

Aircraft Accident Investigation Interim Report

Crash Into The Sea After An In-Flight Fire

Asiana Airlines

B747-400F/HL7604

130 km West Of Jeju International Airport

July 28, 2011



September 17, 2012



Aircraft and Railway Accident Investigation Board

This interim report has been prepared based on the factual information gathered until July 2012 given the absence of the flight recorders, and supplements a preliminary report.

Also, the purpose of the report is to provide the aviation industry and the public with the information related to the accident.

Readers are asked to note that the report is not a completed factual report or investigation report and that the ARAIB has not reached any conclusion regarding the accident.

The Aviation and Railway Accident Investigation Board (ARAIB) has cooperated closely with experts from the National Transportation Safety Board, the Japan Transport Safety Board, and aircraft manufacturers, and was supported by experts from investigation authorities in France, China, Singapore, Taiwan, and the UAE.

This interim report has been translated and published by the ARAIB to make its reading easier for English-speaking people. As accurate as the translation may be, the original text in Korean should be considered as the work of reference.

Contents

Title	1
Synopsis	1
1. Factual Information	3
1.1 History of Flight	3
1.1.1 Chronicles of Events Occurring during AAR991's Operation	3
1.1.2 Flight Path of AAR991	4
1.1.3 Altitude & Speed Reconstructed Based on Radar Data	6
1.2 Injuries to Persons	7
1.3 Damage to Aircraft	7
1.4 Other damage	7
1.5 Personnel Information	7
1.5.1 The Captain	7
1.5.2 The First Officer	9
1.5.3 The Authorized Aircraft Mechanic	11
1.6 Aircraft Information	12
1.6.1 Aircraft History	12
1.6.2 Recent Maintenance History	14
1.6.2.1 Performance of Scheduled Maintenance	14
1.6.2.2 Fault History	15
1.6.3 Aircraft System	16

1.6.3.1 Air Flow Control System	16
1.6.3.2 Fire Warning and Detection System	16
1.6.4 Weight and Balance	19
1.6.5 ACARS System	20
1.6.5.1. Summary	20
1.6.5.2. ACARS Messages	22
1.7 Meteorological Information	24
1.7.1 Precipitation of Incheon Airport	24
1.7.2 Area Weather Conditions	25
1.7.3 Weather Conditions of Incheon and Jeju Airports	26
1.8 Aids to Navigation	27
1.8.1 Radar System	27
1.8.2 Air Traffic Control Communications Facilities	27
1.9 Communications	28
1.9.1. Radio Communications between the Aircraft and ATCs	28
1.9.2 Direct Line Communications between ATCs	28
1.10 Aerodrome Information	30
1.11 Flight recorders	30
1.11.1 FDR and CVR	30
1.11.2 Underwater Locator Beacon	31
1.11.3 Search Operations for Flight Recorders	32
1.12 Wreckage and Impact Information	37
1.12.1 Accident Site	38
1.12.2 Wreckage Recovery	38

1.12.3 Wreckage Examination	40
1.13 Medical and Pathological Information	49
1.14 Fire	49
1.14.1 Summary	49
1.14.2 Fire Damage to Interior of the Airframe	50
1.14.2.1 Wreckage between FS1700 and Aft Pressure Bulkhead	50
1.14.2.2 Wreckage Forward of FS1700 and Aft of Aft Pressure Bulkhead	52
1.14.2.3 Small Miscellaneous Portions of Wreckage	54
1.14.2.4 Cargo Pallets and Containers	54
1.14.2.5 Cargo Control Panels	55
1.14.2.6 Riser Ducts	55
1.14.2.7 Forward Main Cargo Deck Ceiling Panels	56
1.14.2.8 Upper Deck Interior Panel	57
1.14.3 Conductivity Measurements	57
1.15 Survival Aspects	58
1.15.1 General	58
1.15.2 Emergency Response	59
1.15.3 Fixed Emergency Locator Transmitter	61
1.16 Tests and Research	61
1.17 Organizational and Management Information	62
1.17.1 General	62
1.17.2 Simulator and Simulation Training	62
1.17.3 Dangerous Goods Training	63
1.18 Additional Information	64

1.18.1 Classification of Cargo Compartment	64
1.18.2 Cargo Loaded on AAR 991	65
1.18.2.1 Cargo Unloading and Loading History of AAR 991	65
1.18.2.2 Cargo Manifest for Incheon Departing Cargo	68
1.18.2.3 Cargo Build-up on ULD	68
1.18.3 Dangerous Goods	70
1.18.3.1 Lithium-ion Batteries	71
1.18.3.1.1 Manufacturer's Test Results	73
1.18.3.1.2 Manufacturer's Inspection before Packing	73
1.18.3.1.3 Packing Container	74
1.18.3.1.4 Packing and Shipping	74
1.18.3.2 Photo-resist/IC	76
1.18.3.3 Photo-resist/LCD	78
1.18.3.4 Amines Liquid Corrosive N.O.S.	80
1.18.3.5 Paint	81
1.18.3.6 Lacquer for Seal Inspection	82
1.18.3.7 Testimony of the Cargo Handlers	83
1.18.3.8 Maintenance and Repair of Cargo Container/Equipment	85
1.18.3.9 Cargo Handling System	86
1.18.3.10 Cargo Acceptance Procedures	87
1.18.3.11 Cargo Wreckage	88
1.18.4 Emergency Procedures for Fire Main Deck	90

Crash Into The Sea After An In-Flight Fire

- Operator: Asiana Airlines
- Manufacturer: The Boeing Company
- Model: B747-400F
- Registration Mark: HL7604
- Location: International waters 130 km west of Jeju International Airport 33°15'04.56"N 124°59'31.02"E
- Date & Time: July 28, 2011, about 04:10 Korean Standard Time¹⁾

Synopsis

On July 28, 2011, about 04:10, Asiana Airlines flight 991 (Boeing 747-400F, HL7604), a scheduled cargo flight from Incheon International Airport, Incheon, Republic of Korea, to Shanghai Pudong International Airport, Shanghai, China, crashed into the international waters about 130 km west of Jeju International Airport after the flight crew reported a cargo fire to Shanghai Area Control Center (SHI ACC) near a reporting point SADLI on airway A593 about 03:54 and attempted to divert to Jeju International Airport.

The aircraft was a scheduled international cargo flight operating under the instrument flight rule in accordance with the Korean Aviation Act and the Convention on International Civil Aviation. Aboard the aircraft were two pilots.

The two pilots were fatally injured, and the aircraft was destroyed.

Immediately after the accident, search and rescue operations have been

1) Unless otherwise indicated, all times in this report are Korean Standard Time, based on a 24-hour clock.

initiated, and about two hours after the accident, the Korea Coast Guard has recovered some floating debris and wreckage at the accident site.

Focusing on the site where the floating debris was recovered, a search team²⁾ has made efforts to detect an acoustic signal transmitted from the flight recorders until August 28, 2011, but failed to pick up the signal.

Wreckage recovery operations were conducted from July 31 until October 30, 2011, resulting in the recovery of about 1,600 pieces of the wreckage, but were temporarily suspended due to adverse conditions like high waves on October 30. The wreckage recovered until October 30 were stored in a wreckage storage facility near Incheon International Airport.

From January 5 until 20, 2012, the Korea-U.S. joint investigation team examined the wreckage at the storage facility and based on the examination results, prepared field notes.

The wreckage recovery operations temporarily suspended resumed on May 10, 2012 and continued until June 10, 2012. The results of these operations and of the examination on the wreckage recovered will be incorporated in the factual report afterwards.

2) Taiwan and Singapore investigation authorities dispatched two investigators with the search equipment each.

1. Factual Information

1.1 History of Flight

On July 28, 2011, Asiana Airlines flight 991 (B747-400F, HL7604, hereinafter referred to as AAR991) reported a cargo fire to SHI ACC and declared an emergency 50 minutes after takeoff from Incheon International Airport (hereinafter referred to as Incheon Airport). The flight crashed into the international waters 130 km west of Jeju International Airport (hereinafter referred to as Jeju Airport) 1 hour 8 minutes after takeoff or about 18 minutes after the declaration when it attempted to divert to Jeju Airport under the control of the ACC.

1.1.1 Chronicles of Events Occurring during AAR991's Operation

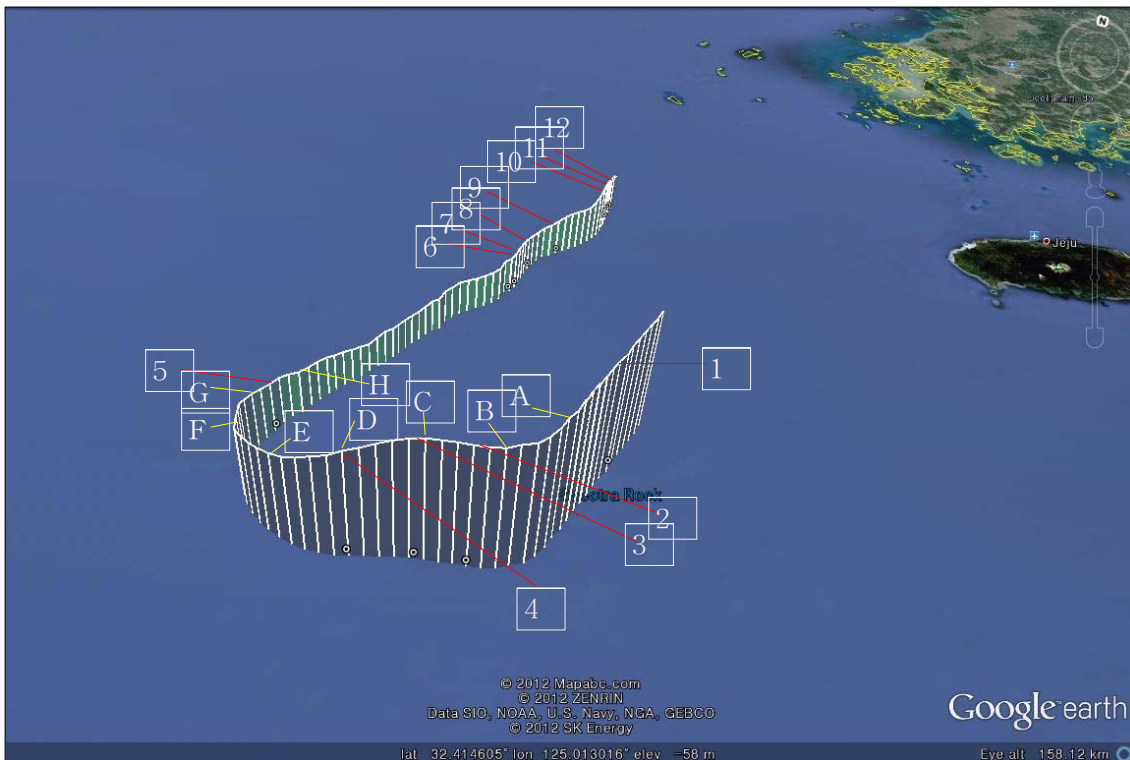
The events that had occurred until AAR991 reported a cargo fire are described in chronological order as shown in [Table 1].

02:42:41	Receipt of a tower en route clearance (FO)
02:47:55	Receipt of an engine start clearance (FO)
02:54:03	Receipt of a taxi clearance to runway 15L (FO)
03:01:28	Receipt of a takeoff clearance (FO)
03:04:28	Report of a takeoff roll (Cap.)
03:05:48	Report of airborne to SEL DEP (Cap.)
03:12:35	Initial contact with ICN ACC (Cap.)
03:13:05	ICN ACC's instruction to fly direct to NIRAT (Cap. replied)
03:26:05	ICN ACC's instruction to change a frequency (FO replied)
03:26:21	ICN ACC's instruction to fly direct to SADLI (FO replied)
03:50:46	ICN ACC's instruction to contact SHI ACC
03:51:15	Initial contact with SHI ACC (FO)

[Table 1] Events in Chronological Order

1.1.2 Flight Path of AAR991

As shown in [Figure 1], AAR991's flight path reconstructed based on ATC radar data is overlaid on the Google Map. Major ATC/pilot communications before and after the emergency declaration caused by a fire and ACARS³⁾ messages are shown in [Table 2] and [Table 3], respectively.



* ATC/Pilot communications and ACARS messages are listed in numerical and alphabetical order, respectively.

[Figure 1] Flight Path

3) The ACARS is an acronym for the Aircraft Communication Addressing and Reporting System. For details, refer to Section 1.6.5.

Order	Time	Transmitter	Summary of ATC/Pilot Communications
1	03:51:15	AAR991	Made initial contact with SHI ACC (FO)
2	03:54:23	AAR991	Requested SHI ACC to allow emergency descent and declared an emergency due to a fire (FO)
3	03:55:08	AAR991	Requested a diversion to Jeju (FO)
4	03:56:02 - 03:58:03	SHI ACC	Had communication with AAR991 pilots about diversion, descent altitude and the airport for diversion
5	03:59:26	AAR991	Reported to SHI ACC descent to 10,000 ft due to a rear cargo fire ⁴) and requested a radar vector to Jeju Airport(FO)
6	04:05:32	KAL886	Relayed ICN ACC's instructions to the AAR991 captain, and the captain replied * Heading 060, descent to 7,000 ft
7	04:05:49 - 04:06:30	AAR991	Had communication with the KAL886 pilot to confirm heading and descending altitude
8	04:06:32	AAR991	The captain said to KAL886, "We are now that rudder control is not working."
9	04:07:34	AAR991	The captain stated, "We have to open the hatch."
10	04:09:47	AAR991	The captain replied to KAL886's question about the control, "Rudder control... flight control, all are not working."
11	04:10:06	AAR991	The FO stated, "We have heavy vibration on the airplane, may need to make an emergency landing, emergency ditching."
12	04:10:15	AAR991	The FO stated, "Altitude control is not available due to heavy vibration, going to ditch... ah." * Afterwards, there was no communication between ATC and AAR991.

[Table 2] Major ATC/Pilot Communications

Order	Time	Summary of Messages
A	03:53	CARGO FIRE MAIN DECK ZONE-11 LOOP-A FAIL
		EQUIPMENT COOLING CAUTION & E/E COOLING SMOKE DETECTED
B	03:54	CARGO FIRE MAIN DECK ZONE-6 AND 10 LOOP-A FAIL
C	03:55	CARGO FIRE MAIN DECK ZONE-3, 4, 5, 7, 8, AND 16 LOOP-A FAIL
D	03:56	CARGO FIRE EXTINGUISHING ARMED 'NO ACTION REQUIRED'
E	03:57	YDM-LWR FAIL (Yaw Damper Lower)
		APU FIRE LOOP-A & -B
		DOOR L5 SWITCH FAIL
		FLIGHT RECORDER FAIL
F	03:58	FMC-L FAIL (NO BUS OUTPUT)
		CARGO BOTTLE A LOW PRESSURE & CARGO BOTTLE B LOW PRESSURE
		CARGO AFT-4 LOOP-A FAIL

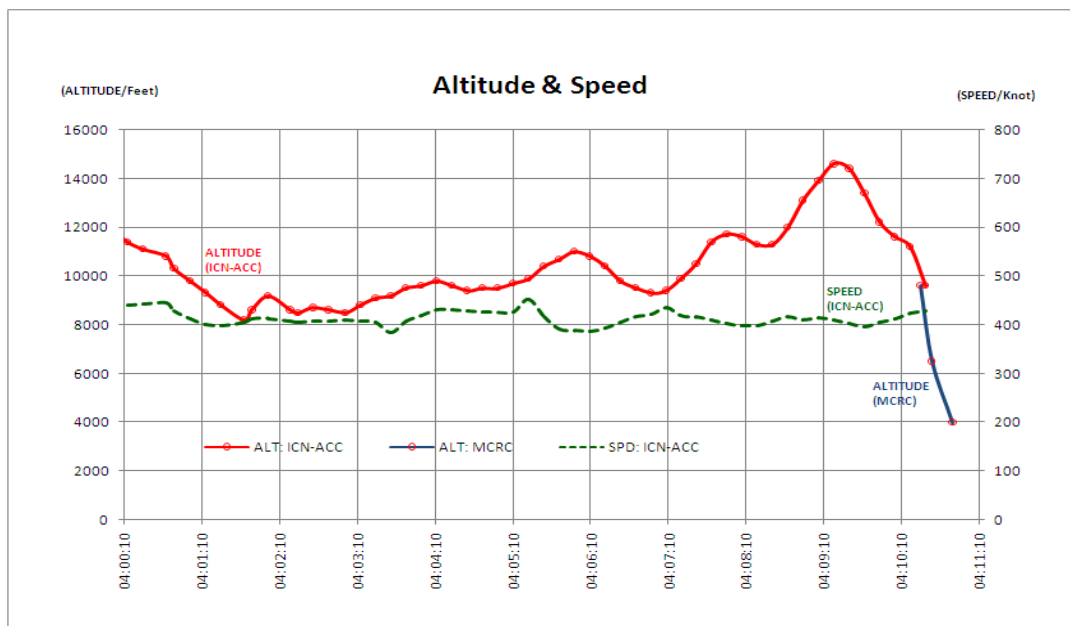
4) The first officer stated, "We have rear, after cargo, fire after cargo."

Order	Time	Summary of Messages
G	03:59	EMERGENCY LOCATOR TRANSMITTER ON
		DC CURRENT SENSOR-6 FAIL (BCU-2)
		APU DUCT FAIL
H	04:00	FLAP LEVER RVDT FAIL (FCU'S)
		UPPER YAW DAMPER ACTUATOR LVDT FAIL (YDM-UPR)

[Table 3] ACARS Messages

1.1.3 Altitude & Speed Reconstructed Based on Radar Data

Based on Incheon Area Control Center (ICN ACC)'s radar data, AAR991's altitude and speed from 04:00:10, a time when the aircraft started descending to 10,000 ft, until 04:10:50 are reconstructed as shown in [Table 4].



[Table 4] Altitude and Speed before the Crash

1.2 Injuries to Persons

Injuries	Crew	Passengers	Other
Fatal	2	0	-
Serious	0	0	-
Minor/None	0	0	-

1.3 Damage to Aircraft

The aircraft was destroyed by fire damage and impact forces caused by the crash into the sea.

