KAIB

KAIB/AAR F0201

AIRCRAFT ACCIDENT REPORT

CONTROLLED FLIGHT INTO TERRAIN
AIR CHINA INTERNATIONAL FLIGHT 129
B767-200ER, B2552
MOUNTAIN DOTDAE, GIMHAE
APRIL 15, 2002

KOREA MINISTRY OF CONSTRUCTION AND TRANSPORTATION

KOREA AVIATION-ACCIDENT INVESTIGATION BOARD

According to Annex 13, Chapter 3, Paragraph 3.1, to the Convention on International Civil Aviation, it is stipulated;

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

And in Chapter 5, Paragraph 5.4.1 of the same Annex, it is recommended as follows;

「Any judicial or administrative proceedings to apportion blame or liability should be separate from any investigation conducted under the provisions of this Annex」

Thus, based on Annex 13 and the Aviation Act of the Republic of Korea, this accident investigation report, including findings herein, as the result of the investigation effort of Air China International Flight 129, shall not be used for any other purpose than to improve aviation safety.

If conflicts occur on the interpretation of this accident investigation report between the Korean version and English version, the Korean version takes priority over English version.

KAIB/AAR F0201
Adopted March 4, 2005

AIRCRAFT ACCIDENT REPORT

Controlled Flight Into Terrain

Air China International Flight 129

B767-200ER, B2552

Mountain Dotdae, Gimhae

April 15, 2002

Korea Aviation-accident Investigation Board
281 Gonghang-Dong
Gangseo-Gu, Seoul
Republic of Korea

AIRCRAFT ACCIDENT REPORT

Korea Aviation-accident Investigation Board. Controlled Flight Into Terrain, Air China International Flight 129, B767-200ER, B2552, Mountain Dotdae, Gimhae, April 15, 2002. Aircraft Accident Report KAIB/AAR F0201. Seoul, Republic of Korea

The Korea Aviation–accident Investigation Board is an independent government agency, established on August 12, 2002. The Board conducts accident investigations in accordance with the provisions of Annex 13 to the Convention on International Civil Aviation and the Korean Aviation Act. The objective of the Board's investigation into an accident or incident is to prevent accidents and incidents, not to apportion blame or liability. The main office is located near Gimpo International Airport, and the flight recorder analysis and wreckage laboratories are located inside the airport.

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Abbreviations

ACC	Area Control Center
ACP	Azimuth Change Pulse
AIP	Aeronautical Information Publication
AFDS	Automatic Flight Director System
ALA	Approach and Landing Accident
ALAR	Approach and Landing Accident Reduction
ALPA-K	Air Line Pilots Association of Korea
AMOS	Automatic Meteorological Observation System
AOC	Air Operating Certificate
A/P	Autopilot
ARP	Azimuth Reference Pulse
ASR	Airport Surveillance Radar
A/T	Auto Throttle
ATC	Air Traffic Control
ATIS	Automatic Terminal Information Service
BDS	BRITE Display Subsystem
BECMG	Becoming
BKN	Broken
BRITE	Bright Radar Indicator Tower Equipment
CA	Air China International
CAAC	General Administration of Civil Aviation of China
CASA	Civil Aviation Safety Authority
CAT	Category
CCAR	China Civil Aviation Rules
CDRS	Continuous Data Recording System
CFIT	Controlled Flight Into Terrain
CG	Center of Gravity
CMM	Component Maintenance Manual
CRM	Crew Resource Management
CVR	Cockpit Voice Recorder
DA	Decision Altitude
DH	Decision Height

DME	Distance Measuring Equipment
DPS	Data Processing System
EGPWC	Enhanced Ground Proximity Warning Computer
EGPWS	Enhanced Ground Proximity Warning System
ENR	En Route
ETOPS	Extended Range Operations with Two Engine Airplanes
FAF	Final Approach Fix
FCTM	Flight Crew Training Manual
F/D	Flight Director
FDAU	Flight Data Acquisition Unit
FDR	Flight Data Recorder
FPM	Feet Per Minute
GCA	Ground Controlled Approach
GEN	General
GPWC	Ground Proximity Warning Computer
GPWS	Ground Proximity Warning System
HDG	Heading
ICAO	International Civil Aviation Organization
IDG	Integrated Driven Generator
IIC	Investigator In Charge
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
KAIB	Korea Aviation-accident Investigation Board
LA	Low Altitude
LDW	Landing Weight
LLZ	Localizer
LOFT	Line Oriented Flight Training
LPC	Low Pressure Compressor
MAC	Mean Aerodynamic Chord
MCAB	Multi-purpose Cabin
MCP	Mode Control Panel
MCT	Maximum Continuous Thrust
MDA	Minimum Descent Altitude
MDH	Minimum Descent Height
MEA	Minimum Enroute Altitude
MEL	Minimum Equipment List

Mhz	Megahertz
MOCA	Minimum Obstruction Clearance Altitude
MOCT	Ministry Of Construction & Transportation
MSA	Minimum Sector Altitude
MSAW	Minimum Safe Altitude Warning
MSL	Mean Sea Level
MTI	Moving Target Indicator
NM	Nautical Mile
NOTAM	Notice To Airmen
NTSB	National Transportation Safety Board
OVC	Overcast
PF	Pilot Flying
PIC	Pilot In Command
PIREP	Pilot Report
PNF	Pilot Not Flying
PRC	People's Republic of China
PSR	Primary Surveillance Radar
RDPS	Radar Data Processing System
RMMS	Remote Maintenance Monitoring System
ROK	Republic Of Korea
RVR	Runway Visual Range
RWY	Runway
SB	Service Bulletin
S/B	Speed Brake
SCD	Specification Control Drawing
SCT	Scattered
SEL	Select
SSR	Secondary Surveillance Radar
STAR	Standard Terminal Arrival Route
TAD	Terrain Alerting and Display
TAWS	Terrain Awareness and Warning System
TERPS	Terminal Instrument Procedure
TOW	Take Off Weight
TRACON	Terminal Radar Approach Control
UTC	Universal Time Coordinated
VMC	Visual Meteorological Conditions
VOR	VHF Omni-directional Radio Range
ZFW	Zero Fuel Weight

I. Title

Aircraft Operator	: Air China International (中國國際航空公司)
Aircraft Manufacturer	: The Boeing Company
Aircraft Type	: B767-200 ER
State of Aircraft Registry	: The People's Republic of China
Registration	: B2552
State of Occurrence	: The Republic of Korea
Date and Time	: April 15, 2002, 02:21:17(UTC), 11:21:17(Korea Standard Time[1])
Place of Accident	: Near Gimhae International Airport, Busan About 4.6km north of runway 18R threshold; on Mt. Dotdae (Elevation of 204 meters) Latitude: N35° 13' 57" 73, Longitude: E128° 55' 40" 80

II. Executive Summary

On April 15, 2002, about 11:21:17, Air China flight 129, a Boeing 767-200ER, operated by Air China International (Air China hereinafter), en route from Beijing, China to Busan, Korea, crashed during a circling approach, on Mt. Dotdae located 4.6km north of runway 18R threshold at Busan/Gimhae International Airport (Gimhae airport hereinafter), at an elevation of 204 meters.[2]

The flight was a regularly scheduled international passenger service flight operating under instrument flight rules (IFR) within Korean airspace, according to the provisions of the Korean Aviation Act and Convention on International Civil Aviation. One captain, one first officer and one second officer, eight flight attendants, and 155 passengers were on board at the time of the accident.

The aircraft was completely destroyed by impact forces and a postcrash fire. Of the 166 persons on board, 37 persons including the captain and two flight attendants survived, while the remaining 129 occupants including two copilots were killed.[3]

Upon notification of the accident, the Korea Aviation-accident Investigation Board (KAIB) initiated an independent investigation, in accordance with the Korean Aviation Act. The investigation authorities of China (State of Registry and Operator) and the United States (State of Design and Manufacture) were notified of the accident and invited to assign Accredited Representatives and Advisors, in accordance with Annex 13 to the Convention on International Civil Aviation.

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[1] Unless otherwise indicated, all times herein are Korea Standard Time, based on a 24-hour clock.
[2] 669 ft above mean sea level.
[3] Includes two persons who died within 30 days due to injuries from the accident.

The on-scene investigation was conducted jointly by investigators from Korea, the United States and China, with each investigation group led by KAIB investigators, from the day of the accident until May 2, 2002. The fact-gathering phase of the investigation continued, including visits by KAIB investigators to the General Administration of Civil Aviation of China (CAAC hereinafter) and Air China. All the factual data from the investigators were assembled into factual reports prepared by the KAIB group chairmen.

The KAIB held a public hearing for two days from November 25 to 26, 2002, in Busan to verify the factual information. It was attended by the participants from the KAIB, CASA, ROK Airforce (Airforce hereinafter), CAAC, Air China, NTSB, Boeing Company, Pratt & Whitney, ALPA-K, families of the victims, and media.

The analysis of this accident included examinations of issues related to weather, the accident sequence, flight crew training and performance, human factors, instrument approach procedures, including the circling approach procedure, air traffic control (ATC) facilities and services, rescue, and management and organizational safety oversight.

As a result of the investigation, the KAIB developed findings derived from the factual information and the analysis of the flight 129 accident. There are three different categories of findings: *findings related to probable causes, findings related to risk, and other findings*.

The ***findings related to probable causes*** identify elements that have been shown to have operated in the accident, or almost certainly operated in this accident. These findings are associated with unsafe acts, unsafe conditions, or safety deficiencies associated with safety significant events that played a major role in the circumstances leading to this 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, including organizational and systemic risks, that have the potential to degrade aviation safety; however, they cannot be clearly shown to have operated in the accident. Further, some of the findings in this category identify risks that are unrelated to this 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 are often included in the ICAO format of accident reports for informational, safety awareness, education, and improvement purposes.

NOTE: Findings are a key part of this report and are published solely to identify safety deficiencies and risks for the prevention of future accidents. Any use of the findings to assign blame or liability would be a violation of international aviation law and international best practices, including those contained in Annex 13, Chapter 3, Paragraph 3.1, and Chapter 5, Paragraph 5.4.1, to the Convention on International Civil Aviation.

Findings Related to Probable Causes

1. The flight crew of flight 129 performed the circling approach, not being aware of the weather minima of wide-body aircraft (B767-200) for landing, and in the approach briefing, did not include the missed approach, etc., among the items specified in Air China's operations and training manuals.

2. The flight crew exercised poor crew resource management and lost situational awareness during the circling approach to runway 18R, which led them to fly outside of the circling approach area, delaying the base turn, contrary to the captain's intention to make a timely base turn.

3. The flight crew did not execute a missed approach when they lost sight of the runway during the circling approach to runway 18R, which led them to strike high terrain (mountain) near the airport.

4. When the first officer advised the captain to execute a missed approach about 5 seconds before impact, the captain did not react, nor did the first officer initiate the missed approach himself.

Findings Related to Risk

1. The flight crew's training for the circling approach was conducted with the simulator only for the Beijing Capital International Airport (Beijing airport hereinafter), and they had never been trained for the circling approach to Gimhae airport's runway 18R.

2. The crew resource management (CRM) training of Air China was insufficient for the three flight crew complement.

3. Air China did not perform the improving action for Service Bulletin (SB) 767-34-0067(May 31, 1989), which was issued by the Boeing Company for the reinforcement of the GPWS functions.

4. Air China provided one set of Jeppesen manuals to the flight crew, which the captain was using during the instrument approach, making it difficult for the other flight crewmembers to crosscheck the information in the manuals.

5. Instrument approach chart used by the flight crew of flight 129 did not depict the high terrain north of the airport.

6. During the circling approach, the flight crew of flight 129 did not use standard callouts defined by Air China.

7. Flight 129 was flown between 150 and 160 kt on the downwind leg, which exceeded the maximum speed of 140 kt of Gimhae airport's circling approach category "C," and the width of the downwind leg was narrower than normal, for which corrective actions were inappropriate.

8. The second officer, tasked with handling radio communications, did not reply correctly to controllers' instructions a number of times, however, the captain and first officer did not correct the second officer's inappropriate replies.

9. When the tower controllers lost visual contact with the flight 129 aircraft on the downwind and base legs, they tried to find the flight 129 aircraft visually, however, they did not use the tower BRITE, which is an aid to complement visual observations.

10. The flight crew did not reply appropriately to the local controller's question when the controller asked them the possibility of landing, because the local controller did not have the flight 129 aircraft in sight after issuing the landing clearance.

11. The approach controller felt that the flight 129 aircraft was flying on a longer pattern than normal, so he asked the local controllers via intercom, "Does it seem go around?" however, the local controllers stated that they did not hear this question.

12. The local controller asked a question to the flight crew to confirm the position of the aircraft, however, the local controller did not issue any direct warning or advice based on his own subjective awareness of the situation.

13. "The Korean Standard Air Traffic Control Procedures" and "Gimhae Base Local Procedures" did not specify radar monitoring of the aircraft on a circling approach by means of the BRITE and MSAW systems.

14. The MSAW system installed in Gimhae tower at the time of the accident was designed only with the function of visual warning, which was not consistent with the ICAO recommendation to include an aural warning also. Thus, the low altitude (LA) warning would not have been noticed in a timely manner, unless the controller monitored the BRITE closely.

15. The MSAW activation area was programmed in the vicinity north of the circling approach area of Gimhae airport, which was set to be higher than the altitude of the circling approach pattern, and the MSAW would be activated in the case of a normal base turn in close proximity to the MSAW activation area within the circling approach area due to its predictive warning function.

16. When the aircraft disappeared from radar, and radio communication was lost between the tower and the aircraft, the tower controllers did not notify the search and rescue department in a timely manner.

17. The measuring equipment of runway visual range (RVR) of Gimhae airport's runway (18R/36L) had been out of order for a considerable time period, thus it had not been operated appropriately for the purpose of category II runway-use.

Other Findings

1. The flight crew and flight attendants received training in accordance with the CAAC and Air China regulations and procedures, and they were certified and qualified for this flight.

2. The flight crew took an adequate rest before the flight.

3. There was no evidence of any medical problems that would have affected the flight crew's performance.

4. Toxicological test results of the captain were negative for alcohol and drugs.

5. Autopsies performed on the victims of the accident revealed severe burn injuries, however, it could not be determined with a certainty whether the causes of death were from the impact trauma, fire, or a combination of both.

6. Airworthiness certificate of the flight 129 aircraft was valid, and its weight and balance were within the specified limits.

7. In the preflight aircraft maintenance inspection prior to departure from Beijing airport, no defects were found in the fuselage of the aircraft, or its systems and engines. During flight, the crew did not report any malfunction, and the examination of the aircraft wreckage did not show any possible malfunction.

8. The GPWS installed on the flight 129 aircraft operated as designed, and it did not generate any warning before the ground impact, because the aircraft was configured for landing, and the terrain closure rate was insufficient to trigger the Mode 2 warning.

9. The controllers handling flight 129 were properly qualified to perform their duties.

10. The weather forecast and ATIS broadcasts available to the flight crew were accurate and up to date.

11. The south wind was strong and there were low clouds and precipitation near Gimhae airport at the time of the accident, and the mountainous area in the north was covered with cloud and fog.

12. There were no international requirements that the aircraft's approach category (ies) and/or weather minima for a circling approach should be informed officially to the air traffic control authority.

13. The pilot should determine the official or existing weather adequate for approach or landing based on the approach category and landing minima, and the controller should take actions such as issuing appropriate instructions to the aircraft to hold or proceed to another airport when reported by the pilot that the weather conditions are below the landing minima of the aircraft.

14. In accordance with Airforce regulations, it was a normal procedure for the approach controller to ask and confirm with flight 129 about its approach category in order to determine whether to issue the approach clearance, considering the weather conditions at that time.

15. When the approach controller issued flight 129 a control transfer instruction to the tower for the first time, the flight did not change to the tower frequency accordingly, of which the reason could not be confirmed. And 1 minute and 8 seconds after issuing the first control transfer instruction, the delayed initial contact with the tower was established upon receiving the second control transfer instruction, however, the landing clearance to flight 129 was issued by the tower controller at the usual position.

16. The local controller had flight 129 in sight briefly at the point passing nearly mid point on the downwind leg, and at the time of issuing the landing clearance, the flight disappeared from his sight. Thus, the local controller issued the landing clearance to the flight including the term, “Not in sight.”

17. The local controller could not be precisely aware that the aircraft was dangerously approaching mountainous terrain, as he lost visual contact with flight 129 from the time of landing clearance issuance until crash on the base turn, due to poor visibility.

18. All of the Korean, ICAO, and FAA procedures for the use of BRITE or Surveillance Radar describe that the local controller may use the BRITE optionally, as an aid augmenting “visual observation” function.

19. Circling approach is visual maneuvering, which the pilot has to confirm ground obstacles visually in the circling approach pattern, and is an extension of an instrument approach procedure which provides for visual circling of the aerodrome prior to landing.

20. The circling approach area and terrain in the vicinity were not depicted on the Gimhae radar video map. So the tower controller was in a poor environment to accurately identify the situation that an aircraft was flying outside the circling approach area and approaching dangerous obstacles, so he could issue a warning or advice by monitoring the BRITE.

21. The use of the certified BRITE was described in the Korean Standard Air Traffic Control Procedures. The certification standard of the BRITE installed in the tower at the time of the accident was not specifically described, however, the tower BRITE could be used as the technically certified BRITE, since it was certified for the completion of installation in accordance with the specifications and design drawing of the ordering authority (Seoul Regional Aviation Bureau), and was regularly maintained and inspected by qualified technicians.

22. The differences between the ICAO and Korean criteria for the flight procedure establishment of Gimhae airport were not described in the ROK AIP effective at the time of the accident.

23. The flight information material used by the flight crew of flight 129 was Jeppesen manual, and it was described in the manual that the circling approach procedure of Gimhae airport was established in accordance with the FAA criteria.

24. The procedure for the circling approach to runway 18R at Gimhae airport was a general circling approach procedure, without the prescribed circling approach track established using the ground visual references, which could cause difficulties in conducting a circling approach flight in poor visibility.

25. Gimhae airport has the instrument approach procedure only to runway 36, thus in the case of runway 18 in use, it requires more time to separate aircraft approaching runway 36 before making a circling approach to runway 18 from the aircraft departing from runway 18.

26. The visual weather observation site at Gimhae airport did not deviate from the establishment requirements of a weather observation site, but as its northern airspace was partially obscured, the weather observer had to move to the observation site located in the ramp to observe the weather, which could be considerably inconvenient.

27. At Gimhae tower operated by the Airforce, a Korea MOCT civil air traffic control coordinator was assigned to be on duty in accordance with a related mutual consent, however, the civil controller was not positioned in the tower at the time of the accident. And due to the system of non-authorization of relevant ratings for the substantial air traffic control services, the civil controller was not able to appropriately carry out the supervision of the regulatory compliance of civil aircraft pilots, and coordination with the civil aviation related organizations, which were described in the mutual consent.

28. The clock installed in the recording equipment of the automatic on-off lighting system of Gimhae airport had been running fast by 19 minutes, which no one was aware until the accident investigation.

29. Air China had not designated Gimhae airport as a "special airport," which would have required the additional preflight training and procedures for the flight crew.

30. The Korea MOCT designated Gimhae airport as a special airport in Flight Safety Regulations, however, it did not include the detailed information in consideration of the characteristics and requirements of the airport, and the required pilot qualification for this information.

31. All the in-flight public announcements of flight 129 were conducted only in English and Chinese, not in Korean for many Korean-speaking passengers, who could not understand the meaning of those announcements clearly.

32. A local resident called 119 immediately after the accident, so the rescue guard could be dispatched expeditiously.

33. Because of no regulation specified for assisting accident victims and their families of aircraft operating to Korea, there were difficulties with assisting the victims and their families.

On the basis of these findings, the KAIB developed safety recommendations to Air China, the CAAC, the Korea Civil Aviation Safety Authority, the Korea Ministry of National Defense, the Korea Airports Corporation, and the International Civil Aviation Organization.

Ⅲ. Body

1. Factual Information

1.1 History of Flight

On April 15, 2002, about 11:21:17 (02:21:17 UTC), Air China flight 129, a Boeing 767-200ER, Chinese registration B2552, operated by Air China, en route from Beijing, China to Busan, Korea, crashed on Mt. Dotdae, located 4.6 km north of runway 18R threshold at Gimhae airport, at an elevation of 204 meters Mean Sea Level (MSL). Flight 129 departed from Beijing airport, China, with one captain, two copilots, eight flight attendants and 155 passengers on board, and was conducting the circling approach to runway 18R at Gimhae airport, after it received its landing clearance.

Of the 166 persons on board, 37 persons including the captain and two flight attendants survived, while 129 occupants including two copilots were killed. The flight was a regularly scheduled international passenger service flight operating under instrument flight rules (IFR) within Korean airspace, according to the provisions of the Korean Aviation Act, China Civil Aviation Rules (CCAR hereinafter) and Convention on International Civil Aviation.

The captain stated that the flight crew reported for duty at 14:00(Beijing time[4]) on April 14, 2002. They received pertinent paperwork for flight operations in accordance with Air China regulations[5], and after routine physical examinations, were declared fit for duty. On the night prior to the flight, the captain slept at the company sleeping quarters. On April 15, 1 hour 15 minutes prior to departure from Beijing, the captain received flight paperwork from the dispatcher at the flight operations office located in the terminal building. Flight 129 departed from Beijing airport about 08:37(Beijing time), 17 minutes after the scheduled time of 08:20(Beijing time).

According to the cockpit voice recorder (CVR) transcript, the flight crew obtained automatic terminal information service (ATIS) information “Oscar”[6] at 10:49:55. However, after receiving information “Oscar” at 10:50:17, the second officer said, “I can’t hear it clearly.” At 10:50:25, the first officer[7] said, “I can’t hear it clearly at all,” and then the first officer conducted an approach briefing which included the runway in

[4] Beijing time: UTC+8.

[5] Flight Operations Manual 4.1, Preflight Preparation.

[6] 0128 UTC, Weather: Wind 230 at 6 kt, visibility 2 miles RAFG, sky condition 3/005, 6/010, 8/025, temperature 16, dew point 13, altimeter 30.00, active R/W 36L, advisory R/W 36R or 18L will be used as taxiway and parallel taxiway will be closed.

[7] The pilot who was seated on the right side.

use, type of approach, transition altitude, missed approach procedures, holding altitude, NAVAIDS (VOR, ILS) in use, and minimum sector altitude (MSA). Approach Checklist items were completed between 10:56:12 and 10:56:30.

At 10:57:25, the flight crew obtained Gimhae airport ATIS information "Papa."[8] At 11:01:02, the second officer[9] said, "I will do communicating, others keep listening, I came to Busan not too often." Thereafter, the second officer handled all the communications with ATC.

At 11:06:30, the second officer made his first contact with Gimhae approach controller, and the approach controller instructed flight 129, "Heading 190, descend to six thousand." The flight was positioned about 32 NM northwest of Gimhae radar, at an altitude of 17.000 ft MSL (MSL for the altitude of aircraft hereinafter).

At 11:06:53, the Gimhae approach controller confirmed that flight 129 received ATIS "Papa." At 11:07:01, the controller informed the crew that runway 36L was in use, and to expect a straight-in approach, which the second officer acknowledged at 11:07:07.

At 11:08:50, the controller queried flight 129 about its approach category, to which the second officer replied, "Please say again." At 11:08:57, the controller then requested the approach category again, and the first officer stated, "Approach category Charlie" at 11:09:01, but the second officer at first said "What?" and then replied to the Gimhae approach controller with "Charlie, Air China 129" at 11:09:07.

At 11:08:56, the ATIS was broadcast as "Quebec,"[10] but there was no recording of that on the CVR. At 11:09:10, the controller notified flight 129 that the runway was changed to 18R, with winds 210 at 17 kt, and to expect the circling approach to runway 18R.

At 11:09:21, after receiving the notification from the controller, the first officer announced to other crewmembers, "Circle approach runway 18 right," and the second officer replied to the controller, "Circle approach 18 right, Air China 129."

[8] 0200 UTC, Weather: Wind 220/7 2 RAFG sky condition 1/8 of the sky obscured by fog 3/005 6/010 8/025 16/13 altimeter 30.00. Advisory R/W 36R & R/W 18L will be used as taxiway and parallel taxiway will be closed.

[9] The pilot who was seated in the jump seat, handling radio communications.

[10] 02:09 UTC, Weather: Wind 210/12 2 RAFG Sky condition 1/8 of the sky obscured by fog 3/005 6/010 8/025 16/13 30.00. Active R/W 18R expect circle approach 18R. Weather minimum CAT "D" & "E" below landing minimum. Advisory R/W 36R & R/W 18L will be used as taxiway and parallel taxiway will be closed.

At 11:09:30, the controller asked whether the flight 129's approach category was "Charlie" or "Delta," and the captain replied, "Category Charlie." The second officer replied to the controller, "Charlie, Air China 129, Charlie."

From 11:10:19 until 11:12:29, the captain and first officer confirmed the landing runway to be 18R, discussed the circling (minimum descent altitude: MDA) to be 700 ft MSL for runway 18R, visual maneuvering and procedures for exiting the runway and the use of taxiways after landing, and the captain cautioned at 11:12:27, "We won't enlarge the traffic pattern, the mountain is all over that side."

At 11:13:01, the captain said, "It's raining, we didn't receive any information on rain?" and at 11:13:35, the first officer said "Flaps 1?" then the captain said "O.K, extend." Thereafter, there was a sound resembling that of flap lever being lowered. recorded on the CVR.

At 11:13:59, after the aircraft reached 6,000 ft, the approach controller instructed flight 129 to turn left to heading 160 degrees, and to descend to 2,600 ft.

At 11:14:47, the captain said, "I'll take off my sunglasses, let my sight adjust to outside, the visibility is not so good," and at 11:15:15, the approach controller instructed flight 129 to turn left heading 090. At 11:15:28, the captain said again, "It's the rainy area." At 11:15:51, the captain said, "Extend," to which the first officer replied, "Flaps 5," and then, there was a sound possibly related to that of flap lever being lowered. The captain said, "The wind is so strong."

At 11:16:33, the approach controller issued the following clearance: "Air China 129, turn left heading 030, cleared for ILS DME runway 36 left, then circle to runway 18 right, report field in sight." The second officer read back, "Turn left heading 030, cleared [unintelligible] approach 18 right, Air China 129."

At 11:16:50, the captain said, "Circle to land" and the first officer acknowledged, "Cleared for ILS approach 36 left, and then circle to land 18 right, report runway in sight." The second officer replied, "OK, OK, I understand, circle to land 18 right, turn left 030."

At 11:17:11, the first officer said, "Little more descent, position almost reached, ILS captured..." At 11:17:30, the captain said, "Do we have to maintain this altitude?" The first officer said, "Do not maintain, continue down to 700 ft."

At 11:17:40, the first officer said, "Too strong wind, gear down?" and at 11:17:42, there was a sound similar to that of landing gear being extended. At 11:17:47, the captain said, "Gear down, flaps 20?" and at 11:17:49, the first officer said, "Flaps 20." At 11:17:50, there was a click sound possibly related to that of lowering flap lever.

At 11:17:54, the controller instructed flight 129 to descend to 700 ft, to which the second officer replied, and then told the other crew members to descend to 700 ft. At this time, the aircraft altitude was at 2,208 ft, airspeed 175 kt (CAS, airspeed represents CAS hereinafter), and ground speed 222 kt.

At 11:18:29, the approach controller instructed flight 129 to report the runway in sight, and at 11:18:39, the captain stated that he had the runway in sight. At 11:18:41, the second officer then reported the runway in sight, at which time, the aircraft altitude was 952 ft, airspeed 158 kt and ground speed 187 kt.

At 11:18:44, the approach controller instructed, "Air China 129, contact tower one eighteen point one, circle west," but the second officer replied only, "Circle, circle, 18 right, Air China 129" (The frequency change instruction was not read back, and the controller did not point it out). The captain directed, "Disconnect, turn left," and at 11:18:53, the first officer said, "I have control(我來), heading select," and then disconnected the autopilot, and flew manually.

After there were several beeping sounds at 11:18:55, the aircraft descended to 700 ft at 11:18:57, and the captain said, "OK, maintain 700 ft, watching the altitude." At 11:18:58, the aircraft altitude was 672 ft, airspeed 158 kt, ground speed 182 kt, heading 347 degrees, with a left bank of 16.7 degrees.

At 11:19:08, there was a "Glide Slope" warning, and at 11:19:11, the first officer said, "Turn off the ILS." The second officer replied, "OK, I have it turned off." Then the first officer said, "OK."

At 11:19:17, the captain said, "20 seconds," and then at 11:19:33, said, "Keep watching the runway." At 11:19:34, the first officer said, "Turning." At 11:19:41, the first officer said, "Engage it again, maintain present altitude 700 ft, heading select," and at 11:19:46, reengaged the autopilot.

At 11:19:52, the approach controller instructed again, “Air China 129, contact tower, one eighteen one,” and the second officer replied, “Contact tower one two one . . . one one eight decimal one, good day, Air China 129.”

While the primary local controller and approach controller were communicating on the direct line that flight 129 had not contacted the tower, at 11:20:00, the captain asked, “Can you see abeam end of runway?” and at 11:20:01, the first officer replied, “Abeam runway end.” At that time, the primary local controller said on the emergency frequency (121.5 Mhz), “This is Gimhae tower on guard, Air China 129, if you hear me, contact one one eight point one.”

At 11:20:02, the captain said, “Timing” to measure for the commencement of turning base. At this time, according to the aircraft track calculated from the FDR data, the aircraft was positioned about abeam the threshold of runway 18R, with an airspeed of 157 kt, ground speed 177 kt and heading 011 degrees.

At 11:20:13, the first officer said, “The wind is too strong, it is very difficult to fly,” and at this time, the second officer reported on the tower frequency 118.1, “Gimhae tower, Air China 129, circle approach 18 right.”

At 11:20:15, 13 seconds elapsed from the start of the time check for turning base, the captain said, “Turning base.” At 11:20:17, the captain said, “I have control (我來飛).” At 11:20:19, the primary local controller requested, “Air China 129, report turning base.” At 11:20:22, the captain said, “Turning right,” and at 11:20:23, the second officer replied to the controller, “Wilco, Air China 129.” At 11:20:24, the first officer urged, “Turn quickly, not too late.”

At 11:20:25, the primary local controller issued the landing clearance with, “Air China 129, check wheels down, wind two one zero at one seven knots, cleared to land runway 36 left, not in sight.”

At 11:20:32, the captain said, "Flaps 30, already extended," and then the captain disconnected the autopilot, and manually started to bank right. At 11:20:33, the secondary local controller corrected and issued the landing clearance to read, "Cleared to land runway 18 right." The whole landing clearance and its correction lasted 9 seconds. At 11:20:35, the second officer replied to the tower, "Circle, [unintelligible] 18 right and QNH three thousand, Air China 129."

In the mean time, at 11:20:34, the captain said, "Reduce speed," and the first officer replied, "OK." At that time, the airspeed was 158 kt, ground speed 170 kt, heading 350 degrees, and then the airspeed began to reduce.

At 11:20:41, when the secondary local controller asked, "Air China 129, can you landing?" the second officer replied at 11:20:47, "Roger, QFE three thousand, Air China 129." At 11:20:47, the approach controller asked the tower on the intercom, "Does it seem go around?" According to the intercom records and tower controllers' testimonies, there was no reply recorded from the tower controllers, and none of them heard the transmission from the approach controller. According to the FDR data, at 11:20:44, the airspeed was 152 kt, ground speed 165 kt, heading 007 degrees, and right bank 23.6 degrees. At 11:20:51, the secondary local controller asked, "Air China 129, say again your intention," but there was no response from the flight crew.

At 11:20:54, the first officer cautioned, "Pay attention to the altitude keeping," and the captain asked, "Assist me to find the runway." At 11:20:59, the first officer said, "It's getting difficult to fly, pay attention to the altitude."

At 11:21:02, the secondary local controller queried, "Air China 129, say position now," at 11:21:05, the second officer replied, "Air China 129, on base[11]." While the second officer was responding, at 11:21:07, the first officer interposed, "Turn on final," and the second officer resumed his reply to the tower, "Turning on final[12], and QFE three thousand, Air China 129."

At 11:21:09, the captain asked, "Have the runway in sight? (看到□道了□)," but at 11:21:10, the first officer replied, "No, I cannot see out (沒有, 看不着)," followed by saying, "Must go around (必須復飛)" at 11:21:12. The captain did not respond.

11 Turning base: the third turning position.
12 Turning final: the fourth turning position.

At 11:21:15, the first officer said, “Pull up! Pull up! (拉起來!, 拉起來!)” at which time, according to the FDR data, the pitch attitude of the aircraft was increased to a positive 11.4 degrees, while engine thrust did not increase. At this time, the secondary local controller reissued the landing clearance, “Cleared to land 18 right, Air China 129.”

At 11:21:17, there was a sound of impact recorded on the CVR. The aircraft impacted the mountain located on a bearing of 354 degrees from the airport, about 4.6 km from the threshold of runway 18R, at an elevation of 204 meters MSL. The last data about the status of the aircraft recorded on the FDR showed altitude 704 ft, airspeed 125 kt, ground speed 133 kt, heading 149 degrees, right bank 26.8 degrees, and pitch angle 11.4 degrees.

Figure 1-1 (in Korean) and Figure 1-2 (in English) depict the flight track from the pertinent FDR data, with the communications of CVR and ATC tape recording transcripts, plotted on the chart, during the circling approach at Gimhae airport, until the time of accident.

The CVR transcript is contained in Appendix 1.

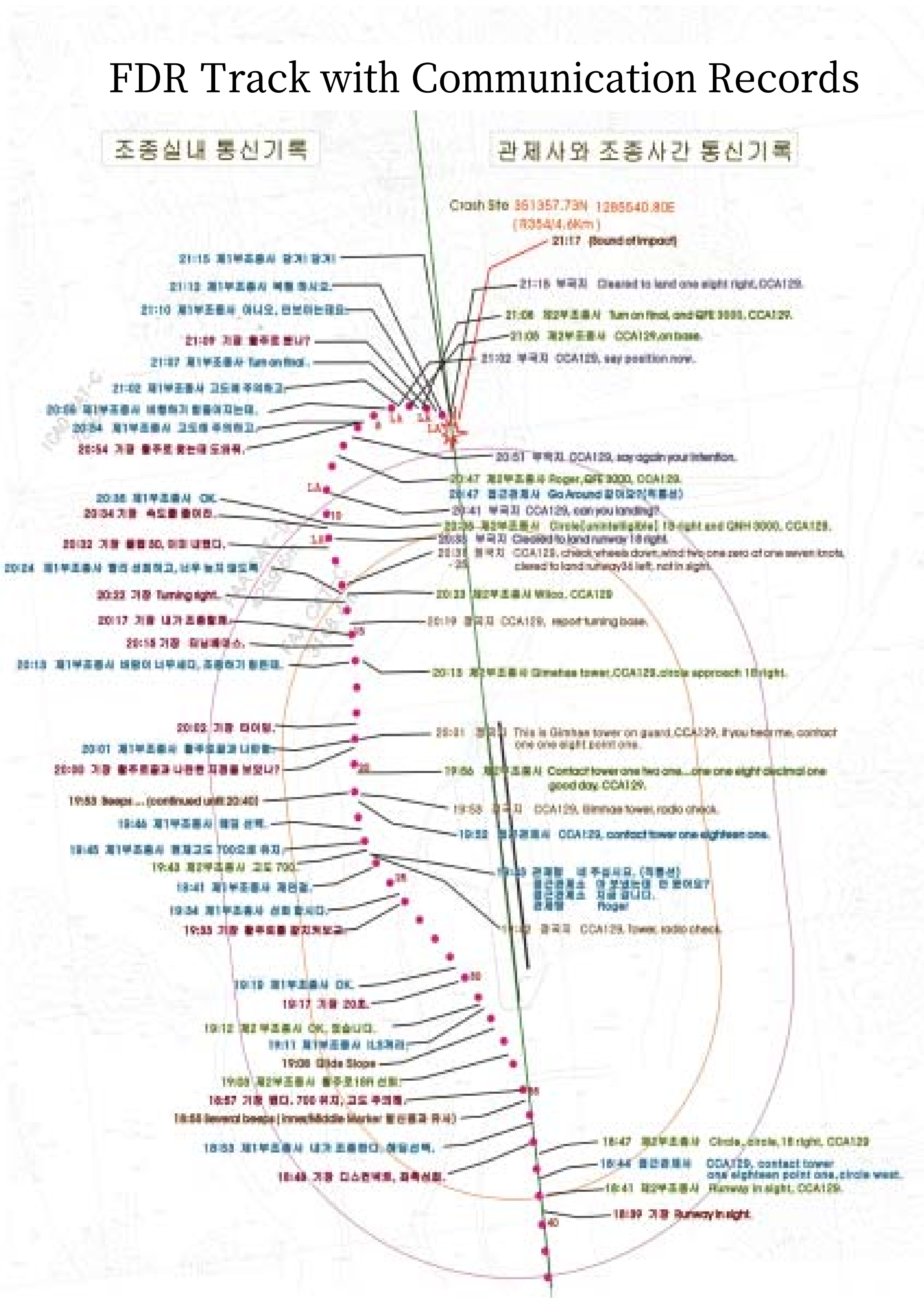

Figure 1-1 CVR & ATC Transcripts Plotted along the Flight Track from the FDR Data (Korean Version)

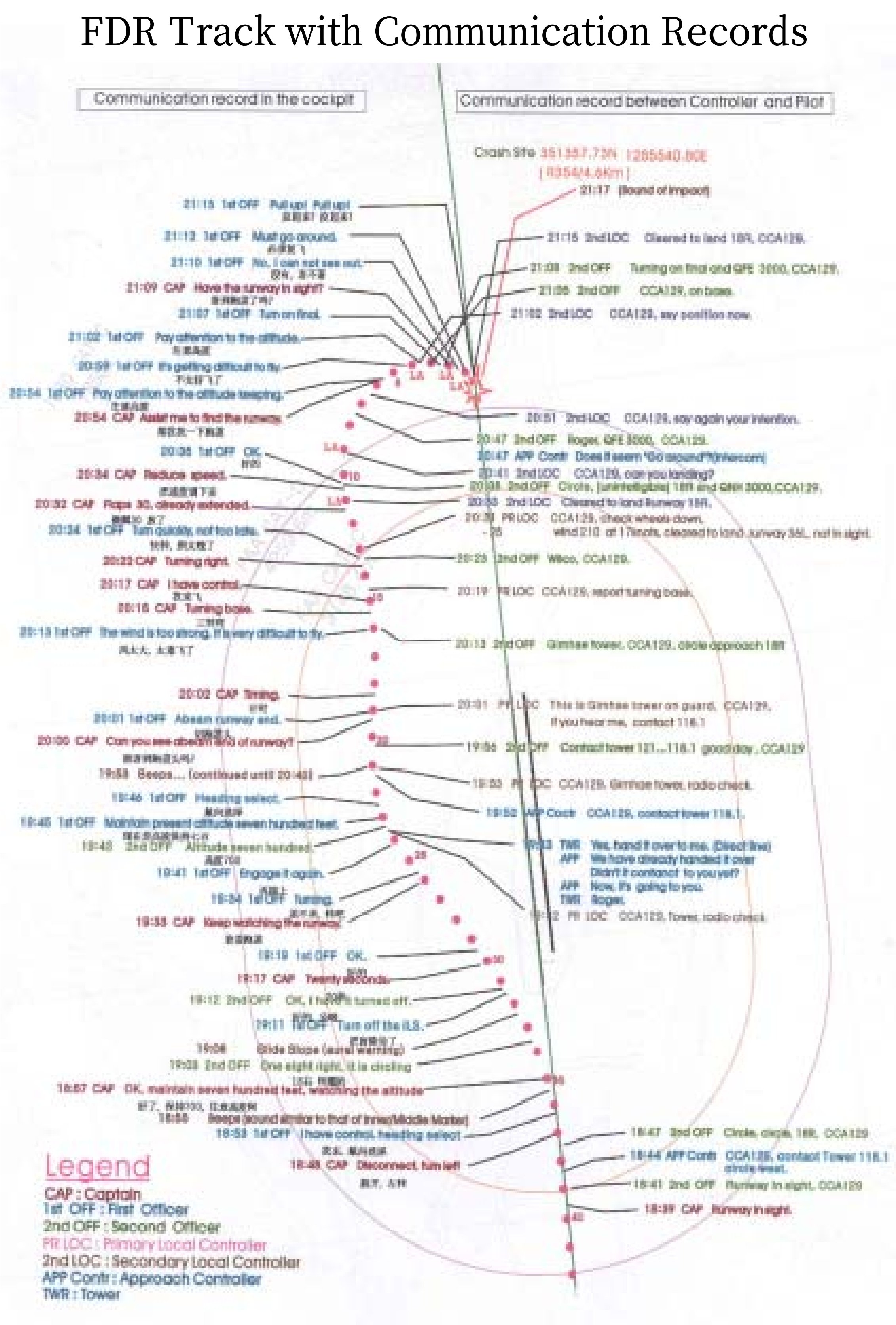

Figure 1-2 CVR & ATC Transcripts Plotted along the Flight Track from the FDR Data (English and Chinese Version)

1.2 Injuries to Persons

Injuries	Flight Crew	Cabin Crew	Passengers	Other	Total
Fatal	2	6	121	0	129
Serious	1	2	34	0	37
Minor	0	0	0	0	0
No Injury	0	0	0	0	0
Total	3	8	155	0	166

1.3 Damage to Aircraft

The aircraft was completely destroyed by impact forces and a postcrash fire. The value of the airframe was estimated to be US $11,740,000.[13]

1.4 Other Damage

Damage to the forest on Mt. Dotdae of some 8,000 m^2, including 12 grave sites, was caused by the aircraft's impact with trees and the ground, along with the spread of the wreckage.[14]

Figure 1-3 Site of Forest Damage

[13] Airliner Price Guide, Winter 2002-2003, Chapter 12-3, Used Retail Price for AVG A/C.
[14] Assessment by the construction department of Gimhae City Hall.

1.5 Personnel Information

1.5.1 The Captain

The captain[15] entered the Civil Aviation Flying University of China in September 1990, graduating in July 1994 to join Air China. He held an Airline Transport Pilot License[16] issued by the CAAC, in accordance with the CCAR, with Ratification of Certification[17] for the B767 aircraft type, and First Class Airman Medical Certificate.[18]

In September 2001, he completed captain upgrade training in Air China training center, and qualification checks with Air China and the CAAC, respectively. He became a captain upon Ratification of Certification for Command issued by the CAAC on November 26, 2001, and thereafter, flew as a captain.

According to Air China's records, the captain had accumulated a total of 6,497 hrs 23 min of flight time, 6,287 hrs 23 min of which were in the B767, with 289 hrs 30 min as a captain. He completed recurrent training[19] from March 8 to 10, 2002.

In accordance with Air China regulations, the captain held a Flight Crew English Certificate[20], and passed the Simulated Air to Ground English Communication Test and Flight Specialty English Test. The captain was originally scheduled for a flight from Beijing to Moscow on April 12, 2002, but a week prior, he arranged for a schedule change to the accident flight of April 15, 2002, in order to take an English test[21] on April 14.

He had flown roundtrip from Beijing to Narita on April 10, 2002 for a total of 7 hrs 40 min, and there were no flights from April 11 to 14, 2002.

At 14:00, April 14, 2002, the captain passed the routine physical examination

[15] Age: 30 (born in Dec 1971)
[16] Certificate No: AP 196783, date of issue: Aug 21, 1997.
[17] Checkride date: Nov 2001, valid until May 2002, A/C type: B767
[18] Medical certificate No: 1-GJ-A0552, date of issue: Nov 26, 2001, valid until Nov 23, 2002.
[19] Certificate No: 06R-059, date of issue: Mar 19, 2002, valid until Sep 10, 2002, A/C type: B767-300.
[20] Certificate No: AP 196783, date of issue: Dec 27, 1999, Nov 15, 2000.
[21] National Airman English Test Level II.

conducted by the internal aeromedical unit, in accordance with company regulations,[22]and then slept in the company-provided sleeping quarters, prior to his flight duty on the day of the accident.

1.5.2 The First Officer

The first officer[23] entered the Airforce Academy in August 1989, graduating in September 1993 to join Air China. He held an Airline Transport Pilot License[24] issued by the CAAC, in accordance with the CCAR, with Ratification of Certification[25] for the B767 aircraft type, and First Class Airman Medical Certificate[26].

In January 2002, he completed upgrade training in Air China Training Center, and qualification checks with Air China and the CAAC, respectively. That same month, he was issued the CAAC Ratification of Certification for first officer, and completed his first flight as a first officer on the B767-200 on February 23, 2002. The accident flight was his third flight as a first officer[27]. Prior to becoming a first officer, he had flown twice into Gimhae airport.

According to Air China's records, the first officer had accumulated a total of 5,295 hrs of flight time, 1,215 hrs 14 min of which were in the Boeing 767. He received recurrent training[28] on December 12, 2001. In accordance with Air China regulations, the first officer held a Flight Crew English Certificate, passed the Simulated Air to Ground English Communication Test and Flight Specialty English Test[29].

He had flown roundtrip from Beijing to Phuket, Thailand, on April 11, 2002 for a total of 11 hrs 40 min. There were no flights from April 12 to 14, 2002.

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[22] Flight Operations Manual 4.1 Preflight Preparation.
[23] Age: 29 (born in Jan 1972)
[24] Certificate No: AP 196699, date of issue: Jun 25, 1997.
[25] Checkride date: Dec 12, 2001,valid until Jul 2, 2002, A/C type: B767.
[26] Medical certificate No: 1-GJ-A0499, date of issue: Nov 13, 2001,valid until Nov 22, 2002.
[27] A total of 23 flights in 2002.
[28] Certificate No: 06R-059, date of issue: Jan 2, 2002, valid until Jul 1, 2002, A/C type: B767-300.
[29] Certificate No: AP 196699, date of issue: Apr 28, 2000, Aug 3, 2000.

At 14:00, April 14, 2002, he passed the routine physical examination conducted by the internal aeromedical unit, in accordance with company regulations.

1.5.3 The Second Officer

The second officer[30] attended the Civil Aviation Flying University of China from September 1993 to June 1997, and was hired by Air China in August 1997. He held a Commercial Pilot License[31] issued by the CAAC in accordance with CCAR, with Ratification of Certification[32] for the Boeing 767 type, and First Class Airman Medical Certificate.[33]

He completed his first copilot transition training and check, at the company level, on November 27, 2000, completing the second check on December 11, 2000, and periodic proficiency checks from June 25 to 27, 2001.The second officer had no flight experience into Gimhae airport in 2002[34].

According to Air China's records, the second officer had accumulated a total of 1,775 hrs 5 min of flight time, 1,078 hrs 55 min of which were in the B767. He received recurrent training[35] from June 25 to 27, 2001. In accordance with Air China regulations, the second officer held a Flight Crew English Certificate, and passed the Simulated Air to Ground English Communication Test and Flight Specialty English Test[36].

The second officer had flown roundtrip from Beijing to Singapore for a total of 13 hrs 15 min from April 12 to 13, 2002. He had no flight on April 14, 2002.

At 14:00, April 14, 2002, he passed the routine physical examination conducted by the internal medial unit, in accordance with company regulations.

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[30] Age: 27 (born in Jun, 1974)
[31] Certificate No: CP 198026, date of issue: Feb 5, 1998.
[32] Checkride date: Nov 1, 2001, valid until Dec 4, 2002, A/C type: B767.
[33] Medical certificate No: 1-GJ-A0693, date of issue: Aug 29, 2001, valid until Aug 29, 2002.
[34] Information based on year 2002 data provided by Air China.
[35] Certificate No: 06R-059, date of issue: Mar 19, 2002, valid until Sep10, 2002, A/C type: B767-300.
[36] Certificate No: CP 198026, date of issue: Aug 4, 2000, Nov 16, 2000.

1.5.4 The Flight Attendants

A total of 8 flight attendants, all of whose nationality was the PRC, were on board. All of them were qualified for their duties, holding the cabin attendant license issued by the CAAC.

The chief purser (female, age 41) joined the company on January 1, 1979, and completed her initial training on February 28, 1979. Her last recurrent training was on June 11, 2001. One purser (male, age 35) was hired on November 1, 1985, completed initial training on December 23, 1985, and his last recurrent training was on July 31, 2001.

The other flight attendant (female, age 41) was hired on December 20, 1978, completed initial training on February 28, 1979, and her last recurrent training was on August 13, 2001. The remaining 5 flight attendants' (1 male / 4 females, ages 23~30) dates of hire ranged from July1, 1993 to February 1, 1998. All had completed their initial training, and the dates of their most recent recurrent training ranged from June 12, 2001 to April 1, 2002.

1.5.5 The Air Traffic Controllers

1.5.5.1 Gimhae Approach Control

The approach controller (age 31) obtained the air traffic controller certificate on November 16, 1993, from the Chief of Staff, Airforce, upon his completion of the initial level course at Communication and Electronics School, Airforce Education and Training Command. He did not obtain the air traffic controller certificate issued by the Minister of Construction and Transportation, R.O.K., however, according to the Korean Aviation Act, Article 27, Para 3, the military servicemen who are engaged in air traffic control services for civil aircraft at military control facilities used by civil aircraft can provide for air traffic control services without the certificate issued by the Minister of Construction and Transportation, ROK.

He was assigned to Gimhae approach control on March 21, 1995, and then obtained further credentials[37] necessary to work as an approach controller. He was the Airforce duty chief at the time of the accident. Prior to Gimhae, he worked as an enroute controller at Daegu Area Control Center (presently, Incheon Area Control Center) from November 19,1993 until March 21,1995.

[37] Flight Information, Non-radar Approach Control, Radar Approach Control.

1.5.5.2 Gimhae Tower

The primary local controller (age 22) in charge of aerodrome control at the time of the accident, obtained the air traffic controller certificate upon his completion of the initial level course at the Communication and Electronics School[38], Airforce Education and Training Command on June 2, 2000. He did not obtain the air traffic controller certificate issued by the Minister of Construction and Transportation, ROK., however, as stated above in 1.5.5.1, according to the Korean Aviation Act, Article 27, Para 3, he could provide for aerodrome control services to civil aircraft. He worked at Gimhae tower since June 3, 2000, and obtained the necessary credentials[39] while working at the tower, and at the time of the accident, he was working at the primary local control position.

The secondary local controller (age 25) obtained the air traffic controller certificate upon his completion of the initial level course at Communication and Electronics School, Airforce Education and Training Command on March 28, 1997. He worked at Gimhae tower since February 1, 1998, and obtained the necessary credentials while working there. The secondary local controller was the duty chief at the time of the accident, working at the secondary local control position. Prior to being assigned to the tower, he worked as a radar controller with the approach control from April 7, 1997 until Jan 31, 1998. He also held an air traffic controller certificate issued by the Minister of Construction and Transportation, ROK in accordance with the Aviation Act, Article 26, on September 27, 2000.

1.5.6 Gimhae Airport Weather Observer

The weather observer on duty on the day of accident held a weather service qualification[40], and obtained a national technical certificate[41] issued by the Human Resources Development Service of Korea.

1.6 Aircraft Information

The flight 129 aircraft[42] was a B767-200ER built in 1985 by the Boeing company, and was introduced and commenced its operation by Air China[43] on October 25, 1985.

The maintenance of Air China's airframe, engines and components were being performed through the contracted[44] maintenance with AMECO.[45]

[38] MOCT designated & approved air traffic controller course.
[39] Flight Information, Aerodrome Control.
[40] Issued by the chief of the 73rd weather group, Airforce (Mar 16,1999), serial No: 94-35.
[41] First class weather engineer, issued on Oct 14,1991.
[42] Serial No: 23308.
[43] As of Apr 16, 2002, possessed 9 B767aircraft in total: 4 B767-200s, 5 B767-300s.
[44] Service agreement for airframe, engines, components between AIR CHINA and AMECO.
[45] AMECO: Aircraft Maintenance & Engineering Corporation, Beijing.

Airworthiness of the flight 129 aircraft was certified by the CAAC through the Authorized Release Certificate/Airworthiness Approval Tag.[46] Airworthiness certificate, nationality registration certificate and radio station license of aircraft were all valid, and the last scheduled inspection[47] of the aircraft was made on March 7, 2002.

Scheduled inspection of the airframe was performed according to the Air China B767 Maintenance Schedule.[48] The Process Manual[49] was comprehensive and covered general procedures, quality assurance, airworthiness approval, general maintenance regulations, process management policy and procedures, maintenance planning management, records management, parts management, and technical training guides, etc.

By April 13, 2002, the total airframe time was 40,409 hrs, of which 16,729 hrs were since overhaul, with a total of 13,844 cycles, of which 6,407 cycles were since overhaul.

The flight 129 aircraft was equipped with Two Pratt & Whitney JT9D-7R4E engines.[50] The left engine was installed on September 23, 2000, and its total time was 29,151 hrs, of which 4,676 hrs were since overhaul.[51]

The right engine was installed on October 24, 2001, and its total time was 31,026 hrs, of which 1,858 hrs were since overhaul[52].

1.6.1 Aircraft Maintenance Discrepancies

During the preflight check performed in Beijing on the day of the accident, no defects were found in the airframe, engines, or any of the systems, and there were no maintenance deferred items in the maintenance records.

The FDR and CVR data showed the normal operation of the landing gear and flaps, and the captain also stated that during flight, all aircraft systems operated normally and were in good technical condition.

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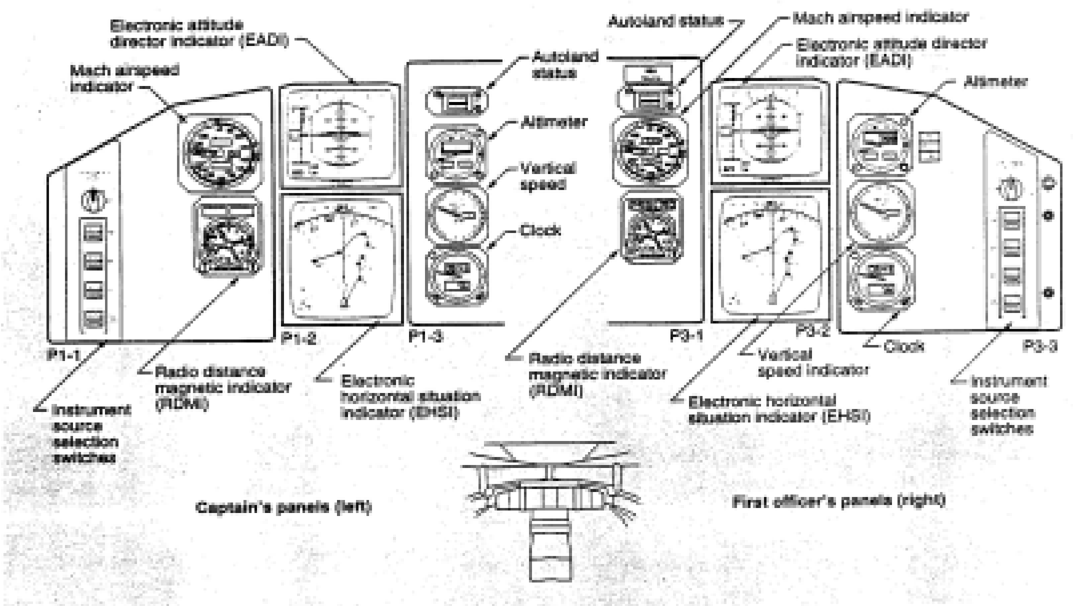
[46] Approval tag AAC-038, issued by the CAAC as a certificate of airworthiness.
[47] The 3A Check (Aircraft log book, Maintenance check record 3-1).
[48] Air China B767 Maintenance Schedule, document No: CCA EMF-MS-03 (revision No 23, Dec 2001).
[49] As amended, Nov 12, 2001.
[50] Serial No, L/H: P716912, R/H: P716929.
[51] Overhauled by the engine manufacturer, Pratt & Whitney, Dec 15,1998.
[52] Overhauled by the Eagle Services Asia (located in Singapore), Sep 24, 1998.

