

AI2016-3

**AIRCRAFT SERIOUS INCIDENT  
INVESTIGATION REPORT**

**PEACH AVIATION CO., LTD.  
J A 8 0 2 P**

July 28, 2016

The objective of the investigation conducted by the Japan Transport Safety Board in accordance with the Act for Establishment of the Japan Transport Safety Board (and with Annex 13 to the Convention on International Civil Aviation) is to prevent future accidents and incidents. It is not the purpose of the investigation to apportion blame or liability.

Kazuhiro Nakahashi  
Chairman,  
Japan Transport Safety Board

Note:

This report is a translation of the Japanese original investigation report. The text in Japanese shall prevail in the interpretation of the report.

# **AIRCRAFT SERIOUS INCIDENT INVESTIGATION REPORT**

**PEACH AVIATION CO., LTD.**

**AIRBUS A320-214, JA802P**

**EMERGENCY OPERATION TO AVOID CRASH INTO WATER SURFACE**

**ABOUT 4 NM NORTH OF NAHA AIRPORT AROUND 300FT**

**AT ABOUT 11:47 JST, APRIL 28, 2014**

July 8, 2016

Adopted by the Japan Transport Safety Board

Chairman	Kazuhiro Nakahashi
Member	Toru Miyashita
Member	Toshiyuki Ishikawa
Member	Sadao Tamura
Member	Keiji Tanaka
Member	Miwa Nakanishi

## SYNOPSIS

### <Summary of the Serious Incident>

On Monday, April 28, 2014, an Airbus A320-214, registered JA802P, operated by Peach Aviation Co., Ltd., as the scheduled Flight 252 of the company, departed New-Ishigaki Airport and approached Runway 18 of Naha Airport, guided by precision approach radar. At about 11:47 Japan Standard Time (JST, UTC + 9 hr : unless otherwise stated all times are indicated in JST) during this approach, at the position of about 4 nm north of the airport, the captain made a go-around as an emergency operation in order to avoid crash into water surface because the aircraft was losing its altitude. On this occasion, the Enhanced Ground Proximity Warning System issued some warnings. After that, the aircraft landed on the airport at 12:10.

There were 59 persons on board, consisting of the captain, five other crewmembers and 53 passengers, but nobody was injured.

There was no damage to the aircraft.

### <Probable Cause>

It is highly probable that the serious incident occurred because the Captain executed an emergency operation in order to avoid crash into water as the aircraft, making an approach for runway 18 by precision approach radar-guidance at Naha Airport, began descent and continued. It is probable that the aircraft began descent due to the captain's unintentional operation. It is also probable that the aircraft continued descending because the captain and the first officer were less aware of monitoring the altitude as they relied on autopilot system over maintaining of altitude and did not properly prioritize their tasks.

In addition, it is probable that insufficient risk management at the Naha Ground Controlled Approach Facility, relating to identification of that aircraft before meeting glide-path might descend and deviate below the Radar Safety Zone, consequently contributed to its continued descent of the Aircraft.

Abbreviations used in this report are as follows:

AP	: Auto Pilot
ARTS	: Automated Radar Terminal System
AT	: Auto Thrust
ATC	: Air Traffic Control
ATIS	: Automatic Terminal Information Service
CAT	: Category
CFIT	: Controlled Flight Into Terrain
CG	: Center of Gravity
CRM	: Crew Resource Management
CVR	: Cockpit Voice Recorder
DME	: Distance Measuring Equipment
ECAM	: Electronic Centralized Aircraft Monitor
EGPWS	: Enhanced Ground Proximity Warning System
FAA	: Federal Aviation Administration
FCOM	: Flight Crew Operating Manual
FCTM	: Flight Crew Training Manual
FCU	: Flight Control Unit
FD	: Flight Director
FDR	: Flight Data Recorder
FMA	: Flight Mode Annunciator
FMGC	: Flight Management Guidance Computer
FMGS	: Flight Management Guidance System
FPA	: Flight Path Angle
ftm	: feet per minute
GA	: Go Around
GCA	: Ground Controlled Approach
GPWS	: Ground Proximity Warning System
HDG	: Heading
ICAO	: International Civil Aviation Organization
ILS	: Instrument Landing System
IMC	: Instrument Meteorological Conditions
LA	: Low Altitude Warning
LSC	: Lower Safety Cursor

MAC	: Mean Aerodynamic Chord
MCDU	: Multipurpose Control Display Unit
MSAW	: Minimum Safe Altitude Warning
ND	: Navigation Display
OM	: Operations Manual
OMS	: Operations Manual Supplement
PANS • ATM	: The Procedures for Air Navigation Services - Air Traffic Management
PAR	: Precision Approach Radar
pb	: push button
PF	: Pilot Flying
PFD	: Primary Flight Display
PM	: Pilot Monitoring
PNF	: Pilot Not Flying
QAR	: Quick Access Recorder
RVR	: Runway Visual Range
RWY	: Runway
SPD	: Speed
TAD	: Terrain Awareness and Display
TCF	: Terrain Clearance Floor
TOGA	: Take Off Go Around
VOR	: VHF Omnidirectional Range
VORTAC	: VHF Omnidirectional Range Tactical Air Navigation System
VS	: Vertical Speed
WGL	: Wireless Ground Data Link

#### Unit Conversion Table

1 ft	: 0.3048 m
1 kt	: 1.852 km/h (0.5144 m/s)
1 nm	: 1,852 m
1 lb	: 0.4536 kg

# Table of Contents

1. PROCESS AND PROGRESS OF INVESTIGATION .....	1
1.1 Summary of the Serious Incident .....	1
1.2 Outline of the Serious Incident Investigation.....	1
1.2.1 Investigation Organization .....	1
1.2.2 Representatives of the Relevant State.....	1
1.2.3 Implementation of the Investigation.....	1
1.2.4 Comments from the Parties Relevant to the Cause of the Serious Incident.....	2
1.2.5 Comments from the Relevant State .....	2
2. FACTUAL INFORMATION .....	2
2.1 History of the Flight.....	2
2.1.1 History of the Flight based on Records of FDR, EGPWS Warnings and ATC Communication ..	3
2.1.2 Statements of Parties relevant to the Serious Incident.....	6
2.2 Damage to Person .....	12
2.3 Damage to the Aircraft .....	12
2.4 Personnel Information .....	12
2.4.1 Flight Crewmembers.....	12
2.4.2 Controllers.....	13
2.5 Aircraft Information.....	14
2.5.1 Aircraft .....	14
2.5.2 Weight and Balance.....	14
2.6 Meteorological Information .....	15
2.6.1 Meteorological Conditions at the Airport.....	15
2.6.2 Aviation Routine Weather Report.....	15
2.7 Flight Recorder Information.....	16
2.8 Information on the Serious Incident Site .....	16
2.8.1 Outline of the Airport and its Surroundings .....	16
2.8.2 PAR Approach .....	17
2.9 Standard Approach Procedure to RWY 18 at the Airport .....	17
2.9.1 Requirements for Stabilized Approach .....	17
2.9.2 Approach Procedures.....	17
2.10 Operation and indication of Instruments.....	18
2.10.1 Instrument Panel .....	18

2.10.2	PFD and ND.....	19
2.10.3	VS Knob.....	20
2.10.4	Thrust Levers .....	21
2.10.5	Altitude Alerts.....	21
2.11	Description in the Company's Manual.....	22
2.11.1	Crew Duties.....	22
2.11.2	Description about Monitoring FMA .....	22
2.11.3	Standard Callout.....	22
2.11.4	The Checklist.....	23
2.12	Principles for Pilots (GOLDEN RULES FOR PILOTS) .....	24
2.12.1	Flying.....	24
2.12.2	Practical use of Automated System.....	25
2.12.3	Understanding FMA .....	25
2.13	Investigation Reports concerning Flight Safety in the U.S.A.....	26
2.13.1	Reliance on automation.....	26
2.13.2	Task/Workload Management.....	26
2.13.3	Importance of Pilot Monitoring.....	27
2.14	FDR Records.....	28
2.15	EGPWS (Enhanced Ground Proximity Warning System).....	29
2.15.1	Enhancement function of EGPWS .....	30
2.15.2	Records of EGPWS .....	31
2.15.3	Response When the EGPWS Warning Issues .....	32
2.15.4	The View of the Aircraft Manufacturer Relevant to EGPWS Warning issuance.....	33
2.16	Investigation by using flight simulator .....	33
2.17	Education and Training for Flight Crewmembers.....	33
2.17.1	Education and Training of the Type of the Aircraft .....	33
2.17.2	Requirements for airport qualification .....	34
2.17.3	PAR approach Experience of the Captain and the First Officer in the Past.....	34
2.18	Report from the Captain after the Serious Incident.....	34
2.18.1	Confirmation by the Captain and the First Officer .....	34
2.18.2	Reporting requirement for a Captain .....	35
2.18.3	In-house Processing to Captain Report.....	35
2.19	Task of Ground Controlled Approach Facility.....	36
2.19.1	Situation in Naha Ground Controlled Approach Facility at the Time of the Serious Incident .....	36
2.19.2	Duty of the Controllers in the Ground Controlled Approach Facility .....	36
2.20	Radar Safety Zone.....	41



2.20.1	Definition of Radar Safety Zone .....	41
2.20.2	Action When Deviated from Radar Safety Zone.....	42
2.20.3	Education and Training for the Controllers in Naha Ground Controlled Approach Facility .	43
2.21	Minimum Safe Altitude Warning (MSAW).....	43
2.21.1	Object of MSAW Function .....	43
2.21.2	Low Altitude Warning .....	44
2.21.3	Regulations relevant to LA .....	44
2.21.4	MSAW Record at the Time of Occurrence of Serious Incident .....	45
2.22	Notification Procedures when LA is issued .....	45
2.22.1	Similar Event in the Past .....	45
2.22.2	Notification Procedures when the Serious Incident occurred .....	46
3.	ANALYSIS .....	48
3.1	Qualifications of Personnel.....	48
3.2	Aircraft Airworthiness Certificate .....	48
3.3	Relations to the Meteorological Conditions.....	48
3.4	History of the Flight.....	48
3.4.1	Situation at Time of Initiating Approach.....	48
3.4.2	Transfer to Final Controller and Beginning of Descent .....	49
3.4.3	Situation at Time of Beginning of Carrying out the Checklist .....	50
3.4.4	Situation at Completion of the Checklist.....	50
3.4.5	The First Officer's Warning and Operation to Stop Descent.....	51
3.4.6	EGPWS Warning and the Situation at Go-Around.....	51
3.5	The Captain's Knob Operation.....	52
3.5.1	The Captain's Situation .....	52
3.5.2	The First Officer's Notice .....	53
3.6	Flight Monitoring .....	54
3.6.1	Background of Lack of Recognition of Descent.....	54
3.6.2	Relation with Automation System .....	54
3.6.3	Maintaining Attention.....	55
3.7	EGPWS Warnings and the Captain's Operations At the Serious Incident.....	56
3.7.1	Issuance of EGPWS Warnings.....	56
3.7.2	The Captain's Operations at the Serious Incident .....	58
3.8	The Captain's Report and Response of the Company.....	58
3.9	History of Flight Monitoring at Naha Ground Controlled Approach Facility .....	59
3.9.1	From Beginning of Descent through Deviation from Radar Safety Zone.....	59
3.9.2	From Time of Issuing LA through Time of Go-Around .....	59