1.4 Other Damage

None

1.5 Personnel Information

1.5.1 The Captain (Male, Age 52)

1.5.1.1 Personnel Records

Employment: Jul. 2, 1991

Promotion to B737 CAP: Dec. 24, 1996

Promotion to B747 CAP: Jul. 3, 2001

Promotion to Senior CAP: Jan. 1, 2004

1.5.1.2 Certificates of Qualifications

License (Category/Issue Date)	Transport/Apr. 23, 1996
Rating (Category/Issue Date)	B737/Oct. 15, 1992 B747/Jul. 23, 1994
Communication (Category/Issue Date)	Radio Operator /May 17, 1994
Physical Exam (Category/Issue Date)	First Class Airman Medical Certificate /Dec. 9, 2010 - Dec. 31, 2011

[Table 5] The Captain's Certificates of Qualifications

1.5.1.3 Flight Hours

Total Flight Hours		14,123:48 (Including 2,501:29 in the military)
Same Type		6,896:07
CAP Flight Hours	Total	9,016:04
	Same Type	5,666:07
Latest Flight Date		Jul. 28, 2011
1 Week b/f Accident Flight		27:17
1 Month b/f Accident Flight		86:08
3 Months b/f Accident Flight		269:23
1 Year b/f Accident Flight		935:58

[Table 6] The Captain's Flight Hours

1.5.1.4 Recent Training & Appraisal

Date	Category	Method	Title	Section/Venue	Type	Class
2011-06-02	Line Qualification Check	RTE	CAP	ICN/TSN/ICN	B744	S
2011-03-03	Proficiency Check	SIM	CAP	Asiana	B744	S
2010-06-06	Line Qualification Check	RTE	CAP	ICN/PVG/ICN	B744	S
2010-03-25	Proficiency Check	SIM	CAP	Asiana	B744	S
2009-06-07	Line Qualification Check	RTE	CAP	ICN/PVG/ICN	B744	S
2009-04-17	Proficiency Check	SIM	CAP	Asiana	B744	S

[Table 7] Recent Training & Appraisal of the Captain

1.5.1.5 Whereabouts in the 72 Hrs before Flight

In the morning on July 24 (Sun), 2011, the captain operating AAR965 arrived at Incheon Airport after the departure from Beijing, and in the afternoon, he took a rest at home in Cheonan.

As usual, he took a walk up a hill next to his apartment and did house chores like cleaning his house on July 25 (Mon) and 26 (Tue). On July 27 (Wed), he departed for his mother's house in Seoul to prepare for the AAR991 flight since the flight was scheduled to depart in early morning on July 28.

The captain had dinner and took a rest for a while. Then, he took a taxi to go to Songjeong Subway Station in Gangseo-gu, the boarding location for Asiana Airlines' commuting bus. By bus, he departed Songjeong Subway Station on July 28, about 00:30 and arrived at Incheon Airport about 01:15.

1.5.2 The First Officer (Male, 44)

1.5.2.1 Personnel Records

Employment: Apr. 2, 2007

Promotion to B767 FO: Feb. 5, 2008

Promotion to B747 FO: Nov. 4, 2010

1.5.2.2 Certificates of Qualifications

Licence (Category/Issue Date)	Transport /Mar. 26, 2008
Rating (Category/Issue Date)	B767/Nov. 19, 2007 B747/Aug. 31, 2010
Communication (Category/Issue Date)	Radio Operator/Feb. 14, 2007
Physical Exam (Category/Issue Date)	First Class Airman Medical Certificate /Oct. 12, 2010 - Oct. 31, 2011

[Table 8] The First Officer's Certificates of Qualifications

1.5.2.3 Flight Hours

Total Flight Hours	5,211:33
Same Type	492:29
Latest Flight Date	Jul. 28, 2011
1 Week b/f Accident Flight	18:22
1 Month b/f Accident Flight	76:57
3 Months b/f Accident Flight	232:37
1 Year b/f Accident Flight	748:18

[Table 9] The First Officer's Flight Hours

1.5.2.4 Recent Training & Appraisal

Date	Category	Method	Title	Section/Venue	Type	Class
2011-02-26	Proficiency Check	SIM	FO	Asiana	B744	S
2011-02-16	CAT- II/III Check	SIM	FO	Asiana	B744	S
2010-11-02	Transition Check	RTE	Probationary FO (Transition)	ICN/TSN/ICN	B744	S
2010-08-07	Transition Check	SIM	Probationary FO (Transition)	Asiana	B744	S
2010-04-18	Proficiency Check	SIM	FO	Asiana	B767	S
2010-01-07	Line Qualification Check	RTE	FO	ICN/TSN/ICN	B767	S
2009-04-19	Proficiency Check	SIM	FO	Asiana	B767	S
2009-02-08	Line Qualification Check	RTE	FO	ICN/FUK/ICN	B767	S

[Table 10] Recent Training & Appraisal of the First Officer

1.5.2.5 Whereabouts in the 72 Hrs before Flight

On July 23 (Sat), 2011, the first officer returned home from a flight to New York/Brussel.

On July 24 (Sun), he slept in the morning and took a walk in a nearby park with his wife in the afternoon.

On July 25 (Mon), he took a walk up a nearby hill and went grocery shopping with his wife in the morning. In the afternoon, he took a walk in a nearby park with his wife.

On July 26 (Tue), he received type training at work and returned home to take a rest.

1.5.3 The Authorized Aircraft Mechanic (Male, 45)

The authorized aircraft mechanic who conducted a final transit check of the accident aircraft holds an aircraft maintenance mechanic type II license⁵⁾, and has accumulated 19 years of line maintenance since his employment on March 9, 1993. He holds a valid license as a B747-400 aircraft mechanic given that he received an engine run-up training and a regular recurrent training after he had obtained a B747 type rating in 2000.

On July 27, the mechanic was on a night shift and went to work at 20:00. He assisted in preparing AAR708 (Incheon/Manila, HL7506) for flight and moved to the freighter ramp to assist in preparing freighters for their night flight.

At the ramp, he had AAR385 (Incheon/Singapore, B747-SF, HL7415, departure at 22:05) and AAR587 (Incheon/Anchorage, B747-F, HL7420, departure at 23:05) prepared for flight, and then had AAR991 (Incheon/Pudong, B747-F, HL7604, departure at 02:45) prepared for flight.

According to his statement, his duties on July 28 are listed in

5) License No.: 6193

chronological order as follows:

00:00 He stood by for HL7605 that arrived as AAR786 at the cargo terminal ramp 624.

00:15 HL7604 arrived at the ramp.

00:20 He was notified by AAR786's captain that HL7604 had no fault.

00:25 He started a transit check⁶⁾ with his fellow mechanic.

01:20 He completed a transit check and filled in his name in the maintenance release box on a flight maintenance log.

02:00 AAR991's captain arrived at the cockpit and deplaned to perform ramp inspection.

02:35 AAR991's door was closed.

02:47 AAR991 was pushed back for departure.

1.6 Aircraft Information

1.6.1 Aircraft History

The aircraft (HL7604) was manufactured by the Boeing Company on February 15, 2006 as a freighter. On February 22, 2006, it was delivered to Asiana Airlines and registered. The aircraft held a valid airworthiness certificate.

On the upper deck of the aircraft were eight seats for passengers and supernumerary crew members.

The aircraft had accumulated 28,752 total flight hours and 4,799 total cycles at the time of the accident. Specifications of the aircraft are shown in [Table 11].

⁶⁾ Transit Check: Pre/Post-flight check of the aircraft, which is performed every flight.

Model	B747-48EF	Registration Mark	HL7604
Seats	8	Owner	Asiana Airlines
Engine Type	CF6-80C2B1F	Thrust	25,945 kg
APU	PW901A	Max. Takeoff Weight	394,625 kg
Line No.	1370	Serial No.	29907
Manufacture Date	Feb 15, 2006	Age	5 years and 5 months
Delivery Date	Feb 22, 2006	Total Flight Hours	28,752
Total Cycles	4,799	Manual Application No.	103

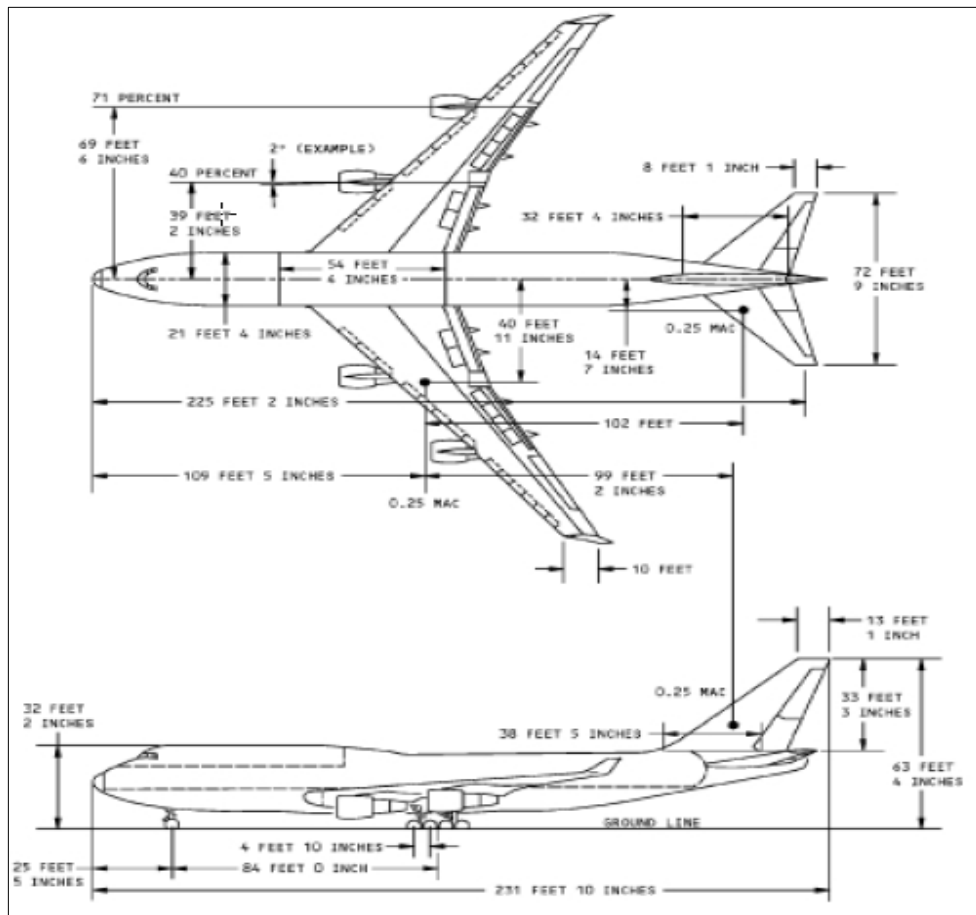
[Table 11] Aircraft Specifications

The aircraft was equipped with four CF6-80C2B1F engines manufactured by General Electric as shown in [Table 12].

No.	Serial No.	Manufacture Date	T.S.N	C.S.N	T.S.O	Last Shop Visit Maintenance	Installation Date
1	704198	1994-09-06	68,036	14,470	669	2011-05-25	2011-06-08
2	706458	2002-03-22	41,556	8,719	22,420	2006-09-11	2009-01-23
3	703198	1996-03-23	62,491	13,408	7,600	2010-02-11	2010-02-20
4	702794	1992-09-01	82,505	13,978	9,689	2009-09-03	2009-09-28

[Table 12] Features of Engines

The dimensions of the aircraft are shown in [Figure 2].



[Figure 2] Dimensions of the Aircraft

1.6.2 Recent Maintenance History

As a result of reviewing the maintenance history of the five months before the accident, it was confirmed that maintenance was carried out on the aircraft according to the maintenance program approved by the Ministry of Land, Transport and Maritime Affairs.

1.6.2.1 Performance of Scheduled Maintenance

Scheduled maintenance performed in the five months before the accident is shown in [Table 13].

Scheduled Maintenance	Cycle	Latest Performance Date	Details of the Program
1A	750 hrs	2011-01-26	1A+2A1+4A1
2A	750 hrs	2011-03-14	1A+2A2+4A2
3A	750 hrs	2011-05-01	1A+2A1+4A3
4A	750 hrs	2011-06-08	1A+2A2+4A4
4C	9000 hrs	2011-01-14	1C+2C+4C
1D	7 yrs	Not Applicable	Cycle Not Arrived

[Table 13] Scheduled Maintenance in the Five Months before Accident

1.6.2.2 Fault History

As a result of reviewing the maintenance history of the five months (March 4 though July 25) before the accident, it was confirmed that there were 208 logged faults and corrective actions. Out of these faults, faults related to pneumatic system, electrical system, cabin, and fire detection system, and their corrective measures were examined.

Three faults with smoke detectors occurred. On April 26, 2011, when the "AFT CGO 4 LOOP" message was displayed, the fire detection system was tested on the ground after landing, but no fault was found. Asiana airlines determined that "AFT CGO 4 LOOP" message is a false fire warning due to moisture. Smoke detectors often malfunctioned due to moisture and thus, the Boeing Company issued a service letter⁷⁾ about actions to correct such a fault. The remaining two faults with fire detectors were concerned with engine fire detector loops, and there were no logged faults with cargo compartment or cabin smoke detectors.

⁷⁾ Doc No.: 747-SL-26-020, Issue Date: March 17, 2004, Title: *Cargo Compartment False Fire Warnings Due To Moisture*

One fault with the pneumatic system and the equipment cooling occurred, and on April 18, 2011, when the "EQUIP COOLING" warning message was displayed on AAR774 (Frankfurt/Incheon), the aircraft diverted to and landed at Koltsovo Airport in Russia. This fault turned out to be a fault with the equipment cooling printed circuit assembly, a computer in charge of the equipment cooling, and thus, the assembly was replaced.

Five faults with the electrical system occurred, but all of them were concerned with the generator.

1.6.3 Aircraft System

1.6.3.1 Air Flow Control System

To be supplemented afterwards.

1.6.3.2 Fire Warning and Detection System

The fire, smoke, or overheat detection systems give the flight crew visual and/or aural indications of abnormal conditions in the engines, lavatories, overhead crew rest area, APU, lower cargo compartments, equipment cooling, wing leading edge, tail cone, or wheel wells.

The fire warning bell sound comes from two speakers in the flight deck. The master warning light indicators are located on the pilot and copilot's side glareshield.

The fire warning bell and master fire warning light is activated when any engine, APU, overhead crew rest area, main deck

compartment or lower cargo compartment smoke, fire, or overheat condition is detected.

The pilot's overhead panel contains a FIRE/OVHT test button. This button is used to test the fire, overheat, and smoke detection systems for engines, APU, wing leading edge, and lower cargo compartment.

There is a separate fire loop for each engine nacelle and cowling - two for each engine - to detect any engine fire and overheat condition.

A smoke detector unit is installed in each lavatory to monitor for presence of smoke.

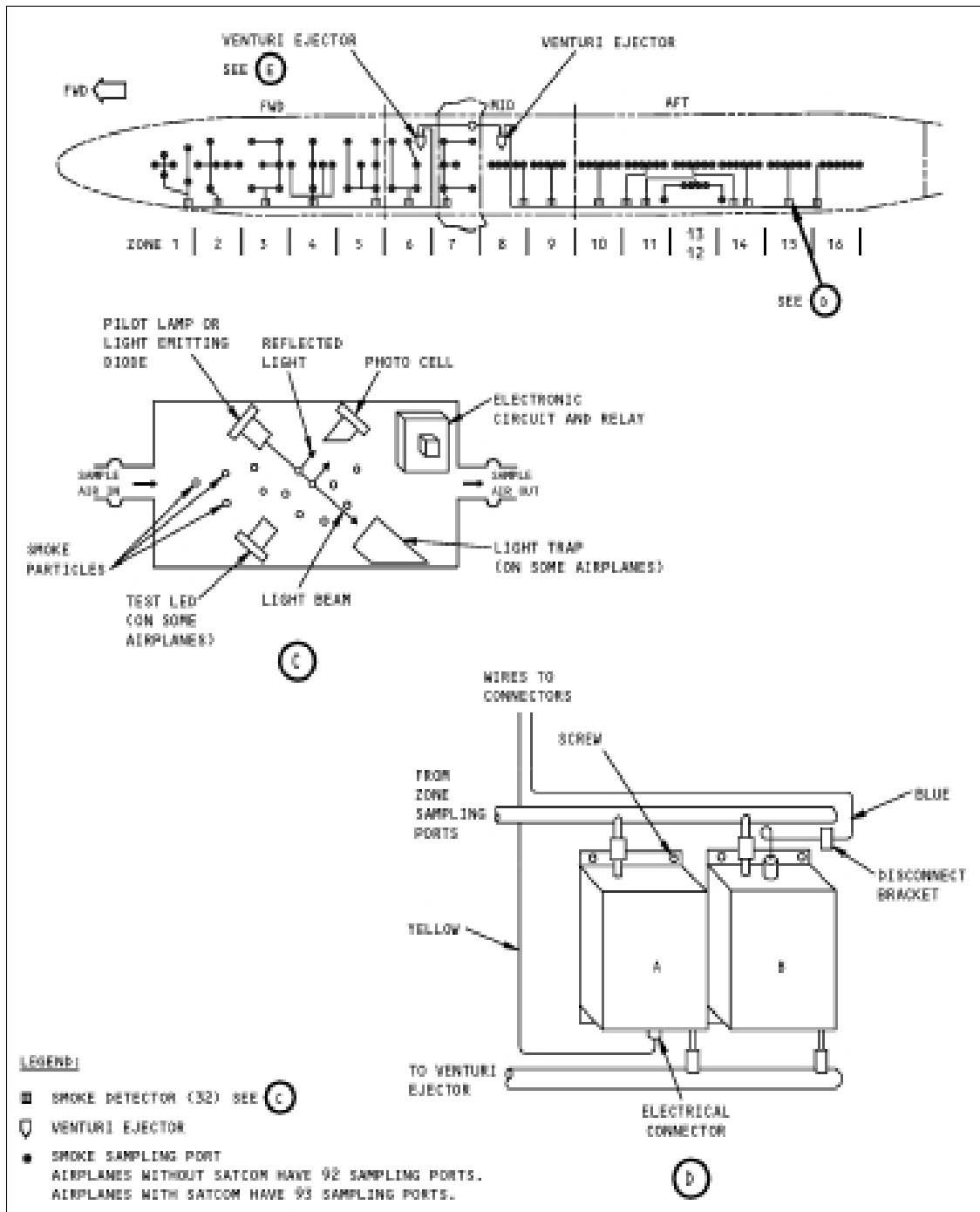
The main deck cargo compartment on a freighter are divided into a total of 16 smoke zones, each of which has two smoke detectors for a total of thirty-two as shown in [Figure 3]. The forward and aft lower cargo compartments are equipped with a total of 16 detectors. The cargo smoke detection system uses a venturi ejector pulling the sample air through the system. When the sample air containing smoke enters the smoke detector, light from a constant source is reflected onto the photocell.

This results in an increase in output voltage, and a signal is related to the flight deck. The generated signal will create master fire warning light, fire bell, warning, and advisory EICAS⁸⁾ messages.

The forward lower cargo compartment and the aft compartment have eight smoke detectors, respectively.

8) Engine-indicating and crew-alerting system (EICAS) is an integrated system to provide flight crew with aircraft engines and other systems instrumentation and warnings.

A smoke detector installed between the supply air duct and exhaust air duct detects smoke in the equipment cooling system. Air continues to flow through the detector for sampling due to the pressure differential between the ducts.



