

Aircraft Serious Incident Report

Landed on Unauthorized Runway China Shanghai Airlines B737-800, B-1949 Gimhae International Airport RWY 18L 07 September 2019



Dec. 2020



This aircraft serious incident report has been prepared in accordance with the Article 25 of the Aviation and Railway Accident Investigation Act of the Republic of Korea.

According to the provisions of the Article 30 of the Aviation and Railway Accident Investigation Act, 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 as follows:

The sole objective of the investigation of an accident or incident shall be the prevention of accidents and incidents. It is not the purpose of the activity to apportion blame or liability. Any investigation conducted in accordance with the provision of this Annex shall be separate from any judicial or administrative proceedings to apportion blame or liability.

Thus, this investigation report 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 Railway Accident Investigation Board, Landed on Unauthorized Runway, China Shanghai Airlines, B737-800, B-1949, Gimhae International Airport RWY 18L, 7 Sept. 2019, Aircraft Serious Incident Report, ARAIB/AIR1905, Sejong Special Self-governing City, Republic of Korea

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

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

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Landed on Unauthorized Runway

- Operator: Shanghai Airlines, China
- Manufacturer: Boeing(US)
- Type: B737-800
- Registration Mark: B-1949
- Location: RWY 18L, Gimhae Int'l Airport, Busan
- Date & Time: 7 Sept. 2019, Approximately 16:471)(0747UTC)

Synopsis

On 7 September 2019, about 16:47, China Shanghai Airlines CSH829, a Boeing 737-800, registration B-1949, on a regular scheduled international passenger service flight departed from Pudong International Airport. During the circling approach to the right traffic pattern, the aircraft was cleared to land on RWY 18R in Gimhae Int'l Airport but landed on RWY 18L which was unauthorized.

This serious incident did not affect other aircraft's operations. Damage to the aircraft as well as injuries to the crew and passengers were not found.

The Aviation and Railway Accident Investigation Board (hereafter referred to as "ARAIB") determines that the probable cause of this serious incident was ^rB-1949 flight crew failed to identify landing RWY 18R during circling approaches under VFR and landed on unauthorized RWY 18L_J

¹⁾ Unless otherwise indicated, all times stated in this report are Korean Standard Time(UTC+9)

Contributing to the serious incident were "(1) During circling approach, B-1949 selected a narrow turning pattern and failed to line up on the final approach course to RWY 18R. (2) Flight crew mistook RWY 18L PAPI for RWY 18R PAPI. (3) Lack of communications(CRM) between the captain and the first officer.」

As a result of this investigation, the ARAIB makes three safety recommendations to Shanghai Airlines.

1. Factual Information

1.1 History of Flight

On 7 September 2019, about 16:47, China Shanghai Airlines CSH829, a Boeing 737-800, Chinese registration B-1949(hereafter referred to as "B-1949"), a regular scheduled international passenger service flight, en route from Pudong International Airport, China to Gimhae International Airport, South Korea, began to approach VOR/DME-A RWY 18L/R²) to runway 18R at Gimhae International Airport.

During approach to VOR/DME-A RWY18L/R, B-1949 was on the final approach course to runway RWY18L/R at an altitude of 2,600ft. About 16:43:40, B-1949 visually identified runway 5 miles on final and 2,600ft. The controller hand-off was transferred from Gimhae approach control to Gimhae control tower.

After the controller hand-off was transferred, B-1949 reported to Gimhae control tower that it was 5 miles on final and continued approaching under VFR on RWY18L/R. About 16:44:22, B-1949 approached to the right traffic pattern³⁾ at 1,700ft.

Entering the right traffic pattern, B-1949 started the base turn at 1,000ft about 16:45:41. Then, it was cleared to land on RWY 18R and notified of wind information from Gimhae control tower.

²⁾ VOR/DME-A procedure is a straight-in procedure by using VOR and DME. It is a circling approach procedure for aircraft to circle and land under VFR around airport because this procedure does not meet the minimum requirements for landing.

³⁾ Traffic pattern: As a procedure for aircraft to land on runway, it includes upwind leg, cross-wind leg, downwind leg, base leg and final approach. Traffic pattern is usually left-hand turns but in some aerodrome such as Gimhae Int'l Airport, right-hand turns traffic pattern is used to avoid the center of town and obstacles.

At the time of the event, it was slightly windy under the influence of typhoon No. 13 "Lingling" which was coming up north in southern part of west coast. The aircraft wobbled and the captain was controlling the aircraft attitude to conduct circling approach to RWY 18R.

B-1949, which obtained Gimhae ATC authorization for landing, continued to turn by about 1.5-mile radius from the end of RWY 18R and approached RWY 18R. At 16:46:30, B-1949 overshoot the final approach course of RWY 18R at 700ft and 0.8 mile on final from the threshold of RWY 18R. Overshooting the final approach course of RWY 18R, B-1949 lined up on RWY 18L at 700ft and 0.3 mile on final at 16:46:38.



[Fig. 1] B-1949 Flight Path

The captain stated that he had to focus on controlling the aircraft's attitude which was getting bumpier due to a strong wind from base turn to circling approach. For that reason, the captain failed to recognize the

situation back then from the moment the aircraft overshooting the final approach course of RWY 18R till the aircraft approaching the final approach course of RWY 18L. Moreover, he stated that he had mistook RWY 18L PAPI for RWY 18R PAPI and B-1949 landed on RWY 18L.

Gimhae control tower confirmed that B-1949 overshot the final approach course of RWY 18R and approached RWY 18L. At 16:46:49, the tower instructed B-1949 to make a go-around but B-1949 landed on RWY 18L at 16:46:50. The following [Fig. 1] shows the B-1949's flight path in accordance with VOR/DME-A procedure.

1.2 Injures to Persons

Aboard the aircraft were a total of 162 people including 8 crew members and 154 passengers(including an infant). There was no injured person.

1.3 Damage to Aircraft

No damages were found due to this serious incident.

1.4 Other Damage

There was no other damage.

1.5 Personnel Information

1.5.1 Captain

The captain (male, age 36) held a valid air transport pilot license⁴), B737/B757/B767 type rating, type rating instructor qualification and level 4⁵) ICAO English Proficiency Certificate.

