ARAIB

Report NO. ARAIB/AIR-F0801

Aircraft Serious Incident Report

Runway excursion during landing
China Airlines, Taiwan
A340-300
B18802
Incheon International Airport
15 August 2008

December 30, 2010

Aviation and Railway Accident Investigation Board
Ministry of Land, Transport and Maritime Affairs
Republic of Korea

According to the provisions of the Article 30 of the Aviation and Railway Accident Investigation Act of the Republic of Korea, it is stipulated;

The accident investigation shall be conducted separately from any judicial, administrative disposition or administrative lawsuit proceedings associated with civil or criminal liability.

And in the Annex 13 to the Convention on International Civil Aviation, Paragraphs 3.1 and 5.4.1, it is stipulated and recommended as follows;

The sole objective of the investigation of an accident or incident shall be the prevention of accidents and incidents, and it is not the purpose of the activity to apportion blame or liability. Any judicial or administrative proceedings to apportion blame or liability should be separate from any investigation conducted under the provisions of this Annex.

Thus, this incident investigation report issued as the result of the investigation on the basis of the Aviation and Railway Accident Investigation Act of the Republic of Korea and the Annex 13 to the Convention on International Civil Aviation, shall not be used for any other purpose than to improve aviation safety.

In case of divergent interpretation of this report between the Korean and English languages, the Korean text shall prevail.

Aircraft Serious Incident Report

Aviation and Railway Accident Investigation Board, Runway excursion during landing, China Airlines, Taiwan A340-300, B18802, Incheon International Airport, 15 August 2008. Aircraft Serious Incident Report ARAIB/AIR-F0801. Seoul, Republic of Korea.

The Aviation and Railway Accident Investigation Board (ARAIB), Republic of Korea, is a government organization for independent investigation of aviation and railway accident, and the ARAIB conducts accident investigation in accordance with the Aviation and Railway Accident Investigation Act of the Republic of Korea and Annex 13 of the Convention on International Civil Aviation.

The objective of investigation by the ARAIB is not to apportion blame or liability but to prevent accidents and incidents.

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China Airlines, Taiwan
Airbus A340-300
B18802
Incheon International Airport, Republic of Korea
15 August 2008

Synopsis

On 15 August 2008, around 11:27 China Airlines (CAL) Flight 160, A340-300, B18802 aircraft (hereinafter referred to as "Flight 160"), which departed Taoyuan International Airport, Taipei, and was approaching to land on the Incheon International Airport runway 34, encountered a precipitation. After touchdown, the aircraft ran off onto the grass right of the runway about 1,000 feet from the threshold of runway 34. A go-around was made after the aircraft ran off the runway.

Informed of the incident on the day, the Aviation and Railway Accident Investigation Board (hereinafter referred to as "ARAIB") dispatched the investigators to investigate the aircraft, tire marks on the runway and the site of facility damage, and notified the ICAO and the Aviation Safety Council of Taiwan of the incident occurrence. The investigation team conducted on-site investigation and collected factual information together with the investigators of the Aviation Safety Council of Taiwan. Based on these processes, the ARAIB prepared a factual report.

The ARAIB derived the results of investigation from the factual information and analysis thereof of the incident of Flight 160, and based on the results of investigation, issued two (2) safety recommendations to the Office of Civil Aviation, Ministry of Land, Transport and Maritime Affairs, Republic of Korea and two (2) safety recommendations to the China Airlines.

1. Factual Information

1.1 History of Flight

Flight 160, which departed the Taoyuan International Airport of Taipei for the Incheon International Airport of the Republic of Korea, encountered precipitation during landing on runway 34 of the Incheon International Airport on 15 August 2008 around 11:27. The aircraft ran off onto the grass right of the runway about 1,000 from the threshold of runway 34 and touched down with its left and right main landing gear. The aircraft made a go-around after it ran off the runway.

Flight 160 was a scheduled international passenger flight and was operating on an instrument flight rules (IFR) flight plan. On board the Flight 160 were the captain, first officer, 11 cabin attendants and 232 passengers, but there was no casualty caused by this incident. But the aircraft came into contact with runway facilities on its way to the go-around, which caused a 15 cm rupture damage to the lower left surface of aft fuselage due to the collision with facility fragments. The weather at the time of the incident was instrument meteorological condition.

The Flight 160 pilots arrived at the assigned aircraft in the Taoyuan Airport around 08:00 and made flight preparations, including an exterior check. When the pilots confirmed the flight data, the weather en route and destination, the Incheon Airport, was visual meteorological condition.

Flight 160 took off from runway 24 of the Taoyuan Airport around 09:10 and flew on B576 at a cruising altitude of 37,000 feet. The captain was the pilot flying[1)], and the first officer was the pilot monitoring[2)].

About 300 NM away from the Incheon Airport, the pilots received D-ATIS[3)] of the Incheon Airport by ACARS[4)], and understood the Incheon Airport weather as visibility of 6 kilometers and ceiling of 11,000 feet with cloud coverage of broken[5)], and the

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1) The pilot responsible for actually flying the aircraft.

2) The pilot who is not actually flying the aircraft but discharges support duties such as carrying out communications and checklists.

3) Digital Automatic Terminal Information Service: service of providing latest daily information to departing/arriving aircraft by continuous and repetitive broadcasting for a given duration of the day through ACARS

4) Aircraft Communications Addressing and Reporting System: a digital data connection system for sending small messages between aircraft and ground station using radio or satellite communication.

type of approach and using runway as ILS/DME RWY 33R.

According to the recordings of the Cockpit Voice Recorder, at 10:17:47 the controller of the Incheon Area Control Center (ACC) informed Flight 160 that Flight 160 was radar identified and the runway in use at the Incheon Airport was the runway 33.

At 11:08:38 the controller of the Incheon ACC handed over Flight 160 to the Seoul Approach Control. At 11:08:55 the pilot reported to the Seoul Approach controller that Flight 160 was passing the altitude of 18,000 feet for 17,000 feet and confirmed "S" for ATIS. According to the ATIS "S", the approach type and runway was ILS 33R and visibility 6 kilometers. At 11:09:14 the Seoul Approach controller advised Flight 160 that the approach would be made to the runway 34.

At 11:16:09 the Seoul Approach controller handed over Flight 160 to the Incheon Arrival controller of the Seoul Approach Control, and at 11:16:40 the Incheon Arrival controller advised Flight 160 that the approach runway was 34 and at 11:20:46 cleared it for ILS 34 approach.

At 11:22:40 the Incheon Arrival controller handed over Flight 160 to the Incheon Control Tower. At 11:23:01 the Incheon Control Tower advised Flight 160 of wind calm and to continue approach to runway 34. At 11:23:09 the Flight 160 pilots mentioned the meteorological phenomenon displayed in red[6)] on airborne weather radar. Subsequently the pilots talked that the size of the meteorological phenomenon displayed on radar screen was very big, judging it to be cloud with rain.

At 11:23:38 the Incheon Tower controller advised Flight 160 of the runway visual range(RVR) of runway 34 as follows:

“RVR Touch Down 700, Mid 2,000, Rollout 2,000 or above” [7)]

At 11:23:51 the captain said that the weather phenomenon on radar was cloud, it was raining, and the size of cloud was large. At 11:23:59 the captain confirmed to the first officer that CAT I[8)] approach minimum RVR was 550 meters and said his

5) Cloud coverage in which the sky is covered with cloudiness of 5/8～7/8
6) Red color display on weather radar means severe precipitation.
7) “The touchdown zone runway visual range is 700 meters, the midpoint 2,000 meters, and the rollout end 2,000 meters or more”.
8) Category Ⅰ- Precision instrument approach category which the decision height is 60 meter above touchdown zone elevation, visibility 800 meters or runway visual range 550 meter or more.

intention to land by autopilot. At 11:24:11 the Incheon Control Tower controller cleared Flight 160 to land advising the RVR was 650 meters.

At 11:26:14 the first officer said, "Oh, the rain is really heavy.” At 11:26:19, hearing the synthetic voice, "Minimum," which means the aircraft was passing the minimum altitude of 223 feet, the captain said runway in sight ahead. At 11:26:23, the captain said, "This is not right, this," and then the sound of wiper operating was recorded. At 11:26:25 the captain said, "I can still see it, oh" and then at 11:26:30 the audible signal of the autopilot being disengaged was recorded.

At 11:26:38 the automatic altitude reporting system reported 20 feet, and then at 11:26:39 the synthetic voice "Retard, Retard," was recorded. After the automatic altitude reporting system reported 10 feet at 11:26:40, the first officer said quickly "Drift, drift to the right, drift to the right" at 11:26:42. At 11:26:42 the voice of calling 5 feet of the automatic altitude reporting system was recorded. At 11:26:43 as the first officer said "Go around", the captain made a go-around calling out "Go around."

For 6 seconds from 11:26:46, the sound of the aircraft's main warning signal was recorded. According to the flight data recorder, Flight 160 was airborne at 11:26:52. After airborne, Flight 160 made an approach by radar vector and landed via ILS/DME RWY33R. After landing, the maintenance personnel discovered the damages on the lower left surface of the aft fuselage, etc. and informed the pilot what they found out. The captain reported these matters to the control tower, and the subsequent operation of Flight 160 was canceled.