[Figure 3] Main Deck Cargo Compartment Smoke Detectors

1.6.4 Weight and Balance

According to Asiana Airlines' loading management procedures, a load master in the cargo department prepares an airplane's weight and balance data by using a computer program and provides such data to flight crew members.

The weight and balance data of the accident aircraft are as follows:

TOW	273,471 kg	MTOW	394,625 kg
ZFW	224,891 kg	MZFW	276,691 kg
LDW	258,412 kg	MLDW	302,092 kg
Takeoff Fuel		48,534 kg	
Trip Fuel		15,059 kg	
Cargo Weight		65,937 kg	

The permissible range of the C.G.(center of gravity) in accordance with a flight manual, the operating range of C.G. in accordance with company rules, and the C.G. in accordance with a flight plan are shown in [Table 14].

(Unit: C.G. % MAC)

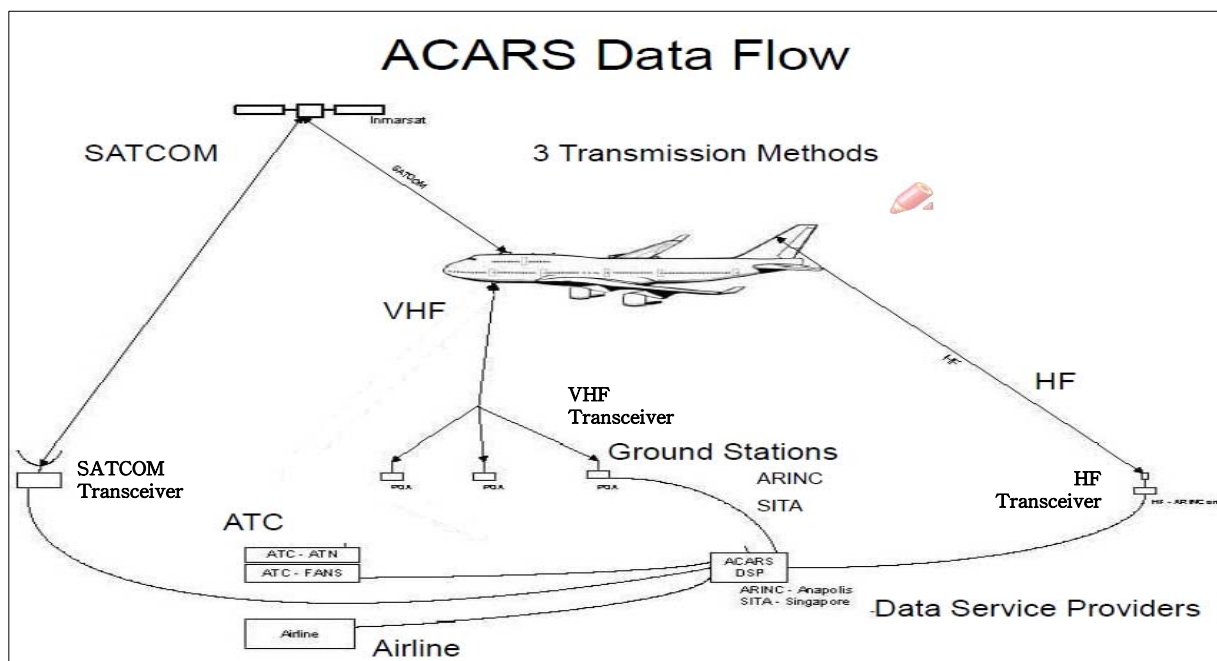
Category	ZFW		TOW	
	Fore	Aft	Fore	Aft
Flight Manual's Permissible Range of C.G.	16	33	11	33
Company's Operating Range of C.G.	16.1	32.2	16.1	32.2
Flight Plan's C.G.	27.31		25.98	

[Table 14] Weight & Balance Data

1.6.5 ACARS System

1.6.5.1. Summary

The Aircraft Communications Addressing and Reporting System (ACARS) is a digital data-link system that provides data communication between an airplane and ground stations by using radio or satellite communications as shown in [Figure 4].



[Figure 4] ACARS

The ACARS messages consist of data that is transmitted automatically and data sent at the request of the crew. Data transmitted automatically is as follows:

- 1) Out, Off, On, In Times: Out event (departure from the gate with all doors closed and parking brake released); Off event (take off with the nose gear squat switch extended); On event (touchdown with the nose gear squat switch compressed); and In event (parked at the gate with the parking brake set and the door open).

- 2) Fault Codes from the Central Maintenance Computer (CMC): Those related to the Engine Indicating Crew Alert System (EICAS) message
- 3) Severe Turbulence and Takeoff Reports: Aircraft Condition Monitoring System (ACMS)
- 4) Aircraft Position: The Flight Management Computer (FMC) requests for flight data updates

Other messages sent at the request of the crew are as follows: Estimated Time of Arrival (ETA); crew identity and payroll⁹⁾ information; flight number; departure and arrival airports; fuel on board; and general text messages. Data requested by the ground is engine reports from the ACMS and FMC database information.

The ACARS communicates through either SATCOM or VHF-C. The VHF-C transceiver can also be used for voice transmission when ACARS is switched from the data mode to the voice mode. Two main components of the ACARS are the Management Unit (MU) interfacing with many other systems to collect and distribute data and the Control Display Units (CDUs) interfacing with the MU. The MU is powered by the No. 2 115v AC bus and the No. 2 28v DC hot battery bus.

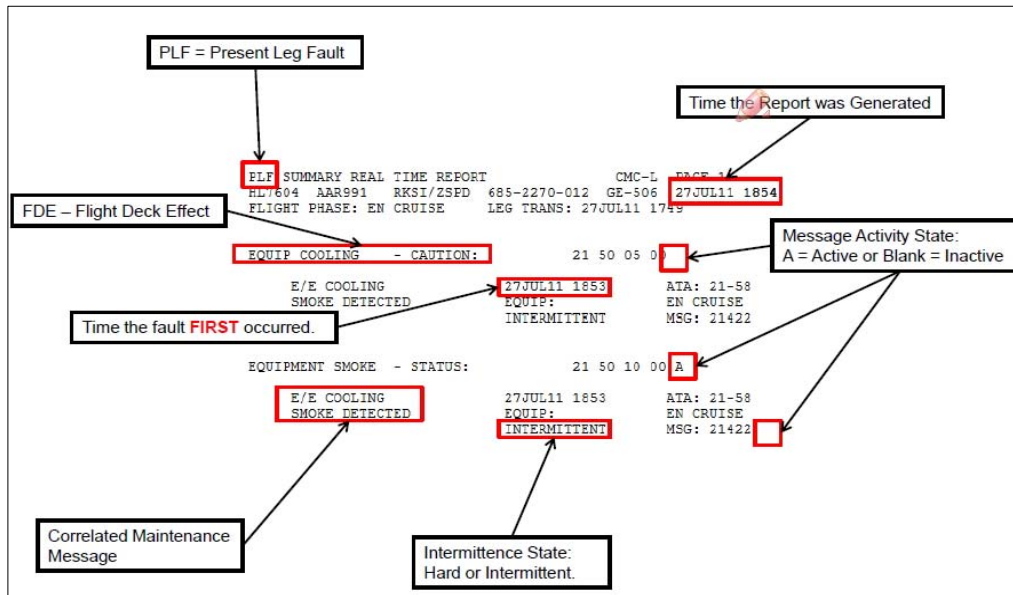
The ACARS Present Leg Fault (PLF) reports are different from the FDR data, and they have the following characteristics:

- 1) The PLF reports are used as a maintenance tool, and their format can be determined by an airlines.
- 2) Uncertainty of Message Time: The PLF messages are processed per minute, and thus, sequencing messages per second is not supported. The CMC turns the messages into the Flight Deck Effect (FDE) data

9) The messages of Asiana Airlines do not include payroll information.

every 90 seconds. The time displayed in relation to a certain fault is not the time when the fault occurred. A PLF summary report is interpreted as shown in [Figure 5].

- 3) ACARS messages, unlike the FDR data that is stored at a regular interval, are discontinuous snapshot data generated only when certain conditions are met through the system logic. That is, out of fault data generated from an airplane, only the data subject to certain conditions is converted into messages.



[Figure 5] PLF Reports Interpretation

1.6.5.2. ACARS Messages

ACARS messages received from AAR991 include the following: aircraft position data; turbulence data; and the FDE data. Data on aircraft positions, turbulences, and the FDE is shown in [Table 15], [Table 16], and [Table 3] in Section 1.1.2, respectively.

Order	Time in GMT	Latitude	Longitude
1	03:07:58	N37.213	E126.369
2	03:14:26	N36.439	E126.369
3	03:17:27	N36.237	E126.345
4	03:21:27	N35.556	E126.312
5	03:24:20	N35.330	E126.285
6	03:26:38	N35.153	E126.264
7	03:53:49	N31.533	E124.588
8	03:56:58	N31.514	E124.229

[Table 15] Aircraft Positions

Turbulence data is generated when the aircraft vertical acceleration G is more than 1.3 G or less than 0.7 G at more than 50 ft radio altitude from takeoff until landing. For the data, a change in acceleration G is measured based on the data generated about 20 seconds ago. When any data is transmitted, the data about 20 seconds ago is also transmitted together.

As shown in [Table 16], turbulence data was transmitted five times in total. The data was transmitted once at 03:05:09 during takeoff when the aircraft ascended to 120 ft for 20 seconds and then, four times during cruising.

After the pilots reported a fire to SHI ACC at 03:54:23, the aircraft descended by 10,034 ft for two minutes and 26 seconds between 03:57:03, second data transmission time, and 03:59:29, fourth data transmission time. The average descent rate per minute was 4,526 fpm.

Flight Leg	Data Transmission Time	Time GMT	Altitude (ft)	Speed (kt)	G	Heading	Pitch	Roll	Descent Rate Per Minute
Takeoff	03:05:09	03:04:49	211	97	1.03	152	0	0	
		03:05:09	331	172	1.32	152	14	-1	360
Cruising ¹⁰⁾	03:57:23	03:57:03	23,478	337	1.04	300	0	10	
		03:57:23	22,333	336	1.35	312	-2	18	435
Cruising	03:57:43	03:57:23	22,333	336	1.35	312	-2	18	
		03:57:43	20,697	345	1.32	328	-5	34	2,454
Cruising	03:58:47	03:58:25	17,690	348	0.91	345	-4	15	4,295
		03:58:47	15,490	363	1.33	011	-5	32	6,000
Cruising	03:59:29	03:59:09	14,045	358	1.13	022	0	5	3,940
		03:59:29	13,294	351	0.66	026	-3	5	2,253

[Table 16] Turbulences

At 03:59, the ACARS message that the Emergency Locator Transmitter (ELT) was on¹¹⁾ was transmitted.

1.7 Meteorological Information

1.7.1 Precipitation of Incheon Airport

Data on precipitation of Incheon Airport in the 27 hours before AAR991's departure¹²⁾ are shown in [Table 17].

Unit: mm

Time Date	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
27	5.0	1.0	-	-	0.5	3.0	22.5	0.0	8.5	22.0	56.5	9.0	-	-	-	-	-	13.5	22.0	0.0	0.0	2.5	2.0	0.0
28	0.5	0.0	0.0	0.0	Not Applicable (Takeoff from Incheon Airport about 03:05)																			

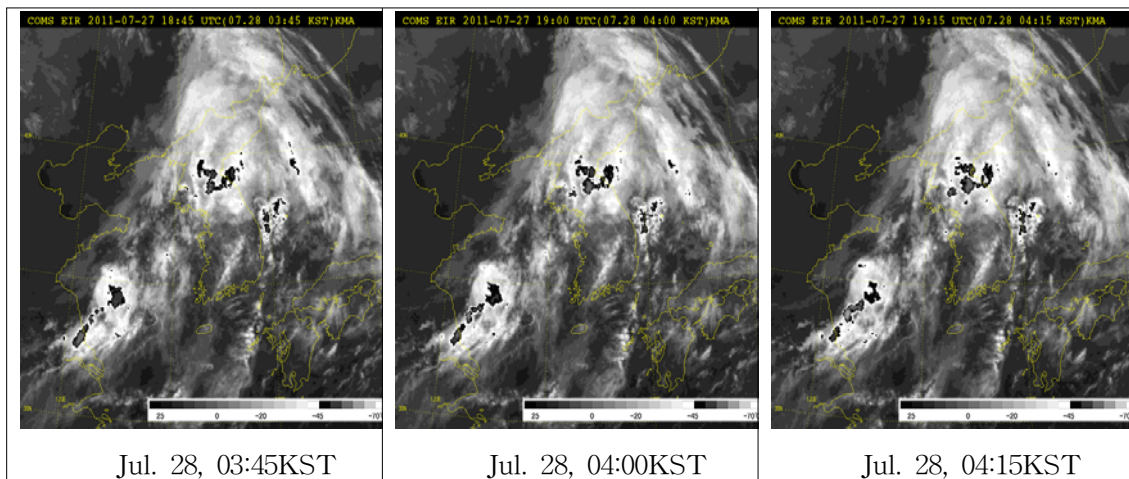
- : No precipitation, 0.0: There is precipitation, but less than measurable unit.

[Table 17] Precipitation of Incheon Airport in the 27 Hours

- 10) Cruising is one stage in the flight plan and does not reflect a real situation where the aircraft made an emergency descent.
- 11) Activation Mode: Automatically activated by impact forces of more than 5G, manually activated by the Remote Control Switch in the cockpit, or manually activated by the Master Switch on the ELT. The ELT is inoperable in the water.
- 12) Data from the Korea Aviation Meteorological Agency in Incheon Airport, and the unit of precipitation is mm.

1.7.2 Area Weather Conditions

Weather observations made by a meteorological satellite surrounding the time of the accident are shown in [Figure 6]. The exact altitude of cloud is difficult to identify, but the weather conditions over Jeju Island and the accident site indicated that a southwest current of air and a westerly current of air flowed in at the middle and upper levels, respectively. Also, there were no convective cloud¹³⁾ or other unusual weather phenomena.

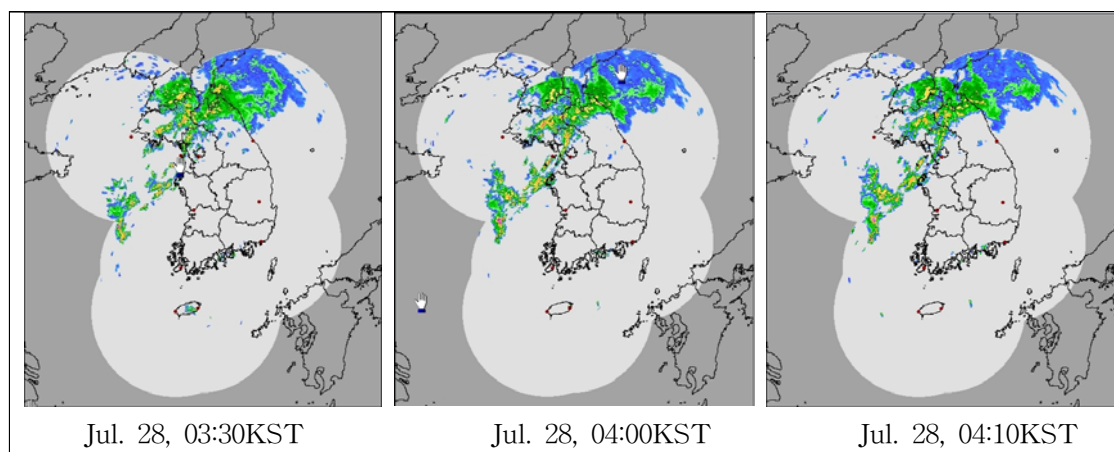


[Figure 6] Weather Observations Made by a Meteorological Satellite

Weather observations made by a weather radar¹⁴⁾ surrounding the time of the accident are shown in [Figure 7], and there was no cloud with rain over Jeju Island and the accident site.

13) A cloud with heavy rain, turbulence, and hail

14) 10 nationwide radars with a surveillance radius of 250 km



[Figure 7] Weather Observations Made by a Weather Radar

At the time of the accident, two airplanes operated by China Eastern Airline and Asiana Airlines were flying at 33,000 ft on airway A593 and at 37,000 ft on airway B576, respectively. The pilots of the two airplanes stated that over the accident site, there was no turbulence or cloud with rain and that there were a weak wind and a clear sky.

1.7.3 Weather Conditions of Incheon and Jeju Airports

A METAR weather report filed when AAR991 took off from Incheon Airport is as follows:

“METAR RKSI 271800Z 20020KT 9999 FEW010 BKN018 OVC080 26/22 Q1007 TEMPO -RA=” (South-southwest surface wind at 20 kt, Visibility 10 km, Overcast at a middle level, Temperature 26°C, Pressure 1007 mb)

A METAR weather report of Jeju Airport that was designated as an emergency landing airport by AAR991 after a cargo fire is as follows:

“METAR RKPC 271900Z 21009KT 150V300 9999 SCT030 BKN180 29/21 Q1010 NOSIG =” (South-southwest surface wind at 9 kt, Variable

from southeast to northwest, Visibility 10 km, Broken at an upper level, Temperature 29°C, Pressure 1010 mb)

Upper wind¹⁵⁾ over Jeju Island (Observatory location: 33.28°N 126.16°E) is shown in [Table 18].

Observation Time	4,000 ft (agl)	6,000 ft (agl)	10,000 ft (agl)
Jul. 27, 21:00	195° at 30 kt	195° at 28 kt	210° at 25 kt
Jul. 28, 09:00	205° at 28 kt	206° at 26 kt	210° at 22 kt

[Table 18] Upper Wind Data

1.8 Aids to Navigation

1.8.1 Radar System

The radar system of ICN ACC was in normal operation until AAR991 took off from Incheon Airport and crashed, and the flight track of AAR991 recorded in the system was separately compiled.