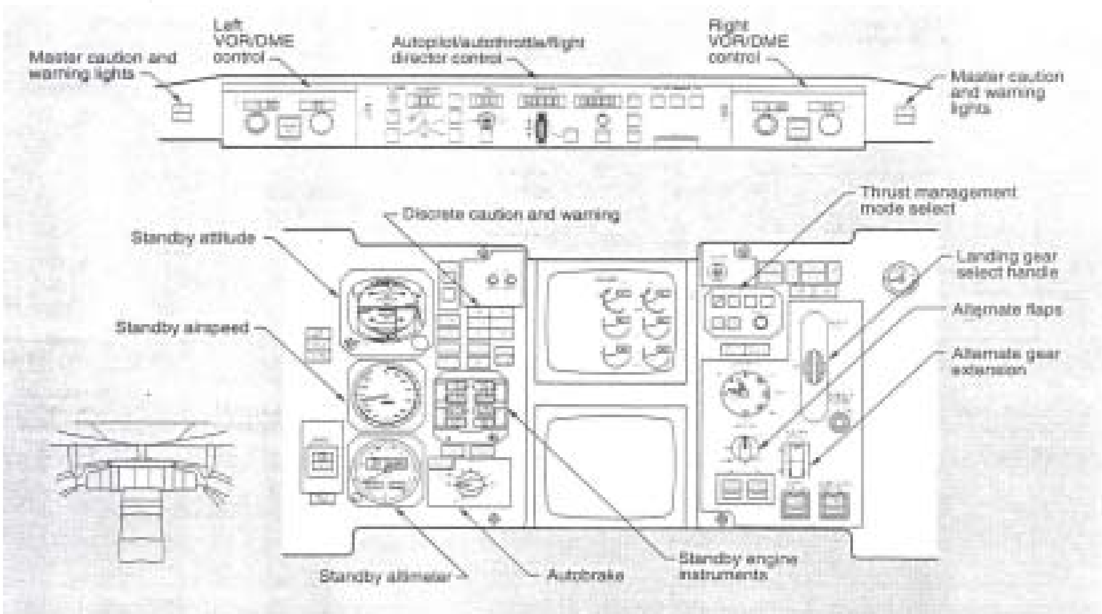
1.6.2 Flight Deck Instruments

The flight deck and the forward electronics bay were completely destroyed by impact forces and a postcrash fire. One burnt airspeed indicator, with the needle indicating approximately 138 kt, was found at the accident site.

Figure 1-4 illustrates the captain's and first officer's instrument panels, located in front of the pilots' seats, on the B767-200.



Captain's and First Officer's Instrument Panels



Pilots' Center Panels

Figure 1-4 Captain's and First Officer's Front Instrument Panels

1.6.3 Weight and Balance

The following weight and balance data were valid at the time of departure.

Zero Fuel Weight (ZFW):	97,360 kg	(214,642 lb)
Fuel On Board (FOB):	15,500 kg	(34,171 lb)
Trip Fuel (TIF):	8,010 kg	(17,659 lb)
Take-off Weight (TOW):	112,860 kg	(248,811 lb)
Landing Weight (LDW Planned):	104,760 kg	(230,956 lb)
Passenger Weight (including cabin baggage)	12,400 kg	(27,337 lb, 155 pax)
Baggage Weight:	1,840 kg	(4,056 lb)
Center of Gravity:	24.6% MAC	

The actual weights were within the authorized maximum weights[53], the fuel[54] on board was suitable for the flight from Beijing to Gimhae, and the CG was within limits[55].

1.7 Meteorological Information

1.7.1 Weather Conditions at Gimhae International Airport

At Gimhae airport, north and northwesterly winds prevail during autumn and winter, and south and southwesterly winds prevail during summer. Visibility is often partially poor due to sea fog, etc. from the south, since the southern part of the airport is located close to a sea. Mountainous terrain to the north, with strong southerly winds prevailing, may cause a mass of low clouds and fog to persist along the mountainous area north of the runway 18R, with a probability of increased precipitation in the area.

After the initial contact with Gimhae approach control, about 11:06:58, the flight crew of flight 129 acknowledged the receipt of ATIS information "Papa," as follows:

"Gimhae international airport information Papa, time at zero two zero zero UTC, weather, wind two two zero at seven knots, visibility two miles rain fog, sky condition one eighth of the sky obscured by fog, sky condition three octas five hundred, six octas

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[53] MZFW: 114,758 kg, MTOW: 156,489 kg, MLDW: 126,098 kg.
[54] Legally required fuel on board: 14,080 kg.
[55] T/O CG % MAC: 11.0 ~36.0.

one thousand, eight octas two thousand five hundred, temperature one six, dew point one three, altimeter three zero zero zero, active runway three six left. Advisory runway three six right or one eight left will be used as taxiway and parallel taxiway will be closed. Advise you have information Papa."

Upon the change of runway to 18R at 11:09, the approach controller informed flight 129 of the runway change to 18R, and surface winds 210 degrees at 17 kt. The local meteorological observation taken by the Airforce Meteorological Office at Gimhae at 11:11, was broadcast as ATIS "Romeo" about 11:18:35, and at that time, flight 129 was on the instrument final approach course to runway 36L, however, it was not recorded on the CVR that ATIS "Romeo" was received by the crew. Information "Romeo" was as follows:

"Gimhae international airport information Romeo, time at zero two one one UTC, weather, wind two one zero at one zero knots, visibility two and half miles with rain fog, sky condition three octas five hundred, six octas one thousand, eight octas two thousand five hundred, temperature one six, dew point one three, altimeter three zero zero zero, active runway one eight right, expect circle approach one eight right. Weather minimum category delta below landing minimum. Advisory runway three six right or one eight left will be used as taxiway and parallel taxiway will be closed. Advise you have information Romeo."

The weather observation taken at 11:45 after the accident, was wind 210 at 10 kt (mean velocity for 2 min), gust 16 kt, visibility 4,000 m with RABR, sky condition SCT 005 BKN 010 OVC 025, temperature 16°C, dew point 13, altimeter 29.99 In Hg.

Analysis of the daily record of surface weather observation by the Gimhae Airforce Meteorological Office in the morning of the accident day from 08:00 until 12:00 revealed that the wind direction was almost steady between 200 and 220 degrees, with the wind velocity between 9 and 12 kt. Peak gust between 14 and 16 kt was observed from 11:45 to 12:00, after the accident.

The visibility was between 2 and 3 miles with light to moderate rain and mist. The visibility at 11:00 on ATIS "Papa" was 2 miles, and the visibility observed at 11:11 with the runway change to 18R was 2.5 miles which was a little bit better than the visibility on ATIS "Papa" that flight 129 received.

The sky was covered by low clouds; coverage over 3 octas of the sky with cloud base between 500 and 800 ft, 6 octas with cloud base between 1,000 and 1,500 ft, and 8 octas with cloud base at 2,500 ft.

The weather at Gimhae and its vicinity in the morning of the accident day showed the steady temperature, dew point and barometric pressure, generally south-southwesterly winds blowing relatively strong, poor visibility due to rain and mist, and very cloudy weather because of low and thick clouds.

The forecast of Gimhae airport valid at the time of the accident, issued by the Gimhae Airforce Meteorological Office at 08:28, was as follows:

"TAF AMD RKPK 142300Z 150024 20006G16KT 3200 –RABR BKN015 OVC030 BECMG 1112 20010KT 1600 BKN005 OVC010"

According to the upper air data at a height of 1 km, observed every 10 minutes between 09:00 and 12:00 on the day of the accident by the national weather radar network including the Korea Meteorological Administration weather radar installed on Mt. Gooduck located approximately 7-8 km southeast of Gimhae airport, about 09:00, there was a wide area of rain clouds of about 2 mm from the shores southwest of Gimhae airport to distant seas to the south and to the southeast as far as Japan, moving slowly to the east, so that at the time of the accident, about 11:20, rain clouds with less than 0.1 mm were remaining in the vicinity of the airport.

Satellite pictures of clouds between 09:00 and 12:00 on the day of the accident showed a very slow movement of wide and long cloud formations lying from east to west between Korea and Japan, with heavy clouds between the sea south of Gimhae and southwestern shores of Japan. According to the pictures, Gimhae aerodrome was placed in front of the cold front, in the southwest anticyclone.

Figure 1-5 shows the radar weather data observed every 10 minutes between 11:00 and 11:30.

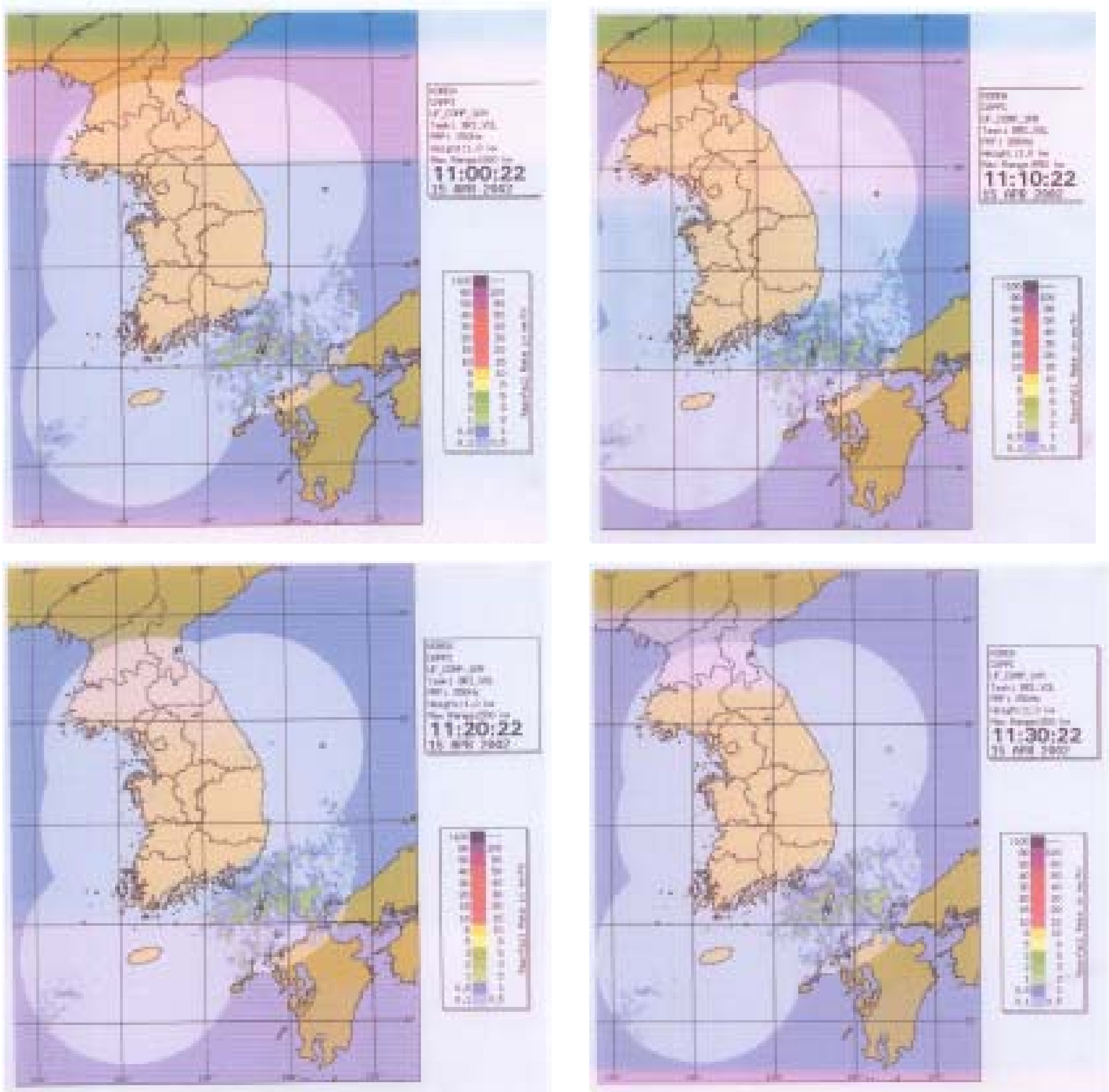

Figure 1-5 Radar Weather Data (11:00 ~ 11:30)

1.7.2 Additional Weather Information

According to the PIREP by a military CN-235 pilot at 10:20 on the day of the accident, the cloud base was observed to be at 500 ft with the top at 8,000 ft. A military C-130 pilot who landed 10 minutes after the accident reported the base at 600 ft or 700 ft. Neither pilots reported the amount of clouds.

According to the report by the rescue squad, which arrived earliest at the site of the accident about 11:58, the mountain was covered in thick fog from halfway up, and the precipitation was described as heavier than drizzle.

1.8 Aids to Navigation

1.8.1 Radio Navigation Aids

Installation of the Airport Surveillance Radar (ASR) used for air traffic control at Gimhae airport was completed[56] on November 29, 1990, and the radar satisfied the special operational commencement flight check for the initial operation on December 4, 1990. The Seoul Regional Aviation Administration (Seoul Regional Aviation Bureau at that time) certified the radar for the completion of installation on December 24, 1990. The radar had been operational since January 15, 1991, and retained normal operation with scheduled maintenance and flight checks. There was no record of malfunction on the day of the accident.

The radar was manufactured by Toshiba, Japan, and consisted of a Primary Surveillance Radar (PSR) and a Secondary Surveillance Radar (SSR). A Radar Data Processing System (RDPS) is integral to the SSR. The ASR is Type TW1374A, and the RDPS is Type TP1121C.

The radar had the Minimum Safe Altitude Warning (MSAW) function, only with the visual warning. No acoustic warning was designed for or incorporated into the radar. The radar function was normal on the day of the accident, according to the radar image record data.

The ILS/DME (108.5 Mhz, IKMA) used by flight 129 for the approach to runway 36L was comprised of Localizer, Glide Path, Middle Marker, Inner Marker and DME, of which the operation was monitored real time by the Remote Maintenance Monitoring System (RMMS). Any malfunction would automatically alert the approach controller and remote maintenance technician.

The ILS/DME operation was routinely flight checked to be satisfactory, and the RMMS records between 11:00 and 12:00 on the day of the accident indicated normal values within allowable error tolerances.

The Gimhae VOR/DME (113.8 Mhz, KMH) is for instrument and missed approaches, and is monitored real time by the RMMS. Any malfunction would automatically alert the approach controller and remote maintenance technician.

The VOR/DME operation was routinely flight checked to be satisfactory, and the RMMS records before (about 05:40) and after (about 12:01) the time of the accident indicated the transmission output within the normal range.

[56] Completion of Gimhae airport radar equipment installation (including a new BRITE Display).

Figures 1-6 and 1-7 illustrate respectively the radar track data and the circling approach area of flight 129 during the circling approach to runway 18R.

No.	Time	Dir (MN)	Dist.(NM) Corr.	Dist.(NM) CDRS	A/S (GS)	Alt. (ft)	Rmk.
45	02:21:27	354.94	4.31	4.96	–	–	–
44	23	353.33	4.21	4.85	–	–	
43	19	351.66	4.12	4.74	–	700	LA
42	15	350.42	4.24	4.88	–	–	LA
41	11	348.26	4.28	4.92	150	700	–
40	07	346.50	4.19	4.82	–	–	LA
39	21:03	343.95	4.13	4.75	160	700	–
38	59	342.78	4.04	4.65	170	700	–
37	55	340.82	3.97	4.57	180	–	–
36	51	339.54	3.88	4.47	180	–	–
35	47	338.36	3.68	4.24	–	–	LA
34	44	338.52	3.56	4.10	190	700	–
33	40	337.17	3.36	3.87	–	–	LA
32	36	337.31	3.24	3.73	190	700	–
31	32	335.73	3.04	3.50	190	700	–
30	28	332.95	2.87	3.30	180	–	–
29	24	330.83	2.68	3.08	180	700	–
28	20	327.62	2.63	3.03	190	–	–
27	16	325.30	2.57	2.96	–	–	–
26	12	322.35	2.40	2.76	190	–	–
25	08	317.91	2.27	2.61	190	–	–
24	05	316.01	2.19	2.52	190	–	–
23	20:01	311.76	2.04	2.35	190	–	–
22	57	307.87	1.86	2.14	190	–	–
21	53	306.16	1.75	2.01	190	–	–
20	49	302.01	1.54	1.77	180	800	–
19	45	299.48	1.43	1.65	180	800	–
18	41	293.20	1.24	1.43	170	800	–
17	37	No Data Recorded due to blind area					
16	33						
15	29						
14	25						
13	22						
12	18						
11	14						
10	10	212.74	0.90	1.04	200	700	–
9	06	202.38	1.00	1.15	200	–	–
8	19:02	199.29	1.15	1.32	200	–	–
7	58	194.04	1.35	1.55	200	800	–
6	54	192.53	1.50	1.73	–	800	–
5	50	191.31	1.66	1.91	–	900	–
4	46	190.30	1.82	2.10	200	1000	–
3	42	189.46	1.98	2.28	210	1100	–
2	39	188.53	2.20	2.53	–	–	–
1	02:18:35	187.77	2.42	2.78	210	1400	–

CDRS Track

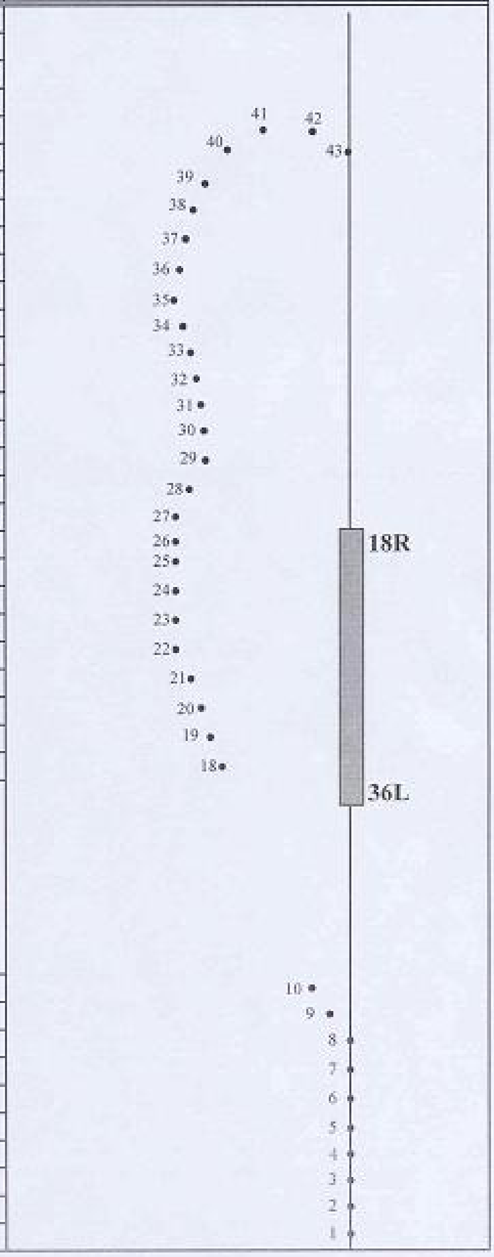

Figure 1-6 CDRS Data

* Approximately 200 ~ 1,100 meters of difference existed from the final approach course to runway 36L to the crash point in the flight track on the drawing based on the CDRS data scaled one to 50,000, thus the CDRS data (distance) was multiplied by an invariable number 0.868976, and the revised the distance was calculated for the correction on the drawing. The flight track was composed on the basis of the revised data.

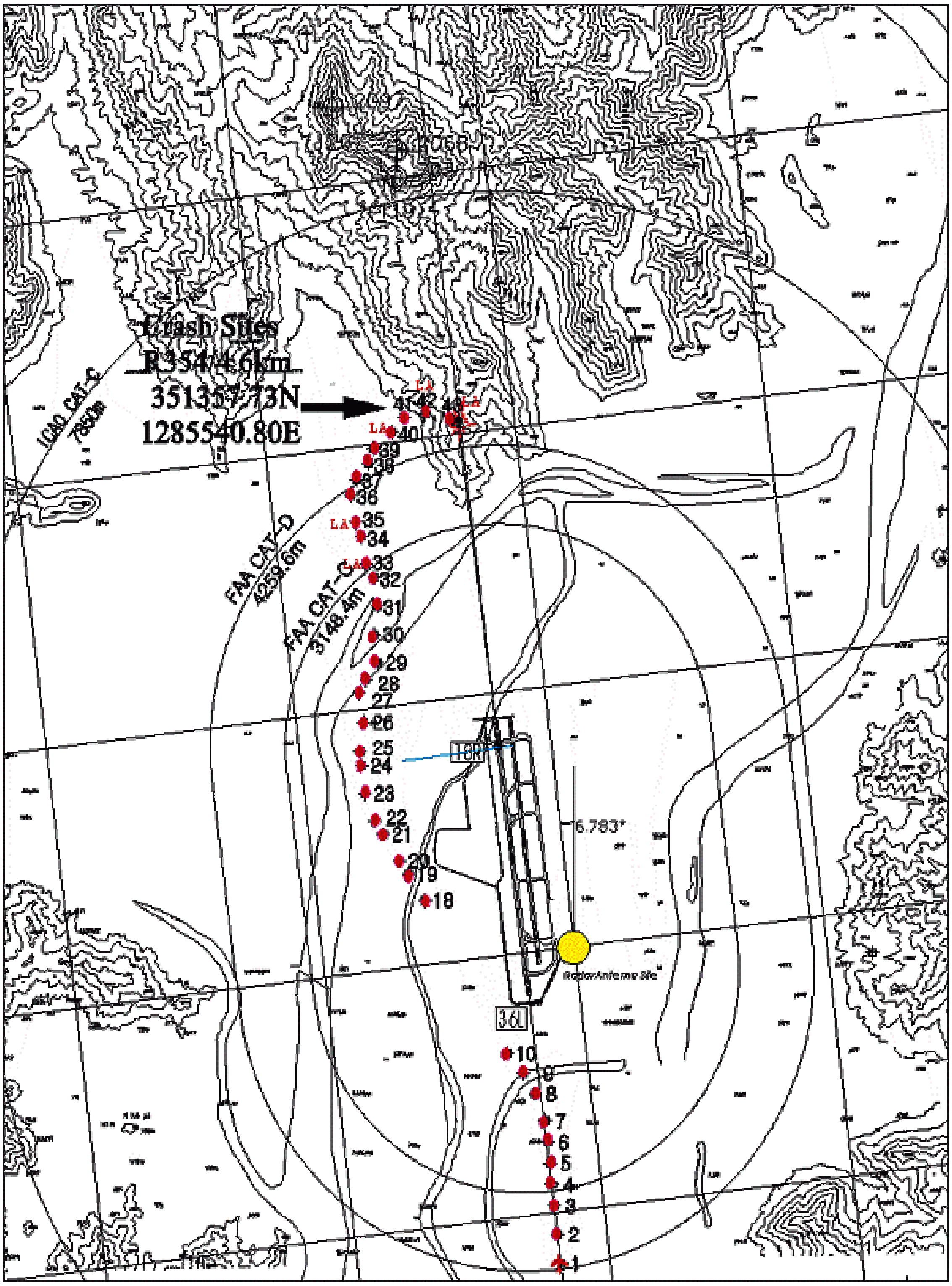

Figure 1-7 Circling Approach Radar Track of Flight 129 and Circling Approach Area

∗ For track data at each number, refer to Figure 1-6

1.8.2 Airport Lighting

According to the statement[57] of the captain of flight 129, he observed the runway lights on the final approach course to runway 36L, however, he saw neither the runway lights on the downwind leg nor circling guidance lights during the circling approach. According to the record of the automatic aeronautical light switching system, and the testimony of the Gimhae tower duty chief in the public hearing, the runway, approach and circling guidance lights[58] of runway 18R were on at the time of the accident.

The automatic light switching and recording systems, used to calculate lighting fees, were installed in the lighting control room. The lighting times are automatically calculated by the clock installed in the system computer. The investigation revealed that the clock had been running about 19 minutes "fast," and the clock was reset correctly by an engineer about 20:30 on April 18, 2002.

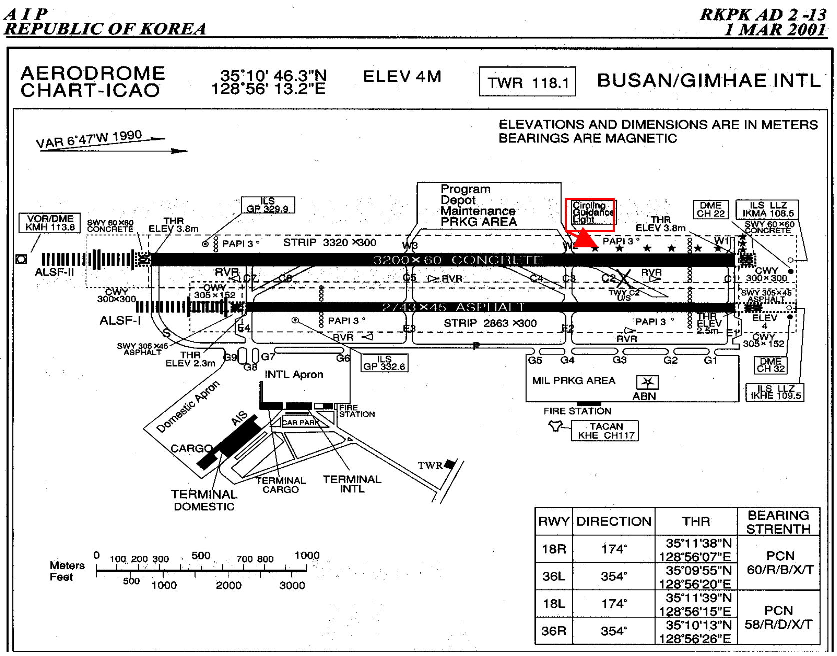

Figure 1-8 Circling Guidance Lights at Gimhae Airport

1.9 Communications

From the time flight 129 entered the Incheon FIR on April 15, 2002, there were no records of communication problems during contacts with Incheon ACC, Gimhae approach control and Gimhae tower.

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57 Captain's interview & public hearing.
58 Refer to Figure 1-8.

1.10 Aerodrome Information

1.10.1 Air Traffic Control Services for Gimhae International Airport

1.10.1.1 Gimhae Approach Control

Gimhae approach control was operated and managed by the Airforce, but the actual radar service was provided by a team comprised of both Airforce controllers and civilian controllers from the Busan Regional Aviation Administration.

At the time of the accident, the team on duty consisted of 6 controllers from the third shift and 2 daily controllers. The controller who handled the approach control of the accident flight was the Airforce duty chief. The assistant controller at the flight information position handled the flight information service. Both controllers were fully qualified for either approach control or flight information duties.

The ATC services provided to the accident flight by the controller at the approach control position began about 11:06, with the aircraft 15 miles northwest of KALDO on the route A-582, when Incheon ACC transferred control to approach control. The approach control services lasted until about 1.7 miles south of runway 36L threshold, when flight 129 began the circling approach to runway 18R, after the pilots had the runway in sight.

The approach controller stated that when the AMOS display began to show trends for tailwinds along the runway 36L, in preparation for a possible circling approach, he queried flight 129 on its approach category, and then reconfirmed the approach category after the runway was changed to 18R.

Upon receiving the report that flight 129 had the runway in sight at 1.7 miles from the end of runway 36L, the approach controller instructed the flight to fly the circling approach to runway 18R, and then transferred control to the tower. He stated that he verified the flight initiating the normal circling approach.

After the approach controller's radio communication transfer to the tower, the tower asked for the flight to be transferred on the direct line, so the approach controller again instructed the flight to switch to the tower frequency. He saw the aircraft on the radar scope entering the normal downwind pattern, and asked the tower, "Does it seem go around?" having felt that the aircraft was flying on a longer pattern than normal. According to the controller's testimony, thereafter, he heard from the tower controller that communication with the flight was lost, and as he heard the flight being called on the emergency frequency, he monitored intently the radar scope, but the target had disappeared.

1.10.1.2 Minimum Safe Altitude Warning System (MSAW)

The MSAW installed at Gimhae airport had been operational since January 15, 1991 concurrently with the Gimhae radar system**,** and was programmed only with a visual warning function.[59]

The MSAW was programmed according to the standards described in the Airforce manual. The approach control area was divided into 2 NM square bins, for a total of 4,900 bins, where the minimum safe altitude of each bin was programmed with 700 ft above the highest obstacle. As shown on Figure 1-9, the minimum safe altitude of the airport's northern bin where Mt. Shinuh[60] is positioned was programmed to 2,800 ft in consideration of the height of that mountain (2,076 ft), and it was set to 1,000 ft for the west bin, and 4,700 ft for the east bin respectively.

The MSAW logic was designed such that the MSAW activates and generates a visual warning, alerting the controller with flashing letters "LA" on the ground speed portion of the target data block, anytime an aircraft is flying below the MSAW activation altitude within the bin programmed with the minimum safe altitude, or will be within the bin in 30 seconds or about 2 miles when approaching from outside the bin below the minimum safe altitude, based on a speed of 250 kt.

The minimum safe altitude was set at "0" ft in the area near the airport with takeoffs and landing traffic centered around the antenna, in order to inhibit frequent activation of nuisance warnings

The MSAW activation bin north of the airport where Mt. Shinuh is located is very close (about 0.15 NM / 280 m) to the circling approach area for category D, thus the MSAW may be activated when an aircraft is flying on the base turn to runway 18R, below the altitude of 2,800 ft within the circling approach area for categories C or D.

Figure 1-9 illustrates possible MSAW activation areas[61] along with circling approach area by the FAA and ICAO standards.

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[59] Note 2 to PANS-ATM 15.6.4 states, "When the level of an aircraft is detected or predicted to be less than the applicable minimum safe altitude, an acoustic and visual warning will be generated to the radar controller within whose jurisdiction area the aircraft is operating."

[60] A mountain adjacent to the north of Mt. Dotdae.

[61] The areas where the predictive warning can be activated in accordance with flight distance by the aircraft heading and speed by means of MSAW predictive warning function (in the case of flight 129, the predictive warning was possible in front of about 1.4 NM, applying 170 kt of ground speed).

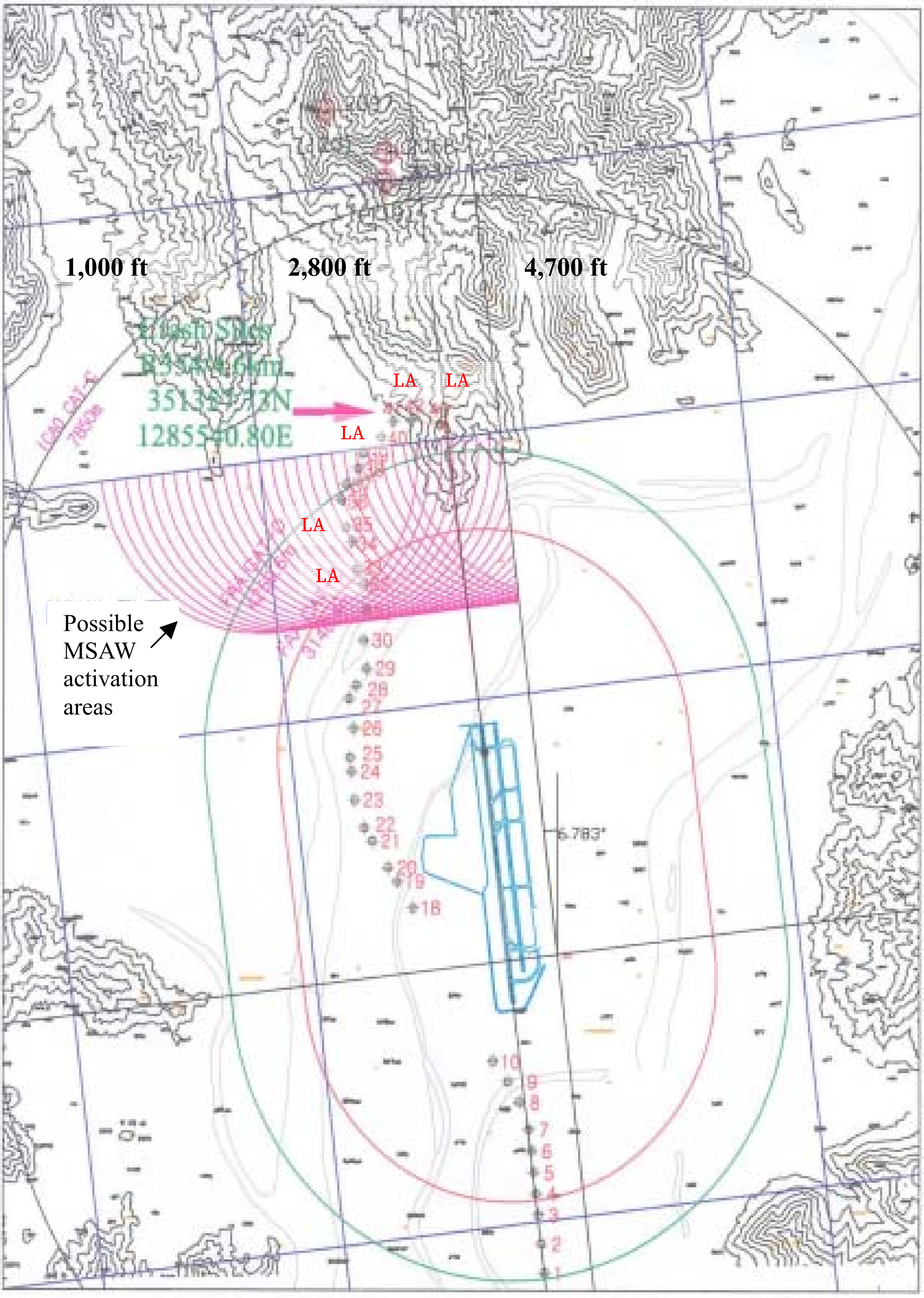

Figure 1-9 Possible MSAW Activation Areas and Circling Approach Area

1.10.1.3 Gimhae Tower

Aerodrome control services at Gimhae tower were provided by the Airforce. One air traffic controller from the Busan Regional Aviation Administration was assigned to the tower for coordination of civil aircraft control during daylight hours, based on a related mutual consent.[62] This controller stated that at the time of the accident, he was not present in the tower control room because he was attending to other duties such as obtaining a signature on the duty log. He stated that he arrived in the control room 7 minutes after the accident occurred. Relevant ratings for aerodrome control services were not authorized to the controller.

At the time of the accident, the duty team consisted of 5 controllers from the second shift and 2 daily controllers, in accordance with the "Tower Duty Schedule for April." Aerodrome control of flight 129 was handled by the primary and secondary local controllers, both of whom were duly qualified for aerodrome control.

Aerodrome control services provided to flight 129 by local controllers were from the commencement of the circling approach, after the pilots had the runway in sight, about 1.7 NM to the threshold of runway 36L, approaching by the ILS/DME RWY36L approach procedure, until the time of crash about 2.5 NM (about 4.6 km) from the threshold of runway 18R along the extended centerline.

In the attempt to contact flight 129, the primary local controller made two "radio checks." as the aircraft entered the downwind leg for the circling approach. But as there was no response, he notified, by a direct line, the approach controller about the situation that flight 129 was not in contact, and asked the approach controller to transfer flight 129 to the tower frequency.

Thereafter, while the primary local controller was attempting to contact flight 129 on emergency frequency of 121.5 Mhz, the initial contact with flight 129 was established on the tower frequency of 118.1 Mhz by a calling of flight 129.

This initial contact between the tower and flight 129 was made slightly past the due west of the threshold of runway 18R, where the primary local controller requested, "Air China 129, report turning base," and immediately thereafter, issued a landing clearance to flight 129. But mistakenly he issued the landing runway as "runway 36L" instead of "runway 18R."

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[62] Article 12 of the mutual consent on control tower operation between the Airforce Unit 5672, Busan Regional Aviation Administration, and Korea Airports Corporation Busan Branch Office.

The secondary local controller recognized this mistaken clearance and immediately reissued the landing clearance to runway 18R, to which flight 129 replied. The secondary local controller then asked, "Can you landing?" when flight 129 went out of sight, to which the second officer replied, "Roger, QFE three thousand, Air China 129." To clarify the pilot's intent, the secondary local controller asked, "Air China 129, say again your intention," but there was no response from flight 129.

When flight 129 remained out of sight without a reply, the secondary local controller asked, "Say position now," to confirm the aircraft's position, to which the second officer replied, "Air China 129, on base, turning on final, and QFE three thousand, Air China 129." The CVR recording during this time showed exchanges between the captain and the first officer as, "Have the runway in sight?" "No, I can not see out," "Must go around," "Pull up! Pull up!" Shortly thereafter, the aircraft crashed, but the secondary local controller was not aware of this crash, and reissued landing clearances with queries on the flight's position 5 times.

Gimhae tower is located near the eastern boundary of the airport, about 1,276 m from the runway 36L/18R centerline, and about 2,129 m from the center of runway 36L threshold, about 1,967 m from the center of runway 18R threshold, respectively.

The console at the tower control room faces west toward the runway, and the local control position is situated at the center of the console, which is the position that the visual monitoring of the airspace under the local controller's control, including both ends of the runway and the traffic pattern to the west, is possible, in weather conditions with no impediment to the visibility.

According to the statement of the secondary local controller, after being notified by approach control that flight 129 was the B767-200 type, the secondary local controller confirmed the aircraft's approach category as "Charlie" and was prepared for flight 129. And he stated that he had the aircraft in sight on the western downwind about 11:19.

1.10.1.4 Tower BRITE Equipment

BRITE[63] is a radar scope designed to be used also under bright conditions. At Gimhae tower, this equipment was installed concurrently with the ASR and operated, and the BRITE scope was installed at the center of the tower controller console.

[63] Type: TP 1219A.

According to the manufacturer's operating and maintenance instruction manual, the BRITE Display System (BDS) receives the following signals.

· MTI/Normal imaging and SSR decoded imaging from the ASR/SSR

· ACP, ARP and TRIGGER from the ASR/SSR

· Digital data (Target and Map) from the DPS

Based on the total loss measurement records, measured on July 28, 2001, of the optical fiber transmission cable from approach control (RAPCON) to tower, signals and digital data to the BRITE scope were being received with almost no loss.

The BRITE was installed on November 29, 1990, concurrently with the radar system, and was certified for the completion of installation by the Seoul Regional Aviation Administration (Seoul Regional Aviation Bureau at that time) on December 24, 1990. An operations instructor for the radar and BRITE stated that he conducted the training for BRITE operators on its use, and that BRITE begun its operation on January, 15 1991. The monthly and weekly inspection records for April, 2002 showed normal operation.

Individual statements by the controllers who provided aerodrome control services at the time of the accident and statements at the public hearing verified that the primary and secondary local controllers used the BRITE to observe flight 129 approaching about 20 NM northwest of the airport while under approach control. But thereafter, they did not use the BRITE in providing the control services to the aircraft through the circling maneuver until the estimated time of the accident. They, then, in the course of searching for the aircraft after crash, noted that the aircraft had disappeared on the BRITE.

The BRITE range is usually set at 20 NM, but the range scale could be adjusted as necessary from 6 NM to 60 NM.

The procedures applicable to the use of the BRITE at Gimhae tower were in accordance with the Standard Air Traffic Control Procedures (Sections 3-1-9 & 3-10-7), which both of civil and military air traffic control facilities apply to the control of all aircraft alike, and the "Gimhae Base Local Procedures" (Chapter 9, Section 4, Para1) applicable to aircraft on VFR arrival.

Article 75 of the Korean Aviation Act and its sub regulations describe the installation and technical standards for radar systems, however, the standards for the BRITE are not prescribed.

1.10.2 The Circling Approach Procedure at Gimhae International Airport

The circling approach procedure[64] which flight 129 used was the "ILS/DME runway 36L, circle to runway 18R," where the pilot would visually identify the runway at or above the 700 ft MDA on the straight in approach to runway 36L, and then enter the airport traffic pattern to the west by a visual flight maneuver to runway 18R.

The ILS/DME 36L instrument approach procedure for Gimhae airport and the circling approach procedure to runway 18R were published in the Aeronautical Information Publication (AIP) by the Civil Aviation Bureau of the Korea MOCT, as well as in the Jeppesen Airway Manual.

The circling approach area for runway 18R at Gimhae airport is established by the FAA TERPS criteria. Approach category "C" is to be within a radius of 1.7 NM from the center of the threshold of runway 18R, and category "D" within a radius of 2.3 NM. The aircraft crashed at a point of about 2.48 NM (4.6 km) from the threshold of runway 18R, which was outside the circling approach area for category "D."

ICAO, Aircraft Operations Procedure (PANS-OPS, Doc 8168-OPS/611), Vol I, Para 4.6 & 4.7 stipulate, 「A circling approach is a visual flight maneuver…After initial visual contact, the basic assumption is that the runway environment (i.e. the runway threshold or approach lighting aids or other markings identifiable with the runway) should be kept in sight while at MDA/H for circling. If visual reference is lost while circling to land from an instrument approach, the missed approach specified for that particular procedure must be followed…」

Articles 30 and 77 of the CAAC Order No. 98 stipulate, 「A circling approach is a visual flight maneuver after completion of an instrument approach. The pilot must continuously keep the runway threshold or approach lighting aids or other markings identifiable with the runway in sight, and maintain the flight within the visual circling approach area…If visual reference is lost, or successful landing is not attainable, the pilot must execute the missed approach, and attempt to land again…」

[64] Established by the Busan Regional Aviation Administration, according to MOCT instruction directory "Air Traffic Control Regulation," and received approval from Gimhae Airforce Unit, operator of Gimhae

The Gimhae Base Local Procedures, Chapter 10, Section 6, Para 3 states that the pilot is to proceed from an instrument approach to runway 36L to the western traffic pattern for the circling approach after making visual contact with the runway, and when the ceiling or the visibility will not allow maintaining the normal visual traffic pattern altitude, the pilot may descend to the circling MDA after receiving a clearance from the control tower. It also states that, if visual contact with the runway is lost during the circling approach, the immediate missed approach must be executed.

Gimhae Base Local Procedures also prescribe that the maximum tailwind for landing at the airport is less than 10 kt. At Gimhae airport, southwestern winds prevail during spring and summer, and the probability to conduct the circling approach to runway 18R was frequently used. In the operation records of the morning of the accident day, there were cases that aircraft on circling approaches conducted missed approaches.

1.10.3 Aeronautical Information

1.10.3.1 Aeronautical Information Publication

The approach procedure for ILS/DME RWY 36L, as shown on Figure 1-10, was depicted on the plan view of instrument approach chart of page RKPK AD 2-20 under Chapter 3 (Aerodrome) of the ROK AIP. It also marked three obstacles in the vicinity of the accident site, with the circling minima for each approach category on the lower part of the page.

Annex 15 to the Convention on International Civil Aviation specifies that the differences in the establishment criteria for flight procedures from those prescribed by ICAO[65] are to be included under GEN 1.7 and ENR 1.5.1 of the AIP. As of April 15, 2002, the differences were not described in the ROK AIP.

There was no record of distribution of the ROK AIP to Air China during the period of one year prior to April 15, 2002.

Base.

[65] PANS-OPS (ICAO Doc 8168-OPS/611).

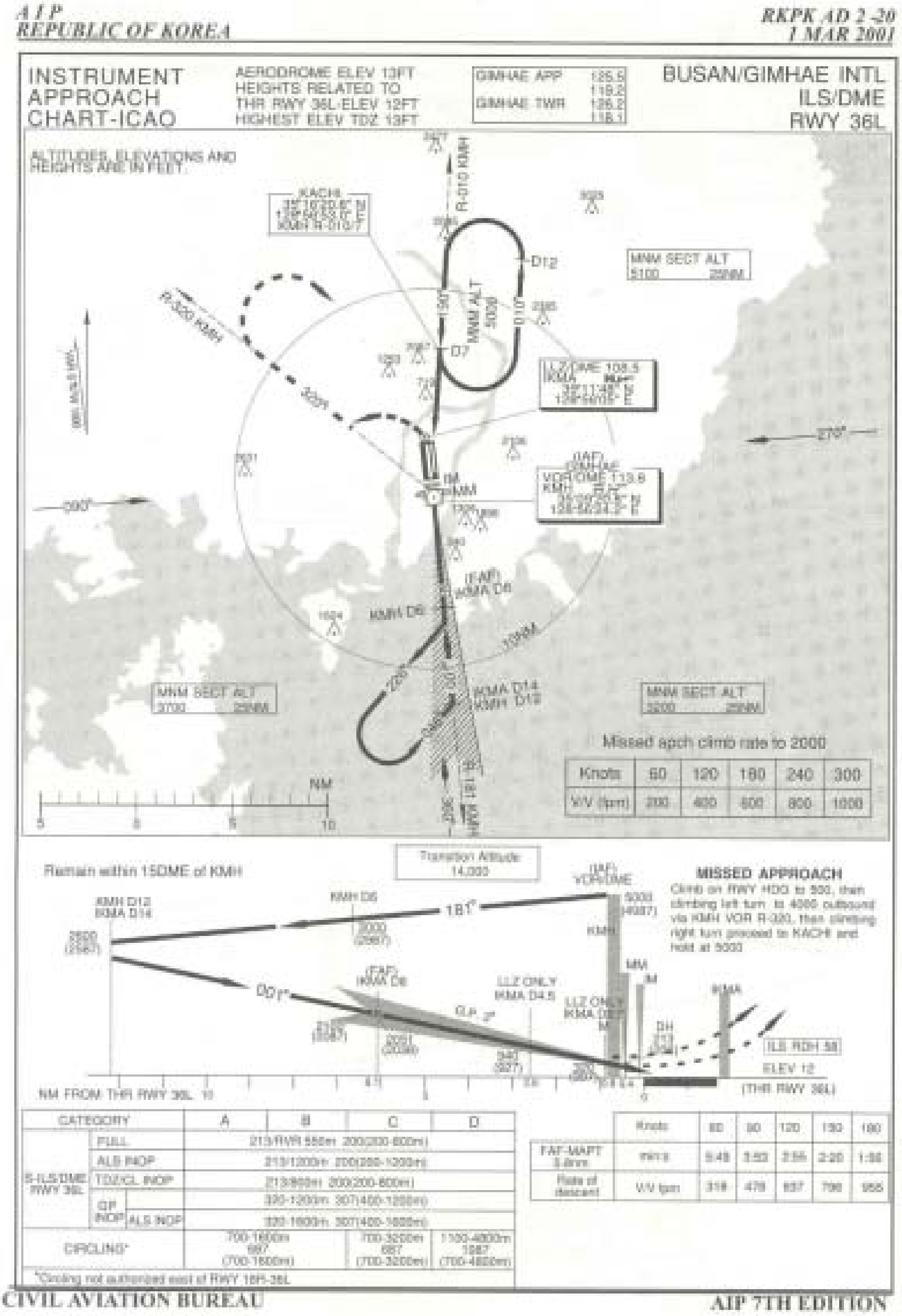

Figure 1-10 ROK AIP Instrument Approach Chart Valid as of April 15, 2002

1.10.3.2 Approach Chart on Gimhae International Airport

The circling approach procedure of Gimhae airport was designed according to the FAA TERPS criteria, which could be determined by references to the introduction part, and lower portion exhibiting the speeds for each approach category of the instrument approach chart, in the Jeppesen Airway Manual, as shown on Figures 1-11A and 1-11B.

The instrument approach chart used[66] by the flight crew of flight 129 as shown on Figure 1-11A (ILS DME Rwy 36L, effective SEP 25, 01), displayed the plan view with contour lines and different shades of color to show heights of the terrain, and obstacle symbols marked with the elevations. The enlarged depiction of the missed approach holding precluded showing the obstacles to the north of the circling approach area. The Jeppesen chart of the Busan, Korea ILS DME or LOC DME Rwy 36L published Oct 25, 2002 was revised according to the amended ROK AIP. Jeppesen took the opportunity in this revision to improve the plan view depiction by changing the plan view scale to include a larger area, including the terrain and obstacles in the vicinity of the accident as shown on Figure 1-11B.

The Jeppesen manual, page 19-1 of Gimhae airport, a visual topographic chart as shown on Figure 1-12, did contain detailed obstacle and topographic information.

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[66] Based on Air China Operations Specifications A009, Article 2.

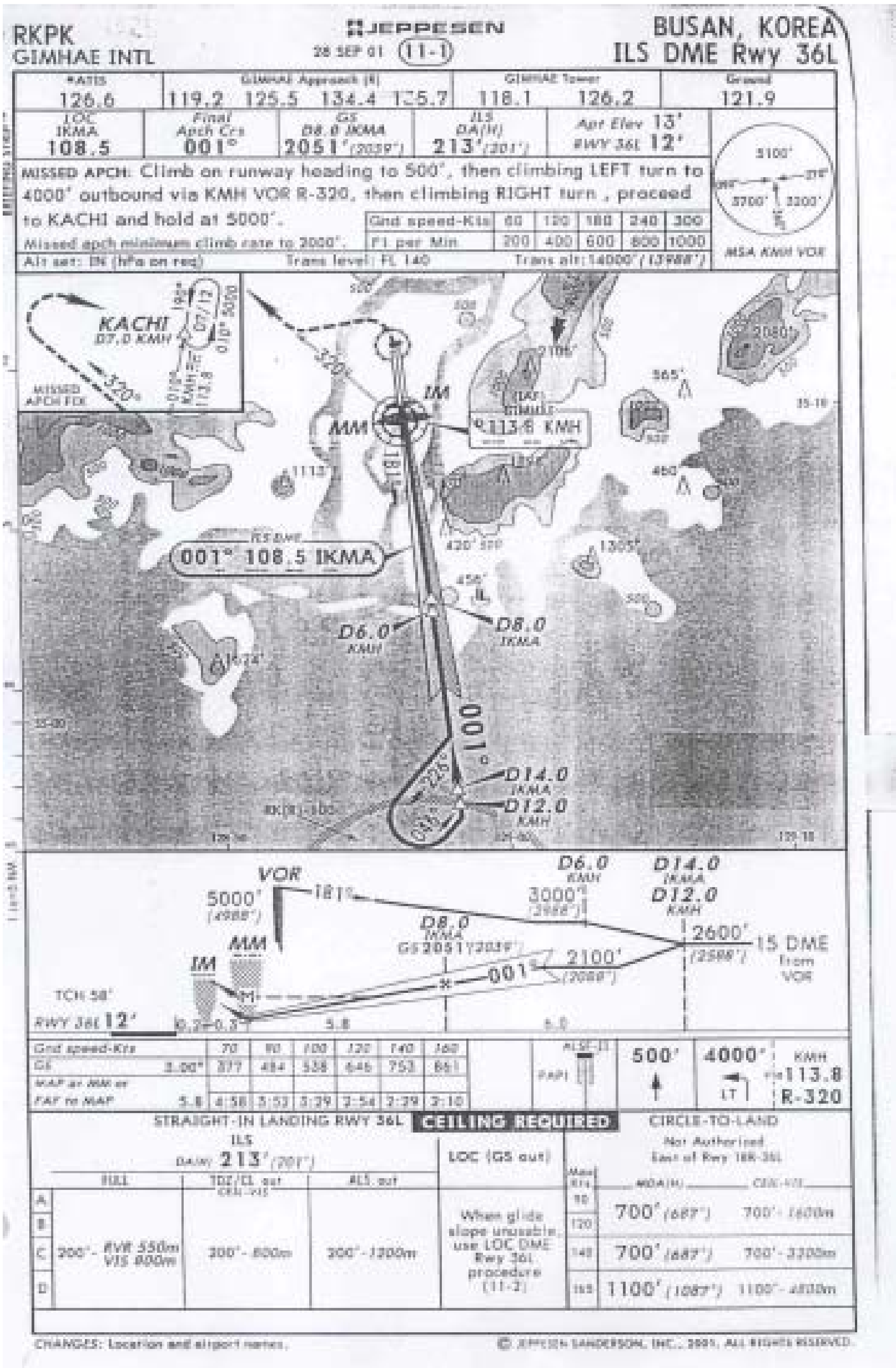
RKPK
GIMHAE INTL
JEPPESEN
28 SEP 01 (11-1)
BUSAN, KOREA
ILS DME Rwy 36L
MISSED APCH: Climb on runway heading to 500', then climbing LEFT turn to 4000' outbound via KMH VOR R-320, then climbing RIGHT turn, proceed to KACHI and hold at 5000'.
KACHI
001° 108.5 IKMA
113.8 KMH
D6.0
D8.0
D14.0
D12.0
STRAIGHT-IN LANDING RWY 36L
CEILING REQUIRED
CIRCLE-TO-LAND

Figure 1-11A RWY 36L Instrument Approach Chart (Issued date: SEP 25, 01)

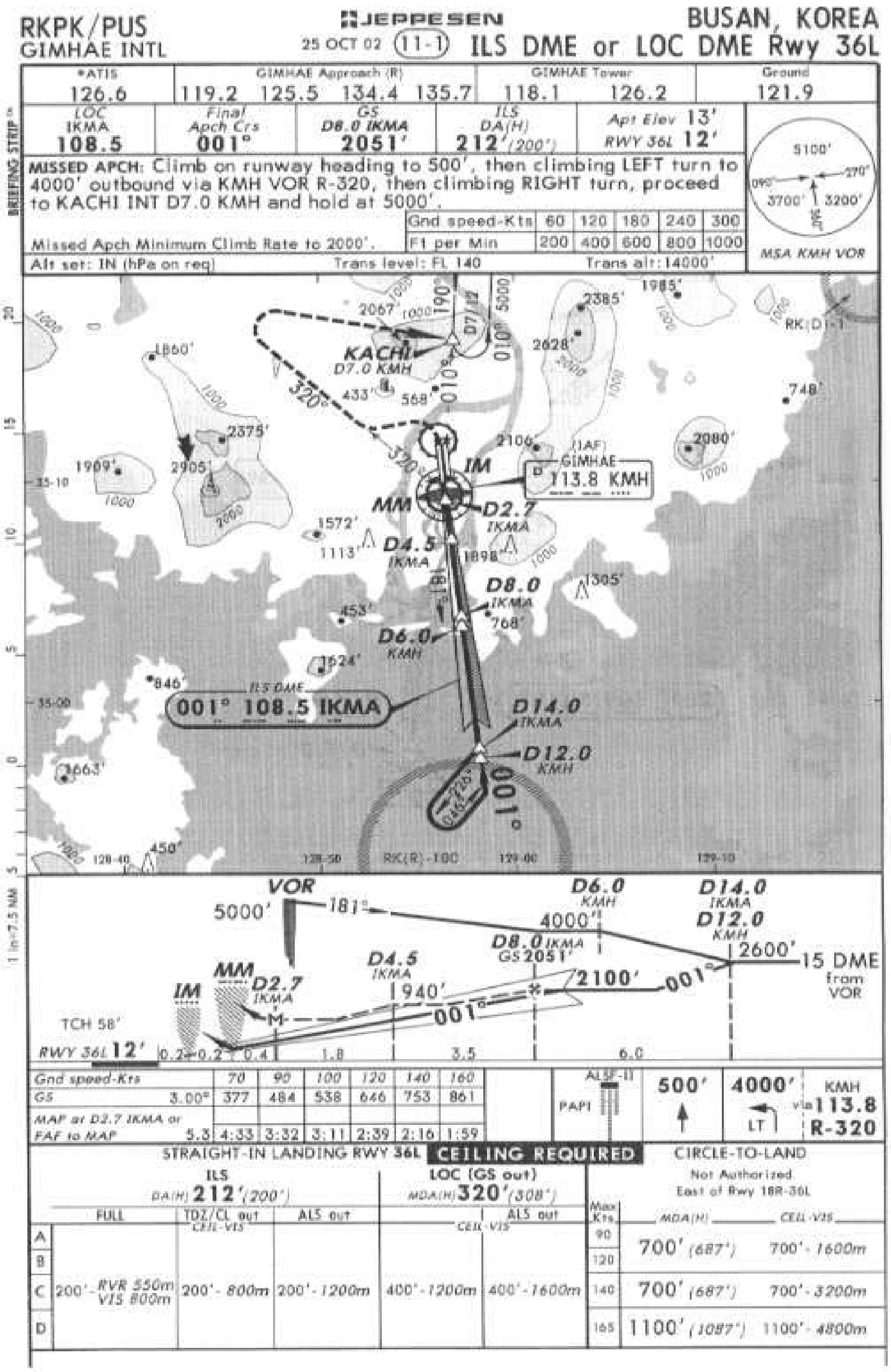

Figure 1-11B RWY 36L Instrument Approach Chart (Issued date: OCT 25,02)

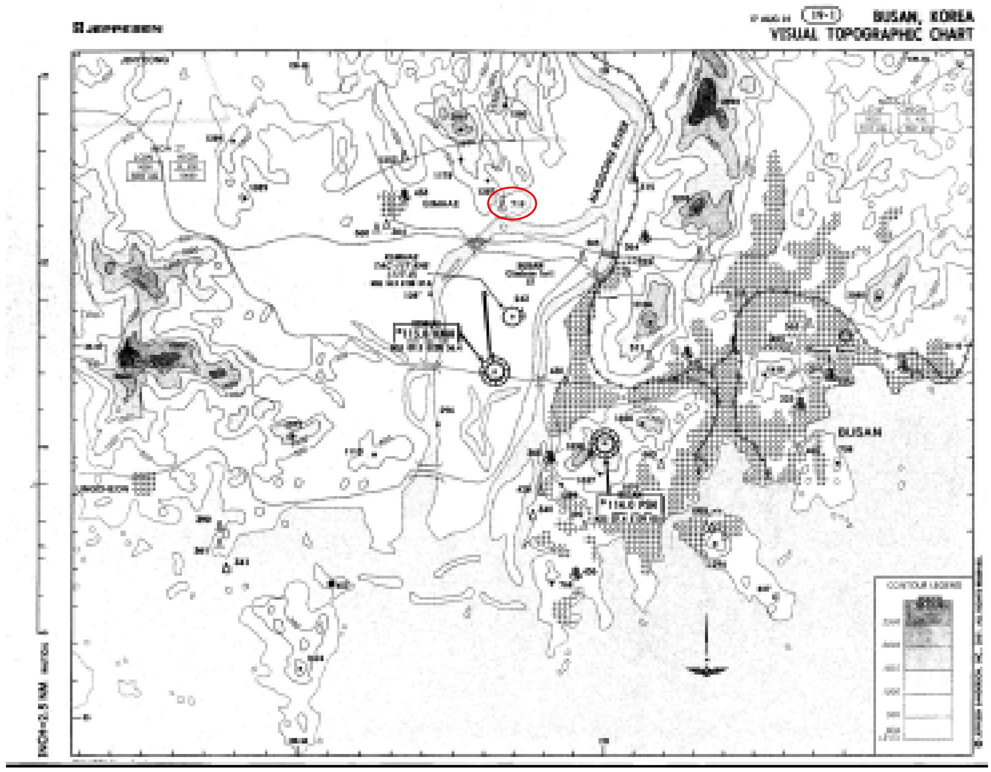

Figure 1-12 Visual Topographic Chart (Jeppesen RKPK page 19-1)

Depictions of the visual maneuvering area (circling approach) boundary are in the Air Traffic Procedures section of the Jeppesen Airway Manual.