1.2 Injuries to Persons

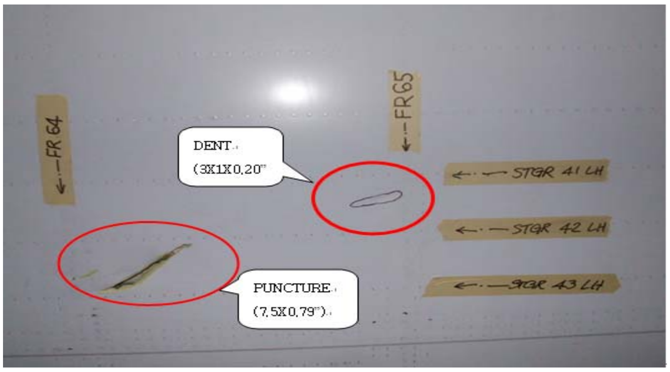
There was no injury to person caused by this incident.

1.3 Damage to Aircraft

The total damage to the aircraft was estimated to be 296,000 US dollars (about 450,000,000 Korean won).

1.3.1 Damage to the Left Side of Aft Fuselage

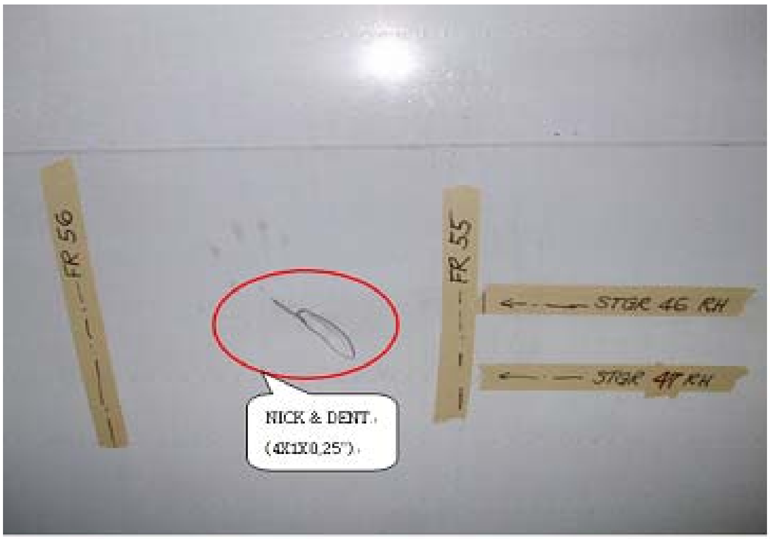
As shown in Photo 1 below, the lower left surface of aft fuselage (between stringer number 42LH～43LH and frame number 64～65) was punctured (7.5 X 0.79") and the bottom left surface of aft fuselage (between stringer number 41LH～42LH, frame number 64～65) was dented (3 X 1 X 0.20").



[Photo 1] Damage to bottom left of aft fuselage

1.3.2 Damage to the Right Side of Aft Fuselage

As shown in Photo 2 below, the bottom right surface of aft fuselage (between stringer number 41RH～42RH, frame number 64～65) was nicked and dented (4 X 1 X 0.25").



〔Photo 2〕 Damage to lower right surface of aft fuselage

As shown in Photos 3-1 and 3-2 below, the lower right surface of aft fuselage and below the passenger door (stringer number 37RH～48RH, frame number 69～76) were scratched in many places.

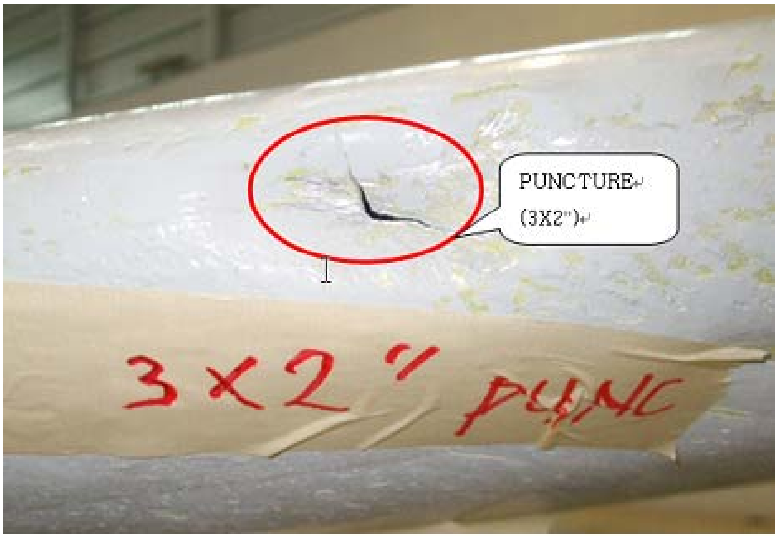
[Photo 3-1] Damage to lower right surface of fuselage in the rear

[Photo 3-2] Damage to lower right surface of aft fuselage

1.3.3 Damage to Horizontal Stabilizer Tip Assembly

As shown in Photos 4 and 5 below, the left horizontal stabilizer tip portion was dented in many places and the front side was punctured.

[Photo 4] Damage to horizontal stabilizer 1



[Photo 5] Damage to horizontal stabilizer 2

1.3.4 Bulk Tire Nicked

As shown in Photo 6 below, #1 tire of the left main landing gear was nicked.

[Photo 6] #1 tire nicked

1.4 Other Damages

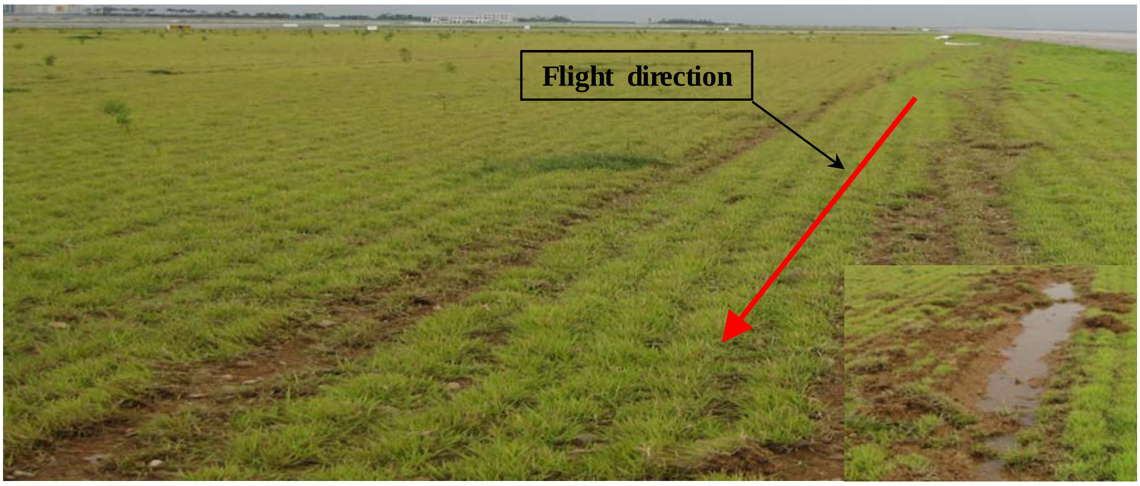
Two taxiway lights[9] located on both sides of Taxiway "T", one taxiway guidance sign[10], and one “10/3” runway distance marker sign[11] were broken by contact with the landing gear and airframe of Flight 160 as shown in Photo 7 and Photo 8.

The landing strip between taxiways “T" and “N2" was damaged by the landing gear of Flight 160, about 400 meters long, 18 centimeters deep at most, and 80 centimeters wide at most as shown in Photo 9.

[Photo 7] Taxiway lights damaged and restored to normal condition

9) Light number: TED02X47, TED02X61
10) Light number: TGS03X-08
11) Light number: DMS01X-015

[Photo 8] Runway distance marker sign damaged



[Photo 9] Landing strip damaged

1.5 Personnel Information

1.5.1 The Captain

The captain (male, 44) was employed by the China Airlines in August 1991. He held an airline transport pilot license (license number 101696) and type ratings in A340-300 and A330 issued by the Taiwan Civil Aviation Authority. The captain's latest airman medical certificate was issued in May 2008 and had no limitation.

The captain started working for the China Airlines as a first officer of B747-200 and became a captain of B747-200 in 2000. He has been working as a captain of A340-300 since 2004.

According to the records of the China Airlines, his total flying time was 9,718 hours including 3,418 hours as a captain of A340.

According to the captain's statements on his last 72 hours activities before the incident, he stayed home on 12 August since he was off duty. On 13 August he made a round trip flight for Taipei/Hongkong, and on 14 August he was off duty so he took care of his children and did some exercise.