3.10	Altitude Monitoring by Controllers.....	60
3.10.1	Features of PAR Screen.....	60
3.10.2	Final Controller's Awareness of Altitude Monitoring .....	60
3.10.3	Actions Taken against LA Issuance.....	61
3.10.4	Risk Management against Descent of Aircraft under Control.....	62
4.	CONCLUSIONS .....	63
4.1	Summaries of Analysis .....	63
4.1.1	General Matters.....	63
4.1.2	History of Flight .....	63
4.1.3	Items Relevant to Causes on Flight Operation .....	64
4.1.4	Other Items Disclosed .....	67
4.1.5	Items Relevant to the Control Facility .....	67
4.2	Probable Causes .....	69
5.	SAFETY ACTIONS.....	70
5.1	Safety Actions Taken.....	70
5.1.1	Safety Actions Taken by the Company .....	70
5.1.2	Safety Actions Taken by the Civil Aviation Bureau .....	72
Appended Figure 1	Estimated Flight Route .....	74
Appended Figure 2	Air Traffic Flow of Arrival Aircraft to Naha Airport (image).....	74
Appended Figure 3	FDR Records.....	75
Appended Figure 4	Meteorological Information .....	76
Appended Figure 5	RWY 18, VOR Approach at Naha Airport .....	77
Appended Figure 6	Three-View Drawing of Airbus 320-214 .....	78
Appended Figure 7	List of ATC Communication Records and the Pressure Altitude of the Aircraft and Others. ....	79

# 1. PROCESS AND PROGRESS OF INVESTIGATION

## 1.1 Summary of the Serious Incident

On Monday, April 28, 2014, an Airbus A320-214, registered JA802P, operated by Peach Aviation Co., Ltd., as the scheduled Flight 252 of the company, departed New-Ishigaki Airport and approached Runway 18 of Naha Airport, guided by precision approach radar. At about 11:47 Japan Standard Time (JST, UTC + 9 hr : unless otherwise stated all times are indicated in JST ) during this approach, at the position of about 4 nm north of the airport, the captain made a go-around as an emergency operation in order to avoid crash into water surface because the aircraft was losing its altitude. On this occasion, the Enhanced Ground Proximity Warning System issued some warnings. After that, the aircraft landed on the airport at 12:10.

There were 59 persons on board, consisting of the captain, five other crewmembers and 53 passengers, but nobody was injured.

There was no damage to the aircraft.

## 1.2 Outline of the Serious Incident Investigation

The occurrence covered by this report falls under the category of "A case where aircraft crew executed an emergency operation during navigation in order to avoid crash into water or contact on the ground" as stipulated in Clause 5, Article 166-4 of the Ordinance for Enforcement of the Civil Aeronautics Act, and was classified as a serious incident.

### 1.2.1 Investigation Organization

On April 29, 2014, the Japan Transport Safety Board (JTSB) designated an investigator-in-charge and two other investigators to investigate this serious incident.

### 1.2.2 Representatives of the Relevant State

An accredited representative and an adviser of France, as the State of Design and Manufacture of the aircraft involved in this serious incident, participated in the investigation.

### 1.2.3 Implementation of the Investigation

April 29, 2014	Aircraft examination and interviews
April 30, 2014	Interviews and confirmatory investigation
May 1, 2014	Interviews

June 6, 2014	Reproductive investigation with a simulator
July 8, 2014	Interviews
July 9, 2014	Confirmatory Investigation on a scheduled flight
August 14, 2014	Interviews

#### 1.2.4 Comments from the Parties Relevant to the Cause of the Serious Incident

Comments were invited from parties relevant to the cause of the serious incident.

#### 1.2.5 Comments from the Relevant State

Comments on the draft report were invited from the relevant State.

## 2. FACTUAL INFORMATION

### 2.1 History of the Flight

On April 28, 2014, an Airbus A320-214, registered JA802P (hereinafter referred to as "the Aircraft"), operated by Peach Aviation Limited (hereinafter referred to as "the Company") as the scheduled Flight 252 of the Company, departed New-Ishigaki Airport and conducted a Precision Approach Radar approach (hereinafter referred to as "PAR approach<sup>\*1</sup>") to Runway 18 (hereinafter referred to as "RWY 18") of Naha Airport (hereinafter referred to as "the Airport"). At about 11:47 during this approach, at the position of about 4 nm north of the airport, the captain (hereinafter referred to as "the Captain") made a go-around as an emergency operation in order to avoid crash into water because the Aircraft was losing its altitude. On this occasion, the Enhanced Ground Proximity Warning System (hereinafter referred to as "EGPWS<sup>\*2</sup>") issued some warnings at the moment. After that, the Aircraft landed on the Airport at 12:10.

The flight plan of the Aircraft was outlined as below:

Flight rules: Instrument flight rules (IFR)	
Departure aerodrome	: Shin-Ishigaki Airport
Estimated off-block time	: 10:35
Cruising speed	: 444 kt
Cruising altitude	: FL 250
Destination aerodrome	: Naha Airport
Total estimated elapsed time	: 0 hr and 42 min

---

\*1 See 2.8.2 for "PAR approach."

\*2 See 2.15 for "EGPWS".

Fuel load expressed in endurance : 3 hr and 00 min  
Alternate airport : Kadena Airbase

When the serious incident occurred, the captain took the left seat in the cockpit of the Aircraft as the PF (Pilot Flying: pilot mainly in charge of flying), and the first officer (hereinafter referred to as "the First Officer") the right seat as the PNF (Pilot Not Flying: pilot mainly in charge of duties other than flying).

According to the records of the flight data recorder (hereinafter referred to as "FDR"), the records of EGPWS warnings issued and the air traffic control (hereinafter referred to as "ATC") communication records, as well as the statements of the flight crewmembers and air traffic controllers (hereinafter referred to as "the Controllers"), the history of the flight up to the serious incident is as summarized below.

### 2.1.1 History of the Flight based on Records of FDR, EGPWS Warnings and ATC Communication

11:02:51 Autopilot system of the Aircraft (hereinafter referred to as "AP") was engaged after the Aircraft departed from Shin-Ishigaki Airport. (The Aircraft continued to fly with AP engaged until just before it landed at the Airport after making a go-around.)

11:26:03 - The Aircraft reported the approach controller at the Naha Radar Approach Control Facility (hereinafter referred to as "the Naha Approach"<sup>\*3</sup>) that it would conduct a VOR approach<sup>\*4</sup> in accordance with the ATIS information<sup>\*5</sup>. The Naha Approach informed the Aircraft of providing radar-guidance along the VOR approach course.

11:33:50 The Aircraft was transferred to the arrival controller at the Naha Radar Approach Control Facility (hereinafter referred to as "the Naha Arrival")

11:34:51 - The Aircraft requested a PAR approach to RWY 18. The Naha Arrival approved the change of the approach.

11:38:15 The Naha Arrival instructed the Aircraft to descend to 1,000 ft.

11:39:12- The Naha Arrival instructed the Aircraft to decelerate to 190 kt. The flap

---

<sup>\*3</sup> If an aircraft flies a PAR approach to Naha Airport, it is transferred in the following order: from the approach controller at the Naha Radar Approach Control Facility (Naha Approach) to the arrival controller at the same facility (Naha Arrival), the pattern controller at the Naha Ground Controlled Approach Facility (Pattern Controller), the final controller (Final Controller) and finally to the controller at the Aerodrome Control Tower of Naha Airport. Based on the traffic stream, aircraft may be directly transferred from the Naha Approach to the Pattern Controller, without going through the Naha Arrival. (See Appended Figure 2)

<sup>\*4</sup> The "VOR approach" is a non-precision approach using the Naha VORTAC Station. (See Appended Figure 5)

<sup>\*5</sup> ATIS is information on the airport such as types of approach, runways to use, airport conditions and weather information. It is provided for aircraft departing from or arriving at the airport.

lever was set to "1"\*6.

11:41:12 - The Aircraft was transferred to the pattern controller at the Naha Ground Controlled Approach Facility (hereinafter referred to as "the Pattern Controller").The Pattern Controller informed the Aircraft that the guidance limit (the minimum altitude for guidance) for RWY 18 was 211 ft.

11:41:25 - The Pattern Controller informed the Aircraft that the airport was under IMC\*7 with visibility of 4,000 m and that the Aircraft would need to follow a published missed approach procedure in the case of negative contact of the runway at the guidance limit.

Around 11:41:30 The Aircraft reached a pressure altitude of 1,000 ft.

11: 42:52 The Pattern Controller instructed the Aircraft to turn right heading 185.

11:44:07 Flap lever was set to "2", and then the airspeed was reduced to160 kt.

11:44:54 The Pattern Controller informed that the TOUCH DOWN RVR\*8 at RWY 18 was 1,700 m and getting worse and that the STOP END RVR\*9 was maintaining more than 1,800 m.

11:45:18 Landing gear handle was set to the DOWN position.

11:45:43 Flap lever was set to "3".

11:46:20 - The Aircraft was transferred to the final radar-guidance controller (hereinafter referred to as "the Final Controller"). The Final Controller began to guide the Aircraft for a PAR approach. The Final Controller performed the communication status check before providing radar-guidance for landing\*10 (hereinafter referred to as "the Communication Check"), and the Aircraft informed that the controller's voice was read in a good reception.

11:46:26 - The Final Controller also informed the Aircraft's voice on the Controller's side was also good in a same manner and instructed, "Do not acknowledge further transmissions." (hereinafter referred to as "Don't Acknowledge Instruction")

---

\*6 There are four flap positions: 1, 2, 3 and FULL. Flaps are initially set to "1" and shifted to the other positions as the aircraft decelerates during an approach. The "FULL" position is used for a normal landing.

\*7 "IMC" stands for "instrument meteorological condition."

\*8 "TOUCH DOWN RVR" is an RVR (runway visual range) value observed in or around the touchdown zone closest to the runway approach end.

\*9 "STOP END RVR" is an RVR (runway visual range) value observed in or around the touchdown zone closest to the runway end.

\*10 "The communication status check before providing radar-guidance for landing," stipulated in the "Standards for Air Traffic Control Procedure" is performed by calling, "how do you read?" The purpose is to verify the sensitivity and articulation on the receiving station, or how the transmitted words sound on the receiving side. Both the final controller and the flight crew need to do this check with each other at the first communication for a PAR approach.

11:46:28 Vertical mode\*<sup>11</sup> was set to VS\*<sup>12</sup> on the AP/FD\*<sup>13</sup> of the Aircraft.

11:46:30- The Final Controller informed the Aircraft had just passed the position of 6nm\*<sup>14</sup>  
from the touchdown point.

11:46:30 The Aircraft began descent in the VS mode with -900 fpm.

11:46:47 Flap lever was set to "FULL".

11:46:53 The Final Controller informed that the Aircraft had just passed 5 nm.

11:47:06 - The Final Controller informed of a landing clearance for RWY 18 with wind  
information of 180 degrees and at 12 kt.

11:47:09 Low Altitude Warning\*<sup>15</sup> was issued at the Pattern Controller's position.

11:47:22 - The Final Controller informed the Aircraft had just passed 4 nm.