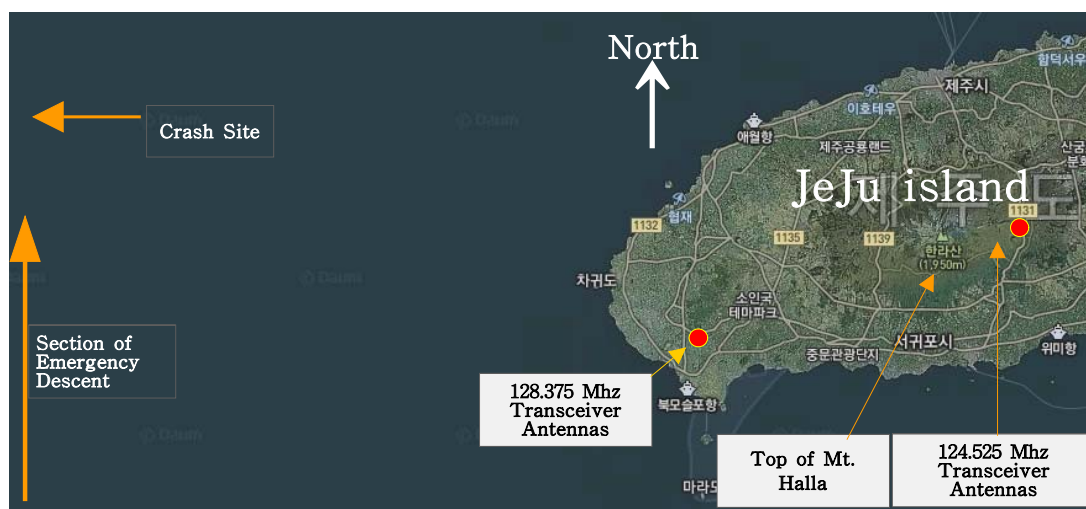
1.8.2 Air Traffic Control Communications Facilities

Transceiver antennas operating at 124.525 Mhz and 128.375 Mhz, two of the frequencies used by ICN ACC, are located in Seongpanac and Moseulpo on Jeju Island as shown in [Figure 8]. The 124.525 Mhz frequency antennas, 10 m tall, are erected on the floor 850 m above sea level, thereby rising 860 m above sea level.

The top of Mt. Halla, 1,950 m above sea level, is located west of the 124.525 Mhz transceiver antennas, whereas there are no geographical

¹⁵⁾ Upper wind is observed every 12 hours. It was used to calculate the crash position from the last flight track of AAR991 (altitude).

obstacles west of the 128.375 Mhz transceiver antennas.



[Figure 8] 124.525 & 128.375 Mhz Transceiver Antennas

1.9 Communications

1.9.1. Radio Communications between the Aircraft and ATCs

At 03:12:35, AAR991 had an initial contact with ICN ACC when the aircraft was flying at an altitude of 18,000 ft after its takeoff from Incheon Airport. At 03:51:08, ICN ACC transferred the flight to SHI ACC when the aircraft was flying at a cruising altitude of 34,000 ft. So far, there was no communication problem or irregularity during AAR991's communication with ICN ACC at a frequency of 124.525 Mhz.

Voice communications between AAR991 and ATCs were separately transcribed.

1.9.2 Direct Line Communications between ATCs

After AAR991 declared an emergency about 03:54, three ACCs exchanged its flight information¹⁶⁾ via direct telephone line in order for SHI ACC to transfer the control to ICN ACC and HUK ACC, and the

following is the main content of their communications:

- At 04:00:01, HUK ACC requested SHI ACC to "transfer the control to ICN ACC at 124.525 Mhz."
- At 04:01:35, SHI ACC notified HUK ACC that "altitude was too low¹⁷⁾ to contact at 124.525 Mhz."
- At 04:01:48, HUK ACC requested SHI ACC to "transfer the control to HUK ACC at 133.6 Mhz."
- At 04:03:14, HUK ACC requested ICN ACC to "give an alternative frequency because communications were not available at 124.525 Mhz."
- At 04:03:17, SHI ACC notified HUK ACC that "altitude was too low to contact at 133.6 Mhz, either."
- At 04:03:18, ICN ACC notified HUK ACC that "SHI ACC was requested to use an alternative frequency, 128.37 Mhz to transfer the control."
- At 04:03:42, HUK ACC requested SHI ACC to "transfer the control to ICN ACC at 128.37 Mhz."

* Even though SHI ACC was notified by HUK ACC of ICN ACC's frequency 128.375 Mhz, however, SHI ACC failed to instruct AAR991 to change its frequency as such.

16) Flight Data: flight number, transponder code, aircraft position and altitude, ATC frequency, emergency situations, etc.

17) About 8,500 ft according to ICN ACC radar data.

1.10 Aerodrome Information

Jeju Airport designated as an emergency landing airport by AAR991 is operable 24/7, and equipped with airport facilities¹⁸⁾ that help B747-400 airplanes take off, land, and park.

At 04:00:04, ICN ACC notified JEJ APP in Jeju Airport via direct line that AAR991 would land in Jeju Airport due to an emergency. Accordingly, Jeju Airport prepared for AAR991's emergency landing.

1.11 Flight Recorders

1.11.1 FDR and CVR

The same types of FDR and CVR installed in the accident aircraft are shown in [Figure 9] and [Figure 10], respectively.



[Figure 9] FDR



[Figure 10] CVR

- Flight Data Recorder (FDR)
 - Manufacturer: Honeywell
 - Type: Solid State FDR (SSFDR)
 - Part No.: 980-4700-042

¹⁸⁾ Airport facilities consist of basic and support facilities.

Serial No.: SSFDR-09943

Weight & Electricity Consumption: 6.8 Kg/15 W, 115 VAC 400 Hz

Impact Shock: 3,400 G for 6.5 ms

Fire Temperature: Max. 1,100 degrees (30 min)

Deep Sea Pressure and Sea Water Immersion: 20,000 ft (30 days)

○ Cockpit Voice Recorder (CVR)

Manufacturer: Honeywell

Type: Solid State CVR (SSCVR)

Part No.: 980-6022-001

Serial No.: CVR120-07910

Weight & Electricity Consumption: 5.9 Kg/8 W, 115 VAC 400 Hz

Impact Shock: 3,400 G for 6.5 ms

Fire Temperature: Max. 1,100 degrees (30 min)

Deep Sea Pressure & Sea Water Immersion: 20,000 ft (30 days)

1.11.2 Underwater Locator Beacon

An underwater Locator Beacon (ULB) emits an ultrasonic pulse of 37.5 KHz at an interval of 0.9 times per second in all quadrants for at least one month when triggered by water immersion, and is fitted to FDR and CVR, respectively. The ULB (model: DK-120) manufactured by Dukane Seacom, Inc. was fitted to the accident aircraft. Lithium batteries that have a shelf life of six years were fitted to FDR and CVR on December 11, 2009 and February 22, 2006, respectively, and have never been replaced since then. Batteries are operable at a temperature range between -2.2°C and 37.8°C.

1.11.3 Search Operations for Flight Recorders

Since notified of AAR991's accident, the ARAIB had conducted search operations in four phases to locate the crash site and search flight recorders.

Despite the operations, no ULB signals enabling the estimation of the flight recorders' position were detected.

The first-phase search operation was conducted from July 28 until August 4, and the summary of the operation is as follows:

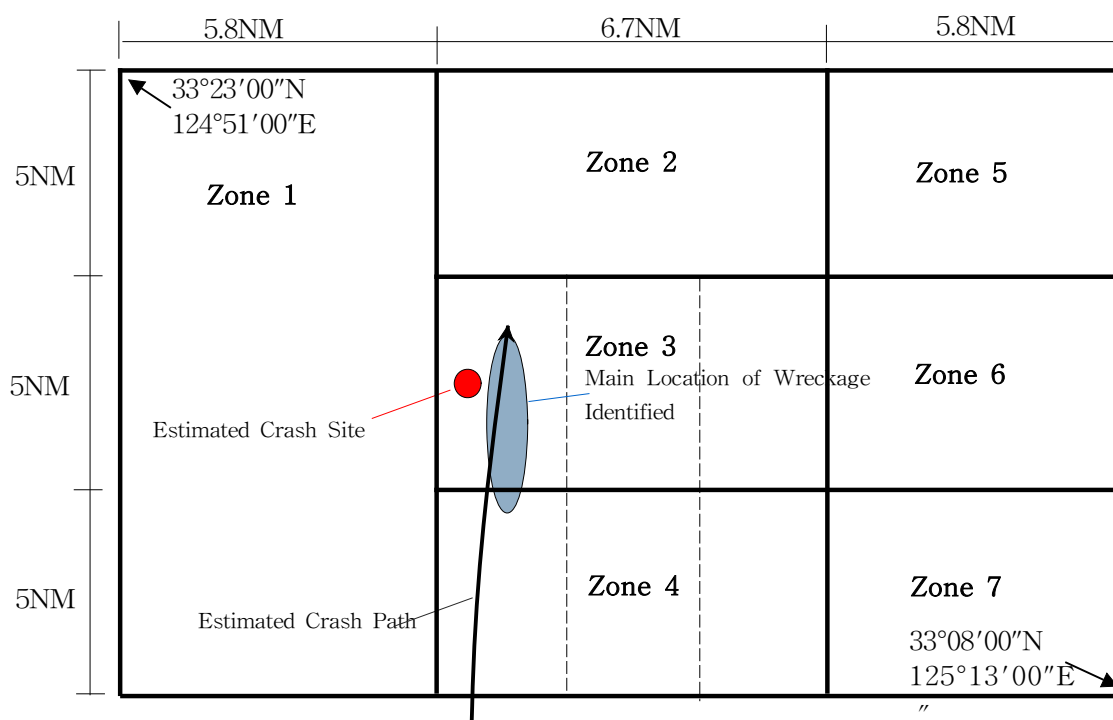
- Participants
 - ARAIB: 1 person (investigator specializing in flight recorders)
 - Coast Guard: 2 persons (search support)
 - Navy: 5 persons (search support)
 - Asiana Airlines: 1 person (search support)

- Search Equipment
 - Portable Pinger Receiver¹⁹⁾: 1 set (ARAIB)
 - Pinger Location Sonar: 1 set (fitted to the Navy vessel)

- Search Area and Operation

The vessels of the Navy and the Coast Guard searched for wreckage by dividing the area into seven zones as shown in [Figure 11]. For the flight recorders, the naval vessels searched Zones 3 and 4 at intervals of 2 km (radius: 1 km), and for the wreckage, the naval boats searched Zones 1, 2, 5, 6, and 7 at random intervals.

19) Device to detect a signal of the ULB fitted to FDR and CVR.



[Figure 11] First-Phase Search Area for Wreckage and Flight Recorders

The second-phase search operation was conducted from August 10 until 14, and the summary of the operation is as follows:

○ Participants

- ARAIB: 2 persons (investigators specializing in ATC & flight recorders)
- Coast Guard: all crew aboard the Coast Guard ship (search support)
- Singapore AAIB: 2 persons (participation in search)
- Asiana Airlines: 6 persons (participation in search)

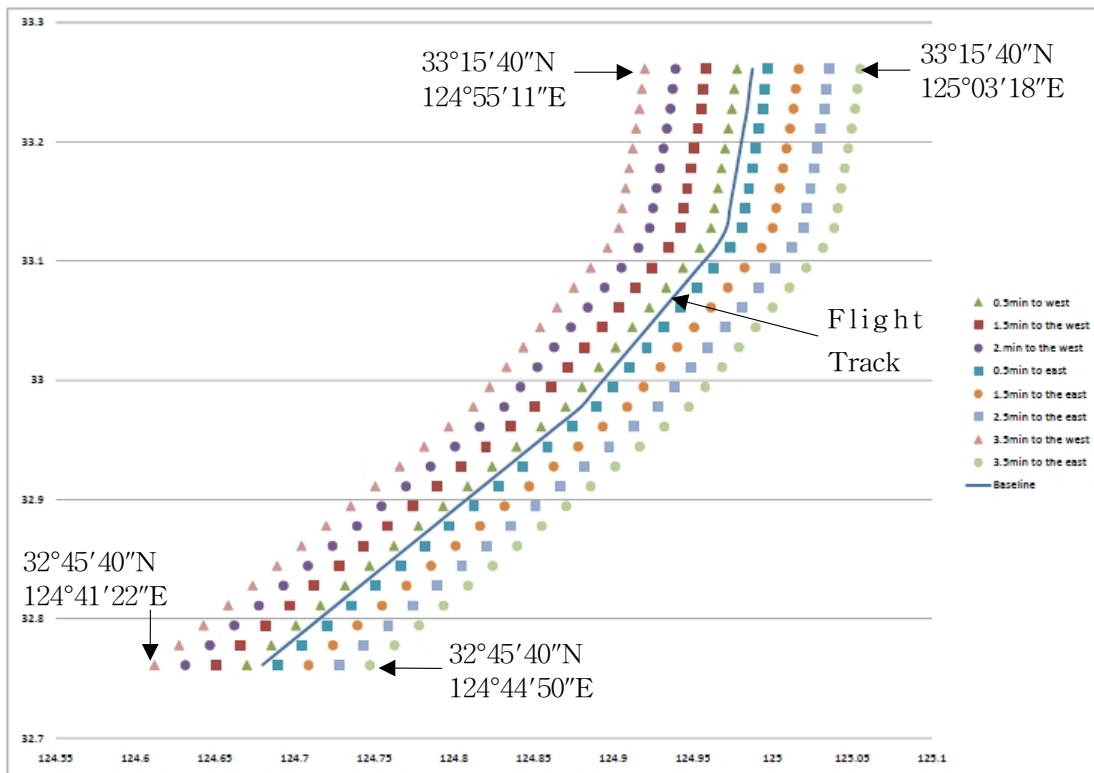
○ Search Equipment

- Portable Pinger Receiver: 5 sets (ARAIB: 1/Benthos 275, AAIB: 2/RJE 275, ASC: 1/RJE 275, Boeing Company: 1/Dukane N30A5B)
- Coast Guard Boat: 4 boats

○ Search Area and Operation

The second-phase search area is shown in [Figure 12], and it was decided to be 14.4 km in width by 66 km in length so that the area could incorporate points between where the aircraft passed one minute before the pilot said that the rudder control was lost and where the northeastern end of the wreckage distribution area was.

On the site, pinger receivers were tested to measure their effective distance. As a result, in consideration of the shortest effective distance (1,000 m), the receivers were dropped at 256 points in the area at intervals of 1,800 m (radius: 900 m) to carry out search operations.



[Figure 12] Second-Phase Search Area for Flight Recorders

The third-phase search operation was conducted from August 16 until 20, and the summary of the operation is as follows:

○ Participants

- ARAIB: 1 person (investigator specializing in ATC)
- Coast Guard: all crew aboard the Coast Guard ship (search support)
- Taiwan ASC: 1 person (participation in search)
- Asiana Airlines: 3 persons (participation in search)

○ Search Equipment

- Portable Pinger Receiver: 3 sets (ARAIB: 1/Benthos 275, ASC: 1/RJE 275, Boeing Company: 1/Dukane N30A5B)
- Coast Guard Boat: 3 boats

○ Search Area and Operation

The third-phase search area is shown in [Figure 13], and it was decided to cover the area from the whole wreckage distribution area located by a side scan sonar to the point where AAR991 had the last communication. The area was more closely searched at 127 points at intervals of 500 m (radius: 250 m) than in the second-phase operation.



[Figure 13] Third-Phase Search Area for Flight Recorders

The fourth-phase search operation was conducted from August 21

until 27, and the summary of the operation is as follows:

○ Participants

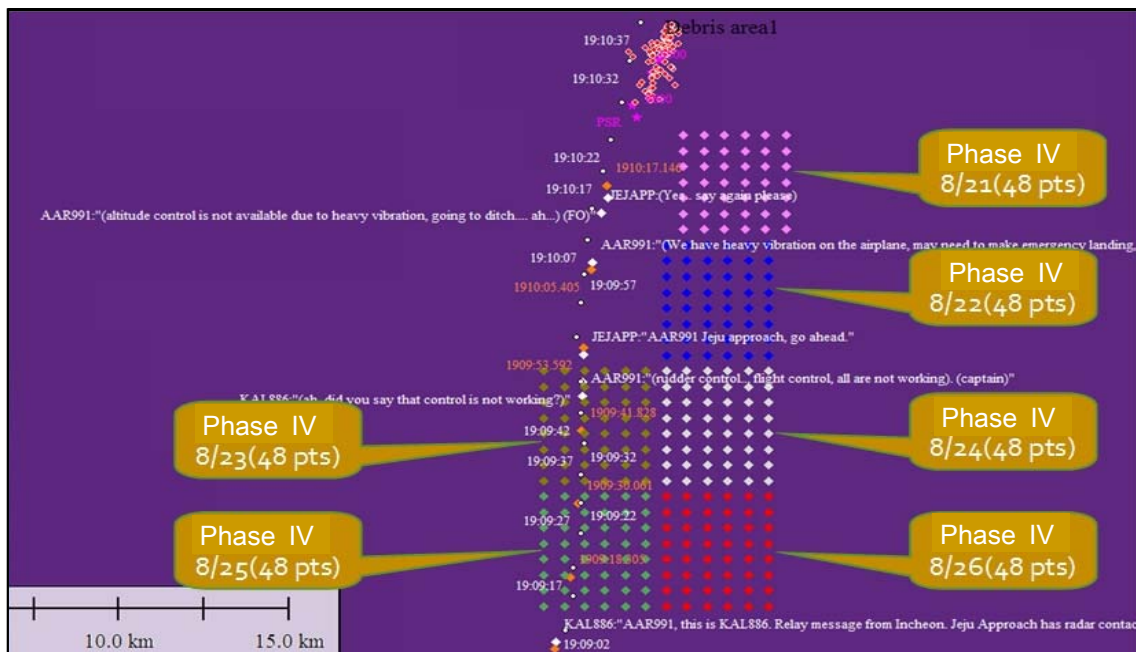
- ARAIB: 1 person (investigator specializing in flight recorders)
- Coast Guard: all crew aboard the Coast Guard ship (search support except for 1 person participating in search)
- Asiana Airlines: 4 persons (participation in search)

○ Search Equipment

- Portable Pinger Receiver: 2 sets (ARAIB: 1/Benthos 275, Boeing Company: 1/Dukane N30A5B)
- Coast Guard Boat: 2 boats

○ Search Area and Operation

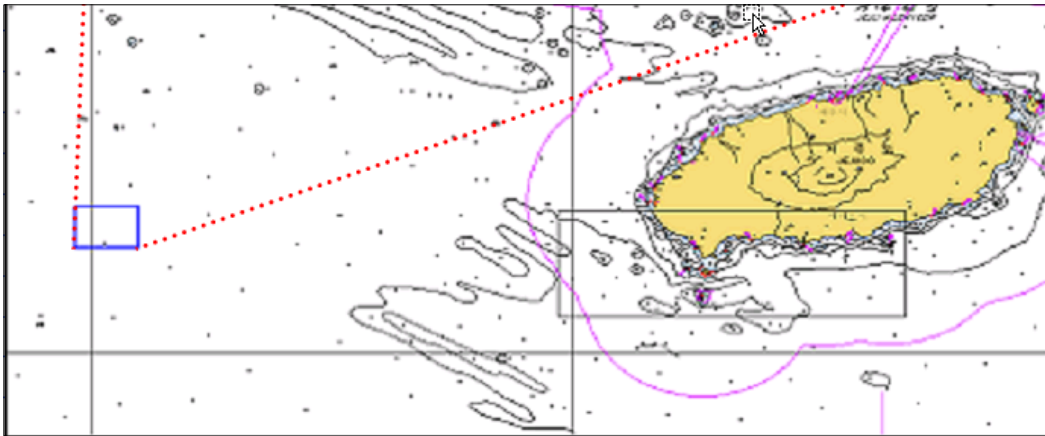
The fourth-phase search area is shown in [Figure 14], and it was decided to cover the area from the point where AAR991 was flying at 14,600 ft to the southern part of the third-phase search area. In consideration of the strong southwest wind at the time of the accident, the area along a 5km band east of the flight track was also searched.