The captain held a valid airman medical certificate⁶⁾ and passed B737 PIC test flight on 12 May 2019. He accumulated 10,322 total flight hours including 3,991 hours in B737 airplanes. He had flown 26 and 84 and 236 flight hours in the 7 and 30 and 90 days, respectively.

He received training for circling approach to land on 22 Sept. 2018 and on 29 Aug. 2019, respectively. He had about 20 times of flight to Gimhae International Airport among which he had landed on RWY 18 through circling-to-approach maneuvering six times.

The captain had a domestic flight with the first officer on 5 Sept. and went to bed at 1 a.m. On 6 Sept., he woke up at 8 a.m. and went jogging by about 10km and then took a nap for about two hours after lunch. He had dinner at 18:00 and went to bed at 20:30. He stated that he did not drink any alcohol or take any illegal medication and was in good health.

1.5.2 First Officer

The first officer (FO) (male, age 27) held a valid air transport pilot license⁷), B737 type rating and level 4 ICAO English Proficiency Certificat

⁴⁾ License No.: 320623198303110038, Acquired Date: 19 Mar. 2014 Re-issued Date: 29 Jun. 2019

⁵⁾ Expired on: 24 Jul. 2022

⁶⁾ First class medical certificate, No.: 320623198303110038, Valid until: 26 Oct. 2019

⁷⁾ License No.: 430723199210110034, Acquired Date: 4 Sept. 2014 Re-issued Date: 23 Aug. 2017

e⁸⁾. He held a valid airman medical certificate⁹⁾ and passed B737-800 type test flight on 6 Jul. 2019.

The first officer had accumulated 3,331 total flight hours, including 3,073 hours in B737. He had flown 22, 78, 235 hours in the 7 and 30 and 90 days, respectively.

The first officer had a domestic flight with the captain on 5 Sept. and no flights on 6 Sept. He did not have a flight to Gimhae International Airport before the serious incident.

1.5.3 Local Controller

The local controller(male, age 23) held a valid air traffic controller license & type rating¹⁰, medical certificate¹¹) and level 5 ICAO English Proficiency Certificate¹²).

At the time of the serious incident, the local controller instructed all flights which were about to land on RWY 18L/R to perform VOR/DME-A procedure and approach RWY 18R. While performing aircraft control, he visually monitored aircraft approaching down wind leg and aircraft approaching base leg and mountain area in the north.

⁸⁾ Expired on: 30 Oct. 2020

⁹⁾ First Class Medical Certificate, No.: 430723199210110034, Valid until: 11 Sept. 2020

¹⁰⁾ Air Traffic Controller License: 26 Jun. 2014, No. 5406, Issued by Minister of Defense / 11 Sept. 2015, No. 31-002182 Issued by chairman of Korea Transportation Safety Authority(Ministry of Land, Transport and Infrastructure), Type Rating: Flight Info. 25 Jul. 2014, Ground Control 25 Aug. 2014, Local Control 15 Dec. 2014

^{11) 18} Jan. 2019, Issued by the 5th Air Force Aeromedical Battalion

¹²⁾ EPTA5, Validity Period: 20 Mar. 2018 ~ 19 Mar. 2024

1.5.4 Supervising Controller

The supervising controller(male, age 42) held a valid air traffic controller license & type rating¹³), airman medical certificate¹⁴) and level 4 ICAO English Proficiency Certificate¹⁵). At the time of the serious incident, he was on-duty as a shift leader.

Around 16:43, the controller made a first contact with B-1949 at 5 miles of VOR/DME-A and looked at the aircraft entering the airport traffic pattern which seemed to be normal. He also listened to the local controller issuing landing clearance to B-1949 at base leg and B-1949 reading back the clearance.

1.5.5 Ground Controller

The ground controller(male, age 24) held a valid air traffic controller license & type rating¹⁶), airman medical certificate¹⁷) and level 4 ICAO English Proficiency Certificate¹⁸). On the day of the serious incident, he checked ground traffic condition and normal condition of maneuvering area before starting his duty. He was on ground controller seat.

¹³⁾ Air Traffic Controller License: 8 Feb. 2005, No. 4220 Issued by Minister of Defense / 12 May 2003, No.1091 Issued by chairman of Korea Transportation Safety Authority(Ministry of Land, Transport and Infrastructure), Type Rating: Flight Info. 2 Jan. 2013, Ground Control 9 Jan. 2013, Local Control 30 Jan. 2013

^{14) 14} Jan. 2019, Issued by the 5th Air Force Aeromedical Battalion

¹⁵⁾ EPTA 4, Validity Period: '17.3.4 ~ '20.3.4

¹⁶⁾ Air Traffic Controller License: 8 Feb. 2005, No. 4220 Issued by Minister of Defense / 12 May 2003, No.1091 Issued by chairman of Korea Transportation Safety Authority(Ministry of Land, Transport and Infrastructure), Type Rating: Flight Info. 2 Jan. 2013, Ground Control 9 Jan. 2013, Local Control 30 Jan. 2013

^{17) 14} Jan. 2019, Issued by the 5th Air Force Aeromedical Battalion

¹⁸⁾ EPTA 4, Validity Period: 4 Mar. 2017 ~ 4 Mar. 2020

1.6 Aircraft Information

1.6.1 General Information

B-1949 was a B737-800 airplane which was manufactured by U.S Boeing company on 14 Jan. 2014. The airplane had accumulated 16,108 total flight hours and a total number of landings was 8,666 times until the serious incident occurred.

State of Manufacturer	U.S.	Manufacturer	Boeing
Manufacture Date	14 Jan. 2014	Serial No.	39933
Туре	B737-800	Registration Date	Unknown
Total flight hours	1,6108 hours	No. of landings	8,666 times

[Table 1] General Information

1.6.2 Aircraft Dimensions

1.6.2.1 General Dimensions

The dimensions of B-1949 are shown in [Fig. 2].





[Fig. 2] General Dimensions

1.6.2.2 Engine

B-1949 was equipped with CFM56-7B two engines manufactured by CFMI¹⁹ International and the engine power was ranging from 24,500lbs to 32,900lbs.