11:47:25 - The Final Controller instructed the Aircraft, "Maintain one thousand,  
maintain one thousand. You are too below for safety approach."  
(Hereinafter referred to as "the Maintain 1,000 ft Call.")

11:47:26 EGPWS warning, "TOO LOW TERRAIN\*<sup>16</sup>," was issued.

11:47:27 Selected vertical speed was changed to 0 fpm as the Aircraft was kept in VS  
mode.

11:47:32 EGPWS warning, "TERRAIN, TERRAIN, PULL-UP\*<sup>17</sup>," was issued.

11:47:33 - The Final Controller instructed the Aircraft to reply, "Air Peach Two Five Two,  
acknowledge, please." (hereinafter referred to as "the Acknowledge Call.")

11:47:35 AP/FD vertical mode was changed to the go-around mode.

11:47:37 - The Final Controller instructed the Aircraft, " Air Peach Two Five Two,  
maintain one thousand. Too low for safety approach."

11:47:41 - The Aircraft reported a go-around.

11:47:43 - The Final Controller informed the Aircraft of receiving a go-around report and  
instructed it to remain on the current frequency.

11:47:48 The Aircraft acknowledged the instruction.

Around 12:10 The Aircraft landed on RWY 18.

---

\*11 "Vertical mode" here means the vertical direction mode of Autopilot/Flight Director (AP/FD) system on the type of aircraft. The aircraft operation in its climbing and descending phase was controlled by the vertical mode. (See Figure 4 in 2.10.2.)

\*12 "The VS mode" is a mode in which climb and descent of the aircraft is controlled by a specified VS (vertical speed) value. VS values are displayed by altitude difference per minute (fpm).

\*13 "FD" stands for flight director.

\*14 "The position of 6 nm from the touchdown point" means that the distance from the aiming touchdown point for PAR approach to the Aircraft is 6 nm. All distances mentioned in this report refer to those from the aiming touchdown point unless otherwise stated.

\*15 See 2.21.2 for "Low Altitude Warning."

\*16 See 2.15.1 (2) for "TOO LOW TERRAIN."

\*17 See 2.15.1 (1) for "TERRAIN, TERRAIN, PULL-UP."

## 2.1.2 Statements of Parties relevant to the Serious Incident

### (1) Captain

The Captain set VOR Approach/RWY 18<sup>\*18</sup> on FMGC<sup>\*19</sup> after receiving ATIS of the Airport, and then he gave a landing briefing (hereinafter referred to as "the Briefing"). Major points in the Briefing were: around the CHATN point<sup>\*20</sup> at 6.0 nm, extend the landing gears, set the flaps to the "FULL" position and complete the landing checklist<sup>\*21</sup> (hereinafter referred to as "the Checklist"); at 3.0 nm,<sup>\*22</sup> begin to descend; the final approach course is 186 degrees; the minimum descend altitude is 420 ft; and the approach speed is 128 kt.

The Aircraft was transferred from the Naha Approach to the Naha Arrival. The Captain recognized, judging from communications between preceding aircraft and the Controller, that the visibility around the Airport was getting worse. Since the Captain knew that some preceding aircraft were requesting PAR approach, he also requested it as they did. The Captain got the approval for the PAR approach.

The Captain had an additional Briefing to reflect the change of the approach procedure from VOR approach to PAR approach. In the Briefing, he confirmed the decision height<sup>\*23</sup> of 211 ft and the missed-approach course, and ordered to display the final approach course of 182 degrees on ND<sup>\*24</sup>. The Captain also ordered to keep VOR approach in FMGC as it was in order to utilize the VOR approach profile on ND as reference to check the positions of 6.0 nm to extend the landing gear and 3.0 nm to begin descending.

The flaps were set at "2" when the Aircraft was transferred to the Pattern Controller and then were set to "3" around when it was transferred to the next Final Controller.

The Captain, while flying the type of Aircraft, often performed the procedure that he first preset his desired vertical speed in the Vertical Speed/Flight Path Angle Window (hereinafter referred to as "the VS Window"<sup>\*25</sup>) shortly before descent, and then pulled the VS knob to initiate a descent.

The Captain was going to have the Aircraft descend upon receiving the controller's instruction on beginning descent. In order to capture the three-degree path without delay, he planned to descend with a large descent rate only when initiating descent. The Captain remembered presetting a vertical speed of -900 fpm at that time but did not remember whether he told his presetting action to the First Officer.

The Captain stated that when viewed in hindsight, it was too early for him to preset the vertical

---

\*18 See Appended Figure 5 for "VOR Approach/RWY 18."

\*19 FMGC: Flight Management Guidance Computer

\*20 See Figure 4 in 2.10.2 for "the CHATN point at 6.0 nm."

\*21 See 2.11.4 for the landing checklist.

\*22 See Figure 4 in 2.10.2 for the 3.0 nm.

\*23 PAR approach is one of precision approaches, pilots shall decide either landing or not at "Decision Height." In the words and terms among ATC facilities they use "Guidance Limit" which refers to guidance height threshold, instead of "Decision Height."

\*24 See 2.10.2 for ND.

\*25 See 2.10.1 and 2.10.3 for the VS Window.



speed in the VS Window because he knew that the indication of VS Window is active for 45 seconds<sup>\*26</sup> and the Aircraft was assumed to have flown at about 3 nm short of the planned point to begin descent when he preset the vertical speed.

After that, the Captain ordered the First Officer to set the flaps to "FULL" and perform the Checklist and then received the First Officer's report of the completion of the Checklist. Although the Captain did not remember well the details of what happened afterward, the First Officer warned him, "TOO LOW," and EGPWS "TERRAIN"<sup>\*27</sup> warning sounded. Almost at the same time, the Controller informed of "TOO LOW FOR SAFE APPROACH." Deciding to make a go-around, the Captain set the thrust levers to the "TOGA"<sup>\*28</sup> position, while using AP. The Captain remembered that during the go-around, he saw the altimeter of 380 ft on PFD<sup>\*29</sup> and heard "TERRAIN" again. On the other hand, he did never remember hearing the "PULL-UP"<sup>\*30</sup> warning. The Captain knew the procedure<sup>\*31</sup> at PULL-UP warning, but he continued using AP because he heard only "TERRAIN"

The Captain was unable to confirm visually the Airport nor the sea surface during this PAR approach because the Aircraft was flying in clouds. He saw neither the display of the red warning area<sup>\*32</sup> on the ND nor the sign of "PULL UP"<sup>\*33</sup> on the GPWS button<sup>34</sup>.

The Aircraft made a PAR approach again and landed on the Airport.

The Captain did not remember the First Officer's advice<sup>\*35</sup> "TOO LOW" referring to the presetting value in the VS Window, and he thought AP had kept the Aircraft flying at an altitude of at 1,000 ft until he initiated a go-around. The Captain did not remember the operation of pulling the VS knob<sup>\*36</sup> at all, which resulted in the Aircraft's descent, although the Captain believed that he himself as PF must have pulled it. The Captain did not know what caused such this situation.

The Captain was aware that the pilot is responsible for maintaining the altitude. On the other hand, he thought that the Controller monitored the altitude of the Aircraft.

## (2) First Officer

The type of approach was changed from VOR approach to PAR approach during the descent to the Airport. The First Officer received a Briefing from the Captain in which he told about the use of the VOR approach settings in FMGC as reference for the distance to the touchdown point, but the Captain did not mention specific procedures for the vertical speed setting and others. The First Officer

---

\*26 See 2.10.3 for details on the VS knob such as its functions and effective time.

\*27 "TERRAIN" is an alert call from EGWS (see 2.15.1 (2)).

\*28 TOGA is a thrust lever position which is applied at take-off or go-around (see 2.10.4).

\*29 See 2.10.2 for PFD.

\*30 "PULL-UP" here means an EGPWS warning (See 2.15.1 (1)).

\*31 See 2.15.3 for the procedure for "PULL-UP" warning.

\*32 See 2.15.1 (1) for the red warning area.

\*33 See 2.10.1 for "PULL UP" on GPWS button.

\*34 See 2.10.1 and 2.15.1 (1).

\*35 See the First Officer's statement at 2.1.2 (2) for the advice.

\*36 See 2.10.3 for the VS knob.

was monitoring the position of the Aircraft on ND throughout the flight. While the Pattern Controller was providing radar-guidance the Aircraft, the First Officer followed the Captain's order of extending the landing gears at about 8 nm and setting the flaps to "3." After that, when the Captain ordered the First Officer to set the flaps to "FULL" and perform the Checklist, the Aircraft was transferred to the Final Controller.

The First Officer mistakenly thought that she set the flaps to "FULL" position concurrently the Captain's order.

The First Officer began to read the Checklist after completing the Communication Check with the Final Controller. In the course of reading, the First Officer noticed the indication "-900 fpm" in the FCU<sup>\*37</sup> VS Window. The Captain had not made a callout of the preset in the VS Window<sup>\*38</sup>, and the First Officer had not realized his preset operation, but she thought the descent at the rate of "900 fpm" would be too large. The First Officer called "TOO LOW" to the Captain, pointing out the figure of -900 in the VS Window in order to tell him that it would make the descending path too deep. The Captain did not respond to her; however, and the Final Controller continued to send instructions. Deciding that she could not discuss with the Captain at that moment and that it would be better to finish the Checklist as soon as possible, the First Officer continued to read the Checklist.

When the First Officer checked ECAM MEMO<sup>\*39</sup> to call out the last item<sup>\*40</sup> in the Checklist, she saw the flap line on the ECAM memo remained in blue although it should be in green<sup>\*41</sup> if the flaps were extended at the planned position. The First Officer realized the flaps had not yet been set to "FULL." Since the First Officer thought that she would set the flaps to "Full" position after receiving another direction from the Captain, she called "FLAPS FULL." However, she could not get response from the Captain partly because the Controller were continuously instructing him. Therefore, she set the flap lever to FULL after she called again "FLAPS FULL." Afterwards, the First Officer tried to resume reading the Checklist. The Final Controller, however, continuously instructed and the First Officer had to wait for ATC instruction's intervals. It took considerable time before the First Officer completed the Checklist<sup>\*42</sup> by reading out "ECAM MEMO," and receiving a response from the Captain, "LANDING NO BLUE."

The First Officer looked at the altimeter when putting the Checklist sheet in, then she realized that the altitude of the Aircraft was as low as about 600 ft. The First Officer warned loudly, "TOO LOW, TOO LOW" (hereinafter referred to as "the TOO LOW Warning"). The Captain turned his face toward the First Officer for a moment, and as soon as he looked back to PFD, his expression suddenly

---

\*37 See 2.10.1 for FCU.

\*38 This is a callout performed by PF to share his operation with PNF by means of verbally calling out his action: presetting -900 fpm in VS Window. See 2.11.3.

\*39 See 2.10.1 and 2.11.4 for the ECAM MEMO.

\*40 The last item is the ECAM MEMO (see 2.11.4).

\*41 See 2.11.4 for the green display for planned positions.