1.10.3.3 Information on Aircraft Approach Category

Aircraft approach category is used to determine the radius of turn required for the circling maneuver and minimum descent altitude for that area, as described in 1.17.3.1, Air China Procedure for Application of Weather Minima.

There is no international standard (procedures or regulations) requiring a formal notification to air traffic control facilities of the approach category and the circling approach minima for wide-body aircraft.[67] Therefore it is up to approach controllers to clear each aircraft for the approach in consideration of its category, and weather conditions.

At Gimhae airport, the ATC authority[68] was notified of the approach category of each type of aircraft operating to Gimhae airport by air carriers through a formal report, but the data were incomplete and unreliable for controllers' use, and no airline had provided the circling approach minima of wide-body aircraft. Therefore, the controllers

[67] Wide-body aircraft (B747, DC10, L1011, A300/310, B767, IL86) as defined in ICAO Doc 9365-AN/910 "Manual of All Weather Operations."

[68] ROKAF (Gimhae Base) and Busan Regional Aviation Administration.

relied on the method of directly asking the pilot when the information was not provided in advance, as the controllers would not be able to know this information aforetime.

1.10.4 Weather Observation

According to a mutual agreement signed between the Airforce Gimhae Base Weather Office and Gimhae Civilian Weather Station of the Meteorological Department, the Airforce is responsible to provide the weather observation and weather forecast service for the Gimhae airport, for which the weather service standards of the Airforce is applied. The duty of Gimhae Civilian Weather Station is to edit the weather information provided by the Airforce to a civil meteorological notification format, and to issue the information to civil airlines.

1.10.4.1 Visual Weather Observation Site

The prevailing visibility and sky conditions (cloud distribution and height) were determined through the visual observation by a certified observer using the long and short range visibility charts. The primary observation site[69] was located on the rooftop of the Airforce Weather Office building.[70]

Views toward the lower skies north and north-northwest of the airport were blocked by the hangar[71] located north of the observation site, including the direction of the final approach course to runway 18R and accident site.

An observer from the Gimhae Airforce Weather Office said that observations of this part of the sky had to be made from the ramp located west in front of the weather office, at a distance which required about five minutes round trip on foot between the weather office and ramp observation site.

There was an aircraft shelter, 5 m high to the north of the ramp observation site, partially blocking the view to the north. But data from the Airforce weather office showed that observations for Mt. Dotdae area from the ramp observation site were possible for heights more than about 225 ft above the elevation of Gimhae airport.

1.10.4.2 Weather Observation Equipment

The weather observation equipment[72] located along the west runway (18R/36L) at Gimhae airport was installed according to ICAO standards,[73] and consisted of an

[69] Installed in November 1970.
[70] Height 3.4 m above the ground level.
[71] Height 26 m above the ground level, constructed in Dec 1990.
[72] Forward scatter method, installed by Korea MOCT Busan Regional Aviation Administration.
[73] Annex 3 to the Convention on International Civil Aviation, Para 4.1.8 and 4.7.5.

anemoscope, an anemometer, a variometer, and a RVR measuring equipment, and had been operational since March 23, 2000, except for the RVR, which had stopped working (issued by NOTAM) since July 12, 2001, when it became unreliable. At the time of the accident, it was not operational.

The weather observation equipment located along the east runway (18L/36R) consisted of an anemoscope, an anemometer, a variometer, a RVR measuring equipment, and instruments for measuring temperature and dew point, cloud height, and a rain gauge. At the time of the accident, all equipment recorded normal operation.

1.11 Flight Recorders

1.11.1 Flight Data Recorder

The aircraft was equipped with a Solid-State Flight Data Recorder (SSFDR),[74] manufactured by AlliedSignal (presently, Honeywell). On the day of the accident, the FDR was recovered about 17:00 at the accident site. The external casing and internal circuit board were severely damaged by impact forces and fire, however, the flight data memory[75] was properly preserved.

The circuit connector cable was burnt out. Therefore, the FDR was taken to Honeywell in Seattle, and all the recorded data were retrieved on April 22, 2002, after repairing the connectors.

The flight data memory contained the last 53 hours (18,800,732 bytes) of flight data before the accident. It recorded 275 parameters of the data, which were decoded by the KAIB for analysis in its analysis laboratory.

The KAIB used the Boeing Company's specifications,[76] as provided by Air China, in order to decode the data recorded on the FDR installed in the flight 129 aircraft. And for the investigation of this accident, major parameter values during the last 900 seconds (15 minutes)[77] were used

The FDR recorded the data up to 11:21:21, and the recordings on the tower recorder were up to 11:21:17, which indicates that there was a 4 second difference. The KAIB determined that the crash time was 11:21:17, on the basis of the recordings on the CVR and tower recorder.

[74] Model No: 980-4700-003, serial No: 3973.
[75] First-written, first-removed method, 64 words per second.
[76] Technical document No: D283T055-20.
[77] Frame No: 184400~ 190640.

1.11.2 Cockpit Voice Recorder

The flight 129 aircraft was equipped with the CVR[78] of A100 type, manufactured by Fairchild. The data retrieval circuit board was damaged, requiring the extraction of the recorded data by first removing the tape to be placed in another CVR of the same A100 type. The result of the verification made in the course of replaying the tape in comparison with the manufacturer's manual[79] revealed that the recordings were made with the CVR connector channel pins mis-matched. Thus, there were some difficulties to identify the voices of each pilot on the CVR, due to the cross wiring of the channels. The following explains the actual connections to the CVR.

Channel No	Standard position from the Manufacturer's Manual	Actual Position Connected
1	Observer Seat	Cockpit (Area microphone)
2	Copilot Seat	Observer Seat
3	Pilot Seat	Copilot Seat
4	Cockpit (Area microphone)	Pilot Seat

1.11.2.1 CVR Transcript

The CVR transcript was prepared at the KAIB analysis laboratory, by joint efforts of the KAIB, CAAC, and NTSB.

At the public hearing held in Busan from November 25 to 26, 2002, some differences were noted between the ATC recordings of communications and CVR transcript, so the parties from the three countries agreed to hold a meeting at the NTSB to resolve these differences.

From February 25 to 28, 2003, the three parties had a meeting to consider the proposal to amend the transcript at the NTSB. As the result of the meeting, the three parties signed the minutes which specified the partially amended transcription would be appended to the final report, and the NTSB had no objection to the amended transcript.

Thereafter, a precision analysis for the verification of the CVR transcript was conducted by the KAIB investigators at the KAIB analysis laboratory, using a digital sound analysis program,[80] and the result of which revealed that some timing and conversations in the transcript needed to be amended, thus the following changes were made.[81]

[78] Model No: 93-A100-80, serial No: 60987.
[79] CMM (Component Maintenance Manual).
[80] A computer program which can determine precise timing (Cool Edit Pro).
[81] The amended CVR transcript was delivered to the China investigation team during a CVR related technical meeting between the KAIB and CAAC held from Oct 30 to 31,2003.

The specific time and contents of the CVR transcript amended by the KAIB are appended as Appendix 1, and the amended transcript signed by three parties at the NTSB laboratory is contained in Appendix 1-1

Time	Source	Before Change	After Change
11:10:12 11:10:07	OBS (#2)	Turn left heading one eight zero Air China 129, descend to four thousand feet	Turn left heading one eight zero Air China 129, descend to four thousand
11:16:35 11:16:33	Approach controller	... ILS DME runway three six left and circle to runway one eight right	... ILS DME runway three six left then circle to runway one eight right ....
11:16:43 11:16:42	OBS (#2)	... Cleared visual one eight right…	... Cleared (unintelligible) approach one eight right…
11:18:48 11:18:44	Approach controller	... Circle to ...	… Circle west
11:20:26~ 11:20:25~	Tower controller	... Not in sight ... correction runway one eight right	... Not in sight… cleared to land runway one eight right
11:20:39 11:20:35	OBS (#2)	Circle approach one eight right and QNH three thousand Air China 129	Circle, (unintelligible) one eight right and QNH three thousand, Air China 129

1.12 Wreckage and Impact Information

1.12.1 General Description

The investigation results on ground markings and the wreckage distribution pattern[82] showed the initial contact with terrain of an elevation of 204m, where the right wing struck trees. As shown on the Figures 1-13 and 1-14, the wreckage was scattered in an area about 200 m long and 100 m wide.

About 30 m from the initial impact with trees, there was a hole about 3 m wide, 3.5 m long and 2 m deep. There was evidence of severe ground impacts from this point on with scattered parts from the flaps, landing gear, and engine inlets.

After the aircraft's impact with the ground, the right wing, empennage, left wing including parts of the fuselage, and two engines were separated respectively. The forward fuselage including the cockpit was totally consumed by a post impact ground fire.

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[82] Refer to Appendix 3, Wreckage Distribution Chart of Air China Flight 129 Aircraft.

Figure 1-13 Photograph of the Accident Site

Figure 1-14 Photograph of the Accident Site

1.12.2 Fuselage

The fuselage was found destroyed in the direction of flight, about 160 m from the point of the initial impact, and the aluminum and other metals of the fuselage were melted by the post impact fire.

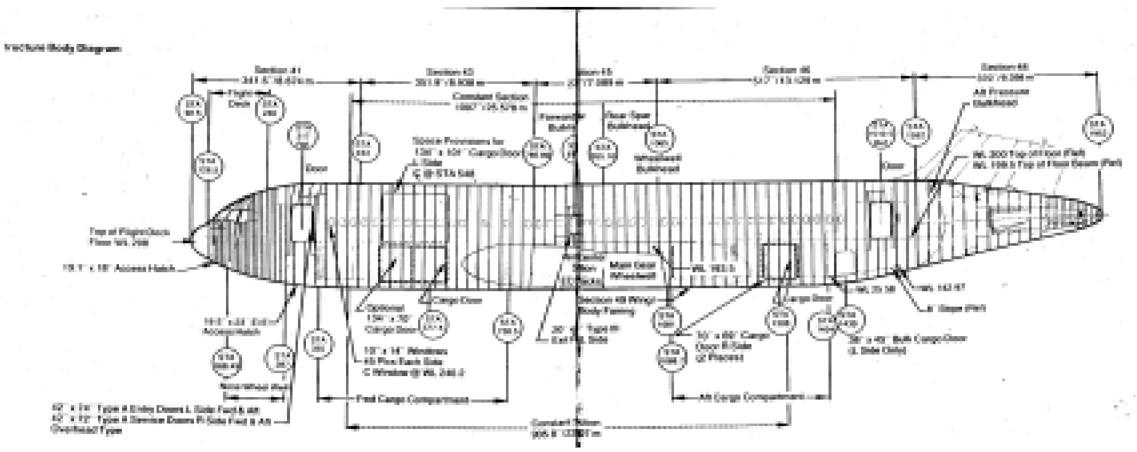

Figure 1-15 Aircraft Structure Diagram

The front part of the fuselage (section 41), including the flight deck, was completely destroyed from the impact forces and fire, making it difficult to recognize the shape including the flight instruments and switches.

The center fuselage parts (sections 43 & 45) and the aft cargo compartment (section 46) were burnt completely to the point of making the shape unrecognizable

1.12.3 Empennage

The empennage (section 48) containing the APU, vertical and horizontal stabilizers was found separated from the fuselage by the impact forces, approximately 25 m northeast from the top of Mt. Dotdae, and there was no fire in this area.

Visual examinations of the ribs, skin and spar at the attachment points showed no evidence of corrosion or fatigue.

The left elevator was found with its trailing edge up and touching the ground, and the right elevator was broken by the ground impact forces.

Both elevator tips were sheared off, with the elevators lying flat on the ground supporting the tail section upright.

The horizontal stabilizer's jackscrew extension was measured to be 14 inches between the lower gimbal assembly and the lower stop.

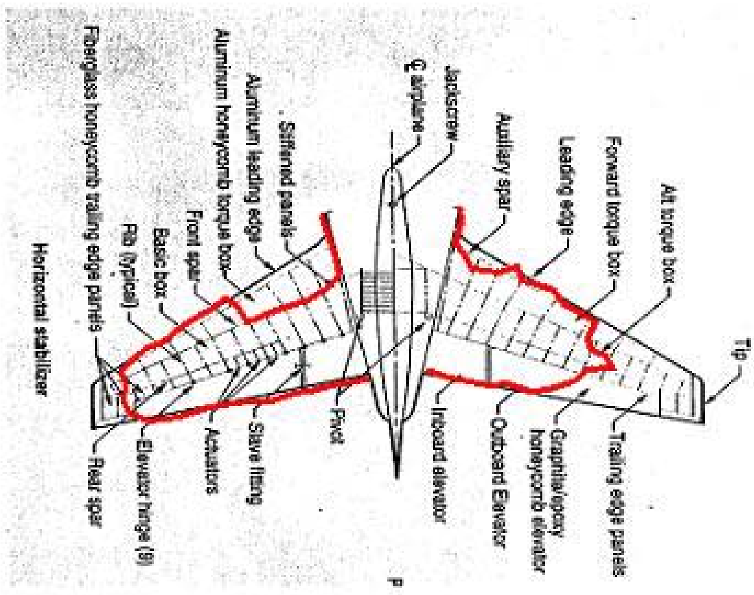

Figure 1-16 The Remaining Portion of the Wreckage (inner area of red line)

The front surface of the left horizontal stabilizer (as shown on Figure 1-16) was damaged and the tip was sheared off by an impact with the trees. While there were signs of the impact with trees on the front inner part of the left stabilizer, there was no sign of the preimpact skin corrosion or damage.

Front parts of the right horizontal stabilizer were found in a good shape, but the outer tip of horizontal stabilizer was partially sheared off from the impact with trees and the ground.

The left and right elevators were damaged by the ground impact, and there was no external damage to the actuators.

The APU was normally attached on the empennage section with no signs of fire.

1.12.4 Wings

The right wing was found separated from the fuselage and inverted by the ground impact, and the left wing was not separated from the burnt fuselage.

There was no fuel found in the right wing fuel tank, and the left wing fuel tank had remaining fuel of approximately 300 lb. There were no signs of fire.

The ailerons of both wings were severely damaged by the impact forces, and the spoilers were found in the closed position, damaged on their surfaces

1.12.5 Engines

The right engine impacted the ground in the direction of flight, about 30 m from the point of the initial aircraft impact with the trees, and was lying down 70 m further from that position in the same direction.

The left engine was found about 200 m forward in the direction of flight from the point of the initial impact.

Both engine inlets contained quantities of dirt and wood. Externally, there were no distortions to the high-pressure compressors, the combustion chambers and the turbines. Borescope examinations of both engines revealed normal conditions. The first stage blades of the low-pressure compressors (LPC) were all bent in the same direction with severe rotational damage.

1.12.6 Aircraft Systems

All of the aircraft systems were operated normally, and the examination on the wreckage revealed no evidence of preimpact damage or malfunction.

Flight deck instruments and controls for the primary[83] and secondary[84] flight control surfaces were damaged by the postcrash fire. Some parts of the flight control surfaces and actuators were found, but none showed evidence of preimpact damage or malfunction

The flight control computers (FCC)[85] were found with the electronic rack in the front part of the fuselage where the flight deck wreckage was located. The casing and connection ports were severely damaged by the postimpact fire.

[83] Ailerons, elevators, rudders.
[84] Flaps, spoilers, slats, speed brakes, stabilizers, etc.
[85] P/N (Package No): 622-4591-512 (SCD S241T100-109), S/N (Serial No): 3338, 3892, 5656.

1.13 Medical and Pathological Information

1.13.1 Toxicological Analysis of the Captain

Blood samples were taken from the captain on the day of the accident at Gimhae St. Mary's Hospital, where he was hospitalized. The hospital's laboratory performed tests for blood type, biochemistry, hematography, serum immunology, and urinalysis. The liver function test had no special remarks, and there was no evidence of alcohol intake.

Drug testing for methamphetamine and MDMA[86] was referred to a related agency on April 28, 2002, which used gas chromatography/mass spectrography to test hair samples. The results were negative.

1.13.2 Fatal Injuries

Of the 129 fatalities, 6 were identified through external means of recognition,[87] and 121 of the remaining 123 occupants were identified through DNA testing by a relevant agency from a total of 186 gene samples collected, while 2 victims were not identified.

The direct cause of death for the 2 occupants who died after arriving at the hospital, was respectively recorded on the death certificates as cardiopulmonary arrest,[88] and suspected heart failure & suspected kidney failure.[89] The direct cause of death for the 4 passengers, who were identified by fingerprints, was respectively recorded on the death certificates as burns over the entire body, brain concussion and cranial fracture,[90] with 2 cases of cardiopulmonary arrest.[91]

Autopsies were performed on the remains of 123 victims for the purposes of identification. According to the opinions on the cause of death of medical specialists who

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[86] 3,4-**M**ethylene**D**ioxy**M**eth**A**mphetamine.
[87] Died in the hospital subsequent to identification: 2, identified through fingerprint: 4.
[88] Intervening antecedent cause of death: heart & breathing failure, antecedent cause of death: traumatic hemothorax.
[89] Antecedent cause of death: 45% burn by fire.
[90] Intervening antecedent cause of death: laryngeal contusion.
[91] Intervening antecedent and antecedent causes of death: 1 multiple damage, 1 unknown damage.

conducted the autopsies, soot was found in 16 of the victims' tracheas, suggesting that they may have been alive at the time of the fire. The medical specialists also reported that it was difficult to make conclusive judgment, because of severe burn injuries, whether the deaths of the victims were caused by impact trauma, fire, or a combination of both.

1.14 Fire

The on-scene investigation revealed no signs of fire on board the aircraft prior to crash. After the ground impact, the right wing and the empennage were separated from the fuselage. These items had no fire damage. The first sign of fire damage was found approximately 150 m from the initial point of impact.

At the accident site, it was raining with heavy fog. Fire fighters, soldiers and police struggled to apply dry chemical and halon fire extinguishing agents, and dirt to put out the fire, but the interiors of the cabin and flight deck were burnt completely, as shown on Figure 1-17. The fuselage fire, accompanied with exploding sounds and heavy smoke, was extinguished about 15:00 on the day of the accident.

Figure 1-17 Photograph of the Aircraft on Fire after Crash

1.15 Survival Aspects

1.15.1 General

The flight deck was fitted with seats for the captain, first officer, and two observers. In the passenger compartment, there were a total of 7 flight attendant jump seats, with 3 seats located in the front of the cabin facing the back of the aircraft, and 2 seats each located respectively in the middle and aft cabin facing forward.

There were a total of 214 passenger seats in the cabin, comprised separately of 18 for business class and 196 for economy class.

There was a total of 166 occupants on board, composed of 11crewmembers and 155 passengers, including 5 children between the ages of 3 and 9. On the day of the accident, 39 occupants, including the captain, survived with serious injuries. But the next day, 1 passenger died, and on May 2, 2002, 17 days after the accident, another passenger[92] died, bringing the total number of survivors to 37, the captain, 2 flight attendants, and 34 passengers.

Figure 1-18[93] shows that 8 of the 34 surviving passengers were seated in the economy class between rows 7 and 14, and out of these, 5 were seated on the left side and 3 in the middle seats. The seating for the other 26 surviving passengers was distributed from rows 19 to 33 in the back of the economy class, of which 3 were on the left side, 18 in the middle, and 5 on the right side.

The 2 surviving flight attendants were seated in jump seats located on the left (L2) and right (R2) in the back of the aircraft.

[92] Refer to 1.13 Medical and Pathological Information for the cause of death for the 2 passengers who died from crash wounds in the hospital.

[93] * The seating chart was made using the passenger manifest and statements of survivors, so there was no way to determine the actual seat locations of the passengers.

* 11 of the dead passengers who changed seats during the flight were not depicted.

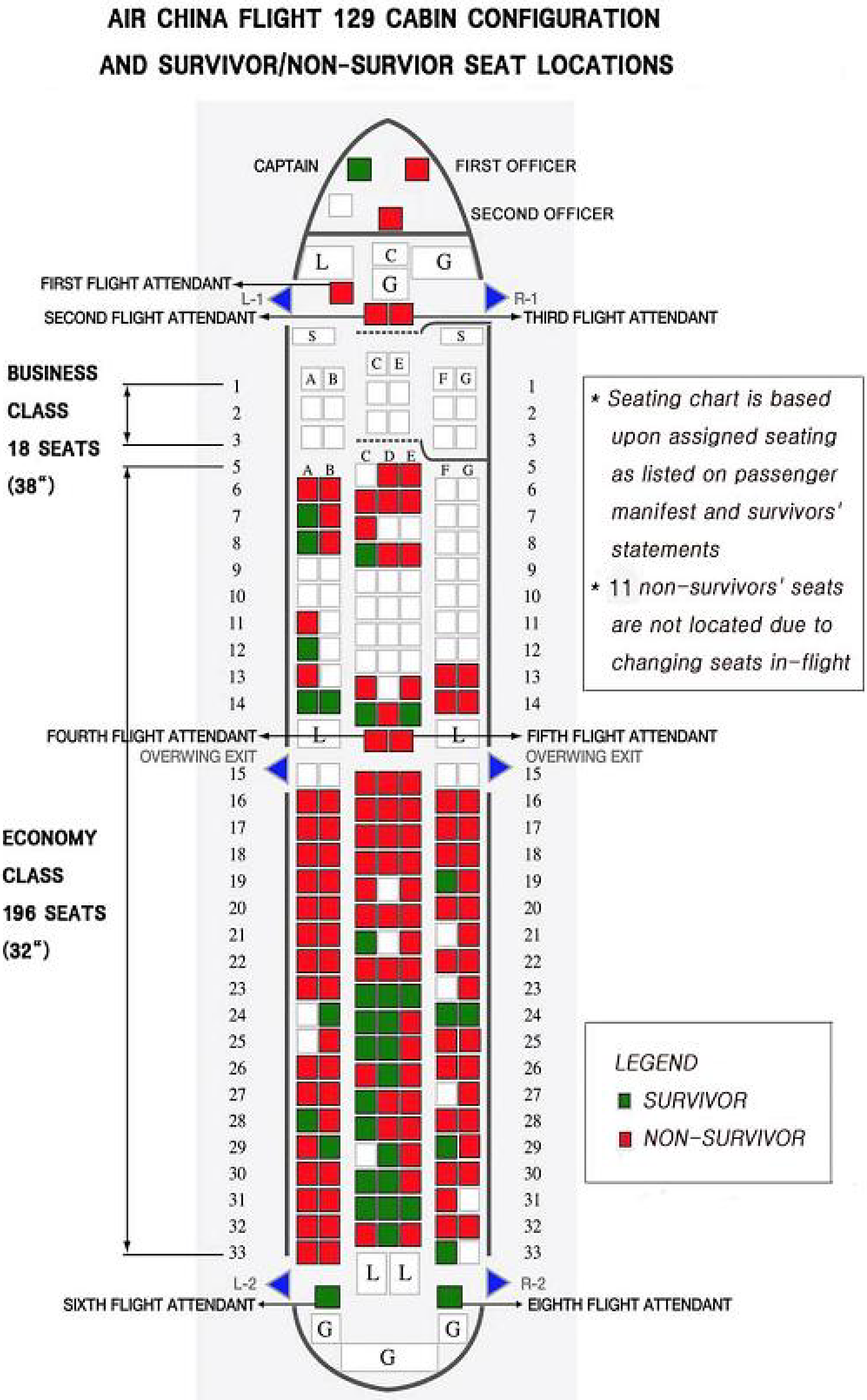

Figure 1-18 Seating Chart Showing the Location of the Occupants

1.15.2 Survivor Statements

Investigators from the KAIB and NTSB interviewed all 37 survivors including the flight attendants, and questionnaires were sent to 34 passengers, of which 9 responded.

The interviews and responses to the questionnaire revealed that the accident occurred suddenly, with loud noise and violent shaking of the aircraft at the point of impact. All items inside the aircraft fell down, seats were thrust forward, and all lights went out, making it dark inside the aircraft, except for light streaming in through the broken fuselage. There was fire erupting throughout the cabin, filling it with heavy smoke and making it difficult to breathe, and people were screaming. Most of the passengers briefly lost consciousness during impact, with feet and legs of some passengers stuck under the seats in front of them.

A flight attendant who was seated at the aft right position (R2) stated that his body was crushed underneath something. He reached to open the door but could not find the handle. He crawled out of the cabin, giving assistance to a female passenger. He then shouted, "Go, Go" to the passengers to move far away from the aircraft, and was helped by a passenger to move away from the aircraft, due to sharp pains in his back and chest. The captain and the flight attendant from the aft left jumpseat position (L2) could not remember their process of escape from the aircraft after crash.

Most of the survivors escaped by walking or crawling through the gaps in the broken fuselage. Most of them stated that they were injured[94] at the time of accident, and that they heard sounds of explosions large and small after escaping. Some passengers stated that they saw pillars of fire and smoke shooting up high from the exploding aircraft.

Some of the Korean passengers stated that they did not understand any of the in-flight announcements, including the predeparture passenger safety briefing, because they were made only in Chinese and English.

[94] Hospital records(clinical assumptions) showed that most of the survivors suffered multiple lacerations and multiple contusions, brain contusion, brain concussion, facial contusion and laceration, lumbar sprain, lumbar fracture, and burns, etc.

1.15.3 Emergency Response

1.15.3.1 Notification of the Accident

Radio communication between the tower local controller and flight 129 was lost about 11:21:17. Although the crash site was located about 4.6 km from the threshold of runway 18R along the extended centerline, which was only about one minute in terms of flying distance, the controller was not able to confirm the crash due to an impediment to visibility.

The local controller tried to communicate with flight 129, 5 times over approximately two minutes to confirm the position of the aircraft when the aircraft remained out of view, calling 10 times on the emergency frequency, but there was no response.

Records of the tower hotline showed that the secondary local controller notified the lost communication situation individually, first to the Gimhae Airforce Base Operations about 11:25, and then to the Gimhae airport Flight Information Office about 11:27. Then the coordination controller confirmed whether there were any reports of crash with the MCRC (Master Control Reporting Center), Gyeongnam fire department and Gimhae fire station. About 11:41, the secondary local controller confirmed through the Incheon ACC whether there was any report of the missing flight.

Records indicated that Gimhae Airforce operation department received notification from the tower about 11:25 of lost communication with the flight, they then notified agencies outside the airport (Gyeongnam and Busan fire departments, etc.) about 11:40

Crash-phone records showed that the tower secondary local controller, who was the duty chief at the time of the accident, made initial notification of the crash behind Mt. Shinuh, using the crash-phone and bell about 11:45, to relevant agencies of Gimhae Base, in accordance with the emergency notification system set up in the Gimhae Base Local Procedures.

Testimony by the air traffic control manager in air traffic control division of Busan Regional Aviation Administration showed that he received the information about lost radio communication with flight 129 from Gimhae approach control about 11:23, and received information about the crash from the Flight Information Station about 11:45. He then notified Busan City's Central Emergency Management Office in accordance with the disaster management plan of the Busan Regional Aviation Administration.

1.15.3.2 Mobilization

About 11:22 on the day of the accident, the Gimhae fire station received a report from an apartment management staff living near the scene of the accident that he heard a loud explosion from the direction of Mt. Shinuh while a plane was flying by at low altitude. Immediately after receiving the call, the Gimhae fire station dispatched 8 persons on the first rescue team to the accident scene, and about 11:30, the second rescue team of about 40 members including the Gimhae fire chief was dispatched to the accident scene. About 11:31, the fire station received calls about an aircraft crash from two passengers using the mobile phone.

About 11:43, the rescue captain from the first team requested helicopter rescue support, but helicopters could not be mobilized due to poor weather conditions. The rescue teams from the Gimhae fire station arrived on the accident scene from about 11:58 on, and began the search and rescue work. The total number of rescue workers and firefighters mobilized from Gimhae and adjacent fire stations was 1,009 on the day of the accident.

The Gimhae police station received the report of crash about 11:43 from the "119" situation room of the Gimhae fire station. The rescue teams from the Gimhae police station arrived on the accident scene from about 12:12 on, and carried out the rescue work. The combat police unit #2502 received a mobilization instruction from the Gyeongnam Provincial Police Agency, and arrived on the accident scene from about 12:25, and began the rescue work. The total number of the police mobilized from the Gimhae police station, combat police unit #2502, surrounding area police stations and standing police units was approximately 2,000 on the day of the accident.

The Army's 39th and 53rd infantry divisions and the 1116th field engineer regiment learned of the accident through a television (YTN) broadcast between about 11:40 and 11:50. The Army soldiers arrived on the scene of the accident from about 12:10 on, and carried out the rescue work. The total number of soldiers from the Army's 39th and 53rd infantry divisions and the 1116th field engineer regiment was 1,071 on the day of the accident.

The Navy's third fleet command learned of the accident through the YTN broadcast about 12:00, arrived on the accident scene from about 14:00 on, and carried out the rescue work. The total number mobilized from the Navy's third fleet command was 226 on the day of the accident.

The fifth tactical airlift wing of the Airforce was notified of the accident by Gimhae control tower, arrived on the accident scene from about 12:30 on, and carried out the rescue work. The total number of airmen mobilized from the fifth tactical airlift wing of the Airforce was 213.

1.15.3.3 Rescue Operations

When the rescue team from the Gimhae fire station arrived on the accident site through a trail behind Dongwon apartment located in Ginae-Dong, Gimhae, the fuselage was engulfed in flames, and there were continual explosions from the front of the fuselage, with pillars of fire rising. It was raining at the accident site, with the visibility of about 10 m due to a dense fog. They heard survivors' screaming for help from a distance, but they were not able to see them because the hill was thickly wooded, so they searched for survivors by clearing the forest.

The fire brigade, police, and military jointly carried out the rescue operations. First aid for the injured and the rescue operations for survivors were completed about 13:21. The on-scene commander[95] stated that there were three main trails[96] to the accident site, but the paths were narrow and slippery due to rain, and it took about 20 to 30 min to climb, and about 30 min to come down the hill for transporting the injured.

About 12:30, three[97] emergency field medical units were set up, since no ambulance could have access to the accident site which was near the summit of Mt. Dotdae. The injured were given simple first aid by the rescue team and medical staff at the accident site, and then were transported down to the emergency medical units.

The emergency field medical units divided the injured according to the seriousness of the injuries, and assigned the patients to nearby hospitals using ambulances. There were 17 urgent cases and 22 emergency cases.

Records from the 13 hospitals in Gimhae and Busan, where the survivors were treated, showed arrival times[98] between 12:00 and 14:45. 6 survivors arrived between 12:00 and 13:00, 17 survivors arrived between 13:00 and 14:00, 15 survivors arrived between 14:00 and 14:30, and 1 survivor arrived at 14: 45.

About 14:40, a command post[99] was set up at a location approximately 1km from the accident site, and a communication network was operated thereafter. Starting on the day of the accident, joint conferences, attended by the fire brigade, police and military, were held as necessary at the accident site, and the search and rescue effort for the lost continued until 17:00 on May 13, 2002.

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[95] The fire chief of Gimhae fire station.

[96] 1. Jine-Dong Dongwon Apt, 2. To Jine-Dong Hyundai Maintenance, 3. To Daedong Myun Suan Li.

[97] In front of Jine-Dong Dongwon Apt No.110 (about 0.9 km to the site).
Next to the Command Post near Jine-Dong Dongwon Apt (about 1 km to the site).
In front of Jine-Dong Hyundai Maintenance Factory (about 1.2 km to the site).

[98] May differ from the actual time, since arrival time includes time expended for patient identification.

[99] Near Jine-Dong Dongwon Apartment.

1.16 Tests and Research

1.16.1 CAB Demonstration

On October 2 and 3, 2002, simulations of the approach to Gimhae airport flown by flight 129 on the day of the accident were made at the Integrated Aircraft System Laboratory of the Boeing Company, located in Seattle, USA, using the B757/767 Engineering Cab,[100] with the demonstrations carried out jointly by a total of 14 investigators[101] from the KAIB, NTSB, FAA and Boeing.

During the simulator demonstrations, the following types of evaluations were conducted:

- Backdrive Simulator Cab (no pilot in the loop) of the circle to land maneuver (starting time 6,100 seconds[102]);
- Backdrive with pilot interrupt (the pilot taking control at his declaration) to hand fly the maneuver and demonstrate the pilot workload.
- A circle to land maneuver flown manually, adjusting heading and timing for the wind conditions from the initial start point (time 6.100seconds) ending with touchdown on runway 18R.
- Starting the base turn (starting time 6,235 seconds[103]) and using the pilot interrupt function, initiated go around and terrain avoidance maneuver, 6, 4 and 2 seconds prior to impact.

The three tracks plotted on Figure 1-19 began from the same starting point, where: ① manual circling approach maneuvering track with wind corrected heading and 20 seconds time check; ② the backdrive cab track; and ③ the FDR track are shown.

(Note: The runway position is the same for all 3 tracks.)

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[100] B757/767 Engineering Cab: A simulator equipment to test B757/767 aircraft systems.
[101] The Chinese party did not intend to participate, thus the demonstrations were not attended by the Chinese party.
[102] The time from the FDR data when the circling approach began, based on JT9D-7R4E engines.
[103] The time from the FDR data when the base turn began, based on JT9D-7R4E engines.

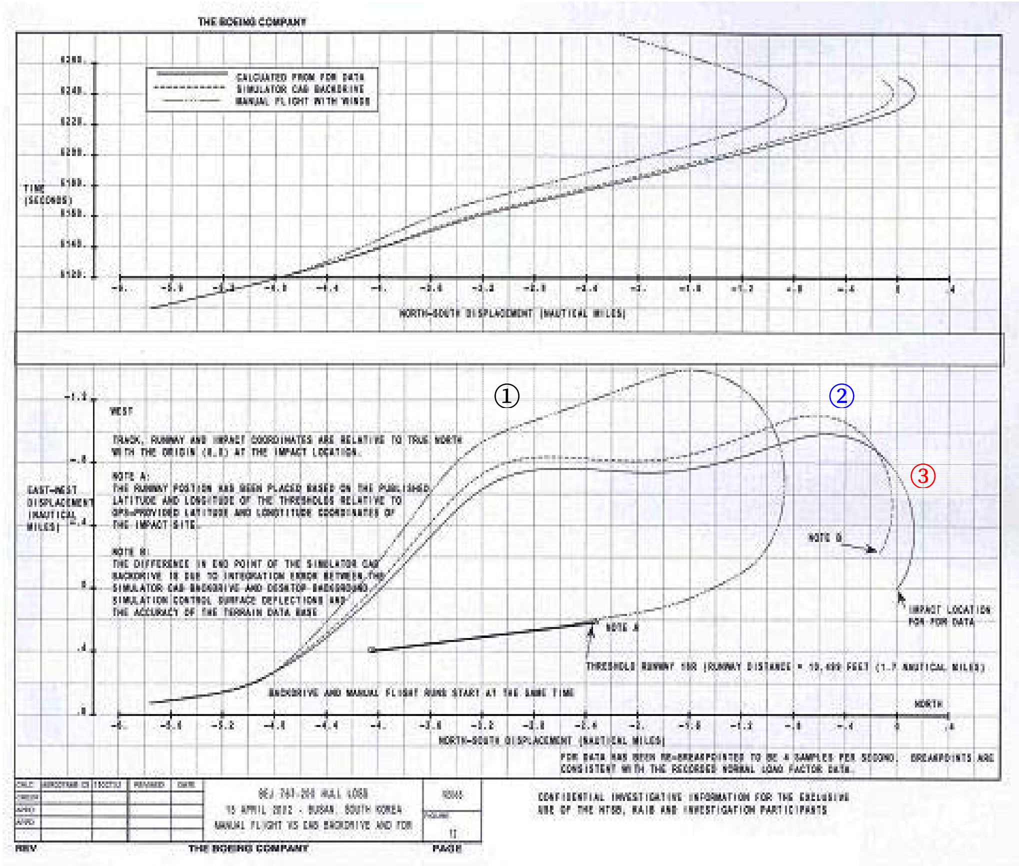

Figure 1-19 Flight Tracks from the Simulator Backdrive Session

The go around maneuvers were flown by advancing the throttles to the forward stop, transitioning flaps from 30 to 20, and pitching the aircraft to 15°nose up, while maintaining the turn to the airport.

(Note: For the 6 seconds initiation of a go around, the throttles were advanced by the autothrottle TOGA[104] function only.)

Terrain avoidance maneuvers were flown by advancing the throttles to the forward stop, pitching to 20°nose up while maintaining the turn to the airport. The backdrive for these maneuvers started at time 6,235 seconds which was the starting time of the base turn, with the pilot interrupt, flying manually, occurring ① 6, ② 4 and ③ 2 seconds prior to the approximate time of impact. Figures 1-20 and 1-21 show the climb performance data, including climb margins, for the go around and terrain avoidance maneuvers respectively. The relative mountain peak is shown graphically.

[104] Takeoff and Go around.

Both go around and terrain avoidance maneuvers showed the aircraft clearing the mountain when either maneuver was performed 6 seconds prior to impact.

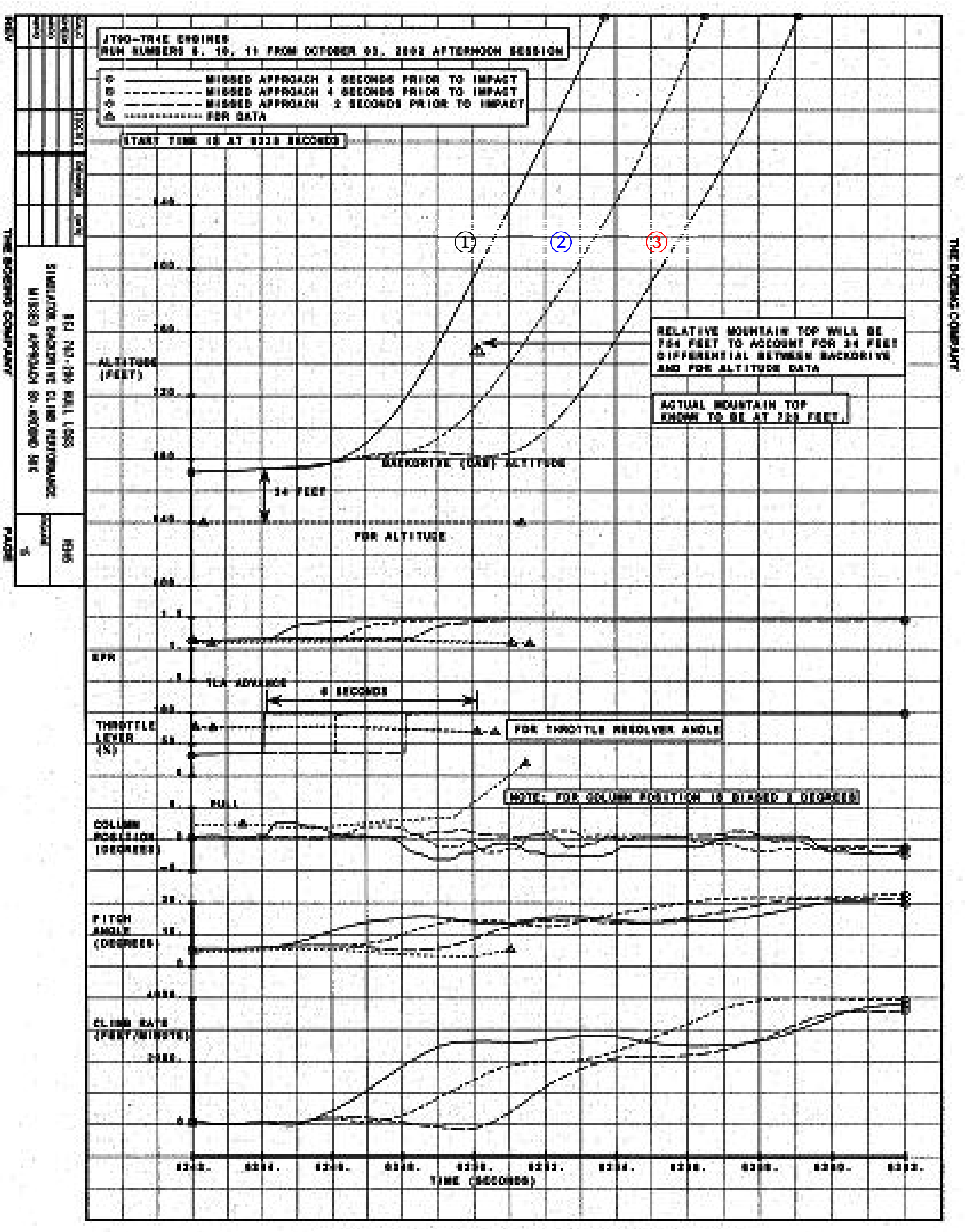

Figure 1-20 Climb Performance Data, Missed Approach Maneuver

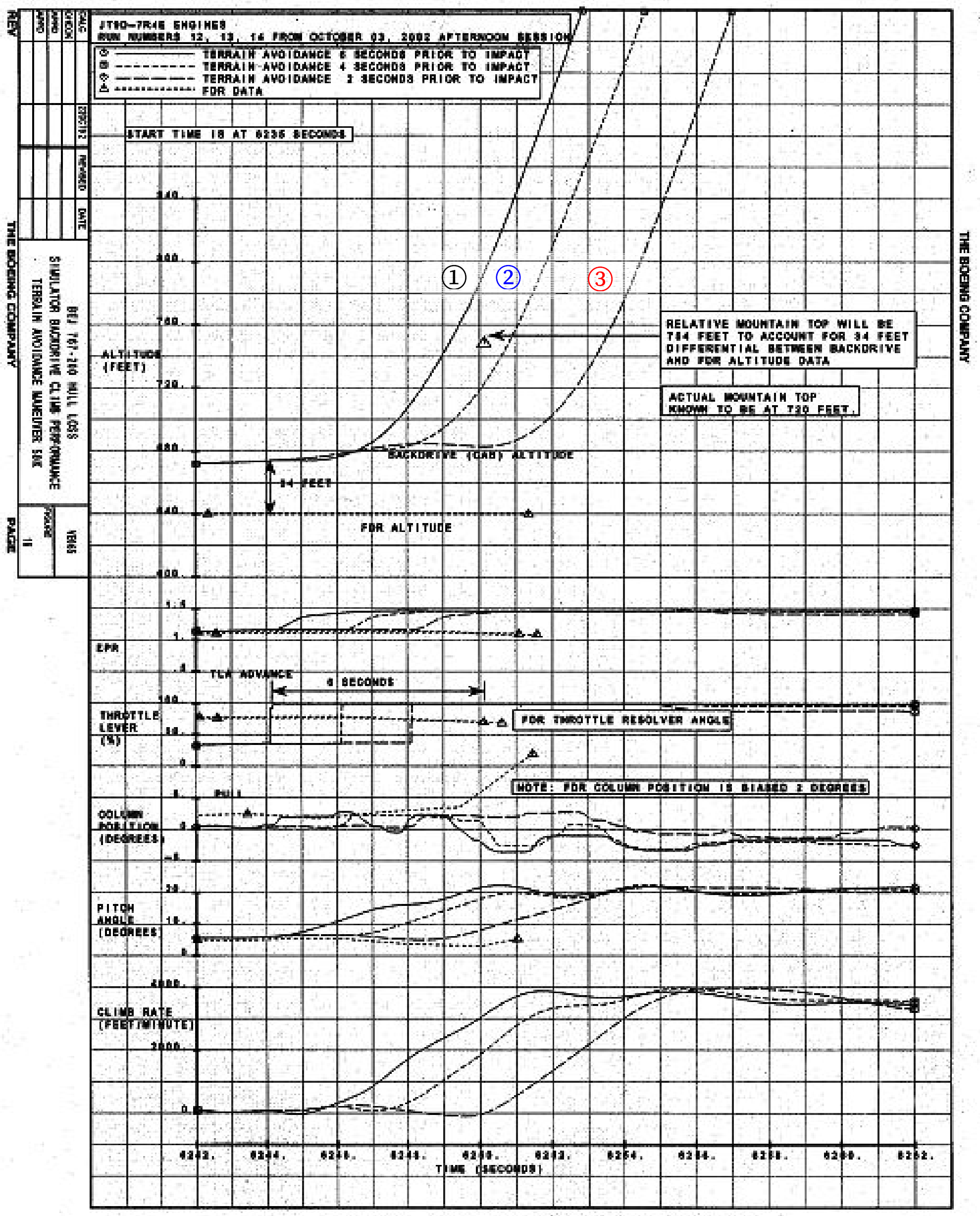

Figure 1-21 Climb Performance Data, Terrain Avoidance Maneuver

1.16.2 Flight Management Computer

The flight management computer[105] of the flight 129 aircraft was removed and taken to the manufacturer, Honeywell[106] on July 25, 2002, in order to confirm whether or not there was any fault with the computer by extracting the data from the non-volatile memory (NVM).

[105] P/N (Part No): 4052500-927, S/N (Serial No): 87090949.
[106] Located in Seattle, WA. USA.

The examination revealed that all the data were lost because of a severe fire and water damage to 5 NVM chips and DC battery located in the IC panel (A-13 card), therefore, analysis on the NVM could not be conducted.

1.16.3 Ground Proximity Warning Computer (GPWC)

The flight 129 aircraft was equipped with the MK-III GPWC, which was manufactured by Honeywell, in Seattle, USA.

Detailed examination on the performance assessment of the GPWC was conducted by the relevant specialists and KAIB investigator at the manufacturer, Honeywell, on July 22 ~ 24, 2002, after the accident.

The examination results revealed that the aircraft was maintaining level flight at an altitude of about 700 ft with the landing gear and flaps extended, approaching Mt. Dotdae of about 230 m (755 ft), at a ground speed of about 133 kt, which was outside the MK-III GPWC's warning envelope. Therefore, it was verified to be normal that a warning was not activated at the time of the accident.

1.16.4 Electronic Engine Controller (EEC)

Non-volatile memories (NVM) of the two EECs[107] installed in the engines were analyzed at the manufacturer, Hamilton Sundstrand on September 4, 2002. The analysis results revealed that the EECs installed in the engines operated normally.

1.16.4.1 Left EEC

The NVM data of the Left[108] EEC showed entries 7 hours[109] before the accident, which were recorded as "MN (Mach Number), Total Pressure (P2) Leak, T2 Heater Required, J2 Not Installed." These entries occurred during the ground maintenance

[107] EEC type: EEC 103-1.
[108] P/N: 780170-13, S/N: 5194, total operating time: 23,463 hrs.
[109] Operating time of only the EEC: 23,456 hrs.

engine test run, and were not related to the accident. No in-flight faults were recorded on the Left EEC.

1.16.4.2 Right EEC

The NVM data of the Right[110] EEC showed entries 8 hours[111] before the accident, and which were recorded as "J2 Not Installed, T2 Heater Required, P2 Leak." These entries occurred during the ground maintenance engine test run, and were not related to the accident. No in-flight faults were recorded on the Left EEC.

1.16.5 Inertial Reference Unit (IRU)

Three inertial reference units[112] of the flight 129 aircraft were found installed in their racks. Precision analysis of the units was made at the manufacturer, Honeywell, at Minneapolis, Minnesota, from September 11 to13, 2002.

Examinations were conducted to determine whether there were any faults during the last 10 power cycles before the accident by extracting data from the non-volatile memory (NVM) units of 2 IRUs. The examination results showed that 2 IRUs operated normally, but the data from the other remaining IRU were lost due to a severe accident-induced damage.

1.16.6 Auxiliary Power Unit (APU) Controller

Precision analysis of the APU controller's[113] NVM of the flight 129 aircraft, conducted on August 2, 2002, at the manufacturer, Honeywell, revealed that the APU was not operating in flight.

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110 P/N: 780170-13, S/N: 0274, total operating time: 27,560 hrs.
111 Operating time of only the EEC: 27,552 hrs.
112 P/N: HG 1050AD04, S/N: 1548/01, 1727 and HG 1050AD09 (S/N: 5734).
113 P/N: 2117342-19, S/N: 36-619.

1.17 Organizational and Management Information

1.17.1 Air China Flight Crew Training

While the CAAC Order 77 (CCAR-62FS) requirement for Chinese airline operators' ground school specified 25 hours of the academic instruction per year, no curriculum or lesson plan was mentioned separately in the regulation. Instead, the ground school requirements were met through seasonal safety education, instructions on revisions by the aircraft manufacturer, and different seminars. The flight crew of the accident flight received the ground school instruction[114] during the simulator flight training.

According to Air China officials, during transition or upgrade training, evaluations (tests) were made upon completion of the ground school. The academic training for the existing line pilots was conducted by instructors prior to the recurrent simulator training, but the training center did not provide the KAIB with the lesson plans or the evaluation criteria.

The ground school and flight training were conducted at the Air China Training Center, and the upgrade and recurrent training on the B767-200 type were conducted using the B767-300 simulator.[115]

The flight crews on the B767 type received proficiency training twice a year in accordance with the B767 Flight Crew Training Manual (FCTM), and the recurrent training syllabus. The training consisted of four lessons, divided into 2 lessons respectively for the first[116] and second[117] half of each year. The contents of each lesson varied widely, where the circling approach training fell under the third lesson during the second half, with Beijing airport as the training airport.

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[114] ① The captain: Aug 30, 2001. ground school test score on simulator training: 97.
② The first officer: Aug 22 ~ Sep 18, 2000. Ground school test score on B767-2/300 type training: 98/96.
③ The second officer: Aug 22 ~ Sep 18, 2000. Ground school test score on B767-2/300 type training: 98/92.

[115] 1 B757-767 dual type simulator , level D, 180° field of vision, CE manufactured & FAA approved Mar 1996, CAAC Approved for operator use.

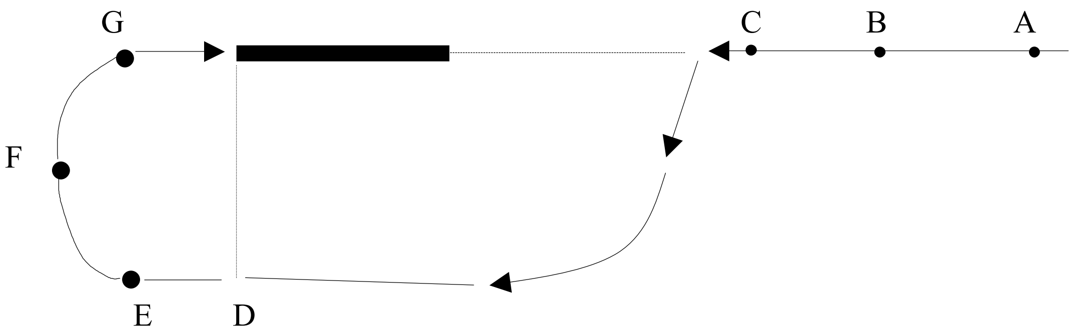
[116] The first lesson and second lesson.

[117] The third lesson and fourth lesson.

1.17.1.1 Circling Approach Procedure Training

The circling approach procedure, as contained in the recurrent B767-200/300 FFS (Full Flight Simulator) training guide issued by the Air China Flight Training Center, was to be conducted as follows:

「Aircraft positioned 6 NM from runway 36L at Beijing airport with autopilot (A/P), auto-throttle (A/T) and flight directors (F/D) engaged; lateral control in LOC mode and vertical control in V/S mode; ceiling at or above 1,000 ft and visibility 5 km; lighting for runway 18R illuminated.



A: Gear down, Flaps 20, call out A/P in use, and use LOC & V/S modes.

B: Set missed approach altitude after reaching the MDA.

C: Select heading offset 45° L/R, time for 20 seconds to enter downwind.

D: Start timing for 20 seconds passing abeam the end of runway.

E: Flaps 30, turn base, complete the landing checklist.

F: Roll out on base, check runway visual glide path, disengage A/P and descend.

G: Roll out on final, turn off both F/Ds, then turn on F/D on the PNF side.

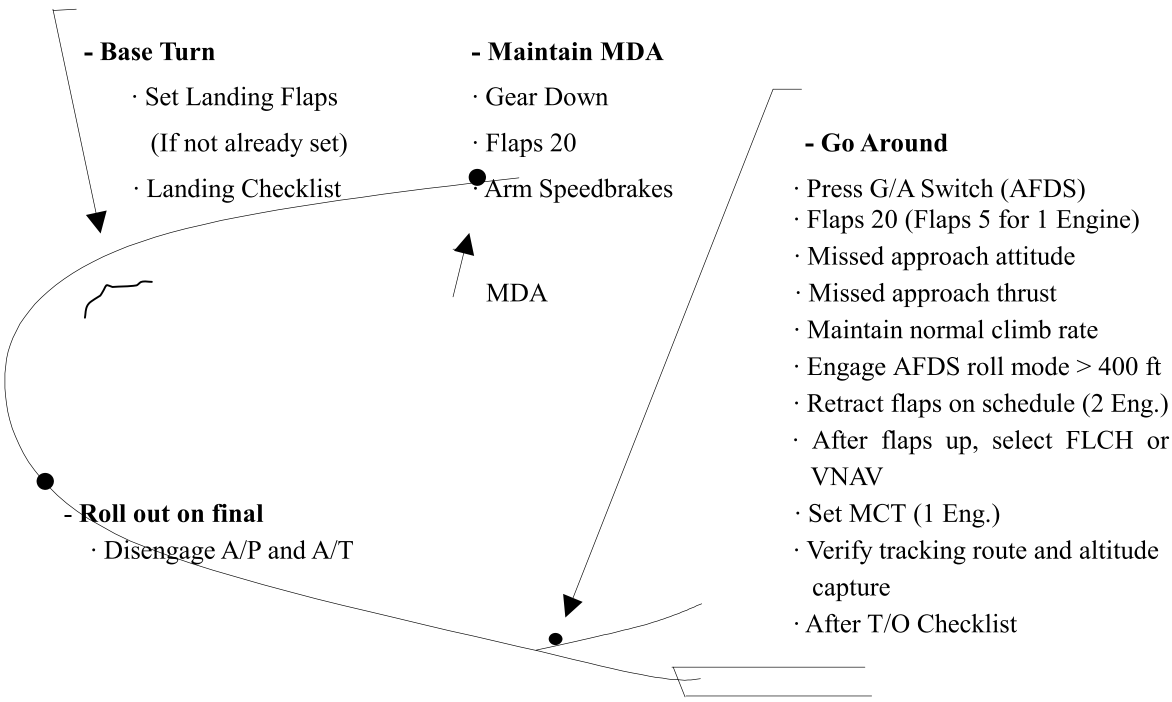
Notes:

1. The above procedure was established with Beijing airport as an object referring to Boeing procedures, and is to be adopted only for training.
2. Apply MDA and visibility limits as the higher of the ceiling & visibility for either end of runway, in accordance with the operations manual and the airport weather minima criteria.
3. Maintain constant visibility for descent to the MDA. May approach and land in

the opposite direction.

4. Correct for winds
5. Assuming visual contact with the runway during base turn, satisfy terrain, weather and local airport requirements.
6. If a missed approach is required during the circling approach, turn in the direction of the runway, not in the shorter direction, even if the turn requires more than 180° of change in heading. Maneuver with the flap setting for missed approach. 」

Additionally, the Air China Flight Crew Training Manual prescribed the following procedure for the circling approach:



1.17.1.2 Crew Resource Management (CRM) Training Program

According to the CAAC Order No. 51[118] and crew resource management section of the Air China's B767 flight crew training handbook, company pilots were required to

[118] Qualification Standards Regulation for Civil Aircraft Pilot and Instructor.

undergo 18 hours of CRM training over a three-day period.

Instructional material included “Principles of Safe Flight,” “Judgment and Decision Making,” “Mistake and Prevention” and “Controlled Flight into Terrain.” Videotapes included titles such as “New Hire Orientation,” “What is your opinion?” “CFIT Prevention,” “Red Warning,” “Bird strike,” “RTO Simplified,” “No Flap Landing” and “What?”

Following completion of training with test scores above 80 points, the training center would issue a certificate, but the training center did not provide the KAIB with certificates for the flight crew of flight 129.

1.17.2 Air China Preflight Procedures

According to Air China’s Operations Manual,[119] crews scheduled for international flights were to report for duty on the day prior to the scheduled flight to obtain the various materials[120] necessary for flight and to update them with the most current revisions. After checking the international flight related documentation and receiving various reporting forms, they were to study the departure and destination airports, enroute information, flight methods, special flight procedure for airport area, including responses for abnormal situations and crew resource management.

They also were required to receive checks from an aeromedical examiner, for a medical clearance to be included in the flight approval documentation. The flight crew of flight 129 was medically cleared for the flight through a physical exam about 14:00 (Beijing time) on April 14, and completed the flight preparation procedures.