1.6.3 Weight and Balance

The actual takeoff weight of B-1949 was 66,798kg which was below the maximum takeoff weight of 78,912kg. There was no issue which could have affected the flight performance because the difference was about 12,114kg. In addition, the center of gravity was within the allowable range. No issues pertinent to the weight and operation performance were found in accordance with aircraft weight and balance.

The weight and balance data of B-1949 is as shown in [Table 2].

¹⁹⁾ CFM International is a joint venture between GE(General Electric) of the United States and Safran Aircraft Engines of France. It is established in 1974 and a 50-50 joint company which mainly produces engines that are now used by about 590 aircraft operators worldwide.

(unit: kg)

Standard Operating Weight(SOW)	43,532		
Passenger and Baggage Weight	13,093	Cargo Weight	None
Zero Fuel Weight(ZFW)	56,625	Maximum Zero Fuel Weight(MZFW)	61,688
Takeoff Weight(TOW)	66,798	Maximum Takeoff Weight(MTOW)	78,912
Landing Weight(LDW)	62,913	Maximum Landing Weight(MLDW)	65,317
Takeoff Fuel	10,173	Trip Fuel	3,885

[Table 2] B-1949 Weight and Balance

1.7 Meteorological Information

On the day of the event, Typhoon No. 13 "Lingling" was heading north and passing above west sea. Around Gimhae Int'l Airport and areas nearby was a strong wind and irregular movement of air. The maximum gust of wind speed warning was issued at the airport.

		070040Z 0700/0806 16025G40KT 9000 - RA BKN020 OVC030					
RKPK	TAF	TX29/0705Z TN23/0720Z					
	AMD	FM070600 21015G25KT 9999 NSW SCT020 BKN030					
		BECMG 0710/0711 18010KT BKN030=					
RKPK		070150Z 0701/0806 18025G40KT 9999 SCT020 BKN030 BKN200					
	TAF	TX30/0705Z TN23/0720Z					
	AMD FM070600 21015G25KT 9999 SCT015 BKN030						
		BECMG 0709/0710 18010KT BKN030=					
	ТЛЕ	070500Z 0706/0812 21015G25KT 9999 SCT020 BKN030					
RKPK	AMD	TN23/0721Z TX28/0805Z					
		BECMG 0708/0709 18012KT BKN030=					
		070600Z 20015G25KT 9999 FEW030 BKN050 BKN120 29/24					
RKPK	METAK	Q1003 RMK CIG050 SLP035 60004 8/150 9/150=					
DIZDIZ		070700Z 20015G25KT 9999 BKN030 BKN070 BKN120 28/23					
KKPK	METAK	Q1004 RMK CIG030 SLP039 8/510 9/520=					
DVDV		070800Z 20010G20KT 9999 BKN035 BKN070 BKN120 29/22					
	WIETAK	Q1004 RMK CIG035 SLP048 8/510 9/610=					

[Table 3] Meteorological Information at the Time of the Event

At 16:45:43, when Gimhae ATC gave landing clearance to B-1949, winds was 230 degrees at 12kts. According to meteorological aerodrome report at 16:00 in Gimhae Int'l Airport, average wind 200 degrees at 15kts of average wind speed and 25kts of maximum wind speed, more than 10km of visibility, about 75% of broken clouds at 3,000ft, 28° C of temperature, 23° C of dew point, QNH 1004 under VFR.

1.8 Aids to Navigation

B-1949 was approaching Gimhae Int'l Airport under IFR. During circling approach, the aircraft landed under VFR. All aids to navigation were normal.

1.9 Communications

Communication between B-1949 and Gimhae Control Tower is as shown in [Table 4] when B-1949 landed in Gimhae Int'l Airport. No communication issues were found.

Time	Transmitter	Content	Note
16:43'40"	CSH829	CSH829. Now insight	Initial Contact VOR-DME/A 5NM
16:43′44"	Tower	CHS829. Circle to RWY18R report base	
16:43′49"	CSH829	Ahreport right base, CSH829	
16:45'41"	CSH829	Tower, CSH829 Now base	
16:45'43"	Tower	CSH829. RWY18R Wind 230 at 12 cleared to land	
16:45'47"	CSH829	RWY18R Cleared to land CSH829	
16:46′49"	Tower	CSH829. Make go around	G/A instruction
16:47'15"	Tower	Ah CSH829. Turn left end of RWY	
16:47'20"	CSH829	Turn left vacate RWY CSH829	
16:48'14"	Tower	CSH829. Hold short of papa	
16:48'17"	CSH829	Hold short of papa CSH829	

16:48'25"	Tower	CSH829. Hold short of papa and contact
		ground 121.9
16:48'28"	CSH829	Hold short of papa 121.9, CSH829
16:48'50"	Ground	CSH829. Why did you land on RWY18L?
16:48′57"	CSH829	Ah My apology
16:49′01″	Ground	CSH829. Roger. We gave landing clearance
		on RWY18R, but you landed on RWY18L.
		So this will be considered as a very
		harmful for air safety. You are expected to
		be
16:49′26"	CSH829	Ah Roger. My apology. CSH829. We
		(jamming) landed on wrong RWY. Sorry.

[Table 4] Communications Transcript Between B-1949 and Gimhae ATC

1.10 Gimhae Int'l Airport Information

There are two runways (18L/36R and 18R/36L) at Gimhae Int'l Airport. With the length of 3,200m and width of 60m, RWY 18R/36L is paved with concrete and mainly used by civil aircraft.

The length of RWY 18R(from threshold²⁰⁾ to end) is 2,000ft(600m) additionally displaced, which enables circling-to-approach airplanes to properly descend at 1,700ft(MDA) to the traffic pattern.

Paved with concrete, RWY 18L/36R is mainly used by military aircraft with the length of 2,743m and width of 45m. At the end of RWY 18L/36R, there is a rectangular clearway with the length of 300m and width of 160m. Further, there is a rectangular clearway with the length of 300m and width of 300m at the end of RWY 18R/36L.

There are seven gates designated as Hot Spot in 'P' taxiway with the width of 30m which is parallel with RWY.

^{20) &#}x27;RWY Threshold' is a point where aircraft is able to use for landing and 'displaced threshold' is RWY threshold that is not located in fore-end.