\*42 See 2.11.4 for completing the checklist.

turned to surprise. Apparently, recognizing the state of the Aircraft's descent, the Captain immediately pushed the VS knob. When the Captain turned back to PFD again and put his right hand on the thrust levers, the EGPWS warning "TOO LOW TERRAIN" sounded. The First Officer seemed that the Captain at that moment was trying to verify what was happening, and finally made a go-around shortly after that. The First Officer did not hear any the Controller's instructions at that time, however, she remembered hearing male voice of "TOO LOW GO AROUND," when the Captain initiated a go-around procedure. Afterwards, the First Officer made a call of "GO AROUND" to the Controller.

The First Officer had never felt odd about the Captain's operation during her previous flights with the Captain, and even during the flight where the serious incident occurred, she thought he was faithfully following operation rules. The First Officer, however, did not see the Captain's operation: setting vertical speed with VS knob and pulling it. She did not hear the Captain's callout about his operations of VS knob either. In addition, the First Officer thought that AP controlled the Aircraft to maintain at an altitude of 1,000 ft and never expected the Aircraft to descend like this under such a situation.

As far as the First Officer remembered, a PULL UP Warning did not sound, and the ND display did not change. The First Officer did not remember that GPWS button was illuminated.

The First Officer was checking outside during the final approach but was unable to see the Runway and the sea surface at all because the Aircraft had been flying in clouds.

### (3) Supervisor for Final Controller Trainee

When the serious incident occurred, a final controller trainee (hereinafter referred to as "the Final Trainee") in a training mission to be certified for the ground controlled approach services, was assigned to all the radio communication of ground controlled approach, under the supervision of a training supervisor (hereinafter referred to as "the Final Supervisor"). Seated on the diagonally backward right side of the Final Trainee, the Final Supervisor set to work at about 11:30.

As the weather condition at the Airport was getting worse, the type of approach had been already changed from VOR approach to PAR approach at around the time the Final Supervisor got started working. The Aircraft was transferred from the Pattern Controller to the Final Controller<sup>\*43</sup> at about 6.5 nm. The ground controlled approach controllers use PAR Indicating System (hereinafter referred to as "the PAR Screen<sup>\*44</sup>") for monitoring the controlled aircraft. At this time, in the azimuth indication on the PAR Screen, the Aircraft was getting closer to the center of the final approach course from the west. In the elevation indication, aircraft maintaining their altitude were normally shown in the

---

\*43 See 2.19.2 for "transfer from the pattern controller."

\*44 PAR Screen includes the azimuth indication, which shows horizontal deviation, and the elevation indication, which shows vertical positions (heights) (see 2.19.2 (4)).

screen as if they were gradually climbing as they moved toward the glide path capture point. In the elevation indication at that time, the Final Supervisor thought that the Aircraft was normally flying and did not see anything unusual.

The Final Supervisor remembered that the Final Trainee had been properly providing radar-guidance the Aircraft. When the Aircraft passed the position of approximately 5 nm, the Final Trainee informed the Aircraft that the Aerodrome Control Tower of Naha Airport (hereinafter referred to as "the Naha Tower") cleared the Aircraft to land<sup>\*45</sup> at the Airport. Around this time, the Final Supervisor heard a sound of "LOW ALTITUDE WARNING" from the area of Pattern Controller's position, and the Pattern Controller said toward the Final Trainee, "The Peach aircraft is descending." The Final Supervisor immediately checked the Aircraft in the elevation indication and found that it was flying lower than usual. Although the Final Trainee instructed the Aircraft "Maintain one thousand. You are too below for a safe approach" and then asked it for reply, but in vain. As the Final Supervisor watched the screen and felt afraid that the Aircraft might continue to descend, she instructed the Final Trainee to repeat the phrase of maintaining 1,000 ft. The Final Trainee told the Aircraft, "Maintain 1,000. You are too below," as an elevation instruction. Then, receiving a go-around call from the Aircraft, the Final Trainee instructed it to fly along the missed approach procedure and maintain 1,000 ft.

A final controller usually focuses on the azimuth indication in order to provide radar-guidance an aircraft to the final approach course after it is transferred from a pattern controller until it reaches at the position of approximately 4.5 nm. A final controller can watch that the target in the elevation indication gradually goes up around the position of 5 to 4 nm. From around this position, a final controller might begin to look at the azimuth and elevation indications alternately, because the timing to begin descent varies with aircraft types and wind conditions. At around the position of 5 nm, a final controller mainly watches the azimuth indication as there is usually communication with the Naha Tower.

Due to the characteristics<sup>\*46</sup> of the elevation indication on the PAR Screen, it is difficult to recognize altitude deviation of a level-flight aircraft<sup>\*47</sup>. Deviation of 500 ft can be recognized, but that of 100 ft cannot be.

The Final Supervisor did not override the Final Trainee's ATC communication because the Final Trainee appeared to be calmly dealing with the situation.

#### (4) Final Trainee

The Final Trainee was in the final phase of training to be certified for ground control approach

---

<sup>\*45</sup> In usual cases, "clearance to land" is granted to an aircraft which is to make a PAR approach as follows: The final controller informs the tower controller that the aircraft has passed five nm; after confirming the safety on the runway, the tower controller notifies the final controller of the clearance and others; and the final controller issues the clearance to the aircraft. (See 2.19.2 (2).)

<sup>\*46</sup> See 2.19.2 (4) for "characteristics of the elevation indication on the PAR Screen."

<sup>\*47</sup> It is the aircraft the controller is in charge of.

operations. When the serious incident occurred, aircraft were making PAR approaches in series due to bad weather.

The Aircraft was flying around the position of 6.5 nm when the Final Trainee completed radio-guiding its preceding aircraft and took over the control of the Aircraft from the Pattern Controller. The target on the PAR Screen was moving as usual, and the Final Trainee began providing radar-guidance the Aircraft after the Communication Check.

In order to guide the Aircraft to the final approach course, the Final Trainee focused on the azimuth indication of the PAR Screen. Then the Final Trainee informed the Naha Tower that the Aircraft had passed 5 nm, and then notified it of landing clearance issued by the Naha Tower.

After that, when the Final Trainee was instructing the Aircraft to correct its direction, he heard a warning sound from the area of the Pattern Controller's position and was told that the Aircraft was descending. The Final Trainee checked the elevation indication, in which the Aircraft was flying lower than usual. The Final Trainee instructed, "Maintain one thousand. Too low for a safety approach." Nevertheless, the Aircraft did not seem to climb at all. After giving the same instructions again, the Final Trainee requested the Aircraft to reply, but it did not answer.

Afterward, the Final Trainee received a report of making a go-around from the Aircraft. Confirming the Aircraft was climbing, the Final Trainee gave it instructions to follow the missed approach procedure and maintain an altitude of 1,000 ft.

#### (5) Pattern Controller

The Aircraft was flying about 20 nm in the north-northwest of the Airport and already maintaining an altitude of 1,000 ft when the Pattern Controller was transferred control of the Aircraft from the Naha Arrival. A pattern controller usually transfers an aircraft to a final controller between 8 and 7 nm positions. The Pattern Controller, however, slightly delayed the transfer of the Aircraft because he saw some echoes of clouds around the position on the PAR screen and waited until the target of the Aircraft on the Screen would be displayed in a stable condition<sup>\*48</sup>. Then the Pattern Controller transferred the Aircraft around 6.5 nm. Afterwards the Pattern Controller was concerned about a succeeding foreign aircraft which was going to be transferred from Naha Arrival just after the Aircraft. At the exact moment "LOW ALTITUDE WARNING" sounded. The Pattern Controller looked at the display device with ARTS-F<sup>\*49</sup> functions (hereinafter referred to as "the ARTS Screen"), in which he found "LA"<sup>\*50</sup> indication in the data block<sup>\*51</sup> for the Aircraft. The Pattern Controller informed the Final Trainee, "The Peach aircraft is descending." The Final Trainee immediately instructed the

---

<sup>\*48</sup> If possible, transfer is performed after the aircraft has left an air area which is suffering bad weather. This is because the final controller uses the PAR Screen for monitoring, which is easily affected by adverse weather.

<sup>\*49</sup> ARTS-F is a system for terminal radar information processing with MSAW function to be described in 2.21. (See 2.19.2 (1).)

<sup>\*50</sup> Refer to 2.21.2 Figure 16 for LA.

<sup>\*51</sup> A data block is a set of information on each aircraft displayed on the ARTS Screen. (See Figure 13 in 2.19.2 (1).)

Aircraft to maintain 1,000 ft, but the altitude indication of the Aircraft continued to go down as low as 300 ft on the ARTS Screen.

Afterward, the altitude indication of the Aircraft turned to climb.

#### (6) Sub-Controller

The sub-controller (hereinafter referred to as "the Coordinator"), who took the seat between the Pattern Controller and the Final Trainee, noticed the Aircraft had been descending from an altitude of 1,000 ft when the Low Altitude Warning sounded. The screen showed the altitude indication of the Aircraft was 600 ft at that time. The Coordinating Controller informed the Final Trainee, who had already controlled the Aircraft that it was descending.

The Final Trainee was calmly giving proper instructions to the Aircraft and repeatedly providing an instruction of maintaining 1,000 ft; nevertheless, the Aircraft continued to descend, and the Final Trainee requested the Aircraft to reply.

The Aircraft informed that it was going to make a go-around, afterward.

In this serious incident, the thrust levers of the Aircraft were set to TOGA at the position of approximately 3.4 nm almost true north from the RWY 18 threshold of the Airport (26° 15' 59" N, 127° 38' 30" E), at the time of 11:47:35 on April 28, 2014.

(See **Appended Figure 1** "Estimated Flight Route.")

## 2.2 Damage to Person

There were 59 persons on board, consisting of the Captain, five other crewmembers and 53 passengers, but nobody was injured.

## 2.3 Damage to the Aircraft

There was no damage to the Aircraft.

## 2.4 Personnel Information

### 2.4.1 Flight Crewmembers

(1) Captain Male, Age 45

Airline transport pilot certificate (Airplane)	February 1, 2006
Type rating for Airbus A320	May 27, 2013
Class 1 aviation medical certificate	
Validity	September 12, 2014
Total flight time	9, 353 hr and 04 min

Flight time in the last 30 days	76 hr and 01 min
Total flight time on the type of aircraft	661 hr and 36 min
Flight time in the last 30 days	76 hr and 01 min

(2) First Officer Female, Age 38

Commercial pilot certificate (Airplane)	April 10, 2000
Type rating for Airbus A320	March 15, 2012
Instrument flight certificate	April 10, 2000
Class 1 aviation medical certificate	
Validity	July 20, 2014
Total flight time	4,626 hr and 07 min
Flight time in the last 30 days	73 hr and 05 min
Total flight time on the type of aircraft	1,387 hr and 07 min
Flight time in the last 30 days	73 hr and 05 min

## 2.4.2 Controllers

(1) Final Supervisor Female, Age 32

Air Traffic Control Certificate	
Ground control approach services	December 13, 2011
Medical Certificate	
Validity	June 30, 2014
Aviation English Language Proficiency Certificate	
Validity	March 31, 2016

(2) Final Trainee Male, Age 35

Air Traffic Control Certificate	
Medical Certificate	
Validity	June 30, 2014
Aviation English Language Proficiency Certificate	
Validity	March 31, 2015

(3) Pattern Controller Male, Age 30

Air Traffic Control Certificate	
Ground control approach services	May 21, 2012
Medical Certificate	

Validity	June 30, 2014
Aviation English Language Proficiency Certificate	
Validity	March 31, 2017
(4) Coordinating Controller Male, Age 34	
Air Traffic Control Certificate	
Ground control approach services	March 22, 2011
Medical Certificate	
Validity	June 30, 2014
Aviation English Language Proficiency Certificate	
Validity	March 31, 2015

## 2.5 Aircraft Information

### 2.5.1 Aircraft

Type	Airbus A320-214
Serial number	4936
Date of manufacture	December 15, 2011
Certificate of airworthiness	Dai-2013-458
Validity:	December 15, 2014
Category of airworthiness	Aircraft Transport T
Total flight time	7,193 hr 38 min
Flight time since the last periodic inspections	1,293 hr 01 min

(maintenance before airworthiness certificate inspection conducted on April 27, 2013)

(See **Appended Figure 6** "Three-View Drawing of Airbus 320-214")

### 2.5.2 Weight and Balance

When the serious incident occurred, the Aircraft's weight is estimated to have been 114,530 lb, and the position of the center of gravity is estimated to have been 28.3% mean aerodynamic chord (MAC)<sup>\*52</sup>, both of which are estimated to have been within the allowable range (maximum landing weight of 142,198 lb and 19.8 - 33.9% MAC corresponding to the weight at the time of the incident).