The following items were specified for the flight crew briefing: 「(1) The captain is to convene the preflight briefing, to be attended by all scheduled cockpit and cabin crew members, for a combined report on the status of all preparation. (2) The captain is to verify each of the activities. (3) He is to clarify division of duties for each respective crew member, to closely coordinate for teamwork, including specific provisions against unlawful activity. (4) He is to verify the validity of all certificates and documents required for flight. (5) He is to make request as necessary to ensure flight safety and service.」

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[119] Flight Operations Manual 4.0.

[120] (1) Jeppesen Airway Manual (2) Communication & Navigation Manual (3) English-Chinese Dictionary (4) Asia, Australasia and Pacific Supplement (Feb 22, 2002) (5) Flight Information Supplement (6) Communication Records (7) Flight Manual (Domestic China).

The flight crew of flight 129 arrived at the dispatcher's office located in the international terminal approximately an hour and half before departure time, and received five flight documents[121] from the dispatcher. Fifteen minutes prior to departure, the load release sheet for the crew was released in the aircraft by an operations agent.

1.17.3 Air China Descent and Approach Procedures

Air China's Operations Manual Section 4.3.8, which described descent and approach procedures, required the crew before each descent to be ready with (1) descent planning, (2) a STAR chart, (3) an approach profile, (4) an aerodrome chart, (5) the landing data, and (6) ATIS information. It stated that the detailed planning and approach clearances were the most important parts of a safe approach.

Prior to the Descent and Approach Checklist, the pilot-flying was to review briefly with the pilot-not-flying: (1) the type of approach and the name of the procedure, (2) the minimum sector altitude, (3) the airport elevation, (4) the MDA/DH, (5) applicable weather minima, (6) missed approach procedures, (7) taxi procedures and (8) the transition level. Each flight crewmember was required to become familiar with the planned approach procedure for recall as necessary.

According to Air China's flight crew training manual,[122] the approach briefing procedure was stated as follows:

「Thorough planning and briefing are the keys to ensuring a safe, unhurried, professional approach. Prior to the start of an instrument approach, the pilot-flying should brief the other pilot as to intentions in conducting the approach. Both pilots should review the approach procedure. All pertinent approach information, including minimum and missed approach procedures, should be reviewed and alternate courses of action considered.

Aircraft Category (FAA)	Speed
C	121 knots or more but less than 140 knots
D	141 knots or more but less than 166 knots

[121] ATC flight plan, computer flight plan, weather sheet, NOTAM, flight release sheet.
[122] B757/767 Flight Crew Training Manual, Page 4.3 (published Dec 1, 1999).

· 767-200/767-400

The 767 is classified as a category “C” or “D” airplane, depending upon maximum landing weight, for straight in approaches. For circling approaches, use category “D” minima, or the minima associated with the anticipated circling speed.」

The Boeing Flight Crew Training Manual stated the following on the approach briefing:

「Thorough planning and briefing are the keys to ensuring a safe, unhurried, professional approach. Prior to the start of an instrument approach, the pilot-flying should brief the other pilot as to intentions in conducting the approach. Both pilots should review the approach procedure. All pertinent approach information, including minimum and missed approach procedures, should be reviewed and alternate courses of action considered.

As a guide, the approach briefing should include at least the following:

· weather & NOTAMS at destination and alternate, as applicable
· type of approach and the validity of the charts to be used
· navigation and communication frequencies to be used
· minimum safe sector altitudes for that airport
· approach procedure including courses and heading
· vertical profile including all minimum altitudes, crossing altitudes and minimum descent altitude (MDA)
· determination of the missed approach point (MAP) and the missed approach procedure
· other related crew actions such as tuning of radios, setting of course information, or other special requirements
· any appropriate information related to non-normal procedure
· managements of AFDS」

According to flight crew training manuals of both Air China and Boeing, detailed approach planning and complete briefing were the conditions to ensure a safe, unhurried, and professional approach. Before starting an approach, the pilot-flying should inform the pilot-not-flying of his/her intentions for the approach to be flown, and both pilots should review the approach to become thoroughly familiar with the whole procedure.

1.17.3.1 Air China Procedure for Application of Weather Minima

The purpose of approach categorization of aircraft is to determine the approach weather minima under poor visibility conditions. The aircraft approach categorization standards of ICAO[123] and FAA[124] are equally based on 1.3 times of the stall speed in the landing configuration at maximum certificated landing weight (MLDW) of the aircraft, divided into categories A, B, C, D and E, with appropriate range of speeds, and only one approach category applies to the aircraft of the same type. The CAAC applies this same standard.

The approach category for each type of aircraft is determined by the aircraft manufacturer through certification testing. The approach category for the B767-200 aircraft type was authorized to be "C." The CAAC approved the B767-200 as approach category "C[125]," and Air China also applied the same standard. This approach category applies to straight-in approaches.

The circling approach category, as determined by ICAO, is applied differently from the range of speeds for the straight-in approach category. In other words, under the same category, the range of speeds for the circling approach was authorized to be higher than the range of speeds for the straight-in approach, to allow for aircraft maneuvering. For example, for category "C," the range of speeds for the straight-in approach is between 121 and 140 kt, but the maximum speed for the circling approach is 180 kt.

According to the FAA standard, for a circling approach, the approach category may be different from that of the straight-in approach. For the circling approach categorization as authorized by the FAA, the range of speeds is not different from the straight-in approach category, but when higher speeds are required for maneuvering in excess of the speed authorized for the approach category, the next higher approach category is to be applied. For example, when the maximum speed of 140 kt for approach category "C" is to be exceeded, circling approach category "D" would be applied. Therefore, for circling approaches, the approach category established according to the aircraft type may be applied differently, as another category, depending upon the planned speed.

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[123] Doc 8168-OPS/611 Volume Ⅱ, Aircraft Operations, 1.9 Categories of Aircraft.
[124] 14 CFR, Part 97.
[125] CCAR No. 98.

Air China's Operations Specifications established that the circling approach category is determined by that category appropriate to the speed to be flown by the aircraft, and the certified operator is to apply the higher between the minima for circling approach to the required runway and the minima specified in the Operations Specifications.[126] For wide-body aircraft, such as the B767-200 and larger, the minima for the circling approach are MDH 300 m, visibility 5 km.

Air China's B767 manual[127] included explanations on the range of speeds for the straight-in approach and the circling approach for the FAA approach categories "C" and "D." It also states that during the circling approach, the minima for approach category "D" or the minimum criteria relevant to the anticipated circling approach speed are to be applied. But Boeing's B767 flight crew training manual[128] included explanations on the speed range under the FAA and ICAO circling approach categories "C" and "D."

1.17.4 Air China Accident History

Air China was founded on July 1, 1988. At the time of the accident on April 15, 2002, it had 68 aircraft on scheduled operations to 43 destinations international and 71 domestic, for a total of 114 airports.

The investigation results showed that Air China did not have a record of any accidents-prior to the flight 129 accident.

1.17.5 Oversight of Air China

1.17.5.1 The CAAC

According to a manager at the CAAC's standardization section, Air China had been delegated with its own oversight authority, until the time of enactment in May 1999 of the Act to regulate the operations approval for the public air transport operator certification. Once the statute became effective, the CCAR No. 83, Part 121.771 required Air China to undergo an approval procedure for the air operator certification within two years.

[126] Circling Approach Weather Minima (Air China Operations Specifications)

Category	A	B	C	D
MDA (m)	100	140	160	205
Visibility (m)	1,600	1,600	2,400	3,600

[127] FCTM 757/767, page 4.3 (Dec 1, 1999).
[128] FCTM 767, page 4.3 (Oct 31, 2001).

However, the CAAC did not provide the KAIB with the documentation showing the air operator certification of Air China.

Since May of 1999, the CAAC has exercised its statutory oversight authority over Air China, developing annual plans and regularly conducting surveillance activities for each area, with on-going inspections on occasion.

In accordance with year 2001 audit plan, the North China Regional Administration of the CAAC, Flight Operations Division conducted an audit of Air China's overall flight operations for a period of one month from February to March 2001.

Areas pointed out for improvement in the audit report include the following:

- No harmonious operation of management systems among flight operations related departments
- No record keeping systems and procedures
- Lack of human resources in flight operations related departments, and absence of procedure and standard of qualification and certification
- Lack of training and flight operations control working facilities
- Lack of standardization of flight operations by fleet types and flight deck duties
- No airport terminal operating procedures and no emergency procedure manual
- No oversight system and procedures for manuals revision by the operator

The major corrective actions to be taken and proposals include the following:

- Systematization of flight operations related departments
- Flight operations standardization and establishment of training record keeping system
- Manuals complement and revision
- Development of work plan for standardization of flight procedures
- Manuals editing and standardization of terminology
- Establishment of Instructor qualification and oversight systems

1.17.5.2 The Korea Ministry of Construction and Transportation (MOCT)

Air China was approved for flight operations to Korea as an international foreign air carrier on December 20, 1994, in accordance with Article 147 of the Aviation Act and

Article 320 of the Enforcement Regulations, and on December 22, 1994, Air China started to operate one daily flight between Beijing and Seoul[129] using B767 aircraft, and four weekly flights between Qingdao and Seoul[130] using B737 aircraft.

Air China's request for change of service by an international foreign air operator was approved by the Minister of Construction and Transportation on May 13, 1996, to operate four weekly flights between Beijing and Busan[131] using B737 aircraft starting on June 1, 1996, in accordance with Article 152 of the Aviation Act and Article 324 of the Enforcement Regulations.

On April 3, 2002, Air China's request for change to the conditions of service (aircraft type) was approved by the Busan Regional Aviation Administrator to permit the operation of B767 aircraft for a period of 12 days[132] starting on April 14, 2002, because of increased passenger demand for flights between Beijing and Busan, in accordance with Article 152 of the Aviation Act and Article 289 of the Enforcement Regulations.

In Article 16 of the Convention on International Civil Aviation, it is stipulated that, "The appropriate authorities of each of the contracting States shall have the right, without unreasonable delay, to search aircraft of the other contracting States on landing or departure, and to inspect the certificates and other documents prescribed by this Convention."

The MOCT did not have a record of surveillance activities conducted on Air China's aircraft, belonging to other contracting State, in accordance with the provisions of Article 16 of the Convention on International Civil Aviation, and nor was there a record of formal coordination of surveillance activities for Air China between the CAAC and CASA. However, since June 2002, safety inspectors from the CASA have been conducting surveillance activities on foreign aircraft including Air China's aircraft, in accordance with the provisions of Article 153, Para 3 (Demand for Reports, etc.) of the Aviation Act.

1.17.6 Air Carrier's Assistance Plan for Aircraft Accident Victims and Their Families

The Korean Aviation Act does not require air carriers operating flights to Korea to submit to the government a plan for the assistance of victims and their families in

[129] CA 123 / 124.
[130] CA 127 / 128.
[131] CA 129 / 130.

preparation for an aircraft accident. Thus, the government of Korea, as the State of Occurrence, experienced many difficulties in its support of the accident victims and their families of flight 129.

1.18 Additional Information

1.18.1 Public Hearing

A public hearing was held in connection with the accident of flight 129 at the Westin Chosun Hotel in Busan on November 25~26, 2002. It was attended by a total of 227 participants. They were 42 from the KAIB and CASA, 22 from the CAAC and Air China, 7 from the NTSB, Boeing Company and Pratt & Whitney, 24 from the Airforce ATC unit and fire fighting & rescue units, 10 from ALPA-Korea, 26 witnesses and 92 families of the victims, with members of the media present. The factual findings by the different investigation groups were made open to the public, and various opinions were heard through the testimonies of the witnesses related to the accident, etc.

A summary of the factual investigation of the accident was presented,[133] and the witnesses' testimonies for each group were as follows. The operations group confirmed the training related to the circling approach procedure, CRM and English education process, Air China record of the CAAC approval for the flight operations to Gimhae airport, actions by the operator prior to the flight operations to Gimhae airport, and the circling approach procedure as specified in Air China's Operations Specifications. And the group confirmed the rationale behind the aircraft configuration of flaps 20 and landing gear down for the circling approach as pertaining to the aircraft manufacturer.

Verification was made of the surviving captain's testimony on the reasons for his selection of approach category "C" and the delay in turning base on the downwind leg, his awareness of the circling approach minima in the Operations Specifications and any differences between ICAO and FAA standards for the circling approach, the time and reason for his loss of visual contact with the runway, his reason for not executing a missed approach in the circumstance of losing the runway in sight, preparation activities of the day prior, and whether simulator training for terrain avoidance maneuver was practiced.

For the maintenance group, the verification was made with the maintenance

[132] April 14 ~ 18th, 20 ~ 25th & 27th .

personnel from Air China whether there was any aircraft malfunction prior to the departure from Beijing airport and at the time of the last periodic check, and also questions were asked to the aircraft manufacturer of the impact energy pertaining to the airframe damage, and verification was made.

For the ATC group, verification was made on the reason of the tower controller's telephone confirmation with the approach controller regarding the approach category of the flight 129 aircraft, the reason for the tower controller's confirmation with the flight information office on the aircraft type and its approach category, the reason for the delayed initial radio contact between the tower controller and flight crew of the flight 129 aircraft, the correction about the landing runway at issuing the landing clearance, the reason for not issuing a safety alert, and whether there was any problem with the visual weather observation site.

For the survival group, verification was made on the initial arrival time of the Gimhae fire station rescue team, and the survivor rescue operations.

The CAAC investigation team presented opinions regarding the one Airforce controller, who provided air traffic control services to flight 129 without holding an air traffic controller certificate issued by the Minister of Construction and Transportation, the controller's lack of English proficiency, and on the differences from ICAO standards not being noted in the ROK AIP.

The Airforce presented opinions on the frequent MSAW "LA" warnings produced during aircraft's approaches at Gimhae airport, on the adequacy of the location of the visual observation site, and on English language training conducted for controllers.

Information that could not be confirmed at the hearing was to be obtained through additional visits to China. Review of the CVR transcript was agreed[134] to be conducted jointly by the teams from Korea, China and USA, at the NTSB.

1.18.2 The Captain's Testimony.

The captain was interviewed over eight occasions in a hospital where he was admitted, from April 16 through July 26, 2002. He also testified as one of the witnesses at the public hearing held in Busan in November 2002, where he answered questions related to the accident.

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[133] Operations, Maintenance, ATC, and Survival Groups.

[134] The joint team of investigators form Korea, China and US A reviewed the CVR transcript at the NTSB laboratory on Feb 26.2003.

Verification was made on the captain's personal history, matters related to the circling approach to runway 18R at Gimhae airport and the aircraft's approach category, the accident sequence, whether there was any aircraft defect during flight, the situation at the time of the accident, and his evacuation from the aircraft.

As the sole flight crewmember to survive the accident, the major testimonies made by the captain during interviews and at the public hearing were as follows:

- As to the flying career, his total flight time was approximately 7,000 hours, of which approximately 6,000 hours were on the B767. He was promoted to captain in October 2001, and his flight time as a captain was approximately 500 hours.
- Three or four flight experiences to Gimhae airport as a captain, with no previous experience for the circling approach to runway 18R.
- Flight preparation was completed under the captain's supervision on the previous day to the flight, in accordance with the company regulations. During this activity, the circling approach was prepared, anticipating the use of runway 18R, and the approach procedure and tower frequencies described in the Jeppesen charts were also reviewed. He was aware of the approach category for the B767-200 to be "C," the presence of mountains of approximately 700 ft elevation around Gimhae airport, the minimum safe altitude, and the short distance from the mountains to the runway.
- For the flight duty assignment, the Beijing to Gimhae sector was to be handled by the first officer as PF, with the captain to take control of the aircraft under special circumstances. For the transfer of control between PF and PNF, the phraseology of "I have control" was to be used.
- One set of Jeppesen manuals was on board, used by the captain during flight.
- Briefing on the circling approach was conducted after the approach clearance to runway 18R had been issued, since the runway was changed. The duration was short, so the captain could not remember details on the specifics, but said that he briefed on the approach procedure, referring to Jeppesen charts. The briefing consisted of the need for an accurate time check, to keep watching the runway, and taxi procedures after landing and a missed approach procedure, etc.
- Actual weather conditions at the time of the approach were sufficient to see the runway clearly at 700 ft on the ILS RWY 36L final approach course, with the visibility of approximately 10km and ceiling of approximately 700 ft. Upon entry into the downwind leg, he recalled visibility to have been approximately 6km, but the clouds gradually became lower on the downwind.

- When the runway was changed during the descent for the approach, nothing was briefed by the first officer as pilot-flying. The "briefing card" used by Air China included the briefing procedure and checklist.
- For a circling approach, he was aware that the Jeppesen charts, Air China's Operations Manual, the procedure learned in the simulator had to be applied, however, he did not know the weather minima of wide-body aircraft. He knew that the straight-in approach category for the B767 was the same as its circling approach category. And he answered that the speed on the approach charts was the speed to be maintained over the threshold [during the sixth interview], and said that it was the speed to be maintained from the start of circling approach to the base turn [during the eighth interview]. He took control of the aircraft on the downwind after calling out, "I have control." After visual contact with the runway, he disengaged the A/P to fly manually. During the circling approach, he said that the runway was not clearly visible, but the vertical visibility was good.
- Rolled out on the downwind leg, he was concentrating on the runway, and therefore did not see any buildings or mountains ahead. He did not remember how he checked for the twenty seconds to have elapsed after pressing the timer button for the base turn, but rather thought that the twenty seconds had not elapsed. He was able to continually verify the runway on the downwind leg. The time of losing visual contact with the runway was when the aircraft entered clouds during the base turn.
- The base turn was started when twenty seconds past abeam the north end of runway 18R, with the ground visible, but without any point of reference. About two thirds of the base turn, the flight entered the clouds, and he saw a hill as the flight emerged from the clouds. Once the base turn was started, there were no words of advice from the first officer, with no comments on the altitude either, but only the callout, "Pull up! Pull up!" After entering the clouds, the captain intended to initiate a go around after rolling out on final to the direction of the runway.
- He did not hear tower transmissions of "Can you landing" "Say again your intention." Just before crash, he did pull up, but the aircraft would not climb. He had no memory of the situation before or after his separation from the aircraft.
- There was no aircraft malfunction prior to departure from Beijing airport or during flight, nor any abnormal situations or instrument malfunction.
- The second officer is assigned for the observation and communication duties, and is

required to advise all deviations, in accordance with the operator's regulations

- The captain decided to take control of the aircraft, because the actual situation pertaining to the weather, the runway and etc. required him to take direct control of the flight. For urgent or special situations, it was also possible for the first officer to take control of the aircraft.
- The captain is required to listen and monitor communications with the headset on when the second officer is in contact with air traffic control, to pay attention and understand the contents of the communications. He said that it would be impossible not to monitor communications. While ATIS is required to be recorded, ATC clearances are selectively recorded, but the person assigned for communication duty is required to record the communications in detail.
- For circling approach training in the simulator, the weather conditions as selected by the instructor were applied, but it was difficult to speak on the specifics of the weather conditions. The operator's simulator was a B767-300 type, which was for circling approaches under category "D".
- When the aircraft was on the approach to runway 36, there was no memory of his hearing about the instruction to contact on the tower frequency after the runway was in sight.
- Between ICAO and FAA standards, the captain knew that the circling approach at Gimhae airport applied the FAA standard.

1.18.3 Information regarding Special Airports

According to a specialist from the training department of Air China, since Gimhae airport was not categorized[135] by the company as a special airport, no special education or training was given to flight crew, and no special flight experience was required.

However, Articles 517 and 518 of the Korean Flight Safety Regulations[136]describe the classifications and operation requirements of special airports, which captains of commercial air transport shall have experience, to be A, B and C, of which Gimhae

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[135] Air China designated Gimhae airport as a special airport after the accident.

[136] Enacted on Oct 4, 2001 according to Article 74-2(newly inserted on Sep 12, 2001) of the Korean Aviation Act.

airport was designated as a Grade "A"[137] special airport due to its high terrain to the north and east. Thus, separate operational experience and education requirements for the captains are stipulated for the operations to the airport.

The designation criteria for special airports are as follows:

「· Airports with terrain, obstacles or other restrictions, which may affect aircraft operations during takeoff, landing or go around.
· Airports requiring special arrival or departure procedures.
· High elevation (above 7,000 ft) airports requiring special aircraft performance.
· Airports with limited aeronautical facilities or available information.
· Any airport requiring special attention during takeoff and landing.」

The CAAC Order 121.469 (Captain Requirements for Operations in Special Areas, Routes or Airports) describes the following on special airport operations:

「• CAAC designates special airport based on terrain, obstacles, complex arrival or departure procedures, and requires the special operational qualifications for captains.
• The certified operator must ensure that captains have experience operating into the airport as a required crewmember within the previous 12 months, have received the training through audiovisual means or have qualified in a simulator approved by the CAAC. When the ceiling is above MEA or MOCA, or the initial approach altitude in the instrument approach procedure is more than at least 300 m (1,000 ft) or visibility is at least 4,800 m (3 miles), no special qualification is required for the captain to operate into the airport.」

Air China's Operations Specifications (C067) specifies the following factors for special airports:

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[137] < Grade A Special Airport Requirements >
- Takeoffs and landings should be attempted with ceiling more than at least 1,000ft above MEA, MOCA or the initial approach fix altitude; and visibility more than at least 3miles.
- Captain must have takeoff & landing experience as an observer within the previous 12 months.
- Captain must be qualified through an audio visual training aid or special airport qualification requirements, etc. approved by the Minister of Construction and Transportation. within the previous

「 · Hong Kong New Int'l Airport: Heavy traffic, busy communication, complex surrounding terrain, many obstacles, complex MET conditions (heavy wind including windshear, thunderstorms, heavy fog, low clouds, low visibility)

12 months.

- Ulan-Bator, Mongolia: Complex surrounding terrain, airport in hilly area, many obstacles, poor obstacle-clearance conditions, one-way takeoff and landing only, complex MET conditions (heavy wind, sandstorm, low visibility, tailwind takeoff and landing, etc.)
- Wujiaba, Kunming: Heavy traffic, high-altitude airport in hilly areas, complex surrounding terrain, many obstacles, poor obstacle-clearance conditions, long landing-run distance, takeoff weight and climb gradient affected during high-temperature season, rare air density affecting engine power, altitude revision required for high-altitude airport (altitude adjustment or using zero altitude), complex MET conditions, heavy wind (including windshear), low clouds, low visibility, frequent thunderstorms, etc.
- San Francisco, USA: Heavy traffic, complex surrounding terrain, with special arrival/ departure procedures
- Ontario, USA: Complex surrounding terrain, with special arrival/ departure procedures

Captains shall be subject to ground training or demonstrations with respect to the use of instrument arrival/departure procedures, operations over complex terrain and under complex meteorological conditions prior to actual take off or landing operations at the above airports, or they shall have the experience in the past 12 months of operating to the above airports as a crewmember. 」

1.18.4 Controlled Flight Into Terrain Accident (CFIT) Information

Aviation accident statistics for a last ten year period ("Boeing's 2000 Statistical Summary of Commercial Jet Airplane Accidents," June 2001) showed that among total 7,282 fatalities, 2,237 (30.7%) were caused by CFIT type accidents. In terms of hull losses, of 391 total, 37 (9.5%) were caused by CFIT type accidents, proving that the CFIT is one of the most frequent types of accidents with many casualties and severe aircraft damage.

By phase of flight, most CFIT accidents occurred from the beginning of descent for landing at the destination airport, until just before touchdown on the runway.

Flight Safety Foundation (FSF) data from 1986 to 1990 showed that most of the CFIT accidents occurred with the aircraft aligned in the direction of the landing runway, and some during missed approach, but others more than 15 NM outside the airport, showing that CFIT accidents were not necessarily related to high terrain near an airport.

The causes of the accidents were mostly related to the flight crew, such as problems of communication, navigational error, procedural noncompliance, lack of situation awareness, aircraft handling error, decision-making error or negligence. Regarding equipment issues, traditional GPWS equipment (Modes 2 or 4) provides aural or visual warnings if terrain is approached while not in the landing configuration. If the aircraft is in landing configuration, in level flight, and terrain closure does not exceed 2,253ft per minute, such as the case with flight 129, aural or visual warnings will not occur. Another equipment issue addressed by FSF was that MSAW was not in wide usage.

For environmental factors, FSF cited natural elements such as weather, terrain, temperature, wind, ice and fog. There are also artificial elements such as whether there are ATC radar services available to handle approach and departure, whether ATIS or VOLMET[138] are available, airport equipment and facilities, such as the presence of circling lights, the approach lights, VASI[139]/ PAPI[140], and approach procedures and approach charts.

1.18.5 ALAR (Approach and Landing Accident Reduction)

The FSF approach and landing accident reduction (ALAR) Task Force began Flight Safety Foundation-led efforts in 1991, in counsel with the International Civil Aviation Organization, to help reduce the leading causes of accidents[141]. Because controlled flight into terrain (CFIT) was the leading cause of fatalities in commercial jet aviation, initial work focused on CFIT.

By 1996, the task force work had resulted in more than a dozen important recommendations to help prevent CFIT accidents, and articles in FSF publications increased awareness of CFIT.

The task force used a variety of data. High-level analyses were conducted on one set of data that included 287 fatal accidents from 1980–1996 (inclusive). Detailed case studies were conducted on another set of data that included 76 accidents and serious

[138] Meteorological Information for Aircraft in Flight.
[139] Visual Approach Slope Indicator.
[140] Precision Approach Path Indicator.
[141] In 1990 through Oct. 15, 2000, western-built large commercial jets have been involved in 42 CFIT hull-loss accidents and 137 hull-loss ALAs.

incidents from 1984–1997. Specific flight crew behavioral markers were isolated in the case studies and in line observations of 3,300 flights. The task force's conclusions and recommendations were supported by the data.

Final recommendations of the FSF ALAR Task Force were published in the *Flight Safety Digest* article "Killers in Aviation: FSF Task Force Presents Facts About Approach-and-landing and Controlled-flight-into-terrain Accidents." The ambitious objectives of the task force require the support of the entire aviation industry. The FSF *ALAR Tool Kit* is among the products developed by the task force to help reach the objectives.

Generally, inadequate situational awareness[142] involved inadequate awareness of the vertical position of the aircraft and often resulted in CFIT. Enhanced ground-proximity warning systems (EGPWS)/terrain awareness and warning systems (TAWS) and radio altimeters, which provide predictive terrain-hazard warnings, are installed in thousands of aircraft, but many aircraft do not have this equipment.[143]

The statistics do not imply increased risk when the captain is flying. Nevertheless, the task force found that inadequate crew resource management (CRM) was involved in several ALAs that occurred when the captain was the pilot-flying. The problem of transitioning from instrument flying to visual flying can be minimized by conducting a monitored approach.

The FSF ALAR Task Force believes that stabilized approaches are essential in preventing approach-and-landing accidents (ALA). The task force cited a list of Recommended Elements of a Stabilized Approach as follows:

1. The aircraft is on the correct flight path;
2. Only small changes in heading/pitch are required to maintain the correct flight path;
3. The aircraft speed is not more than V_{REF} + 20 kt indicated airspeed and not less than V_{REF};
4. The aircraft is in the correct landing configuration;

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142 Inadequate situational awareness was a factor in 51% of ALAs.

143 Currently available safety equipment was not installed in 29% of the aircraft in ALAs.

5. Sink rate is no greater than 1,000 ft per minute; if an approach requires a sink rate greater than 1,000 ft per minute, a special briefing should be conducted;
6. Power setting is appropriate for the aircraft configuration and is not below the minimum power for approach as defined by the aircraft operations manual;
7. All briefings and checklists have been conducted;
8. Specific types of approaches are stabilized if they also fulfill the following: instrument landing system (ILS) approaches must be flown within one dot of the glide slope and localizer; a category II or category III ILS approach must be flown within the expanded localizer band; during a circling approach, wings should be level on final when the aircraft reaches 300 ft above airport elevation; and,
9. Unique approach procedures or abnormal conditions requiring a deviation from the above elements of a stabilized approach require a special briefing.

During analyses of the 76 accidents and serious incidents mentioned earlier, several significant statistics regarding CRM, SOPs, and training emerged:

- 74% - Inadequate crew decision making
- 72% - Inadvertent non-adherence to procedures
- 63% - Failure in CRM (cross-check/coordination)
- 46% - Failures in company management
- 40% - Deliberate non-adherence to procedures
- 37% - Inadequate training

The ALAR Task Force addressed several specific elements for the prevention of ALAs (CFIT) as follows:

Standard Operating Procedures

- Establishing and adhering to adequate SOPs and flight crew decision-making processes improves approach-and-landing safety.
- States should mandate, and operators should develop and implement, SOPs for approach and landing operations.
- Operators should implement routine and critical evaluation of SOPs to determine the need for change.
- Operators should provide education and training that enhance flight crew decision making and risk management.

Communication Factors

- 33% of the ALAs and serious incidents involved incorrect or inadequate ATC instruction/advice/service.

Pilot-Controller Communication

- Improving communication and mutual understanding between controllers and pilots of each other's operational environment will improve approach-and-landing safety.

Controllers and pilots must work together, but there is a gap in their understanding of each other's challenges. The pilot is focused on one very complex airplane in the demanding environment of approach and landing. The controller is focused on traffic flow. Both are balancing safety and efficiency. They also push the ATC system to increase capacity of landing/takeoff runways, reduce landing intervals, reduce radar separation minimums, use complex multiple-runway combinations and use land-and-hold-short (LAHSO) procedures. In this demanding environment, flight safety depends on spoken communication. Remember: The captain has the final responsibility for the safety of the flight.

Terminal Area Infrastructure

- 21% of ALAs involved lack of ground aids.
- 12% of ALAs involved lack of ATC equipment (terminal approach radar, minimum safe altitude warning).
- The risk of ALAs during non-precision approaches is five times greater than the risk of ALAs during precision approaches.
- The risk of ALAs in the absence of terminal approach radar is three times greater than the risk of ALAs with terminal approach radar available.
- Precision approach capability and approach radar reduce the risk of ALAs.
- Encourage crews to use more precise approach guidance at all times such as ILS, GNSS[144], PAPI and VASI.
- Develop precision approach capability to all runways by application of technology (e.g., GNSS and LAAS[145]).
- Implement MSAW or equivalent on all approach radars for ATC terrain warning.

[144] GNSS = Global Navigation Satellite System.
[145] LAAS = Local Area Augmentation System.

Environment

- 59% of ALAs involved poor visibility.
- 21% of ALAs involved disorientation/visual illusion.
- 18% of ALAs involved runway condition:
  - 73% of ALAs involved overruns on contaminated runways.
- 37% of ALAs involved precipitation/winds
- The risk of ALAs is higher in operations conducted in low light and poor visibility, on wet or otherwise contaminated runways, and with the presence of visual or physiological illusions.
- Flight crews should be trained in operations involving these conditions before they are assigned line duties.
- Flight crews should make operational use of a risk-assessment tool to identify approach and landing hazards. Appropriate procedures should be implemented to reduce the risks.

Safety Data Monitoring Programs

- Through the collection and analysis of in-flight parameters, FOQA[146] programs identify performance trends that can be used to improve approach-and-landing safety.
- FOQA should be implemented worldwide in concert with information-sharing partnerships such as GAIN[147], BASIS[148] and ASAP[149].
- Provisions should be made on aircraft for equipment to support data collection and analysis.

Aviation Safety Information

- Global sharing of aviation information decreases the risk of ALAs.
- FOQA data must be de-identified.
- Public awareness of the importance of information sharing must be increased.

[146] FOQA = Flight Operational Quality Assurance.
[147] GAIN = Global Aviation Information Network.
[148] BASIS = British Airways Safety Information Service.
[149] ASAP = U.S. Federal Aviation Administration Aviation Safety Action Program.

- Airlines and regions that share information have the lowest accident rates.
- Crews that are aware of an accident and its causes are less likely to repeat that type of accident.

ALAR Tool Kit[150]

- *Flight Safety Digest:* "ALAR Briefing Notes"
- *Flight Safety Digest:* "Killers in Aviation: FSF Task Force Presents Facts About Approach-and-landing and Controlled-flight-into-terrain Accidents"
- FSF ALAR Task Force Conclusions and Recommendations
- FSF ALAR Task Force Members
- Selected FSF Publications
- *Approach-and-landing Risk Awareness Tool*
- *Approach-and-landing Risk Reduction Guide*
- *Standard Operating Procedures Template*
- ALAR Information Posters
- *CFIT Checklist*
- *CFIT Alert*
- *Flight Operations and Training*
- *Equipment for Aircraft and Air Traffic Control*
- *Air Traffic Control Communication*
- *Pilot Guide to Preventing CFIT*
- *Approach-and-landing Accident Data Overview*
- *An Approach and Landing Accident: It Could Happen to You*
- *CFIT Awareness and Prevention*
- Links to Aviation Statistics on the Internet

ATC Recommendations

ATC controllers have a responsibility to use standard phraseology when communicating with pilots. They must maintain adequate language skills to do this effectively.

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[150] The ALAR tool kit was produced on a CDROM, which included numerous tools for the prevention of ALAs (CFIT). Copies of the tool kit were distributed widely to airlines and other safety organizations.

If a pilot receives a clearance that he is unable to comply with, he must advise ATC of his inability to comply with the clearance. If a pilot does not understand a clearance, he should request ATC to repeat it until he does understand it.

Pilots must also use the autopilot in the mode that facilitates compliance with ATC instructions. When in a terminal area, it is too late for one pilot to be “head-down” programming an approach into the FMC. Instead, fly using heading select or VOR/LOC. This keeps both pilots in the loop and allows both pilots to watch for traffic and monitor the airplane.

It is essential that pilots read back all clearances and that ATC verifies that the read back is correct. Both pilots listening to ATC clearances and practicing good CRM will help ensure that an accident does not occur because of a misunderstood clearance.

2. Analysis

2.1 General

The three flight crewmembers of flight 129 were certified and qualified in accordance with the requirements of the CCAR, Korean Aviation Act, ICAO Standards, and Air China manuals. They had sufficient rest prior to the scheduled flight, and no medical conditions were discovered which might have adversely influenced their performance.

The aircraft was properly certificated, equipped, and maintained in accordance with pertinent CCAR, ICAO Standards, and Air China procedures. The aircraft was authorized to operate within Korean airspace pursuant to the Korean Aviation Act.

The aircraft was loaded properly within the regulatory limitations of weight and balance. There was no evidence of preimpact mechanical malfunction of the aircraft structures, flight control systems, or engines.

The analysis of this accident examined weather factors at the time of the approach, the accident sequence, circling approach criteria, flight crew performance, flight crew training relevant to Air China's circling approach procedure and crew resource management.

Maintenance factors, the role of the air traffic controllers, functions and operational criteria of the BRITE and the MSAW equipment were also reviewed. In addition, the CAAC oversight of Air China's training programs, surveillance activities of the Korea MOCT over foreign air carriers, survival factors, including post-accident search and rescue, and the other factors relevant to the flight were examined.

2.2 Weather Factors on the Approach

Approximately 20 minutes prior to the accident, Gimhae weather was reported to be 500 ft (AGL) scattered[151], 1,000 ft broken,[152] 2,500 ft overcast[153] with light drizzle, and visibility 3,200 meters with winds 7 kt from the southwest. The winds from the southwest then increased to 12 kt, so that approximately 12 minutes prior to the accident, Gimhae tower changed the active runway to 18R. The official weather conditions were above the weather minimum for the circling approach of approach category "C" aircraft.

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[151] The sky condition is covered from 3/8 to 4/8 amount of clouds.
[152] The sky condition is covered from 5/8 to 7/8 amount of clouds.
[153] The sky condition is covered 8/8 amount of clouds.

After the runway change to 18R, local weather observations were made, which were the same in content as the earlier ATIS “Papa” routine observations, except the improved visibility of 4,000 meters. The information of the local observations were received by the approach control, where it began to be broadcast as ATIS “Romeo.” By this time, the flight was already on the final approach course to runway 36L. In such case, the controller was not required to inform the crew to obtain ATIS “Romeo.”

While the aircraft was on the circling maneuver at an altitude of about 700 ft (MSL), it was difficult for the tower controller to maintain visual contact. The controller testified that he visually acquired the aircraft briefly about midway on the downwind leg to the west. The KAIB presumes that the clouds were moving north toward the mountains, near the base turn area to runway 18R, covering the terrain around the elevation of the crash site down to the point of impact, with some clouds.

The KAIB also believes that the crew could not keep the runway in sight continuously during the base and final turns, and did not have sufficient forward visibility as a result of flying through the clouds.

2.2.1 Visual Weather Observation Site

The line of sight north and north northwest from the rooftop of the Gimhae airport Weather Office, which was designated for visual weather observations[154], was obstructed due to the presence of a large hangar blocking the observer’s view of the sector for the base turn and final approach course to runway 18R.

To observe the blocked sector, the observer had to move to the ramp in front of the weather station. However, this weather observation arrangement did not deviate from the establishment requirement of a ground observation site described in the Airforce Manual 5-345(Section 2, Para 1) and the FAA(Order 7210.3S, Para 2-9-7), WMO “Guide to practices for meteorological offices serving aviation"(WMO-No.732, Para 6.1.8 & 6.2.1.1) and the requirements of Annex 3 (Para 4.1.6, Aeronautical meteorological observation) to the Convention on International Civil Aviation. However, the site is not the ideal place where the observer can have an unobstructed view of weather conditions over the aerodrome.

Since approaches to runway 18R at Gimhae airport were frequent, including circling approaches under IMC, observations of visibility and sky conditions for the base turn area and its vicinity would have been required, and it would have been considerably inconvenient for the observer to walk down to the ramp for each observation.

[154] Prevailing visibility and sky conditions (cloud coverage and height).

2.2.2. Runway Visual Range (RVR) Measurement System

Runway 36L/18R at Gimhae airport had lighting facilities and RVR installed, along with ILS for a category II instrument approach and landing, but the RVR system ceased operation, so that the runway was usable for only category I instrument approach and landing.

While the visibility was 4,000 meters at the time of the accident, since "prevailing visibility" was to be applied in the determination of circling approach weather minima[155], the KAIB believes that the non-operational RVR was unrelated to the accident. However, the RVR system was out of commission for an extended period of time[156] and not in proper operation as planned.

2.3 Accident Sequence

2.3.1 Description of the Circling Approach and Required Flight Crew Procedures at Gimhae Airport

According to ICAO Doc 8168-OPS/611 Vol I, Para 4.6 & 4.7 and the CCAR 98, Articles 30 and 77, when flying a circling approach within the circling approach area for the approach category of the aircraft, the pilot may continue the circling approach as long as he maintains visual contact with the runway and its environment.[157] If the runway and its environment are lost, the pilot must execute an immediate missed approach.

The circling approach procedure to runway 18R at Gimhae airport is a general circling approach procedure, without the prescribed circling approach track established using ground visual references or runway lead-in lights. Therefore, it requires a very close coordination among the flight crew when conducting a circling approach. Since the captain is seated on the left side for a right hand pattern, it is difficult to see the runway, so the first officer seated on the right side should assist the captain by calling out passing abeam the end of the runway, the time to base turn, runway position, and ground references.

Air China's procedure[158] for a circling approach, when using the A/P, A/T, and F/D,

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[155] Gimhae Airport Operations Mutual Agreement, Article 26, Para 3A.
[156] From Jul 12, 2001 until the time of this writing.
[157] Runway threshold, approach lighting aids, other markings identifiable with the runway.
[158] Air China 757/767 FCTM, page 4.37,
CCAR-62FS, Attachment 4, Lesson 3.

was to conduct an ILS approach to runway 36L, by using the localizer (LOC) mode for lateral navigation, and the vertical speed (V/S) mode for vertical control. Once reaching the circling MDA along the final approach course to runway 36L, the heading select (HDG SEL) mode would be used to turn left 45 degrees from the final approach course, and fly for twenty seconds to enter the downwind leg. Twenty seconds after passing abeam the approach end of runway 18R on the downwind leg, the pilot should turn base, set flaps to 30 degrees, complete the landing checklist, and with the landing assured, turn off the A/P to continue descent to landing.

In Boeing's training manual[159], the following guidance is provided: 「Use the weather minima associated with the anticipated circling speed. As an option the approach may be flown with flaps 25 or 30. Maintain MDA using ALT HOLD mode and use HDG SEL or HDG HOLD for the maneuvering portion of the circling approach. If circling from an ILS approach, fly the ILS in LOC and VNAV or V/S modes.

Use of the APP mode for descent to a circling approach is not recommended for several reasons:

· The AFDS does not level off at MCP altitude

· Exiting the APP mode requires initiating a go around or disconnecting the autopilot and turning off the flight directors.」

The circling approach procedure when transitioning from a precision approach (ILS) was identical in the training manuals of Air China and Boeing, that the LOC and other vertical mode should be used, not the APP mode. However, Air China's training manual did not explain why the APP mode should not be used for a circling approach.

2.3.2 Circling Approach Pattern of Flight 129

According to the FDR data, as instructed by the Gimhae approach controller, flight 129 made the ILS final approach to runway 36L in the localizer and approach modes, and then initiated the circling approach to runway 18R. The minima for category "C" circling approach were used, of which the ceiling was 700 ft and visibility 3.2 km.

Flight 129 entered the final approach course at an altitude of 2,600 ft and heading of 030 degrees in the LOC mode of the AFDS lateral mode, and 7 seconds after entering the

[159] FCTM 767, page 4.41(Oct 31,2001).

final approach course, the APP mode was engaged, however, the glide slope mode of the vertical mode was not engaged, and then flight 129 descended to about 1,000 ft in the vertical speed and flight level change modes.

Thereafter, the heading hold mode of the AFDS lateral mode was used, and after maintaining about 700 ft, the heading select mode was used during the circling approach for the entry into the downwind leg. Even if the flight crew of flight 129 used the APP mode on the final approach course to runway 36L, since the glide slope mode was not engaged, they could select other modes (HDG HOLD, HDG SEL) of the AFDS lateral mode without disconnecting the A/P, therefore, it is assumed that the flight directors would have properly displayed indications according to the modes selected by the flight crew.

Once the runway was identified about 1,100 ft, on the left turn for entry into the downwind leg, the first officer declared his intention to fly the aircraft using an expression, "I have control(我來)," and then apparently disconnected the A/P to fly the aircraft manually.

When flight 129 reported the runway in sight, the approach controller issued a frequency change instruction, "Air China 129, contact tower one eighteen point one, circle west," to which the flight crew of flight 129 read back only, "Circle, circle, 18 right, Air China 129."

The flight crew of flight 129 held English test certificates in accordance with the CCAR[160], but the second officer's ATC communications including the frequency change to the tower instruction, etc. were not properly monitored by the captain or the first officer, resulting in untimely exchanges with the tower controllers. When the flight crew established contact with the tower, the actual position of the aircraft was nearly abeam the threshold of runway 18R.

According to the FDR data, the first officer as PF, upon initiating the turn for the circling approach from the final approach course to runway 36L, did not turn the aircraft left 45 degrees (HDG 315 degrees) using the standard rate turn[161] for the entry into the downwind leg, instead he turned the aircraft in a shallow bank angle (5.3 ~19.9 degrees maximum), which resulted in a delay in turning the aircraft to the heading of 315 degrees. Thus, passing near abeam the threshold of runway 18R, the aircraft entered the

[160] Number 51, Chapter 7, Article 67, Para 7.
[161] A turn of three degrees per second (360 degrees in two minutes).

downwind leg. At this time, because of the adverse influence of the shallow bank angle, the wind direction and wind speed of 210 degrees at 17 kt, when passing abeam the threshold of the runway, the aircraft was located at a position of 1.1 nautical miles on the downwind width which was narrower than the normal downwind width[162], and the captain reengaged the A/P after the downwind entry.

According to the captain's testimony, while timing 20 seconds after passing abeam the north end of the runway, being concerned with receiving the landing clearance from the controller, he was not able to make the base turn. But the analysis of the FDR data revealed that the heading of flight 129 changed to the left at this time, which is assumed that the captain probably turned the aircraft to the left, in order to widen the pattern. Simulation results showed that turning base on the downwind width that flight 129 had flown would have caused the aircraft to overshoot the final approach course.

Maintaining the correct indicated airspeed, altitude, continuous contact with visual references and timely base turn are the essential conditions for the circling approach and landing, however, the first and second officers did not aggressively advise the captain about the completion of base turn timing, and to make a go around earlier, when the runway or other visual references were not in sight.

According to FDR and CVR data, when the aircraft was passing abeam the threshold of runway 18R, the timing of the flight crew was correct. It was probably because the captain considered the effect of the tail wind, that 13 seconds (11:20:15) after the timing, he directed the first officer who was flying the aircraft at that time, to make the base turn, saying, "Turning base." However, the KAIB believes that the captain, in consideration of the circumstances including the effect of the tailwind, visibility status, etc., decided to control the aircraft from 11:20:17 on, saying "I have control."

Prior to the base turn, the aircraft was flown on the downwind at a speed of 150~160 kt, thus when passing abeam the threshold of runway 18R, the airspeed was in excess of 140 kt which was the maximum speed for category "C." According to the FDR data, the indicated airspeed, when the aircraft passing abeam the threshold of runway 18R, was 158 kt, and the ground speed was 177 kt, which may have been a factor that caused the extended downwind leg.

At 11:20:02, the aircraft passed abeam the approach end of the runway on the downwind and began the time check. At 11:20:22, when the 20 seconds elapsed, the

[162] Criteria of circling approach area for CAT "C": 1.7 NM.

normal base turn did not begin. At 11:20:37, the captain disconnected the A/P at the heading of 351 degrees and began the delayed base turn, but not until 11:20:42, after approximately 40 seconds elapsed, did the aircraft heading finally pass through 360 degrees toward the south. This was a decisive factor in the aircraft flying outside the circling approach criteria for both categories "C" and "D."

When the captain began the base turn at 11:20:37, he flew the aircraft manually, probably with his attention dispersed for crosschecking the cockpit instruments, runway and other references. With the reduced visibility, it would have been difficult to become aware of outside conditions.

At 11:20:54, the captain asked the first officer, "Assist me to find the runway," but the first officer did not respond whether the runway or the other references were in sight, but at 11:20:59, the first officer said, "It's getting difficult to fly." The captain did not remember this remark. It cannot be determined why the first officer made this remark, but presumably it might have been when the flight entered the clouds.

At 11:21:02, without remarks regarding outside conditions, the first officer advised, "Pay attention to the altitude," and at 11:21:09, when the captain again asked, "Have the runway in sight?" the first officer replied at 11:21:10, "No, I can not see out." At 11:21:12, the first officer said, "Must go around." Although the forward obstacles were seen through a gap in the clouds, and at 11:21:15, the first officer yelled, "Pull up! Pull up!" and the captain did a pull up action, it was too late. As a result, the aircraft impacted the mountain.

Flight 129 was equipped with traditional GPWS equipment, so with the landing gear down, flaps in the landing configuration (25 degrees or more), and maximum closure rate of 1,800fpm, there was no ground proximity terrain warning per design.

2.4 Flight Crew Performance

2.4.1 Approach and Circling Approach Briefing

According to a Human factors research report,[163] a good approach briefing is important to develop a "shared mental model" to ensure "that all crewmembers are solving the same problem and have the same understanding of priorities, urgency, cue significance, what to watch out for, who does what, and when to perform certain activities."

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[163] Orasanu, J. "Decision-making in the Cockpit." In Cockpit Resource Management, 1993, Ed. E.L. Weiner, B.G.Kanki, and R.L.Helmreich, San Diego: Academic Press, page 159.

Between 10:54:54 and 10:55:47, the first officer as PF conducted a briefing on nine items for the approach to runway 36L. Some items were omitted, such as the DA/DH, and it was not clear where the briefing began or ended. No comments were made for the precise assignment of tasking for each crewmember, as per Air China's B757/767 flight crew training manual[164].

After the runway change to 18R, between 11:10:19 and 11:12:29, there was a discussion type briefing between the captain and first officer on the MDA, taxiway entry after landing, circling approach pattern, and obstacles, etc. However, no mention was made of the priority, urgency, importance, items requiring a special attention or crew coordination during a circling approach. The briefing was insufficient for the crew to be precisely aware of the overall circling approach procedure and the items that they needed to be cautious of during an approach.

The KAIB believes that when a runway change or other situations require an additional briefing during flight, there is a need to devise a method ensuring enough time to conduct an additional briefing that the approach procedure can be sufficiently reviewed.

2.4.2 The Captain's Performance

2.4.2.1 The Circling Approach as Conducted by the Captain

The captain testified that his plan for the circling approach was to visually identify the runway on the final approach course to 36L, then turn 45°left to the heading of 315°, fly for 20 seconds and turn right onto the downwind leg parallel with the runway direction (heading 360°), then after passing abeam the north end of the runway, time 20 seconds outbound for the base and final turns to landing.

However, the combination of strong southerly winds (210 degrees at 17 kt) with the shallow bank turn delayed the downwind leg entry, where the width of the pattern was approximately 1.1 NM[165] (2.03 km) wide on the downwind leg, narrower[166] than the

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[164] FCTM 757/767, Page 4.3

"Thorough planning and briefing are the keys to a safe, unhurried, professional approach. Prior to the start of an instrument approach, the pilot-flying should brief the other pilot as to intentions in conducting the approach. Both pilots should review the approach procedure. All pertinent approach information, including minimums and missed approach procedures, should be reviewed and alternate courses of action considered."

[165] Refer to Figure 1-7 Circling Approach Radar Track of Flight 129 and Circling Approach Area.

[166] The width of downwind leg for visual approach (FCTM, Page 4.41): approximately 2 NM.

normal downwind width. Flight simulations from this narrow downwind position to the base turn and thereafter, consistently showed overshooting[167] the final course. None of the crew, however, commented on the downwind width. Therefore, it is assumed that due to the narrow downwind width, it would have been difficult for the flight crew to confirm the runway visually during, or after the base turn.

At 11:20:02, when passing abeam the threshold of runway 18R, the captain began timing for the base turn. Fifteen seconds thereafter, at 11:20:17, he said, "I have control (我來飛) ," and then began to fly the aircraft as PF.

Flight 129 did not adjust the base turn point for tailwinds, and after 20 seconds had elapsed, at 11:20:22, the captain called, "Turning right" (The FDR and radar data showed that the base turn was not commenced at this time). After 22 seconds (11:20:24), the first officer advised, "Turn quickly, not too late," but the captain later did not remember hearing this advice. The recordings on the CVR indicate that both the captain and first officer were probably cognizant the timing for the base turn had expired.

From 11:20:25, 23 seconds elapsed from the beginning of the timing, until 11:20:33, the tower's landing clearance was issued over nearly 8 seconds. According to the FDR, CVR and radar track data, it is assumed that flight 129 did not initiate the base turn during this time, and the captain was paying attention to the landing clearance issued by the tower controller while turning left to widen the pattern. At 11:20:24, the first officer may have realized the necessity for the base turn at this time, and advised the captain, "Turn quickly, not too late," however, it is assumed that the captain was distracted by listening to the landing clearance during this time, and did not initiate the base turn. Therefore, the KAIB determines that the captain did not comply with the basic flying procedure to initiate the turn first, and then to pay attention to ATC communications.

Upon completion of the landing clearance to runway 36 at 11:20:32, the captain said, "Flaps 30, already extended." At 11:20:33, the tower controller issued a corrected landing clearance to runway 18R, and the captain said at 11:20:34, "Reduce speed." At 11:20:37, with the aircraft heading 351°, the autopilot was disconnected for the base turn.

Since the base turn was flown manually, the captain would have had to consign much of his attention to the attitude indicator and aircraft control, in addition to keeping external references and the runway in sight, which would have placed him under twofold workload. Therefore, it would have been difficult for him to become aware of the

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[167] When finishing the final turn, aircraft will be located outside (overshoot) of the runway centerline. [This case assumed civil aircraft using a normal bank angle (25~30 degrees) turn].

situation outside the aircraft.

That may explain why he did not call the first officer for the completion of the landing checklist after the flaps were set to 30°, thereafter, with the second officer's incorrect reply to the tower transmission being left uncorrected, and why he did not later remember the contents of the exchanges with the tower.

Since the captain was seated on the left side, it would have been difficult for him to have the runway in sight by himself during the base turn to the right. Therefore, at 11:20:54, he asked the first officer to help him locate the runway. And he queried at 11:21:09, whether the runway was in sight, but at 11:21:10, the first officer said, "No, I can not see out," and then at 11:21:12, the first officer advised the captain to go around, however, there was no response from the captain. The captain later stated that during the base turn, they entered the clouds, but did not execute an immediate go around, having thought that he would go around after they rolled out on final (180°).

Therefore, the captain did not comply with the requirement [168] to execute an immediate missed approach, if visual contact with the runway or ground references are lost, or if the flight enters a cloud. The KAIB determines that the failure to initiate a go around at this point is an important factor in the circumstances that led to the accident.

According to the captain's testimony, he had no experience with the circling approach at Gimhae airport, and the circling approach training on B767 aircraft used only Beijing airport. Since Gimhae airport was not classified as a special airport requiring an additional training, the captain was probably unaware of the danger posed by terrain in the vicinity of the circling approach area north of the runway during the circling approach.

2.4.2.2 The Summary of Captain's Performance on the Circling Approach

The captain had landing experience on runway 36L, however, it was his first circling approach to runway 18R. And the runway change occurred while on the radar approach pattern, not allowing sufficient time to prepare for the circling approach, which may have placed him under undue pressure.

Being unaware of Air China's Operations Specifications for circling approach weather minima of wide-body aircraft, the captain attempted the circling approach below the weather minima of wide-body aircraft. While he selected and notified category “C” to the controller, he actually flew the circling approach at the speeds appropriate for category “D” aircraft.

He said that the base turn point was missed while focusing his attention on the landing clearance. But the FDR data and simulation results showed that the downwind width as flown would have had the aircraft overshoot the final approach course, so it is likely that he turned left in order to widen the pattern. Furthermore, during the base turn, he entered the clouds and lost sight of the runway and other visual ground references, but did not execute an immediate missed approach.

In the exercise of his command authority over the other crewmembers, the captain failed to take into account the overall situation to make timely decisions. His knowledge of circling approach and execution of flight procedures were not according to the operations manual and procedures, and he did not clearly assign duties to his crew.

2.4.3 The First Officer’s Performance

According to the captain’s testimony, the first officer was assigned PF duty for the Beijing/Gimhae sector on the previous day to the flight. During the initial descent, the active runway was 36L, and the first officer conducted the approach briefing for landing, omitting some items.

When the approach controller asked for the approach category of the aircraft, he told the second officer “C,” but there was no discussion on the approach category even after the runway was changed to 18R. The captain and first officer then conducted a briefing for the circling approach, but nothing was said about the weather minima in the Operations Specifications, circling approach category, circling approach procedure, precise assignment of duties, or crew coordination procedure, etc.

The fact that major items specified in the procedures and flight manual were not covered during the briefing may have resulted from the approach briefing not being conducted in a systematic order using the guidance material, rather, it was left up to the PF’s judgment. The reason that Air China’s standard callouts were not made during the approach was probably due to the flight crew’s lack of understanding of the standard callout procedures.

As PF, the first officer disconnected the A/P to fly the aircraft manually when turning 45°(315°) to the left for the initiation of the circling approach on the final approach course

[168] Flight Operations Manual 4.3.8.7 Missed approach and Go around, CCAR No. 98, Articles 30 & 77.

to runway 36L. At this time, the first officer did not turn the aircraft at the appropriate bank angle, nor did the captain mention the width of the pattern and time check. Therefore, it is determined that the flight crew briefing on the circling approach procedure and CRM were not adequate, and the flight crew's performance of the approach was non-standard.

The CVR showed that at 11:20:24(22 seconds elapsed from the beginning of timing), the first officer told the captain without mentioning that 20 seconds for measuring to keep in the circling approach criteria in accordance with Air China's procedure had passed, "Turn quickly, not too late," however the captain had no memory of hearing it. At 11:20:54, when the captain asked the first officer to help him find the runway, the first officer advised the captain to pay attention to the altitude at 11:20:54 and 11:21:02

When the captain asked again "Have the runway in sight?" at 11:21:09, the first officer said "No, I can not see out," and then at 11:21:12, he said, "Must go around," but the captain did not attempt to go around immediately. In the light of the time that the sound of the ground impact recorded on the CVR at 11:21:17, if either the captain or first officer had executed an immediate go around, the ground impact may have been avoided. However, since the captain was PF, the first officer probably could not take over control.

As the first officer seated on the right side was in a better position than the captain to have the runway in sight during the downwind leg and base turn, he should have been more intent to keep the runway in sight, and aggressively advised the captain. But he said nothing about whether the runway was in sight or lost, until the captain asked him, "Have the runway in sight?" which indicates that the first officer did not perform his normal duty as PNF.

The first officer demonstrated less than an aggressive attitude toward his duties, and he neglected his duty of providing immediate advice, when becoming cognizant of deviations from procedures, such as the prohibition of entering clouds during a circling approach.

At 11:21:15, the first officer yelled, "Pull up! Pull up! (拉起來!, 拉起來!)" but by this time, the mountain was too close, and too late for any corrective action.