[Fig. 3] Runway Layout of Gimhae Int'l Airport

1.11 Flight Recorders

B-1949 was equipped with flight data recorder(FDR) and cockpit voice recorder(CVR). However, it was impossible to retrieve FDR and CVR data due to the late notification of serious incident.

1.12 Wreckage and Impact Information

There was no damage to B-1949.

1.13 Medical and Pathological Information

N/A

1.14 Fire

No fire was occurred due to this serious incident.

1.15 Survival Aspects

Passengers or crew members were not injured due to this serious incident.

1.16 Test and Research

1.16.1 B-1949 Flight Path from Right Traffic Pattern till Landing

ARAIB analyzed B-1949 flight path and its altitude of each location based on QAR(quick access recorder) provided by Shanghai Airlines.



[Fig. 4] Comparison between Normal Flight Path and B-1949 Flight Path

As shown in [Fig. 4], B-1949 flight path started from downwind at ①, base turning at ②, 90° turn at ③, final rollout 18L at ④. Compared to normal circling approach track, the width of circling approach track of B-1949 was narrow.

At 16:45:57, B-1949 made a right turn by 90° in base leg. As shown in [Fig. 5] and [Fig. 6], an airplane normally maintains its altitude from 900ft to 1,000ft at 90 degrees turning point to land on RWY 18R but B-1949 made a turn at 720ft which was lower than normal altitude by about 200ft.



[Fig. 5] Normal Flight Pattern at 90 Degree Turning Position and B-1949 Flight Pattern



[Fig. 6] Normal Flight Altitude and B-1949 Altitude at 90 degree turning position

As shown in [Fig. 7] and [Fig. 8], an airplane normally maintains its altitude from 300ft to 500ft at the final rollout. However, B-1949 lined up



on runway 18L with its altitude of about 140ft which was very low.

[Fig. 7] Normal Flight Location at Roll out Position and B-1949 Location



[Fig. 8] Normal Flight Altitude at Roll out Position and B-1949 Altitude

Compared with normal aircraft's circling approach track and B-1949's flight path, B-1949's circling approach radius was narrow. It indicates that B-1949 would have circled and approached at low altitude by about 200ft.

1.17 Organizational and Management Information

1.17.1 Shanghai Airlines Organization and Management

Shanghai Airlines was established on 30 Dec. 1985 and have used Shanghai Hongqiao Int'l Airport and Pudong Int'l Airport as hub airports.

From 2007 to 2010, Shanghai Airlines joined the Star Alliance(Airline alliance). After acquired by China Eastern Airlines in Feb. 2010, however, Shanghai Airlines withdrew from Star Alliance. Shanghai Airlines has joined Sky Team with China Eastern Airlines on 21 Jun. 2011. and became a formal member of the Sky Team alliance.

Shanghai Airlines is currently operated as a subsidiary of China Eastern Airlines and has held about 104 airplanes including A330-300, B737-700, B737-800 and B787-9. The Airlines mainly operates domestic flight routes in China but it also established international flight routes including the Republic of Korea and Japan in Asian region. It has 140 destinations.

China Eastern Airlines, the parent company of Shanghai Airlines, was established in April 1995. It is located in Shanghai and one of the China's top three civil airlines. Same as Shanghai Airlines, China Eastern Airlines uses Hongqiao International airport and Pudong International Airport as hub airports. The Airlines has held about 510 airplanes and it has about 1,052 destinations in 177 different countries worldwide.

1.17.2 Shanghai Airlines Circling Approach Procedure in Gimhae Int'l Airport RWY 18L/R²¹)

1.17.2.1 Use of Gimhae Int'l Airport VOR/DME-A 18L/R Procedure

At Gimhae Int'l Airport located in Busan, the Republic of Korea, airplanes which are supposed to land on RWY 18 must approach runway by implementing VOR/DME-A 18L/R procedure which is a circling approach procedure. A pilot normally set landing position prior to D7.0(7NM: nautical mile²²) and complete landing checklist. Airplanes descend to 1,700ft(MDA²³) once it passes D7.0 and adjusts go-around altitude by operating ALT Hold mode.

After a pilot finish setting visual reference for circling approach under VFR, he must continue checking visual reference and controlling aircraft to land through normal maneuvering. The minimum descent altitude(MDA) in this procedure is 1,700ft and a pilot must set visual reference and immediately report his location to ATC.

A pilot must set visual reference and enter into circling approach area. Then, he descends from 1,700ft and attempts to land without any notification of his current location. In case he is not able to set visual reference prior to D3.0 or loses visual reference under MDA conditions, he must immediately make a go-around.

In addition, a pilot must input 2.3 miles to FMC(flight management

²¹⁾ Excerpt from Shanghai Airlines training materials for pilots who would operate flight in Gimhae Int'l Airport in Busan, the Republic of Korea

²²⁾ D7.0 refers to 7DME and it means 7NM(nautical miles)

^{23) &}quot;Minimum descent altitude/height(MDA/H)" refers to altitude(MSL) or height(airfield altitude) that non-precision approach or circling approach aircraft must not descend below designated altitude in case visual reference such as runways and airport light aids are not identifiable. MDA for circling approach procedure is based on airfield altitude.

computer) in circling protection area of the threshold of runway and utilize it as a reference during circling approach. B737-800 airplane is a category C aircraft but the radius of circling approach area must be set depending on the actual approach speed. In case turning speed is more than 148kts, a pilot must select the circling protection area of category D aircraft.

The pilot should have recognized that consecutive turns caused the aircraft to turn the final approach course fast. The width of the third turning became wider that the aircraft became closer to the final approach course.

1.17.2.2 Use of Obstruction Markings When on a Circling Approach

As shown in [Fig. 9], reference point for the third turning is very important in case an airplane circles around a small hill²⁴ located in Samjung-dong Gimhae City. If a pilot controls the aircraft to passe the hill, the aircraft would be within circling protection area and distance of the fifth turning proves to be relatively sufficient.



[Fig. 9] Small Hill in Samjung-dong(Reference Point)

24) It was described as a small hill in Shanghai Airlines Document

If an airplane flies above No. 10 highway, pilots would be able to visually check obstruction markings. In that case, pilots are not supposed to fly over a sign and there are obstacles behind it. In case it is impossible to control approach position, the airplane is likely to be located in the west(maintenance hangar) of runway rather than the east(terminal) of runway

1.17.3 Designated Special Aerodrome Classified by Shanghai Airlines

The category of designated special aerodrome has special operation requirements. It requires a pilot to have certain qualifications and different operations assurances for risk factors that involve geographical features, runway conditions and approach procedure of airport.

