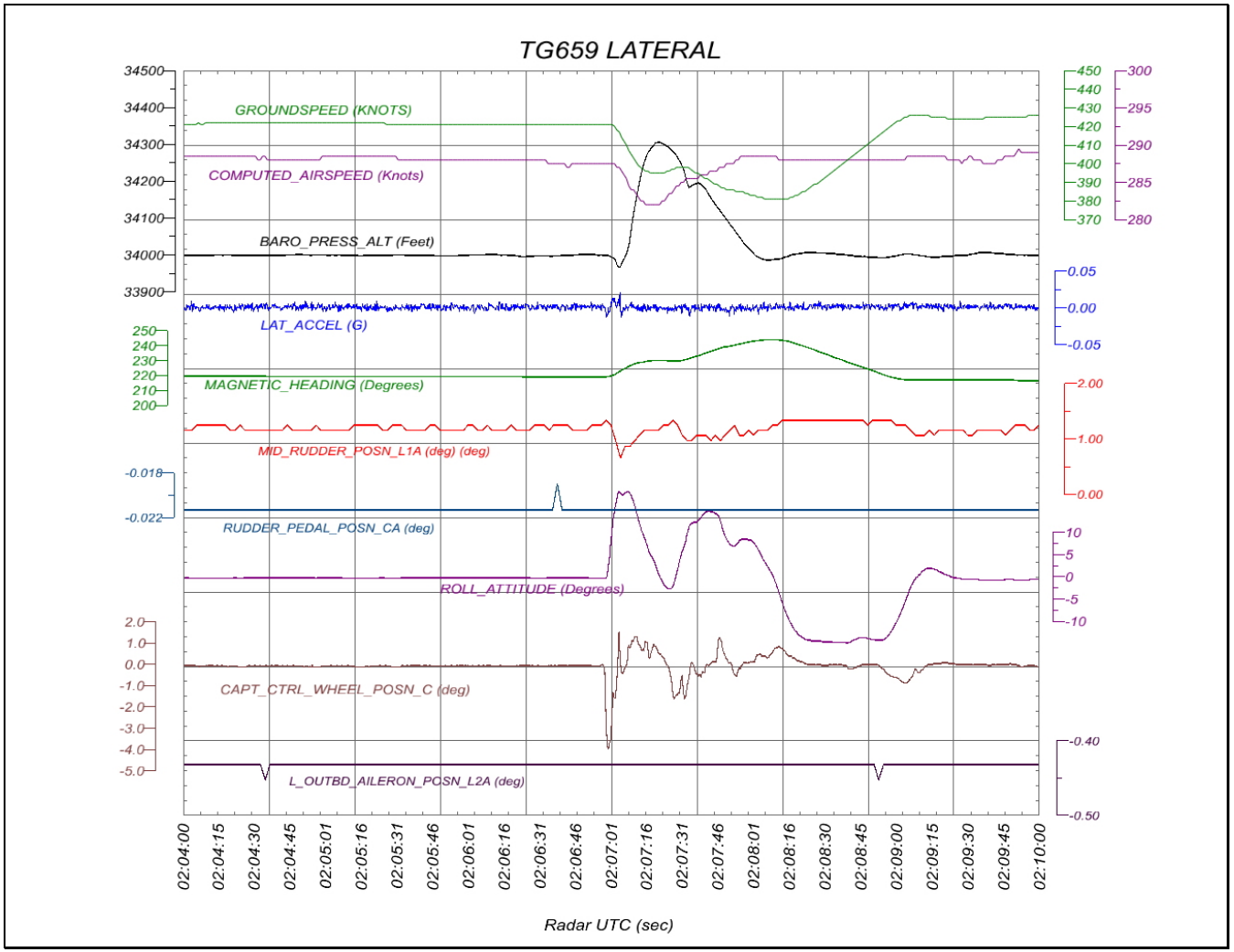

Figure A7-6 TG659 SSFDR data plot (lateral axis, 02:04 ~ 02:10)