The KAIB believes that Air China needs to devise a means for standardization of the flight crew briefing procedures, standard callout procedures, checklist challenge and response procedures and checklist items, the altitude awareness procedures, and the various approach maneuvering guidance, and operating procedures, etc.

2.4.4 The Second Officer's Performance

According to an Air China flight operations team manager, on international flights, typically the second officer is there to assist the first officer, by handling radio communications. At 11:01:02, when the second officer said that he would handle the communications, even though he had little experience of landing at Gimhae airport, the captain did not object, which shows that the captain was not particularly concerned with the second officer's handling of radio communications.

After the runway was visually identified on the approach to runway 36L, the second officer read back only the circling approach instruction among the approach controller's control transfer instructions to the tower frequency and to conduct the circling approach. And contact with the tower was not established until on the downwind leg, being instructed again on the approach frequency. To the controller's question "Can you landing?" he replied "Roger, QFE three thousand, Air China 129," which shows that he did not communicate accurately with ATC.

Judging from the second officer's inappropriate responses in a number of communications with ATC and also in relaying information to other crewmembers, Air China may need to review its English language training program for flight crew on international flights.

Although it was incumbent on him as the second officer primarily to handle ATC communications, he did not advise the captain of any procedural deviations, such as entering the clouds during the circling approach, which may indicate his lack of knowledge, experience and positive attitude toward the proper performance of duties as a second officer.

2.5 Human Factors Issues—Situational Awareness and Crew Coordination

The KAIB believes that the flight crew of flight 129 lost situational awareness of danger posed by obstacles, etc. as they transitioned from the ILS approach to the circling approach, after reporting the airport in sight. A loss of situational awareness can be due to a failure to attend to and perceive the information that is necessary for people to understand a given situation. The acquisition and maintenance of situational awareness is particularly important for individuals in complex, dynamic, social-technical industries, such as aviation. Research has indicated that humans have limited working memories and attention resources.[169] Therefore, increased attention to some elements results in less attention to other elements.

A loss of situational awareness occurs due to high concurrent task load and environmental stressors. The ICAO Human Factors Training Manual, Doc 9683, 1st edition, 1998, (Para 3.3.3) states, in part, that "Loss of situational awareness occurs when a pilot develops, and fails to recognize, a lack of perception of the state of the aircraft and its relationship to the world. Loss of situational awareness occurs when a pilot is unaware of the basic capabilities and limitations of automated systems, or develops erroneous ideas of how systems perform in particular situations."

Intracockpit conversations amongst the flight crew recorded on the CVR and radio communications with the tower indicate that the flight crew did not appreciate the seriousness of the situation and failed to perceive the danger of proceeding with the circling approach. It is readily apparent that the flight crew of flight 129 lost situational awareness about the position of the aircraft in relationship to the high terrain north of the airport, during the circling approach.

The KAIB believes that the loss of situational awareness was precipitated by the lack of a proper approach briefing when the runway was changed from 36L to 18R. Further, the flight crew failed to configure the aircraft correctly for the circling approach (APP mode for LOC), which increased the PF's workload and led to a poorly conducted turn to the downwind leg. At this same time, there is evidence that the flight crew was not communicating properly among themselves or with ATC. For example, the flight crew failed to switch to tower frequency when they were cleared for the circling approach. They also misunderstood and responded incorrectly to other ATC communications. Nor did they respond to comments made by other crewmembers on several occasions: a classic symptom of loss of situational awareness.

As the flight progressed on the downwind and base legs for the circling approach, there were several examples of inappropriate intracockpit and pilot-to-tower communications. This indicates that the flight crew was distracted and probably overloaded with the workload to conduct the approach. In general, all the three flight crewmembers failed to maintain an awareness of the situation regarding the flight path of

[169] Endsley, Mica. 1996. Situational awareness in aircraft. In Brent J. Hayward and Andrew R. Lowe (Eds.), Applied aviation psychology: achievement, change, and challenge: proceedings of the Third Australian Aviation Psychology Symposium. pages 403- 417. Aldershot; Brookfield, Vt: Avebury.

the circling approach to runway 18R and the aircraft's proximity to high terrain. The evidence also indicates a breakdown in crew coordination.

ICAO Doc 9683 states, in part (Para 1.4.25), "Crew coordination is the advantage of teamwork over a collection of highly skilled individuals. Its prominent benefits are:

- an increase in safety by redundancy to detect and remedy individual errors; and
- an increase in efficiency by organized use of all existing resources, which improves the in-flight management."

Doc 9683 continues (Para 1.4.26), in part, "The basic variables determining the extent of crew coordination are the attitudes, motivation, and training of the team members. Especially under stress (physical, emotional, or managerial), there is a high risk that crew coordination will break down. The results are a decrease in communication (marginal or no exchange of information), and increase in errors (e.g., wrong decisions), and a lower probability of correcting deviations either from standard operating procedures or the desired flight path…."

Doc 9683 adds (Para 1.4.27), in part, "The high risks associated with a breakdown in crew coordination show the urgent need for Crew Resource Management training,… This kind of training ensures that:

- the pilot has the maximum capacity for the primary task of flying the aircraft and making decisions;
- the workload is equally distributed among the crewmembers, so that excessive workload for any individual is avoided; and
- a coordinated cooperation, including the exchange of information, the support of fellow crewmembers, and the monitoring of each other's performance, will be maintained under normal and abnormal conditions."

The breakdown in crew coordination was also precipitated by the lack of an adequate approach briefing that did not prepare the flight crew to work as a team during the circling approach.

The crew did conduct an approach briefing for the ILS approach to runway 36L about 10:54:54, and they probably could have completed that approach successfully for several reasons. There would have been positive glide path guidance, the captain had flown that approach previously, and most of their line experience was in flying ILS approaches.

Proper crew coordination was certainly important because the flight crew had not conducted the circling approach to runway 18R previously. Early in the approach phase, at 11:01:05, the second officer, who was handling communications said, “Others keep listening, I came to Busan not too often.” This comment reflects an attempt at crew coordination by soliciting the other members of the team to maintain attention to his radio calls. The captain said to his crew at 11:06:11, “I feel it is seldom to be instructed to fly this traffic route, it is the first time.” This indicates a concern on his part about not having previous experience on this approach to runway 18R. The flight crew did not have experience in circling approaches to runway 18R at Gimhae airport.

The fact that the crew conducted the circling approach exceeding the airspeeds of category “C,” flying category “D” airspeeds illustrates a lack of understanding of the parameters for such approaches. There were virtually no communications among the flight crew to verify the proper conduct of the circling approach before they commenced it, which is another example of poor crew coordination.

Indications of mental overload, loss of situational awareness, and poor crew coordination were also illustrated by a comment at 11:13:01, when the captain said “It’s raining, we didn’t receive any information on rain?” The other flight crew did not answer this comment or clarify the situation, although the ATIS information they had received earlier did clearly contain information about rain. Apparently, the captain “did not hear” the comment about rain on ATIS, which suggests he was under high stress and his attention was dispersed.

Scores of aircraft accidents have occurred in the past because of a breakdown in crew coordination and loss of situational awareness on the part of flight crew. In particular, statistics reveal that non-precision instrument approaches are much more demanding than ILS approaches and result in a significantly higher number of accidents. Many of the previous accidents have occurred with very similar circumstances regarding the flight crew planning for an ILS approach and being changed to a non-precision instrument approach at the last minute. Consequently, training for circling approaches needs to be more intense and adherence to procedures and proper crew coordination are more necessary.

In summary, the KAIB believes that the crew coordination among the flight crew of flight 129 was not attained amicably by not conducting an adequate approach briefing, and the individual crewmembers did not point out errors made by the others. The breakdown in crew coordination led to a loss of situational awareness on the part of the flight crew, and they failed to detect the dangerous situation until it was too late.

2.6 Flight Crew Training

The KAIB reviewed Air China's B767 flight crew training and proficiency check programs, which may have been relevant to the performance of the flight crew of flight 129.

Air China had been conducting biennial special training for medical emergency, with biannual recurrent simulator training oriented to improve crew handling of various abnormal situations.

2.6.1 Ground School

For the B767-200/300 crew, the recurrent training syllabus consisted of upgrade training[170], and recurrent training with four simulator profiles. The training included a ground school course with the following subjects[171]:

「・ The CAAC regulations pertaining to flight operations

・ The operator's flight operations regulations and manuals

・ Aircraft Flight Manual and Aircraft Operations Manual

・ Required knowledge pertaining to flight operations

The ground school will focus on the latest changes to the above subjects and new information.」 And it was also described in the Air China's Flight Crew Training Guide that tests are required for each ground school subject.

Air China's records showed that the flight crew of flight 129 had completed their ground school requirements, but no subjects were specified on the circling approach minima according to the Operations Specifications or Air China's circling procedure, etc., leading the KAIB to conclude that Air China's ground school program requires to be complemented.

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170 The upgrade to captain was attained on Nov 26, 2001, and according to Air China's Flight Crew Training Manual (B767) and records, the captain completed upgrade training (FFS training hours: 3 lessons / 6 hrs).

171 Air China's Flight Crew Training Guide (B767) 5.7.2.1 Review Items of Ground School.

2.6.2 Circling Approach Procedure Training

Circling approach training was included as the third item among the four training events during the second half, with Beijing airport as the training airport, which has almost no ground obstacles in the vicinity. The applicable weather for training was 1,000 ft ceiling with 5 km visibility.

The training profile was as follows: from 6 NM on final to Beijing airport's runway 36L, follow the localizer, descending to the MDA with landing gear down, flaps 20°, A/P and A/T engaged, then maintain MDA until the visual identification of the runway. Enter the downwind leg using the HDG SEL mode with the autopilot still engaged. Passing the downwind leg abeam the end of the landing runway, time 20 seconds, then lower flaps to 30°, and start the base turn. Perform the landing checklist. After completion of the base turn, visually check the runway, and when a normal glide path is established, disconnect the A/P for a manual descent to landing.

The actual weather conditions for the accident flight were worse than those used for training, and the flight and configuration operating procedures followed by the crew were different from those established through Air China's training manual (B767), probably due to unawareness of the procedures and insufficient training for the circling approach.

A procedure of applying data from the collection and analysis of airport risk factors to flight crew training was insufficient. In the light of this accident, there was no terrain avoidance go around training for sudden obstacles that may appear during a circling maneuver. Therefore, the KAIB urges that risk factors at Gimhae airport, obtained from data collection and analysis, be applied to circling approach training.

2.6.3 Crew Resource Management Training

ICAO Assembly Resolution A26-9 of 1986 has resulted in the publication of a Digest in order to facilitate crew resource management training by the members States and air carriers. Training materials for CRM/LOFT are contained in Digest No. 2[172].

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[172] ICAO Human Factors Digest No. 2 of 1986 for CRM & LOFT related training material contains: (1) Background information on CRM training (2) Phases of CRM training (3) Curriculum development standards (4) Course materials to be included (5) Training methodology and (6) Expected outcomes from CRM training. Since these guidelines for education and training do not specify learning contents or their course objectives, respective air carriers have adopted the spirit of the ICAO Resolution to take into consideration the particular traits and cultural background of its crews, in the development of CRM training methodology for application in parallel with flight operations.

The complete elimination of human error is implausible, since human performance is limited and mistakes will inevitably occur in almost any given situation. Reduction of error and thereby the achievement of safe operation will not be realized unless a culture of safety is first internalized. True safety culture results from an environment of open communication where safety initiatives are not intended to apportion blame or to find fault. CRM training based on such a safety culture will be able to effectively achieve goals of safety and efficiency.

It can be said that the primary purpose of CRM training is in the internalization of safety culture for safe operation. Air China's Operations Manual also stated that crew resource management techniques are intended to improve crew communication and to standardize procedural compliance, and to integrate crew teamwork for flight safety based on common awareness, and to promote captain's situational awareness toward good decision making.

But the contents of CRM training for respective training courses outlined in Air China's training handbook were the same, irrespective of differences in the courses, with lectures and videos centered on theory and case studies. It was devoid of practical training courses with various scenarios possible from real-life situations during flight. Training in such real-life scenarios would enable crewmembers to more quickly, accurately and safely resolve problems by close participation in the problem-solving process from its awareness to its solution, through a systematic cooperation by each individual crewmember's combined efforts.

Generally recommended CRM training courses cover the following areas:

· Specify individual roles and responsibilities during flight operations.
· Emphasize the importance of monitoring and good communication for verification.
· Recognize the availability of human resources from other crewmembers, ATC, flight dispatch, etc.
· Recognize the resource management is the responsibility of all crew, not just the captain.

Flight 129's FDR and CVR data revealed that the flight crew's intra communications and compliance with standardized procedures were insufficient, and that crew coordination for problem solving was not attained smoothly. It is determined that the reason for this is because the flight crew was ineffective in managing the available flight deck resources systematically.

Therefore, the KAIB believes that rather than CRM education centered on theory and lectures, Air China needs to develop a more realistic and effective CRM training program.

2.6.4 Standard Callout Procedures

The manufacturer's flight crew training manual[173] states the following: 「Both crewmembers should be aware of altitude, airplane position and situation. Avoid casual and nonessential conversation during critical phases of flight, particularly during taxi, takeoff, approach and landing. …The pilot-not-flying makes callouts based on instrument indications or observations for the appropriate condition. The pilot-flying should verify the condition/location from the flight instruments and acknowledge. If the pilot-not-flying does not make the required callout, the pilot-flying should make it.

One of the basic fundamentals of the "Crew Coordination Concept" is that each crew member must be able to supplement or act as a back-up for the other crewmember. Proper adherence to standard callouts is an essential element of a well-managed flight deck. These callouts provide both crewmembers required information about airplane systems and about the participation of the other crewmember. The absence of standard callouts at the appropriate time may indicate a malfunction of an airplane system or indication, or indicate the possibility of incapacitation of the other pilot.」

However, the CVR data revealed that callouts between the PF and PNF during the approach were not consistent with Air China's standard callout procedures. When the first officer recommended a go around, the captain was required to make an immediate go around in accordance with 4.3.8.6 of the operations manual, but he did not execute a go around.

2.7 Simulator Flight Test and Its Results

On October 2 and 3, 2002, the KAIB, NTSB, FAA and Boeing personnel participated in a simulator cab demonstration of the attempted circle to land accident profile of flight 129. The team also participated in the simulation of a circle to land approach, terrain avoidance and go around maneuver. The terrain avoidance and go around maneuvers were initiated 6, 4, and 2 seconds prior to impact and flown per

[173] Chapter 1, page 1.18 Callouts.

standard procedure.

The simulation exercise demonstrated a successful landing on runway 18 at Gimhae airport when adjusting the circle to land profile for given wind conditions. Also, It was verified that successful go around and terrain avoidance maneuvers, flown per standard procedure, could have been made, had they been initiated at least 6 seconds prior to impact.

2.8 Controlled Flight Into Terrain (CFIT)

In the establishment of procedures and programs to prevent deadly CFIT type accidents during the approach phase, the KAIB determines that the special management and oversight of those airports with higher risk factors during approach are required. Moreover, airlines need to include CFIT prevention measures into their procedures and training manuals, and civil aviation regulators need to institute programs for prevention of CFIT accidents.

The KAIB suggests the following improvement measures to be considered in the establishment of preventive procedures and programs[174].

· Flight crew factors

- Implementation of specific training for correct situational awareness, mutual communication, decision making, actions, monitoring, and challenging under CRM training to maximize crew coordination for the problem solving in the cockpit
- Compliance with standard operating procedure (SOP)
- Proficiency training in response to GPWS warnings

· Controller factors

- Positive advice to pilot errors in order to prevent an accident
- Understandable message exchange with flight crew using simple, clear, and standard words

* English language training and evaluation of the flight crew and ATC controllers

[174] Improvement Measures on CFIT/Ground Accidents & Runway Incursions, 2002, The Korea Transportation Institute.

whose first language is not English

· Equipment factors

- Installation of EGPWS which improves upon the design of the GPWS
- An addition of MSAW function to the airport radar
- Constant update of the program with the latest data and consideration to minimize the uncovered areas
- Credibility maximization through checks of the software and hardware errors
- An establishment of the procedures for normal operation and emergency activation system

· Environment factors

- In the case that weather conditions become worse below the approved minimum, abandon the approach and divert to another airport.
- Controllers should advise of current weather status on a real time basis to the flying pilot. And the pilot should compare changes of barometric altitude with radio altitude.

· Airport equipment and facilities

- In the case of a sudden advent of low pressure, altimeter settings should be frequently advised to pilots by controllers, and airport information including the latest weather information should be provided to pilots through VOLMET, or ATIS.
- The highest operational quality of the equipment for approach and landing
- The installation of circling guidance lights along the circling track at an airport which has CFIT accident risks.

· The design of the approach procedures and display on charts

- The design of a non-precision instrument approach should ensure 3 degree descending angle to keep a constant rate of descent instead of a step down descent.
- The instrument approach chart for flight crew should include contour lines to recognize terrain features and color coding for the flight crew to identify easily the altitude of FAF and MDA/DH. Domestic airports which have high risks of CFIT accidents with high mountains in the vicinity of an airport should have color-coded contour lines on a priority basis.
- The dangerous obstacles or high terrain along the approach track should be

indicated on the approach chart for flight crew to identify easily during flight.

· Management factors

- Each operator should prepare standard operating procedure (SOP), of which the meanings are clear, precise and easily comprehensible. Flight crews should be educated and trained according to this SOP. Their compliance should be monitored and evaluated.
- All the pertinent information about special airports or airways with many risk factors of CFIT accidents should be provided to flight crews far in advance of flights.
- Flight crews should be trained in a simulator to be fully aware of the CFIT risk factors in the vicinity of the destination and alternate airports.

· Development of the CFIT checklist and positive application

- Applying a CFIT checklist such as the one developed by the Flight Safety Foundation, flight crews should be aware of CFIT risk factors exiting along the approach path and touchdown area during precision and non-precision instrument approaches to each airport.

2.8.1 Instrument Approach Chart for Circling

The Jeppesen's instrument approach chart (11-1), used by the captain of flight 129 who had no experience of the circling approach at Gimhae airport, had nothing wrong in its chart manufacture standard, but it did not show any reference point for the circling approach, circling approach area, or any mountains north of the runway. The instrument approach chart was developed for the details of the instrument approach, thus it would be difficult to include dangerous terrain and obstacles precisely in the limited space on the chart.

For airports with high terrain around, requiring caution during circling approaches, such as Gimhae airport, it is determined that a separate visual circling approach chart needs to be developed, in which visual references oriented to the runway, the radius of circling approach area, major ground references, warning messages about dangers, etc. are described.

2.8.2 The GPWS installed in the Flight 129 Aircraft

The GPWS installed in the flight 129 aircraft was a MK-III GPWC[175] produced by Sundstrand Data Control[176], and was the first generation digital GPWC designed in the

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[175] Part No: 965-0577-001, serial No: 1005, TSO (Technical Standard Order) C92BCAA Spec14, Hardware Mod 16, Software Mod 16, SCD (Specification Control Drawing) Boeing part No: S220T102-102.

[176] Honeywell Company (at the present time).

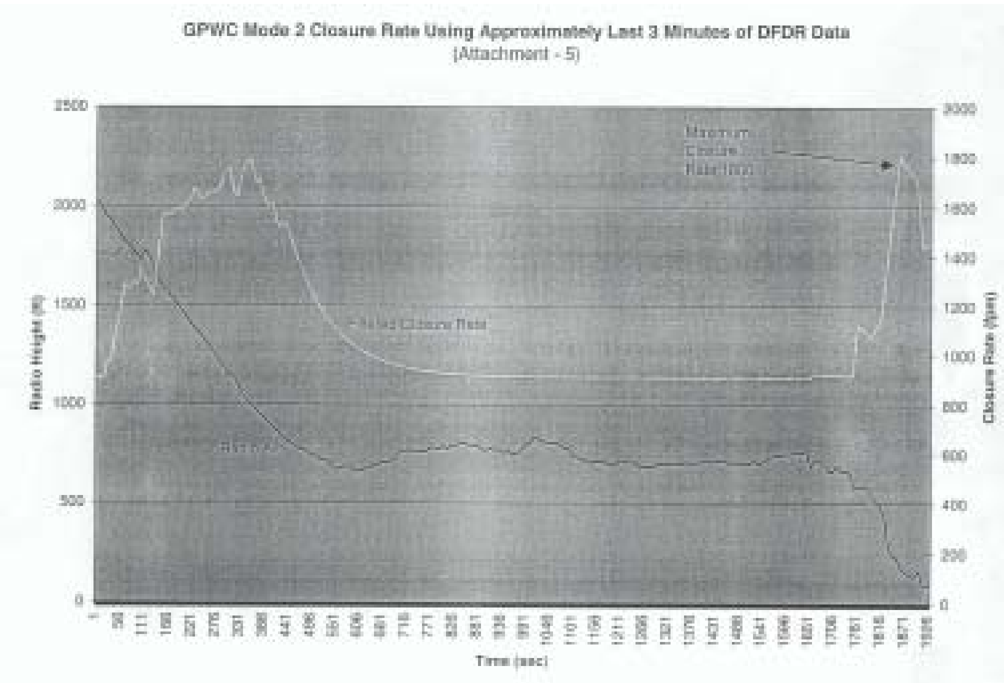
late 1970s.

MK- III GPWC was designed to generate the basic warnings from Mode 1 to Mode 5 as follows;

- Mode 1 - Excessive Descent Rate
- Mode 2 - Excessive Closure Rate
- Mode 3 - Altitude Loss After Takeoff
- Mode 4 - Unsafe Terrain Clearance Not in Landing Configuration
- Mode 5 - Below Glide Slope Alert

Flight 129 was descending, in the landing configuration with the landing gear and flaps down. At the time when the altitude was about 700 ft, it was approaching Mt. Dotdae at a speed of about 133 kt. This profile was less than the Mode 2 (Excessive Closure Rate), which should generate the warning of excessive closure to terrain.

According to a close examination[177] by Boeing of the radio altitude data of the FDR, the descent rate for the last 3 minutes from an altitude of 2000 ft until the ground impact increased from about 900 fpm to 1800 fpm, and at 700ft on the circling approach, it decreased to 900 fpm. It again increased to 1800 fpm just before the impact, as shown in the figure 2-1.



[177] GPWC Performance Evaluation Report, Attachment 5 (GPWC Mode2 Closure Rate), August 27,2002, B-H200-17467-ASI.

Figure 2-1: During the Last 3 Minutes of DFDR Data, GPWC Mode 2 Closure Rate

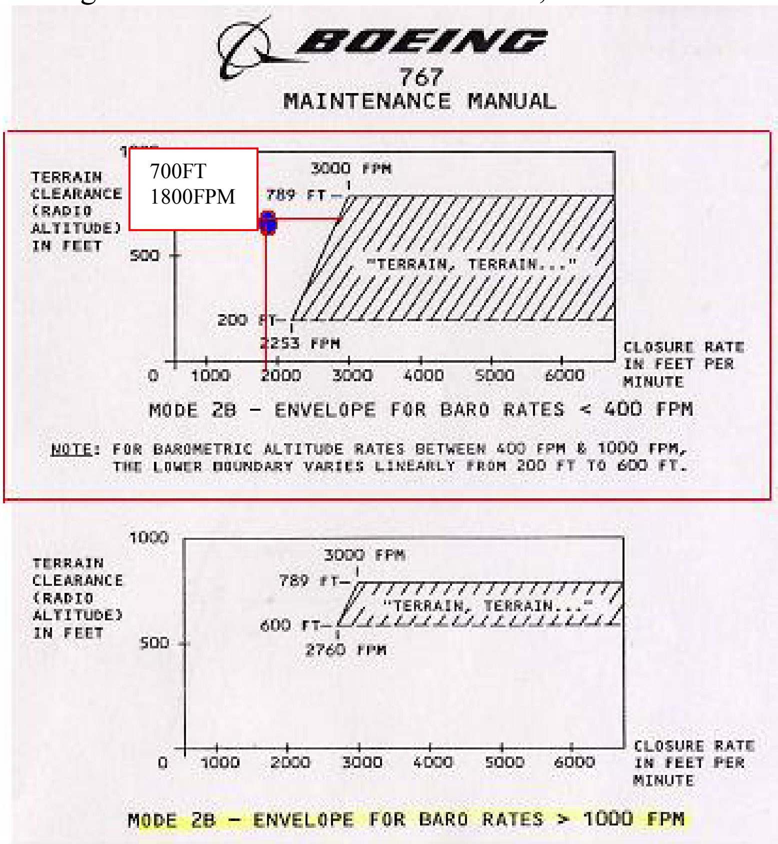


Figure 2-2 : Mode 2B Envelope for Barometric Rates < 400 FPM (Indication part)

The aircraft was in level flight and the baro rate was zero at the impact with Mt.Dotdae, which, as marked on the upper part of Figure 2-2, is applicable to Mode 2B-envelope for baro rate < 400fpm. According to the Figure, when the closure rate is 2, 253 fpm~3,000 fpm, Mode 2 warning will be generated per design. In the case of flight 129, the maximum closure rate was 1,800fpm, which was outside the Mode 2B-envelope to generate the warning. Therefore, it was confirmed to be normal that the MK- III GPWC installed in the aircraft did not generate any warning.

Boeing issued a service bulletin[178] (SB No. Boeing 767-34-0067) to install the MK-V GPWC which had the capability to provide operator selected automated radio altitude callouts not available in the MK- III GPWC, and recommended to perform the SB. However, Air China's maintenance contractor(AMECO, Beijing) stated that the bulletin

[178] Issued date: May 31,1989.

had not been received, [179] and the GPWC installed in the flight 129 aircraft was not modified.

Boeing officials[180] stated that it had sent the bulletin to the CAAC and to Air China, but the dispatch records could not be verified, since they are maintained for only up to 6 years.

2.8.3 Safety Aspects of EGPWS

EGPWS[181] improved the basic functions of traditional GPWS with an addition of terrain threat information using the latest scientific technology. EGPWS was designed to generate aural and visual warnings for the flight crew 30 to 60 seconds prior to terrain contact to allow the flight crew adequate time to respond to the threat. Among the enhanced and added functions, dangerous terrain information was inserted into the TAWS, which recognizes dangerous terrain and provides warnings.

The traditional GPWS was susceptible to nuisance warnings and would provide little or no advance warning when the aircraft was configured for landing, due to design constraints of the technology available at the time of the design of the system. In order to improve upon the design, a Terrain Clearance Floor (TCF) was introduced into the EGPWS computer which creates an increasing terrain-clearance envelope around the intended destination airport runway directly related to the distance from the runway. TCF warnings are based on current aircraft location, nearest runway center point position and radio altitude. TCF is active during takeoff, cruise, and final approach. In the case of approaching this sector, Terrain Awareness and Warning System activates aural and visual warnings as shown in the Figure 2-3.

[179] Based on replied letter from AMECO dated April 24, 2002.
[180] Based on replied letter from Boeing dated August 8, 2003.
[181] B767s manufactured after February 1999 have the EGPWS installed.

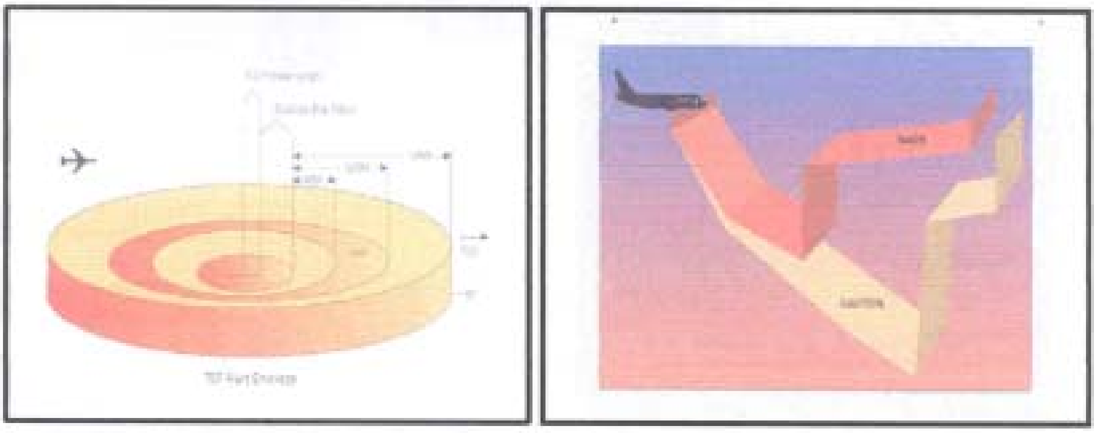
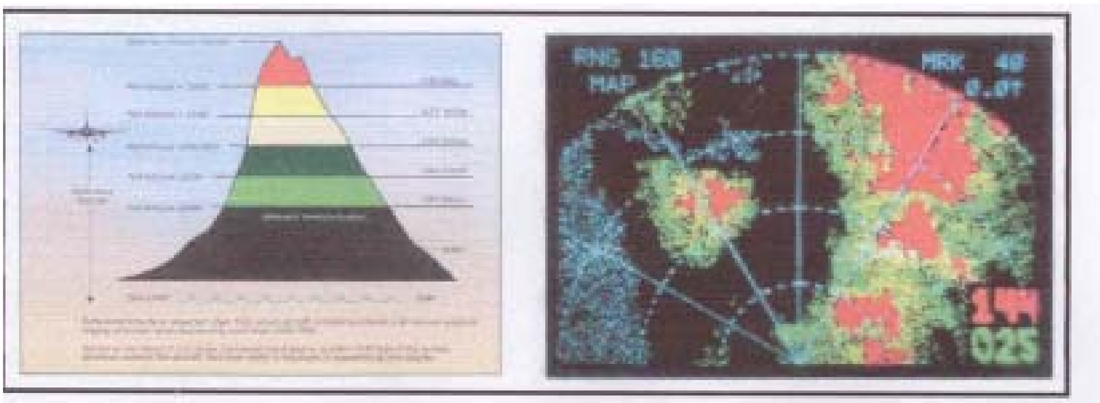


Figure 2-3: Terrain Clearance Floor Alert Envelope, Centered on the Runway

When an aircraft approaches an alert envelope, the EGPWS activates caution lights and generates an aural warning, “Too Low Terrain.” Both aural and visual warnings are generated 60 seconds prior to impact, and an aural “Pull Up” is generated 30 seconds before impact.

Through the Terrain Awareness Display (TAD) feature, EGPWS terrain information is displayed as visual and aural warning to the crew, as shown on Figure 2-4.

Terrain information is displayed on the weather radar screen in the cockpit. Terrain more than 2,000 ft above the aircraft is displayed in red, terrain between 2,000 ft above to 500 ft below (250 ft with gear down) the aircraft is displayed in yellow, and terrain that is 500 ft below (250 ft with gear down) to 2,000 ft below the aircraft is displayed in green.



When the aircraft is cruising, descending, or turning, sensors of terrain display are working and are capable of recognizing obstacles within the 30 degree cone from the flight path direction.

If the flight 129 aircraft had an EGPWS installed, it would have been a valuable tool to alert the flight crew about the approaching high terrain.

2.8.4 Special Airport Designation

The criteria to designate a special airport by the Korea MOCT and CAAC state pilot qualifications required for operation, and also general reasons for the designation as a special airport. However, they do not state detailed information, regarding approach methods, runways, risk factors, and obstacles, etc. This information may not be sufficient for operators to use. For the categorization of an airport as a special airport, appropriate criteria should be developed, including detailed pilot qualification requirements, in consideration of characteristics and requirements of the airport.

For example, if the circle to land on runway 18R at Gimhae airport is a requirement to be designated as a special airport, it cannot be said that a requirement for the pilot's flight experience is sufficed only with the precision instrument approach to land on runway 36L, or takeoff from runway 18R. Therefore, it is determined that the requirements of pilot qualification for a special airport should be specific.

2.9 Maintenance Factors

2.9.1 Fuselage

There was no evidence of explosion or sabotage in the case of the flight 129 accident.

A fire occurred in the fuselage after the ground impact. The left main gear and tires were burnt, which probably generated considerable smoke and toxic gases.

At the ground impact, the fuselage split into three parts of right wing, empennage, fuselage with left wing attached to, and the examination of the wreckage revealed no indication of corrosion or fatigues, nor any evidence of mechanical malfunction or fire in flight.

2.9.2 Engines

There were no deferred maintenance items by MEL of the engines installed in the flight 129 aircraft, and Airworthiness Directives (ADs) were complied with. Neither was there any preflight malfunction with engines.

The analysis of the flight crew's conversations, based on the CVR and FDR data, showed no engine problems or fire during flight.

Examination of the engines revealed damage to the fan blades, compressor, and turbine sections, by the engine rotating force at the time of impact, which indicates that the engines were running normally at the time of impact.

2.9.3 Flight Control System

The FDR analysis and wreckage examination revealed no mechanical malfunction in association with the accident.

2.10 Air Traffic Control Factors

2.10.1 Confirmation and Information on Aircraft Approach Category

With the active runway 36L, the AMOS was displaying surface winds favoring a tailwind, and weather conditions were below circling minima for category "D" aircraft. Thus, the approach controller expected the circling approach to runway 18R, and asked flight 129 for their approach category to determine the possibility of an approach by the flight. But when the pilot responded that the flight was category "Charlie," knowing that the active runway was 36L, it was possible that the pilot may have expected the straight-in approach to runway 36L.

The approach controller knew the approach category of B767-300 to be "D," having been notified of the runway change to 18R from the tower controller, and the weather conditions at that time were below the circling approach minima for category "D." Therefore, it is assumed that he again asked the pilot for the approach category, in order to verify the issuance of the approach clearance to flight 129, according to the Gimhae Base Local Procedures, Chapter 8, Section 8, Para 1.[182]

[182] ATC procedure for civil aircraft below approach weather minima: "The controller should not issue the approach clearance when the weather conditions at the base are below landing minima, even if the pilot requests to initiate the approach."

The pilot should determine the official weather notified by the ATIS or ATC facility, or existing weather adequate for approach or landing based on the approach category and landing minima of the aircraft, and the controller should take actions such as issuing appropriate instructions to the aircraft to hold or proceed to another airport when reported by the pilot that the weather conditions are below the landing minima of the aircraft.

There are no international standards or regulations requiring a formal notification of approach category or wide-body aircraft's circling minima to the air traffic control facilities. When, without notification from the pilot, the controller requires such information, he/she has to inquire of the pilot directly, which increases the controller's workload. Therefore, in the case of applying a different approach category to the same aircraft for the straight-in approach and circling approach respectively, it may cause misunderstanding and error between the pilot and controller, in application of a correct approach category.

At Gimhae airport, the ATC Authority requests each air carrier operating to Gimhae airport to submit the approach categories of each aircraft type by means of an official document, but no air carriers have reported on the circling approach minima of wide-body aircraft. Therefore, since the controller would not be aware of the approach category or circling approach minima in advance, unless the pilot provides the information aforetime, the most accurate method would be for the controller to ask the pilot directly.

The KAIB determines that the flight plan format needs to be changed to include items for the approach category and circling approach minima[183], in order for the controller to easily identify an aircraft's approach category and circling approach minima, and to reduce unnecessary workload between the controller and the pilot.

2.10.2. ATC Communication Transferring Instruction and Readback

After the flight crew reported runway 36L in sight to the approach controller, while the approach controller was issuing a control transfer instruction to flight 129, the part which he pronounced the frequency as "one eighteen point one" was to be "one one eight point (or decimal) one" according to the standard ATC Procedures, Para 2-4-17. The crew did not read back perfectly against the control transfer instruction of the approach controller, nor did the controller point out the imperfect readback. At the request of the tower, about one minute eight seconds later, the approach controller again instructed flight 129 to switch to the tower frequency. The captain stated that he was not aware of the reason for the delay in switching to the tower frequency. Furthermore it was impossible to confirm the correct reason due to death of the second officer in charge of communications.

According to the regulations[184] pertaining to transfer of control, frequency is not the item that shall always be read back by the pilot. However, according to the Enforcement Regulations of the Korean Aviation Act, Article 207, Para 2, the pilot of an aircraft shall confirm the correct instruction with the controller when the control transfer instruction including the frequency received from the controller is not clear. Since the second officer replied with the ATC instruction and flight 129's call sign, and he did not request to confirm the instruction including the frequency change, and the controller did not issue the control transfer instruction again right after the imperfect readback, it can be said that the controller did not know that the flight crew may not have heard the full control transfer instruction including the frequency.

Considering the fact that between the first and second ATC instructions to change the frequency, intracockpit conversations between the captain and first officer were limited to comments about flying the circling approach, it does not appear that the delays in transferring to the tower frequency resulted in a distraction for flying the circling approach. Nor did it prevent the crew from receiving the landing clearance at the normal position at the appropriate time, after the second frequency change instruction.

Circling approaches within an airport where a tower is in operation should normally be conducted after receiving a clearance from the tower, and the circling maneuver should be performed under tower control. For entry into the tower control zone, positive radio contact should be established with the tower, to follow its instructions.

But there was no record of dialogue among the crewmembers regarding the frequency change, from the entry into the downwind leg until the controller's second instruction. All three crewmembers may have simply missed the control transfer instruction, or the captain and first officer may not have monitored ATC communications.

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[183] Include wide-body aircraft minima.
[184] Annex 11 to the Convention on International Civil Aviation, Para 3.7.3.1 & ICAO Doc4444, 4.5.7.5.1.

2.10.3 Air Traffic Control of an Aircraft on Circling Approach

The communication was not established with flight 129 from the time initiating the circling approach until the flight was in sight, passing slightly the mid way on the downwind leg. And the primary local controller requested the transfer of radio communication from the approach controller, attempting to contact on the tower and emergency frequency at the same time, which shows that the local controller provided normal control services.

The CDRS data[185] and the CVR analysis showed that the initial radio contact was established when the second officer of flight 129 called the tower, passing slightly the west of the approach end of runway 18R. The primary local controller instructed the flight to report turning base, but also issued the landing clearance before flight 129 reported "turning base," after he visually recognized that flight 129 was already close to the point of turning base. The issuance of the landing clearance was proper according to the provisions of ICAO Doc 4444, Section 7.5.2. Because the aircraft was not in sight when he issued the landing clearance, he notified the flight "Not in sight," which was a normal ATC instruction, in accordance with the Korean Standard ATC Procedures 3-10-7.

The local controller was not aware nor advised that flight 129 was in close proximity and approaching dangerously the mountainous terrain during the turning base, it was probably because the controller was not able to correctly determine the dangerous situation by visual confirmation under the poor visibility at that time obscuring both the aircraft and terrain north of the airport.

2.10.4 Radio Communication with the Tower

Having issued the revised landing clearance, the secondary local controller asked flight 129, "Can you landing?" probably in the attempt to determine whether the pilot considered the landing would be feasible, since he was not able to maintain visual contact with the aircraft. But the pilot replied, "Roger, QFE three thousand, Air China 129," which is determined to be an inappropriate reply to the controller's question.

It is expected that, with the aircraft still not in sight, the local controller may have been concerned as he was aware of high terrain near the base turn area. He may have also expected subconsciously that the pilot was flying the circling approach with the runway in sight, in accordance with the principle of the circling approach flight procedure. In

[185] CDRS Data (Figure 1-6), CVR&ATC Transcripts Plotted along the Flight Track from the FDR Data (Figures 1-1, 1-2).

addition, he may not have been aware of the situation to recognize clearly that the aircraft was dangerously in close proximity to the mountainous terrain. Therefore, it is determined that the local controller asked questions relying on the pilot's judgment and determination.

When the aircraft flying in the base turn area near mountainous terrain was continuously out of sight after the landing clearance, it would have been far better for the local controller to have reminded like "Caution, Mountainous Area," or he could have advised directly like "Check your position immediately" rather than asking questions such as "Can you landing?" and "Say position now." Then, the intentions of the controller would have been understood more clearly by the pilot.

The provision of these warnings, advice or information pertain to additional air traffic control services, and according to Para 2-1-1 of the Korean Standard ATC procedures, the ability to provide additional services is limited by many environmental factors including radar performance and each controller's capability to detect the current situation, and to warn or advise the pilot by means of appropriate phraseology. When the factors stated above become inappropriate in the current service environment, it is recognized that these services cannot be provided.

After the controller issued the landing clearance until the time of crash, it is determined that the position of the aircraft was not in the final approach phase which is prescribed in ICAO Doc 4444 PANS-ATM, Section 7.5.2 and ICAO Doc 9157, Part 4, Para 1.4.13. Therefore, the KAIB believes that communications with flight 129 made by the local controller after the time of the landing clearance until crash were not deviated from radio communication minimizing regulation prescribed in Airforce manual 5-345, air traffic management, Chapter 4, Section 8, Para 2.[186]

2.10. 5 Issues Related to MSAW and BRITE

2.10.5.1 Minimum Safe Altitude Warning (MSAW) System

The air traffic control authority of Gimhae airport established the value of the MSAW in consideration of the height of Mt. Shinuh (2,076 ft) located to the north of the airport, and low altitude warnings may be displayed on the radar scope, even when an aircraft flies normally below the altitude of 2,800 ft in the vicinity of the airport.

[186] When an aircraft is in the final approach, touchdown, landing roll, missed approach and initial takeoff ascending phase, the controller should minimize the communications provided they are not necessary control instructions.

Comparing[187] the MSAW system with the circling approach area, the altitude of the MSAW activation bin which is about 2.5 miles from the end of runway 18R was 2,800 ft MSL. This grid was located in close proximity to the circling approach area for approach category "D" (approx. 0.15 NM / 280 m), so that it was possible for an aircraft in either approach category "C" or "D" to activate the visual predictive warning function of the MSAW while flying below 2,800 ft during a normal base turn maneuver to runway 18R.

Analysis of the radar track of flight 129 showed two low altitude predictive warnings as the aircraft passed outside the category "C" area, and three other warnings before impact with the mountain. There was no indication that there was any malfunction with the radar, MSAW, or other equipment that would have prevented the low altitude warnings from being displayed on the radarscopes. The analysis showed that those were normal warnings.

Because of the terrain in the vicinity of Gimhae airport, the MSAW system may activate for aircraft both within and outside the circling approach area. Therefore, it would be necessary to depict the circling approach area or a safety line on the radar video map, in order for the controller to determine accurately whether an aircraft is flying outside the circling approach area. At the time of the accident, the Gimhae radar video map depicted the runway and its extended centerline, concentric distances from the radar antenna, major terrain, the approach control area, training areas and airways. However, there was no display of the circling approach area or high terrain in the vicinity. The KAIB believes that the circling approach area or similar information on the video map would be a useful tool to assist controllers in determining more precisely the location of the aircraft, validity of the warning, and whether safety alerts should be issued to a flight that may be approaching high terrain.

Flight 129 was under IFR, and did not cancel the IFR flight plan. The circling approach for landing is an extension of an instrument approach procedure which provides for visual circling of the aerodrome prior to landing after completion of the instrument approach.

The altitude of the circling approach area at Gimhae airport was set at "0"ft per the design of the MSAW system, and aircraft flying within the circling approach area is not the object of warnings. However, if the controller had been aware that flight 129 was flying into high terrain out of the circling approach area of approach category "C," he should have issued safety alerts based on his judgment. The issuance of safety alerts can be limited by the capability of each controller and environmental factors such as the radar

[187] Refer to Possible MSAW Activation Areas and Circling Approach Area (Figure 1-9).

performance.

The MSAW system at Gimhae airport was designed and produced to display only visual warning, thus unless the controllers had been continuously monitoring the radar scope or BRITE display, they would not have been able to recognize warnings in progress, and thereby to provide safety alerts in a timely manner. However, it is a common practice in many other installations at domestic or overseas airports, as well as an ICAO recommendation[188] that the MSAW incorporates both acoustic and visual warning functions. Human factors considerations regarding controller vigilance during monitoring of radar scopes dictate that the acoustic warning function should be included to complement the visual warning, particularly to alert the controllers and their supervisors to an impending problem that might otherwise be overlooked.

2.10.5.2 The Use of BRITE

The primary and secondary local controllers stated that they used the BRITE to observe flight 129 approaching 20 NM northwest of the airport under approach control, and they realized that it disappeared from the radar in the course of search for the aircraft after radio communication was lost. Thus, they probably did not watch the BRITE while flight 129 was conducting the circling approach.

Para 3-1-9 of the Korean Standard Air Traffic Control Procedures states that tower controllers may use the certified BRITE for purposes of identifying an aircraft or its position, and for verifying traffic separation. ICAO Document 4444 ATM/501, Para 8.10.1 also specifies that aerodrome controllers may use Surveillance Radar under the authorization and conditions prescribed by the appropriate ATS authority, to radar monitor flight operations in the vicinity of the aerodrome.

Both of the above air traffic control procedures are primarily based on the continuous visual observation of the aircraft on or in the vicinity of the aerodrome, and stipulate the use of the BRITE as an aid to assist the controller to meet his/her responsibilities within the scope of his/her tasks, and not to disturb the principle of visual observation.

The tower log at the time of the accident showed that there was no other traffic under tower control except the accident aircraft, and the local controller was visually watching the location of the aircraft before and after the entry into the control zone. Thus, it is determined that the controller did not need to monitor the BRITE continuously for the

[188] Note 2 to PANS-ATM 15.6.4 states, "When the level of an aircraft is detected or predicted to be less than the applicable minimum safe altitude, an acoustic and visual warning will be generated to the radar

purpose of identifying an aircraft, its position, or verifying traffic separation, as prescribed in the Korean Standard ATC Procedures, Para 3-1-9.

When visual monitoring of flight 129 became difficult and the aircraft went out of sight, the tower BRITE could have been used by the local controller(s) as an aid to determine its position. Since there was no other traffic under tower control, except flight 129, had one of the two, or both controllers referred to the BRITE screen, the MSAW low altitude warnings (LA) could also have been observed. An aural warning also would have been useful to alert the controllers to the situation.

The Gimhae radar video map depicted the runway and its extended centerline, concentric distances from the radar antenna, major terrain, the approach control area, training areas and airways. However, there was no display of the circling approach area or terrain in the vicinity, and accordingly it may have been somewhat insufficient for the local controller to confirm by monitoring the BRITE whether an aircraft flying the circling approach to runway 18R was outside the circling approach area.

It is described in the Gimhae Base Local Procedures, Chapter 9, Section 4 that the tower takes over control of the aircraft under VFR from approach control by referring to the BRITE, after obtaining the inbound information. The primary and secondary local controllers stated that they became aware of flight 129 approaching Gimhae airport by observing the BRITE, positioned 20 NM northwest of the airport, while under approach control. They also stated that in their search effort, once radio contact was lost, they came to know that the aircraft had disappeared from the BRITE screen. Thus, it is determined that the tower controllers had experience of using the BRITE frequently to determine the location of aircraft approaching the airport.

The approach controller felt that the aircraft was flying on a longer pattern than normal, so he asked the tower at 11:20:47 via intercom whether the aircraft was making a go around. However, the tower controllers stated that they did not hear this question. It is assumed that the pilot's reply, "Roger, QFE three thousand, Air China 129" and the approach controller's asking, "Does it seem go around?" may have been transmitted through the two speakers[189] almost concurrently, which would have led to interference, or the secondary local controller may not have been able to hear, as he was focusing on acquiring the aircraft visually while communicating with flight 129.

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controller within whose jurisdiction area the aircraft is operating."

[189] Intercom speaker and VHF ATC speaker.

The tower BRITE range scale could be adjusted as necessary from 6 NM to 60 NM, but the tower controllers set it at 20 NM range at that time.

It is determined that for the prevention of future accidents, it is necessary to improve the MASW system to have the aural warning function, to reset the BRITE environment including the video map for the precise identification of the aircraft deviating from the circling approach area, to revise the operating procedure for the effective utilization of the BRITE when the tower controller provides the aerodrome control services, and to conduct the training of controllers in this regard.

2.10.6 ATC for Civil Aircraft by Military ATC

Gimhae aerodrome is under the jurisdiction of the Minister of National Defense, and air traffic control services to civil aircraft operating within the airspace of the aerodrome are performed under the authority and responsibility of the Minister of National Defense (the Chief of Staff, Airforce), designated by the Minister of Construction and Transportation, in accordance with the “No. 8, Article 8, Regulation for Delegation and Entrustment of Administrative Authority.” Qualification of Airforce controllers is maintained according to the relevant Airforce regulations.

The Aviation Act[190] entitles Airforce controllers to provide ATC services to civil aircraft without a certification issued by the Minister of Construction and Transportation, ROK. Air traffic control services to flight 129 which was a civil aircraft provided by Airforce controllers who were duly qualified by relevant Airforce regulations met statutory requirements.

2.10.7 The Role of ATC Coordinator for Civil Aircraft

At Gimhae tower which also provides air traffic control services to civil aircraft, a civil air traffic control coordinator of Korea MOCT was retained in accordance with the related agreement and mutual consent to supervise the regulatory compliance of civil aircraft pilots, and to coordinate with the civil aviation related organizations[191] for matters in association with air traffic control services, at the request of Airforce

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[190] Article 27, Para 1, Para 3

1. No person holding a certification of qualification shall be engaged in any air service other than that pertaining to the certification which he holds.
3. The provisions of paragraph 1 shall not apply to servicemen who are engaged in the control service for civilian aircraft at military control facilities used by civilian aircraft.

[191] Civil aviation related organizations excluding Airforce such as Busan Regional Aviation Administration, air carriers, etc.

controllers. However, the coordinator was not authorized to provide substantial air traffic control services.

In the situation of not providing direct aerodrome control services, it would have been difficult for one coordinator to fully monitor real time for the regulatory compliance of civil traffic under military control during all duty hours. Only upon request by the military controller and not until after something happens, would the civil coordinator advise or take cooperative actions as necessary.

Gimhae airport is one of Korea's major international airports with an average of about 180 to 200 flights daily by civil aircraft. Therefore it is determined that rather than one civil air traffic control coordinator supervising the regulatory compliance of numerous civil aircraft and coordinating with civil aviation related organizations, if a sufficient number of civil air traffic controllers provide the air traffic control services directly, such services will be provided more effectively.

2.11 Radar Facility

2.11.1 Installation and Certification of the Radar

When Seoul Regional Aviation Administration[192] installed the BRITE in Gimhae tower, the same authority inspected and certified the BRITE for the completion of installation according to the purchase specifications of the BRITE Display System included in the design document, and the BRITE was regularly maintained and inspected by qualified radar technicians. Therefore it is determined that the BRITE was officially certified in terms of its technical requirements.

Signals from the primary and secondary surveillance radars, along with processed digital data, were being displayed on the tower BRITE with the same resolution as that of the approach control radar. Video recording of the radar screen showed that the aircraft's flight number, altitude, speed and the MSAW warnings were displayed normally at the time of the accident.

The certificate issued by the government authority upon completion of installation, along with regular maintenance by radar technicians, officially certifies the BRITE in terms of its technical requirements. However, the KAIB determines that separate procedures/regulations[193] for the completion of installation inspection, or certification and the regular maintenance of the BRITE need to be established, or the current

[192] At that time, Seoul Regional Aviation Bureau, Ministry of Transportation.
[193] Refer to FAA Order 6000.15C, Chapter 5.

regulations[194] should be complemented.

2.12 Airport Lighting

In order to facilitate the pilot's identification of the runway or circling maneuvering area, Annex 14 to the Convention on International Civil Aviation, Para 5.3.6 recommends the installation of circling guidance lights in addition to the runway and approach lights. At Gimhae airport, lights[195] for the circling approach to runway 18R were installed in accordance with the related regulations.[196] Automated recording of aviation lighting activation showed the lights were turned on at the time of the circling approach.

Since installation, the clock recording the activation of the aviation lights had been running fast by approximately 19 minutes, which no one was aware of until the accident. It is determined that this resulted from the lack of operations and maintenance procedures for the equipment, thus, it is necessary to establish those procedures and operate the system accordingly.

In the light of the conditions at Gimhae airport where a circling approach must be made to runway 18R with terrain near the base turn area, a circling approach procedure may need to be developed with the visual track defined by the use of visual ground references. And in the case that the track is defined, the installation of runway lead-in lights would specifically aid the pilot-flying under IMC.

Further, according to the increment of civil air traffic volume at Gimhae airport, in order to resolve a problem that requires more time to separate aircraft approaching runway 36 before making a circling approach to runway 18 from the aircraft departing from runway 18, considerations should be given to the development of instrument approach and visual circling approach procedures to runway 18, with a radar monitoring system to facilitate terrain avoidance along the approach corridor, as well as the installation of runway lead-in lights.

2.13 Aeronautical Information Services

2.13.1 Aeronautical Information Publication (AIP)

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[194] Technical standards of NAVAIDS described in Enforcement Regulations of the Aviation Act related to the inspection of completion.

[195] Runway lights, approach lights, circling guidance lights.

[196] Enforcement Regulations of the Aviation Act, Article 225 & ICAO Doc 9157-AN/901, Part 4, Chapter 7.

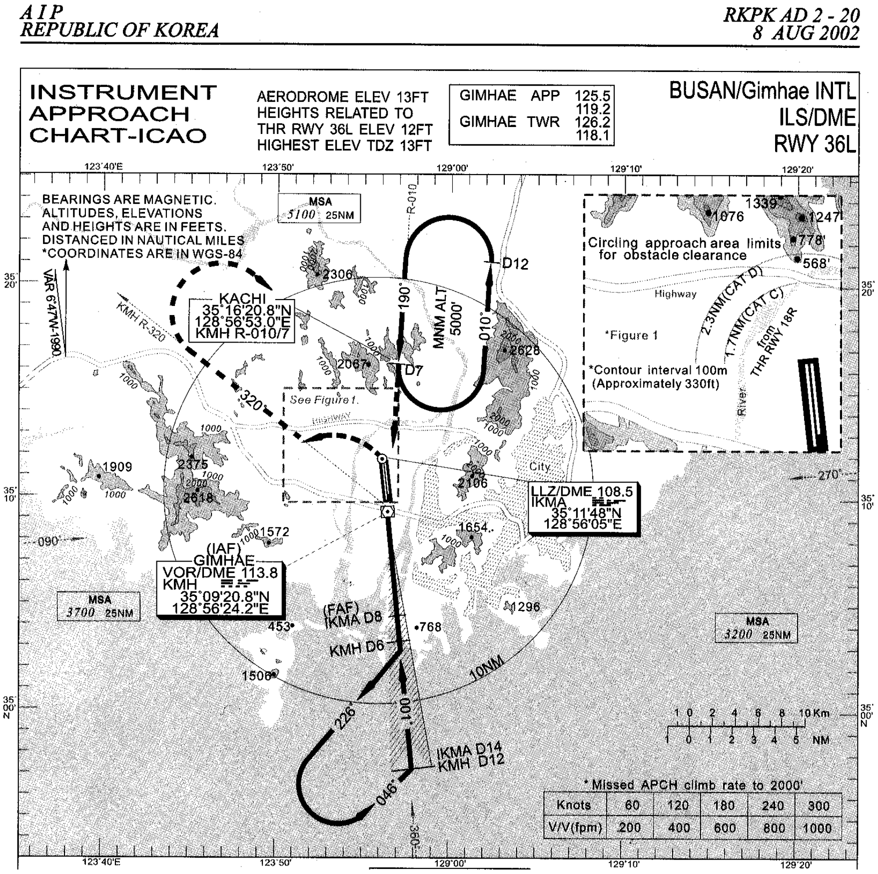
Flight procedures for approaches to Gimhae airport were prescribed in the ROK Aeronautical Information Publication where the charts were depicted according to the ICAO Chart Manual.

It is required in GEN 1.7 and ENR 1.5.1 of the AIP that the differences should be described, should there be any difference between the Korean criteria and ICAO standards for flight procedure establishment including the departure, approach and holding. However, as of April 15, 2002, there were no differences for these items described in the AIP. Therefore, referring only to the AIP, there was no method to distinguish whether ICAO or FAA criteria had been applied in Korea. It would have been inconvenient for AIP users, because they would have to contact the respective ATC authority or FIS (Flight Information Service) in order to verify this information.

The AIP revision of February 20, 2003 included the flight procedure criteria (for departure, approach and holding) at eighteen airports in Korea to make the criteria more easily identifiable.

The Jeppesen manual used by the flight crew of flight 129 clearly showed the circling approach procedure of Gimhae airport had been developed based on the FAA TERPS criteria, so that the circling procedure of Gimhae airport would not have caused confusion with the ICAO standards.

An instrument approach chart for the AIP revision of August 8, 2002, as shown in Figure 2-5, now has an inset on the upper right corner with a magnified view of the base turn area for runway 18 with contour lines, ground references, and category “C” and “D” turn radius, in order to promote a better understanding of the circling procedure of Gimhae airport.



Knots	60	120	180	240	300
V/V(fpm)	200	400	600	800	1000

Figure 2-5 Gimhae Instrument Approach Chart (revised, effective August 8, 2002)

2.14 Emergency Response

After the local controller's final communication with flight 129, since the aircraft was continuously out of sight, the local controller attempted the communication a number of times for about 2 minutes to confirm the flight's position, and called the flight on the emergency frequency about 10 times, but there was no reply.

After the landing clearance, the aircraft was about one minute flying distance to the landing runway when radio contact was lost, and no visual or radar contact was established[197], but the controller did not determine the situation to be an emergency. The controller then individually informed the related departments using the hotline, but did not use wording to convey the urgency of the situation, probably due to the lack of experience and training in responding to an emergency situation.