Shanghai Airlines has classified special aerodrome with special operations requirements into three types: Grade "1" airport, Grade "2" airport and Grade "3" airport.

1.17.3.1 Gimhae Int'l Airport Classified into Designated Special Aerodrome

Shanghai Airlines has classified Gimhae Int'l Airport and Cheongju Int'l Airport into Grade "1" special aerodrome and defines the following operations conditions.

- Approach facility or approach procedure is not standard.
- There is an abnormal characteristics or performance limitation.
- Emergency procedures should be established against failures during takeoff.
- Due to geographical limitations, there is only unidirectional landing

runway. Emergency procedure should be established for missed decision height to initiate go-around, minimum descent altitude(MDA) or special go-around.

• There is a non-standard approach procedure due to geological reasons.

1.17.4 Designated Special Aerodrome's Operations Management

Shanghai Airlines has standardized operations management of special aerodrome and established regulations on the purpose of securing safe operations Pilots who operate aircraft in designated special aerodrome must receive theoretical education for all special aerodrome's emergency procedure and be familiar with emergency procedure for each aerodrome.

major roles and responsibilities of each There are department. Operations management department is responsible for establishing designated special aerodrome's operations management regulations and setting up organization to monitor operations and carrying out continuous oversight and supervision. Flight management department is in charge of flight training program arrangement for operations in special aerodrome, training program implementation and pilots' qualification oversight and supervision. Operations department is responsible for operations training plan implementation for special aerodrome and conformity assessment for flight crew's qualifications. Safety oversight department is in charge of accident information gathering, analysis, investigation and handling.

1.17.4.1 Operations Training and Education for Designated Special Aerodrome

Shanghai Airlines' pilots must complete training for designated special aerodrome(Gowon Airport excluded) prior to operations The training

should be approved by manager and company.

Training pilots who intends to initiate operations in special aerodrome must receive education for training course 1 and 2 that are designated by company. Prior to preparation for operations in newly designated special aerodrome, training must be fully conducted for training course 2.

Ground training for special aerodrome does not commonly require theoretical test. However, any special requests made by manager or operator may require technical flight management department to create test questions and establish its plan.

1.17.4.2 Acquiring Operational Qualification and its Maintenance for Designated Special Aerodrome

A captain who operates flight in a designated special aerodrome must have a total of 300 hours of flight experience and pass technical test conducted by flight check inspector.

In case flight duty intervals exceed 12 months in special aerodrome (Gowon airport excluded), a pilot must be trained for re-qualification as prescribed by the aircraft's "flight training guidelines" and then he or she is qualified for performing flight duty. In addition, a pilot is able to take on a role as captain in performing flight in special aerodrome.

1.18 Others

1.18.1 Airport Light Aids and Obstruction Markings on RWY 18

Runway Lead-in Light System(LDIN), Precision Approach Path Indicator(PAPI),

Circling Guidance Light(CGL), obstruction markings and etc. are installed in RWY 18 at Gimhae Int'l Airport, which enables aircraft to conduct circling approach.

1.18.1.1 Runway Lead-in-Light System(RLLS)

Runway lead-in light system²⁵⁾ on RWY 18 are composed of 5 white flickering lights from base turn to final centerline. There are a total of 17 runway lead-in-light system in which 5 system in the first point and 3 respective system in the remaining points.



[Fig. 10] Runway Lead-in-Light System on RWY 18

The length of Runway Lead-in-Light System is 1,408.15m from point 1(base turn) to point 2. The length of Runway Lead-in-Light System is 1,454.55m from point 2(base leg) to point 3. The length of that is 1,454.56m from point 3(base leg) to point 4. The length of that is 1,454.68m from point 4 to point 5(final). The total length of Runway Lead-in-Light System is 5,818.35m combining with the length of 46.44m.

²⁵⁾ Runway Lead-in Light System(LDIN or RLLS) are composed of three lights or more installed on ground or height close to ground to provide visual guidance in straight-in approach course or areas where dangerous terrain, obstacles and noise control procedure exist.

The installation and pattern of Lead-in-Light System on RWY 18 are as shown in [Fig. 10].

1.18.1.2 Precision Approach Path Indicator(PAPI)

Precision approach path indicator²⁶) is installed on the left side of runway when viewed from the aircraft entry. However, in case the length of PAPI system is less²⁷) than 420m, in can be installed in the left and right side of runway. PAPI should all be adequate during day and night operations and approach angle should be appropriate for aircraft which was entering runway. Each light system group has three or more linear or group flashing lights. In this case, fixed light can be added to identify runway lead-in light system.



[Fig. 11] PAPI Offset Shape in the right on RWY18R

²⁶⁾ Precision Approach Path Indicators(PAPI): PAPI is installed in outer runway to make it possible for pilots to identify adequacy of approach angle during landing. When the aircraft is within the range of normal approach angle, two PAPI close to runway are red while two others far from runway are white. When PAPI is a little higher than normal approach angle, one PAPI close to runway is red while three others are white. In case PAPI is lower than normal approach angle, all lighting system is red.

²⁷⁾ Approach light system on RWY 18R at Gimhae Int'l Airport is 420m long.

There are a total of 4 PAPI installed: one PAPI each to the left and right side on RWY 18L, one PAPI each to the left and right side of 18R.

According to the Aeronautical Information Publication²⁸(AIP)'s RKPK AD 2.21 NOISE ABATEMENT PROCEDURES 2.2 approach 2) Circling Approach RWY 18L/R b) Display for RWY 18R PAPI Direction Adjustment Light, PAPI on the left side of RWY 18R is properly installed. However, as shown in [Fig. 12], PAPI on the right side is 12 degrees offset to the west so that aircraft conducting a circling approach is able to recognize approach angle as soon as possible for landing.

PAPI on RWY 18 is supposed to be unavailable 2 miles away from lights due to obstacles.