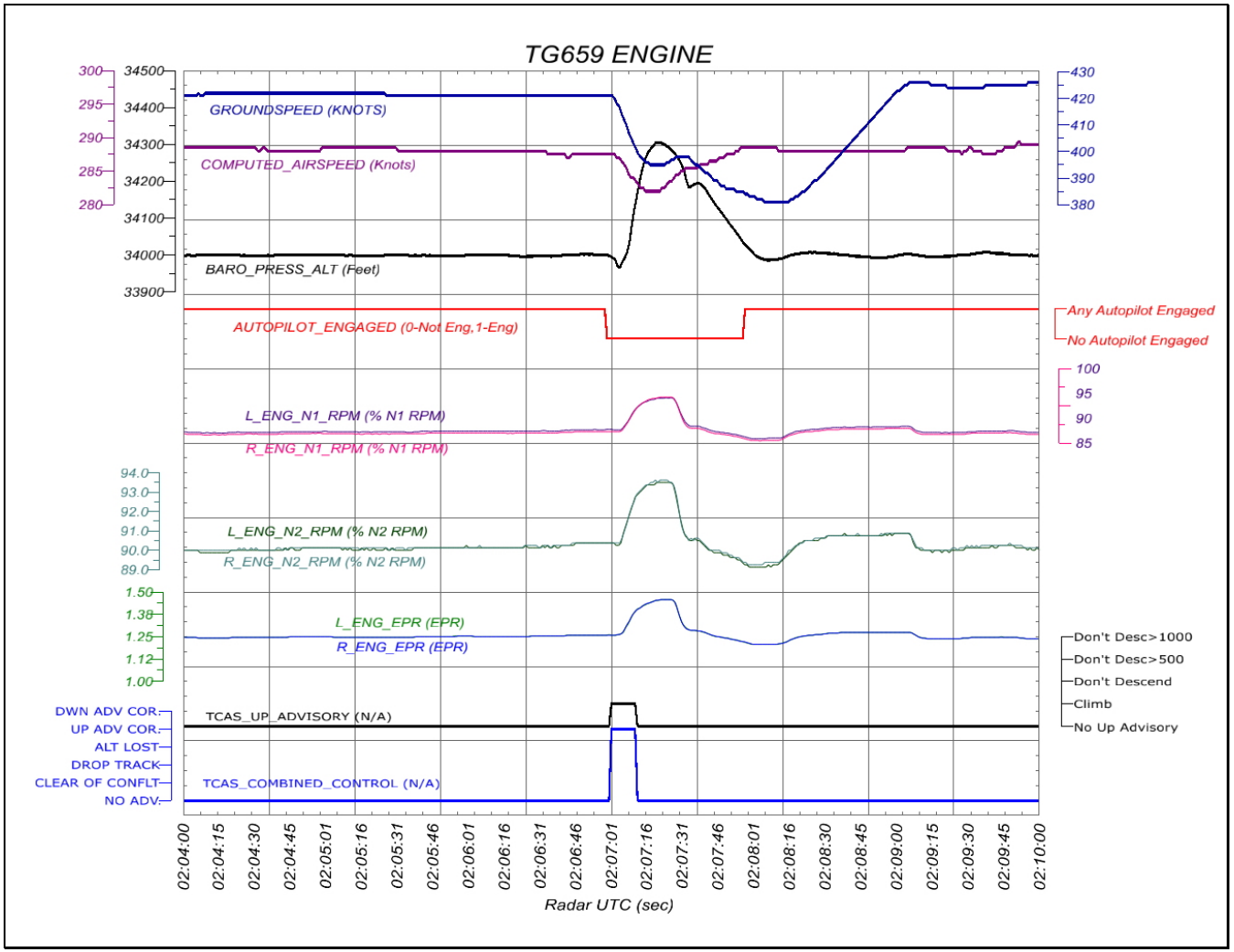

Figure A7-7 TG659 SSFDR data plot (engine related, 02:04 ~ 02:10)

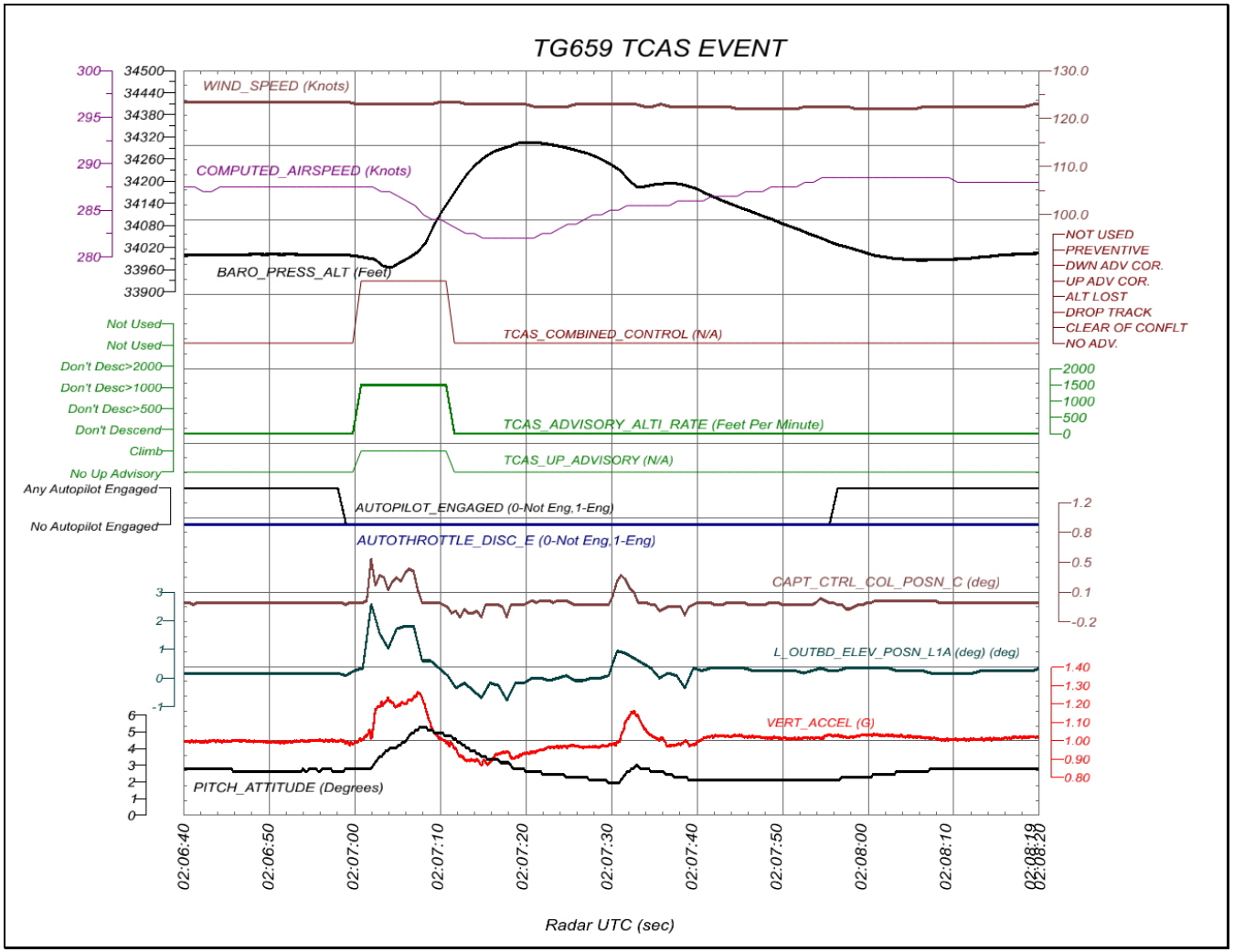

Figure A7-8 TG659 SSFDR TCAS related parameters plot (02:06:40 ~ 02:08:20)