About 11:45, approximately 24 minutes after the accident, the secondary local controller concluded that flight 129 had crashed behind Mt. Shinuh, and used the

[197] Standard ATC Procedures 10-2-5, Emergency situation.

crash-phone and bell to make the initial notification to related departments within the airport according to the contingency plan specified in the Gimhae Base Local Procedures. It is determined that this resulted from a non-expeditious determination about the emergency situation.

Had the tower controller referred to the BRITE, and carefully pondered the location of his visual contact with flight 129, and also the flight's last reported position, he may have been able to assume the location and time of the crash more expeditiously, subsequently to make the initial emergency notification more quickly using crash-phone and bell, and to notify the fire and rescue agencies concerned outside Gimhae airport earlier.

In the case of this accident, the location of the crash was close to the residential area of Gimhae, thus the first rescue team from Gimhae fire station was dispatched to the scene of the accident, based on a report by one of the local residents made about 11:22, immediately after the accident. Consequently, irrespective of the delayed initial notification from Gimhae airport, the initial emergency response could be attained relatively quickly.

2.15 Oversight Issues

2.15.1 Air China

2.15.1.1 Regulations of Air China

The circling approach minima described in Air China's Operations Specifications[198] and in its operations manual[199] were not identical, which may have been a source of confusion for the flight crew to understand.

Considering dialogues recorded on the CVR of flight 129, after the runway change to 18R was notified from the approach controller, none of the three crewmembers including the captain made comments on the circling weather minima of wide-body aircraft, except for the circling approach category "C" minima, prescribed on the instrument approach chart being used. This indicates that Air China's training was insufficient for the flight crew on circling approach minima specified by the Operations Specifications.

Therefore, Air China should examine its system to establish various procedures and

[198] Minima in Operations Specifications: MDH 300 m, visibility 5 km.
[199] Wide-body A/C circling approach minima in Operations Manual: ceiling 300 m, visibility 4,800 m (3 miles).

training programs in this regard, and to include oversight actions to verify application of those procedures by flight crewmembers.

2.15.1.2 Flight Crew Carry-on Manual of Air China

Most of air carriers around the world provide aeronautical charts according to the number of required flight crew prior to a flight's departure in order for the flight crewmembers to individually confirm the data with the charts.

Air China provided a single set of the Jeppesen Airway Manuals to be carried in the flight deck for crewmembers of flight 129 to share. One set is deemed insufficient for crewmembers to crosscheck necessary information during a flight phase with time constraints such as the approach phase for landing.

Therefore, it is determined that Air China should provide the airway manuals with minimum of two sets to be carried in the cockpit, in order for the captain and first officer to crosscheck.

2.15.1.3 In-flight Public Announcement of Safety Information

Annex 6 to the Convention on International Civil Aviation[200] specifies an operator to ensure that passengers are made familiar with the location and use of seatbelt, emergency exits, life vest, oxygen mask and other individual emergency equipment, including passenger emergency briefing card.

While in the case of flight 129 accident, it precluded prior notification to passengers through an in-flight announcement, since the preflight safety briefing and all announcements during flight were conducted in Chinese and English languages only, most of the passengers who spoke only Korean[201] would not have clearly understood the contents of the announcements.

For flights to Korea, for the sake of passenger safety, it is urged that Air China consider making in-flight announcements in languages including Korean for the majority of the passengers, in order to preclude language problems in understanding in-flight

[200] Part 1, Chapter 4 Flight Operations. 4.2.11.1.
[201] 135 Korean of 155 passengers.

public announcements of safety information.

2.15.2 CAAC

In 1994, when Air China first began its operations to Korea, the CAAC did not conduct the pre-operational inspection, due to insufficient relevant legislation, therefore Air China conducted its own review prior to operation.

The relevant legislation was complemented after May 1999, and Air China, which had been in operation before then, was recognized to suffice the requirements of the pre-operational inspection, in accordance with Article 121.771 of the CAAC Order 83.

Records showed that in 2001, the CAAC conducted an operation status inspection of Air China, where measures were suggested to correct problems with flight operations. However, judging from the lack of understanding and application of the procedures on the minima of circling approach by the flight crew of flight 129, a program to check and supervise Air China's flight crew's knowledge and proficiency should be reviewed.

2.15.3 Korea MOCT

2.15.3.1 Air Carrier's Assistance Plan for Aircraft Accident Victims and Their Families

ICAO has provided Guidance Material in Circular 285-AN/166, Guidance on Assistance to Aircraft Accident Victims and Their Families, which outlines the responsibilities and tasks for States regarding the provision of assistance to victims and families of the victims of aircraft accidents. Some States, including the US, have specific requirements[202] for air carriers to establish and submit to the government the plans for assisting the aircraft accident victims and their families in a systemic manner. Thus, it is determined that relevant Korea Act and regulations should be developed for the air carriers operating to Korea to establish plans for assisting aircraft accident victims and their families, and submit them to the government for review and approval.

2.15.4 Korea Airports Corporation (KAC)

[202] US Code, Title 49, Sec.41113, Plans to address needs of families of passengers involved in aircraft accidents, Sec. 41313, Plans to address needs of families of passengers involved in foreign air carrier accidents.

The warning function of the MSAW of the radar including the BRITE installed at Gimhae airport was limited to visual warning only, so that the controller had to continually monitor the display in order to be aware of the MSAW activation. This installation was not consistent with the ICAO recommendation that would include an aural warning. Therefore it is determined that effort should be made to augment the system with an aural warning function[203], which would reduce risk and enhance safety.

[203] In accordance with a radar enhancement plan of Gimhae airport, the MSAW was exchanged to have aural warning function, after the accident.

3. Conclusions

As a result of the investigation, the KAIB developed findings derived from the factual information and the analysis of the flight 129 accident. There are three different categories of findings: *findings related to probable causes, findings related to risk, and other findings*.

The ***findings related to probable causes*** identify elements that have been shown to have operated in the accident, or almost certainly operated in this accident. These findings are associated with unsafe acts, unsafe conditions, or safety deficiencies associated with safety significant events that played a major role in the circumstances leading to this 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, including organizational and systemic risks, that have the potential to degrade aviation safety; however, they cannot be clearly shown to have operated in the accident. Further, some of the findings in this category identify risks that are unrelated to this 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 are often included in the ICAO format of accident reports for informational, safety awareness, education, and improvement purposes.

NOTE: Findings are a key part of this report and are published solely to identify safety deficiencies and risks for the prevention of future accidents. Any use of the findings to assign blame or liability would be a violation of international aviation law and international best practices, including those contained in Annex 13, Chapter 3, Paragraph 3.1, and Chapter 5, Paragraph 5.4.1, to the Convention on International Civil Aviation.

3.1 Findings Related to Probable Causes

1. The flight crew of flight 129 performed the circling approach, not being aware of the weather minima of wide-body aircraft (B767-200) for landing, and in the approach briefing, did not include the missed approach, etc., among the items specified in Air China's operations and training manuals.

2. The flight crew exercised poor crew resource management and lost situational awareness during the circling approach to runway 18R, which led them to fly outside of the circling approach area, delaying the base turn, contrary to the captain's intention to make a timely base turn.

3. The flight crew did not execute a missed approach when they lost sight of the runway during the circling approach to runway 18R, which led them to strike high terrain (mountain) near the airport.

4. When the first officer advised the captain to execute a missed approach about 5 seconds before impact, the captain did not react, nor did the first officer initiate the missed approach himself.

3.2 Findings Related to Risk

1. The flight crew's training for the circling approach was conducted with the simulator only for Beijing airport, and they had never been trained for the circling approach to Gimhae airport's runway 18R.

2. The crew resource management (CRM) training of Air China was insufficient for the three flight crew complement.

3. Air China did not perform the improving action for Service Bulletin (SB) 767-34-0067(May 31, 1989), which was issued by the Boeing Company for the reinforcement of the GPWS functions.

4. Air China provided one set of Jeppesen manuals to the flight crew, which the captain was using during the instrument approach, making it difficult for the other flight crewmembers to crosscheck the information in the manuals.

5. Instrument approach chart used by the flight crew of flight 129 did not depict the high terrain north of the airport.

6. During the circling approach, the flight crew of flight 129 did not use standard callouts defined by Air China.

7. Flight 129 was flown between 150 and 160 kt on the downwind leg, which exceeded the maximum speed of 140 kt of Gimhae airport's circling approach category "C," and the width of the downwind leg was narrower than normal, for which corrective actions were inappropriate.

8. The second officer, tasked with handling radio communications, did not reply correctly to controllers' instructions a number of times, however, the captain and first officer did not correct the second officer's inappropriate replies.

9. When the tower controllers lost visual contact with the flight 129 aircraft on the downwind and base legs, they tried to find the flight 129 aircraft visually, however, they did not use the tower BRITE, which is an aid to complement visual observations.

10. The flight crew did not reply appropriately to the local controller's question when the controller asked them the possibility of landing, because the local controller did not have the flight 129 aircraft in sight after issuing the landing clearance.

11. The approach controller felt that the flight 129 aircraft was flying on a longer pattern than normal, so he asked the local controllers via intercom, "Does it seem go around?" however, the local controllers stated that they did not hear this question.

12. The local controller asked a question to the flight crew to confirm the position of the aircraft, however, the local controller did not issue any direct warning or advice based on his own subjective awareness of the situation.

13. "The Korean Standard Air Traffic Control Procedures" and "Gimhae Base Local Procedures" did not specify radar monitoring of the aircraft on a circling approach by means of the BRITE and MSAW systems.

14. The MSAW system installed in Gimhae tower at the time of the accident was designed only with the function of visual warning, which was not consistent with the ICAO recommendation to include an aural warning also. Thus, the low altitude (LA) warning would not have been noticed in a timely manner, unless the controller monitored the BRITE closely.

15. The MSAW activation area was programmed in the vicinity north of the circling approach area of Gimhae airport, which was set to be higher than the altitude of the circling approach pattern, and the MSAW would be activated in the case of a normal base turn in close proximity to the MSAW activation area within the circling approach area due to its predictive warning function.

16. When the aircraft disappeared from radar, and radio communication was lost between the tower and the aircraft, the tower controllers did not notify the search and rescue department in a timely manner.

17. The measuring equipment of runway visual range (RVR) of Gimhae airport runway (18R/36L) had been out of order for a considerable time period, thus it had not been operated appropriately for the purpose of category II runway-use.

3.3 Other Findings

1. The flight crew and flight attendants received training in accordance with the CAAC and Air China regulations and procedures, and they were certified and qualified for this flight.

2. The flight crew took an adequate rest before the flight.

3. There was no evidence of any medical problems that would have affected the flight crew's performance.

4. Toxicological test results of the captain were negative for alcohol and drugs.

5. Autopsies performed on the victims of the accident revealed severe burn injuries, however, it could not be determined with a certainty whether the causes of death were from the impact trauma, fire, or a combination of both.

6. Airworthiness certificate of the flight 129 aircraft was valid, and its weight and balance were within the specified limits.

7. In the preflight aircraft maintenance inspection prior to departure from Beijing airport, no defects were found in the fuselage of the aircraft, or its systems and engines. During flight, the crew did not report any malfunction, and the examination of the aircraft wreckage did not show any possible malfunction.

8. The GPWS installed on the flight 129 aircraft operated as designed, and it did not generate any warning before the ground impact, because the aircraft was configured for landing, and the terrain closure rate was insufficient to trigger the Mode 2 warning.

9. The controllers handling flight 129 were properly qualified to perform their duties.

10. The weather forecast and ATIS broadcasts available to the flight crew were accurate and up to date.

11. The south wind was strong and there were low clouds and precipitation near Gimhae airport at the time of the accident, and the mountainous area in the north was covered with cloud and fog.

12. There were no international requirements that the aircraft's approach category (ies) and/or weather minima for a circling approach should be informed officially to the air traffic control authority.

13. The pilot should determine the official or existing weather adequate for approach or landing based on the approach category and landing minima, and the controller should take actions such as issuing appropriate instructions to the aircraft to hold or proceed to another airport when reported by the pilot that the weather conditions are below the landing minima of the aircraft.

14. In accordance with Airforce regulations, it was a normal procedure for the approach controller to ask and confirm with flight 129 about its approach category in order to determine whether to issue the approach clearance, considering the weather conditions at that time.

15. When the approach controller issued flight 129 a control transfer instruction to the tower for the first time, the flight did not change to the tower frequency accordingly, of which the reason could not be confirmed. And 1 minute and 8 seconds after issuing the first control transfer instruction, the delayed initial contact with the tower was established upon receiving the second control transfer instruction, however, the landing clearance to flight 129 was issued by the tower controller at the usual position.

16. The local controller had flight 129 in sight briefly at the point passing nearly mid point on the downwind leg, and at the time of issuing the landing clearance, the flight disappeared from his sight. Thus, the local controller issued the landing clearance to the flight including the term, “Not in sight.”

17. The local controller could not be precisely aware that the aircraft was dangerously approaching mountainous terrain, as he lost visual contact with flight 129 from the time of landing clearance issuance until crash on the base turn, due to poor visibility.

18. All of the Korean, ICAO, and FAA procedures for the use of BRITE or Surveillance Radar describe that the local controller may use the BRITE optionally, as an aid augmenting “visual observation” function.

19. Circling approach is visual maneuvering, which the pilot has to confirm ground obstacles visually in the circling approach pattern, and is an extension of an instrument approach procedure which provides for visual circling of the aerodrome prior to landing.

20. The circling approach area and terrain in the vicinity were not depicted on the Gimhae radar video map. So the tower controller was in a poor environment to accurately identify the situation that an aircraft was flying outside the circling approach area and approaching dangerous obstacles, so he could issue a warning or advice by monitoring the BRITE.

21. The use of the certified BRITE was described in the Korean Standard Air Traffic Control Procedures. The certification standard of the BRITE installed in the tower at the time of the accident was not specifically described, however, the tower BRITE could be used as the technically certified BRITE, since it was certified for the completion of installation in accordance with the specifications and design drawing of the ordering authority (Seoul Regional Aviation Bureau), and was regularly maintained and inspected by qualified technicians.

22. The differences between the ICAO and Korean criteria for the flight procedure establishment of Gimhae airport were not described in the ROK AIP effective at the time of the accident.

23. The flight information material used by the flight crew of flight 129 was Jeppesen manual, and it was described in the manual that the circling approach procedure of Gimhae airport was established in accordance with the FAA criteria.

24. The procedure for the circling approach to runway 18R at Gimhae airport was a general circling approach procedure, without the prescribed circling approach track established using the ground visual references, which could cause difficulties in conducting a circling approach flight in poor visibility.

25. Gimhae airport has the instrument approach procedure only to runway 36, thus in the case of runway 18 in use, it requires more time to separate aircraft approaching runway 36 before making a circling approach to runway 18 from the aircraft departing from runway 18.

26. The visual weather observation site at Gimhae airport did not deviate from the establishment requirements of a weather observation site, but as its northern airspace was partially obscured, the weather observer had to move to the observation site located in the ramp to observe the weather, which could be considerably inconvenient.

27. At Gimhae tower operated by the Airforce, a Korea MOCT civil air traffic control coordinator was assigned to be on duty in accordance with a related mutual consent, however, the civil controller was not positioned in the tower at the time of the accident. And due to the system of non-authorization of relevant ratings for the substantial air traffic control services, the civil controller was not able to appropriately carry out the supervision of the regulatory compliance of civil aircraft pilots, and coordination with the civil aviation related organizations, which were described in the mutual consent.

28. The clock installed in the recording equipment of the automatic on-off lighting system of Gimhae airport had been running fast by 19 minutes, which no one was aware until the accident investigation.

29. Air China had not designated Gimhae airport as a “special airport,” which would have required the additional preflight training and procedures for the flight crew.

30. The Korea MOCT designated Gimhae airport as a special airport in Flight Safety Regulations, however, it did not include the detailed information in consideration of the characteristics and requirements of the airport, and the required pilot qualification for this information.

31. All the in-flight public announcements of flight 129 were conducted only in English and Chinese, not in Korean for many Korean-speaking passengers, who could not understand the meaning of those announcements clearly.

32. A local resident called 119 immediately after the accident, so the rescue guard could be dispatched expeditiously.

33. Because of no regulation specified for assisting accident victims and their families of aircraft operating to Korea, there were difficulties with assisting the victims and their families.

3.4 Consultation of Draft Final Report

In accordance with Annex 13, Paragraph 6.3, the KAIB forwarded copies of the Draft Final Report to China (State of Registry and Operator) and the United States (State of Design and Manufacture) inviting their significant and substantiated comments on June 8, 2004. The KAIB accepted all of the comments[204] returned by the United States (NTSB) on August 8, and made appropriate revisions to the Draft Final Report.

The KAIB received comments from China (CAAC Aviation Safety Committee) on August 5, 2004, but the KAIB could not accept all of the comments returned by China. Therefore, the KAIB and CAAC held a technical meeting to discuss the differences from August 26 to 30, 2004. Following the meeting, the KAIB made several changes to the report. A second Draft Final Report was then forwarded to China (CAAC Aviation Safety Committee) for additional consultation in a technical meeting held from November 1 to 4, 2004.

China (CAAC Aviation Safety Committee) could not fully accept the KAIB's second Draft Final Report, therefore, a second response was forwarded to the KAIB on December 19, 2004. The KAIB held a third technical meeting from February 17 to18, 2005, and a fourth technical meeting from March 31 to April 1, 2005, on the second comments returned by China (CAAC Aviation Safety Committee). However, the KAIB and CAAC still could not reach agreement on certain parts of the factual information, analysis, and conclusions.

In spite of several technical meetings held by the KAIB of the State responsible for the conduct of the flight 129 accident investigation, the KAIB was not able to accept all of the comments returned by China (CAAC Aviation Safety Committee). Therefore, in accordance with Annex 13, Paragraph 6.3, the comments from China (CAAC Aviation Safety Committee) are included in Appendix 6 to this report.

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[204] Although not required by Annex 13 to the Convention on International Civil Aviation, US transmittal letter is appended in Appendix 7 to this report for information purposes.

4. Safety Recommendations

As a result of the investigation of the flight 129 accident, the KAIB developed safety recommendations to Air China International, the General Administration of Civil Aviation of China, the Korea Civil Aviation Safety Authority, the Korea Ministry of National Defense, the Korea Airports Corporation, and International Civil Aviation Organization.

Air China International

1. Review the Air China training program for "Circling Approaches" to
   (1) assure the differences between PANS-OPS and TERPS instrument flight procedures are understood;
   (2) Boeing circling or Air China circling procedures are understood with attention to automatic flight and mode selections;
   (3) circling flap configurations and radius of turn are reviewed;
   (4) circling area, obstruction clearance altitude/height, and minimum obstruction clearance be reviewed;
   (5) review missed approach procedure if visual contact is lost while on the circle to land maneuver;
   (6) review procedures for wind correction and tracking on circling approaches.

2. Review a method to standardize the contents and procedures of various briefings used by the flight crew in flight, standard call-out procedure, checklist items for each stage and checklist execution procedure, mutual altitude awareness procedure and various application methods.

3. Review the ground school class subjects of the CRM curriculum to improve on the actual sense of the field and substantial effect through the theory and practice.

4. Examine the necessity for each required flight crew to possess their own approach charts for the flight.

5. Review the need to install EGPWS in aircraft, according to the recommendation by ICAO.

6. The establishment of the training procedure for understanding of CFIT accidents and avoidance, and the prevention program, should be examined. And a review is urged on a method of special management of the airports potentially having risk factors during the approach, and reinforcement of surveillance activities on such airports.

7. On flights to Korea, Korean language should be included in public announcements in-flight.

The General Administration of Civil Aviation of China

1. Review the Air China training program for "Circling Approaches" to assure;
   (1) differences between PANS-OPS and TERPS instrument flight procedures are understood;
   (2) Boeing circling or Air China circling procedures are understood with attention to automatic flight and mode selections;
   (3) circling flap configurations and radius of turn are understood;
   (4) circling area, obstruction clearance altitude/height, and minimum obstruction clearance are understood;
   (5) missed approach procedure if visual contact is lost while on the circle to land maneuver are understood;
   (6) procedures for wind correction and tracking on circling approaches are understood.

2. The establishment of training procedures for understanding of CFIT accidents and avoidance, and the prevention program, should be examined. And a review is urged on a method of special management of the airports potentially having risk factors during the approach, and reinforcement of surveillance activities on such airports.

3. Review the need for EGPWS installation in aircraft, according to the recommendation by ICAO.

4. On international flights, particularly to Korea, require airlines to include the respective local language in passenger public announcements.

Korea Ministry of Construction and Transportation (CASA)

1. A review is urged on a method to depict the circling approach area or safety line on the radar video map, in order for the local controller to be precisely aware of the aircraft approaching terrain, flying outside the circling approach area in IMC, and to provide safety alerts. And a method should be reviewed to complement the specific methods and procedures for the local controller to issue safety alerts to aircraft, consistent with the environmental features of the airport.
2. Because Gimhae Airport as a major international airport of which service is used by many scheduled civil aircraft, and the civil air traffic volume is expected to increase continuously, the related agreement and mutual consent with the Airforce authority should be reexamined, and a specific method should be reviewed for the civil air traffic control coordinator assigned at the tower to contribute substantially to air traffic services to civil aircraft, and to cooperation with civil aviation related organizations.
3. With regard to the installation of BRITE, apart from the certification system for completion of installation, a method should be reviewed to complement the procedure or regulation concerning the official certification and certification maintenance.
4. Describe the differences in the ROK AIP in case that the establishment criteria of instrument flight procedure used in Korea (airports) are different from the standard prescribed by ICAO (PANS-OPS).
5. Publish information and guidance associated with hazards in IMC or night operations in international and domestic publications, and develop a method to provide visual aids to pilots flying circling approaches by the installation of obstruction lights for the terrain in close proximity to the circling approach area, or runway lead-in lights.
6. The establishment of instrument approach procedures to runway 18 at Gimhae airport should be examined, and a method should be developed to introduce radar monitoring or other latest safety alert systems, in consideration of the terrain in the vicinity of the final approach course.
7. A method should be developed to conduct regular simulated emergency training in preparation for an accident outside the airport, in association with the regular simulated training under the airport's contingency plan.
8. A review is urged on a method that in the case of scheduled air carriers' requesting operational change, documents such as operations and maintenance regulations should be included in the requesting papers to confirm the aircraft type's suitability for the airport.

9. A method should be developed to include air carriers' assistance plan for aircraft accident victims and their families in the related legislation, in preparation for accident occurrences.

10. A positive method should be developed to recover the function of runway visual range system at Gimahe airport, in order to operate the system to suit the purpose of CAT II runway-use.

Korea Airports Corporation

1. The Korea Airports Corporation should make it clear where the responsibility lies for the maintenance and management of the recording equipment of the automatic on-off lighting system, in cooperation with the authority concerned. To ensure records of the exact on/off time of the lighting system, the establishment and implementation of the maintenance and management procedure including the on/off time check is urged.

Korea Ministry of National Defense (ROK Airforce)

1. A review is urged on a method to depict the circling approach area or safety line on the radar video map, in order for the local controller to be precisely aware of the aircraft approaching terrain, flying outside the circling approach area in IMC, and to provide safety alerts. And a method should be reviewed to establish and implement the specific methods and procedures for the local controller to issue safety alerts to the aircraft, in cooperation with the authority concerned.

2. The related agreement and mutual consent with the Ministry of Construction and Transportation authority should be reexamined to allocate a role and responsibility suitable for the actual situation to the civil air traffic control coordinator assigned at Gimhae tower, and a review is urged on a method for civil air traffic control coordinator to contribute substantially to air traffic services to civil aircraft, and to cooperation with civil aviation related organizations.

3. The establishment of an instrument approach procedure to runway 18 should be examined with the cooperation of the related authority, and a review is urged on a method to introduce radar monitoring or other latest safety alert system, in the consideration of terrain in the vicinity of the final approach course.

4. Clarify where the responsibility lies for the maintenance and management of the recording equipment of the automatic on-off lighting system, and the procedure of the maintenance and management with on/off time check by the person in charge should be established to ensure records of the exact on/off time.

5. In order to disseminate information on the emergency situation effectively and rapidly to rescue and supporting organizations, the local air traffic control procedures should be complemented, and the training curriculum of the rapid judgment and dissemination system on emergency situations should be examined.

6. In consideration of the fact that, even in IMC, there have been frequent circling approaches to runway 18, a method should be developed to establish a visual observation site with an unobstructed view of both sides of the runway in order to observe weather with expedition in a convenient manner.

7. With regard to the installation or use of the BRITE, a review is required on a method to complement or newly establish the procedure or regulations of the official certification and certification maintenance, in cooperation with the authority concerned.

8. A method should be developed to recover expeditiously the function of runway visual range system at Gimahe airport in cooperation with the authority concerned, in order to operate the system to suit the purpose of CAT II runway-use.

ICAO

1. ICAO should consider the need to develop a standard that an approach category column of aircraft be added in the flight plan, and to record an appropriate term identifying wide-body aircraft for an air carrier, which has circling minimum of the wide-body aircraft, along with the approach category.

Ⅳ. Appendices

붙임 7　항공사고조사위원회의 최종사고조사보고서 초안에 대한 미국측 (국가교통안전위원회) 의견 [Comments from the United States (NTSB) on the KAIB's Draft Final Report]

※ 미국측 (국가교통안전위원회)의 다음 첨부자료 내용은 본 보고서에 반영되었으므로 붙임 7에서 제외되었음

Enclosures: NTSB Staff Comments

a) Boeing Comments

b) Boeing Comments Enclosure b

c) Boeing Comments Enclosure c

d) Boeing Comments d

총 1쪽

National Transportation Safety Board

August 3, 2004

Mr. Heung-Ok Choi
Director General
Korea Aviation-Accident Investigation Board
281 Ghonghang-Dong Gangseo-Gu Seoul
157-815 The Republic Of Korea

Dear Mr. Choi:

Attached are the NTSB staff comments on the draft final report on the accident involving Air China flight 129, a Boeing 767-200, registration B2552, which crashed near Gimhae International Airport, on April 15, 2002.

I would like to congratulate you and the Korea Aviation-Accident Investigation Board on conducting a very thorough investigation. Moreover, the KAIB produced an excellent and comprehensive draft final report that will further aviation safety.

Also attached to this letter are comments provided by The Boeing Company. The NTSB staff agree with The Boeing Company comments.

Please inform me if the KAIB chooses not to amend the draft final report to include the substance of any of the comments offered by either the NTSB or The Boeing Company.

Thank you again for providing us the opportunity to review your report. We look forward to receiving the final version of the report.

Best regards,

Joseph M. Sedor
US Accredited Representative

Enclosures: NTSB Staff Comments

a) Boeing Comments
b) Boeing Comments Enclosure b
c) Boeing Comments Enclosure c
d) Boeing Comments Enclosure d

General Administration of Civil Aviation of China

Comments on KAIB Aircraft Accident Report (Draft)

Aviation Safety Committee of CAAC

CONTENTS

Comments on KAIB Aircraft Accident Report (draft)

Based on the KAIB aircraft accident report (draft), the CAAC made supplements and modification, and completely stated as follows. The table shows the differences between the KAIB aircraft accident report (draft) and CAAC comments.

Item No	Title	Remarks
1.1 **1.2** **1.3** **1.4** **1.5** **1.5.1** **1.5.2** **1.5.3** **1.5.4** **1.5.5** **1.5.6** **1.5.7** **1.6** **1.6.1** **1.6.2** **1.6.3** **1.6.4** **1.6.5** **1.6.6** **1.6.7** **1.7** **1.7.1** **1.7.2** **1.8** **1.8.1**	**History of Flight** **Injuries to Persons** **Damage to Aircraft** **Other damage** **Personnel information** **The Captain** **The First Officer** **The Second Officer** **The Flight Attendants** **Gimhae Airport Approach Controller** **Gimhae Tower Controller** **Gimhae Airport Weather observer** **Aircraft Information** **Aircraft Condition** **General information of Engines** **Operating information of Aircraft and Engines (by April 13, 2002)** **Information on Aircraft's Three Certificates** **Information on Scheduled Inspection** **Aircraft Maintenance and Fault History** **Aircraft System Conditions** **Meteorological Information** **Weather Conditions at Gimhae Airport** **Additional Weather Information** **Aids to Navigation** **Radio Navigation Aids**	See the KAIB Report
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1.9	**Communications**	See the KAIB Report
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1. Factual Information

1.8 Aids to Navigation

1.8.2 Airport Lighting

According to the original records of the airport lighting, when CA129 was circling approach, approach light and circling guidance light on runway 18R was turned off. An automatic recording system is installed in the Gimhae Airport lighting control room to calculate the lighting fee. The timing clock within the computer system automatically calculates the time used for lighting. It was said the timing clock within the computer system was reset 19 minutes back at 20:30 on 18 April.

According to the tower controller’s statement at the public hearing, the runway approach and circling guidance lights of the runways 36L and 18R were turned on when CA129 was approaching. But, when the captain of CA129 being interviewed, he stated there was no circling guidance lights in sight. During the public hearing, the captain also testified that he could see the approach light of 36L during approach，and on the downwind leg of circling aprroach，he could clearly see the runway，but did not see any lights.

1.10 Airport Information

1.10.2 The Circling Approach Procedure of Gimhae Airport

When using runway 36L under instrument meteorological conditions, the aircraft follows ILS or VOR/DME procedure to have the straight-in approach. When using the runway 18R, the aircraft has to use straight-in approach procedure of runway 36L to descend to the MDA of circling approach, and after having the runway in sight, apply circling approach to land.

Gimhae Airport local procedure prescribes that the tailwind wind limit for landing at the airport is less than 10 knots. At Gimhae Airport, southwestern winds prevail during spring and summer, and the circling approach to the runway 18R was frequently applied. In the abnormal operation recordings, there were some occasional miss approaches when circling approach failed.

1.10.3 General Operation Information of Gimhae Airport

Gimhae Airport is an airport jointly used by military and civilian, and the military is responsible for weather observation, weather forecast and air traffic control. There are averagely 32 international flights, 131domestic flights per day.

The air carriers operating in this airport are: Air China, China Eastern , China Northwestern , China Northern , Korean Air, Korean Asia Airlines, Japan Air, US Northwest Airlines, Some Russian Airlines etc. The types of aircraft operated there are B777, B767, B737, A300, A310, A320, A330, MD90, MD82 and FK100 etc.

1.10.4 Abnormal Operation Condition on the Day prior to the Accident

Flight /Type	Local time	Description	Reason	Supplement
KAL1103 A300-600	08：08 —08：50	Failed to circling app twice, hold for 9min, alter to RKSS	Runway not in sight	ceiling：1500ft ，vis：3miles MDA：1100ft
AAR8803 A321	08：15 —08：36	Failed to circling app, hold for 15min Radar displayed the ground speed on downwind leg was 180 knots	Runway not in sight on base leg	Crew informed other flights in Korean that cloud was on the base leg. MDA:700ft
KAL662 A330-300	08：24 —08：52	Failed to circling app. Alter to Incheon	Runway not in sight on base leg	Controllers informed the obstacle with Korean language. MDA:1100ft
KAL818 A330	08：26 —09：05	Hold at KACHI and alter to Incheon	Poor weather condition at the airport.	Not conduct the circling approach
KAL1105 A300-600	08：31 —09：04	Failed to circling app, hold for 15min and alter to Incheon	Runway not in sight on downwind leg	Ceiling 1000ft； VIS：2.5miles； below D,E landing minimum； MDA：1100ft
AAR8533 A321	08：36 —09：21	Failed to circling app, hold for 18min and alter to Daegu Radar displayed the ground speed on downwind leg was 180-200 knots	Runway not in sight on base leg.	MDA: 700ft
KAL1109 A300-600	08：39 —09：23	Hold for 30min and alter to RKSS	Poor weather condition at the airport.	Flow control by the RAPCON
KAL1000 A300-600	08：39 —09：23	Alter to Daegu	Poor weather condition at the airport.	Required the weather condition to the Gimhae

1.10.5 Weather Observation

According to the agreement signed between the ROK Air Force Gimhae Base Weather Office and Gimhae Civilian Weather Station of the Meteorological Department, the ROK Air Force shall be responsible to provide the weather observation and weather forecast service for the Gimhae airport, the applicable service standards of the ROK Air Force shall be implemented. The duty of Gimhae Civilian Weather Station is to collect the weather information provided by the Air Force with the civil meteorological report format and issue it to the civil airlines.

1.10.5.1 Visual Weather Observation Site

The visual weather observation site of the Gimhae Airport Weather Office is located on rooftop of the Air Force weather office. A hangar in the north blocked the observation view and the views toward the lower skies north and northwest of the Gimhae Airport (including the site where the accident occurred) were blocked. The weather observer from the Gimhae Air Force Weather Office stated that when making the observations of this part of the sky, the observers have to leave the observation platform for the apron west to weather office, at a distance which required five minutes round trip on foot between the weather office and the apron observation site. The weather observation post was constructed in December 1971, and maintenance hangar was built in December 1990. There was no blockage to the views toward the north approach area direction of the Gimhae Airport before construction of this hangar.

1.10.5.2 Weather Observation Equipment

The automatic weather observation system located along the east runway of the Gimhae airport was installed in December 28th, 1990, and put into service since March 23rd, 2000. The system consists of an anemometer, instrumentation for measuring temperature and dew point, rain gauge, barograph, laser beam ceilometers and RVR (runway visual rang) measuring equipment. At the time of the accident, all the equipment recorded normal operation.

The RVR measuring equipment had stopped to provide service (Notice to Airman had been issued) on July 12， 2002. And at the time of the accident, it was still in the unserviceable state, and only the equipment itself was still in the “on” state, and recorded a value measured.

1.16 Test and Research

Since both the Chinese and Korean Investigating Teams have different opinions on the first transfer instruction given by Gimhae approach controller, the Chinese investigation team had 10 controllers and 8 pilots to listen to the clearance “Air China 129, Contact Tower one eighteen point one, Circle to….”. The result was that none of them could identify it.

1.18 Other Information

1.18.1 Information on Special Airports

Korean 《Flight Safety Regulations》[1], Article 517 and 518 stipulates: Special airports are divided into class A, class B and class C. Among them, Gimhae airport is defined as class A[2]

[1] Formulated in accordance with the《Korean Aviation Law》Article 74-2.

[2] Requirements on class A airport:

because of high terrain north and east to the airport. Therefore requirements on flight experience and training are stipulated for a captain who flies to this airport.

This information had not been published to the public, nor notified to CAAC and Air China.

Air China did not list Gimhae airport as a “special airport” in its operation specifications, so neither special training was conducted nor special requirements on flight experience was required.

No takeoff and landing is allowed when the ceiling is lower than 1000 feet above the minimum enroute altitude (MEA), or minimum obstacle clearance altitude (MOCA), or initial approach altitude, and visibility is less than 3 miles.

In the last three months, the captain must have the takeoff and landing experience as an observer.

The captain must be trained and qualified in the audio-visual training equipment, which is approved by the minister.

2. Analysis

2.1 General

The three flight crew members were certified and qualified in accordance with the ICAO standards, CAAC regulations and the requirements specified by Air China. They had had sufficient rest prior to the flight, and no physical conditions that were not fit for their duty were found. The flight operation within the Korean airspace was in accordance to the Korean Aviation Regulations.

The aircraft had been certified airworthy in accordance with the ICAO standards, CAAC regulations and the requirements specified by Air China. It was properly equipped and serviced by maintenance. There was no evidence of malfunctions with the airframe, the flight controls or the engines prior to the accident. The aircraft had been loaded properly within the limitations of weight and balance.

This section analyses the weather factors at the time of the approach, weather observation, flight crew and controller performance, utilization of equipment and navaids by air traffic control, related flight procedure and navigation data, etc.

2.2 Weather Factors

2.2.1 Weather conditions

On the date of the accident, the Gimhae Airport was in a southwest warm & wet airflow, which was located before the cold front and behind the subtropical anticyclone. It was covered by stable precipitus, which caused a long-playing mass of low clouds and bad visibility, and the south wind increased gradually.

According to the airport weather observation at 08:00: the wind direction/wind speed was changed from 140°/ 4knots to 200° /9knots; and the scattered (SCT) cloud base was reduced from 1000ft to 800ft. At 09:00 the weather observation was reported the wind speed increased to 11knots, and the broken (BKN) cloud base was reduced to from 1500ft to 1000ft. At 09:43, there was a special report: the wind speed further increased to 12knots.

At 11:11: the Gimhae Airport weather observation was reported: wind direction/wind speed was changed to 210° /10 knots; and visibility 4000 meters, with light rain and mist, 500ft scattered (SCT), 1000ft broken (BKN); 2500ft overcast (OVC).

At the time of the accident, the wind direction/wind speed recorded in the Gimhae Airport automatic weather observation system had been 210°/13knots; and maximum gust speed 17knots.

While the flight CA 129 was flying on the downwind leg, the wind speed recorded on the flight data recorder (FDR) was 25 knots. The first officer said: “The wind is too strong, it is difficult to fly”.

It can be seen from the above that the weather on the day of the accident at the Gimhae Airport was so bad for circling approach. Before to the accident of CA129 occurred, eight aircraft had landed the alternate airport due bad weather condition, among them, five aircraft executed go-around after failed circling approach to runway 18R.

2.2.2 Meteorological Observation

World Meteorological Organization 《Guide to practices for meteorological offices serving aviation》(WMO-No.732) 6.2.1.1 stipulates, "The observing office should be sited so as to provide an unobstructed view of the weather conditions over the aerodrome and its immediate vicinity from the observer's working position, ……"

Federal Aviation Administration (FAA) 《Air Traffic Control Facilities Management》(Order 7210.3), Part I 2-9-7 stipulates: "……to give a proper indication of weather conditions in the areas of aircraft approaches, landings, and takeoffs, the site…… the site shall also have an essentially unobstructed view of : a. the most frequently used instrument runway and its final approach area; and b. at least half of each quadrant of the natural horizon.".

At Gimhae Airport, southwestern winds prevail during spring and summer. Aircraft more frequently use the runway 18R for circling approach. According to the above regulations and the meteorological characteristics at Gimhae airport, the observer should be able to continuously monitor the weather change in the maneuvering area for circling approach of runway 18R without any obstructions. However, the north sight field of visual weather observation post was obstructed due to the presence of large hangars, blocking the observer's direct view of sector for circling approach to runway 18R, so there was possibility to cause the observer to be unable to timely discover the weather change in the north, and it would have an adverse affect on performing a special observation and report[3]. Although the observer could left the observation platform and walk to the apron to observe the blocked area, it would have been considerably inconvenient for the observer to do so, and unable to ensure the observation and report without delay.

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[3] The special observation and report is an observation and report between the two routine observation reports or after the previous special observation report, which is made in the time when the weather change has relatively great affect on the flight. For the details, see Annex 3 to the Convention on International Civil Aviation《Meteorological Service for International Air Navigation》.

2.3 Flight Crew Performance

As directed by the Gimhae Airport approach controller, CA129 had made the ILS approach to runway 36L, and then circling approach to runway 18R. The minimum of circling approach for category "C" was applied, which was ceiling 700 feet, visibility 3.2km. When the aircraft approached to runway 36L, the flight crew use autopilot (A/P) mode to conduct the instrument landing system (ILS) approach. When decent to 700 feet, the crew reported the runway in sight, then disconnected the autopilot, manually flew the aircraft to turn to downwind leg of runway18R, but thereafter, the following abnormalities happened:

The circling approach operation procedure recommended in the Air China B767 training manual is: at the phase of instrument flight straight-in approach, use the localizer (LOC), vertical speed (V/S). If the Approach (APP) mode is used for the straight-in approach, when turning to downwind leg, the correct operation procedure for this should be: disconnected the autopilot, turn off both flight directors (F/D), and turn on again, then use the heading selector (HDG SEL) to adjust the target heading and use manually control to fly the aircraft away from the course towards downwind leg. The recordings in the flight data recorder (FDR) showed when CA129 flight crew had disconnected the autopilot to turn left using a left bank angle, they did not turn off and turn on again the flight directors (F/D), the flight director were still set in approach (APP) mode, and the flight directors (F/D) gave a right turn indication relative to the left bank angle. As the flight directors provided an opposite indication, it probably required the flight crew to make judgment, thus causing a lag in the flight maneuver. During the time from starting to fly the aircraft to turn left and thereafter, the left bank angle was only up to 5-15 degree (the normal value is 25 degree), resulting in a delay in time for turning the aircraft to heading 315 degree to intercept downwind leg , so that in the time when near passing abeam the threshold of runway 18R, it turned back to the downwind leg heading. Because turning to the downwind leg was made using a bank of less than the normal bank, and the adverse influence of wind direction and wind speed of 210/17 knots, when passing abeam the threshold of the runway, the aircraft was located at position with 1.1 nautical miles of downwind width, which was 0.3 nautical miles narrower than the normal downwind width. The Chinese team believes: As CA129 used the operational procedure not recommended by the manual and thus made the flying more difficult, resulting in the delayed entry onto the downwind leg and the narrow traffic pattern.

According to the normal control procedure, when CA129 reported the runway in sight, the approach controller would transfer the aircraft to the tower controller. But due to the fact that at this time, the approach controller's voice of the frequency change instruction he issued "Air China 129, contact tower, one eighteen point one, circle west, …" was difficult to identify, and the phrase to read the frequency was not standard, the flight crew only read back: "Circling, circling, 18R, CA129"and did not read back the frequency transfer clearance to contact tower. The approach controller did not point it out and make correction. Judged by this, the flight crew did not get the transfer clearance of contacting the tower and tower frequency. The controller thought the flight crew would have established contact with tower as instructed, but in fact, the flight crew didn't. This resulted in an interruption of the controlling for 1 minute 8 seconds. When the flight crew established contact with tower, the actual position of the aircraft was already abeam the threshold of runway 18R. During the remaining time, the instructions issued by the tower controller significantly increased the workload of the flight crew.

The deviation from the normal flight procedure and interruption of the air traffic control had a potential affect on the subsequent flight of CA129.

When aircraft passing abeam the threshold of runway 18R, the timing of flight crew is correct. Probably it was because that the captain had considered the affect of the tail wind, at 11:20:15,13 seconds after the timing, he directed the first officer who was flying the aircraft at that time, to make base turn. It was also probably because the captain thought it was on the final phase of flight, so he took over the aircraft from the first officer to fly by himself. The first officer might have already realized the necessity for a quick base turn, at 11:20:24, he urged to caution the captain: "Turn quickly, not too late". But immediately afterwards, at 11:20:25, the tower controller issued the landing clearance which last 9 seconds, including the tongue slip "Cleared to land, runway 36L. correction …" Due to this instruction, the captain failed to respond to the first officer's reminding, "Turn quickly" for base turn. According to the testimony of the captain, it was confirmed that the captain had been distracted at the time by the above clearance from the tower controller.

The Chinese team believes: a judgment had to be made before the captain had not fully understood the real meaning of the controller's instruction, as a result, the flight was adversely affected and failed to decisively fly the aircraft to the base turn. And it is also an objective fact that the time of issuing the landing clearance by the controller and tongue slip in the instruction had caused an adverse influence on the captain to fly the aircraft to base turn.

Another factor that caused the extended downwind leg was high ground speed of the aircraft. CA129 made ILS approach to runway 36L and circling approach to runway 18R according to the speed and altitude of approach category "C". In accordance with the criteria of the procedures, in a calm condition, the indicated air speed when aircraft passing abeam the threshold of runway 18R should not be greater than 140 knots, and the actual timing of the base turn should depend on the current wind direction and wind speed so as to keep the flight track of aircraft within the safety obstacle clearance protection area of the procedure, (with the landing runway threshold as center, the radius is 1.7 nautical miles for Category "C"). But, according to data recorded in the flight data recorder (FDR), the indicated airspeed when aircraft passing abeam the end of runway 18R was 158 knots, and the ground speed up to 177 knots.

Due to the above causes, the position where CA129 actually enter the base turn was 1.1 nautical miles beyond the protection area for TERPS Category "C" at Gimhae Airport.

On the day of the accident, due to the adverse affect of sea fog from the south and strong southwest wind, there was amass of low cloud and fog on the mountainous north of the Gimhae Airport and persisted a long time around there. During the second half of base turn, CA129 actually entered the cloud. Under the circumstances that visual contact with runway and any visual references on ground were lost and the first officer cautioned: "Must go around", the captain didn't execute the missed approach procedure, still attempted to make the final turn to runway 18R. Anlthough the crew might have been awared of obstacles in front of them , and the first officer yelled "Pull up, pull up", the captain did a pull up action, but it was too late. As a result, the aircraft was impacted with mountain.

2.4 Air Traffic Control Factors

2.4.1 Transfer Instruction of Approach Controller

After the flight crew reported the runway in sight, the approach controller instructed CA129 to change the radio frequency to the tower frequency, but the second officer did not read back the entire instruction, and the approach controller did not correct it. The flight crew did not change the frequency to contact the tower, and then approximately one minute and eight seconds later, the approach controller directed the second time for the same change to the tower frequency.

According to the ATC records, after the approach controller had issued the frequency change instruction for the first time, the flight crew didn't read back this instruction, and the recording recorded in the cockpit voice recorder (CVR) showed no exchange about crosscheck content of frequency change among crewmembers. In the interview and public hearing, the captain of CA129 stated that in his memory, the flight crew had received the frequency change instruction until at the position of downwind leg.

The Chinese investigation team believes: The reason for CA129 flight crew's failing to timely change to tower frequency was that the crew had not received the first frequency change instruction.

After repeatedly listening to and analyzing the ATC recordings and the cockpit voice recorder (CVR), the Chinese investigation team believes that the frequency change instruction of the approach controller is really too unintelligible for identification, and the controller used non-ICAO standard frequency phrases. In February 2003, at the invitation by the Korean side, the Chinese and Korean investigation team again listened to questionable contents of ATC recordings and the cockpit voice recorder (CVR) in the lab of the US National Transport Safety Board (NTSB), the American participants also agreed on the conclusion that the frequency change instruction was unintelligible. In May 2004, the Chinese investigation team asked 8 pilots and 10 controllers to listen to the contents of the instruction in the CVR respectively, but no one could identify this frequency change instruction.

The Chinese investigation team believes that the unintelligible frequency change instruction of the approach controller had caused CA129 flight to contact tower too late. And the delay in contact with the tower led to the communication between the tower controller and the flight crew to be concentrated in the critical phase of circling approach, which significantly increased the workload of the flight crew.

2.4.2 Communication of the Tower Controller

After CA129 had established contact with Gimhae tower, the controller asked CA129 first time to report the base turn, the flight crew replied: “Roger”. According to the cockpit voice recorder (CVR), the first pilot said at 11:20:24:” Turn quickly, not too late”, but just in that time, the tower controller issued landing clearance with mistaken contents for over 9 seconds. In the interview, the captain stated: “As the tower was giving us the instruction, and we were concerned with the instruction, so we were unable to check time”. In the public hearing, the captain made the same statement again.

The Chinese investigation team believes: The landing clearance of the controller interfered objectively the operation of the flight crew to enter the base turn, which was one of the causes to have CA129 to extend the downwind leg and fly the aircraft into mountainous area.

According to the regulations specified in Chapter 4 Paragraph 8 ‘Precautions for Radio Communication’, ROK Air Force textbook 《Air Traffic Control Management》(5-345): “When aircraft is in the final approach, touchdown, landing run, missed approach and initial takeoff ascending phase, it is the time that needs a pilot to concentrate his mind. Therefore, the controller should minimize all the communications as much as possible, provided they are not necessary control instructions. However, it should be ready to issue the information that has affected on safety of aircraft, such as to confirm or notify the airport conditions”.

After issuing the landing clearance, the tower controller had not issued any direct safety alert to CA129, and on the contrary, four times communications irrelevant to the safety alert were made with the flight crew, which distracted the crew’s attention. If the controller had thought it was necessary to communicate with the flight crew, he would have cautioned the crew to watch carefully the mountainous terrain, or to issue a direct safety alert.

The Chinese investigation team believes: The four times communications made after the tower controller issued the landing clearance are in violation to the above regulations, these unnecessary communications interfered objectively the flight crew in flying and decision making in the final approach portion.

2.4.3 Automatic Terminal Information Service (ATIS)

Automatic terminal information service at Gimhae airport is recorded on the spot by the approach controller himself, but the tone quality was poor because of no sound insulation. This interfered the understanding of the weather conditions on that day. In flight, crew complaint “I can’t hear it clearly, I can’t hear it clearly at all ” and “ the voice is too poor”.

2.4.4 Utilization of Radar

2.4.4.1 Control Radar at Gimhae Airport

The control radar at the Gimhae airport had the Minimum Safe Altitude Warning (MSAW) function, but only with visual warning function, not with aural warning function.

Annex 11 to the Convention on International Civil Aviation, Para. 3.9 stipulates: "Radar systems should provide for the display of safety-related alerts and warnings, including conflict alert, conflict prediction, minimum safe altitude warning and unintentionally duplicated SSR codes."

ICAO 《Procedures for Navigation Services－Air Traffic Management》(PANS-ATM, Doc 4444), Para. 15.6.4, note 2 provides: " In the MSAW function, the reported levels from transponder-equipped aircraft with Mode C capability are monitored against defined minimum safe altitudes. When the level of an aircraft is detected or predicted to be less than the applicable minimum safe altitude, an acoustic and visual warning will be generated to the radar controller within whose jurisdiction area the aircraft is operating. "

The Chinese investigation team believes：Since the Minimum Safe Altitude Warning (MSAW) of the control radar at the Gimhae airport was not provided with aural warning function, no proper warning was provided to the tower controller in this accident and the radar failed to perform its real MSAW warning function.

2.4.4.2 Gimhae Approach Control

According to the provisions of FAA Air Traffic Control Order 7110.65M5-1-13, the radar service should not be terminated until the aircraft conducting instrument approach lands.

ICAO Document 4444, Para.8.6.6.1 states: "An identified aircraft observed to deviate significantly from its intended route or designated holding pattern shall be advised accordingly. Appropriate action shall also be taken if, in the opinion of the controller, such deviation is likely to affect the service being provided.

ICAO Document 4444, Para.15.6.4.2 stipulates: "In the event an MSAW is generated in respect of a controlled flight, the following action shall be taken without delay: a) if the aircraft is being provided with radar vectors, the aircraft shall be instructed to climb immediately to the applicable safe level and, if necessary to avoid terrain, be given a new radar heading; b) in other cases, the flight crew shall immediately be advised that a minimum safe altitude warning has been generated and be instructed to check the level of the aircraft.

At 11:20:47, the approach controller reminded the tower controller that CA129 was likely to go around. From this, it can be judged that after transferring the CA129 to the tower controller, the approach controller was still keeping on radar monitoring. According to the radar record, MSAW warning appeared at 11:20:41 and 11:20:47. From the radar, the approach controller found that the downwind leg of CA129 was already longer than the normal, so subjectively thought that CA129 was likely to go around and reminded the tower, but he didn't tell the tower about appearance of MSAW warning concerning CA129. With no response received from the tower controller, and MSAW warning appeared for 3 times successively on the radar display at 11:21:09, 11:21:15 and 11:21:16, the approach controller did not continue to remind the tower controller to alert CA129.

The Chinese investigation team believes that, if the approach controller had timely issued an alert of being lower than the minimum safe altitude to CA129 when MSAW warning displayed appeared on the radar display for the first time at 11:20:41 (36 seconds before the accident), it wound have been very possible to avoid the accident.

In the public hearing, the Air Force ATC department of Gimhae airport replayed a video about appearance of MSAW warning on the Gimhae radar display, so as to explain that false MSAW warnings often appeared in the daily ATC operation due to limitation of MSAW functional setting of radar system. The Chinese investigation team believes, the MSAW function in the control radar is an important measure to prevent aircraft from impaction with ground obstacles, the controllers should pay great attention to MSAW warning and should be able to distinguish real warnings from false warnings, and timely issue safe alert to aircraft according to MSAW warning. It is wrong not to pay close attention to MSAW warning using frequent appearance of false warning as an excuse.

2.4.4.3 Gimhae Tower Control

ICAO Annex 11, Para. 2.2 states， "The objectives of the air traffic services shall be to: …b) prevent collisions between aircraft on the maneuvering area and obstructions on that area;….d) provide advice and information useful for the safe and efficient conduct of flights."

ICAO Document 4444, Para. 8.4.1 stipulates, "Where suitable radar systems and communication systems are available, radar-derived information, including safety-related alerts and warnings such as conflict alert and minimum safe altitude warning, should be used to the extent possible in the provision of air traffic control service in order to improve capacity and efficiency as well as to enhance safety."

ICAO Document 4444, Para. 8.10.1 also stipulates, "…surveillance radar may be used in the provision of aerodrome control service to perform the following functions: a) radar monitoring of aircraft on final approach; b) radar monitoring of other aircraft in the vicinity of the aerodrome…d) providing navigation assistance to VFR flights"

On the day of the accident, visual monitoring of the aircraft was difficult, and the use of radar would be helpful to monitor the aircraft. Prior to the accident, there had been 5 Korean aircraft, which executed going around during circling approach to runway 18R.Among them, one A330 was cautioned by the tower controller using Korean language when flew into the north mountainous area. The Chinese investigation team infers that the tower controller determined the location of the aircraft with reference to the radar. But, when it was unable to visually monitor CA129, none of the 5 duty personnel used the radar to monitor the aircraft.

At 11:20:47, the Gimhae approach controller informed, by intercom, the tower of that CA129 was likely to go around. But this important information didn't draw attention of tower controller, and none of controllers referred to the tower radar according to this information. They still attempted to visually search aircraft, and even worse, they did not timely provide this important information to CA129, nor issued direct safety alert. At 11:20:32, the figure 1-2 in KAIB report showed that CA129 had already flown outside the protection area of circle approach of TERPS category "C" aircraft and MSAW warning appeared on the tower radar display for several times.

The Chinese investigation team believes, under the condition that the tower controllers were unable to make visual contact of CA129, because the radar had not been used to monitor the aircraft, they lost the opportunity of directly providing a warning to CA129 and the possibility of avoiding the accident.

2.5 Flight Procedure

2.5.1 Circling Procedure of Gimhae Airport

The FAA 《Terminal Instrument Procedure》(TERPS) standards was used for design the circling procedure of Gimhae Airport, with which the protection area for Category "C" aircraft was 1.7 NM (3.2km) from the runway threshold, the published minimum descend altitude (MDA) was 700ft; And the circling protection area for Category "D" aircraft was 2.3 NM (4.3km) from the runway threshold; the published value of the MDA was 1100ft.

TERPS criteria and ICAO standard (included in 《Procedures for Air Navigation Service-Aircraft Operations》(PANS-OPS Doc 8168) are greatly different in the design of circling protection area. The protection area of the former is far smaller than that of the latter. Should the ICAO standard be applied, the circling protection area for Category "C" aircraft would be 4.23 NM (7.85km) from the runway threshold; MDA would be 2400 feet.

The aircraft crashed at a point 4.6 km form the runway threshold with true azimuth of 354°, which was outside TERPS Category "D" protection area but inside ICAO PANS-OPS Category "C" protection area.

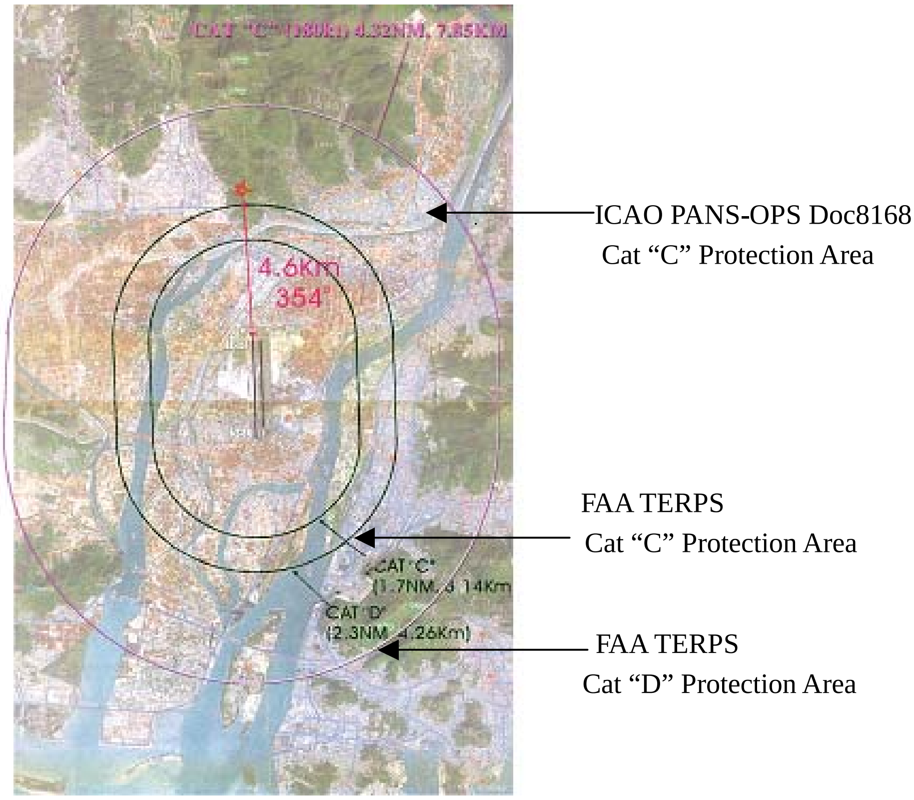


Figure 1 Relationship between aircraft crashed site and circling protection area

It is difficult for pilots and controllers to understand and distinguish the difference between these two criteria, particularly when the two criteria are applied simultaneously in one country without a clear and definite explanation.