[Figure 14] Fourth-Phase Search Area for Flight Recorders

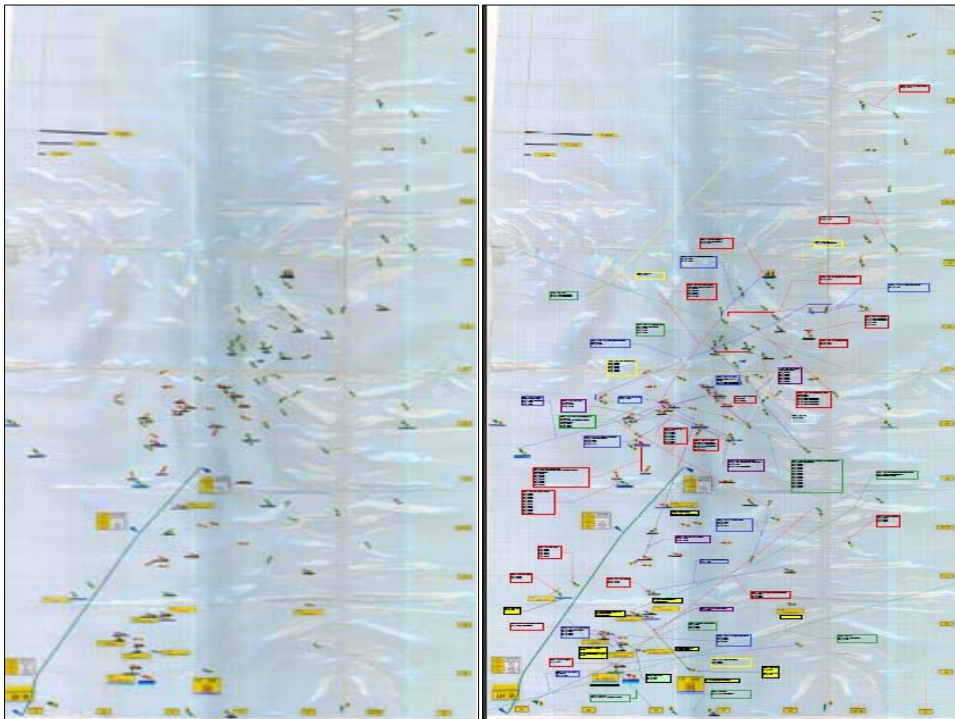
1.12 Wreckage and Impact Information

As shown in [Figure 15], the wreckage of AAR991 was found underwater in the area inside blue rectangular enclosure.



[Figure 15] Accident Site

As shown in [Figure 16], the wreckage was distributed in the area 3 km in width by 4 km in length in southwest-northeast direction.



[Figure 16] Wreckage Distribution Map

1.12.1 Accident Site

The depth of the sea at the accident site is estimated at 85 m on the west, 87 m in the middle, and 81 m on the east.

The average speed of current measured at a sea buoy and the sea floor was about 5 kt and 1 - 2 kt, respectively. The currents at the accident site flew in a northwesterly direction at high tide and in a southeasterly direction at low tide.

The sea floor consisted of mud and sand about 60 cm thick, and was generally flat. According to the data of a salvage company, the average visibility at the sea floor was about 0.5 m.

During July and August in 2011, the accident site was hit by seven typhoons²⁰).

1.12.2 Wreckage Recovery

In the morning on July 28 after the accident aircraft had disappeared from the radar, resources from the Coast Guard, the Navy, and the Air Force were dispatched²¹) to the accident site.

On July 30, the ARAIB took over the floating debris²²) that was first recovered by the Coast Guard at the accident site, and temporarily stored it at a safe area in Jeju Airport. Additional ships and airplanes²³) for

20) Typhoons that influenced the accident site from July 12, 2011 until September 5, 2011: Ma-on (2011-6); Tokage (2011-7); Nock-ten (2011-8); Muifa (2011-9); Merbok (2011-10); Nanmadol (2011-11); and Talas (2011-12).

21) Coast Guard: 5 ships (one of 3,000 t, three of 1,500 t, one of 300 t) and 4 helicopters, Navy: 1 ship and 1 helicopter, Air Force: 2 helicopters.

22) 869 pieces of debris from the aircraft and cargo.

23) 8 ships (Coast Guard: 8, Navy: 2, Korea Hydrographic and Oceanographic Administration: 1) and 3 airplanes (Coast Guard: 2, Navy: 1).

rescuing the pilots and searching for the wreckage were dispatched.

From August 1, the naval ship was dispatched and searched for the ULB signal. On August 2, using a side scan sonar, two search boats²⁴⁾ of the Japanese salvage company searched for the underwater wreckage and confirmed that the aircraft wreckage was widely distributed on the seabed.

On August 17, a salvage tug of the Japanese salvage company equipped with recovery equipment²⁵⁾ identified the empennage. On August 20, the salvage tug tried in vain to recover it but picked up the aircraft skin by using a remotely operated vehicle (ROV).

The Japanese salvage company recovered some wreckage and withdrew from the accident site on August 20.

From September 6 until 8, the Navy recovered three pieces of the aircraft skin identified by saturation divers at the site.

From September 27 until October 30, the Korean salvage company selected by Asiana Airlines following the Japanese one conducted a recovery operation by using divers and one-boat trawling.

The recovered items were moved onto a barge. On the barge, investigators from the ARAIB, staff members from Asiana Airlines, and experts from the Boeing company assigned a tag number to each item and photographed it for identification, and on November 2, they were moved to a wreckage storage facility nearby Incheon Airport.

24) Aso Maru and Hayashio Maru.

25) A remotely controlled underwater vehicle (working class ROV)

1.12.3 Wreckage Examination

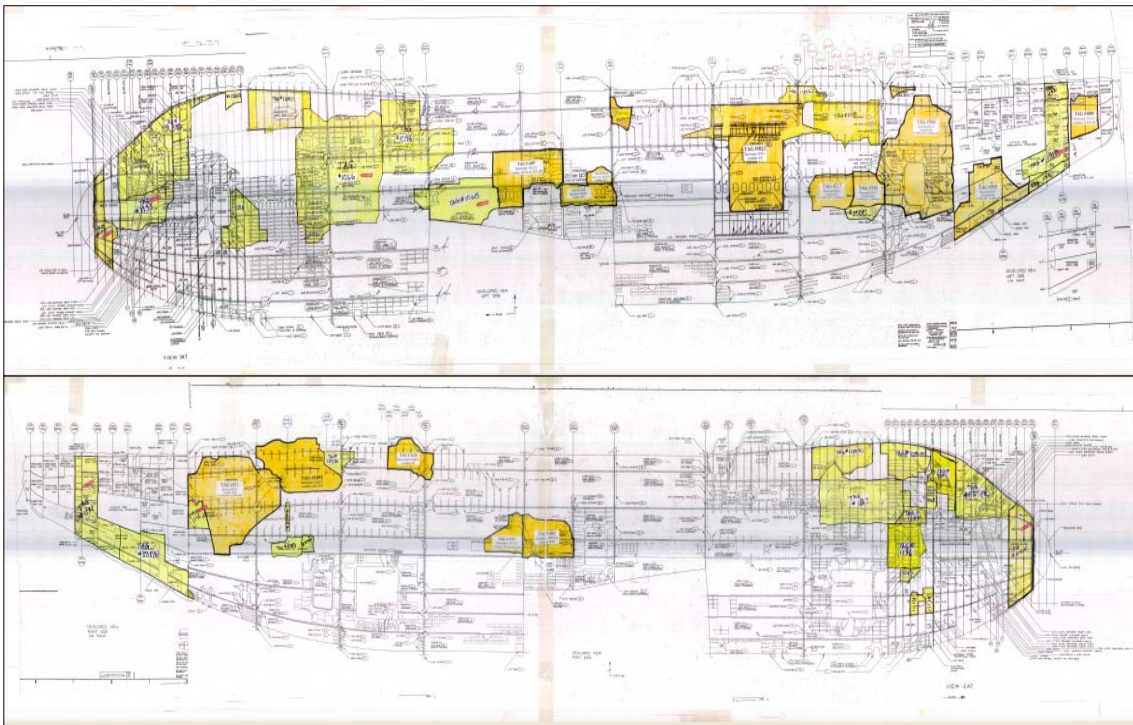
From August 1 until September 8, investigators from the NTSB, the FAA, and the Boeing Company and engineers from Asiana Airlines examined the first floating debris picked up by the Coast Guard under the supervision of the ARAIB investigators at a temporary storage facility in Jeju Airport. Identification of the debris and assessment of its impact damage, direct fire damage, sooting, etc. were carried out.

After recovered wreckage was moved to the Incheon wreckage storage facility, investigators from the ARAIB and engineers from Asiana Airlines conducted the following tasks: identifying wreckage; documenting the location of wreckage on the aircraft; assessing fire damage and sooting of wreckage; classifying cargo and assessing its fire damage; and photographing small pieces of unidentified wreckage.

From January 5 until 20, 2012, investigators from the NTSB, the FAA, and the Boeing Company visited the Incheon wreckage storage facility and conducted investigation in such areas as fuselage/structure, fire, cockpit, and cargo.

The wreckage identified by the fuselage/structure group was marked on the fuselage diagram as shown in [Figure 17], and the wreckage recovered until October 30, 2011 was tagged²⁶).

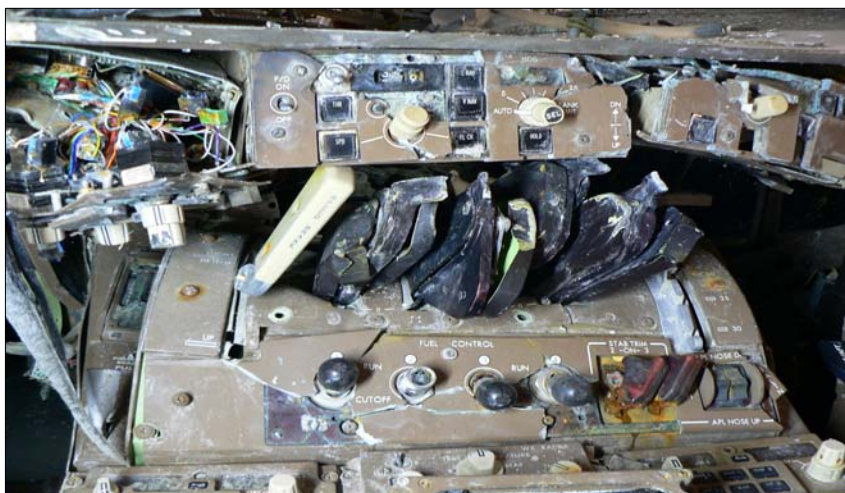
26) Tag Numbers: 1 - 173 (initial floating debris); 201 - 225 (wreckage recovered by the Nippon Salvage Co., Ltd.); 504 - 511 (wreckage recovered by the Navy); 1001 - 1153 (wreckage recovered by KT Submarine); and 2000 - 3999 (wreckage tagged by the US investigation team).



[Figure 17] Wreckage Marked on the Fuselage Diagram

As shown in [Figure 18], the positions of switches and the condition of annunciator lights, circuit breakers, and various parts were examined.

Some of cockpit instruments were removed and under magnification, filaments of light bulbs were examined in order to identify whether annunciator lights had been hot at the time of impact.



[Figure 18] Forward of the Cockpit (Throttle Quadrant and Mode Control Panel)

The overall cockpit section was extensively pressure formed and was crushed flat.

Fuel cutoff switches #3 and #4 were found with the toggle in the OFF position, but under magnification, it was confirmed that they were OFF due to impact forces.

Light bulb filaments of annunciator lights removed from the cockpit were examined. As a result, some annunciator lights with deformed filaments were identified, but it was confirmed that they were not related to the accident.

As shown in [Figure 19], the cockpit smoke evacuation shutter was found closed, but a well defined soot trail was discovered on the exterior skin (tag # 1128). As a result of an examination, it was assumed that impact forces closed the shutter.



[Figure 19] Exterior Skin of the Cockpit Smoke Evacuation Shutter

Out of the wreckage recovered until October 30, 2011, sections between fuselage station (hereinafter referred to as "FS") 1400 and FS2400 contained

direct fire damage. Upper fuselage Skins and frames forward of FS1400 were also found to be partly sooted.

There were blue dye splatters on the surfaces of the right inboard spoiler and the right wing tip upper surface. Also, there were a lot of blue and red dye splatters on the floor of the main cargo deck and on the upper section of the left main deck cargo door.

Some of the control cables were found twisted and rolled by extreme tensile forces.

Wing and Empennage surfaces out of the wreckage recovered so far are the left and right winglet, right wing tip, the right inboard spoiler and the left horizontal stabilizer with outboard elevator still attached.

As shown in [Figure 20], the right wing tip was separated from the wing at wing station (hereinafter referred to as "WS") 1500. Blue dye splatters were found on the top surface of the wing, and multiple small electrical components with a diameter of 5 mm were imbedded in the composite wing upper surfaces.

The top and bottom surface of the wing contained multiple black waffle-like markings caused by collisions with electrical components containers as well as sporadic blue dye splatters.



[Figure 20] Damage to the Right Wing

The forward facing surface of the fuel jettison tube as well as the inside surface of a skin fragment in the right wing fracture at WS1516 also contained black waffle-life markings. No indications of hydro forming were found on the top and bottom surface of the wing.

The winglet was separated from the right wing. Blue dye was discovered inside the wingtip at the point where the winglet was fractured from the wing as well as on the upper surface of the right wing. No blue dye was found on the recovered right or left winglet.

As shown in [Figure 21], the left horizontal stabilizer was separated from the empennage. The remaining skin fragments along the upper and lower fracture areas were bent upwards.

The skin on the top side of the fracture zone contained areas of compressive buckling tearing.



[Figure 21] Left Horizontal Stabilizer

The honeycomb panels along the trailing edge of both the top and bottom surface of the stabilizer were slightly hydro formed, and honeycomb panels along the bottom side were intact, whereas four panels along the top side were not present.

The inboard elevator was separated from the stabilizer just aft of the hinge, and the trailing edge of the outboard elevator was damaged. The outboard tip (tag #1069) of the stabilizer was fractured at station 510 and was recovered separately from the stabilizer (tag #1056).

As shown in [Figure 22], a forward section of the nose cargo door was separated from the fuselage at FS160/180, and the radome was missing.

The skin of the nose cargo door without the radome demonstrate compressive buckling 360 degrees along the leading edge. The forward pressure bulkhead was hydro formed. Upper portions of both sides of

the door, including the hinges, were recovered with the cockpit section (tag #1151).



[Figure 22] Nose Cargo Door

As shown in [Figure 23], the flight data recorder rack mounted close to the L5 door was separated. The upper portion of the frame was thermally damaged, and the interior surface of the L5 door was heavily sooted.



[Figure 23] Exterior and Interior Side of the L5 Door

As shown in [Figure 24], portions of the wreckage above the floor in

the region between FS1740 and FS2360 contained thermal damage on the exterior skin as evidenced by discoloration of the exterior paint and internal metal structure. The recovered skin panel that extended from FS2180 to FS2360 (tag #511) was representative of this level of thermal damage and also contained areas where the skin had been burned through.



[Figure 24] Fire Damage to the Skin

As shown in [Figure 25], the inner insulation materials of the main deck cargo door aft of the left fuselage was burned, and some cargo items melt and charred stuck to the interior surface of the wreckage. The frame and cargo items were melt and stuck to the upper side of the door hinge.



[Figure 25] Interior and Exterior Side of the Main Deck Cargo Door

As shown in [Figure 26], the section 48 of the aft fuselage contained no internal sooting or fire damage but did have external soot accumulation on the underside of the left and right skin panels. Most of the damage appeared to have been caused by impact forces during the crash into the sea.



[Figure 26] Damage to the Section 48 of the Aft Fuselage

1.13 Medical and Pathological Information

According to the autopsy report, the captain's cause of death was multiple rib fractures and rupture of multiple organs (heart, lungs, and liver) by external traumatic forces formed in the upper right chest, and no medications, toxic agents or alcohol components were detected.

The first officer's cause of death was multiple rib fractures and lung rupture by external traumatic forces formed in the chest, and no medications, toxic agents or alcohol components were detected.

1.14 Fire

1.14.1 Summary

Portions of the wreckage contained fire damage including sooting. The wreckage has sustained severe damage from FS1700 to the aft pressure bulkhead, and sooting trails caused by smoke were found on the exterior of the flight deck's skin.

The Fire Group examined the recovered wreckage and cargo at a storage facility at Incheon Airport. Portions of the wreckage containing the majority of the obvious fire damage from approximately FS1700 to the aft pressure bulkhead were stored in an indoor storage facility. The indoor storage facility is an area enclosed by a temporary tent to examine the wreckage with fire damage. This tent was torn down after the examination. The remaining large portions of the wreckage at the aft and forward of FS1700 as well as the smaller portions of the wreckage were laid out outdoors.

A tag number was assigned to each piece of the wreckage. All the

investigative groups used the same tag numbers to log and locate the parts on the aircraft structure.