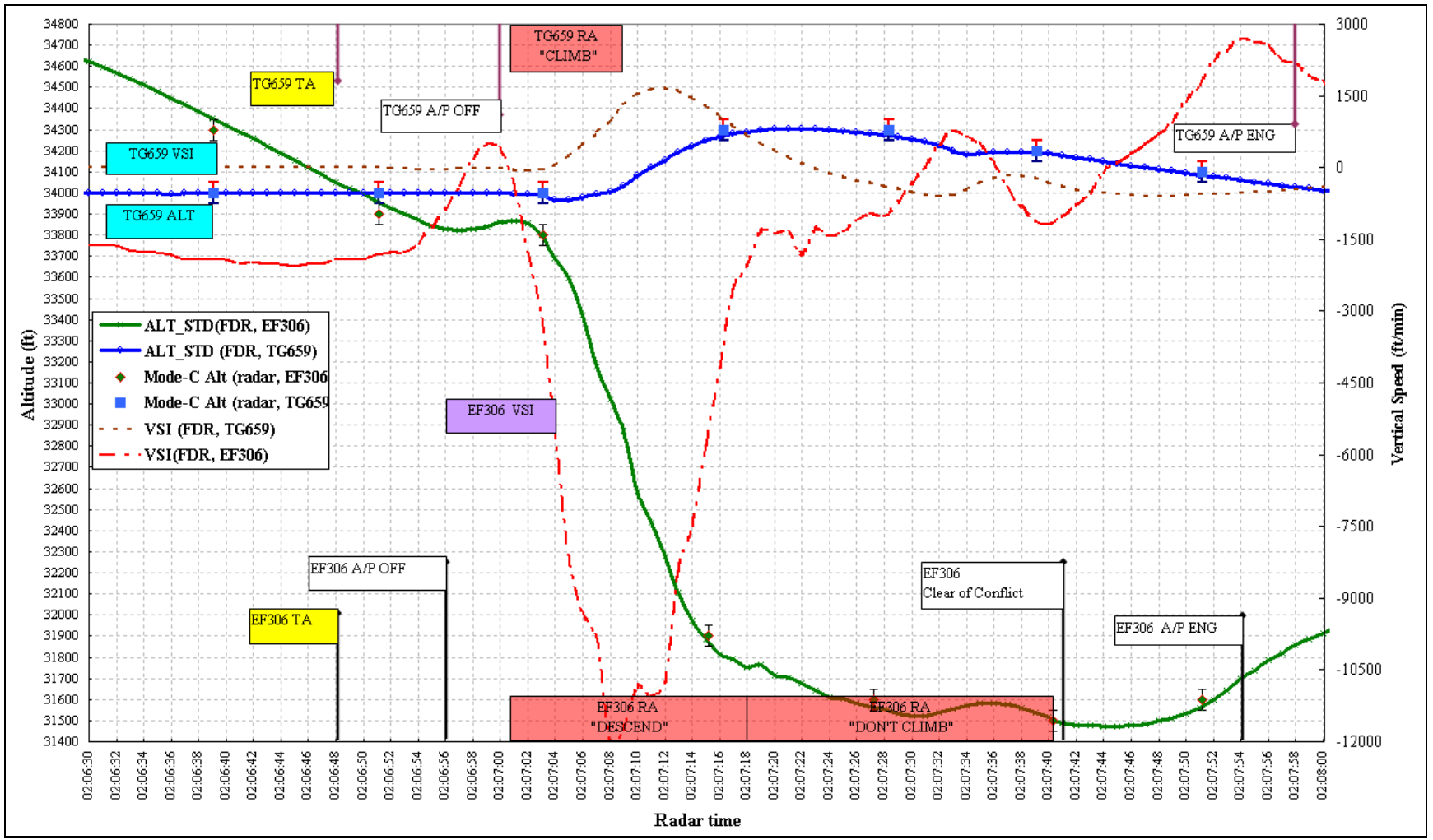

Figure A7-9 Related parameters data plot during TCAS activation (altitude, vertical speed, and autopilot)

Attachment 8　Incheon ACC Radar System Data for EF306 and TG659

Time	ACID	Current Lat/Long		Current Speed	Current Alt	Distance	Azimuth
		Latitude	Longitude				
0202:38.290	THA659	323444N	1261640E	417.92	34000		
0202:39.075	FEA306	312432N	1254651E	470.21	39000	74	200
0202:51.075	FEA306	312603N	1254739E	473.95	39000		
0202:51.481	THA659	323305N	1261436E	488.23	34000	70	199
0203:02.755	THA659	323206N	1261532E	425.39	34000		
0203:03.112	FEA306	312731N	1254813E	471.75	39000		
0203:14.752	THA659	323049N	1261454E	402.98	34000		
0203:15.169	FEA306	312902N	1254901E	476.15	39000		
0203:26.819	THA659	322926N	1261423E	400.78	34000		
0203:27.177	FEA306	313029N	1254944E	477.47	38800	62	199
0203:38.824	THA659	322809N	1261346E	403.64	34000		
0203:39.173	FEA306	313201N	1255008E	473.73	38500		
0203:51.951	THA659	322649N	1261215E	434.62	34000		
0203:56.861	FEA306	313329N	1255044E	473.73	38300		
0204:02.868	THA659	322532N	1261236E	417.48	34000		
0204:03.238	FEA306	313459N	1255112E	471.75	37900		
0204:14.871	THA659	322409N	1261210E	412.21	34000		
0204:15.279	FEA306	313626N	1255155E	470.43	37600		
0204:26.919	THA659	322252N	1261132E	412.65	34000		
0204:27.279	FEA306	313750N	1255239E	466.48	37300		
0204:38.935	THA659	322133N	1261101E	412.65	34000		
0204:39.292	FEA306	313923N	1255319E	470.87	37000		
0204:50.892	FEA306	314051N	1255400E	473.07	36800		
0204:56.567	THA659	322013N	1261033E	412.65	34000		
0205:04.085	FEA306	314220N	1255431E	469.34	36500		
0205:08.550	THA659	321855N	1261005E	412.65	34000		
0205:14.983	FEA306	314358N	1255514E	482.74	36300		
0205:16.060	THA659	321732N	1260923E	416.16	34000		
0205:26.976	THA659	321613N	1260841E	422.75	34000		
0205:26.976	FEA306	314528N	1255553E	486.04	36100	33	199
0205:39.011	FEA306	314658N	1255632E	487.79	35800		
0205:39.012	THA659	321452N	1260813E	422.31	34000	30	199
0205:51.002	FEA306	314832N	1255711E	489.99	35600		
0205:51.003	THA659	321333N	1260738E	422.53	34000	26	199
0206:03.050	FEA306	315001N	1255747E	485.60	35300		
0206:03.051	THA659	321215N	1260707E	421.00	34000	22	199
0206:15.062	FEA306	315133N	1255827E	484.50	35000		
0206:20.755	THA659	321055N	1260632E	421.00	34000		
0206:27.137	FEA306	315307N	1255904E	486.25	34700		
0206:28.232	THA659	320940N	1260444E	436.60	34000	17	196
0206:39.093	THA659	320816N	1260529E	412.65	34000		
0206:39.093	FEA306	315441N	1255941E	488.23	34300	14.42	200
0206:51.129	THA659	320653N	1260454E	414.62	34000		
0206:51.129	FEA306	315613N	1260015E	489.11	33900	11.35	200
0207:03.108	THA659	320536N	1260419E	414.40	34000		
0207:03.108	FEA306	315747N	1260058E	491.53	33800	8.3	200
0207:15.176	FEA306	315923N	1260140E	497.46	31900		
0207:16.295	THA659	320426N	1260331E	407.59	34300	5.27	197
0207:27.205	FEA306	320059N	1260223E	503.83	31600		