2.5.2 Aeronautical Information

2.5.2.1 AIP （Aeronautical Information Publication）

The information used by the controller at the Gimhae Airport was from the Korean AIP.

As a national formal aeronautical information document, the AIP is the basis for foreign airlines operating in that state. The main differences between the national regulations and ICAO recommended standards, measures, and procedures should be included in AIP. Annex 15 to the Convention on International Civil Aviation requires claiming the “criteria on which holding, approach and departure procedures are established. If different from ICAO provisions, the requirement is for presentation of criteria used in a tabular form”.

In Para. 1.17 of the ROK AIP, it only stated “Aircraft Operation (ICAO Doc8168) is applied to construction procedure for instrument flight procedure. However, United States Standard for Terminal Instrument Procedure (TERPS 8260.3) may be applied in a case that the establishment of instrument flight procedures is impossible by the application of ICAO regulations concerned because of ground obstacles, limitation of airspace utilization and so on”. But, no specific operation conditions were pointed out, causing the operators difficult to specifically understand which airport of Korea and which procedure used TERPS criteria as well as the concrete contents of the TERPS criteria. The ROK AIP did not specify as required by Annex 15 the main differences[4] of standard used for the Gimhae Airport flight procedure design from the ICAO standard.

In the Korean AIP information, there is no description on the design standard of Gimhae Airport flight procedure; it is impossible to know that the Gimhae Airport is designed according to the TERPS criteria. In the AIP approach chart, there was only distinctive mark for aircraft types, but no note on aircraft speed.

The Korean AIP chart had no relief and contour shown in brown color as required by ICAO Annex 4. See Figure 1-10 of KAIB report.

2.5.2.2 Jeppesen Information

In the ATC portion of the Jeppesen manual, there is a description on Korean airports as follows: "Instrument approach procedures are based on the guidance contained in PANS-OPS, Doc.8168,Vol.II and/or the United States Standards for Terminal Instrument Approach Procedures (TERPS) for civil procedures. Military and joint civil/military instrument approach procedures are based primarily on the United States TERPS."

In the Jeppesen manual, there are two kinds of approach chart formats; one is for the procedures designed with ICAO criteria, the other with FAA TERPS criteria. At the time of accident, all the ROK approach procedures in Jeppesen chart whether they are designed with ICAO or FAA TERPS criteria, were identified as TERPS criteria. See Figure 1-11A of KAIB report.

Air China provides each international flight with Jeppesen chart. CA129 flight had carried the Jeppesen approach chart. CA129 flight crew was clear about the mountainous terrain to north of the airport. In the approach briefing, the captain said: "We won't enlarge the traffic pattern …the mountain is all over that side.", and the first officer also cautioned: "Turn quickly, not too late", but the crew were not made clear of the size of circling protection area.

The position of key obstacle (719 feet), in the topographic chart of Jeppesen as shown on Figure 1-12 of KAIB report, which relating with the site where CA129 crashed, was about 2km deviated from the actual position by east, which had an adverse influence on pilot' recognition of the terrain.

[4] The ROK AIP authority revised its AIP information in August 2002. In the part of ENR1.5, the TERPS criteria applied to the Gimhae Airport was descried, and principles to determine the aircraft category using the TERPS criteria are included. In the approach chart of Gimhae Airport, circling speed, area and appropriate obstacle information are marked.

2.6 Aircraft Category

2.6.1 Category of B767-200

In accordance with the ICAO standard, the definition of aircraft category is based on 1.3 times stall speed in the landing configuration at maximum certificated landing Mass..

Category "C"- Indicated air speed is 224 km/hour (121 knots) or more but less than 261 km/hour (141 knots)

Category "D"- Indicated air speed is 261 km/hour (141 knots) or more but less than 307 km/hour (166 knots)

According to this definition, the related speed of B767-200 is 137 knots, with which B767-200 was classified as Category "C" aircraft.

2.6.2 Discussion of CA129 category by Air Traffic Controller of Gimhae Airport

Before the approach controller notified the crew of the runway change to use circling approach, as the weather condition then was above the circling approach minima for Cat "C", but below that for Category "D", the approach controller queried the CA129 for aircraft category . After the flight crew replied "C", the clearance of runway change was issued to CA129. After the tower controller had confirmed from the approach controller that CA129 was B767-200 , he was suspicious of whether CA129 was Category "C". Then he asked the flight information office by phone. The flight information office thought CA129 to be B737. After the tower controller had confirmed B767, the flight information office said: "In case of B767-200, then it is related to category "D". After the tower controller confirmed the aircraft type again with the approach controller, he discussed again with the flight information office on the category of B767-200, the flight information office said: "We can consider it is category "C" if the pilot said so"

In the circling approach, maximum indicated air speed of CA129 on the downwind leg was 158 knots. Based on ICAO standard, it was still within the speed limits for the Category "C". But the flight procedures of Gimhae airport is designed with TERPS, circling minimum of Category "D" should be used when the speed exceeds 140 knots.

Neither the flight crew nor controllers were aware that actual category minimum was related to the speed with speed, i.e. although B767-200 was Category "C" aircraft, circling minimum of Category "D" should have been used during circling approach because the speed exceeded 140 knots. If CA129 descended to 1100 feet as required for Category "D" minimum, it would not have crashed into mountains of 669 feet.

2.6.3 Management of the Civil Aviation Authority of ROK on Aircraft Category

At the time of accident, there were no prescription on aircraft category in the applicable aviation regulations of ROK, and no statements was made on how to use the approach minimum in the ROK AIP.

Busan Regional Aviation Authority of ROK required all the airlines operating at Gimhae Airport to report the aircraft types and their approach category (including circling) in written form, and then notified this information to Gimhae military ATC unit. But prior to the accident, Air China was not required to provide such kind of form.

On the same day before the accident, two A321 aircraft, when making circling approach, were directed to descend to MDA 700feet of Category “C” minimum. The speeds on downwind leg of both aircraft exceeded 140knots. This shows that in such case as that two design criteria of flight procedures are used at the same time in Korea, it is not exceptional to make mistakes in the category judgment.

IACO 《Manual of All Weather Operations》(Doc 9365-AN/910) stipulates: “The state of the Aerodrome has responsibility for safety of air navigation within its own borders. It follows that it retains the authority to accept the minima approved by other States at its aerodromes. ” Due to particularity and frequent utilization of the circling approach procedure of Gimhae Airport, if the Busan Regional Aviation Authority had informed all the airlines operating in Gimhae airport of this special requirements on category, it would have drawn the attention of relevant flight crew and controllers.

2.7 Airport Runway Lighting

Since the clock within the computer system at Gimhae airport lighting control room was reset 19 minutes back at 20:30, April 18th after the accident, the Chinese investigation team holds that doing so violated the relevant regulations provided in ICAO Annex 13. According to the statement of the Captain in the interviews and public hearing, the Chinese investigation team is suspicious of the circling guidance light being turned on at the time of accident.

3. CONCLUSION

3.1 Findings of the Investigation

1. The flight crewmembers and flight attendants had received training. They were certified and qualified for this flight.

2. The aircraft was certified airworthy; weight and balance were within the specified limits.

3. In the final preflight maintenance inspection prior departure at Beijing Capital International Airport, any defects were not found in the fuselage of the aircraft as well as its systems and engines. During flight, the crew didn't report any malfunctions, and the examination of the aircraft wreckage did not show any possible malfunctions.

4. The south wind was strong at Gimhae airport when the accident occurred. There was low clouds and precipitation. The mountainous area in the north was shaded by cloud and fog. The circling approach was difficult under such weather condition.

5. The air traffic of Gimhae Airport was controlled by Air Force. It was appropriate in accordance with the related regulations and procedures of Korea for the Air Force controller to provide services to civil aircraft.

6. When the tower controllers lost the visual contact of CA129, they failed to use radar to determine the location of aircraft, and when low altitude warning displayed, they did not issue a safety alert.

7. When the approach controller found that the downwind leg of CA129 was longer than the normal and MSAW warning, he reminded the tower controllers, but no response received. The approach controller failed to take further measures to alert the flight crew.

8. The functions of Minimum Safe Altitude warning system (MSAW) at Gimhae airport did not conform to the relevant prescription of ICAO, for it was not equipped with aural alert.

9. Transfer instruction issued by the approach controller was hard to recognize, resulting in the short interruption in ATC process.

10. On the control radar display, the boundaries of the protected area of circling approach for all categories of aircraft were not depicted, and the marks of obstacles in the mountainous north of the airport were not complete.

11. In the Jeppesen approach chart used by CA129 flight crew, the position relationship between the runway and the key obstacles relating the site of the accident was wrongly marked.

12. The flight crew’s training in circling approach was conducted in the simulator, but they had never conducted the training of circling approach to Gimhae Airport's runway 18R.

13. Air China provided an insufficient Crew Resource Management (CRM) training for the three-pilot crew.

14. The flight crew participated in classes of various legal regulations according to Air China's operational requirements, but during this flight they performed its circling approaching in violation of the circling minimum of wide-body aircraft.

15. When the crew performed circling approach to enter the downwind leg, the width was narrower than normal, and no corrections were made.

16. It cannot be confirmed that the circling guidance lights was turned on when the aircraft was approaching.

17. The contents of Automatic Terminal Information Service manually recorded at Gimhae airport was hard to comprehend, and the controller did not use VHF to inform the crew of the important information that the weather conditions were below the minima of circling approach for Category “D”.

18. The ground proximity warning system (GPWS) installed at the aircraft, due to the fact that the terrain warning was inhibited when aircraft had been in landing configuration, , did not generate any warning just before the ground impact.

19. As of April 15th, 2002, there was no recording of any difference from ICAO Standard on aircraft category in ROK AIP.

20. The visual field of meteorological observation site of Gimhae Airport did not meet the appropriate requirements of 《Guide to practices for meteorological offices serving aviation》 of World Meteorological Organization.

21. When the aircraft disappeared from radar and radio contact of the aircraft with tower was lost, the tower didn't notify search and rescue department in time, while local residents called 119 about the case.

22. The Korean Civil Aviation Authority did not inform the CAAC and Air China of listing the Gimhae airport as a “special airport”.

3.2 Probable Causes

Chinese investigation team believes that possible causes of the accident might be:

At the time of accident, weather condition was poor with low cloud， precipitation and low visibility. There was strong tailwind on the downwind leg and the mountainous area north of the airport was covered by cloud. The flight crew mishandled in performing the circling approach to runway 18R. The flight crew did not make the base leg turn at the proper time, thus led the aircraft to fly outside the circling approach protection area. The flight crew didn't execute miss approach when they lost the sight of the runway during the visual maneuvering of the circling approach.

When MSAW warning appeared on the radar display, the controller failed to provide safety warning to the flight crew; unintelligible frequency transfer instruction and frequent communication with the flight crew had an impact on the flight crew’s operation of base turn and final approach.

4. SAFETY RECOMMENDATIONS

After more than two years' investigation, Chinese investigation team suggests safety recommendations to Air China , General Administration of Civil Aviation of China, Korea Ministry of Construction & Construction, Korea Ministry of National Defense and Korea Airport Corporation:

Air China

1. Make more explicit circling minimum of aircrafts in operation specifications and flight operation manual, further improve the circling approach procedure in the flight training program.

2. Contents of various briefings and the implement of procedures used by the flight crew in flight should be often reviewed. The flight crew resource management training should be strengthened.

3. The analysis and evaluation on the risk factors of airports used by Air China should be taken to enhance the consciousness of keeping away risks. Busan Gimhae Airport should be listed as one of the special airports to strengthen a pertinent training on this airport.

4 The Enhanced ground proximity warning system (EGPWS) should be added in accordance with CAAC's airworthiness order.

5. In flight to Korea, cabin broadcast in Korean language should be added.

General Administration of Civil Aviation of China

1. A sustained inspection on the training of flight crew should be strengthened.

2. For international flights, the airlines should be required to include the local language in passenger announcement.

The Korea Ministry of Construction and Transportation

1. The operating procedure for tower radar should be improved, and specific prescription on the functions and usage of the radar warning be made.

2. Airports used by civil aviation should apply unified flight procedure design criteria. In case that the applied criteria are different from the ICAO standards, they should be stated in the AIP in order to avoid confusion when used by pilots and the ATC controller.

3. Military controllers engaged in controlling civil aircraft should participate in civil aviation ATC training and obtain the controlling certificate issued by civil aviation authorities.

4. Consider to adopt new technology and satellite based navigation system to improve the operation safety of airports with challenged terrain.

5. The colored contour and relief should be depicted in the approach chart in accordance with requirements of ICAO Annex 14.

Korea Airport Corporation

1. It should be made clear that who is responsible for service of the airport's lighting system, and establish the implementation procedure, so as to ensure the integrity of records for the exact time of on/off of the airport's lights.

The Ministry of National Defense (Air Force)

1. Considering that the north terrain of Gimhae airport is complicated, the instrument approach procedures to runway 18R should be established, the airfield control radar be upgraded and corresponding alert be set up according to the requirements of ICAO Annex 11 and Document 4444.

2. The communication facilities in ATC unit of Gimhae Airport should be improved and maintained to improve the quality of ground-air communication. ATC controllers' English level should be improved.

3. A voice synthetic system should be used for ATIS to improve the reception quality.

4. A better observation site with unobstructed view should be chosen at Gimhae Airport in order to provide timely and correct weather report.

REFERENCE DOCUMENTS

A.　CVR record

B.　ATC record (including the intercom record)

C.　Records of the Public Hearing

D.　KAIB Accident Report（draft）

E.　Flight Safety Foundation《Approach and Landing Accident Reduction (ALAR)》

F．ICAO　《CFIT education and training aid》

G．Applicated Regulations

ICAO

Annex 2《Rule of the air》

Annex 3《Meteorological Service for International Air Navigation》

Annex 4《Aeronautical Charts》

Annex11《Air Traffic Services》

Annex 13《Aircraft Accident and Incident Investigation》

Annex 15　《Aeronautical Information Services》

Doc 4444《Procedure for air navigation services－Air Traffic Management》

Doc 8168-OPS/611《Procedure for air navigation services－Aircraft Operations》（I，II）

Doc 9365 AN/910　《Manual of All weather operations 》

Doc 9426-AN/924　《Air Traffic Services Planning Manual》

MOCT

《Standard Operation Procedure of Air Traffic Control》

Gimhae Airport　《Local Operation Procedure》

CAAC

98th order《Rules for Aerodrome operation minimum establishment and implementation》

FAA

Order 7110.65 《Air traffic Control》

Order FAA 7210.3 《Facility Operation and Administration》

Order 8260.3 《Terminal Instrument Procedures》（TERPS）

붙임 5 : GPWS 성능 분석 보고서

(GPWS Performance Evaluation Report)

총 14쪽

Richard S. Breuhaus
Chief Engineer
Air Safety Investigation
Commercial Airplanes

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

BOEING

27 August 2002
B-H200-17467-ASI

Mr. Al Dickinson
National Transportation Safety Board
490 L'Enfant Plaza, SW
Washington, DC 20594-0003

Subject: GPWS Performance Evaluation Report - Transmittal –
Air China 767-200ER B-2552 Landing Accident Near Busan, South Korea - 15 April 2002

Dear Mr. Dickinson

The enclosed GPWS Performance Evaluation report is provided to you in support of the subject investigation being conducted by the Civil Aviation Bureau of the Ministry of Construction and Transportation Korean Civil Aviation Bureau (KCAB) of South Korea.

The information included with this correspondence is considered confidential commercial information of Boeing and is provided on a confidential basis for the exclusive use of the NTSB and other investigative parties in connection with their investigative activities. Boeing does not authorize release of this information to the public.

If you have any questions, please do not hesitate to call Mr. Dennis Rodrigues, 425-237-8301

Very truly yours,

Richard S. Breuhaus
Chief Engineer, Air Safety Investigation
Org. B-H200, MC 67-PR
Telex 32-9430, STA DIR AS
Phone (425) 237-8525
Fax (425) 237-8188

Encl:

- Evaluation of GPWS Performance Air China 767 Crash April 15, 2002 at Busan, South Korea
  Includes the following attachments:
  1. Ground Proximity Warning System wire diagram (2 pages)
  2. Ground Proximity Warning System schematic (2 pages)
  3. Graph of radio Altitude from DFDR (1 page)
  4. Tabular Radio Altitude from DFDR (1 page)
  5. GPWC Mode 2 Closure Rate (1 page)
  6. Mode 2B Closure Rate Envelope (1 page)
  7. Additional aircraft DFDR parameters used in analysis (1 page)

Ms. Carolyn DeForge, NTSB

Evaluation of GPWS Performance

Air China 767 Crash April 15, 2002 at Busan South Korea

OEING

Executive Summary

This paper is a summary of the Ground Proximity Warning System for Air China 767 airplane line number 127, registration number B-2552, variable effectivity VE065. This airplane was delivered in October of 1985 to Air China and crashed while on approach to Kimhae International Airport in Busan, South Korea on April 15, 2002.

Accident Summary – CA flight 129 enroute from Bejing to Busan, South Korea crashed into a mountain while attempting to land at Kimhae International Airport in Busan, South Korea. The crash occurred at 11:23 am on April 15, 2002. Weather was foggy, rainy and windy. The flight crew began the approach to RWY 36L, however due to a tailwind they were instructed by ATC to circle to land at RWY 18R. The airplane crashed below the peak of Mount Mulbong, approximately 3 miles north of the runway. The right wing impacted first at an elevation of 204 meters (670 feet). Mount Mulbong elevation is 230 meters (755 feet).

Data Summary - The airplane was configured to land with the gear down and flaps at 30 at the time of impact. Airspeed and groundspeed were approximately 120 knots. Pitch attitude was 5 degrees and the airplane was banking to the right. Pressure altitude was constant at approximately 700 feet. Radio altitude decreased from 500 feet to 0 feet in the 12 seconds prior to impact. There were no GPWS alerts recorded on the CVR or the DFDR.

GPWS Configuration - The airplane was equipped with a MK-III Ground Proximity Warning Computer (GPWC) with a manufacturing date of September 1984.

Analysis - GPWS alerts possible given the airplane was configured for landing would be Mode 1 excessive descent rate or Mode 2B excessive closure rate. Mode 1 alerts can be immediately ruled out since the airplane was flying level. Mode 2 alerts were not triggered because the terrain closure rate magnitude and duration were less than that required to cause an alert with the gear and flaps lowered.

Tabular radio altitude data from the DFDR was used to run a simulation using a MK-III GPWC. The simulation confirmed that the closure rate was not sufficient to trigger the Mode 2B boundary.

Conclusion – The GPWC performed per design. Mode 2 alerts were not triggered because the terrain closure rate magnitude and duration were less than that required to cause an alert with the gear and flaps lowered.

Ground Proximity Warning System Description

The airplane was equipped with a MK-III GPWC. The MK-III was the first generation digital GPWC. It's design dates from the late 1970's.

Details of the GPWC recovered from the crash site:

SCD Boeing p/n S220102-102.
Sundstrand Data Control (now Honeywell) p/n 965-0577-001
Manufacturing date 84 09
TSO C92B CAA Spec 14
H/W Mod 16
S/W Mod 16

The MK-III GPWC provides what are known as basic alerting modes 1 through 5. Mode 1 is Excessive Descent Rate, Mode 2 Excessive Closure Rate, Mode 3 Altitude Loss After Takeoff, Mode 4 Unsafe Terrain Clearance Not in Landing Configuration and Mode 5 Below Glideslope Alert.

Possible options for this version GPWC are an alternative audio alert selection and a Mode 6 aural annunciation of "Minimums-Minimums" when the airplane passes through the pilot's selected decision height. These options could be activated through airplane wiring changes.

Attachments 1 and 2 are the as-delivered GPWS wire diagrams and schematics applicable to this airplane. The airplane wiring indicates that neither of the options were activated.

Boeing has no record of Boeing Service Bulletins being incorporated, which would have modified the as-delivered GPWS.

Boeing Service Bulletin 767-34-0067 dated May 31, 1989 was released to all 767 operators at the time, to allow installation of a later version of the GPWC; either the S220T102-204 or S220T102-205 on this airplane. The generic name for this p/n GPWC is the MK-V indicating the GPWC had reactive windshear detection and alerting capability. The S220T102-204 and 205 had the capability to provide an operator selected set of optional Mode 6 radio altitude callouts which could include 2500, 1000, 500, 400, 300, 200, 100, 50, 40, 30, 20 and 10 feet as well as approaching minimums and minimums type callouts.

Boeing Service Bulletins could be requested by a customer to retrofit reactive windshear detection and alerting capability. FAA FAR 121.358 required reactive windshear detection and alerting for U.S. registered airplanes on or before January 2, 1991.

Boeing 767s manufactured after February 1999 have the Enhanced Ground Proximity Warning System (EGPWS) which is generically referred to as a Terrain Awareness and Warning System (TAWS). This system is mandated to be installed on all large commercial transports by January 2003 under ICAO Annex 6 International Standards for Commercial Transport Airplanes. Boeing Service Bulletins can be requested by a customer to retrofit this system on delivered airplanes.

BOEING

Analysis of CVR and DFDR Data

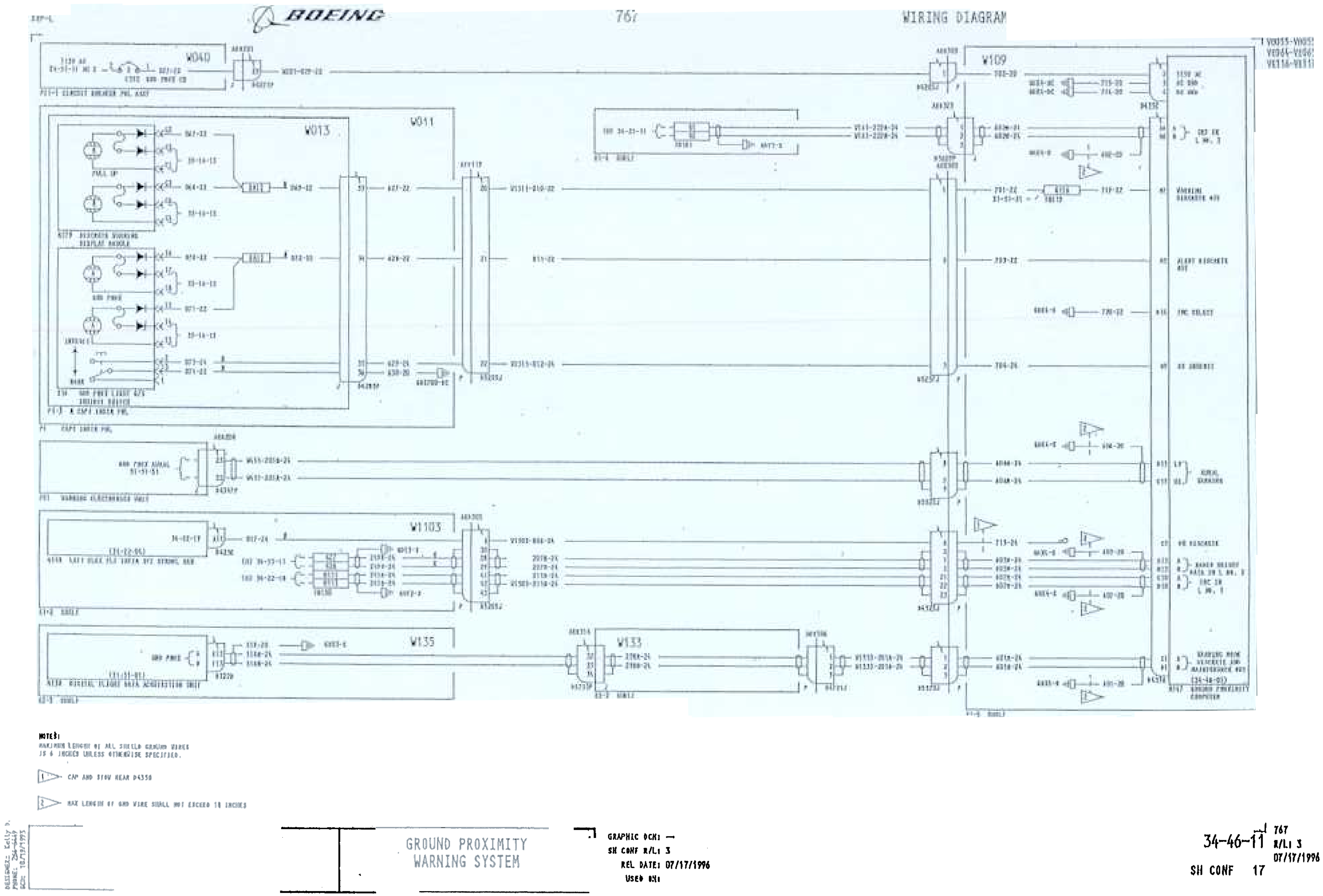
Radio altitude data from the DFDR was used to run a simulation using a MK-III GPWC. This radio altitude data is included (attachments 3 and 4). With the airplane configured to land, the alert threshold is defined by attachment 6. In order to avoid nuisance alerts during normal approach and landing, additional radio altitude filtering is applied to the calculated closure rate signal. The maximum filtered closure rate from the simulation was approximately 1800 feet per minute (attachment 5). This closure rate will not trigger the Mode 2B boundary (attachment 6)

Attachment 7 is a plot of additional DFDR data used in the GPWS alerting analysis showing approximately the last 32 seconds of the flight.

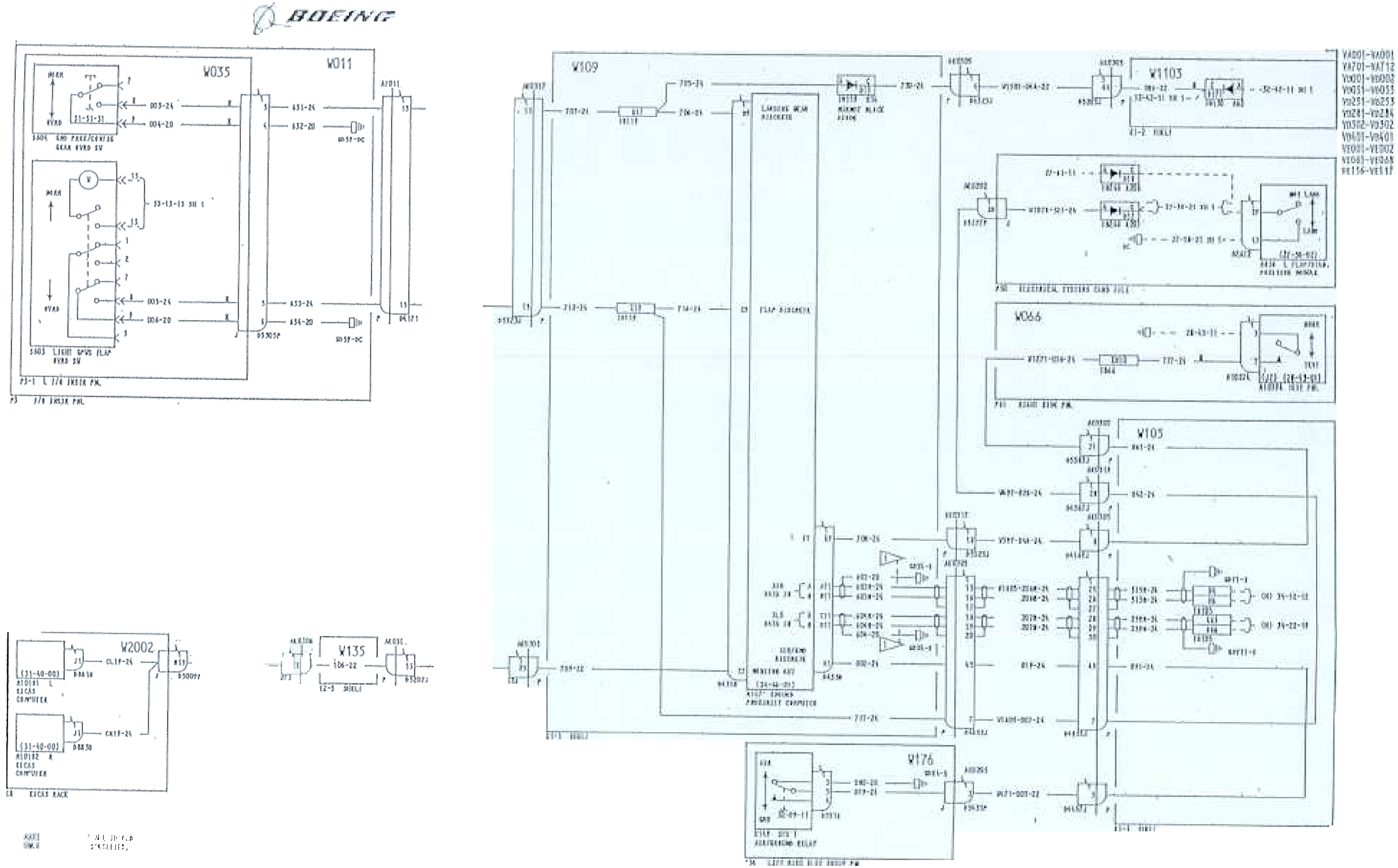
Conclusion – The GPWC performed per design. Mode 2 alerts were not triggered because the terrain closure rate magnitude and duration were less than that required to cause an alert with the gear and flaps lowered.

Attachments:

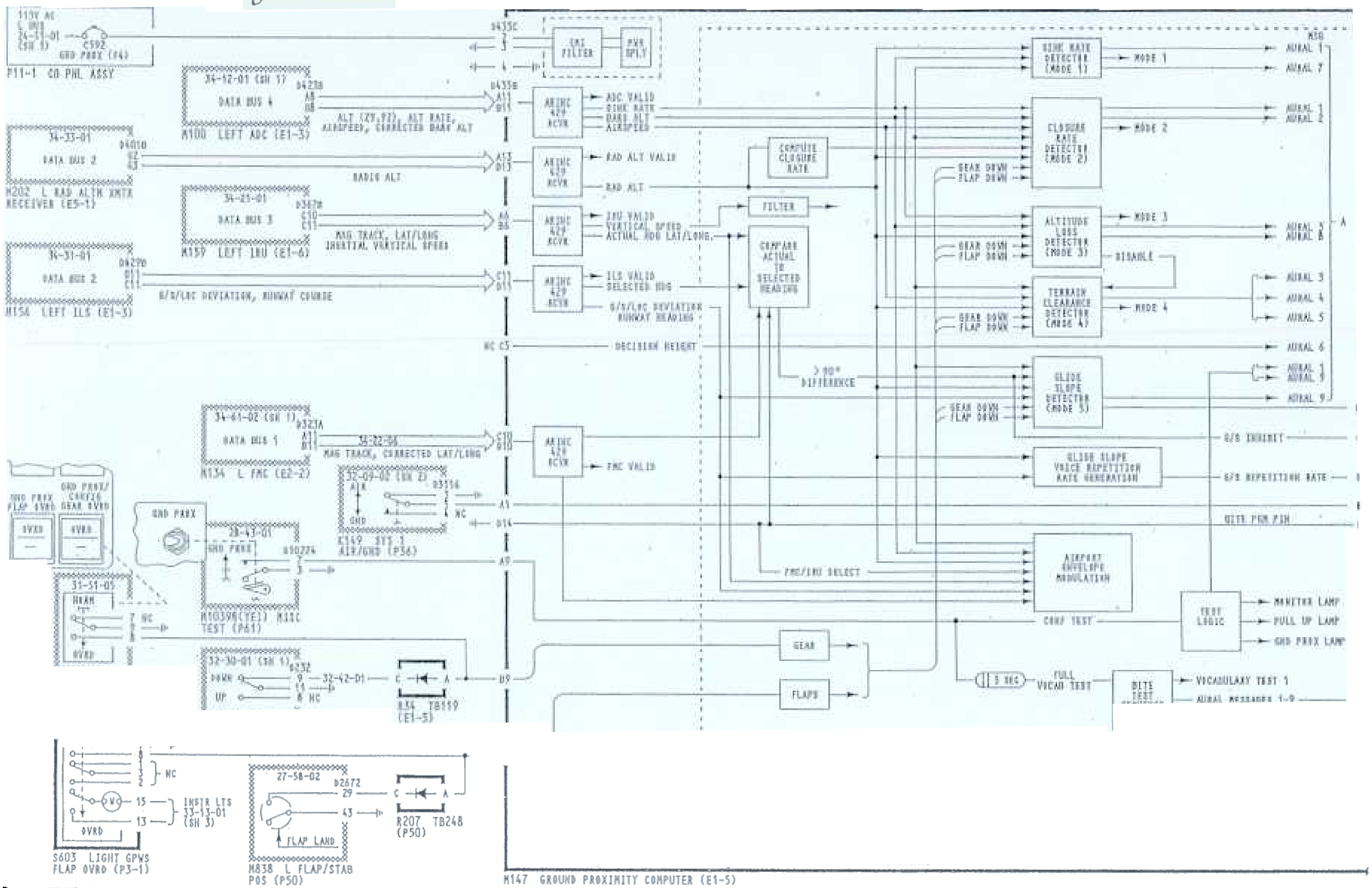
1. Ground Proximity Warning System wire diagram (2 pages)
2. Ground Proximity Warning System schematic (2 pages)
3. Graph of Radio Altitude from DFDR – Approximately Last 3 Minutes (1 page)
4. Tabular Radio Altitude from DFDR – Approximately Last 3 Minutes (1 page)
5. GPWC Mode 2 Closure Rate Obtained from Test Using Radio Altitude data (1 page)
6. Mode 2B Closure Rate Envelope (1 page)
7. Additional aircraft DFDR parameters used in analysis (1 page)



Ground Proximity Warning System Wire Diagram
(Attachment 1)



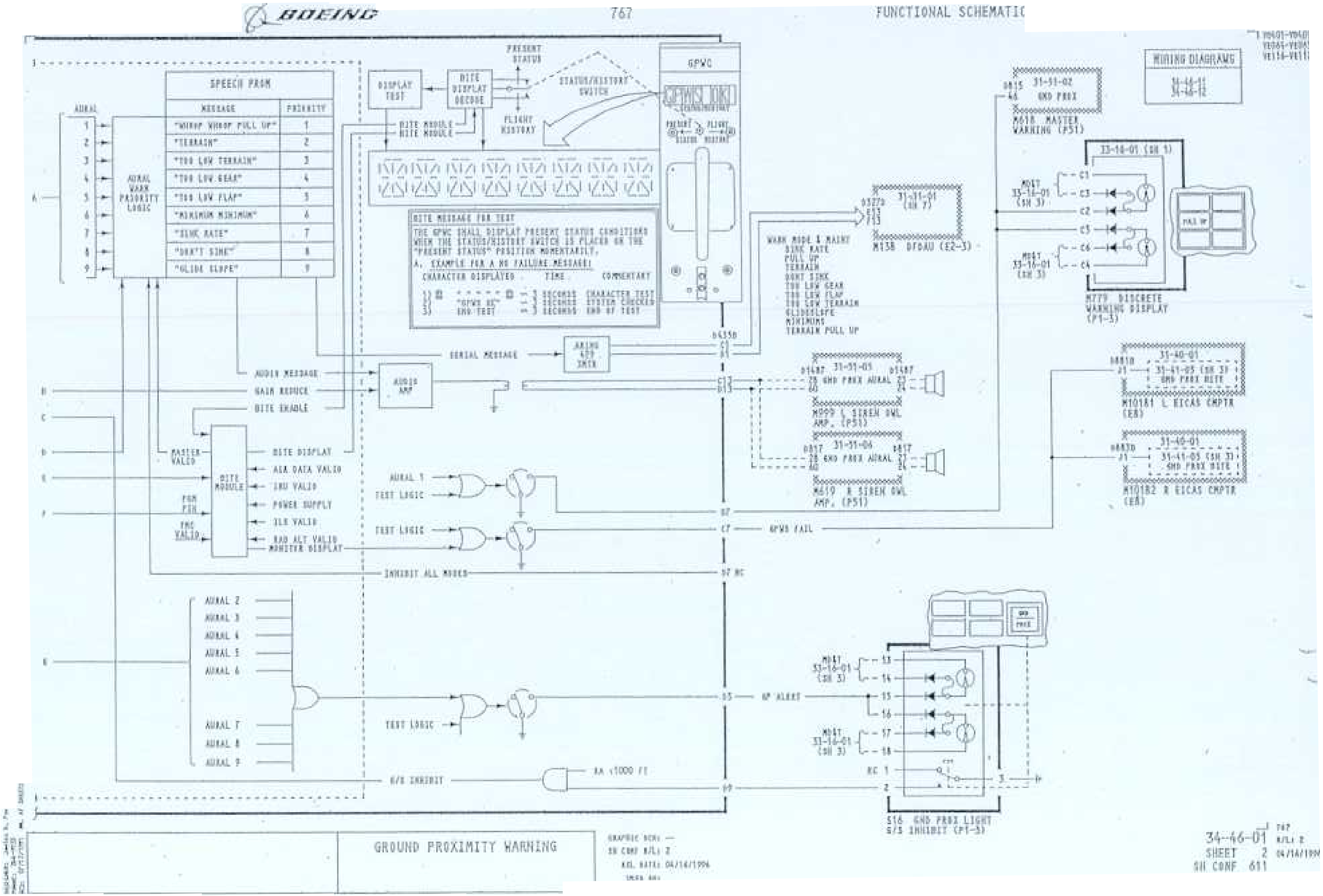
GROUND PROXIMITY
WARNING SYSTEM



GROUND PROXIMITY WARNING

GRAPHIC DCR: —
SH CONF R/L: 3
REL DATE: 10/10/1996
USED ON:

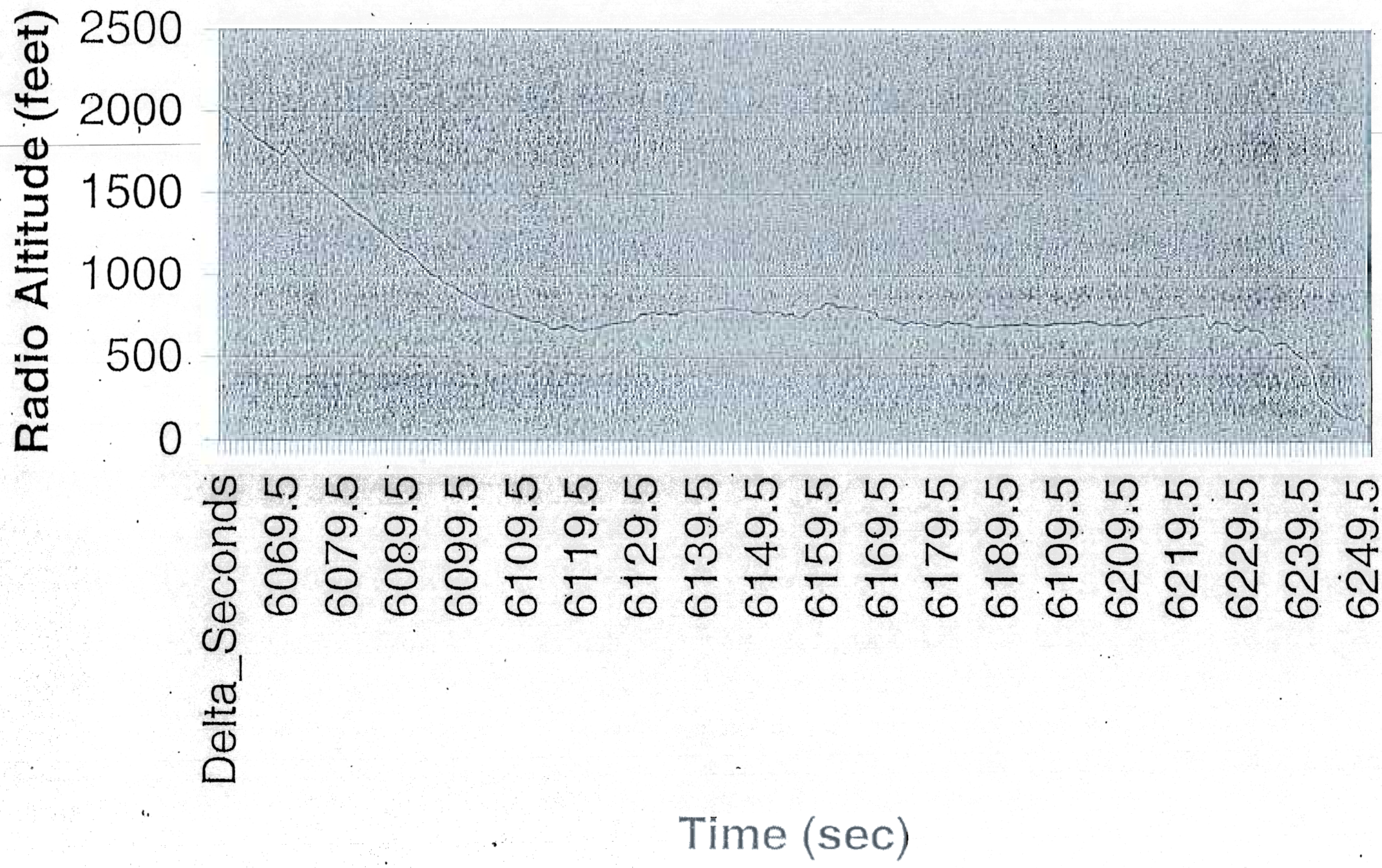
DESIGNER: Lana P Hoyt
PHONE: 266-9750
GCD: 02/11/1995



Ground Proximity Warning System Schemati ~ Continued
(Attachment 2)

Radio Altitude From DFDR - From Approximately Last 3 Minutes of Flight

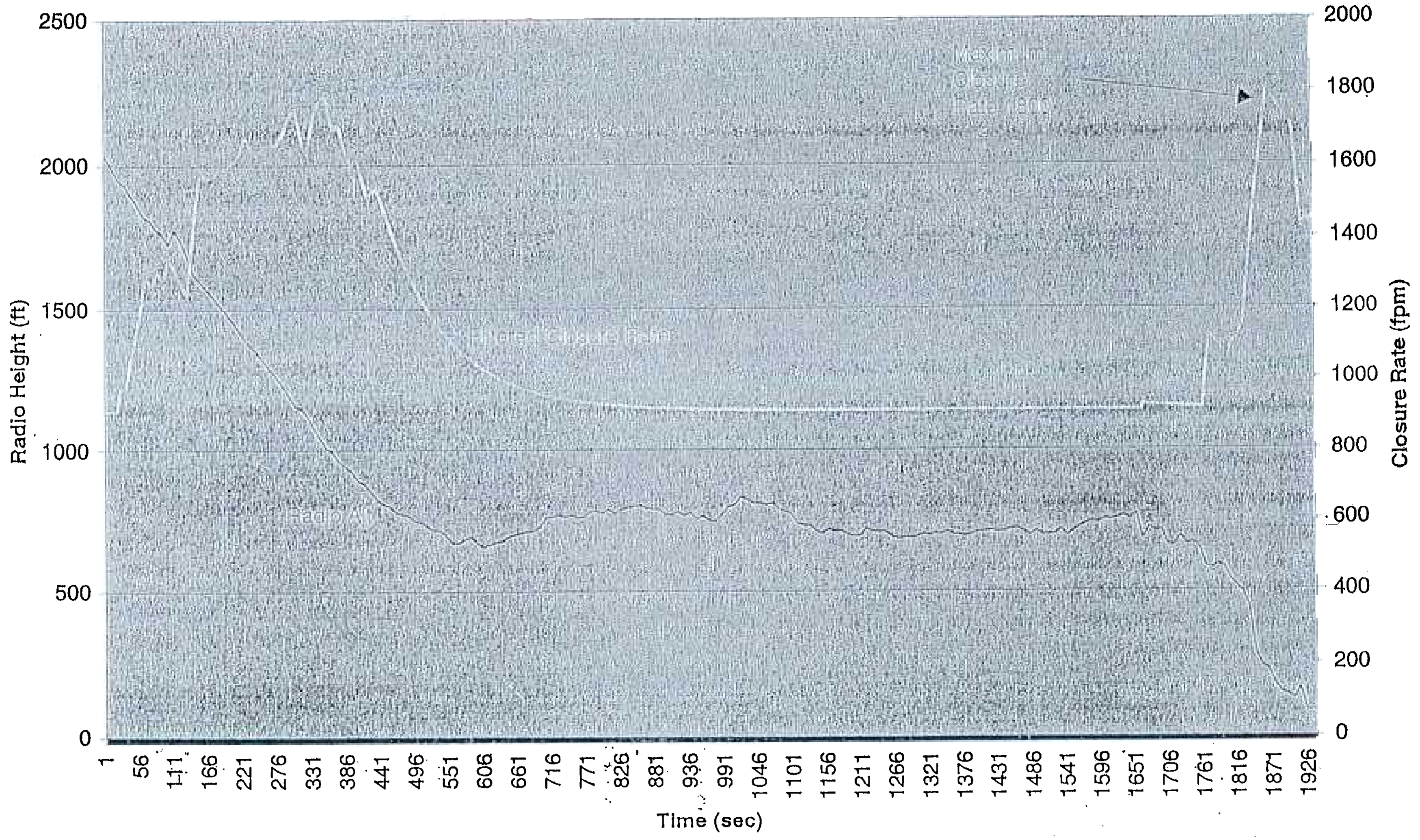
(attachment 3)



Tabular Radio Altitude From DFDR From Approximately Last 3 Minutes of Flight
(Attachment 4)

Delta_Seconds	RadAlt (ft)	6109.5	748	6159.5	796	6209.5	698
6060.5	2030	6110.5	742	6160.5	804	6210.5	698
6061.5	1992	6111.5	728	6161.5	834	6211.5	700
6062.5	1950	6112.5	716	6162.5	824	6212.5	716
6063.5	1934	6113.5	714	6163.5	810	6213.5	692
6064.5	1898	6114.5	694	6164.5	812	6214.5	712
6065.5	1866	6115.5	672	6165.5	804	6215.5	724
6066.5	1824	6116.5	670	6166.5	810	6216.5	736
6067.5	1808	6117.5	684	6167.5	790	6217.5	744
6068.5	1780	6118.5	690	6168.5	780	6218.5	738
6069.5	1762	6119.5	670	6169.5	770	6219.5	752
6070.5	1726	6120.5	656	6170.5	736	6220.5	748
6071.5	1778	6121.5	664	6171.5	730	6221.5	754
6072.5	1740	6122.5	674	6172.5	728	6222.5	762
6073.5	1684	6123.5	676	6173.5	710	6223.5	750
6074.5	1622	6124.5	690	6174.5	702	6224.5	770
6075.5	1596	6125.5	698	6175.5	716	6225.5	682
6076.5	1570	6126.5	704	6176.5	710	6226.5	720
6077.5	1544	6127.5	708	6177.5	710	6227.5	710
6078.5	1514	6128.5	712	6178.5	698	6228.5	712
6079.5	1488	6129.5	724	6179.5	692	6229.5	664
6080.5	1458	6130.5	758	6180.5	694	6230.5	660
6081.5	1428	6131.5	762	6181.5	720	6231.5	692
6082.5	1392	6132.5	770	6182.5	708	6232.5	664
6083.5	1370	6133.5	760	6183.5	708	6233.5	670
6084.5	1346	6134.5	768	6184.5	708	6234.5	654
6085.5	1314	6135.5	758	6185.5	692	6235.5	586
6086.5	1286	6136.5	760	6186.5	684	6236.5	580
6087.5	1258	6137.5	780	6187.5	688	6237.5	594
6088.5	1226	6138.5	782	6188.5	688	6238.5	582
6089.5	1190	6139.5	774	6189.5	690	6239.5	536
6090.5	1156	6140.5	790	6190.5	700	6240.5	514
6091.5	1144	6141.5	772	6191.5	696	6241.5	490
6092.5	1118	6142.5	790	6192.5	702	6242.5	436
6093.5	1074	6143.5	794	6193.5	700	6243.5	282
6094.5	1038	6144.5	800	6194.5	708	6244.5	242
6095.5	1006	6145.5	802	6195.5	698	6245.5	226
6096.5	992	6146.5	794	6196.5	696	6246.5	178
6097.5	960	6147.5	790	6197.5	694	6247.5	152
6098.5	944	6148.5	790	6198.5	702	6248.5	
6099.5	924	6149.5	770	6199.5	708	6249.5	130
6100.5	894	6150.5	766	6200.5	710	6250.5	164
6101.5	882	6151.5	780	6201.5	712	6251.5	90
6102.5	856	6152.5	764	6202.5	708		
6103.5	828	6153.5	776	6203.5	710		
6104.5	810	6154.5	752	6204.5	718		
6105.5	802	6155.5	764	6205.5	720		
6106.5	780	6156.5	748	6206.5	708		
6107.5	772	6157.5	746	6207.5	696		
6108.5	766	6158.5	770	6208.5	710		

GPWC Mode 2 Closure Rate Using Approximately Last 3 Minutes of DFDR Data
(Attachment - 5)



Mode 2B Closure Rate Envelope
(Attachment 6)

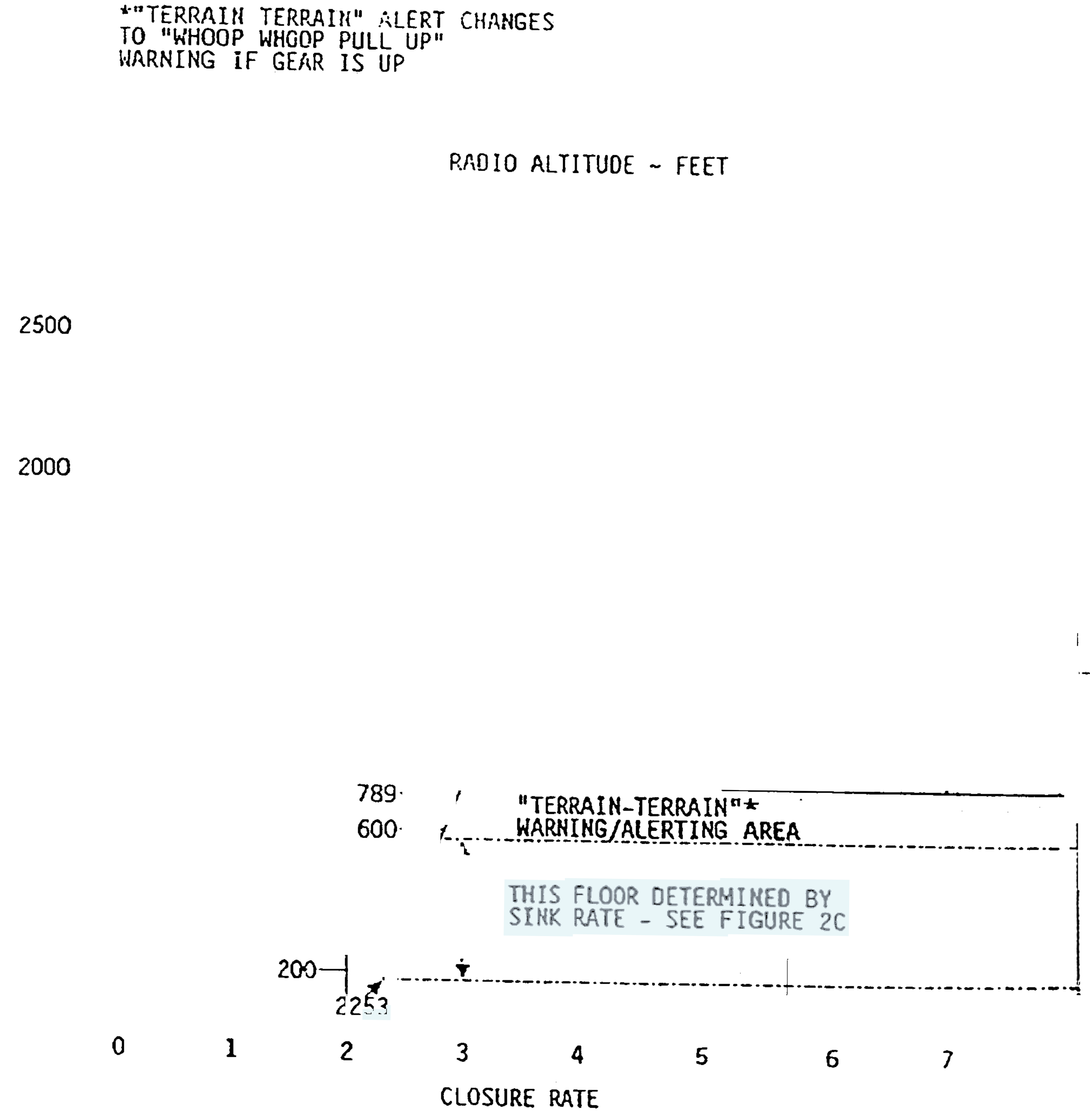
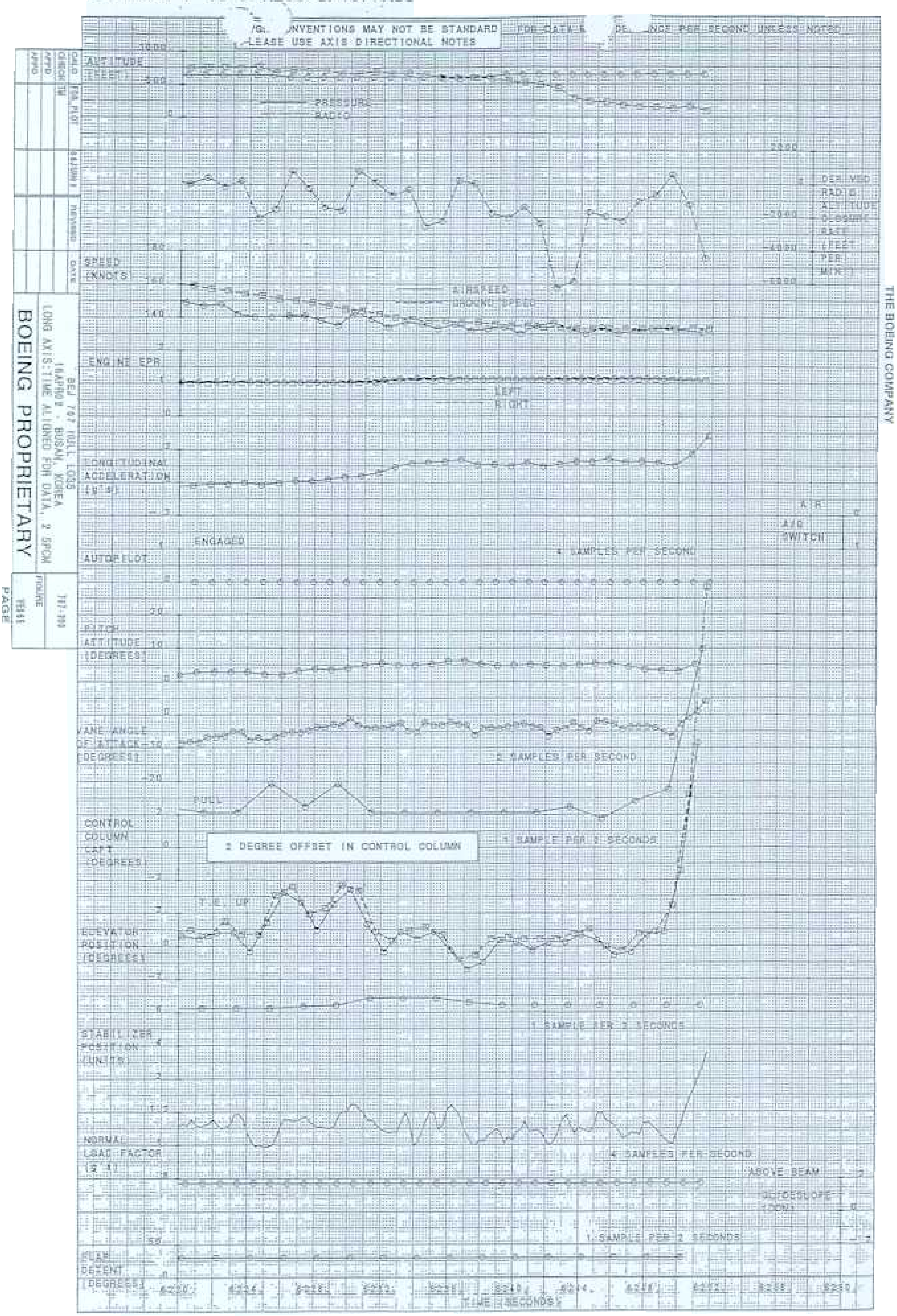


Figure 2B-1

Mode 2B - Closure Rate (Landing Flap or G/S < 2 Dots) Sheet 1

BOEING CORPORATE OFFICES SEATTLE, WA 98124	SIZE A	FSCM NO 81205	DWG NO S220T102		
			SHEET 1	PAGE 14.13	REV AC

tachment 7 to B-H200-17467-ASI



붙임 4 : 129편 항공기의 EEC 비휘발성 기억장치 자료 추출 및 분석자료

(Extraction and Analysis Data of EEC Non Volatile Memory of Air China Flight 129 Aircraft)

총 4쪽

CA129 Executive Summary for EEC Fault Dump Review Engines 1 & 2

Units reviewed: s/n SEEC0274 and SEEC5194

On Wednesday, Septemeber 4, the Non Volitile Memory (NVM) was retrieved and reviewed from the subject units by P&W and Hamilton Sundstrand..