1.5.2 The First Officer

The first officer (male, 33) was employed by the China Airlines in November 2005. He held a commercial pilot license (license number 302342) and a type rating in A340-300 issued by the Taiwan Civil Aviation Authority. His latest airman medical certificate was issued in May 2008, with the limitation of wearing glasses or contact lenses for vision correction. And he weared glasses when he was interviewed.

The first officer has been working as a first officer of A340-300 since he started working for the China Airlines.

According to the records of the China Airlines, his total flying time was 1,695 hours including 1,438 hours on A340.

According to his statements on his last 72 hours activities before the incident, on 12 August he had a round trip flight for Taipei/Hanoi and on 13 August he attended a safety meeting in the company. On 14 August, his day off, he spent his time with a friend of his.

1.5.3 Local Controller of Control Tower

The local controller (male, 39), who was in charge of the provision of the aerodrome control for Flight 160, obtained the air traffic controller license on 28 April 1995, was appointed as an air traffic controller belonging to the Seoul Regional Aviation Administration(SRAA) on 20 June 1996, and obtained the rating for the aerodrome control service of the Incheon Control Tower. Since his obtainment of the rating he has been discharging the aerodrome control service in the Incheon Control Tower until the time of the incident on 15 August 2008.

His activities during last 24 hours before 08:00 on the day of the incident: he worked at the Control Tower from 12:00 to 21:00 on 14 August, and after that he rested at home until the duty time on the day of the incident.

1.6 Aircraft Information

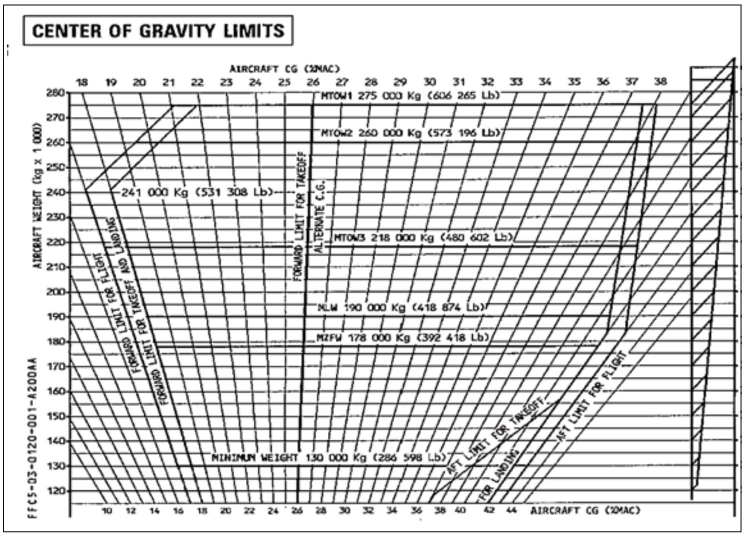
1.6.1 Aircraft history

Flight 160 was a pressurized, low-wing and wide body passenger transport category aircraft and equipped with four CFM56-5C4 engines. The aircraft had 35,460 flight hours till the day of the incident and made 1,233 flight cycles. The aircraft was manufactured by the Airbus Company in 2001 and the China Airlines introduced it in June 2001. The aircraft was airworthiness certified and the planned maintenances had been performed properly.

1.6.2 Weight and Balance

Flight 160 had the maximum take-off weight of 275,000 kg(606,265 pounds), the maximum landing weight 190,000 kg (418,874 pounds), and the maximum zero-fuel weight of 198,000 kg (392,418 pounds). The weight and balance table based on the flight crew operation manual approved by the Taiwan Civil Aviation Authority is shown in Table 1 below.

According to this Table, the take-off weight was 218,522 kg (401,824 pounds), zero-fuel weight was 164,484 kg(362,624 pounds), and the center of gravity of aircraft during takeoff was 33.6% MAC (Mean Aerodynamic Chord) and the center of gravity of zero-fuel weight was 34.5% MAC.



[Table 1] Weight and balance data

1.7 Meteorological Information

1.7.1 Incheon Airport Automatic Observation Weather

The automatic observation weather data for runway 34 at the time when Flight 160 was landing on the runway 34 is shown in the Table 2 below.

Data by Minute

기상자료 : 34

time	mean DIR 10 min			mean SPD 10 mim			temp	dew pt	hum	PW	MOR(Meter)			RVR(Meter)			min CIG	Ambient Pressure			
	mean	max	min	mean	max	min					16	MID	34	16	MID	34		QFE	QFF	QNH	QNH
11:16	300	320	290	7.8	9.6	5.7	26.1	23.4	84	DSSS	P2000	P2000	P2000	P2000	P2000	P2000	NCD	1000.7	1000.8	1001.3	29.57
11:17	300	320	290	7.7	9.6	5.7	26.3	23.4	84	DSSS	P2000	P2000	P2000	P2000	P2000	P2000	NCD	1000.7	1000.8	1001.3	29.57
11:18	310	330	290	7.5	9.6	4.9	26.2	23.8	86	DSSS	P2000	P2000	P2000	P2000	P2000	P2000	16900	1000.7	1000.8	1001.3	29.57
11:19	310	330	290	7.3	9.6	4.8	26.2	23.9	88	RA	P2000	P2000	1900	P2000	P2000	1900	NCD	1000.7	1000.8	1001.3	29.57
11:20	310	330	290	7.0	9.6	3.9	25.9	23.8	89	RA	P2000	P2000	1100	P2000	P2000	1100	NCD	1000.7	1000.8	1001.3	29.57
11:21	310	330	290	6.7	9.6	2.5	25.8	24.0	90	RA	P2000	P2000	800	P2000	P2000	800	NCD	1000.7	1000.8	1001.3	29.57
11:22	310	330	280	6.1	9.6	1.9	26.0	24.1	90	RA	P2000	P2000	800	P2000	P2000	800	NCD	1000.7	1000.8	1001.3	29.57
11:23	310	330	260	5.4	9.6	1.4	25.9	24.4	91	RA	P2000	P2000	700	P2000	P2000	750	20000	1000.6	1000.8	1001.2	29.57
11:24	360	130	000	4.7	9.1	0.5	25.8	24.1	91	RA	P2000	P2000	600	P2000	P2000	650	NCD	1000.7	1000.8	1001.2	29.57
11:25	360	200	000	4.1	8.8	0.5	25.6	23.8	90	RA	P2000	P2000	600	P2000	P2000	650	NCD	1000.6	1000.7	1001.2	29.57
11:26	010	290	000	3.4	7.4	0.2	25.6	24.3	92	RA	P2000	P2000	700	P2000	P2000	750	NCD	1000.6	1000.7	1001.2	29.57
11:27	040	340	000	3.0	6.2	0.2	25.7	24.3	92	RA	P2000	P2000	900	P2000	P2000	900	NCD	1000.6	1000.7	1001.2	29.57
11:28	080	340	000	2.8	6.2	0.2	25.5	23.8	90	RA	P2000	P2000	900	P2000	P2000	900	NCD	1000.6	1000.7	1001.2	29.57
11:29	110	340	000	2.4	5.9	0.2	25.5	24.0	91	RA	P2000	P2000	1300	P2000	P2000	1300	NCD	1000.6	1000.7	1001.2	29.57
11:30	360	050	000	2.1	4.2	0.2	25.8	23.9	90	RA	P2000	P2000	1700	P2000	P2000	1700	NCD	1000.5	1000.7	1001.1	29.57
11:31	190	360	000	2.0	4.0	0.2	25.7	23.9	90	RA	P2000	P2000	P2000	P2000	P2000	P2000	NCD	1000.5	1000.7	1001.1	29.56
11:32	360	060	000	2.0	4.5	0.2	25.7	24.0	90	RA	P2000	P2000	P2000	P2000	P2000	P2000	NCD	1000.5	1000.6	1001.1	29.56
11:33	360	060	000	2.3	4.9	0.2	25.8	23.8	89	RA	P2000	P2000	P2000	P2000	P2000	P2000	NCD	1000.5	1000.6	1001.1	29.56
11:34	360	060	000	2.6	5.9	0.2	25.8	24.0	90	RA	P2000	P2000	P2000	P2000	P2000	P2000	NCD	1000.4	1000.6	1001.0	29.56
11:35	340	360	190	2.9	5.9	0.2	25.8	24.0	90	RA	P2000	P2000	P2000	P2000	P2000	P2000	NCD	1000.4	1000.6	1001.0	29.56

[Table 2] Runway 34 weather data

When Flight 160 was aligned with the extended centerline of runway 34 at 11:22:56, the wind of runway 34 given by the Incheon Control Tower local controller to Flight 160 was "calm"[12], and the RVR given at 11:23:37 was 700 meters for the runway 34 touchdown point, 2,000 meters for the midpoint and 2,000 meters for the roll out point of the runway.