0207:28.298	THA659	320333N	1260052E	449.12	34300	2.86	333
0207:39.141	THA659	320210N	1260124E	420.56	34200		
0207:40.296	FEA306	320238N	1260240E	504.71	31500	1.17	246
0207:51.187	THA659	320108N	1260055E	386.06	34100		
0207:51.187	FEA306	320411N	1260351E	512.62	31600	3.93	219
0208:03.230	FEA306	320543N	1260428E	508.89	32000		
0208:03.231	THA659	320017N	1255956E	363.65	34000	6.65	215
0208:15.204	FEA306	320715N	1260505E	499.22	31800		
0208:15.205	THA659	315928N	1255840E	361.01	34000	9.49	215
0208:27.260	FEA306	320840N	1260540E	483.62	31600		
0208:33.199	THA659	315832N	1255749E	361.01	33900		
0208:39.210	FEA306	321012N	1260615E	475.71	31400		
0208:39.575	THA659	315729N	1255637E	370.90	34000	15	212
0208:51.298	FEA306	321137N	1260647E	464.94	31200		
0208:51.666	THA659	315616N	1255602E	379.91	34000	18	210
0209:03.322	FEA306	321301N	1260727E	455.49	31000		
0209:09.306	THA659	315512N	1255512E	379.91	34000		
0209:15.381	FEA306	321424N	1260755E	446.48	30800		
0209:15.739	THA659	315334N	1255455E	390.67	34000	24	208
0209:27.397	FEA306	321547N	1260826E	439.67	30700		
0209:27.742	THA659	315211N	1255436E	408.25	34000		
0209:39.384	FEA306	321711N	1260907E	439.45	30600		
0209:39.797	THA659	315058N	1255339E	420.12	34000		

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Attachment 9 Apparent size of the TG659 Viewed from the EF306 Cockpit

The apparent size[35] of an aircraft varies in the form of an exponential function during the head on approach of two aircraft on collision course. It means that the object stays in a very small size for a relatively long period of time before it "explodes" optically just few seconds prior to the collision[36]. In general, the apparent size is the width projected on the cockpit windshield for measuring its length, which is determined by the relative distance of two aircraft, closure rates, and reference dimensions (i.e. wing span). The apparent size analysis result is illustrated at Figure 2.2-1.

During the TCAS TA activation, the two aircraft' ground speeds, the relative bearing angle were 493 knots, 421 knots and 11.32 deg, respectively. At that time, the closure speed was 910 knots. So that, the apparent size and elevation angle[37] of the TG659 projected on the EF306 windshield were 0.22 cm and 0 deg, respectively.

During the TCAS RA activation, the two aircraft' ground speeds, the relative bearing angle were 493 knots, 421 knots, and 10.7 deg, respectively. At this time, the closure speed, apparent size and elevation angle of the TG659 were 910 knots, 0.30cm, and 0.14 deg, respectively.

At 02:07:19 (17 seconds prior to CPA), the two aircraft' ground speeds and the relative bearing angle were 523 knots, 395 knots, and 5.3 deg, respectively. At the same time, the closure speed, apparent size and elevation angle of the TG659 were917 knots, 0.61 cm, and 0.53 deg, respectively. Figure A10-1 indicated that from time 02:07:26 to 02:07:36 (CPA), the apparent size of the TG659 was exploded rapidly from 1 cm to about 40 cm, the relevant elevation angle was increased from 9.9 deg to 26.8 deg; the relative bearing angle was changed from -2.6 deg to -87.0 deg.

In summary, at TCAS RA activation, the closure speed of two aircraft was 910 knots, and the flightcrew of EF306 was probable to see the TG659 on it's windshield with the size of 0.3 cm. During the activation of "RA Descend", the apparent size of the TG659 expanded to 0.57 cm. Since the TCAS issued the "adjust vertical speed adjust until to 02:07:36, then the TG659 performed the climb and right-turn maneuver, so that the apparent size became larger rapidly (about 0.6 cm ~ 40 cm) and the trend moved from the center windshield to the

35 Mid-Air Collisions, 1989-1999 safety study, BEA. Incident in Air Transport, Number 3- April 2005, BEA.

36 More detail information: "Mid-Air Collisions Safety Study," http://www.bea-fr.org. FAA AC 90-48C

37 Assumptions: 1. the distance between the pilot's eye points to the windshield is 80 cm, the elevation angle is 0 deg when the pilot's horizontal view, and ignore the aircraft's pitch variation and pilot's head maneuver during the time of TCAS TA/RA activation.

upper-left hand side of windshield.