Review of the NVM by Pratt & Whitney confirmed that the last faults recorded in EEC s/n SEEC0274 was 8 hours prior to the event, and 7 hours prior to the event in EEC s/n SEEC5194.

Our conclusion is that both EECS appeared to be functioning properly up to and just prior to the event. Details of the fault review are attached.

Signatures:

Hamilton Sundstrand:

KAIB:

Pratt & Whitney:

September 4, 2002

Observations (0274/5194)

1) Total time = 27560/23463
Highest fault time = 27552/23456
Conclusion Last fault occurred 8/7 hrs prior to last time EEC was operating.

2) "Time of last failure" = 27561/23463.5
Conclusion EEC memory did not fully update when it last depowered

3) MN & P2 indicate all faults in memory occurred on ground

4) When EEC working, EPR mode in csc(*) If problem detected, EEC freezes amount of downtrim. Pilot always has control of eng thrust.
(*) overboost protection available when EEC is operating properly

Observations (cont)

5) min/max N2 values [illegible] resoluti[illegible]

100% N2 7807

7) Faults 3 7 show N2 > 100% N2 Expect result [illegible] is [illegible] as [illegible] that actual N2 was lo[illegible] Pa[illegible] to [illegible] Requ[illegible]t possible [illegible] w[illegible] OFDR data since [illegible] w[illegible] recorded approx 8 hours pr[illegible] to event

8) It is possible that fault numbers 3 7 may have been set during maintenance (High power run?) Faults set on ground

MODEL		EEC 0274/5194	BY	Sept 4, 2002
FILE			DATE	
JOB			PAGE	3 OF 3

FAULT CODE	Label Bit	Description
54	354 20	Circuit fault 3.0 solenoid
255	354 2	Circuit fault 3.5 Solenoid
256	350 15	J2 unplugged
075	353 24	P2 & Air Data computer Do not agree, probe heat off. Possible Icing
235	352 22	Reset Position solenoid lectrical failure
067	350 25	P2 does not agree TC Air Data Computer
061	350 18	EGT Range fault

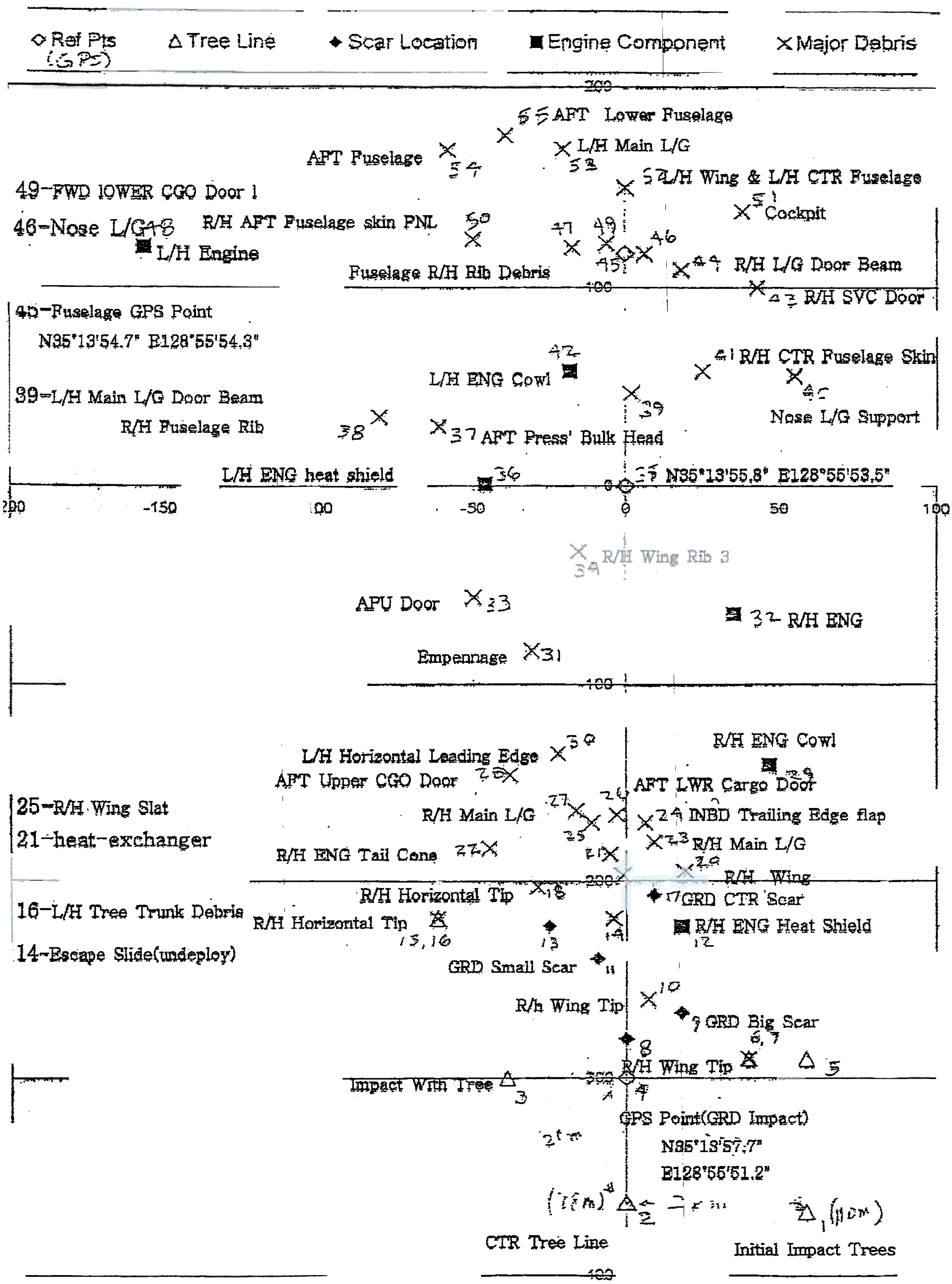
Timothy R. Bauman
Sanford R. Carlisle
[illegible]
Byeom. Soon cheal
SIM JAI DON
Leo Kuk
Michael L. Young
[illegible]

붙임 3　　29편 항공기의 잔해 포도

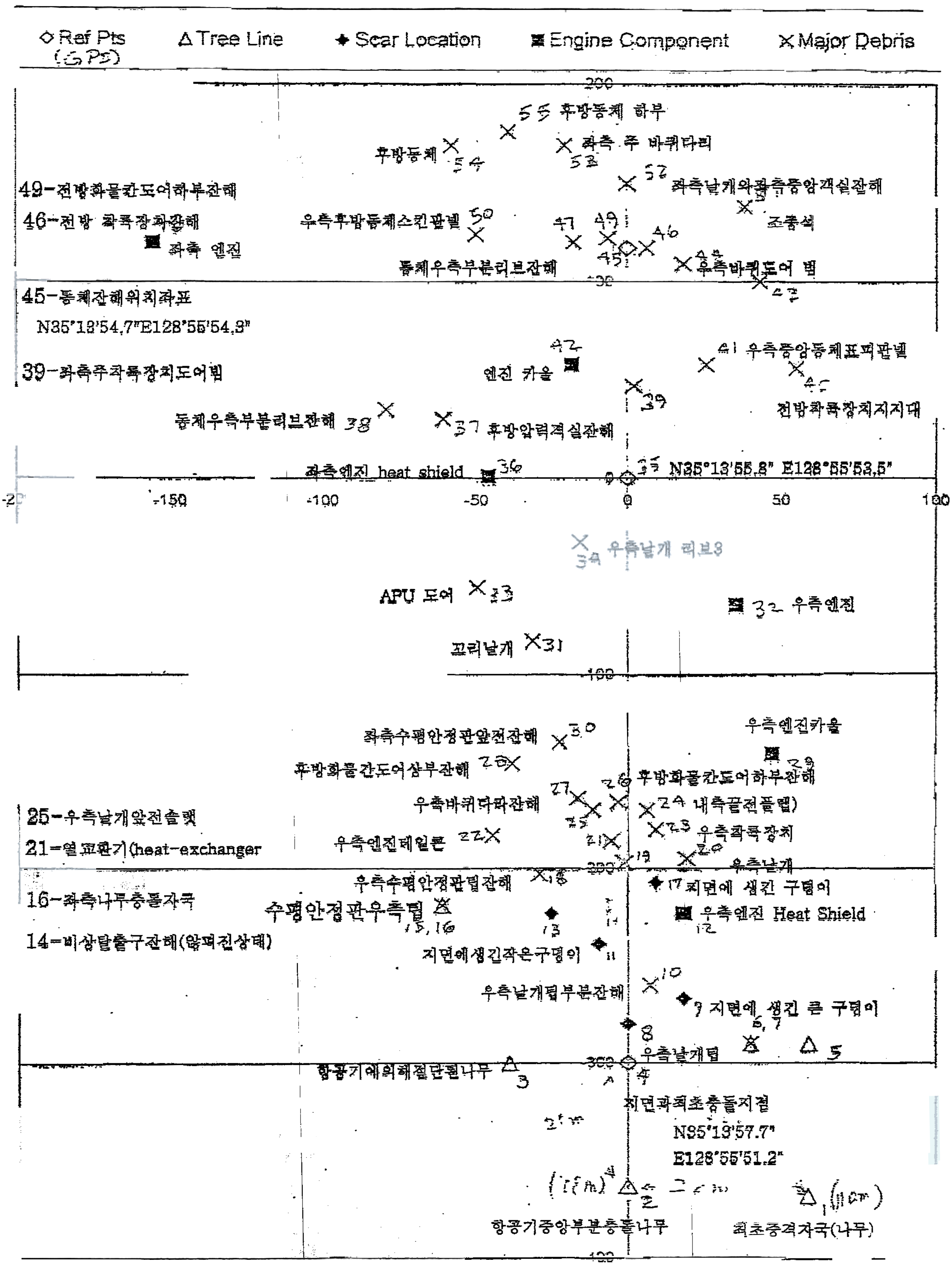
(Wreckage Distribution Chart of Air China Flight 29 Aircraft)

총 2쪽

China Air 129 Debris Scatter



China Air 129 Debris Scatter



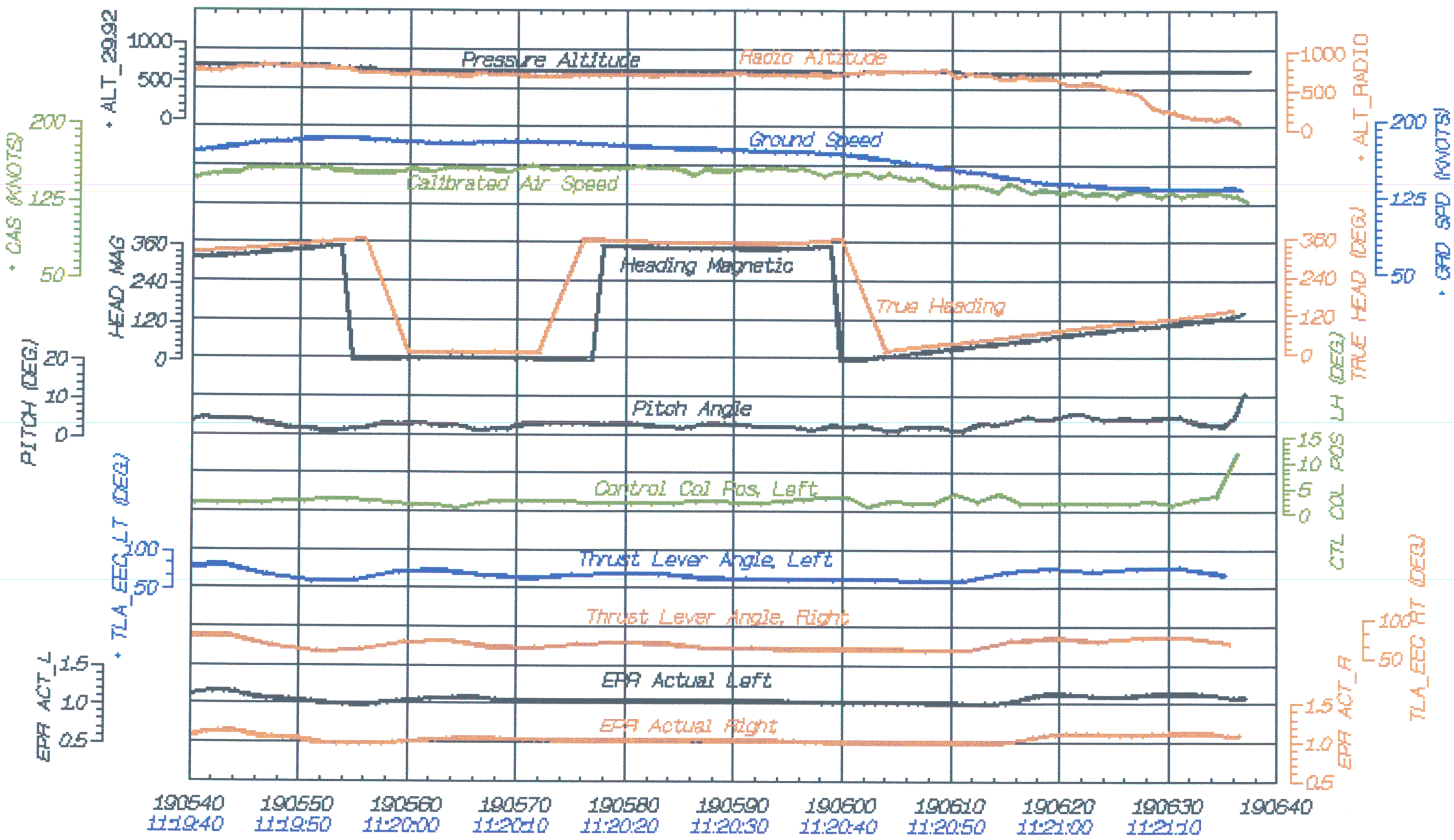
붙임 2 : 비행자료기록장치 기록
(Flight Data Recorder Plot)

총 4쪽

Flight Data Analysis

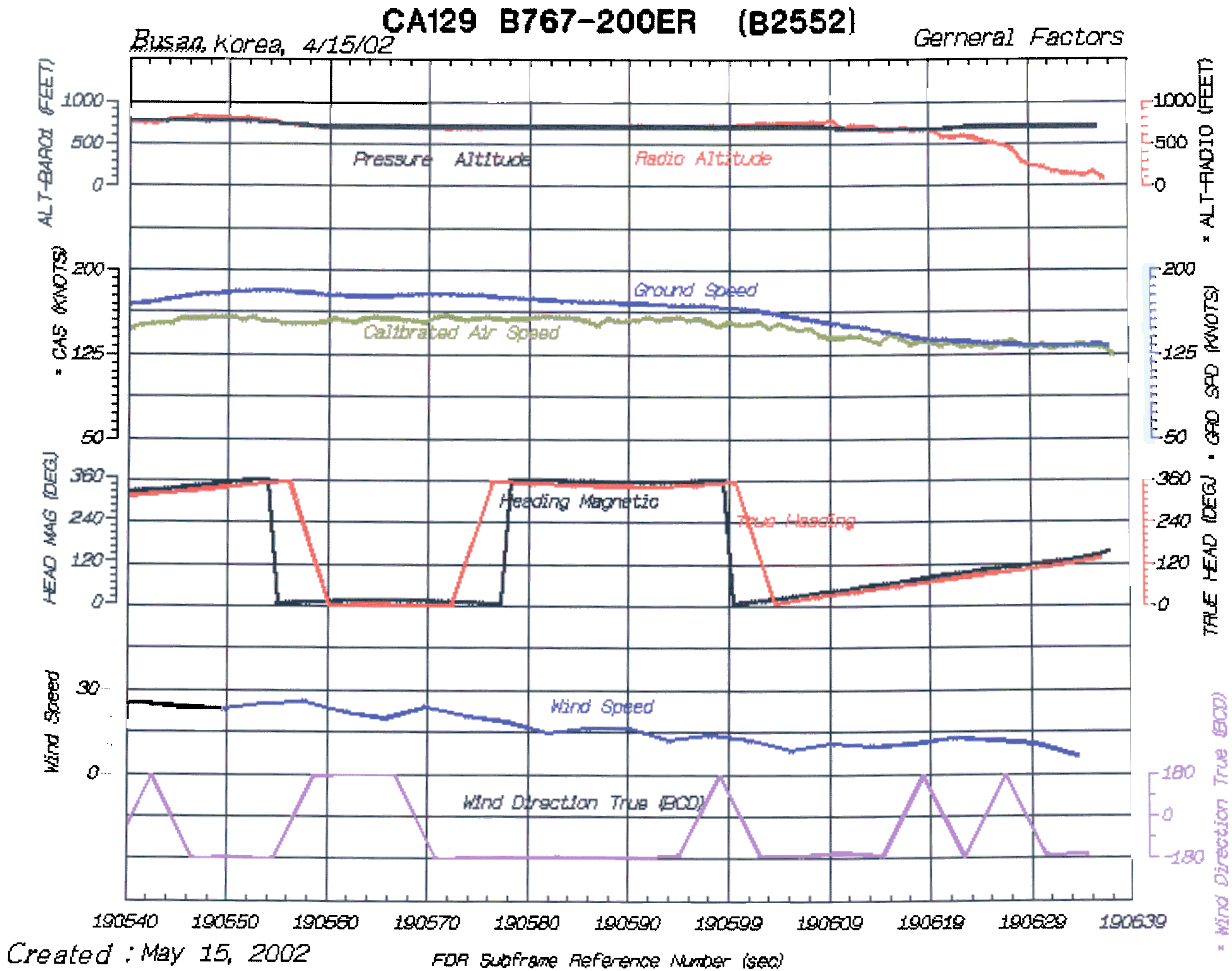
CA129 B767-200ER (B2552)

Busan, Korea, 4/15/02



Created: May 15, 2002

Korea Aviation-accident Investigation Board



Created : May 15, 2002

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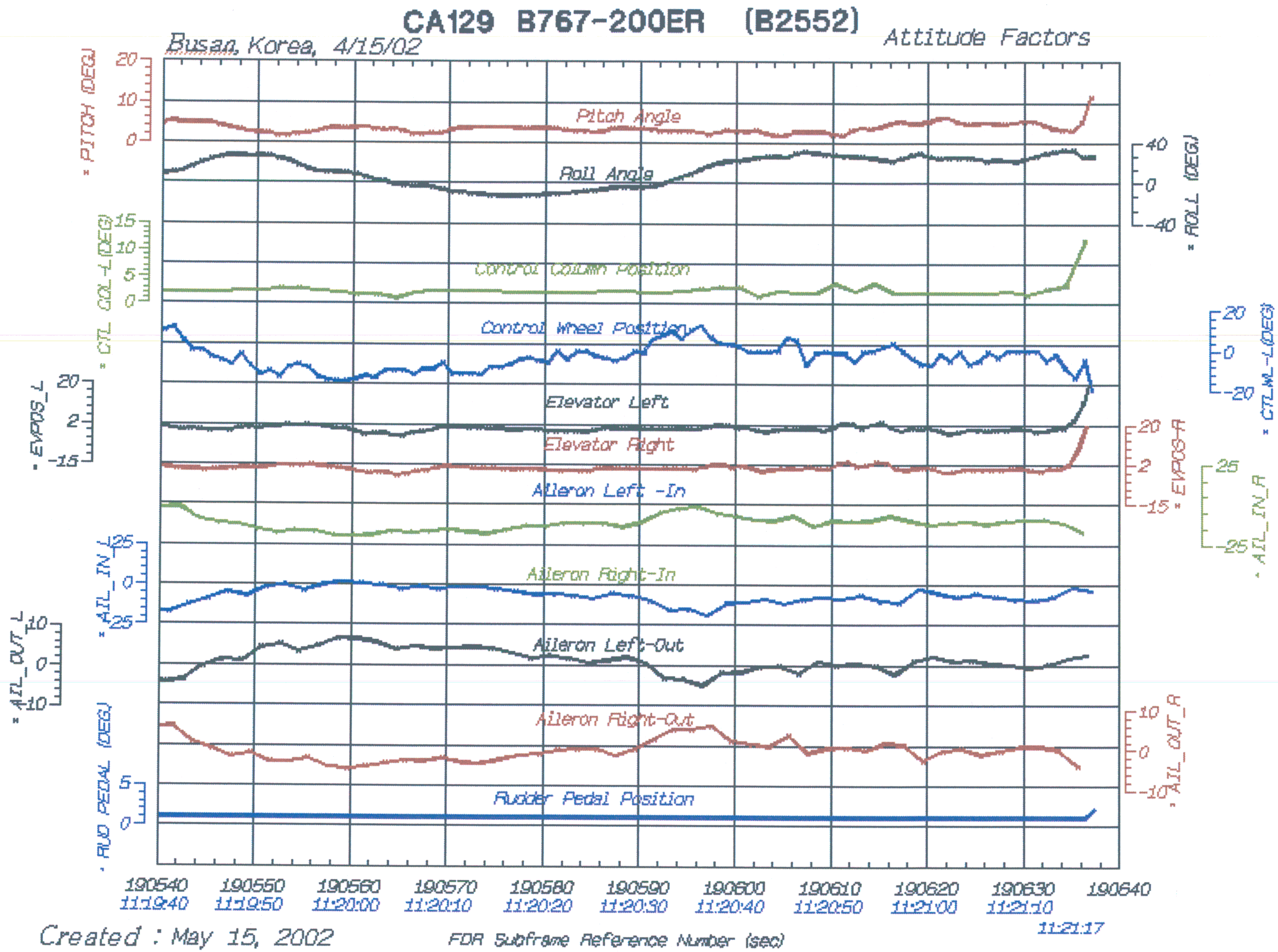

Created : May 15, 2002

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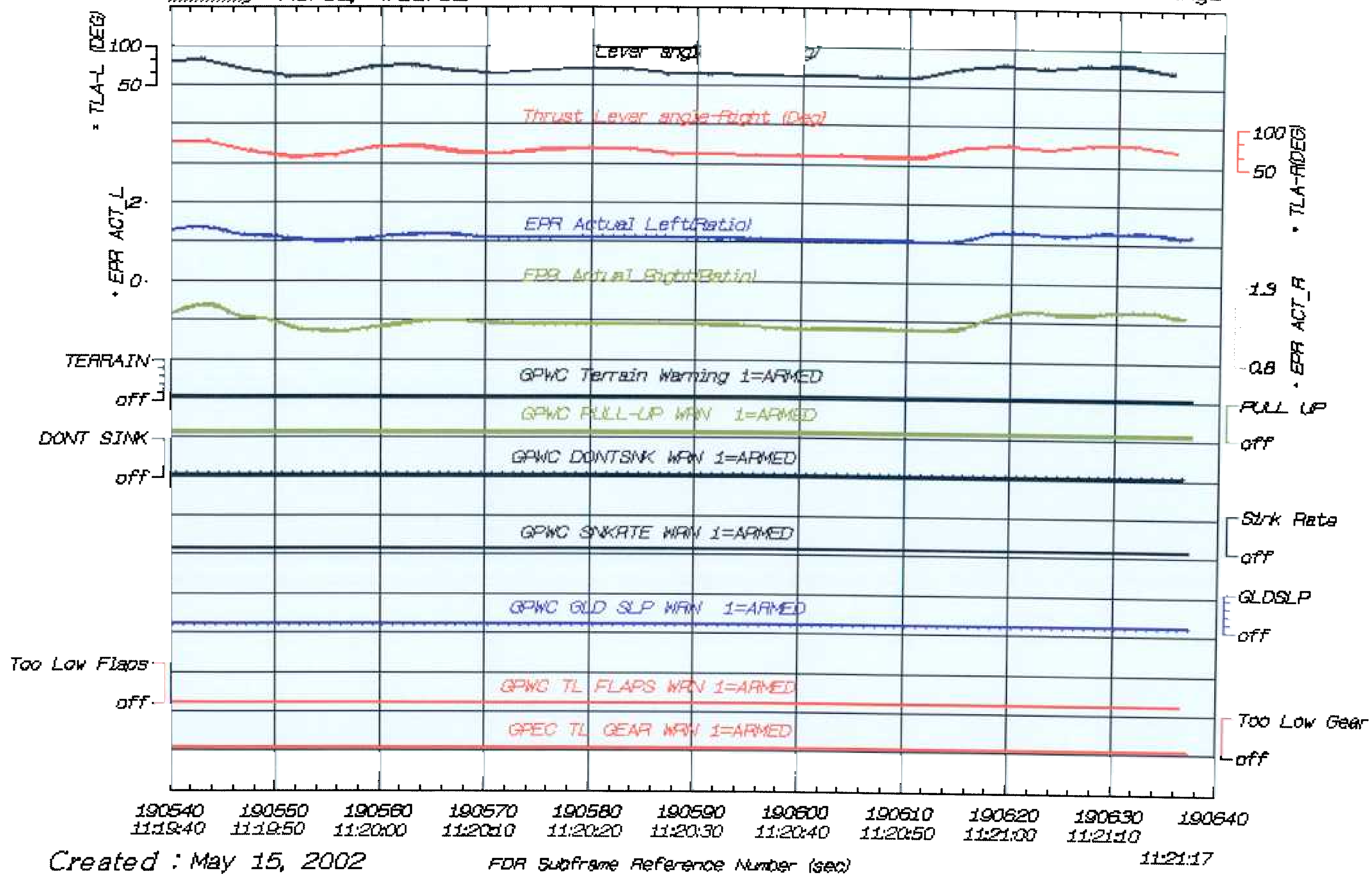
CA129 B767-200ER (B2552)

Busan, Korea, 4/15/02 — Engines & Warnings



Created : May 15, 2002

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붙임 1 : 조종실 음성녹음 기록

(Cockpit Voice Recorder Transcript)

총 17쪽

Local T.	SRC	CH's	Contents
10:49:31.5	ATIS	2	Visibility two miles rain fog, sky condition three octa five hundred, six [ATIS broadcasting]
10:49:54.7	ATIS		…18 right… (ATIS broadcasting)
10:50:17.0	OBS		听不清. ((잘 들리지 않는데.)) (I can't hear it clearly.)
10:50:21.1	ATIS		International airport information oscar
10:50:24.5	F/O	2	根本听不清. ((분명히 잘 들리지 않는데.)) (I can't hear it clearly at all.)
10:50:30.8	ATIS	3	Two miles rain fog, sky condition three octa five hundred, six octa one thousand, eight octa two thousand five hundred temperature one six, dew point one three, altimeter three zero zero zero, active runway three six left, advisory runway
10:50:59.9	ATIS	1 2 3 4	Gimhae international airport information oscar, time at zero one two eight UTC, weather wind two three zero at six knots, visibility two miles rain fog, sky condition three octa five hundred, six octa one thousand, eight octa two thousand five hundred temperature one six, dew point one three, altimeter three zero zero zero, active runway three six left, advisory runway three six right or one eight left will be used as taxiway and parallel taxiway will be closed.
10:52:13.4	ATIS	1 2 3	Advise you have information oscar ... Gimhae international airport…dew point one three, altimeter
10:52:20.9	OBS	2	给的是什么? ((우리한테 어떤 데이터가 주어 졌죠?)) (What data were we given?)
10:52:23.2	OBS	2	三千 ((3000.)) (Three thousand.)
10:52:35.0	OBS	1 2	18度, 36L,我听到 ((나는 18도, 활주로 36L로 들었음.)) (Eighteen degrees, three six left, I heard.)
10:52:47.7	OBS	2 4	三千. ((3000.)) (Three thousand.)

10:52:58.3	OBS	2	
10:53:01.0	OBS	2 3 4	8度? ((18도?)) (Eighteen degrees?)
10:53:02.2	F/O	2 3	16度吧. ((16도.)) (Sixteen degrees.)
10:53:06.0	ATIS	2	Weather wind two three zero at six knots, visibility two miles rain fog, sky condition three octa five hundred,..
10:53:26.3	OBS	2	18度, 露点16. ((18도, 노점온도 16.)) (Eighteen degrees, dew point one six.)
10:54:53.5	F/O	3	预计雷达引导左三边. ((레이더 벡터 받아 좌측 다운윈드로 진입이 예상되고.)) (Expect radar vectors to left downwind.)
10:55:05.8	F/O	3 4	过渡高度··· ((전이고도...)) (Transition level ...)
10:55:07.7	F/O		213··· ((213...)) (Two one three.)
10:55:10.9	F/O	3	复飞. ((복행.)) (Go around.)
10:55:13.7	F/O	3	如果复飞我们将···经过···VOR经向线飞向 KACHI. ((그리고 만약 복행 할 경우... 우리는... VOR 레이디얼 320으로 KACHI까지 비행을 계속할것이다.)) (If I missed approach...we will fly to .via VOR radial three two zero to KACHI.)
10:55:26.6	F/O	3	等待5000. ((5000피트로 대기.)) (Holding altitude five thousand feet.)
10:55:32.4	F/O	3	盲降频率108.5. ((ILS 주파수는 108.5.))

			(ILS frequency is one zero eight point five
10:55:34.6	F/O	3	Zero zero one.
10:55:37.6	F/O	3	没有远近台, VOR113.8 带DME.
			((OM, IM 없음, VOR은 113.8 DME가 있음.))
			(No outer marker, no inner marker. VOR one one three point eight with DME.)
10:55:44.6	F/O	3	北部安全高度5100.
			((북쪽 안전고도는 5100.))
			(Safe altitude in north is five one zero zero.
10:55:46.6	F/O	3	西南安全高度3700.
			((남서쪽 안전고도는 3700.))
			(Southwest safe altitude is three thousand seven hundred feet.
10:56:12.4	F/O	3	进近检查单.
			((접근 점검항목.))
			(Approach checklist.)
10:56:13.7	F/O	3	增压, 调定.
			((기내압력 조정.))
			(Cabin pressure set.)
10:56:14.1	CAP	3	调好.
			((OK.))
			(OK.)
10:56:15.0	F/O	3	空速游标.
			((목표속도 셋.))
			(Target speed setting.
10:56:16.9	CAP	4	
			((127.))
			(One two seven.)
10:56:18.7	F/O	3	高度表.
			((고도계수정치 셋.))
			(Altimeter setting.)
10:56:21.3	CAP	3	调3000.
			((3000으로 셋.))
			(Set to three thousand

10:56:23.7	F/O	3	无线电导航仪表. ((무선항법 점검.)) (Radio navaids check.)
10:56:25.4	CAP	3	检查好. ((검사, OK.)) (Check, OK.)
10:56:27.6	F/O	3	自动刹车选择. ((오토브레이크 선택.)) (Autobrake select
10:56:28.4	CAP	3	 ((2.)) (Two.)
10:56:28.7	F/O	2 3	再现检查. ((재현검사.)) (Recall.)
10:56:30.3	CAP	3	检查完. ((검사 완료.)) (Check completed.)
10:56:30.4	F/O	3	进近检查单完成. ((접근 점검항목 완료.)) (Approach checklist completed.)
10:56:34.4	OBS	1 2	通播给的是英寸汞柱. ((ATIS에서 준 것이 인치-헥토파스칼 인가?)) (ATIS gives us inches-hectopascals?)
10:56:53.2	ATIS	4	...left will used at taxiway and parallel taxiway will be closed. Advice you have information oscar···. GIMHAE international airport information papa, time at zero two zero zero
10:57:05.4	F/O	3	我听到16度. 16도로 들었는데.)) (I heard temperature is one six
10:57:09.8	F/O	2 3 4	INCHEON control, Air China 129, ready for descent.
10:57:12.9	OBS	1 2	通播改为"P." ((ATIS가 "P"로 변했군.)) (Information changed to papa.)

10:57:13.9	ACC	1 2 3 4	Air China 129, descend to flight level two three zero initially
10:57:19.0	F/O	2 3 4	Initially two three zero Air China 129.
10:57:22.3	F/O	3	下降 230. ((230으로 강하.)) (Descend to two three zero.
10:57:22.7	OBS	2 3 4	调230. ((230으로 조정.)) (Select altitude to two three zero.)
10:57:25.3	ATIS	4	GIMHAE international airport information papa, time at zero two zero zero UTC …, visibility two miles rain fog, sky condition one eight of the sky obscured by fog …, temperature one six dew point one three, altimeter three zero zero zero …
10:57:35.9	ATIS	3 4	Zero zero zero advise you have information papa.
10:57:53.2	ATIS	1 2 3	GIMHAE international airport information papa, time at zero two zero zero UTC …
10:58:36.6	F/A	3	请讲, 25分, 16度, 谢谢. ((말씀하세요, 25분, 16도, 감사합니다.)) (Arrival time twenty-five, temperature one six
10:58:42.1	OBS	1 2 4	通播"P", 16度. ((ATIS 정보는 "P", 16도.)) (Information papa, sixteen degrees.)
10:58:45.0	OBS	2	36L. ((36L.)) (36L.)
10:59:21.0	OBS		到早了. ((좀 일찍 도착했군.)) (We have arrived earlier.)
10:59:22.9		3	[Sound similar to that of seat adjustment.]
:00:22.1	F/O	2 3 4	Incheon control, Air China 129, reaching two three zero ready for further descent.
11:00:32.9	ACC	1 2 3 4	Air China 129, descend to flight level one...seven zero.
11:00:38.5	F/O	2 3 4	Descend to level one seven zero, Air China 129.
1:00:42.4	F/O	3	下降到170. ((170으로 강하.))

			(Descend to one seven zero.
11:00:42.7	OBS	2 3	170调好.
			((170으로 조정.))
			(Select altitude to one seven zero.
11:01:01.5	OBS	1 2	我来通讯.
			((내가 통신을 맡겠습니다.))
			(I will do communicating.)
1:01:04.8	OBS	2	你们监听, 我来釜山来得少.
			((당신들은 잘 들으시오, 부산에 온 적이 적은데.))
			(Others keep listening. I came to Busan not too often.)
11:02: .8	ACC	1 2 3 4	Air China 129, descend to flight level one nine zero.
11:02:15.4	OBS	2 3 4	Continue flight level one nine zero, Air China 129.
11:02:20.5	OBS	1 2	保持190.
			((190유지.))
			(Maintain level one nine zero.)
11:02:39.3	OBS	2	把速度调下来.
			((속도를 줄이세요.))
			(Reduce speed.)
1:03:05.6	ACC	1 2 3 4	Air China 129, descend to flight level one seven zero.
11:03:08.6	OBS	1 2 3 4	Descend to flight level one seven zero, Air China 129.
11:03:14.2	OBS	1 2	继续下170.
			((계속해서 170으로 강하.))
			(Continue down to level one seven zero.
11:03:34.2		2 3 4	[Sound similar to that of morse code]
11:04:02.4	OBS	1 2	盲降是对的.
			((ILS 식별이 정확하다.))
			(ILS identifier is correct.)
11:04:53.0	OBS	1 2 3 4	Control, Air China 129, maintaining flight level one seven zero.
11:04:57.8	ACC	2 3 4	Air China 129, standby.
11:06:04.	F/O	3	我看到的点, 在这儿…
			((내가 본 지점은, 여기에서))
			(The point that I saw, here .
11:06:09.1	F/O	3	在那
			((저기.))

			(There.)
11:06:11.3	CAP	4	我感觉得少指挥按这个航线飞， 头一回.
			(이런 장주로의 지시는 드물다고 느끼는데, 처음이다.)
			(I feel it is seldom to be instructed to fly this traffic route, it is the first time.)
11:06:17.2	ACC	1 2 3 4	Air China 129, contact Gimhae approach, one two five decimal five, good day.
11:06:21.7	OBS	2 3 4	One two five decimal five, good day, Air China 129.
11:06:25.6	OBS	2	125.5.
			((125.5.))
			(One two five decimal five
11:06:30.	OBS	1 2 3 4	GIMHAE approach, Air China 129, good morning, maintaining flight level one seven zero, with you.
11:06:38.3	APP	1 2 3 4	Air China 129, Gimhae approach, fly heading one nine zero, descend to six thousand.
1:06:44.6	OBS	1 2 3 4	Roger, turn heading one nine zero and descend to six thousand, Air China 129.
11:06:51.2	F/O	3	航向190, 航线选择.
			((헤딩 190, 헤딩선택.))
			(Heading one nine zero, heading select.
11:06:52.9	APP	1 2 3 4	Air China 129, verify you have information papa.
11:06:57.5	OBS	2 3 4	Information papa received, Air China 129.
11:07:00.9	APP	2 3 4	Air China 129, roger, active runway three six left, expect straight-in approach.
11:07:07.2	OBS	1 2 3 4	Roger, Air China 129.
11:07:09.2	OBS	1 2	下降6000.
			((6000으로 강하.))
			(Descend to six thousand feet.
1:07:55.0	OBS	2 3 4	BUSAN approach, Air China 129, confirm visual approach runway three six left?
11:08:00.8	APP	1 2 3 4	Air China 129, three six left, Gimhae active runway three six left in use.
11:08:06.8	OBS	2 3 4	Roger, Air China 129.
11:08:10.7	OBS	2	就是目视进近.
			((바로 비주얼 접근이다.))

			(That means visual approach.
11:08:21	F/O	3	高度表调定3000. ((고도수정치 3000.)) (Altimeter set three thousand.)
1:08:35.4		4	[Sound similar to that of map]
11:08:50.0	APP	1 2 3 4	Air China 129, request approach category.
11:08:55.2	OBS	1 2 3 4	Please say again.
11:08:57.0	APP	1 2 3 4	Air China 129, request approaching category.
11:09:01.0	F/O	3	进近类别 "C." ((접근범주 "Charlie.")) (Approach category "Charlie.")
11:09:02.3	OBS	2 3	什么? ((뭐라고?)) (What?)
11:09:06.6	OBS	1 2 3 4	Charlie, Air China 129.
11:09:10.0	APP	1 2 3 4	Air China 129, roger copy, this time active runway change one eight right, wind two one zero at one seven knot, expect circling approach one eight right.
1:09:21	F/O	3	反向进近跑道18右. ((선회접근착륙 활주로 18R.)) (Circle approach runway one eight right.
11:09:22.4	OBS	1 2 3 4	Circle approach one eight right, Air China 129.
11:09:29.6	APP	2 3 4	Air China 129, confirm your category is Charlie or Delta?
11:09:35.4	CAP	4	"C" 类. ((접근범주 "Charlie.")) (Category "Charlie.")
11:09:36.3	OBS	2	Charlie, Air China 129, Charlie.
11:09:39.6	APP	1 2 3 4	Air China 129, roger.
11:09:43.7	CAP	3 4	220度, 多少海里? 十多海里. ((바람방향은 220도인데 얼마나 세지? 십 몇 노트?)) (Wind direction is two two zero, but how much? more than ten knots?)
11:09:55.	F/O	3	万尺. ((10000피트.))

			(Ten thousand feet.)
11:10:03.	APP	1 2 3 4	Air China 129, turn left heading one eight zero, descend to four thousand feet.
11:10:07.	OBS	1 2 3 4	Turn left one eight zero Air China 129, descend to four thousand.
11:10:19.2	CAP	4	18右, 转圈的. ((그러니까 과연 18R이군.)) (That means we are using runway one eight right.)
10:35.7	F/O	3	MDA是七百尺. ((최저강하고도는 700피트.)) (MDA is seven hundred feet.)
11:10:39.6	CAP	1 4	果然是18号, 18右, 目视. ((자 우리 18번으로 사용하고, 18R, 비주얼.)) (We are really using one eight, one eight right visual.)
11:10:47.2	F/O	3	就是六百八十? ((그러니까 680?)) (This means six hundred eighty?)
1:10:50.6	F/O	3	六百八十几? ((680 얼마?)) (Six hundred eighty what?)
1:10:52.	F/O	3	看一下. ((보시오.)) (Take a look.
11:10:55.8	CAP	4	六百八十七, 七百 ((687, 700입니다.)) (Six hundred eighty seven, seven hundred
11:11:14.0	CAP	1 4	早点做完就完. ((미리미리 조치하는 게 좋지.)) (It's all right to have it done earlier.)
11:11:23.2	F/O	1 3 4	看那边滑行道. ((저쪽 유도로 좀 보세요.)) (Look at that side taxiway.)
11:11:24.7	F/O	3	这边的叫什么? ((이쪽은 뭐지?))

				(What is this side called ?)
1 11:30.3	CAP	2 3 4		C6 出来就是 E4. ((C6로 나오면 곧 E4이고.)) (Comes out of Charlie six is Echo four.
11:11:33.6	F/O	3		是那个斜的吗? ((그 대각선 말입니까?)) (Is that the diagonal one?)
11:11:34.2	CAP			直接退出, C6出来就是 E4,C6 C7都行 ((직접 빠져나오거나, C6로 나오면 E4이고 C6 C7 모두 괜찮다.)) (Vacate the runway directly or come out of Charlie six is Echo four or use Charlie six, Charlie seven.)
11:11:37.4	CAP	4		如果是关了就是跑道头, C5肯定是关了. ((만약에 막혀있으면 활주로 끝으로 나오고, C5는 분명히 막혀있고.)) (If it is closed, possibly we will use end of the runway, Charlie five is closed for sure.)
11:11:45.3	CAP			C6,C7 不知道 ((C6, C7은 모르겠음.)) (We don't know Charlie six and Charlie seven.)
12:27.2	CAP	4		航线不能做大了, 那边全是山. ((우리는 장주패턴을 넓게 하면 안 되는데, 저쪽은 전부 산이야.)) (We won't enlarge the traffic pattern, the mountain is all over that side.)
11:12:29.0	F/O	3		对. ((맞습니다.)) (Right.)
11:13:00.5	CAP	4		下雨了, 本场没有报有雨啊? ((어 비가 오는군, 우리는 비온다는 정보가 없었는데?)) (it's raining, we didn't receive any information on rain?)
11:13:15.3		2 3		[4 beeps]
11:13:34.6	F/O	3		襟翼 1? ((플랩 1?)) (Flaps one?)
11:13:35.1	CAP	4		好的, 放.

			((OK, 내려.))
			(OK, extend.)
1:13:35.9			Clicks [possibly flaps related]
11:13:58.7	APP	1 2 3 4	Air China 129, turn left heading one six zero, descend to two thousand six hundred.
11:14:03.4	OBS	1 2 3 4	Turn left heading one six zero, descend to two thousand six hundred feet, Air China 129.
11:14:15.0	OBS	2	左转160, 下降2600.
			((160도로 좌측선회, 2600으로 강하.))
			(Turn left heading one six zero, descend to two thousand six hundred feet.)
11:14:37.0		1 2 3 4	[multiple clicks.]
1 4:47.	CAP	4	拿下眼鏡适应适应.
			((안경 벗고 밖에다 눈을 좀 적응시켜야겠는데.))
			(I will take off my sunglasses, let my sight adjust to outside.
11:15:02.5	CAP	4	能见度不怎么样.
			((시정이 안 좋은데.))
			(The visibility is not so good.)
11:15:14.8	APP	1 2 3 4	Air China 129, turn left heading zero nine zero.
15:19.1	OBS	1 2 3 4	Turn left heading zero nine zero, Air China 129.
11:15:23.3	OBS	2	左转90度.
			((90도로 좌측선회.))
			(Turn left heading zero nine zero.)
11:15:28.0	CAP	4	雨区阿.
			((비가 오는 지역인데.))
			(It's the rainy area.)
1:15:51.1	CAP	4	放.
			((내려.))
			(Extend.)
1 15:51.6	F/O	3	襟翼5.
			((플랩5.))
			(Flaps five.)
16:02.4		2 3 4	Clicks. [possibly flaps related]
1:16:05.4	CAP	4	这么大风

((바람이 센데.))

(The wind is so strong.)

11:16:33.4 APP 2 Air China 129, turn left heading zero three zero, cleared for ILS DME runway three six left, then circle to runway one eight right, report field in sight.

1 16:41.8 OBS 2 Turn left heading zero three zero, cleared [unintelligible] approach one eight right, Air China 129.

11:16:49.7 CAP 4 反向.

((선회접근착륙.))

(Circle to land.)

11:16:53.8 F/O 3 反向,可以盲降36L,反向落地18R,看到跑道叫.

((선회접근착륙, ILS 36L로 접근허가, 그런 다음 활주로 18R로 선회 접근착륙, 활주로 보이면 보고.))

(Circle to land, cleared for ILS approach three six left, and then circle to land one eight right, report runway in sight.)

1:16:54.6 OBS 2 好的,好的, 明白, 18R, circle to land.

((OK, OK, 알겠음, 18R, 선회접근착륙.))

(OK, OK, I understand, circle to land one eight right.

1 17:05.3 OBS 2 左转030.

((30도로 좌측선회.))

(Turn left zero three zero.

11 7:06.8 1 2 3 4 [Metallic noise.]

11:17:10.7 F/O 3 下一点, 快到了.

((좀 더 강하, 거의 다 왔음.))

(Little more descent, position almost reached.

11 7:17.5 F/O 3 按盲降...

((ILS 잡혔네...))

(ILS captured...)

11:17:29.8 CAP 4 是不是要保持这个高度呀?

((이 고도를 유지해야 하는가?))

(Do we have to maintain this altitude?)

11:17:30.9 F/O 3 不保持.

((유지하지 말고.))

(Do not maintain.)

7:33.2	F/O	3	下七百. ((700으로 강하.)) (Continue down to seven hundred feet.
7:39.5	F/O	3 4	风太大,放轮? ((바람이 너무 세다, 착륙기어 내려요?)) (Too strong wind, gear down?)
11:17:42.1			[Sound similar to that of landing gear being extended]
1:17:47.3	CAP	4	放轮, 襟翼20? ((착륙기어 내림, 플랩 20 ?)) (Gear down, flaps twenty?)
11:17:48.9	F/O	3	襟翼20. ((플랩 20.)) (Flaps twenty.)
1 17:50.0			Clicks [possibly flaps related]
11:17:54.4	APP	1 2 3 4	Air China 129, descend to seven hundred.
11:17:57.2	OBS	2 3 4	Seven hundred, Air China 129.
11:18:00.3	OBS	2 4	下降700 ((700으로 강하.)) (Descend to seven hundred feet.
1:18:28.7	APP	1 2 3 4	Air China 129, report field in sight.
11:18:34.	OBS	2 3 4	Runway not in sight, Air China 129.
11:18:39.0	CAP	4	Runway in sight.
1:18:40.5	OBS	1 2 3 4	Runway in sight, Air China 129.
18:43.7	APP	2	Air China 129, contact tower one eighteen point one, circle west.
1 18:47.4	OBS	2 3 4	Circle, circle, one eight right, Air China 129.
11:18:48.4	CAP	4	脱开, 左转. ((디스컨넥트, 좌측선회.)) (Disconnect, turn left.)
11:18:52.5	F/O	4	我来. ((내가 조종한다.)) (I have control.)
11:18:53.3	F/O	3	航向选择. ((헤딩선택.))

			(Heading select.)
1 :18:55.2		1 2 3 4	Several beeps [sound similar to that of inner/middle marker]
11:18:56.5	CAP	3 4	好了, 保持700, 注意高度阿
			((됐다,700 유지, 고도 주의해.))
			(OK, maintain seven hundred feet, watching the altitude.
11:19:02.9	OBS	1 2	18右 转圈的
			((활주로 18R, 선회접근.))
			(One eight right, it is circling.)
11:19:07.6		4	Glide Slope [aural warning]
11:19:11.4	F/O	3 4	把盲降关了
			((ILS를 꺼라.))
			(Turn off the ILS.)
1 19:12.3	OBS	1 2 4	好的 关啦
			((OK, 껐습니다.))
			(OK, have it turned off
11:19:16.7	CAP		
			))
			(Twenty seconds
1:19:18.5	F/O	3	
			((OK.))
			(OK.)
11:19:33.2	CAP	4	看着跑道
			((활주로 잘 지켜보고.))
			(Keep watching the runway.
11:19:34.0	F/O	1 2 3	差不多, 转吧.
			((선회합시다.))
			(Turning.)
11:19:41.0	F/O	3	再接上
			((재연결.))
			(Engage it again
11:19:43.4	OBS	1 2	高度700.
			((고도 700.))
			(Altitude seven hundred

1:19:44.8	F/O	3	现在是高度保持七百. ((현재고도 700으로 유지.)) (Maintain present altitude seven hundred feet.)
11:19:46.0	F/O	3	航向选择. ((헤딩선택.)) (Heading select.)
11:19:51.5	APP	1 2 3 4	Air China 129, contact tower, one eighteen one.
11:19:53.3			Beeps [beeping slowly increased then decreased in rate, continued until 11:20:40]
11:19:55.7	OBS	1 2 3 4	Contact tower one two one...one one eight decimal one, good day, Air China 129.
11:19:59.5	CAP	4	能看到跑道头吗? ((활주로 끝과 나란한 지점을 보았나?)) (Can you see abeam end of runway?)
11:20:01.0	F/O	3	切跑道头. ((활주로 끝과 나란함.)) (Abeam runway end.)
11:20:01	TWR	3 4	This is GIMHAE tower on guard, Air China 129, if you hear me contact one one eight point one.
11:20:01.8	CAP	4	计时. ((타이밍.)) (Timing.)
11:20:13.0	OBS	1 2 3 4	GIMHAE tower, Air China 129, circle approach one eight right.
11:20:13.1	F/O	3	风太大, 太难飞了. ((바람이 너무 세다, 조종하기 힘든데.)) (The wind is too strong, it is very difficult to fly.)
11:20:14.8	CAP	3	三转弯. ((터닝베이스.)) (Turning base.)
11:20:16.9	CAP	4	我来飞. ((내가 조종할께.)) (I have control.
11:20:18.9	TWR	1 2 3 4	Air China 129, report turning base.
11:20:21.5	CAP	4	Turning right.

11:20:22.7	OBS	2 3	Wilco, Air China 129.
11:20:23.6	F/O	3 4	快转,别太晚了 ((빨리 선회하고, 너무 늦지 않도록.)) (Turn quickly, not too late.)
11:20:25.0	TWR	1 2 3 4	Air China 129, check wheels down, wind two one zero at one seven knots, cleared to land runway three six left, not in sight.
:20:32.0	CAP	4	襟翼30 放了. ((플랩 30, 이미 내렸다.)) (Flaps 30, already extended
11:20:32.6	TWR	1 2 3 4	Cleared to land runway one eight right.
11:20:33.9	CAP	4	把速度调下来. ((속도를 줄여라.)) (Reduce speed
11:20:34.7	F/O	4	好的 ((OK.)) (OK.
:20:34.8	OBS	2 3 4	Circle, [unintelligible] one eight right and QNH three thousand, Air China 129.
1:20:41.3	TWR	2 3 4	Air China 129, can you landing?
11:20:47.1	OBS	2 3 4	Roger, QFE three thousand, Air China 129.
11:20:50.9	TWR	2 3 4	Air China 129, say again your intention.
11:20:54	CAP	3 4	帮我找一下跑道. ((활주로를 찾는데 도와줘.)) (Assist me to find the runway.)
11:20:54.	F/O	3 4	注意高度. ((고도에 주의하고.)) (Pay attention to the altitude keeping.)
11:20:59.0	F/O	3	不太好飞了. ((비행하기 힘들어 지는데.)) (It's getting difficult to fly.)
11:21:01.9	F/O	3 4	注意高度. ((고도에 주의하고.)) (Pay attention to the altitude
:21:02.	TWR	1 2 3 4	Air China 129, say position now.

11:21:05.2	OBS	1 2 3 4	Air China 129, on base
11:21:06.7	F/O	1 2 3 4	Turn on final.
11:21:08.	OBS	2 3 4	Turning on final, and QFE three thousand, Air China 129.
11:21:08.9	CAP	4	看到跑道了吗？ ((활주로 봤나 ?)) (Have the runway in sight?)
11:21:10.4	F/O	3	没有，看不着. ((아니오, 안 보이는데요.)) (No, I can not see out.)
11:21 1.7	F/O	3	必须复飞. ((복행하시오.)) (Must go around.)
11:21:14.7	F/O	3 4	拉起来! 拉起来! ((당겨! 당겨!)) (Pull up! Pull up!)
11:21:14.7	TWR	1 2 3 4	Cleared to land one eight right, Air China 129.
:21:17.0			[Sound of impact.]

붙임 1 1 : 3국이 서명한 수정된 조종실 음성녹음기록

(The Amended CVR Transcript Signed by 3 Parties)

총 6쪽

Feb.26.2003

MINUTE OF JOINT MEETINTG

1. INTRODUCTION

For the purpose of clarification with respect to the doubtful words both in the transcript of CVR and air to ground communication between pilot of CCA129 and the controllers of GIMHAE ATC facilities. The Korean Accident Investigation Board (KAIB), the General Administration of Civil Aviation of China (CAAC) and NTSB had a joint meeting in NTSB headquarter from Feb, 25 to Feb, 26 During these two days, the three parties re-listened carefully to the CD-ROM copy of CVR and copy of air to ground communication with the assistance of NTSB technical experts. Some agreement was reached on the clarification of recordings Nevertheless, some doubtful words still remain since it was so difficult to clarify.

2. RESULTS

2.1 CVR

2/26/03

26/02/03

2/26/03

The CAAC believe that the original transcript of CVR signed by the three parties on 25th APR 2002 is correct and no changes to the transcript are required. The KAIB believe several words were wrong in the original transcript and suggested several changes which will be attached to the original transcript.

2.2 ATC COMMUNICATION

After the carefully clarification, several changes to the transcripts were suggested by the CAAC and KAIB. The changes to the transcripts are attached to the original transcript

Korean Investigator

Mr. Kim Yong Sok

2/26/03

Chinese Investigator

Mr. Liu Ya Jun 26/02/03

US Accredited Representative

Mr. Joseph M. Sedor 2/26/03

ATTACHMENT TO CVR HEARING

(

1. Korea(KAIB), China(CAAC) and US(NTSB) investigative team met at NTSB lab from Feb. 25 to 26, 2003 to review CVR recording and transcript.

2. The participants were

KAIB : Shin myung-nam, Kim yong-sok, Min byung-woo.
CAAC : Wang lifeng, Wu chengchang, Mao yanfeng, Xu sian
NTSB : Joe Sedor, Dave Kirchgessner, Albert Reitan.

3. Korean investigative team (KAIB) suggested the following changes

Time	Spoken by	From	To
11:16:43	pilot	...Cleared visual approach	...Clear cleared approach18R
11:20:26	tower	.... Not in sight... correction RWY 18R	... Not in sight... cleared to land RWY 18R

4. U S investigative team (NTSB) proposes no changes to transcript

KOREA(KAIB) : [signature]

USA(NTSB) [signature] JOSEPH SEDOR, US ACC REP 2/26/03

The approach control audio recording was reviewed at US NTSB laboratories on February 25 and 26, 2003. The following changes were suggested:

CAAC investigative team:

1116'43" P: Turn Left Heading 030 Clear Visual App 18R CCA129

1118'48" C: CCA129 CTC Tower eighteen…circle west

All three investigative teams:

1118'52" **P:** Circle, Circle 18R CCA129

Korean Investigator

Mr. Kim Yong Sok 2/26/03
Mr. Shin Myung Nam 2/26/03
Mr. Min Byung Woo 2/26/03

Chinese Investigator

Mr. Yajun Liu 26/02/03
Mr. Mao Yan Feng 2/26/03

NTSB Investigator

Ms. Barbara Zimmermann Barbara Zimmermann 2/26/03

The control tower audio recording was reviewed at US NTSB laboratories on February 25 and 26, 2003. The following changes were suggested:

Add under 11 19'43"

T: This is Gim Hae Tower on guard, CCA129, If you hear me contact 118.

Change

P: WILCO, CLEARED TO LAND 18R AND QNH 3000 AT. CCA129

To

P: CIRCLE, CLEARED TO LAND 18R AND QNH 3000 CCA129
(Korean investigator)

P: CIRCLE, CLEARED TO LAN EIGHT RIGHT AND QNH 3000 CCA129
(YAJUN LIU / CAAC)

P: CIRCLE APPROACH ONE EIGHT RIGHT AND_ QNH 3000 CCA129
(MAO YAN FENG / CAAC),

Change

P CCA129

To

P QFE 3000 CCA129 (KAIB)

P: Roger QFE 3000 CCA129 (CAAC)

Change

T(Bae Dong Hoon): THIS IS GIM HAE TOWER ON GUARD CCA129 IF YOU HEAR ME CONTACT 118.1 118.1 SAY POSITION NOW

To

T(Bae Dong Hoon): THIS IS GIM HAE TOWER ON GUARD CCA129 CCA129 IF YOU HEAR ME GIMHAE COME UP FREQUENCY 118.1 118.1 GIMHAE TOWER ON GUARD OUT (ALL PARTIES)

26/02/03 2/26/03

Korean Investigator

Mr. Kim Yong Sok 2/26/03
Mr. Shin Myung Nam
Mr. Min Byung Woo 2/26/03.

Chinese Investigator

Mr. Yajun Liu 26/02/03
Mr. Mao Yan Feng 2/26/03

NTSB Investigator

Ms. Barbara Zimmermann 2/26/03