---

<sup>\*52</sup> "MAC" stands for Mean Aerodynamic Chord, which is a blade chord representing aerodynamic characteristic of a blade. MAC is the typical chord length when they are not identical, such as those of a sweptwing. The value 28.3% MAC indicates the position at 28.3% from the leading edge of the aerodynamic average of blade chords.



## 2.6 Meteorological Information

### 2.6.1 Meteorological Conditions at the Airport

According to the local aviation weather report for the Okinawa area issued by the Naha Aviation Weather Station of the Japan Meteorological Agency at 6:30 on April 28, 2014, the general weather conditions and forecasts were as follows: (excerpts)

*There is a long front around the Okinawa area, producing middle and low-level clouds over the airports in the area. The radar observations show that echoes by low-level warm humidity and the front spread across the area, moving east-northeast. (omitted) Low-level warm humidity is flowing toward the front from south, which will disturb the atmosphere in the main island of Okinawa area.*

### 2.6.2 Aviation Routine Weather Report

Aviation routine weather report for Naha Airport around the time the Aircraft landed was as follows:

- 11:00 Wind direction 170 degrees; Wind velocity 14 kt; Prevailing visibility 10km or more;  
Weak shower  
Cloud: Amount SCT, Cloud base 1,000 ft  
Amount BKN, Cloud base 1,300 ft  
Amount FEW, Cloud base 2,000 ft, altocumulus  
Temperature 23°C; Dew point 19°C  
Altimeter setting (QNH) 1012 hPa
- 11:30 Wind direction 170 degrees; Wind velocity 14 kt; Prevailing visibility 6 km; Shower  
Cloud: Amount SCT, Cloud base 1,000 ft  
Amount BKN, Cloud base 1,300 ft  
Amount FEW, Cloud base 2,000 ft, altocumulus  
Temperature 23°C; Dew point 20°C  
Altimeter setting (QNH) 1012 hPa
- 12:00 Wind direction 160 degrees; Wind velocity 12 kt; Prevailing visibility 4,500 m  
RWY 18 Runway visual range 1,800 m No change; Shower  
Cloud: Amount FEW, Cloud base 700 ft  
Amount BKN, Cloud base 1,000 ft  
Amount FEW, Cloud base 2,000 ft, altocumulus  
Temperature 23°C; Dew point 21°C  
Altimeter setting (QNH) 1012 hPa

(See **Appended Figure 4** "Meteorological Information")

## 2.7 Flight Recorder Information

The Aircraft was equipped with an FDR, which had a maximum recording time of 25 hours, and an EGPWS both made by Honeywell of the United States of America, and both retained the data when the serious incident occurred. On the other hand, the data recorded by the Cockpit Voice Recorder (hereinafter referred to as "CVR"), which had a maximum recording time of 2 hours, made by Honeywell of the United States of America during the flight had been overwritten, and no useful data were left.

The time data on the FDR was calibrated by correcting the time signals in the ATC communication records with the VHF transmission keying signals on the FDR.

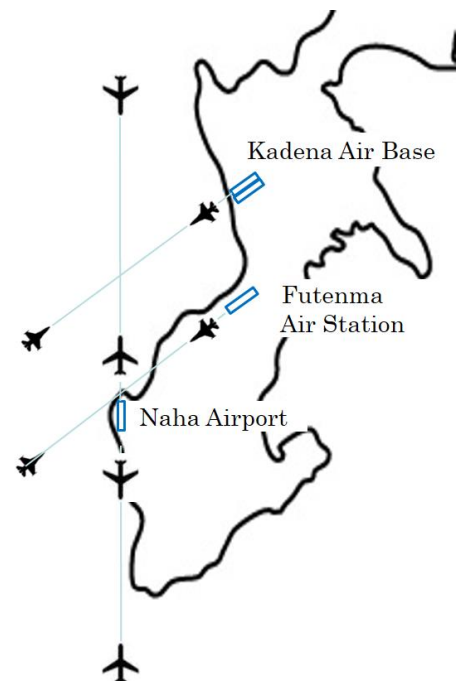
## 2.8 Information on the Serious Incident Site

### 2.8.1 Outline of the Airport and its Surroundings

The Airport, located in the south part of the main island of Okinawa, has an airfield of 3,000 m in length and 45 m in width at an elevation of 11 ft. It has RWY 18/36 (182 / 002 degrees in magnetic heading). The Airport is shared by civil aircraft and the Japan Self Defense Force aircraft. Aircraft can make a precision approach\*<sup>53</sup> to RWY 18 by PAR approach and RWY 36 by ILS approach and PAR approach. NHC (Naha VORTAC) is placed on the west of the RWY 18 threshold.

Kadena Air Base of the U.S. Air Force is located about 12 nm north-northeast of the Airport, and Futenma Air Station of the U.S. Marine Corps is located about 7 nm northeast of the Airport. Therefore, routes of inbound and outbound aircraft to and from the Airport intersect with those to and from the two airfields. (See **Figure 1**.)

In order to ensure the separation between these aircraft, the controllers of the Airport, in principle, instruct inbound aircraft to RWY 18 at the Airport to maintain 1,000 ft before reaching the intersecting airspace with routes for those flying aircraft to and from both U.S. airfields. Accordingly, an aircraft needs to maintain a low altitude of 1,000 ft as an initial altitude to commence PAR precision approach for a specified length of time.



**Figure 1**

### **Air Traffic around Naha Airport**

Note: The routes and others in the figure are just images.

\*<sup>53</sup> "Precision approach" is an instrument approach guided by information or instructions regarding azimuth (horizontal angle of direction) and glide path (vertical descent angle).

## 2.8.2 PAR Approach

Among the airports which the Ministry of Land, Infrastructure, Transport and Tourism provides air traffic control services, only the Airport offers ground controlled approach services. These are radar-guiding services for landing which a ground controlled approach facility provides aircraft flying under instrument flight rules. Such an approach is called PAR approach, in which the facility provides a guidance including instructions on their vertical and horizontal position obtained from Precision Approach Radar (PAR) and information to guide the aircraft on the final approach.

PAR approach is a precision approach the same as ILS approach. Decision height, missed approach procedure, initial altitude to maintain after missed approach, and such for RWY 18 PAR approach at the Airport have been officially published, but specific flying course and altitude as appeared in VOR approach chart (see **Appended Figure 5**) have not been. The final altitude (glide path capturing altitude) at which aircraft is instructed to begin descent by an The Controller is usually 1,000 ft when performing PAR approach to RWY 18.

## 2.9 Standard Approach Procedure to RWY 18 at the Airport

### 2.9.1 Requirements for Stabilized Approach

The FCOM of the Company stipulates requirements of STABILIZED APPROACH for the type of the aircraft in the section "STABILIZATION CRITERIA." One of them defines that aircraft, when passing at the height above ground level of 1,000 ft, should make a stabilized approach on the final approach course with a landing configuration under instrument meteorological conditions. The FCOM also stipulates in the section "NORMAL OPERATION" that a pilot should confirm the completion of the Checklist after a landing configuration was set. Consequently, when following the standard approach procedure of the type of the aircraft, the Checklist will have been completed before aircraft descends below the height above ground level of 1,000 ft.

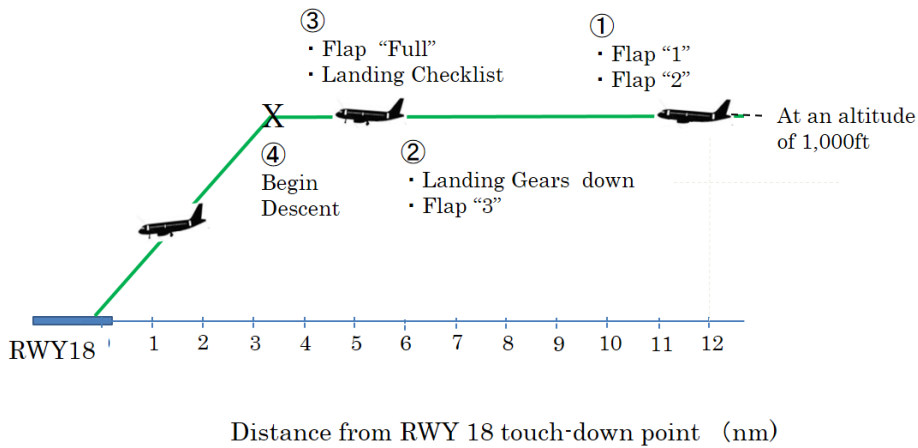
In addition, the FCOM P<sup>\*54</sup> stipulates the maximum descend rate of 1,000 fpm when flying at or below the height of 1,000 ft from that of the runway.

### 2.9.2 Approach Procedures

Based on the requirements described in 2.8.1, **Figure 2** illustrates, as a rough sketch of a standard procedure for the type of the aircraft to make an approach from a level-flight at an altitude of 1,000 ft to RWY 18.

---

\*54 The "FCOM P" is the Primary FCOM, in which the Company has stipulated procedures and methods for its flight operations in the course of the flight by the type of aircraft. The FCOM P also provides descriptions of aircraft's systems and materials related to the flight operation. The provisions of FCOM P have precedence of those of FCOM when there is a discrepancy between them.