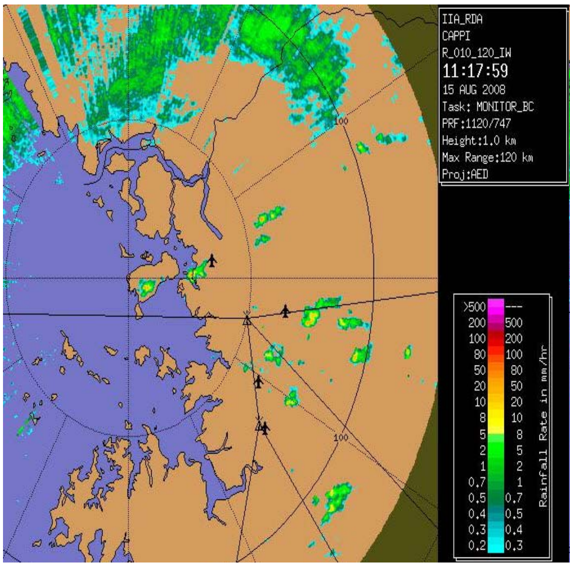
12) Wind speed is less than 3 knots.

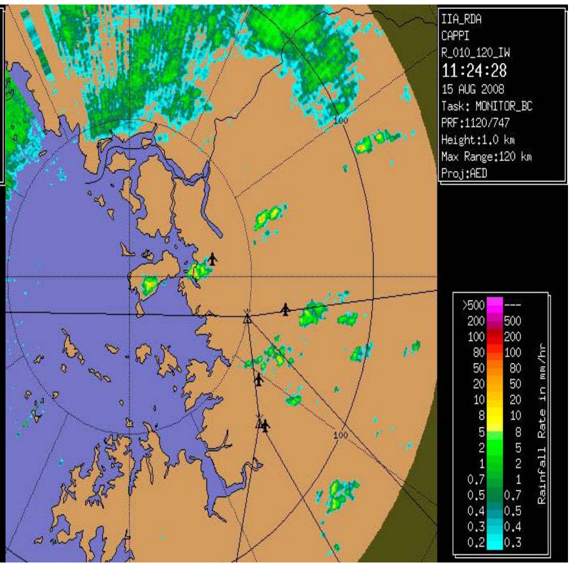
At 11:24:12 when Flight 160 was about 5 miles on the final approach course of runway 34, the weather given by the local controller to Flight 160 as it was cleared to land was RVR 650 meters, surface wind "calm."

1.7.2 Weather observed by the Terminal Doppler Weather Radar(TDWR)

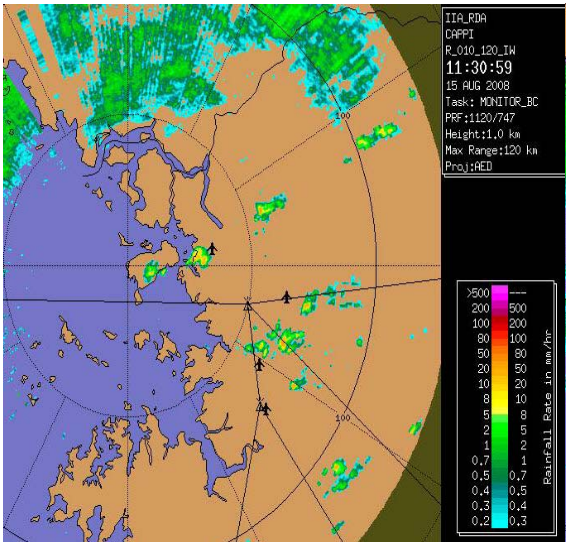
In the Incheon Control Tower, one TDWR display unit was installed at the Tower Chief position located at the center of the Control Tower.

The precipitation ratio images observed by the TDWR around the time when Flight 160 was approaching to land on the Incheon Airport runway were as shown in Figures 1, 2, 3 and 4. According to these, small banks of cloud containing precipitation of 20 mm or more per hour were passing the south end of Incheon Airport from west to east.

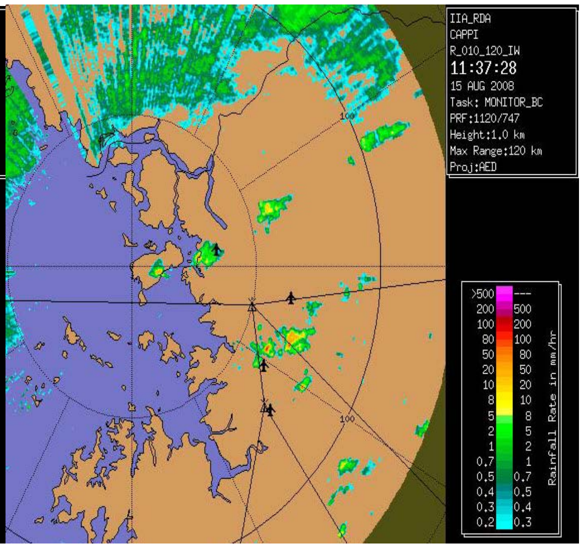




[Fig. 1] Precipitation image at 11:17:59 [Fig. 2] Precipitation image at 11:24:28

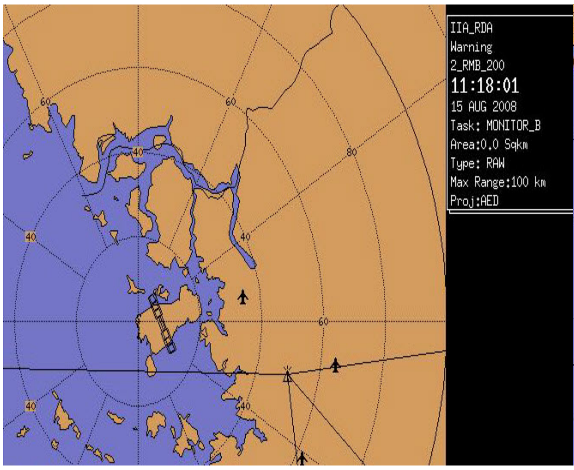


[Fig. 3] Precipitation image at 11:30:59

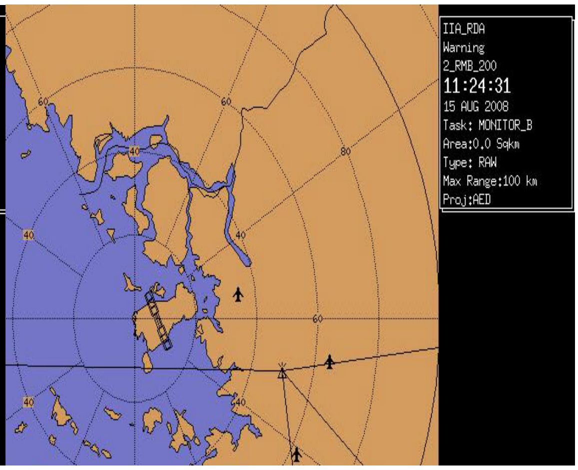


[Fig. 4] Precipitation image at11:37:28

The images of the microburst detector (TDWR) at the time when Flight 160 was approaching runway 34 are shown in Figures 5 and 6, and the microburst was not detected according to these image data.



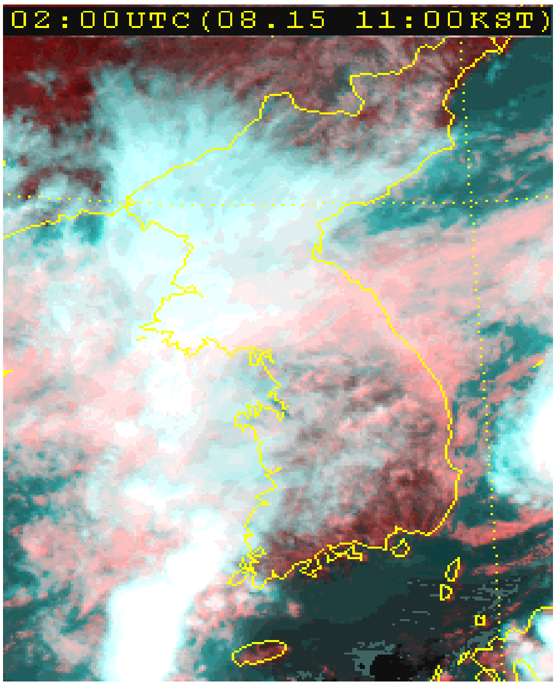
[Fig. 5] Microburst Detector image at 11:18:01



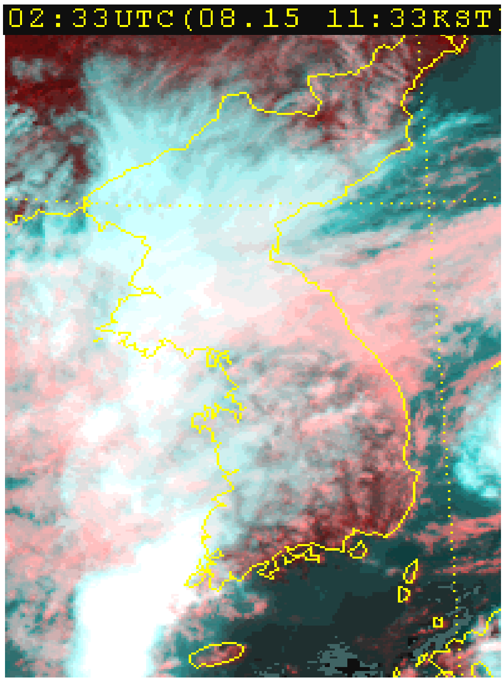
[Fig. 6] Microburst Detector image at 11:24:31

1.7.3 Weather Observed by Weather Satellite

The distribution of clouds as observed by the weather satellite at the time when Flight 160 was approaching was laid lengthily north to south along the west coast of the Korean peninsula as shown in Figures 7 and 8.