For the examination of the wreckage, a numbering convention was used to grade the level of fire damage sustained. This convention was as follows:

#0 Damage (no evidence of sooting or thermal damage)

#1 Damage (soot evidence)

#2 Damage (minor charring and/or paint discoloration from heat)

#3 Damage (heavy charring and/or incipient melting)

#4 Damage (melted/consumed)

1.14.2 Fire Damage to Interior of the Airframe

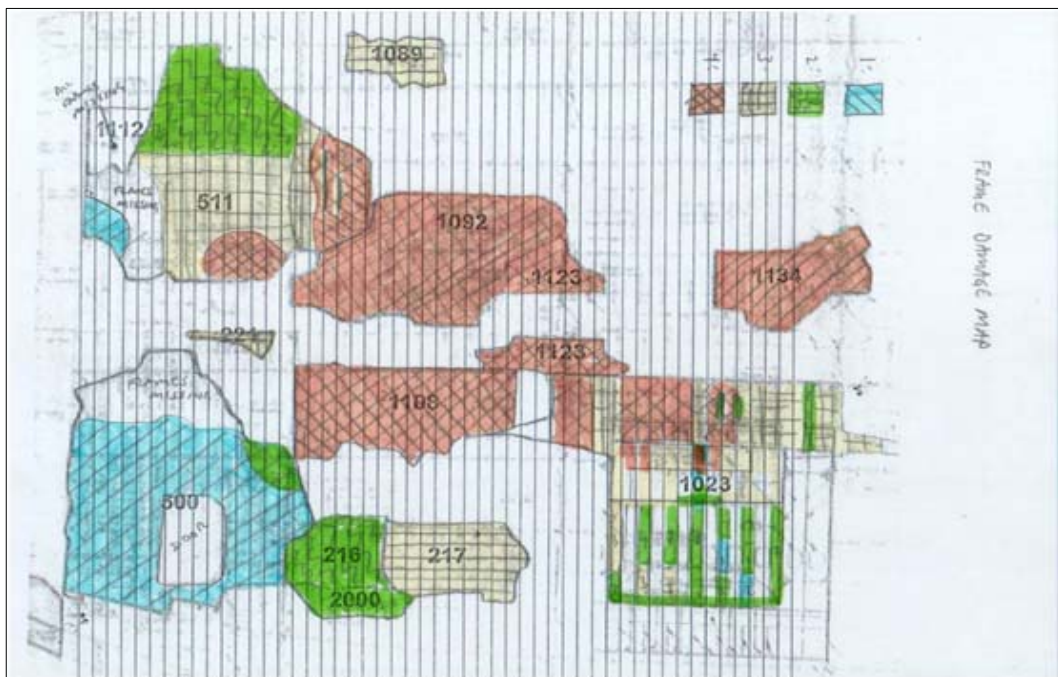
1.14.2.1 Wreckage between FS1700 and Aft Pressure Bulkhead

The wreckage from this area have the most fire damage of all the wreckage collected to date. Detailed thermal damage maps were generated for these portions of the aircraft. These portions included tag numbers 1089, 1112, 511, 1092, 1123, 1134, 221, 1108, 500, 216, 217, 2000, and 1023. They were mostly between the aft main deck cargo door and the L5 door as shown in [Figure 28]. This area can be characterized overall as having been exposed to the highest temperatures as evidenced by severe thermal damage on the interior structure and discoloration of the paint on the exterior of the aircraft's skin.

The aft main deck cargo door sustaining fire damage is shown in [Figure 27], and the thermal damage map for the wreckage with severe fire damage is shown in [Figure 28].



[Figure 27] Aft Main Deck Cargo Door



Numbering Convention: #1 (Blue), #2 (Green), #3 (Gray), #4 (Red)

[Figure 28] Airframe Thermal Damage Map

1.14.2.2 Wreckage Forward of FS1700 and Aft of Aft Pressure Bulkhead

The aft pressure bulkhead was partially recovered in multiple pieces. They had sustained thermal damage originating on the side facing the interior of the main cargo deck.

Portions of the aft pressure bulkhead showing the side facing the main cargo deck is shown in [Figure 29]. As shown in [Figure 30], portions of the wreckage aft of the pressure bulkhead did not have evidence of fire damage.



[Figure 29] Aft Pressure Bulkhead Showing Side Facing Main Cargo Deck



[Figure 30] Wreckage behind Aft Pressure Bulkhead

As shown in [Figure 31], on the exterior of the skin panels on the right and left side of the wreckage aft of the pressure bulkhead were soot trails (marked as arrow) caused by smoke exiting the outflow valves.



[Figure 31] Soot Trails from Outflow Valves

As shown in [Figure 32], portions of the wreckage forward of FS1700 generally had fire damage consisting of sooting with areas of more severe damage along the upper areas of the aircraft's crown²⁷). Evidence of sooting was found all the way forward in the main cargo deck on the bottom face of the ceiling liners under the flight deck.



[Figure 32] Wreckage forward of FS1700

27) crown: cabin behind the occupied area and or above the ceiling liners but inside the pressure vessel

1.14.2.3 Small Miscellaneous Portions of Wreckage

Many pieces of the wreckage of yet undetermined location within the aircraft were also examined. These pieces had a range of damage levels from no damage to severe melting.

1.14.2.4 Cargo Pallets and Containers

Some cargo pallets, portions of pallet edge rails and portions of Unit Load Devices (ULD) were examined. The main cargo deck of the aircraft was loaded with pallets in every cargo position except for one which had a ULD.

The main cargo deck has 30 positions in total, and there were six empty positions in total: three under the flight deck (A1, A2, B); two near the aft main cargo door (PL, RL); and one forward of the aft pressure bulkhead.

The lower cargo bays contained two ULDs and multiple pallets.

An example of a cargo pallet edge rail with fire damage is shown in [Figure 33].



[Figure 33] Cargo Pallet Edge Rail

1.14.2.5 Cargo Control Panels

In the main cargo deck, there are multiple control panels for managing the loading of cargo pallets and containers and manipulating their positions. These control panels were found to have varying degrees of fire damage. An example of the cargo loading control panel is shown in [Figure 34].

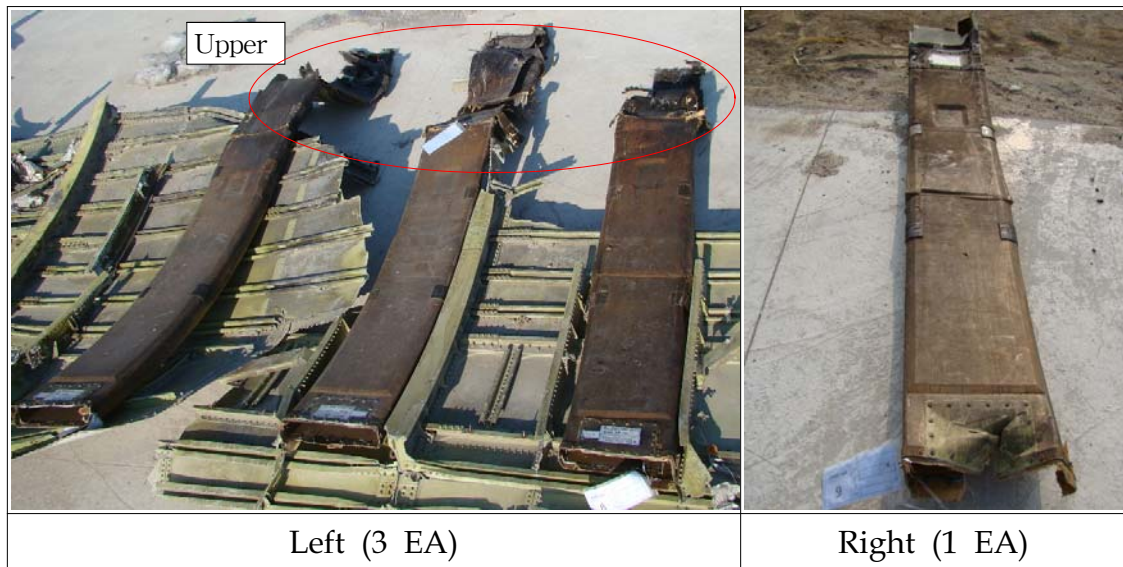


[Figure 34] Cargo Loading Control Panel

1.14.2.6 Riser Ducts

Portions of four out of the six riser ducts²⁸⁾ on the aircraft were examined. As shown in [Figure 35], all of these ducts had sustained fire damage which was consistently more severe along the upper portions and tapered off towards the bottom.

28) Ducts through which conditioned air from the air conditioning packs flows to the main deck and upper deck air distribution system. They are located behind the cargo liners in the left and right hand sidewalls between FS800 and FS1000.



[Figure 35] Riser Ducts

1.14.2.7 Forward Main Cargo Deck Ceiling Panels

Portions of the ceiling panels belonging to the area under the flight deck were examined. As shown in [Figure 36], the forward most ones from the vicinity of FS360 had a layer of soot adhering to the surface. Ceiling liners aft of FS360 were also sooted and had a darker appearance.



[Figure 36] Liners from Vicinity of and Aft of FS360

1.14.2.8 Upper Deck Interior Panel

As shown in [Figure 37], a panel from the interior of the upper deck area was found to have an area exhibiting soot accumulation. The panel is part of the lavatory module wall where the cabin attendant panel and emergency equipment is installed.



[Figure 37] Upper Deck Interior Panel with Area of Sooting

1.14.3 Conductivity Measurements

On a few of the large portions of the wreckage (#500, #1089, #511 and portions of the aft pressure bulkhead), measurements of the electrical conductivity were taken in an effort to see if that information would provide any additional insight beyond what can be accomplished by a traditional visual examination. An example of the conductivity measurements is shown in [Figure 38].



[Figure 38] Conductivity Measurement Points and Values

1.15 Survival Aspects

The autopsy on the pilots on October 31, 2011 showed that the cause of death was multiple rib fractures, lung rupture etc. formed in the chest.

The coroner stated that injuries may have been caused when the aircraft had crashed into water.

1.15.1 General

On October 28, 2011, the captain and the first officer were found with the seat belt fastened on the left and right pilot seat, respectively. A 4-point seat belt²⁹⁾ was installed on the captain seat³⁰⁾ and the co-pilot seat.

29) Part No.: 5000-1-01A2396/02A2396 (The Boeing Company)

30) Part No.: 3A258-0041-011, Serial Number 44508 (IPECO Europe Ltd.)

1.15.2 Emergency Response

At 03:59:09 on July 28, 2011, ICN ACC received the information from FUK ACC that "AAR991 declared an emergency and requested diversion to Jeju Airport." and then notified JEJ APP of the situation.

At 04:03:57, ICN ACC received the notification of a cargo fire from KAL886 operating near AAR991. At 04:03:58, AAR991 began squawking 7700 informing an emergency was displayed on the radar screen.

On the radar screen at ICN ACC was displayed the "CST"³¹⁾ code word.

At 04:11:05, the Air Force-related agency declared AAR991 as the flight track of interest, and at 04:12:00, AAR991's track disappeared from the radar screen about 130 km west of Jeju Island.

About 04:12, as the track disappeared, JEJ APP directed fire engines, etc. to stand by in preparation for the aircraft's emergency landing.

At 04:12:49, ICN ACC inquired of the Air Force-related agency about the display of the flight track, but was notified that there was no relevant data. Accordingly, at 04:13:00, ICN ACC notified the agency that AAR991's track disappeared from the radar screen. About 05:08, the agency dispatched one patrol aircraft³²⁾ located closest to the accident site.

About 06:20, the patrol plane arrived at the site and searched the area. About 06:25, it notified the Air Force-related agency that the floating debris presumed to be the wreckage of the accident aircraft was found on the water about 130 km west of Jeju Airport. About 06:42, the Coast Guard's ship

31) "CST" appears in the data block when an aircraft's reply to the radar site is not received.

32) A twin-engine, medium-range, maritime patrol aircraft.

conducting search operations based on such information found the floating debris of the aircraft at 33°15'8"N, 125°01'7"E for the first time.

At 04:15, ICN ACC also inquired of the Coast Guard as to whether the distress signal of the Emergency Locator Transmitter was received, but confirmed that it was not. The Coast Guard requested by ICN ACC to conduct search and rescue operations at 04:21:00 dispatched two helicopters, which were affiliated with Jeju Base and Mokpo Base and arrived at the accident site to join search operations about 06:54 and 08:25, respectively.

About 06:15, the ship affiliated with the Coast Guard arrived at the accident site, and about 06:42, found the debris, seats, lifeboats, etc. and reported this progress to JEJ APP. Multiple ships affiliated with the Coast Guard arrived at the accident site and commenced search operations.

At 04:30, the Navy was aware of the accident and about 05:38, dispatched one patrol aircraft³³⁾, which arrived at the accident site about 06:04, and about 09:30, two naval vessels arrived at the accident site. On July 29, two naval minesweepers arrived at the accident site, one at 07:05 and the other at 07:35.

The National Emergency Management Agency notified by the Air Force of the accident through wire communication about 04:30 reported the situation to higher authorities³⁴⁾.

The Korea Hydrographic and Oceanographic Administration notified by the Coast Guard of the accident about 03:00 on July 29 dispatched one research vessel³⁵⁾ from Jeju Island for search operations about 03:20.

33) A four-engine, turbo-prop, antisubmarine aircraft.

34) Higher authorities like the Prime Minister's Office.

35) "Haeyang 2002"

1.15.3 Fixed Emergency Locator Transmitter

At 03:59:13, the ACARS³⁶⁾ message about "ELT ON"³⁷⁾ was transmitted, but the distress signal was not received by the situation room of the Coast Guard. Furthermore, the signal was not received even after the crash of AAR991.

The ELT automatically activates when the deceleration sensing inertia switch senses the impact of 5G and more. 150 seconds after turned ON, it transmits the aircraft information every 50 seconds thereafter. It is in stable operation for one hour at temperatures between -20°C and +55°C, but is inoperable in the water. The antenna connected to the ELT is mounted at STA2127.5 forward of the vertical stabilizer.

The ELT was manufactured in conformity with the requirements of the COSPAS/SARSAT system³⁸⁾. It operates on 406.025 Mhz and is mounted at STA2110, S-4L. The specification of the ELT is shown in [Table 19].

Manufacturing State	Manufacturer	Model No.	Part No.	Serial No.	Installation Date
France	ELTA	A06V2	95N6088	05422257	Jun. 3, 2009

[Table 19] Specification of Fixed ELT Installed on AAR991

1.16 Tests and Research

To be supplemented afterwards.

36) The ACARS is an acronym for the Aircraft Communication Addressing and Reporting System that is a digital data-link system that provides data communication between an airplane and ground-based computers.

37) It indicates that the ELT was in operation.

38) The COSPAS/SARSAT system is an international satellite system coordinated by USA, Russia, etc. to detect alert transmissions.

1.17 Organizational and Management Information

1.17.1 General

To be supplemented afterwards.

1.17.2 Simulator and Simulation Training

A B747 simulator manufactured by CAE on August 12, 1994 was delivered to Asiana Airlines on December 4, 1994, and since then, has been operated by the company. The simulator is configured as a passenger version of the B747. Accordingly, it is incapable of simulating a main deck cargo fire for B747 freighters.

Asiana airlines contracted with a Boeing subsidiary to provide training for its pilots. The training syllabus was prepared by Asiana Airlines and approved by the Office of Civil Aviation under the Ministry of Land, Transport and Maritime Affairs. The Boeing affiliate used instructor pilots employed by a contractor, Cambridge Communications Ltd. (CCL), to train and assess Asiana's pilots using the Asiana syllabus. As of August 2011, six CCL instructor pilots were on site at Asiana for this purpose.

Given the limitations of the B747 passenger aircraft simulator, the CCL instructor pilots trained the B747 freighter Fire Main Deck procedures by referring to a cargo plane's panel diagram and the flight crew operations manual. During simulator training, the instructors simulated a main deck fire on a B747 freighter by giving trainees verbal instructions and using the passenger plane's lower cargo deck fire message.

1.17.3 Dangerous Goods Training

One instructor of the flight training team is exclusively in charge of dangerous goods (DG) training for Asiana Airlines' pilots. He provides the DG training to pilots during basic and recurrent training. The pilots initially receive four hours of the DG training during the basic training, and then one hour during the recurrent training every year. However, hands-on training is not available to the pilots.

The instructor exclusively in charge of DG training stated that he had trained the pilots with an emphasis on cargo safety standards for lithium-ion batteries and cargo fire procedures during the first half-year type training in 2011 after the fatal UPS crash in 2010. In addition, it was confirmed that the pilots had been notified of the UPS cargo jet fire accident.

DG training given to AAR991's captain and the first officer is shown in [Table 20].

Year	Training Topic	Training Date	
		Captain	First Officer
2009	DG Handling	Jul. 21, 2009	Jul. 30, 2009
	Emergency Equipment		
2010	DG Handling	Jul. 22, 2010	Oct. 28, 2010
	Emergency Equipment		

[Table 20] DG Training Given to the Pilots

Also, it was confirmed that the cockpits of all other B747 cargo planes operated by Asiana Airlines were equipped with the Emergency Response Guide for Aircraft Incidents Involving Dangerous Goods³⁹).

1.18 Additional Information

1.18.1 Classification of Cargo Compartment

According to the Korean Airworthiness Standards 25.857, the cargo compartment is classified into either A, B, C or E classes, and the requirements of the compartments of each class are as follows:

- (a) Class A. A Class A cargo or baggage compartment is one in which-- (1) The presence of a fire would be easily discovered by a crewmember while at his station; and (2) Each part of the compartment is easily accessible in flight.
- (b) Class B. A Class B cargo or baggage compartment is one in which-- (1) There is sufficient access in flight to enable a crewmember to effectively reach any part of the compartment with the contents of a hand fire extinguisher; (2) When the access provisions are being used, no hazardous quantity of smoke, flames, or extinguishing agent, will enter any compartment occupied by the crew or passengers; and (3) There is a separate approved smoke detector or fire detector system to give warning at the pilot or flight engineer station.
- (c) Class C. A Class C cargo or baggage compartment is one not meeting the requirements for either a Class A or B compartment but in which-- (1) There is a separate approved smoke detector or fire detector system to give warning at the pilot or flight engineer station; (2) There is an approved built-in fire extinguishing or suppression system controllable from the cockpit; (3) There are means to exclude hazardous quantities of smoke, flames, or extinguishing agent, from any compartment occupied by the crew

39) Refer to *Emergency Response Guidance for Aircraft Incidents Involving Dangerous Goods* (Doc 9481).

or passengers; and (4) There are means to control ventilation and drafts within the compartment so that the extinguishing agent used can control any fire that may start within the compartment.

- (e) Class E. A Class E cargo compartment is one on airplanes used only for the carriage of cargo and in which-- (1) [Reserved] (2) There is a separate approved smoke or fire detector system to give warning at the pilot or flight engineer station; (3) There are means to shut off the ventilating airflow to, or within, the compartment, and the controls for these means are accessible to the flight crew in the crew compartment; (4) There are means to exclude hazardous quantities of smoke, flames, or noxious gases, from the flight crew compartment; and (5) The required crew emergency exits are accessible under any cargo loading condition.

The lower cargo compartment of HL7604 is a C-class cargo compartment, and the main deck is an E-class cargo compartment.

1.18.2 Cargo Loaded on AAR991

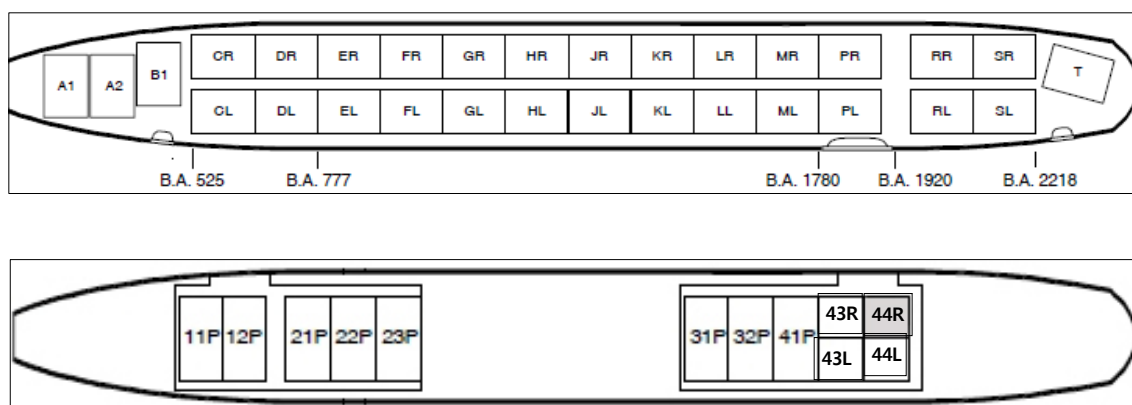
1.18.2.1 Cargo Unloading and Loading History of AAR991

On July 28, 2011 at 00:05 before leaving for Shanghai, HL7604 arrived at Incheon Airport as flight AAR786 (Frankfurt-Incheon). The whole cargo load of 86,461.2kg (36 pallets, 1 container) was unloaded⁴⁰).