1.18.1.3 Circling Guidance Light

Circling guidance lights²⁹ enables pilots to identify the threshold of runway as the aircraft enters downwind leg to traffic pattern or passes distance needed to align and adjust flight path. Considering guidances provided by other visual reference facilities, it enables a pilot to visually check runway threshold and other objects so that he could easily turn in base leg and final approach segment.

Circling guidance lights are installed in the right circling area of RWY 18R. The lights are installed about 40m from the edge of runway. Three lights are installed at intervals of about 30m from the extended threshold of runway. The length of the installed circling guidance lights is

²⁸⁾ Aeronautical Information Publication(AIP) is a critical element for air navigation, which contains permanent aviation information composed of General, En-route and Aerodrome.

²⁹⁾ As an aeronautical ground light, circling guidance light installed in the right side of outer RWY 18R gives guidance to aircraft in racetrack holding pattern which is unable to identify runway or runway approach area with approach lighting systems and runway edge lights.

2,953ft(900m) from the displaced threshold of RWY 18R and seven lights are installed at intervals of 150m. Circling guidance lights layout is as shown in [Fig. 12].



[Fig. 12] Circling Guidance Light Layout

1.18.1.4 Obstruction Markings

Aside from lights installed to provide a guidance of obstacles to flight crew during daytime flight, visual signals of obstruction markings vary including colour, marker, flag and etc.



[Fig. 13] Obstruction Markings on RWY 18 in Gimhae Int'l Airport

Immovable objects requiring signs should be colored if it is possible. In case an object with continuous surface and both width and length of projected objects are more than 4.5m, it should be colored with check pattern.

Obstruction markings are installed to make it possible to identify aircraft locations in traffic pattern after the base turn on RWY 18L/R at Gimhae Int'l Airport. As shown in [Fig. 13], the markings are installed 3.4km northwestward in Buram-dong, Gimhae, Gyeongnam.

1.18.2 Circling Approach Procedure of Local Flight Procedure in Gimhae Int'l Airport

The instrument approach chart(VOR/DME-A RWY 18L/R³⁰) is a instrument landing procedure for general circling approach. There is lead-in light marked in the chart. The note includes 1. Circling N/A for E of RWY 18L/R, 2. Circling N/A for RWY 36L/R, 3. Missed approach requires minimum climb of 290ft/NM to 6000ft. VOR/DME-A RWY 18L/R approach procedure is as shown in [Fig. 14].

According to Aeronautical Information Publication(AIP) RKPK AD, 2.21 noise abatement procedures 2.2 approach 2) circling approach, it recommends all aircraft to avoid the north of Namhae highway for noise control except an airplane or helicopter which might face emergency situation or unavoidable circumstances during which circling approach is performed to land RWY 18L/R.

³⁰⁾ AIP RKPK AD CHART 2-39



[Fig. 14] VOR/DME-A RWY 18L/R Instrument Approach Procedure

1.18.3 Captain's Statement

On 7 September 2019, the captain had Shanghai Airlines No. 829 flight departing from Pudong Int'l Airport and heading to Gimhae Int'l Airport. The type of the aircraft on the day of the event was B737-800 and the aircraft registration was B-1949.

According to the meteorological information at Gimhae Int'l Airport, which was confirmed during flight preparation, the average wind speed was 28kts and the maximum gust of wind speed was 38kts at 180 degrees direction due to the effect of typhoon. He prepared for his flight in compliance with the flight plan and decided to perform VOR/DME-A approach. He was supposed to land on RWY 18R at Gimhae Int'l Airport. The aircraft took off smoothly in Pudong Airport and everything was normal including en route flight.

Prior to descent, the captain was given meteorological and aerodrome information through Automatic Terminal Information Service(ATIS³¹). He decided to approach and land by using VOR/DME-A RWY 18R. Flight crew made their preparation prior to descent and set aircraft frequency vector on 113.8. After setting decision altitude on 1,700ft, he completed inputs for approach procedure.

Gimhae approach control used radar and the aircraft was vectored to approach VOR route. The captain entered the route and descended its altitude in accordance with approach procedure. After checking the aerodrome runway, the captain reported it to Gimhae ATC. The tower reported to the captain, saying that he needs to report back at the third turning position and instructed to land on RWY 18R.

During the course of a change to the fifth turning and entering the final approach course, the captain forgot external conditions due to a strong wind and a sudden jolt. He mistook RWY 18L PAPI as RWY 18R PAPI. Consequently, visual reference point was wrong and he landed on RWY 18L at Gimhae International Airport.

1.18.4 Local Controller's Statement

According to the local controller's statement, he stated that B-1949 had made a first contact with Gimhae ATC at 16:43 at 5 miles of

³¹⁾ Automatic Terminal Information Service(ATIS): ATIS provides updated information for all aircraft arriving or departing through continuous and repetitive broadcast all day or within a certain period of time

VOR/DME-A. Subsequently, he instructed B-1949 to circle to RWY 18R, report base.

The local controller stated that B-1949 had entered to the right traffic pattern and checked the aircraft's altitude and direction of travel were normal from down wind leg until base. At 16:45, the controller was informed of B-1949's base point. The local controller issued wind information and a landing clearance to B-1949 on RWY 18R and confirmed that B-1949 clearly read back the landing clearance.

The local controller thought that the approach width was narrow when B-1949 overshot turning base and entered the turning final. However, there is a slight difference depending on a pilot's maneuvering technique and wind condition of airspace. He assumed that B-1949 might have shown a different type of maneuvering in traffic pattern but the aircraft flew within the radius of circling approach area.

The controller told that B-1949 approached too narrow at the short final position(about at one mile) and reported to the shift leader that it seemed to land on another runway. However, he could not judge exactly about B-1949's approach path from the view of the tower.

The local controller recognized that B-1949 would land on RWY 18L when it was located on the threshold of runway. He was given advice about go-around from the shift leader. The controller instructed B-1949 to go around but the aircraft continued approaching without a response and landed on RWY 18L. He stated that he had already known RWY 18L was clear and thought that landing on RWY 18L might have been safer than instructing to B-1949 to make a go around. For that reason, he did not take another action.