[Fig. 7] Cloud distribution image at 11:00



[Fig. 8] Cloud distribution image at 11:33

1.8 Aids to Navigation

According to the records of the remote monitoring equipment, the instrument landing system (ILS) and the distance measuring equipments (DME) used by Flight 160 when it was approaching to land on Incheon Airport runway 34 were operating normally.

According to the records of the Incheon Airport lighting facility[13] monitor, after Flight 160 making a go-around from runway 34 at 11:26:53, the runway lights, runway centerline lights and approach lighting system were turned on in sequence between 11:29:37 and 11:29:41.

According to the Air Traffic Control Procedures, paragraph 3-4-4, the approach lighting system is to be operated when the prevailing visibility is below 5 statute miles, and according to the same Procedures, paragraph 3-4-9, the runway lighting system is to be operated when the ground visibility of the runway in use is less than 2 statute miles.

1.9 Communications

According to the records of communications between Flight 160 and air traffic

13) Navigation facilities for assisting aircraft by light.

control, there was no communication problem between the flight crew and controllers.

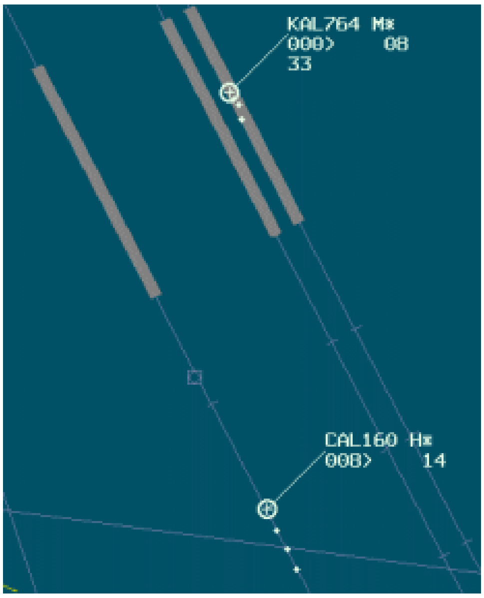
1.10 Aerodrome Information

1.10.1 General Description

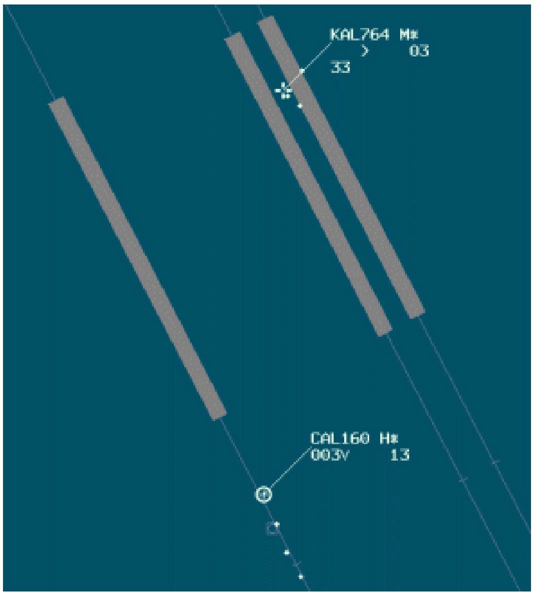
The dimensions of the Incheon Airport runway 34 are as follows;
landing distance available 4,000 m, width 60 m, true bearing 324.67°, touchdown zone elevation 7 meters (22.9 feet), and the runways are equipped with lighting systems suitable for the CAT-III[14] operation, and the CAT-IIIB approach was possible at the time of the incident.

1.10.2 Airport Surveillance Radar Recordings

According to the recordings of the airport surveillance radar, the lateral deviation situations from the extended centerline of runway 34 until immediately before touchdown of Flight 160 are as shown in Figures 9 to 12.

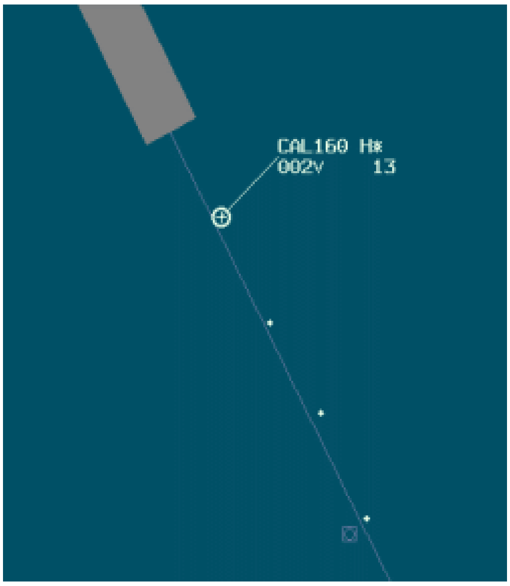


[Fig. 9] Position at 800 feet

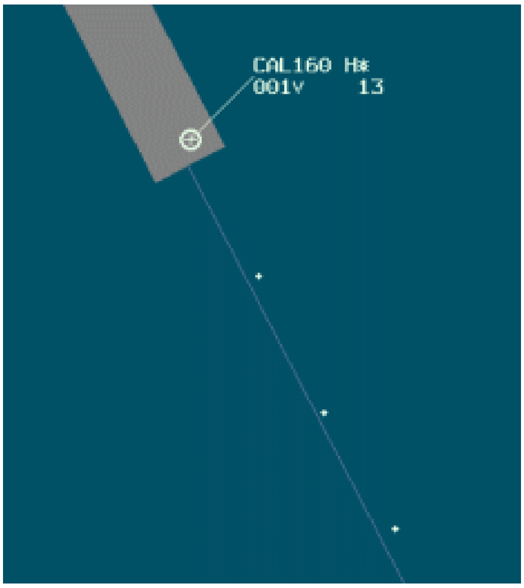


[Fig. 10] Position at 300 feet

14) Category IIIA - A precision instrument approach and landing with: a decision height lower than 30 m, or no decision height: and the runway visual range not less than 200 m
Category IIIB - A precision instrument approach and landing with: a decision height lower than 15 m, or no decision height: and a runway visual range less than 200 m but not less than 50 m.

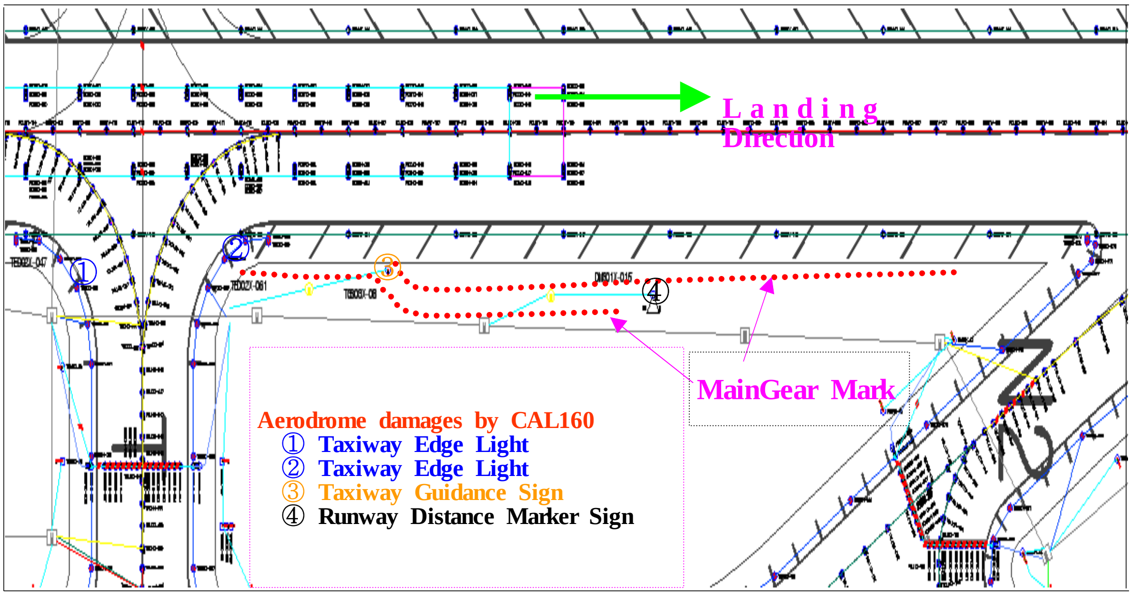


[Fig. 11] Position at 200 feet



[Fig. 12] Position at 100 feet

According to the records of the ASDE (Airport Surface Detection Equipment) and the results of investigation of the trace, the circumstances of runway excursion as shown roughly in Figure 13.