From 01:00 to 02:02 on July 28, 2011, 58,265.8 kg of cargo (30 pallets, 5 containers), which is 60 cases by master airwaybill, was loaded at Incheon Airport. As shown in [Figure 39], 35 positions including 24 positions in the main deck and 11 positions in the lower cargo compartment were used.

⁴⁰) Working Hours: 00:17 - 00:58

At positions of main deck, CL, CR, DL, DR, EL, ER, FL, FR, GL, GR, HL, HR, JL, JR, KL, KR, LR, ML, MR, PR, RR, SL and SR were loaded Code M (318 cm × 244 cm) pallets, and at position LL was loaded a Code M container, and positions A1, A2, B1, PL, RL and T were empty.



[Figure 39] Layout of main deck (top) and lower cargo compartment (bottom)

At position 11P of the front lower cargo compartment was loaded a Code A (318cm × 224cm) container, and at positions 12P, 21P, 22P and 23P were loaded Code M pallets.

At positions 31P, 32P and 41P of the rear lower cargo compartment were loaded Code M pallets, and at positions 43L, 43R and 44L were loaded AKE (153cm × 156cm) containers, and position 44R was empty.

Asiana Airlines classified cargo based on the master airwaybill number given to each cargo and loaded it in the ULDs. Then, according to the cargo load plan, the company loaded the ULDs matching the ULD numbers with the positions of cargo compartments.

Cargo weight is the weight including the ULDs, net and tare. The cargo manifest by position is as shown in [Table 21], and there were no

significant abnormalities when unloading or loading the cargo.

Loading Sequence	ULD		Cargo Weight (kg)	Remarks
	Position	ULD Number		
Main deck cargo loading sequence (Loaded by side door)				
1	CR	PMC14612AAR	940	
2	DR	PMC12829AAR	865	
3	ER	PMC14867AAR	1,400	
4	FR	PMC14070AAR	1,450	
5	GR	PMC15639AAR	2,246	
6	HR	PMC11554AAR	2,645	
7	JR	PMC14089AAR	2,550	
8	KR	PMC13317AAR	2,925	
9	LR	PMC15592AAR	3,134	
10	MR	PMC15223AAR	3,494	
11	SR	PMC14489AAR	1,520	
12	SL	PMC14841AAR	2,480	
13	RL	PMC15301AAR	1,260	
14	CL	PMC12988AAR	1,370	
15	DL	PMC11437AAR	1,590	
16	EL	PMC12174AAR	1,975	
17	FL	PMC12854AAR	2,495	
18	GL	PMC15528AAR	2,000	
19	HL	PMC11340AAR	1,454	
20	JL	PMC14695AAR	1,878	
21	KL	PMC12355AAR	3,050	
22	LL	AMA08668AAR	2,990	
23	PR	PMC13389AAR	1,575	Dangerous goods loaded
24	ML	PMC11978AAR	1,790	Dangerous goods loaded
Lower deck cargo loading sequence				
1	23P	PMC13363AAR	1,730	
2	22P	PMC15460AAR	1,680	
3	21P	PMC12799AAR	1,182	
4	11P	AAP06606AAR	1,545	
5	12P	PMC15494AAR	2,584	
6	31P	PMC15520AAR	1,910	
7	32P	PMC13821AAR	2,415	
8	41P	PMC12697AAR	2,650	
9	43L	AKE20493AAR	363	
10	43R	AKE28149AAR	363	
11	44L	AKE21128AAR	440	
Total weight of cargo			65,938	

[Table 21] AAR991 Cargo Manifest

1.18.2.2 Cargo Manifest for Incheon Departing Cargo

The quantity of Incheon departing cargo was 39,331 kg by 48 AWBs, and the cargo acceptance time was from July 27 at 10:11 through 28 at 00:06. For security check during acceptance, X-ray screening and explosives trace detector check were conducted, and there were no significant abnormalities during the acceptance of cargo.

The total weight of cargo transshipped at Incheon Airport was 18,934.8 kg as shown in [Table 22], and the weight by departure point is as follows:

Departure Point	Air Carrier	Arrival Date & Time	Weight (kg)	Remarks
Osaka	AAR191	7. 27. 20:15	258.6	Dangerous goods
Fukuoka	AAR131	7. 27. 13:10	1,024.9	
	AAR133	7. 27. 20:40	128.3	
Dehli	AAR768	7. 27. 12:00	145.0	
Manila	AAR704	7. 27. 05:00	931.0	
	AAR702	7. 27. 17:45	21.0	
Frankfurt	AAR542	7. 27. 12:20	865.0	
Los Angeles	AAR2831	7. 27. 07:50	1,285.0	
	AAR965	7. 26. 05:25	11,201.0	
San Francisco	AAR2831	7. 27. 07:50	3.0	Dangerous goods
Seattle	AAR2377	7. 27. 11:30	3,072.0	

[Table 22] Cargo Transshipped at Incheon Airport

1.18.2.3 Cargo Build-up on ULD

The cargo loaded on the ULDs at Incheon Asiana Cargo Terminal from 17:00 on 27th to 00:30 on 28th is as shown in [Table 23] and [Table 24] below.

ULD No.	ULD Weight (kg)	No. of Packages	Main Content
AAP06606OZ	1,545	150	PHOTOMASK, HYNIX MEMORY CHIP, MASK, CIS WAFER
AKE20493OZ	363	36	MEMORY, SYSTEM LSI
AKE21128OZ	440	18	EXPRESS CARGO
AKE28149OZ	363	15	IC, SYSTEM LSI
AMA08668OZ	2,990	260	PHOTOMASK, IC
PMC11340OZ	1,454	3	BRAKE HOSEFITTING, BOLT
PMC11437OZ	1,590	6	LED BACKLIGHT UNIT
PMC11978OZ	1,790	161	FLAMMABLE LIQUID, PCB, CMOS, CONNECTOR, IC, SILICON, COMPRESSOR, BAG SHIELDING
PMC12174OZ	1,975	54	LEAD FRAME, SLF INDUCTOR, MOULD PARTS,
PMC12355OZ	3,050	13	SEMICONDUCTOR, WAFER, TRANSFER, CYLINDER DIA 125MM QUINTEC, ELECTRODE FOR CCFL
PMC12799OZ	1,182	24	IC DRIVER SOURCE, CLEANING DISK, MULTI LCD INSPECTION EQUIPMENT, FILM GUIDE, TEXTILE FABRICS WOVEN
PMC12988OZ	1,370	22	FABRIC, IC DRIVER SOURCE
PMC13317OZ	2,925	103	CKD LIGHTUNIT SET, LEAD FRAME, LED PKG, SLF INDUCTOR, MOULD PARTS, PCB, CABLE
PMC13363OZ	1,730	60	SHAFT SUB ASSYETC, IC DRIVER SOURCE, WOVEN FABRIC
PMC13389OZ	1,575	65	LITHIUM ION BATTERY, PAINT, AMINES LIQUID CORROSIVE, PAINT, PHOTO COLOR RESIST, AUTOMOTIVE PART FLAMMABLE LIQUID
PMC13821OZ	2,415	36	AUTO PARTS SEAL, COMPUTER PARTS, SAFEELIA PIT EM150, BOBBIN ASSEMBLY, TEXTILE FABRICS, WOVEN FABRIC, SATELLITE RADIOPART
PMC14070OZ	1,450	39	IC, SILICON, OZC CLEAN
PMC14489OZ	1,520	18	IC, T R PACKAGE, EZ CLEAN, SILICON, COMPRESSOR
PMC14612OZ	940	4	LED BACKLIGHT UNIT, IC, SILICON, EZ CLEAN
PMC14695OZ	1,878	40	TRANSFER ROLLER, COMPUTER, PLATE, ANTENA PART, PCB SOURCE, CKD BACKLIGHTUNIT, SECURITY PRODUCT,
PMC14841OZ	2,480	40	HARD DISK DRIVE FOR PLAY STATION, DIFFUSION FILM, EITAXIAL WAFER, CASE POLE SPACER BOTOM, BRAZE FILLER PASTE, MAS FLOW EQUIPMENT
PMC15223OZ	3,494	68	LED, ELBOW FITTING, ADHESIVE PLASTIC,

			SEMICONDUCTOR DEVICE PART, SUITABLE FOR MANUFACTURING PRINTED CIRCU, LABEL, FACING HEAD UNIT
PMC15301OZ	1,260	24	TFT DISPLAY GLAS SCREEN NEC RELAYS, EITAXIAL WAFER, CASE POLE SPACER BOTOM, BRAZW FILLER PASTE, MASS FLOW EQUIPMENT, DIE ATTACH FILM
PMC15460OZ	1,680	8	DENSE LOADER, EITAXIAL WAFER TFT DISPLAY GLASS SCREEN, CASE POLE SPACER BOTOM, BRAZE FILLER PASTE MASS FLOW EQUIPMENT
PMC15494OZ	4,258	4	POLARIZING FILM
PMC15520OZ	1,910	5	POLARIZING FILM
PMC15528OZ	2,000	19	CHIP ON WAFER, ELECTRICAL GOODS, IC, SILICON
PMC12697OZ	2,650	19	PMC Pallet Stack (PMC ----OZ) 10699, 11508, 12617, 13173, 13473, 13853, 14126, 14384, 14771, 14864, 15104, 15161, 15455, 15497, 15520, 15845, 15860, 15917, 16136

[Table 23] Cargo Loaded on ULDs at Incheon Airport

ULD No.	ULD Weight (kg)	No. of Packages	Content	Work Place
PMC11554AAR	2,645	20	Network equipment	L.A. USA
PMC12829AAR	865	15	Network equipment	L.A. USA
PMC12854AAR	2,495	18	Network equipment	L.A. USA
PMC14089AAR	2,550	18	Network equipment	L.A. USA
PMC14867AAR	1,400	17	Network equipment	L.A. USA
PMC15592AAR	3,134	5	Fruit (cherry)	Seattle USA
PMC15639AAR	2,246	29	Network equipment	L.A. USA

[Table 24] Cargo Loaded from Other Departure Points & Transshipped to AAR991

1.18.3 Dangerous Goods

Declared dangerous goods loaded on the accident aircraft were products of 6 companies on 8 master airwaybills as shown in [Table 25]. All dangerous goods were loaded on the main cargo deck. Of them, two items were loaded on the ML pallet and the other five items were loaded

on the PR pallet, and all of them were positioned adjacent to the main deck side cargo door. Dangerous goods included flammable liquids, corrosive liquids and lithium-ion batteries.

Dangerous Goods	AWB No. 988 -	Departure Point	Total Weight (kg)	Net Quantity	Item Description
Lithium-ion batteries	-63857393	Osaka Japan	258.6	243.6 kg	Lithium-ion battery for hybrid automobile
Photo-resist/IC	-68738121	Incheon	114	41.58 L	Sensitizing solution for raising the sensitivity of semiconductor
	-68738110		386	166.32 L	
	-68738132		621	272.16 L	
Photo-resist/LCD	-68693542	Incheon	679	477 L	Liquid synthetic resin for coating LCD panel
Amines Liquid Corrosive N.O.S.	-68119586	Incheon	8	5 L	-Anti-static agent for preventing static electricity -Mixed liquid for preventing dust from attaching to paint and impurities from attaching to various products
Paint	-68527056	Incheon	22	12 L	Paint for damp proof insulation of electronic circuit
Inspection Seal Lacquer	-68019571	San Francisco	3	0.236 L	Seal lacquer for preventing loosening of bolt/nut

[Table 25] Dangerous Goods Loaded on AAR991

1.18.3.1 Lithium-ion Batteries

The lithium-ion batteries shipped onboard the accident aircraft were regulated as Class 9⁴¹⁾ UN3480, Packing Group II, dangerous goods. The lithium-ion battery shipment consisted of cells that were assembled in stacks of 6 or 12 for use in hybrid electric vehicles.

The individual cells were rated at 25 Ah at 3.65 volts and 89.8 Wh. The total number of stacks was 18, including 15 of the 12-cell (x12S) configurations and 3 of 6-cell (x6S) configurations.

As shown in [Figure 40], 12-cell configurations batteries were packed

41) Class 9: classified by ICAO as miscellaneous dangerous substances and articles including lithium-ion batteries, dry ice, etc.

one per box in 15 fiberboard boxes, and 6-cell configurations batteries were packed two per box in two fiberboard boxes and the remaining one packed individually, so the total number of the fiberboard boxes was 17.

This product was loaded at the main deck PR position in a single pallet wrapped in plastic.



[Figure 40] 12-Cell (Left) & 6-Cell (Right) Batteries



[Figure 41] 1-Cell Battery

[Figure 41] above shows 1-cell battery.

The manufacturer states that in case of a battery fire, it can be extinguished by carbon dioxide, nitrogen, water, and powder extinguishant (ABC extinguishant).

1.18.3.1.1 Manufacturer's Test Results

The lithium-ion battery manufacturer provided data relating to the testing of 50 cells from March 2, 2009 to May 14, 2009 according to the method and standards prescribed in the "UN Recommendations for Transport of Dangerous Goods".

- The manufacturer's test report indicated the cells were subjected to an altitude simulation test, thermal test, vibration test, shock test, external short-circuit test, impact test, overcharge test and forced discharge test.

In addition, one of the lithium cells produced from each lot⁴²⁾ was extracted randomly to conduct tests such as nail penetration, submergence and contact with chemical substances, and all the tests showed no problems that would lead to thermal runaway or fire.

The nail penetration test simulates a worst case failure by short-circuiting the battery at 10% and 100% state-of-charge (SOC). Based on a risk assessment from this testing regime, the manufacturer has adopted 10% SOC as the standard for all of its lithium-ion battery shipments.

1.18.3.1.2 Manufacturer's Inspection before Packing

The manufacturer stated that each battery produced is subjected to quality assurance inspections before packaging the product for shipment. He added that cells and stacks loaded onboard the accident aircraft all passed company inspection standards.

- Cell inspection items are visual inspection, insulation film condition

42) Product unit of a specific number produced in one batch.

inspection, internal short-circuit inspection and characteristics inspection.

- Stack inspection items are size inspection, weight inspection and visual inspection.

1.18.3.1.3 Packing Container

The Dangerous Goods Declaration for the shipment of lithium-ion batteries loaded onto the accident aircraft indicated that packaging was in accordance with ICAO TI Packing Instruction 965.

The packing containers used for the lithium-ion battery shipment were specification 4G/Y40 fiberboard boxes. The packing weight limit for each box used for Packing Group II materials, such as the lithium-ion batteries, was 40 kg.

One box can be packed with two 6-cell batteries or one 12-cell battery. Since the weight of two 6-cell batteries is about 16 kg and the weight of one 12-cell battery is about 14 kg, the battery weight 14 - 16 kg to the packing limit weight of the box 40 kg is 40% or less.

The manufacturer stated that the safety margin was taken into consideration for the reason of packing at or below 40% of the packing limit weight. Under the ICAO Dangerous Goods Regulations, the lithium battery package quantity limitation for cargo aircraft is 35 kg.

1.18.3.1.4 Packing and Shipping

The produced batteries have the terminals covered with insulating material to prevent external short-circuit in transit and are packed as shown in [Figure 42]. The polyethylene wrapping has a melting point of 122 degrees Celsius.



[Figure 42] Batteries Packed in Plastic

Batteries are wrapped with polyethylene and they are put into an inner packaging material fit for the shape of battery as shown in [Figure 42] to prevent shaking. And then the batteries wrapped with the inner packaging material are put in the box and the top is covered with impact preventing packaging material (bubble wrap), and the box is closed to complete packaging.

The manufacturer stated that the product is kept in a separate place with temperatures between 20 to 30 degrees Celsius before shipping, that humidity does not affect battery performance, and that there had been no abnormal cases during sea, land, and air transport of the lithium-ion batteries.

[Figure 43] below shows the final packing state of the lithium-ion batteries in a production plant.



[Figure 43] Final Packing State of Lithium-ion Batteries

1.18.3.2 Photo-resist/IC

This product is a highly flammable liquid and is managed as a class-3 flammable liquid. Two types of photo-resist solution filled with violet and yellow liquid, respectively, as shown in [Figure 44] were loaded.

The two types were composed of 50 or more weight percentage of propylene glycol monomethyl ether acetate (PGMEA).



[Figure 44] Two Types of Photo-Resist Solution (Violet & Yellow)

This product is stored and transported between 0 and 10 degrees Celsius, but even if the temperature exceeds 10 degrees Celsius, safety is not affected. Though, it is no longer marketable since the quality deteriorates. The manufacturer said that it is not necessary to maintain the aircraft cargo compartment at a specific temperature since the product is packed so as to maintain optimum temperature until destination.

It is clearly stated in the MSDS⁴³⁾ that the flash point⁴⁴⁾ of the product is 47 degrees Celsius, high-temperature heat, that sparks and flames should be avoided during handling, and that acrid smoke and poisonous gases are generated if exposed to high temperatures or during fire. This product is used in the manufacture of integrated circuits and is light yellow liquid with a sweet aroma.

This product is contained in a total of 127 brown glass containers (one gallon per glass container). These glass containers are put in a black polyethylene bag, and four of them are put in one fiberboard box of UN specification, which is filled with styrofoam (for buffering and maintaining temperature) in all directions together with blue ice for maintaining the temperature of the product low. The fiberboard boxes packaged in such a way are 32 in all.

The product was loaded on the pallets at positions ML and PR. Five overpacks⁴⁵⁾ made by binding 29 small packaging boxes were loaded at ML, and one overpack made by binding three small packaging boxes was loaded at PR.

43) Material safety data sheets (MSDS) conform to the United Nations' Globally Harmonized System of Classification and Labeling of Chemicals. The MSDS outlines the dangers, composition, safe handling, and disposal of hazardous chemicals.

44) A flash point is the lowest temperature at which a product can vaporize to form an ignitable mixture in air.

45) Repacking with wood or strong protective material for buffer, etc. after individual packing.

After the boxes are finally sealed by the manufacturer, they are transferred to a third-party dangerous goods packing company, which prepared the dangerous goods declaration on behalf of the shipper.

1.18.3.3 Photo-resist/LCD

This product is a highly flammable liquid and is managed as a class-3 flammable liquid. The main component is 50 to 60 weight percentage of propylene glycol monomethyl ether acetate (PGMEA) and is similar to the above photo-resist solution used for etching integrated circuits.