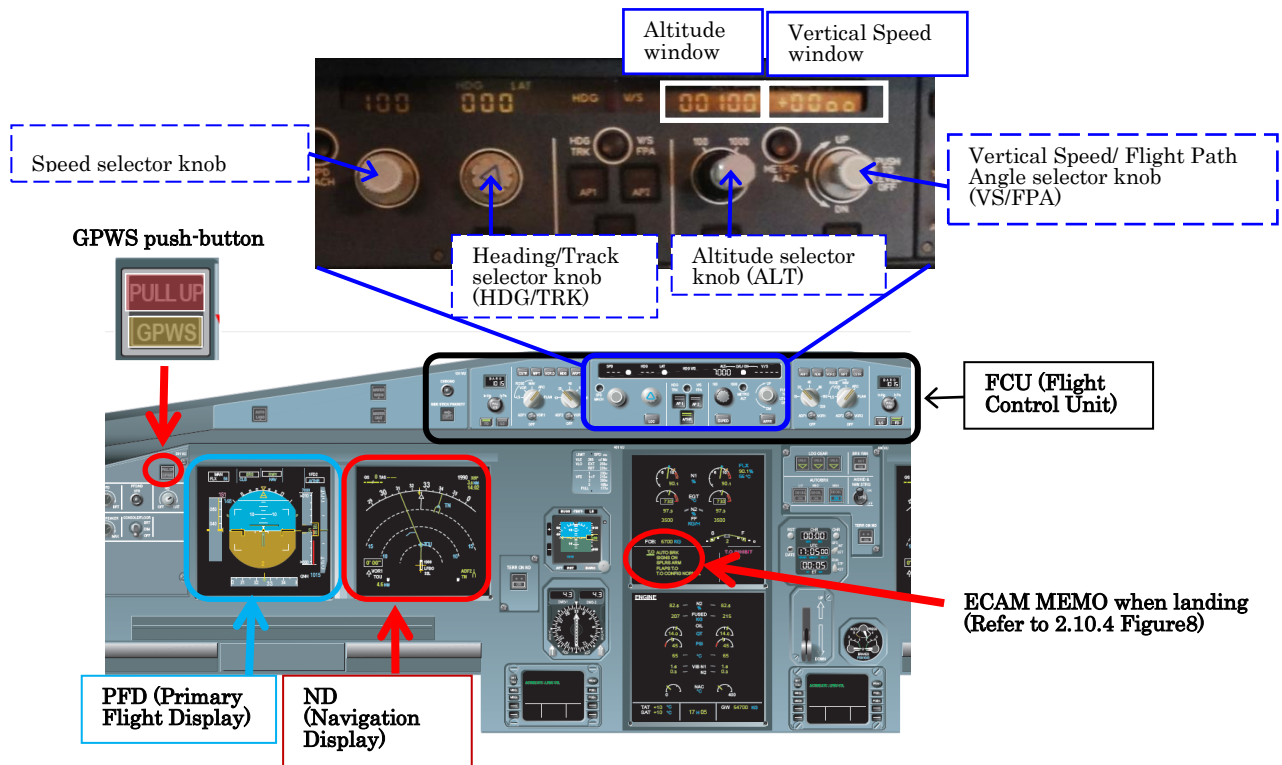
- (1) Set the flaps to "1," and then "2" to decelerate.
- (2) Extend the landing gear around the position of 6.0 nm and set the flaps to "3."
- (3) Set the flaps to "FULL," and perform the Checklist to complete it before beginning descent.
- (4) Begin descent around 3.0 nm.

**Figure 2 Standard Approach Procedures to RWY 18 at the Airport**

## 2.10 Operation and indication of Instruments

### 2.10.1 Instrument Panel

Overview of A320 Instrumental Panel right in front of flight crews is as below.



**Figure 3 A320 Instrument Panel**

As shown in **Figure 3**, FCU is incorporated in the glare shield panel, in which some selector

knobs and respective windows to set and display the specified value such as SPD (Speed), HDG/TRK (Heading/Track), ALT (Altitude), VS/FPA (Vertical Speed/Flight Path Angle) are placed.

Integrated instrument PFD is placed on the front of each pilot's seats in the instrument panel. ND, which has useful navigational functions such as map display, is placed side by side with PFD in the closer location to the central panel. PULL UP-GPWS buttons (hereinafter referred to as "the GPWS button") are placed aside of PFD.

Two liquid-crystal screens are located in a column around the center of the instrumental panel to display various kinds of data. The type of the Aircraft is equipped with a monitoring system called ECAM, which monitors the conditions of engines and other systems and displays measures when anything abnormal occurs. The lower part of the upper liquid-crystal screen has a space for ECAM messages to show warnings and caution warnings if any malfunctions happen to an aircraft. In normal conditions, this space is used to display ECAM MEMO<sup>\*55</sup>, with which flight crewmembers can confirm landing configurations of an aircraft in the landing phase.

### 2.10.2 PFD and ND

**Figure 4** shows sample displays of PDF and ND respectively during an approach to RWY 18 of the Airport from the investigation with a flight simulator.

Looking at the PFD, the vertical speed indicator, in which the pointer promptly aligns to the yellow base line, shows 0 fpm: an aircraft is maintaining its altitude. The pressure altitude shows 1,000 ft, the radio altimeter shows 1,020 ft, and heading (magnetic heading) shows 182 degrees. Final approach course and waypoints of VOR RWY 18 in **Appended Figure 5** and final approach course of PAR approach are shown in the ND. Current position of the aircraft is shown by an aircraft symbol: flying around 6.0 nm on the final approach course.

---

\*55 See 2.11.4 for the "ECOM MEMO" at landing.

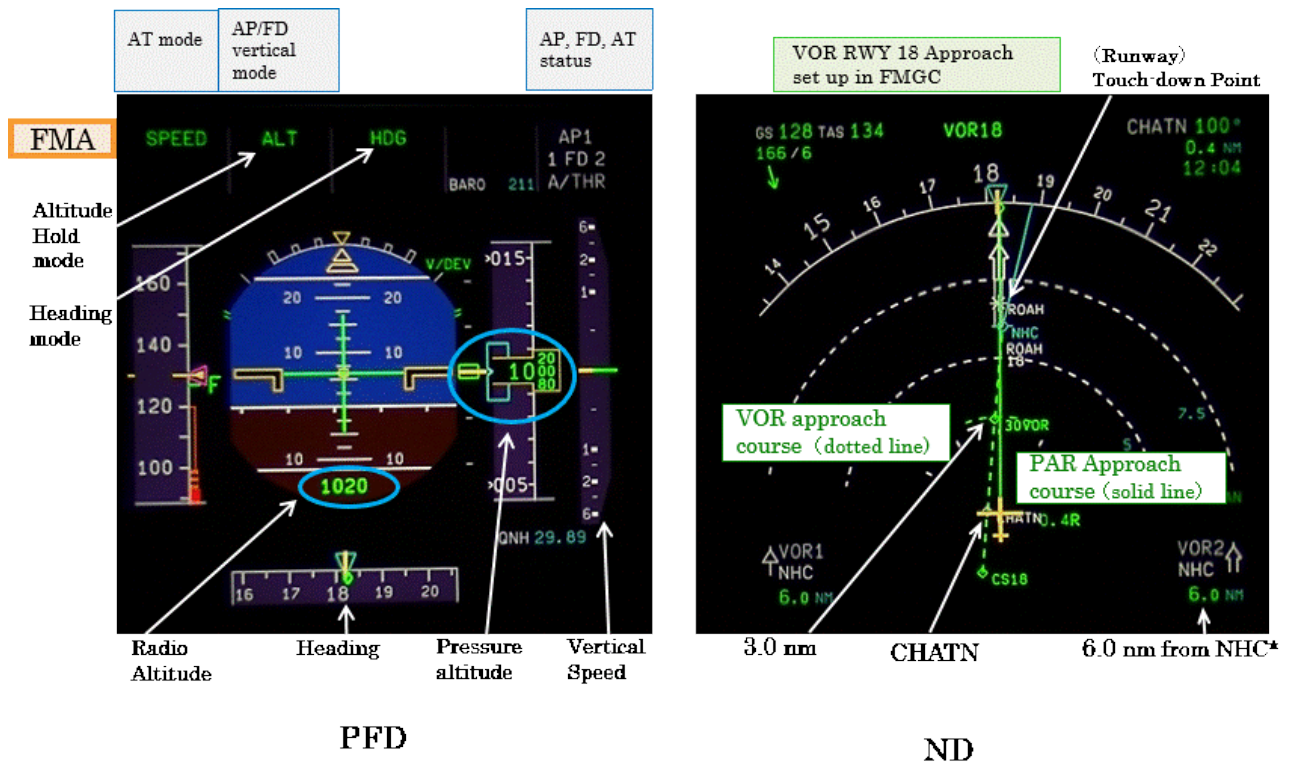


Figure 4 PFD and ND Display Examples

When AP/FD mode changes, FMA display varies as shown in **Figure 5**. In order to capture pilot's attention, the new mode after the change is shown in the white box and maintained for ten seconds. Afterward, the white box disappears.

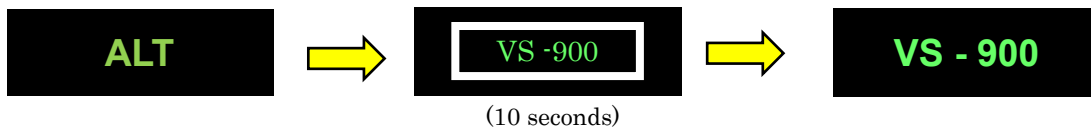


Figure 5 Example of FMA Change When the Mode Changes Occurs

### 2.10.3 VS Knob

The function of VS knob in the FCU panel (**Figure 3**) is as below.

A pilot can set a specific vertical speed in VS Window\*<sup>56</sup> by rotating VS knob clockwise or counterclockwise (**Figure 6**). The knob has a spring-back structure, which returns the knob to its home position after pushed or pulled, and holds proper friction to operate it. Through this feature the knob would not be inadvertently worked in such a case as a pilot unconsciously touches it. In other words, the knob is designed to work when it is operated with a certain-level force. Pulling VS knob engages VS mode, having an aircraft climb or descend at the vertical speed set in VS Window. Pushing the

\*<sup>56</sup> A vertical speed value set in VS Window is displayed and effective for 45 seconds after being set. The value is reset when the effective period passes.

knob when VS mode is engaged resets the vertical speed to zero: resuming to a level-flight while VS mode is retained. VS knob is an input device, thus a pilot cannot recognize the current VS mode status by VS knob itself, can confirm the current VS mode status only by FMA.

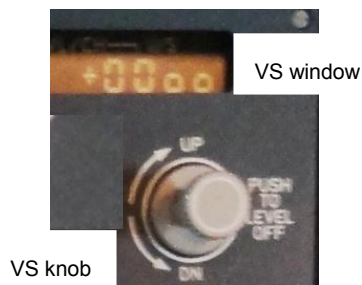


Figure 6 VS knob and VS window.

#### 2.10.4 Thrust Levers

Using AT is recommended in the normal procedure for the type of the aircraft. While AT is engaged, once a pilot sets the thrust levers (Figure 7) to "CL" position in an initial climb phase after take-off, the positions of thrust levers do not move<sup>\*57</sup> even if AT changes thrust. Therefore, a pilot cannot recognize an increase or a decrease in thrust by the movement of thrust levers.

When go-around is required, a pilot sets go-around thrust by pushing thrust levers forward to "TOGA" position and this makes both vertical and horizontal AP/FD modes change to go-around.

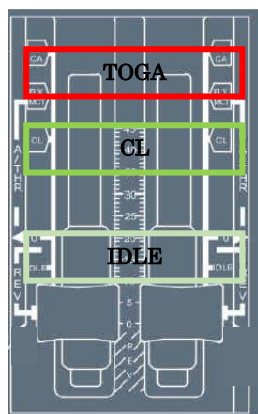


Figure 7 Thrust levers

#### 2.10.5 Altitude Alerts

The type of the aircraft is equipped with altitude alert system; it issued an altitude alert (hereinafter referred to as "ALT ALERT") in case that an aircraft deviates 200 ft or more from the altitude value in FCU ALT window. This specification, however, is designed to inhibit an ALT ALERT in case that landing gears are extended. The FDR did not retain any records of ALT ALERT when this

---

<sup>\*57</sup> Thrust levers of the type of aircraft while engaging AT is normally hold at the fixed position regardless of thrust change. A pilot, however, shall move to set thrust levers to "IDLE" position during a landing flare.

serious incident occurred.