[Fig. 13] Situation map of runway excursion

1.11 Flight Recorders

The Flight 160 aircraft was equipped with a solid state flight data recorder (SSFDR)[15] made by the Honeywell Company that can record for more than 25 hours.

The investigation team down loaded the data from the flight data recorder, and analyzed the parameters for the time period of the incident.

The cockpit voice recorder installed in the aircraft was a solid state cockpit voice recorder (SSCVR)[16] made by the L3 Communications Company that can record for 120 minutes. The investigation team made a transcript of about 20 minutes before and after the incident from the cockpit voice recorder.

The results of analyzing major parameters of the flight recorders are shown in Table 3 below.

UTC Time	FDR data & trajectory	CVR data / Note
11:25:36	■ A/C GW 169.7t (MLW 190t) ■ CG 33.3% ■ Both A/P engaged, in LOC and G/S ■ A/THR engaged, speed managed ■ Vapp 134kt (VLS+ 5) ■ Configuration FULL (slats/flaps=24°/32°) ■ Gear down. ■ A/C aligned on LOC and G/S ■ Magnetic Heading ~ 332° (runway QFU 332°) ■ CAS ~ Vapp ■ RA = 730ft	
11:26:02		CM1: "Runway ahead continue" CM2: "Check"
11:26:04	■ A/P LAND mode engages automatically Stabilized approach : ■ CAS = 133 kt ■ GS = 131 kt ■ LOC deviation ≈ 0.0 dot ■ G/S deviation ≈ 0.0 dot ■ Magnetic Heading = 332° ■ RA = 380ft	CM1: "LAND green" CM2: "Check"

15) Part No : 980-4700-003, Serial N0.: 7232
16) Part No.: 2100-1020-02, Serial N0. : 113721

UTC Time	FDR data & trajectory	CVR data / Note
11:26:14	■ RA = 250ft ■ A wind gradient resulted in CAS decreasing to a minimum 4 seconds later.	CM2: "Oh the rain is rea lly heavy"
11:26:18	■ CAS = 130 kt	
11:26:19	■ RA = 200ft ■ CAS = 131 kt ■ GS = 135 kt ■ A/THR commands a N1 increase, and both CAS and GS increase. ■ The A/C began deviating slightly above the glide (G/S deviation = 0.1 dot above beam) ■ The A/P commanded a pitch decrease to recover the flight path. The pitch decreases from 5° nose up to 1° nose up	A/C: "Minimum" CM1: "OK Runway ahea d" CM2: "Ok"
11:26:23		CM1: "this is not right this "
11:26:24		Sound of wiper sweeping
11:26:25		CM1: "I can still see it oh"
11:26:26	■ RA = 120ft ■ G/S deviation ≈ 0.5 dot above beam (0.35 μA) ■ CAS = 142 kt ■ Cross wind ≈ 5 kt from the right and decreasing	CM2: "Oh Yes"
11:26:28	■ Pitch at 1° nose up position	CM1: "Auto Pilot off"
11:26:29	■ RA = 76ft ■ A/P 1&2 disconnected ■ Both FD remained engaged ■ LOC deviation ≈ 0.1 dot right of beam ■ G/S deviation ≈ 0.4 dot above beam ■ The PF increases the pitch	A/C: "One hundred" CM2: "OK"
11:26:30	■ RA = 62ft ■ PF side stick input to the right (2.8°), then	A/C: Auto pilot disconnect

UTC Time	FDR data & trajectory	CVR data / Note
	back to neutral	
11:26:31	■ RA = 46ft ■ The A/C began to roll to the right (~2°) Cross wind veers from right to left	
11:26:33		A/C: "Fifty"
11:26:34	■ RA = 22ft ■ PF began applying left pedal inputs	A/C: "Forty"
11:26:35	■ RA = 22ft ■ CAS = 134 kt ■ Cross wind ≈ 5 kt from the left ■ PF orders right side stick inputs (10.5°) ■ The A/C roll increased to the right ■ The A/C started deviating to the right of the runway (LOC deviation ≈ 0.2 dot right of beam) ■ A/C heading moving to the left (Magnetic Heading = 331°)	A/C: "Thirty"
11:26:38	■ RA = 9ft	A/C: "Twenty"
11:26:39	■ RA 8ft ■ CAS = 128 kt ■ Bank angle ≈ 6° to the right ■ LOC deviation ≈ 0.4 dot right of beam ■ Magnetic Heading = 330° ■ PF side stick input neutral ■ Rudder pedal input to the left (12°) ■ Thrust Levers retarded (from CLIMB detent to FLIGHT IDLE) ■ A/THR disengaged	A/C: "Retard retard"
11:26:40		A/C: "Ten"
11:26:42	■ Right MLG Touch Down (until 02h26min46 s) ■ Aircraft 40m to the right of runway centreline	CM2: "drift, drift to the right, drift to the right" A/C: "Five"

UTC Time	FDR data & trajectory	CVR data / Note
	■ Pitch = 6° nose up ■ Roll = 5° to the right ■ PF side stick input to the left (5.6°) ■ GS = 133 kt ■ LOC deviation ≈ 0.7 dot right of beam ■ Magnetic Heading = 328°	
11:26:43	■ Left MLG Touch Down (until 02h26min50 s) ■ Max rudder pedal input to the left (30.2°) during 3 seconds ■ LOC deviation ≈ 0.8 dot right of beam Magnetic Heading = 326°	CM2: "Go around"
11:26:44	■ FMA A/THR TOGA Displayed ■ LOC deviation ≈ 0.9 dot right of beam ■ Magnetic Heading = 323° ■ TLA to TOGA detent ■ PF pulls the stick to full back stick while applying full left rudder pedal ■ The pitch increases	CM1: "Go around"
11:26:46	■ Magnetic Heading = 315° ■ Aircraft 50m to the right of runway centreline(20m from right edge)	Sound of master warning for 6 sec
11:26:47	■ Right MLG uncompressed ■ Magnetic Heading = 313° ■ Pitch 10° nose up ■ RA = 0ft	
11:26:49	■ RA = 0ft ■ The crew retracts one step of flap (FLAP FULL to FLAP 3)	CM2: "Flap"
11:26:50	■ Pitch 16° nose up ■ Bank angle 8° to the left ■ RA = 0ft	Note: The A/C significant sideslip angle, resulting from the full left pedal input resulted in banking the A/C to the left (dihedral effect[17]).
11:26:51	■ Left MLG uncompressed ■ Magnetic Heading = 317°	Note: the actual lift off time was possibly 1 or 2s before the LH MLG was

UTC Time	FDR data & trajectory	CVR data / Note
	■ GS = 123 kt ■ Loc deviation ≈ 80 mA to the right ■ Aircraft 20m to the right of runway centreline	seen uncompressed.
11:26:54	■ RA = 33ft ■ Side stick roll order = 20° ■ Bank angle = 11 ° to the right	
11:26:58	■ The crew selects Gear up	
11:27:11	■ The crew engages A/P 1	

[Table 3] Recordings of the Flight recorders

1.12 Wreckage Information

There was no wreckage in this incident.

1.13 Medical and Pathological Information

The two pilots held valid airmen's medical certificates, and no evidence of pathological factors or negative elements that could affect the pilots' ability to discharge their duty was found.

1.14 Fire

There was no fire in this incident.

1.15 Survival Aspects

There was no survival issue related to this incident.

17) In order to increase lateral stability of aircraft, the wing is attached to the fuselage with the end portion slightly upward compared with the root portion.

1.16 Tests and Research

No test and research were conducted in connection with this incident.

1.17 Organizational and Management Information

There was no organizational and management issues in this incident.

1.18 Additional Information

1.18.1 Summary of pilot's interview

The flight crew checked the related flight information and found that there was no significant weather report en route, the NOTAM and TAF (terminal aerodrome forecast) all indicated that the ICN airport was under visual meteorology condition and there was no anomalies shown on the runway and taxi way.

The flight crew acquired the weather, runway status of ICN airport from aircraft communication address and reporting system (ACARS). The visibilities was 6 Km, ceiling was 11,000 broken, meet the VFR condition (CAT 1).

The flight crew intercepted the ILS glide slope of runway 34 at 1,600 ft, 12 DME, and transferred the control from ICN approach to tower. The tower announced the runway RVR 700 meters. The flight crew found that the weather RDR detected a mass of CB above the runway 34 during approach. The tower reported the RVR 700 meters, higher than the CAT-I approach standards which is 550 meters minimum. The flight crew completed the landing final check list and felt the visibilities was going down, but still above the CAT-I landing minimum.

The flight crew applied auto pilot to conduct the ILS approach until passing 550 feet AGL and runway insight. Then the captain announced "runway in sight, continue" and disconnected the auto pilot to manual control.

The captain manually controlled the aircraft maintain the aircraft on the ILS glide slope. While passing the runway end, the rain falling was getting worse and the visibilities went down rapidly.