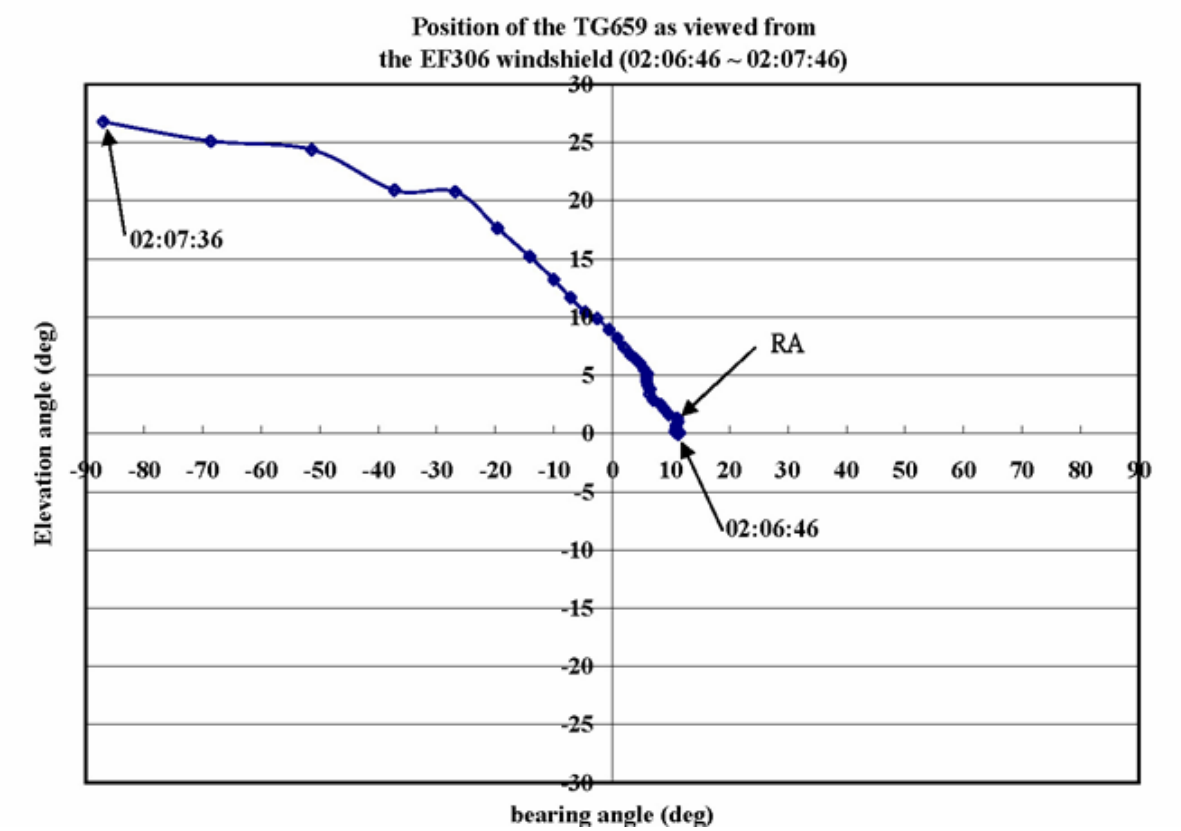


Figure A10-1 The relevant elevation angle and bearing angle of TG659 viewed from EF306 cockpit

Attachment 10 EF306 & TG659 RADAR TRACK ANALYSIS

EF306 & TG659 RADAR TRACK ANALYSIS

Time	ACID	Current Position		Current Velocity		Current Speed	Current Alt	Predicted Position		Difference (Current)		Difference (Predicted)		Predicted Alt
		X	Y	X	Y			X	Y	Alt	Dist	Alt	Dist	
02:04:03.238	EF306	-33.34	-254.00	157.76	444.51	471.75	37900	-28.1	-239.18					
02:04:14.871	TG659	-15.28	-205.00	-119.97	-394.41	412.21	34000	-19.3	-218.15					
02:04:15.279	EF306	-32.72	-252.56	161.50	441.87	470.43	37600	-27.3	-237.83	3600	50.66	900	21.27	34900
02:04:26.919	TG659	-15.81	-206.28	-121.07	-394.41	412.65	34000	-19.9	-219.43					34000
02:04:27.279	EF306	-32.09	-251.16	167.43	435.28	466.48	37300	-26.5	-236.65	3300	47.74	600	18.47	34600
02:04:38.935	TG659	-16.25	-207.59	-122.17	-394.19	412.65	34000	-20.3	-220.73					34000
02:04:50.892	EF306	-30.91	-248.16	177.76	438.35	473.07	36800	-25	-233.55	2800	43.14	-1700	13.64	32300
02:04:56.567	TG659	-16.66	-208.91	-122.17	-394.19	412.65	34000	-20.7	-222.05					34000
02:05:04.085	EF306	-30.47	-246.69	166.77	438.57	469.34	36500	-24.9	-232.07	2500	40.22	-200	10.86	33800
02:05:08.550	TG659	-17.06	-210.22	-122.17	-394.19	412.65	34000	-21.1	-223.23					34000
02:05:14.983	EF306	-29.84	-245.06	166.77	452.86	482.74	36300	-24.3	-229.96	2300	37.11	500	7.32	34500
02:05:16.060	TG659	-17.66	-211.59	-129.86	-395.29	416.16	34000	-22	-224.77					34000
02:05:26.976	EF306	-29.28	-243.56	167.65	456.15	486.04	36100	-23.7	-228.36	2100	32.57	300	2.31	34300
02:05:26.976	TG659	-18.25	-212.91	-148.75	-395.73	422.75	34000	-23.2	-226.1					34000
02:05:39.011	EF306	-28.72	-242.06	168.75	457.69	487.79	35800	-23.1	-226.8	1800	29.57	-900	0.79	33100
02:05:39.012	TG659	-18.66	-214.25	-146.78	-395.95	422.31	34000	-23.6	-227.45					34000
02:05:51.002	EF306	-28.16	-240.50	168.97	459.89	489.99	35600	-22.5	-225.17	1600	26.51	-200	3.90	33800
02:05:51.003	TG659	-19.16	-215.56	-148.10	-395.51	422.53	34000	-24.1	-228.74					34000
02:06:03.050	EF306	-27.63	-239.03	166.99	455.93	485.60	35300	-22.1	-223.83	1300	23.57	-1400	6.64	32600
02:06:03.051	TG659	-19.59	-216.87	-144.14	-395.51	421.00	34000	-24.4	-230.05					34000
02:06:15.062	EF306	-27.06	-237.50	165.01	455.49	484.50	35000	-21.6	-222.32	1000	21.94	-1700	8.24	32300
02:06:20.755	TG659	-20.09	-218.19	-144.14	-395.51	421.00	34000	-24.9	-231.37					34000
02:06:27.137	EF306	-26.53	-235.94	162.82	458.13	486.25	34700	-21.1	-220.67	700	18.88	-2000	11.36	32000
02:06:28.232	TG659	-21.63	-219.44	-194.24	-390.89	436.6	34000	-28.1	-232.47					34000
02:06:39.093	EF306	-26	-234.37	160.18	461.21	488.23	34300	-20.7	-218.99	300	14.42	-3300	15.62	30700
02:06:39.093	TG659	-21	-220.84	-115.14	-396.17	412.65	34000	-24.8	-234.05					34000
02:06:51.129	EF306	-25.5	-232.84	157.54	462.96	489.11	33900	-20.3	-217.41	-100	11.35	-3700	18.79	30300
02:06:51.129	TG659	-21.5	-222.22	-96.9	-403.2	414.62	34000	-24.7	-235.66					34000