According to the MSDS, the flash point of the product is 43 degrees Celsius, and has a danger of explosion if heated. This product is used to manufacture LCD flat panel displays and is bright blue or bright red liquid with "B" or "R" marked in the product name. The integrity of the product is sensitive to temperature and light.

Three types of the product were in 53 brown plastic containers of 10 liters, 9 liters per container. These containers were sealed in transparent plastic bags respectively as shown in [Figure 45]. In one box filled with styrofoam together with blue ice for maintaining the product temperature low were put two brown plastic containers to make 27 small packaged boxes.

The 27 small packaged boxes were repacked into one overpack and were loaded on the pallet at position PR.



[Figure 45] Photo-Resist Solution and the Inner Packing of Each Package Loaded

These plastic containers are made of high-density polyethylene and are closed with polyethylene screw caps with Teflon coated gaskets. These containers are subject to a leak test in which the container was stood upside down for 12 hours, a 120 cm high drop test, and a 20 KPa pressure test of five minutes.

This product is stored at 5 degrees Celsius in the manufacturer's facility and transported in a refrigerated truck to a forwarder. The forwarder repacks the product with prefabricated styrofoam packing material and blue ice for air transport. A digital temperature recorder⁴⁶⁾ provided by the manufacturer is packed together one per cargo.

The manufacturer's person in charge stated that no containers have leaked or have been returned due to a defective product for the past eight years of loading this product.

46) This temperature gauge can check only the highest temperature inside of the box to confirm the marketability of the product.

1.18.3.4 Amines Liquid Corrosive N.O.S.

This product is a corrosive liquid and is managed as a class-8 corrosive material. The main component is 90 weight percentage of ethoxylated alkylamines. The flash point is 100 degrees Celsius or higher.

According to the MSDS, this product has no special risks of flammability or explosion, and the material is colorless transparent liquid.

This product was supplied to a domestic company by a French company and was repacked and transported through a cargo agent. The cargo agent classified the product, selected packing material and declared dangerous goods on behalf of the shipper.

The cargo agent did dangerous goods cargo packing work every three months on behalf of the domestic company. The related person of the cargo agent stated that he leak checks the plastic containers received from the manufacturer prior to packaging and there were no products in an unsatisfactory condition.

This product was shipped in one 5-liter plastic container. This container was sealed in a transparent plastic bag and placed in a UN specification 4G fiberboard box together with styrofoam insert. A corrosive material label was affixed to the box as shown in [Figure 46]. This product was loaded at ULD position PR.



[Figure 46] Final Packing Sample of Amines

1.18.3.5 Paint

A Japanese company supplies this product to a domestic company which supplies it to the Asian region through a distribution company. It is managed as a class-3 flammable liquid. The main component is 50 to 60 weight percentage of ethylcyclohexane.

According to the MSDS, the flash point of this product is -1 degree Celsius, and if the temperature exceeds the flash point, an explosive dust or vapor air mixture can be formed. It is a blue transparent liquid.

This product was shipped in 12 metal containers, one liter per container. These containers are packed in one fiberboard box filled with styrofoam as shown in [Figure 47].



[Figure 47] Final Packing Sample of Paint

The products were packed in UN specification packing boxes and overpacked, and moved to a dangerous goods handling company.

The dangerous goods handling company inspects packages for damage, and attaches dangerous goods labels and completes dangerous goods declarations on behalf of the shipper. This cargo was loaded at ULD position PR.

1.18.3.6 Lacquer for Seal Inspection

This product is a colored paste that is managed as a class-3 flammable liquid. The product contains 30 to 60 weight percentage of ethanol, and the product has a flash point of 42.8 degrees Celsius.

The product is packaged in 16 plastic tubes, about 15 grams per tube, as shown in [Figure 48], and the total quantity was 0.236 liters. The product tubes were packed in one fiberboard box with a "flammable liquid" label affixed. This cargo was loaded on the pallet at ULD position PR.



[Figure 48] Final Packing and Product of Torque Seal

1.18.3.7 Testimony of the Cargo Handlers

Investigators interviewed the load master of AAR991 and nine persons who handled the dangerous goods and received their statements, the content of which is as follows:

As part of Asiana's cargo shipment acceptance process, x-ray screening was conducted at Incheon Airport before all dangerous goods were loaded on pallets, excluding the lithium-ion batteries that departed Kansai International Airport in Japan and the lacquer that departed San Francisco International Airport in the United States.

The photo-resist solutions⁴⁷⁾ of the two companies among the dangerous goods of [Table 25] described in 1.18.3 were kept temporarily in the cool rooms at Asiana's facilities. Three⁴⁸⁾ dangerous goods packages including paint and lacquer were stored in Asiana's temporary dangerous goods storage area, and the lithium-ion batteries⁴⁹⁾ were stored in their transit DG check-up storage area.

47) MAWB No.: 988-68738110 (2), 988-68738132 (3), 988-68693542 (3), and 988-68738121 (1).

48) MAWB No.: 988-68119586 (1), 988-68527056 (1), and 988-68019571 (1).

49) MAWB No.: 988-63857393 (1).

At about 22:05 on July 27, 2011, the dangerous goods except for the lithium-ion batteries were gathered to be loaded onto two pallets. The lithium-ion batteries were inspected within one hour and then brought to the cargo build-up area with the other dangerous goods.

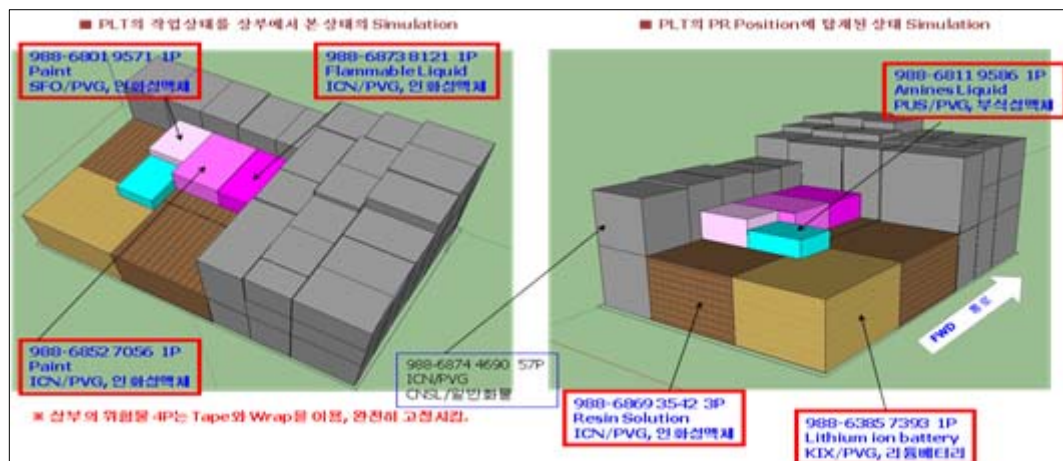
At about 23:30, the build-up of the two dangerous goods pallets was completed. Subsequently, the loadmaster signed confirming acceptance, and the two dangerous goods pallets were weighed and loaded on the aircraft.

The load master and nine cargo handlers stated they did not observe any problem of damage or leakage.

Asiana Airlines reconstructed the loading configuration of the two pallets of PMC11978OZ and PMC13389OZ that had been loaded respectively at ULD positions ML and PR of the accident aircraft as shown in [Figure 49] and [Figure 50] below. The reconstruction is based on Asiana cargo handler's recollection of package positioning on the pallets.



[Figure 49] Reconstruction of Loading of ML Pallet (PMC11978OZ)



[Figure 50] Reconstruction of Loading of PR Pallet (PMC13389OZ)

These two pallets were loaded on the aircraft between 01:00 and 02:00 on July 28, 2011. Subsequently, about 02:15, the loadmaster notified the captain of AAR991 of the characteristics of the dangerous goods. The captain escorted the two dangerous goods pallets as they were loaded in ULD positions ML and PR.

At about 02:30, the captain signed the NOTification TO Captain for special load (NOTOC)⁵⁰, weight and balance sheet, load manifest and cargo loading checklist. The aircraft was pushed back about 02:47.

1.18.3.8 Maintenance and Repair of Cargo Container/Equipment

Maintenance and repair records during the past one year for the ULDs loaded on AAR991 indicated that all reported defects were repaired in accordance with the supplier's instructions and that no uncorrected defects were found.

On August 11, 2011, investigators visited Asiana's cargo facilities

50) A document that notifies the captain of dangerous goods and other special load among all cargo at the cargo departure airport. The NOTOC lists the location, quantity, type of packaging, and procedures to follow in the event of an emergency.

located at Incheon Airport to observe cargo loading practices on a 747-400SF (HL7414) aircraft that is similar to the accident aircraft. The condition of about 20 ULDs were examined to find that all of them were serviceable.

Some of the containers had visible signs of repair. All the pallet nets were serviceable and installed normally.

Investigators inspected an additional 25 pallets in Asiana's cargo warehouse to find that all were in serviceable condition. Two AKE containers examined in the warehouse were also serviceable.

Asiana told investigators that as a means of preventing leakage and for security reasons the airline installs a thick plastic sheet under flammable liquid cargo and two layers of thinner plastic sheet to cover the loads.

1.18.3.9 Cargo Handling System

The main deck cargo handling system of the accident aircraft consisting of drive units, conveyance and restraints was manufactured by Telair International Company and was installed according to a U.S. FAA issued Supplemental Type Certificate.

Investigators examined repair records of the latest two years of the main deck and lower lobe cargo handling systems of the accident aircraft. The records revealed only routine maintenance and repair of the cargo handling system.

During the visit of August 11, 2011 to Asiana's cargo facilities located at Incheon Airport, investigators checked the condition of a similar cargo

handling system onboard a 747-400SF (HL7414) aircraft. The cargo handling system was found to be serviceable.

1.18.3.10 Cargo Acceptance Procedures

All shipments accepted from the Asiana's cargo customers/cargo agents are supposed to conform to the Asiana's Cargo Service Operation Procedures. The relevant procedures are described in Chapter 7 of this Manual.

In addition to the above procedures, the Asiana Cargo department has additional guidelines in the form of "Additional Dangerous Goods Handling Procedures for IATA Dangerous Goods Regulations," last amended in August 2011. The guidelines include specific procedures for cargo acceptance personnel to use for the prevention of accepting undeclared dangerous goods.

The cargo agents intending to offer dangerous goods shipments at Asiana's Incheon Airport cargo facilities are first required to register as a dangerous goods handling agent of Asiana Airlines and provide IATA Dangerous Goods Regulations training documentation for personnel that are involved with inspecting shipments and preparing related documents.

At present, Asiana Airlines has a roster of 96 freight forwarders/cargo agents approved to offer dangerous goods to the company facilities at Incheon Airport.

All dangerous goods that are delivered to the Asiana Cargo department must be tendered loose and are subjected to an inspection by an Asiana dangerous goods specialist on the basis of the IATA Dangerous Goods

Regulations.

1.18.3.11 Cargo Wreckage

As of January 2012, about 95 cargo wreckage items were salvaged and the loading position was determined for 65 items.

The ULD container at position LL of the main cargo deck was recovered. No traces of fire damage was found on the inside of the wreckage as shown in [Figure 51], but the outside of the container was heavily covered in soot.



[Figure 51] Inside and Outside of the ULD Container at Position LL

Films that had been loaded in ULD position MR was recovered with burned and blackened traces.

There were no fire damage or sooting in the container wreckage located at 44L and 43L of the lower cargo compartment.

Edge rails of cargo pallets were found separated from the pallets as shown in [Table 26], and the serial number of a certain rail could be confirmed as shown in [Figure 52].

Location		Rail Condition
41 P	Bottom floor pallet	No sooting, severe corrosion, and the net that fixed cargo was attached
	19 empty pallets	Pallet edge rails were found from 6 out of 19 pallets, all have no traces of fire
	SL	Traces of soot and slight melting
	SR	Traces of soot and slight melting, some portions with severe corrosion
	PR	Traces of soot and blue dye splatters Cargo net with 2-strand burnt traces, the one end with blue dye splatters, the other end with red dye splatters
	ML	Trances of burning and soot
	LR	No traces of fire

[Table 26] Condition of Edge Rails




[Figure 52] Rail Sample Marked with Serial Number

Recovered debris from the cargoes loaded at positions 11P, 12P, 22P, 31P, 32P, CR, DL, DR, EL, ER, FL, FR, GL, GR, HR, JR, KR, and LL included communications equipment, electronic parts, various reel tapes, computers and computer parts, and plastic packaging, but all had no traces of fire damage.

1.18.4 Emergency Procedures for Fire Main Deck

Emergency procedures for Fire Main Deck in the flight crew operations manual in effect at Asiana Airlines on the day of the accident had been revised on April 1, 2011. The procedures are as follows:

8.32


ASIANA AIRLINES
 747 Flight Crew Operations Manual

MAIN
DECK

FIRE MAIN DECK
FIRE MN DK AFT, FWD, MID

HL7413 - HL7415, HL7419, HL7420, HL7436 - HL7616


Condition: Smoke is detected in the main deck cargo area(s).

- 1 Don the oxygen masks.
- 2 Establish crew communications.
- 3 SUPRNMRY OXY switchON
- 4 MAIN Deck CARGO FIRE
ARM switchConfirmARMED

HL7436 - HL7616
SATCOM will shut down to prevent overheating.

Two packs are automatically shut down and the associated PACK messages are shown.

Select the pack control selectors that have the PACK messages shown.

- 5  PACK control selectors One pack on, two packs **OFF**

Warning! Either pack 1 or 3 must be operating to prevent excessive smoke accumulation on the flight deck.

- 6 CARGO FIRE
DEPRES/DISCH switch Push and hold for 1 second

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 8.32 D6-30151-423(AAR) April 1, 2011

ASIANA AIRLINES 
747 Flight Crew Operations Manual

8.33

▼ FIRE MAIN DECK continued ▼

- 7 Climb or descend to 25,000 feet when conditions and terrain allow.
- 8 Plan to land at the nearest suitable airport.
- 9 Do **not** accomplish the following checklists:
CABIN ALTITUDE or Rapid Depressurization
TEMP ZONE
TRIM AIR OFF

10 Checklist Complete Except Deferred Items

▼ Continued on next page ▼

8.34

ASIANA AIRLINES 
747 Flight Crew Operations Manual

▼ FIRE MAIN DECK continued ▼

Deferred Items

Descent Checklist

- Recall Checked
- Autobrake ____
- Landing data VREF____, Minimums____
- Approach briefing Completed

Approach Checklist

- Altimeters ____

Warning! Inform ground personnel not to open the cargo door until all supernumeraries and crew have exited the airplane and fire fighting equipment is nearby.

Landing Checklist

- Speedbrake Armed
- Landing gear DOWN
- Flaps ____



Valid emergency procedures on the day of the accident are the procedures issued by the Boeing Company on May 10, 2011. This revised checklist was distributed to B747 pilots on August 1, 2011 after the accident. The revised procedures are as follows:

8.32 ASIANA AIRLINES
747 Flight Crew Operations Manual

MAIN DECK

FIRE MAIN DECK

FIRE MN DK AFT, FWD, MID

HL7413 - HL7415, HL7419, HL7420, HL7436 - HL7616

Condition: Smoke is detected in the main deck cargo area(s).

- 1 Don the oxygen masks.
- 2 Establish crew communications.
- 3 SUPRNMRY OXY switch ON
- 4 MAIN Deck CARGO FIRE ARM switch Confirm ARMED

HL7436 - HL7616
SATCOM will shut down to prevent overheating.
Two packs are automatically shut down and the associated PACK messages are shown.

- 5 PACK 2 control selector OFF

Warning! Either pack 1 or 3 must be operating to prevent excessive smoke accumulation on the flight deck.

- 6 CARGO FIRE
DEPRES/DISCH switch Push and hold for 1 second
- 7 Expedite a climb or descent to 25,000 feet when conditions and terrain allow. Plan to stay at 25,000 feet as long as possible. After the descent has been started, do not delay the approach and landing.

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8.32

D6-30151-423(AAR)

May 10, 2011

▼ FIRE MAIN DECK continued ▼

- 8 Plan to land at the nearest suitable airport.
- 9 Do **not** accomplish the following checklists:
 - CABIN ALTITUDE or Rapid Depressurization
 - PACK
 - TEMP ZONE
 - TRIM AIR OFF

10 Checklist Complete Except Deferred Items

Deferred Items

Descent Checklist

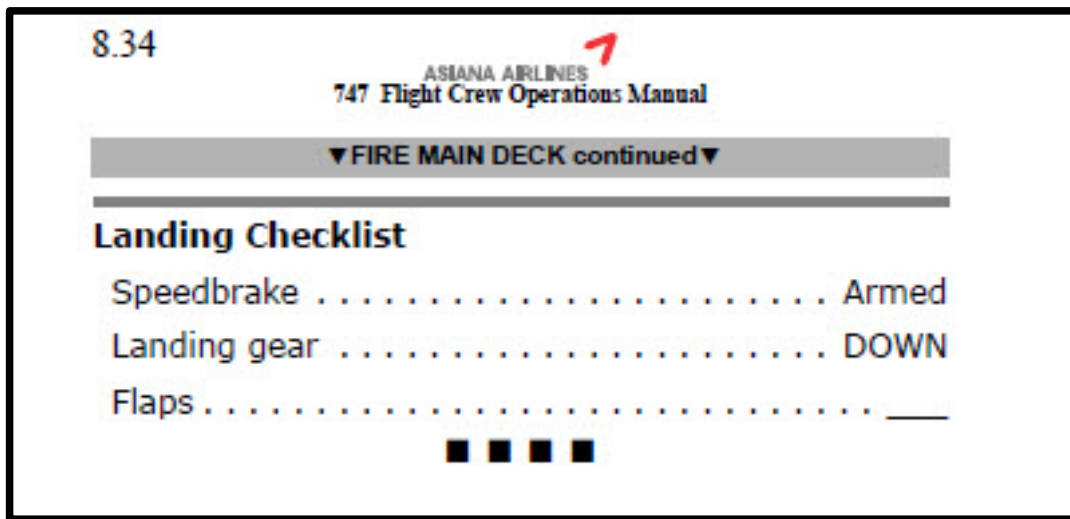
- Recall Checked
- Autobrake ___
- Landing data VREF___, Minimums___
- Approach briefing Completed

Approach Checklist

- Altimeters ___

Warning! Inform ground personnel not to open the cargo door until all supernumeraries and crew have exited the airplane and fire fighting equipment is nearby.

▼ Continued on next page ▼



According to data submitted by a person concerned with Asiana Airlines, a plan for revising the procedures was posted on the Intranet crew bulletin board on April 12, 2011.

According to log-in records, the captain and the first officer read this notice on April 12 and 14, 2011, respectively.