## **2.11 Description in the Company's Manual**

### **2.11.1 Crew Duties**

FCOM P of the Company defines Crew Duties as follows: (excerpts)

*(a) PF: Pilot Flying. The PF will take charge mainly of controlling the airplane and monitoring the flight conditions.*

*(b) PNF: Pilot Not Flying. The PNF will monitor the PF and flight conditions, take charge of duties other than airplane control and make callouts or advice when necessary.*

(omitted)

*(d) In all situations the priority is that the flight crew must continue flying the airplane and monitoring the airplane condition necessary for the flight.*

(omitted)

### **2.11.2 Description about Monitoring FMA**

#### **(1) FCOM P**

Referring to monitoring FMA, FCOM P defines that it is important to verify the active modes, armed modes and their changes correctly as indicated by FMA at all flight phases.

#### **(2) FCOM**

FCOM defines as follows: (excerpt)

##### *FMA*

*The PF should call out any FMA change, unless specified differently (example. CAT II & III task sharing). (omitted)*

*The PNF should check and respond, "CHECKED" to all FMA changes called out by the PF.*

### **2.11.3 Standard Callout**

FCOM describes Standard Callout for operations of FCU panel as follows: (excerpt)

#### *ACTIONS COMMANDED BY PF*

##### *GENERAL*

*The following commands do not necessarily initiate a guide mode change,*

*e.g.: selected to managed/managed to selected.*

*The intent is to ensure clear, consistent, standard communication between crewmembers.*



All actions performed on the FCU and MCDU must be checked on the PFD and ND. Ensure that the correct FCU knob is used, then verify indications on the PFD/ND.

### SET

The "SET" command means using an FCU knob to set a value, but not to change a mode. SET is accomplished by only rotating the appropriate selection knob.

Example:

- "SET HDG \_\_\_" (omitted)

### MANAGE/PULL

The "MANAGE" command means pushing an FCU knob to engage, or arm, a managed mode or target. The "PULL" command means pulling an FCU knob to engage a selected mode or target.

Example:

- "PULL HDG 090" (HDG/TRK knob is pulled and turned). (omitted)

Note: If the value was previously set, there is no requirement to repeat the figure. Simply call e.g. PULL HDG.

The VS/FPA knob has no managed function. The standard callouts for the use of this knob are as follows:

- "V/S Plus (or Minus) 700 PULL. " (omitted)

The manufacturer of the type of the aircraft states that there is no clear rules for call-out in presetting operation of the VS knob in the FCU panel.

## 2.11.4 The Checklist

According to FCOM, the landing checklist shall be completed when it is read and confirmed by PNF following PF's order. The checklist of the type of the aircraft is as follows: (excerpt)

CABIN CREW . . . . . ADVISED\*58  
A/THR . . . . . SPEED/OFF\*59  
AUTOBRAKE . . . . . AS RQRD\*60  
ECAM MEMO . . . . . LDG NO BLUE

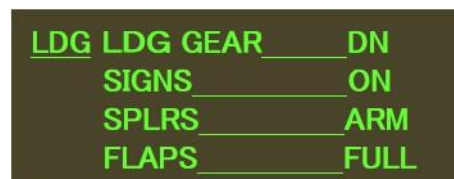


Figure 8 Example of ECAM MEMO

The top three items in the landing checklist can be quickly set forward at PNF's discretion as

\*58 "CABIN CREW...ADVISED" means the verification of sending the signal to notify their cabin attendants of landing in about 10 minutes.

\*59 "A/THR...SPEED/OFF" means the status of Auto Throttle System.

\*60 "AUTOBRAKE...AS RQRD (required)" means the actual status of Auto Brake to be called out.

PNF reads out the items of left column and confirm them on his or her own, and then announces their actual and confirmatory status of right column. Regarding the last item, however, coordination between PF and PNF is essential: when PNF calls "ECAM MEMO," PF shall respond "LANDING NO BLUE"<sup>\*61</sup> after PF confirmed the normal configuration for landing by checking four items in ECAM MEMO<sup>\*62</sup> (Figure 8). Receiving PF's response, PNF shall report to PF, "Landing Checklist Complete."

## 2.12 Principles for Pilots (GOLDEN RULES FOR PILOTS)

The FCTM<sup>\*63</sup> of the Manufacture of the Aircraft describes the "GOLDEN RULES FOR PILOTS" which are basic and the most important items and the Company distributes the name-card-sized cards with their summary on them to all the flight crewmembers : (excerpt)

### GENERAL GOLDEN RULES

*The following four Golden Rules for Pilots are applicable to all normal operations, and to all unexpected or abnormal/emergency situations:*

- 1. Fly. Navigate. Communicate.*
- 2. Use the appropriate level of automation at all times.*
- 3. Understand the FMA at all times.*
- 4. Take action if things do not go as expected.*

#### 2.12.1 Flying

The FCTM describes "Fly. Navigate. Communicate." in the first section of the "Golden Rules for Pilots" as below. (excerpt)

*Fly! Navigate! Communicate! The flight crew must perform these three actions in sequence and must use appropriate task-sharing in normal and abnormal operations, in manual flight or in flight with the AP engaged.*

- *Fly*

*"Fly" indicates that:*

- *The Pilot Flying (PF) must concentrate on "flying the aircraft" to monitor and control the pitch attitude, bank angle, airspeed, thrust, sideslip, heading, etc., in order to achieve and maintain the desired targets, vertical flight path and lateral flight path.*

---

<sup>\*61</sup> The right part in ECAM MEMO shall be indicated in blue when the relevant part is not in a normal landing configuration, and in green when it is. "LANDING NO BLUE" is derived from no blue display in ECAM MEMO, and indicates that the aircraft is configured for a normal landing.

<sup>\*62</sup> "Four items in ECAM MEMO" means that LDG GEAR is "DN (down)", CABIN SIGNS are "ON", Speed Brake (SPLRS) is set to "ARM", and FLAPS is set to "FULL," as shown in Figure 8.

<sup>\*63</sup> "FCTM" is a manual to provide pilots with practical information how to operate the type of the aircraft and supplements FCOM. It should be referred together with FCOM and if there is contradiction between them in their contents, it is said to prioritize FCOM.

- *The Pilot Not Flying (PNF) must assist the PF and must actively monitor flight parameters, and call out any excessive deviation. The PNF's role of "actively monitoring" is very important.*  
(omitted)

### 2.12.2 Practical use of Automated System

The FCTM describes "Use the appropriate level of automation at all times." in the second section of the "Golden Rules for Pilots" as below. (excerpt)

*Aircraft are equipped with several levels of automation, used to perform specific tasks. The flight crew must determine the appropriate level of interaction with automated systems, based on the flight situation and the task to be performed.*

*To use the appropriate level of automation at all times, the flight crew must:*

- *Determine and select the appropriate level of automation that can include manual flight*
- *Understand the operational effect of the selected level of automation*
- *Confirm that the aircraft reacts as expected.*

### 2.12.3 Understanding FMA

The FCTM also describes "Understand the FMA at all times." in the third section of the "Golden Rules for Pilots" as below. (excerpt):

*The flight crew must confirm the operational effect of all actions on the FCU, or on the MCDU\*<sup>64</sup>, via a crosscheck of the corresponding annunciation or data on the PFD and on the ND.*

*At all times, the flight crew should be aware of the following:*

- *Guidance modes (armed or engaged)*
- *Guidance targets*
- *Aircraft response in terms of attitude, speed, and trajectory*
- *Transition or reversion modes.*

*Therefore, to ensure correct situational awareness, at all times, the flight crew must:*

- *Monitor the FMA*
- *Announce the FMA*
- *Confirm the FMA*
- *Understand the FMA*

---

\*64 "The MCDU" is a device to enter data to the FMGC and others.

## 2.13 Investigation Reports concerning Flight Safety in the U.S.A.

### 2.13.1 Reliance on automation

There is a description concerning automation in the "Operational Use of Flight Path Management Systems" (hereinafter referred to as "the WG Report in 2013") issued in September 2013 by The Flight Deck Automation Working Group (hereinafter referred to as "the WG") which FAA\*<sup>65</sup> played a key role and formed. It is explained as below. (excerpts):

#### *3.2.4.1 Pilot reliance on automated systems*

*The WG found in its investigations that pilots sometimes over-rely on automated systems – in effect, delegating authority to those systems, which sometimes resulted in deviating from the desired flight path under automated system control. (omitted)*

*"Reliance on automation reduces pilots' awareness of the present and projected state of the aircraft and its environment, resulting in incorrect decisions and actions."*

### 2.13.2 Task/Workload Management

Task/workload management is described in "the WG Report in 2013" as below. (excerpts):

#### *3.4 Task/Workload Management*

*Deficiencies in task management, such as distraction or loss of vigilance, have been cited as either causal or contributory factors in accident cases. When viewed in isolation, such findings may suggest a contributory lack of proficiency or skill and the question often has been raised "how could the pilot have missed that?" (e.g., low airspeed, setting flaps for takeoff, etc.). However, the WG found that task management, the maintenance of vigilance and avoidance of distraction are not trivial tasks. (omitted)*

*Managing tasks within the flight deck is complex and requires managing flight deck workload, distractions, and tasks generated by others outside the flight deck. (omitted)*

*For prioritization of tasks, pilots are taught to Aviate, Navigate, and Communicate. (omitted) It is also easy to discuss these three concepts at a high level for flying today's complex airplanes in complex airspace. The WG analysis shows that it becomes harder to operationalize these concepts when there are many tasks within each area, and tasks often overlap or are left awaiting a further trigger for completion or continuation. This may explain why the data show that during times of high workload, the myriad of tasks required of the*

---

\*65 FAA stands for Federal Aviation Administration, US Department of transportation.

*pilots may result in no one monitoring the flight path of the airplane, or breakdown in communication between the pilots, or breakdown of cross verification procedures of FMS inputs. (omitted)*

*In the WG analysis, high workload and time pressure were common vulnerabilities identified in the factor analysis of incident data (omitted)*

*Pilots are required to analyze the situation and use their knowledge and skills to assess the situation and prioritize the tasks that need to be done in the time available. (omitted)*

### **2.13.3 Importance of Pilot Monitoring**

The followings are described in the "ENHANCED FAA OVERSIGHT COULD REDUCE HAZARDS ASSOCIATED WITH INCREASED USE OF FLIGHT DECK AUTOMATION, " (hereinafter referred to as "the Audit Report in 2016") which is the audit report relevant to automation from the Office of Inspector General of U.S. Department of Transportation to FAA as of January 7, 2016 (excerpts):

*Effective pilot monitoring is key to maintaining safety when using automated systems. (omitted) Properly performing pilot monitoring may break the chain of events leading to an accident. (omitted)*

*Because many pilots use automation in most phases of flight, their ability to effectively perform monitoring duties is critical to maintaining safety. Pilot monitoring consists of a pilot carefully observing the aircraft's flight path, automation modes, and on-board systems and actively cross-checking the actions of other crew members. (omitted)*

#### **RECOMMENDATIONS**

- 1. Develop guidance defining pilot monitoring metrics that air carriers can use to train and evaluate pilots. (omitted)*

#### **APPENDIX. AGENCY COMMENTS\*<sup>66</sup>**

*(omitted)*

*The FAA will develop guidance defining pilot monitoring duties and responsibilities that air carriers can use to develop pilot training and evaluation. The guidance will address the definition of pilot monitoring in the operational environment, and it will provide the basis for development of a curriculum and syllabus by carriers. The FAA plans to complete this action prior to January 31, 2017.*

---

\*66 Since FAA had already received the audit report draft before its publication, FAA appended the comments to it.