02:07:03.108	EF306	-24.88	-231.28	163.7	463.4	491.53	33800	-19.4	-215.83	-200	8.30	-1100	21.88	32900
02:07:03.108	TG659	-22	-223.5	-103.05	-401.22	414.4	34000	-25.4	-236.87					34000
02:07:15.176	EF306	-24.28	-229.69	171.61	466.92	497.46	31900	-18.6	-214.13	-2100	6.60	-19200	23.76	14800
02:07:16.295	TG659	-22.69	-224.66	-133.81	-384.96	407.59	34300	-27.2	-237.49					37000
02:07:27.205	EF306	-23.66	-228.09	176.88	471.75	503.83	31600	-17.8	-212.37	-2700	3.52	-8100	26.82	28900
02:07:39.141	TG659	-24.5	-226.91	-238.18	-346.73	420.56	34200	-32.4	-238.47					33300
02:07:51.187	EF306	-22.41	-224.91	182.37	479.22	512.62	31600	-16.3	-208.94	-2500	3.93	-1600	33.69	31600
02:07:51.187	TG659	-24.91	-227.94	-188.09	-337.06	386.06	34100	-31.2	-239.18					33200
02:08:03.230	EF306	-21.88	-223.37	188.53	472.63	508.89	32000	-15.6	-207.62	-2000	6.65	2500	35.57	35600
02:08:03.231	TG659	-25.75	-228.78	-185.45	-312.89	363.65	34000	-31.9	-239.21					33100
02:08:15.204	EF306	-21.34	-221.84	182.81	464.5	499.22	31800	-15.3	-206.36	-2200	9.50	-4000	37.84	30000
02:08:15.205	TG659	-26.84	-229.59	-221.7	-284.99	361.01	34000	-34.2	-239.09					34000

Attachment 11 Boeing FDR Data Analysis

[redacted]
Air Safety Investigation
Commercial Airplanes

The Boeing Company
P.O. Box 3707 MC 67-PR
Seattle, WA 98124-2207

15 June 2007
66-ZB-H200-ASI -18279

[redacted]
Aviation Safety Council
Taiwan
Via e-mail: [redacted]

Subject: Boeing FDR Data Analysis- Far Eastern Air Transport 757-200 B-27015 TCAS Evasive Maneuver Event- 22 November 2006

References: a) Service Request 1-248715985, FAT 757 Passenger Injuries Due to Evasive Maneuver
b) 757 Flight Crew Operations Manual (FCOM), Document Number D632N001-200R, Section 15.20.26, Revision 12, Dated November 21, 2006
c) 757 Quick Reference Handbook (QRH), Document Number D632N001-200R, Dated November 21, 2006, QRH Maneuvers Section MAN.1.8
d) 757 Flight Crew Training Manual (FCTM), Dated October 31, 2006, Section 7- Maneuvers - TCAS

Dear Mr. [redacted]:

The subject event was reported to Boeing via reference (a) and the ASC provided the FDR data to Boeing for analysis. We have plotted and analyzed the data and have some observations to share with the investigation, see attached enclosures.

The information included with this correspondence is considered confidential investigative information for the use of the ASC, NTSB and other investigative parties in connection with their investigative activities.

If you have any questions, please contact Ms. Lori Anglin at 206-852-1476 or via e-mail at lori.m.anglin@boeing.com

Very truly yours,

[redacted]

Enclosure 1: Boeing FDR Data Analysis – Delta Airlines 757-200 NA522
Enclosure 2: Longitudinal parameters vs. time
Enclosure 3: Lateral-Directional parameters vs. time

cc: [redacted]

Boeing FDR Data Analysis- Far Eastern Air Transport 757-200 B-27015
TCAS Evasive Maneuver Event- 22 November 2006

Incident Description

In the Reference (a) Service Request, Far Eastern Air Transport reported that a 757-200, variable NT883, registration B-27015, performed an evasive maneuver in response to a TCAS advisory on November 22, 2006. During the maneuver, several passengers and crew members were injured. The Taiwan ASC is investigating the incident.

Flight Data Recorder (FDR) Data Analysis

The NTSB provided the raw binary FDR data to Boeing for review. The data was converted to engineering units and plotted for analysis. The following Boeing plots of the FDR data are attached:

Figure 1: Longitudinal parameters vs. time
Figure 2: Lateral-Directional parameters vs. time

The weight was reported to be 178500 lbs at the time of the event.

Observations from FDR Data

The FDR data are presented in two plots. Figure 1 shows the FDR longitudinal and TCAS parameters and Figure 2 shows the FDR lateral/directional parameters. Note, the FDR data only contain information related to TCAS Resolution Advisories (RA), not Traffic Advisories (TA).

The FDR data show the airplane in a 2000 ft/min descent, with the autopilot engaged, passing through an altitude of 34000 feet (time 11660 seconds). During the next 8 seconds, the autopilot was disconnected and the column was pulled to arrest the descent. This resulted in a climb of 1000 ft/min. At time 11670 seconds, a TCAS Resolution Advisory (RA) of "Descend" was provided to the crew. The TCAS Advisory Rate was to descend at 1500 ft/min. Nearly concurrent with the descend advisory, the column was pushed approximately 4 degrees. The airplane responded with the pitch attitude decreasing to -18.0 degrees and normal load factor to -1.0 g's. The descent rate (vertical speed) reached approximately 15000 ft/min, which was 13500 ft/min above the advisory descent rate. After 5 seconds of zero to -1.0 g flight, +2.5 g's were pulled to arrest the increasing descent rate. At time 11687 seconds, the TCAS Resolution Advisory of "Descend" changed to "Don't Climb". Also at this point, the airplane began to level off at an altitude of 31500 feet and the large load factors began to subside. At time 11722 seconds, the autopilot was re-engaged and the normal descent was resumed. The autothrottle remained engaged throughout the event.

Additional TCAS Information

Electronic Flight Instrumentation System (EFIS) wiring diagram data indicates that the aircraft had TCAS display option for Attitude Director Indicator (ADI) and Horizontal Situation Indicator (HIS) selected. Thus, TCAS Resolution Advisory (RA) would have been displayed on the Electronic Attitude Director Indicators (EADIs) and TCAS RA and Traffic Advisory (TA) display would have been available on the Electronic Horizontal Situation Indicators (EHSIs). Aural TCAS RA warning, 'Descend, Descend', would have accompanied the RA command display on the EADIs. The following FCOM/QRH information presents the recommended pilot response to an RA indication.