The flight crew felt the aircraft abnormal sink rate with the rain falling at the 50 feet auto call out. The visibilities almost went to 0 with the rain falling and the captain lost his visual contact to the runway while he started to flare. Moment later, the flight crew recovered there visual contact to the ground but they found the aircraft drift to the right. CM2 called "aircraft drift to the right, go around" but the aircraft was still sinking and the flight crew felt the gear had touched the ground at the moment of flight crew initiated go around.

After go around, the flight crew level off the aircraft at 3,000 ft and contacted approach prepared the next approach under the approach control. The flight crew report "low on fuel" to approach after they checked the fuel remaining was 8000 lb.

1.18.2 China Airlines' Flight Operations Manual

The flight operation policy of the China Airlines is prescribed in the Chapter 5 of the Flight Operations Manual. The Chapter 5 deals with cockpit resource management, cockpit procedures, weather minimums, visual flight operation, low visibility procedures, adverse weather procedures and risk management. Especially the Paragraph 9 contains the operational procedures to be used in cold and hot weather, turbulence, thunderstorm, wind shear, and penetration procedures for typhoons and volcanic ashes.

Chapter 6 has contents relating to procedures and control maneuvers. Especially the Paragraph 9 contains the meteorological information analysis, approach briefing procedures, and the specific procedures and techniques to be performed when conducting missed approach procedures.

The followings are important contents of the Flight Operations Manual relevant to this incident:

☐ Standard landing minimums (China Airlines FOM 5.5.5.2)

To operate below RVR 4,000ft or visibility 1,200 m on any approach, either flight director or autopilot must be engaged in Approach / Land Mode, as appropriate, special approach lighting, runway lighting or markings, and landing weight restrictions apply.

☐ Use of autopilot (China Airlines FOM 5.6.5.3)

An autopilot should be engaged for normal flight conditions above 10,000 ft. An autopilot must be engaged for all CAT II/IIIa approaches and autoland is mandatory if autopilot function is normal for the autoland maneuver. The autopilot and autothrottles, if functioning normally, shall be engaged for approaches in IMC anytime the reported ceiling and visibility is less than: 300 ft above DH/MDH; or 1,600 meters (1 mile) above minimum visibility/RVR For example, if the MDA for a VOR approach is 520 ft (400 ft MDH) and the minimum visibility is 1,600 meters, the autopilot must be used for the approach anytime the prevailing ceiling is less than 700 ft or visibility is less than 3,200 meters (2 miles). The autopilot, if functioning normally, shall remain engaged until required visual references are established, at which time the autopilot may be disconnected.

CM2[18] may conduct an autoland when flight conditions satisfy cruise captain / relief pilot / first officer takeoff and landing criteria.

□ Autopilot use during approach(China Airlines FOM 5.6.5.5)

Pilots should not necessarily disconnect the autopilot when visual conditions are established on an ILS approach. Plan to conduct an automatic landing any time visibility is marginal or when it is deemed necessary. Use of autoland is recommended if flight time exceeds 8 hours.

□ Missed approach (China Airlines FOM 6.10)

A go-around/missed approach is considered a normal procedure, which must be applied without hesitation when the required visual references cannot be established or in the event of an unstable approach. As such, flight crew members are expected to execute a missed approach without hesitation or fear of punishment. The basic rules for a missed approach are:

○ A missed approach must be initiated if the required visual references have not been established upon reaching the DA/DH or MAP.
○ If after descent below the DH/DA/MDA, the PF cannot maintain visual reference, or a safe landing cannot be assured, an immediate missed approach must be executed.
○ Protected obstacle clearance areas for missed approach are based on the assumption that the missed approach will be executed at the MAP, at an altitude not lower than MDA or DH/DA. No consideration is given to an early turn prior to reaching the MAP. Therefore, in the event of an early missed approach, published turns shall not be

18) the First officer acting a Pilot Flying

executed prior to reaching the MAP, unless instructed by ATC. Published altitude restrictions shall be carefully reviewed and flown.

○ If a missed approach has been executed, the PIC must verify fuel status and adequate fuel to operate to the alternate airport in compliance with Company fuel policy before executing a second approach.

○ If a second approach is missed due to weather conditions, diversion to the alternate is mandatory unless, in the opinion of the PIC, another approach is the safest course of action.

□ Airborne weather radar (China Airlines FOM 5.13.10)

Weather radar units must be activated at both pilot stations whenever operating in the vicinity of thunderstorms or other weather involving convective activity. Normally, radar returns should be displayed on the Navigation Display so that track can be easily compared to storm location in crosswind conditions. Steep rainfall gradient is associated with maximum turbulence and is a rapid change in rain intensity over a short horizontal distance. Use extreme caution when approaching a terminal area where airborne radar indicates developing (weak echo) or mature storms. Even weak storm echoes in the generation stage, can endanger an aircraft due to initial downdraft and gust front activity.

1.18.3 Principle of weather radar operation

According to the Airbus Company's manual[19)], it is essential to understand the principle of the airborne weather radar to interpret the phenomenon displayed on the weather radar.

The weather radar can detect precipitation only. Its capability of detection depends on the size of water droplet, composition and number of water droplet. Water droplets reflect about five times stronger than ice crystals of the same size.

The weather radar detects

- rain
- wet hail and wet turbulence

19) Flight Operations Briefing Notes, Adverse Weather Operation, Airbus Co.

- ice crystals, dry hail, dry snow, in this case, the reflection is weak.

Meanwhile, the weather radar does not detect

- cloud, fog or wind
- clear air turbulence (having no precipitation)

2. Analysis

2.1 General

The Flight 160 pilots completed training courses in accordance with the Aviation laws and related regulations of Taiwan, and held valid qualification certificates and aviation medical certificates, and their on-duty time, flight duty time, rest time and flight duty schedules were in conformity to relevant standards.

The Flight 160 aircraft was equipped with necessary equipments and had been maintained in accordance with the Aviation laws and regulations of Taiwan. There was no evidence discovered in flight operation management and weight and balance which would have caused adverse effect to this incident.

With regard to this incident, the ARAIB set the focus of analysis on: whether the pilots were able to obtain in advance the information of visibility so bad as the runway was not visible; whether the pilots' approach and landing maneuvers were adequate; whether the pilot's decision to go around was appropriate; and whether the weather information was provided properly by the air traffic authorities and the runway lights were turned on timely.

2.2 Performance of the pilot

2.2.1 Weather information obtained before landing

According to the weather information checked by the pilots through the weather data file at the flight preparation stage, there was no forecast relating to poor visibility around the time estimated for Flight 160 to arrive at the Incheon Airport.

Also in the weather information of the Incheon Airport as checked through D-ATIS by the pilots during enroute flight, there was no information implying poor visibility or precipitation.

On the final approach course, at 11:23:09 the pilots recognized precipitation appeared in red color on the airborne weather radar display that was judged to be located right above the runway 34. It was at 11:23:38, 3 minutes 5 seconds before touchdown, when the pilots were advised for the first time on the final approach course by the controller of the weather information involving poor visibility.

The red display of precipitation on weather radar is not necessarily visibility information. And the runway visual range of 650 meters or 700 meters as advised by the controller is not directly related with flight visibility[20] so poor that the runway cannot be identified with the naked eyes. Therefore, it is judged that the pilots were not possible to infer visibility so poor that they could not identify the runway by such weather information or advice.

Therefore, the ARAIB judged that among the weather information or advice that the pilots had before, during flight or immediately before touchdown, there was no such information that could have made the pilots give up the instrument approach to the designated runway beforehand.

2.2.2 Pilots' understanding and response to the weather information before landing

The runway visual range is measured from the time when the visibility falls below 2,000 meters and its value is provided to the pilot. Notifying the runway visual range means that the visibility is not generally good. The pilots were advised of the runway visual range by the controller on the final approach course three minutes before touchdown.

The pilots discovered the phenomenon displayed in red on the airborne weather radar about 28 seconds before they were advised of the runway visual range information by the controller. The red display means heavy precipitation. They were confused with this abrupt weather change at that moment. The pilots exchanged a dialogue that the size and intensity were so serious as they doubted whether it is true or false. After discussing the situation and reconfirming the landing weather minimum for RVR 550 of CAT I landing, they decided to use the autoland if the situation deteriorated. Other than that, the most current weather report shown that the visibility is still above CAT I condition. However, precipitation is usually accompanied with turbulence or deterioration of visibility.

When adverse weather is anticipated, the pilots should review whether to continue to use the autopilot and autothrottle, and the conditions required for an immediate go-around when necessary, that is, confirming visual references, etc.

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20) Flight visibility means the average forward horizontal distance, from the cockpit of an aircraft in-flight, at which prominent unlighted object maybe seen and identified by day and prominent lighted maybe seen and identified by night.(FAR CFR.14.1)

Then, it might be a deviation from the generally accepted flying principle for adverse weather condition that the captain switched flying from autopilot to manual before touchdown despite that he obtained the runway visual range information that the visibility immediately before landing would not be good.