1.18.5 Supervising Controller's Statement

According to the supervising controller's statement, followed by B-1949's line up on the final approach course, he watched over B-1949's movement with the local controller, saying "Looks like it would land on another runway way, doesn't it?" The local controller kept monitoring B-1949 but he could not make a clear judgement because he watched it diagonally. Furthermore, he could not instruct B-1949 to make a go-around recklessly so that he continued watching the aircraft's approach.

The supervising controller knew that B-1949 was supposed to land on RWY 18L from the threshold of runway. However, the local controller could not determine to instruct the aircraft to go around so that the supervising controller instructed the local controller to instruct B-1949 to make a go-around. As instructed by the supervisor, the local controller instructed B-1949 to make a go-around but the aircraft did not read back for instruction. The aircraft landed on RWY 18L.

Subsequently, there was a supervising controller's instruction given to B-1949 to enter taxiway. He advised the ground controller to instruct B-1949 to stand by on taxiway E5 for a moment and checked runway 18L. The captain of B-1949 stated that he had answered, saying "I was concentrated on the aircraft line up with runway and did not know the runway direction"

1.18.6 Ground Controller's Statement

As instructed by the supervisor, the ground controller instructed B-1949 to stand by on taxiway E5 and asked for the reason why he landed on unassigned runway. B-1949 captain acknowledged that he was distracted

by external condition and too much focused on controlling the aircraft. He also apologized for his action. Accordingly, the controller notified B-1949 of serious risk factors which would have brought about a consequential effect. He also requested the captain that if he needed to land on another runway which is not assigned, he should have reported to the ATC in advance.

After B-1949 parked on ramp at 17:15, the ground controller stated that he had contacted B-1949 captain who acknowledged that he failed to recognize the aircraft's approach to RWY 18L before landing.

2. Analysis

2.1 General

ARAIB analyzed the causes of the serious incident that B-1949 landed on RWY 18L although it was given a landing clearance from ATC to land on RWY 18R.

2.2 Airport Light Aids on RWY 18 and B-1949 Landing

As shown in [Fig. 15], there are reference light aids for circling area on ground, which enables aircraft to perform safe operation and effective turning flight towards RWY18L/R. In addition, there is PAPI to the right circling path on RWY 18R, which allows pilots to utilize approach angle before entering the final approach course. Both light aids and PAPI were displaced to the west and have been operated.



[Fig. 15] Lead-in-Light System for Circling Approach and PAPI Group

As the captain had mentioned in his earlier statement, he focused too much on controlling aircraft attitude due to a strong wind and roar so that he failed to recognize surroundings on flight path. B-1949 overshot RWY 18R final approach course and lined up on RWY 18L.

In addition, the captain mistook RWY 18L PAPI as RWY 18R PAPI an d the aircraft landed on RWY 18L. The captain's failure to check external condition due to excessive attention paid to aircraft attitude control is con sidered as human error caused by the captain's carelessness.

2.3 Cockpit CRM

The captain occupied the left seat and the first officer occupied the right seat in B-1949 on the day of the serious incident. As B-1949 had to turn to the right traffic pattern from the base turn, the captain would have approached as he watched visual reference objects on the left side. The first officer who occupied the right seat would have paid attention to runway. The captain did his best to control the aircraft which was shaking severely due to a strong wind and roar.

The first officer who was seated on the right side could have seen runway while he was circling to approach from base until entering the final approach course. In addition, after the third turning on RWY 18R, he should have turned outside a small hill which was a visual reference object located in Samjung-dong. However, the first officer presumably recognized B-1949's turning inside the hill and the moment of B-1949 overshooting final approach course of RWY 18R.

However, it was hard to identify whether the first officer gave an appropriate advice to the captain that B-1949 made a right turn inside the

small hill following the third turning to RWY 18R and overshot final approach course. It is considered that the captain presumably judged the aircraft would approach an authorized runway for landing.

2.4 Circling Approach Pattern

2.4.1 Narrow Downwind Leg Width Determined by B-1949

B-1949 set the width of the downwind leg to narrow one when wind blew from the right side.

B-1949's circling approach course and normal circling approach course are as shown in [Fig. 16]. B-1949's approach course shown in green indicates that the aircraft turned inward about 600 to 800m compared to the aircraft making the normal circling.



[Fig. 16] Normal Flight Path on RWY 18R and B-1949 Flight Path

Category	① turning to	2 downwind	③ base	④ 90°	⑤ LNAV	6 final
	downwind		turning	turn	disengage	roll-out
Normal	0.0	0004	0004	0004		
Path	2.8	2.3~2.4.	2.3~2.4	2.3~2.4		
B-1949	2.3~2.4	2.0~2.1	2.0~2.1	1.75~1.7	1.1~1.2	0.15~0.2

(Distance from RWY 18R: mile)

At the time of the event, wind blew at 200° direction with its speed of 15kts and maximum instantaneous wind speed was at 25kts with right wind speed at 0kts. The aircraft should have flown wider on the downwind leg not to overshoot RWY 18R turning final. However, the actual width of downwind leg which B-1949 flew was narrow, which contributed to the aircraft overshooting RWY 18R turning final.

2.4.2 Focus too much on Flight Instrument due to Narrow Traffic Pattern After Final Turn

B-1949 did not consider wind and drove the timing of base turn earlier³²⁾ on narrow downwind leg. Accordingly, flight path became dramatically narrower from base turn position till lining up with runway in final approach course. It indicates that the aircraft should have adjusted altitude within a short period of time(flight path) and made a final turn in order not to overshoot final segment on landing runway.

Consequently, B-1949's captain should have increased descent rate within a short period of time and maintained bank angle within a maximum range of bank angle not to overshoot final approach segment. The captain should have continued to check landing runway visually for circling approach and landing. B-1949's captain was presumably under a situation where he should have frequently checked flight deck instruments

³²⁾ According to the captain's statement, base turn started 10 seconds after passing RWY 18 threshold

to comply with allowable descent rate and bank angle.

When the captain turned to the final approach segment, he should have continued to look at runway and visually identified landing RWY 18R. Then, he should have made a final turn and adjusted altitude while keeping an eye on runway. In this case, the captain should have avoided flying under instrument flight rule and looking at flight deck instrument not to go beyond the range of descent angle and bank angle.