Guidance Information from the Boeing FCOM and QRH manuals

The Reference (b) 757 FCOM provides the following information with respect to TCAS Descend RA:

Voice Annunciations for ADI Guidance

Voice Annunciation	*Condition*	*Response*
DESCEND, DESCEND	*Present ADI pitch attitude is within the red RA region*	*Adjust ADI pitch attitude to remain outside the red RA region*

The Reference (c) 757 QRH Maneuvers provides the following recommended procedure with respect to TCAS Descend RA:

Traffic Avoidance
The following is accomplished immediately by recall whenever a TCAS traffic advisory (TA) or resolution advisory (RA) occurs.

WARNING: Comply with the RA if there is a conflict between the RA and air traffic control.

WARNING: Once an RA has been issued, safe separation could be compromised if current vertical speed is changed, except as necessary to comply with the RA. This is because TCAS II-to-TCAS II coordination may be in progress with the intruder aircraft, and any change in vertical speed that does not comply with the RA may negate the effectiveness of the other aircraft's compliance with the RA.

Note: If stick shaker or initial buffet occurs during the maneuver, immediately accomplish the APPROACH TO STALL RECOVERY procedure.
Note: If high speed buffet occurs during the maneuver, relax pitch force as necessary to reduce buffet, but continue the maneuver.
Note: Do not use flight director pitch commands until clear of conflict.

For TA:
Pilot Flying
- *Look for traffic using traffic display as a guide. Call out any conflicting traffic.*
- *If traffic is sighted, maneuver as required.*

For RA, except a climb in landing configuration:
Warning: A DESCEND (fly down) RA issued below 1,000 feet AGL should not be followed.
Pilot Flying
- *If maneuvering is required, disengage the autopilot and autothrottle. Smoothly adjust pitch and thrust to satisfy the RA command. Follow the planned lateral flight path unless visual contact with the conflicting traffic requires other action.*
- *Attempt to establish visual contact. Call out any conflicting traffic.*

The Reference (d) 757 FCTM provides the following recommended procedure with respect to TCAS Descend RA:

The responsibility for avoiding collisions still remains with the flight crew and ATC. Pilots should not become preoccupied with TCAS advisories and displays at the expense of basic airplane control, normal visual lookout and other crew duties.

Traffic Advisory (TA)
A Traffic Advisory (TA) occurs when nearby traffic meets system minimum separation criteria, and is indicated aurally and visually on the TCAS traffic display. A goal of the TA is to alert the pilot of the possibility of an RA. If a TA is received, immediately accomplish the Traffic

Avoidance maneuver in the QRH. Maneuvers based solely on a TA may result in reduced separation and are not recommended.

Resolution Advisory (RA)
When TCAS determines that separation from approaching traffic may not be sufficient, TCAS issues a Resolution Advisory (RA) aural warning and a pitch command. Maneuvering is required if any portion of the airplane symbol is within the red region on the attitude indicator (as installed) or if the existing vertical speed is in the red band (RA VSI) (as installed). Flight crews should follow RA commands using established procedures unless doing so would jeopardize the safe operation of the airplane or positive visual contact confirms that there is a safer course of action. If a RA is received, immediately accomplish the Traffic Avoidance maneuver in the QRH.

RA maneuvers require only small pitch attitude changes which should be accomplished smoothly and without delay. Properly executed, the RA maneuver is mild and does not require large or abrupt control movements. Remember that the passengers and flight attendants may not all be seated during this maneuver. The flight director is not affected by TCAS guidance. Therefore, when complying with an RA, flight director commands may be followed only if they result in a vertical speed that satisfies the RA command.

Conclusions
Although not confirmed by a pilot report, the FDR data suggests that the crew was aware of traffic in the area, from either a TCAS Traffic Advisory (not recorded in the FDR data) or visually, and responded to the traffic by discontinuing the normal descent and entering a shallow climb. Then the crew received a TCAS Resolution Advisory to descend at 1500 ft/min, which was opposite of their original maneuvering. The push over to comply with the resolution advisory resulted in the airplane reaching a normal load factor of approximately -1.0 g's and a descent rate of 15000 ft/min. The recovery from this rapid descent involved maneuvering that resulted in normal factors between 0 and 2.5 g's.

Boeing recommends in the Reference (c) 757 QRH, that for a TCAS Resolution Advisory that the pitch and thrust be smoothly adjusted to satisfy the RA command. Based on analysis of the FDR data only, the rapid descent maneuver performed in this event greatly exceeded the recommended procedure.