According to the China Airlines' Flight Operations Manual 5.6.5.5, pilot should not necessarily disconnect the autopilot when visual conditions are established on an ILS approach. Plan to conduct an automatic landing anytime visibility is marginal or when it is deemed necessary. This part of manual significantly emphasis the importance of pilot decision in the event of marginal weather conditions.

The reason of the Flight 160 pilots switched from autopilot to manual flight despite the existing FOM is judged as the Flight 160 pilots' underestimate of the red display on the weather radar and their habitual maneuver based on the experience of ordinary times that if a runway is once insight at the decision height, it would be in sight continuously until touchdown.

2.2.3 Captain's landing and touchdown maneuvers

Because of the facts that the runway and approach lighting systems were not activated during the approach and landing, with RVR of 650m without runway lighting system, the runway feature could be impaired by the rain.

Without sufficient visual cues, according to the FDR data21), after the captain disconnected autopilot at 11:26:29 and selected manual flight, he tried to control the aircraft by sweeping the side stick left and right, and mostly to the right, to maintain the attitude of the aircraft.

Just before the autopilot disconnection, there was a 5 knots right cross wind shifting from right to left. At the time of touchdown the wind was more than 5 knots from the left. The pilot’s side stick inputs and the left cross wind component contributed to the aircraft drift to the right.

With insufficient visual cues, the captain was maneuvering towards the runway he assumed. The captain's side stick and rudder inputs were inappropriate to the situation in which the aircraft was drifting to the right which eventually resulted in the runway excursion.

The captain's such manoeuvre means that the pilots were flying not positively confirming the visual cues. This agrees with the pilot's statements that he did not have the runway in sight for a while.

2.2.4 Captain's decision to go around

According to the China Airlines Flight Operations Manual (FOM) 6.10, the pilots are to make a go-around maneuver immediately if there is no visual reference to a runway before landing.

The captain's go-around maneuver was carried out at 11:26:45 in accordance with the first officer's advice. It is judged that the pilots were flying some seconds without sufficient visual reference in precipitation until the go-around was initiated. The go-around not being made immediately when the pilots were losing the runway visual reference provided a cause of trouble of the aircraft running off the runway because of the captain's banking to the right during flare.

It is often observed from other cases of accident that the flight procedure for an immediate go-around, if the runway cannot be confirmed with visual reference, is not followed. Such a deviation from the norm is thought to be caused by the lack of experience and training for an extreme situation of losing visual reference immediately before touchdown, rather than an intentional one.

In order to integrate the go around practice with daily operation, the maneuver model of immediate go-around in case of losing the visual reference, should be repetitively and trained.

2.2.5 Cockpit Resources Management

If a pilot loses any one of the visual references during approach, he should let the other pilots know this fact. From the time 11:26:35 when it is judged that the pilots lost visual reference until the time 11:26:42 when the visual clue was reconfirmed, there was no communication between the two pilots. If the first officer had let the captain know this as soon as the visual reference was lost, it might be helpful for the captain to execute a go around maneuver immediately before touchdown.

In addition to periodical and repetitive technical training, the pilots should be advised that the communications and mutual cooperation are especially important during instrument approach in adverse weather condition.

2.3 Effects of wind on the runway excursion of Flight 160

It is impossible to know the exact amount of the wind that blew immediately before touchdown, but according to the analysis of the investigation agency of France, it is judged as not far from left cross wind of 5～6 knots.

A left cross wind of about 5～6 knots is such a wind that can be normally controlled when the pilot has the runway in sight. But if the pilot does not properly cope with a situation not having the runway in sight, it could make the aircraft drift to the right.

Therefore, the ARAIB determined that although the left cross wind of 5～6 knots could have contributed to the aircraft drift to the right, it shall not be the main cause of the running off the runway during landing.

2.4 Weather information provided by controller

When Flight 160 was approaching to the Incheon Airport under the control of the Seoul Approach Control, the visibility of the Incheon Airport was 6 km, but the runway visual range of the runway 34 touchdown zone started decreasing below 2,000 m from immediately before Flight 160 was aligned with the final approach course to runway 34 of the Incheon Airport.

After Flight 160 was aligned with the final approach course of runway 34, it was handed over to the Incheon Control Tower. After initial contact with the Incheon Control Tower, the local controller advised Flight 160 two times that the runway visual range of runway 34 touchdown zone were 700 meters and 650 meters respectively. This was proper action in accordance with the provisions of Paragraph 2-8-2 of the Air Traffic Control Procedures. It is judged that it should have made the Flight 160 pilots, who were approaching understanding the visibility as 6 kilometers, recognize the visibility decreasing.

When the runway visual range is decreasing rapidly, the fog, rain, snow, etc. become the factors of obscuring and decreasing visibility. Even if the meteorological authorities did not provide information on such visibility obstructing phenomena[21], it is judged to be helpful to flight safety that the pilot is informed of the visibility obstructing phenomena (especially precipitation) as well as the runway visual range if the controller can judge by the airport weather radar or with the naked eyes.

2.5 Controller's operation of the airport lighting system

When Flight 160 was approaching to the Incheon Airport on the airway the prevailing visibility was 6 kilometers, and when it was on the final approach course, the runway visual range of runway 34 touchdown zone decreased as low as 650 meters. In such a case the Control Tower should operate the approach lights and runway lights, but the airport lighting system was operated after Flight 160 made a go-around.

The local controller on duty at the time testified that the overall visibility of the Incheon Airport was so good to the extent that it was strange to have the runway visual range displayed and only the touchdown zone of runway 34 was hazy and not clearly seen. According to the record of the TDWR at the time when Flight 160 touched down on the runway 34, a small lump of cloud containing precipitation of more than 20 millimeters per hour was passing the south end of the aerodrome from west to east.

Due to this the runway visual range of the runway 34 touchdown zone decreased to as low as 650 meters, but the local controller could not confirm the runway visual range shown on the panel. And the TDWR display also was located in the place where the local controller could not see easily, so it is analyzed that the location of TDWR display did not help for him to find out the meteorological condition and the reason for a decreased runway visual range.

Because the local controller could not make a decision and judgment to immediately cope with the rapidly decreasing visibility in part of the aerodrome, he did not operate the approach lights and runway lights, so it is analyzed that the approach lights not turned on did not help for the pilots to confirm the runway visually when Flight 160 was approaching and landing on the runway 34.

Therefore, it is judged necessary to devise a scheme whereby the local controller primarily rely on the information observed by the officially recognized weather observation system to take immediate action appropriate for the situation, and a TDWR

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21) If rain visibility is more than 5 km, visibility obstructing phenomena are not included in the meteorological report.

display is additionally installed in a place where the local controller can easily see it so that he can recognize and judge more accurately the weather condition in and around the aerodrome.

It will also be necessary to review installation of an alerting system which can assist the controller to decide whether to turn on or off the runway lights according to weather condition.

3. Conclusions

On the basis of the factual information and the analysis of the Flight 160 incident investigation, the Aviation and Railway Accident Investigation Board determines the findings in three categories: findings related to probable causes[22)], findings related to risk[23)] and other findings[24)].

3.1 Findings Related to Probable Causes

a. An instant go-around was not made while the visual references of the runway were not positively confirmed.

3.2 Findings Related to Risk

a. The approach lighting system and runway lights of runway 34 were not turned on, so that they did not help the pilots visually confirm the runway.
b. The China Airlines' manual for using the autopilot according to weather condition were not observed during landing.
c. A local precipitation located near the threshold of runway 34 was detected by the weather radar of Flight 160, but the information was not properly utilized.

3.3 Other Findings

None

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

23) **Findings related to risk** identify elements of risk that have the potential to degrade aviation safety. Some of the findings in this category identify unsafe acts, unsafe conditions, and safety deficiencies, including organizational and systematic risks that have the potential to degrade aviation safety; however, they cannot be clearly shown to have operated in the incident. Further, some of the findings in this category identify risks that are unrelated to this incident, but nonetheless were safety deficiencies that may warrant future safety actions.

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

4. Safety Recommendations

As a result of its investigation of the Flight 160 incident occurred on 15 August 2008 at the Incheon International Airport, the Aviation and Railway Accident Investigation Board makes the following safety recommendations.

To China Airlines

a. Devise a scheme for the pilots to observe more thoroughly the standards for landing on autopilot of the China Airlines Flight Operations Manual (FOM) 5.6.5.5. (AIR-F0809-1)

b. Provide the pilots with technical training relating to adverse weather repetitively, so that the missed approach principles of FOM 6.10 can be more strictly observed in the field, and with CRM training on the cases of occurrences caused by late decision to abort landing under adverse weather condition. (AIR-F0809-2)

To Ministry of Land, Transport and Maritime Affairs (Office of Civil Aviation)

a. Devise a scheme whereby the meteorological conditions in and around the aerodrome are recognized more accurately so as to provide the pilot with the information as necessary, including a scheme for additionally installing an airport weather radar display in a place where the local controller can easily see it. (AIR-F0809-3)

b. Review installing a system for letting the controller identify audio-visually the fact whenever the weather conditions reach the on/off standards of aeronautical lighting. (AIR-F0809-4)