The first officer on the right seat who was able to identify landing runway should have continued to check landing runway and gave an advice to the captain about the runway information in order for the captain not to miss the timing of final turn. In particular, in turning final segment where he had to pay attention to landing runway and CRM was critical, the first officer should have avoided focusing too much on monitoring descent rate and bank angle instrument.

In an airport like Gimhae Int'l Airport where runways are in parallel with each other, captain and first officer should visually check both runways prior to turning final segment, which was critical for flight crew to exactly identify landing runway. At that time, they must caution not to mistake parallel taxiway as runway.

Followed by B-1949's final turn, the flight path became short. The captain was concerned about descent rate and bank angle with his heavy workload. He was dependent on instrument and failed to visually check landing runway, thereby leading to overshoot final course. Furthermore, the captain presumably mistook RWY 18L PAPI as RWY 18R PAPI when the aircraft lined up on the runway.

As a less experienced pilot who had flown Gimhae Int'l Airport for the first time, the first officer did not properly ask for an advice to the captain and focused too much on flight deck instrument. He probably overlooked the importance of CRM which could have helped the captain to line up with landing runway.

2.5 Radar Screen Analysis for B-1949 Flight Path

As shown in [Fig. 17], Gimhae approach control radar screen shows that B-1949 overshot RWY 18R final approach course and lined up on RWY 18L.

It indicates that the captain failed to identify that B-1949 passed over the final approach course of RWY 18R.



[Fig. 17] Image of B-1949 Overshooting RWY 18R

[Fig. 18] shows that the captain or the first officer misidentified runway from the moment of overshooting RWY 18R which was authorized until the moment of lining up with RWY 18L.



[Fig. 18] Image of B-1949 Line up with RWY 18L

Considering all these matters, roles and responsibilities were not properly assigned to the captain and the first officer so that they presumably failed to perform their roles in an appropriate way. It indicates that crew resource management was not sufficiently implemented in a cockpit where the flight crew should have asked and given an accurate advice about flight condition.

3. Conclusions

3.1 Findings

- 1. The flight crew of B-1949 held all valid qualification certificates refored for operation. There were no special issues or factors which could have affected the flight.
- 2. There was a difference in flight plan of CSH829(Pudong airport to Gimhae airport) of B-1949 but no issues pertinent to the weight and operation performance were found in accordance with aircraft weight and balance.
- 3. Typhoon No. 13 "Lingling" was heading north and passing above west sea. Due to the typhoon, around Gimhae Int'l Airport was a strong wind and irregular movement of air.
- 4. Runway lead-in light system(RLLS), precision approach path indicator (PAPI), circling guidance light, obstruction markings are installed in circling approach area, which gives guidance to aircraft to circle and approach to the direction of RWY 18.
- 5. While B-1949 attempted to land by performing circling approach under VFR, all aids to navigation were properly operated.
- B-1949 was given landing clearance to RWY 18R as instructed by Gimhae ATC controller. There was no communication error when B-1949 contacted the air traffic control unit during flight.
- 7. B-1949 was equipped with FDR and CVR; however, its recorded data were erased and could not be downloaded due to the late report of

the serious incident.

- 8. B-1949 mistook RWY 18L PAPI as RWY 18R PAPI. During circling approaches, the captain focused too much on controlling aircraft attitude due to a strong wind after base turn and failed to recognize that the aircraft overshot RWY 18R final approach course.
- Local controller of Gimhae ATC checked that B-1949 overshot the final approach course on the authorized RWY 18R and approached RWY 18L. At 16:46:49, the controller instructed B-1949 to go around but B-1949 landed on RWY 18L at 16:46:50.
- 10. Shanghai Airlines classified designated special airports into grade 1, grade 2 and grade 3. Gimhae Int'l Airport was classified into grade 1 special airport. In addition, flight crew are given operational qualification for special airports only when they completed a designated education and training and passed the test.
- 11. The first officer of B-1949 did not have experience of the circling approach at Gimhae Int'l Airport before the serious incident occurred.
- According to QAR data, the width of circling approach pattern of B-1949 was narrower than that of normal circling approach pattern and the altitude was low by about 200ft.
- 13. Considering the wind blown from the right side, B-1949 could not widen the downwind leg pattern. Furthermore, the aircraft drove the timing of base turn, which is assumed that B-1949 flight path became radically shorter from the third turning position till lining up with runway.

- 14. Followed by the third turning, the captain was presumably under a situation where he should have increased descent rate and bank angle not to overshoot the turning final within a short period of time(flight path) and frequently checked flight deck instruments to comply with allowable descent rate and bank angle.
- 15. The captain should have continued to check landing runway visually. However, as the captain flew in a short pattern from the third turning (base turn) till turning final, he was dependent on flight deck instruments, which is considered that he did not have much time to identify landing runway.
- 16. The first officer who did not have flight experience in Gimhae Int'l Airport paid attention to monitoring other flight deck instruments after the third turning. He presumably might not have given an advice to the captain and CRM would not have been properly implemented.

3.2 Probable Cause

The Aviation and Railway Accident Investigation Board(ARAIB) determines that the probable cause of this serious incident was ^rDuring circling approaches under VFR, B-1949 flight crew failed to identify landing RWY 18R and landed on unauthorized RWY 18L_J

Contributing to the serious incident were $\lceil ①$ During circling approach, B-1949 selected a narrow turning pattern and failed to line up on the final approach course to RWY 18R. ② Runway misidentification that RWY 18L PAPI being mistaken for RWY 18R PAPI ③ Insufficient CRM between the captain and the first officer.

4. Safety Recommendations

4.1 To Shanghai Airlines

- 1. In case of aircraft operations in Grade 1 designated special aerodrome, it is recommended to implement flight plan based on characteristics of special airports and provide measures to captain and first officer in order to cross check their roles during preflight briefing. (AIR1905-1)
- It is advised to review traffic pattern, flight procedure and detailed CRM among flight crew members in case of circling approaches in Gimhae Int'l Airport. (AIR1905-2)
 - * During circling approaches for landing, it is advised to emphasize the importance of landing RWY identification and continuous visual check.
- 3. For flight crew who would first begin to operate flights in designated special aerodrome, it is recommended to provide pre-flight education for special airports and make sure to implement it. (AIR1905-3)