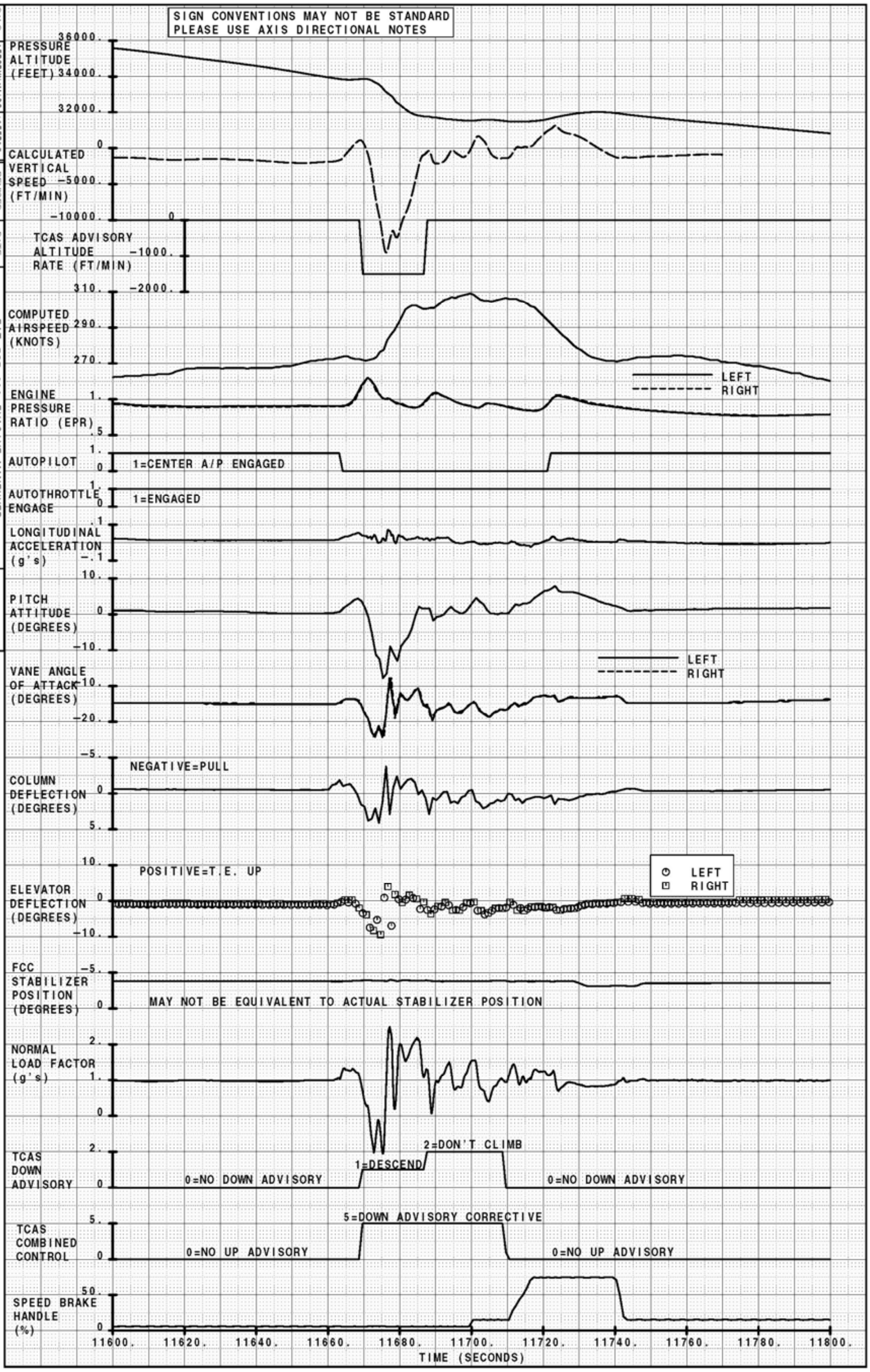
BOEING PROPRIETARY

FAT 757-200 EVASIVE MANEUVER
22NOV06 -- TIME ALIGNED DATA
LONGITUDINAL PARAMETERS

CALC	AERODYNAMICS	12FEB07
CHECK		
APPD		
APPD		
	REVISED	DATE

FIGURE 1 NT883

PAGE



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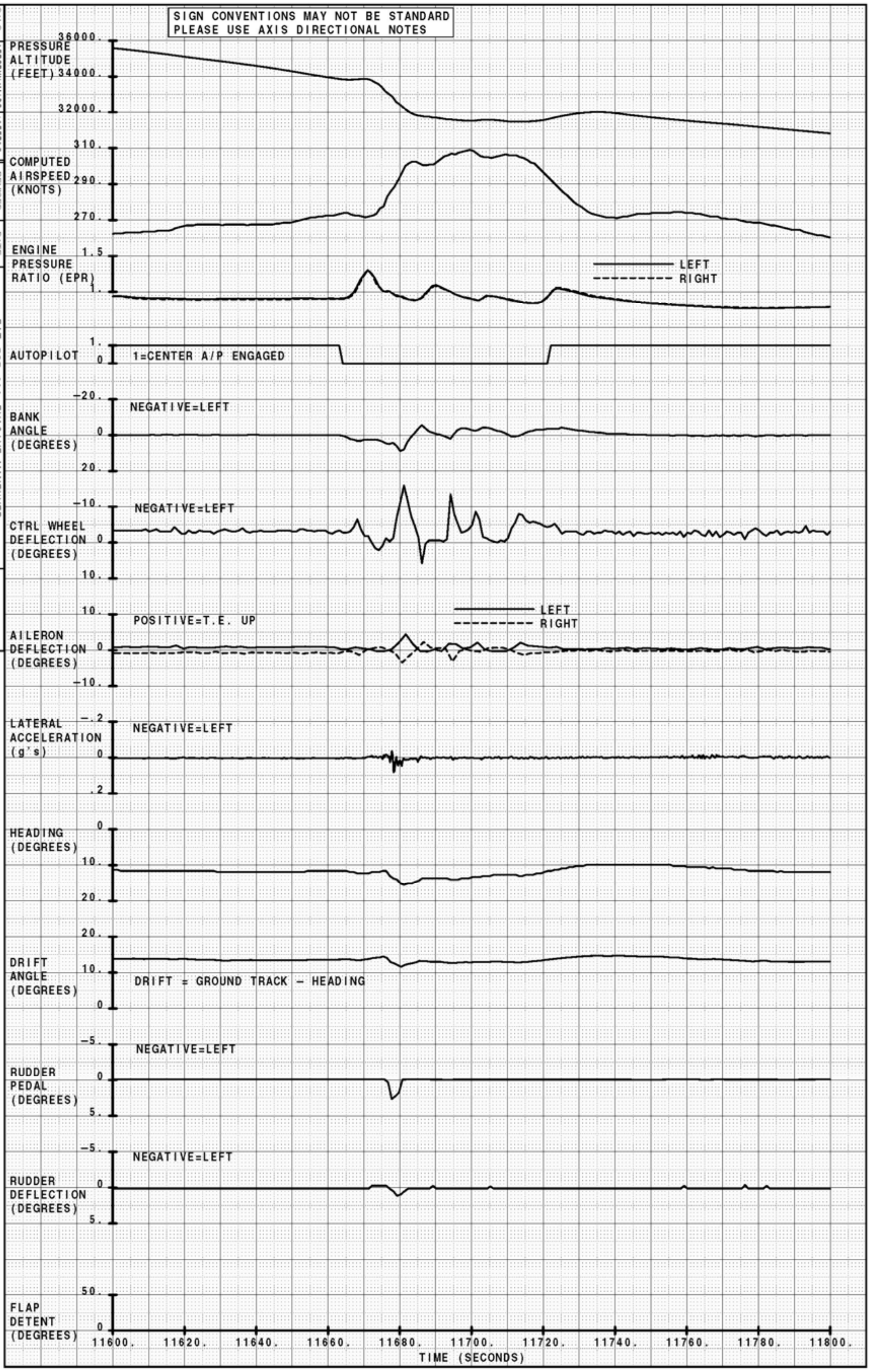

CALC	AERODYNAMICS	12FEB07
CHECK		
APPD		
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	REVISED	DATE

BOEING PROPRIETARY

FAT 757-200 EVASIVE MANEUVER
22NOV06 -- TIME ALIGNED DATA
LATERAL-DIRECTIONAL PARAMETERS

NT883

FIGURE 2

PAGE