## 2.14 FDR Records

From the **Table 1** and the **Appended Figure 3** "FDR Records", the followings can be read. Bracket [ ] in the section corresponds with [A] to [R] in the **Appended Figure 3**.

As shown in the **Table 1**, at 11:46:28, the Longitudinal Modes of the Aircraft changed to VS mode [B], the Selected Vertical Speed which was the invalid data until 11:46:28 became 0 fpm at 11:46:29 and changed to - 900 fpm at 11:46:30 [A]. The manufacturer states that it is probably the vertical speed was set before pulling VS knob from the fact that the elevator of the Aircraft moved downwards one second after the VS mode was selected, although the order of setting the vertical speed on the VS window and the operation of pulling VS knob cannot be determined from the FDR records. It should be noted, as shown in [H], the point the VS mode was selected was about 5.7 nm (from Naha VORTAC).

The pitch angle began to decrease in [C]; however, the positions of throttle levers were being fixed on the position of "20 (CL)" and the engine speeds N1 Actual Engines<sup>\*67</sup> decreased very slowly [D]. As shown in [F], the vertical speed of the Aircraft was gradually plunging to minus direction and as shown in [G], radio height and pressure altitude cor. QNH also become gradually lower.

Afterward, as shown in **Table 1**, the Selected Vertical Speed - 900 fpm which was kept until 11:47:25 changed to - 800 fpm at 11:47:26, 0 fpm at 11:47:27. According to the manufacturer, the changes of the Selected Vertical Speed probably caused by pushing VS knob. After that, the pitch of the Aircraft began to increase [K], the vertical speed began to decrease [M], and the thrust of the Aircraft began to increase [L].

On the other hand, EGPWS "TOO LOW TERRAIN" at 11:47:26 [P]<sup>\*68</sup> and "TERRAIN TERRAIN PULL-UP"<sup>\*69</sup> [Q] issued. The throttle levers were set on the position of TOGA at 11:47:35 [M], vertical direction mode of AP/FD became GA mode [J], vertical and longitudinal acceleration increased [R], radio height recorded the lowest value of 241 ft at 11:47:37 as shown in **Table 1** [O].

As shown in the **Appended Figure 7**, "HDG" was precisely set by adjusting HDG knob in the FCU following the instruction of radar guidance by the Controller.

---

\*67 N1 Actual Engines are one of the indices to show the amount of engine thrust.

\*68 Refer to 2.15.1 (2) for TOO LOW TERRAIN.

\*69 Refer to 2.15.1 (1) for TERRAIN TERRAIN PULL-UP.

**Table 1. FDR Records.**

	Time	Vertical Modes of AP/FD	Selected Vertical Speed (fpm)	Pitch angle (degree)	Vertical speed (fpm)	Radio hight (ft)	Pressure altitude* 1 (ft)	EGPWS Warning*5
	11:46:27	Other	*4	4.9	-32	1063	1002	
	11:46:28	VS*2		5.3	-32	1062	1002	
	11:46:29	VS	0	5.3	-16	1062	1002	
One second increment	11:46:30	VS	-900	5.6	-16	1061	1002	
	11:46:31	VS	-900	4.9	-96	1060	1002	
	11:46:32	VS	-900	3.9	-224	1062	1002	
	11:46:33	VS	-900	3.5	-416	1060	994	
	11:46:34	VS	-900	3.2	-528	1056	990	
	11:46:35	VS	-900	2.8	-640	1050	978	
	11:46:40	VS	-900	2.5	-832	990	914	
	11:46:45	VS	-900	2.1	-848	918	842	
	11:46:50	VS	-900	1.8	-528	850	786	
Five second increment	11:46:55	VS	-900	1.4	-576	804	746	
	11:47:00	VS	-900	1.1	-768	748	690	
	11:47:05	VS	-900	0.7	-912	675	618	
	11:47:10	VS	-900	1.1	-944	596	546	
	11:47:15	VS	-900	0.4	-912	520	470	
	11:47:20	VS	-900	1.1	-864	442	398	
	11:47:25	VS	-900	1.1	-896	364	322	
	11:47:26	VS	-800	1.1	-912	350	310	
	11:47:27	VS	0	1.1	-896	332	298	TOO LOW TERRAIN (TCF)
	11:47:28	VS	0	1.8	-784	317	282	
	11:47:29	VS	0	3.5	-640	299	270	
	11:47:30	VS	0	4.2	-544	285	262	
	11:47:31	VS	0	4.6	-416	273	254	
One second increment	11:47:32	VS	0	4.9	-336	265	250	TERRAIN TERRAIN PULL-UP (TAD)
	11:47:33	VS	0	5.3	-288	257	246	
	11:47:34	VS	0	5.6	-256	252	246	
	11:47:35	GA*3		6.0	-96	245	242	
	11:47:36	GA		6.3	208	244	242	
	11:47:37	GA		9.5	1008	241	250	
	11:47:38	GA		13.7	1584	247	270	
	11:47:39	GA		15.8	2480	268	306	TOO LOW TERRAIN (TCF)
	11:47:40	GA		17.2	2880	300	338	
	11:47:41	GA		17.6	3264	342	398	
	11:47:42	Other		16.9	3360	394	434	

- \*1 Pressure altitude (ft) is corrective value by the Japan Transport Safety Board.
- \*2 It shows being VERTICAL SPEED mode.
- \*3 It shows being GO AROUND mode.
- \*4 Slant lines indicate invalid data.
- \*5 TERRAIN Warning or PULL-UP Warning shown in EGPWS Warning fields.

## 2.15 EGPWS (Enhanced Ground Proximity Warning System)

The Aircraft was equipped with EGPWS: enhanced function added to GPWS (Ground Proximity Warning System). EGPWS has geographical data in the system and is able to issue cautions or warnings against terrains ahead of aircraft with effective display in ND, and alerting sound effectively

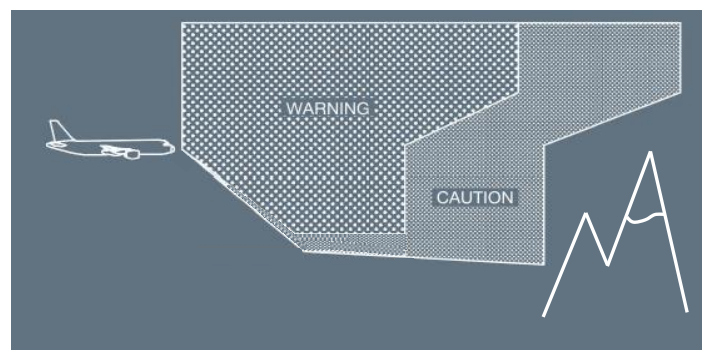
by comparing the geographical data with flying position data of the aircraft. Further, the GPWS buttons shown in **Figure 3** (2.9.1) are placed right next to both captain's and first officer's PFDs in the Instrument Panel.

### 2.15.1 Enhancement function of EGPWS

The following two enhanced functions issued caution and warning in the serious incident (**Figure 9**):

#### (1) TERRAIN AWARENESS AND DISPLAY (TAD)

TAD sets caution and warning areas ahead of the aircraft on the basis of the altitude of the aircraft, runway elevation of the nearest airport, distance from its runway threshold, ground speed and turning rate and other information. TAD issues the following warnings when a terrain or an obstacle remains more than one seconds within the monitoring area.



**Figure 9 Vertical Surface Schematic of TAD Monitoring Area**

There are two alert levels in TAD: Caution and Warning. In the case of Caution, yellow caution area accompanied with "TERRAIN" in yellow, is displayed on ND as shown in **Figure 10**, the yellow lamp "GPWS" of the GPWS button turns on, and aural warning of "CAUTION TERRAIN" sounds. In the case of warning, red warning area accompanied with "TERRAIN" in red is displayed on ND as shown in **Figure 10**, the red lamp "PULL-UP" of the GPWS button turns on, and a set of three aural warning of "TERRAIN TERRAIN PULL-UP", "PULL-UP", "PULL-UP" (hereinafter referred to as "PULL-UP warnings") sounds.

According to the EGPWS manufacturer, a set of PULL-UP warning consists of a five-second cycle: the first "TERRAIN TERRAIN PULL-UP", two seconds later "PULL-UP", and two seconds later another "PULL-UP". Once TAD issues a PULL-UP warning, a set of every aural warning lasts to sound without exception even if the aircraft breaks out from the warning area in a moment.

Considering the Data Sampling Rate of EGPWS computer is once per second, it is difficult to identify the correct time of issuing EGPWS warning. Hence, according to the manufacture, the possibility should be taken in to account that the occurrence time on the record may include a time



lag of around one second.

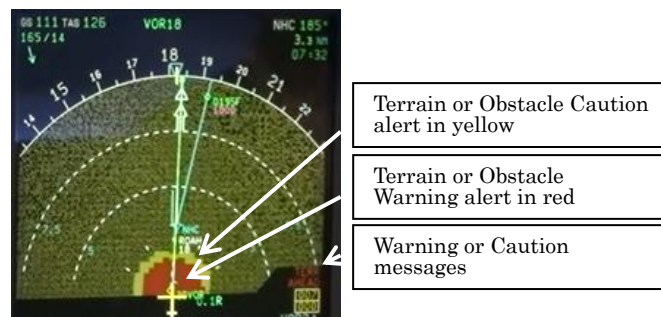


Figure 10 Image of ND display When PULL-UP issued

## (2) TERRAIN CLEARANCE FLOOR (TCF)

TCF monitoring area is saved in the database by each runways with its topographic feature. When aircraft deviates from a normal approach path and invades into a TCF area for some reason, whether an aircraft is configured for landing or not, TCF function turns on GPWS of GPWS button and sounds aural warning of "TOO LOW TERRAIN" (hereinafter referred to as "TERRAIN warning") sounds.

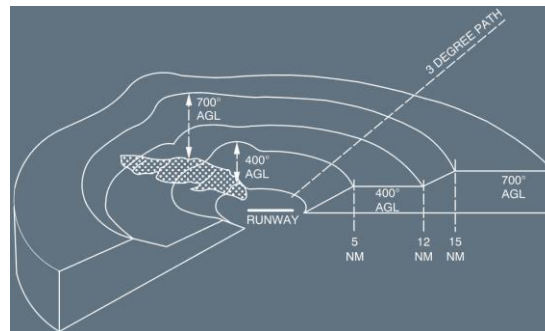


Figure 11 Schematic of TCF Area

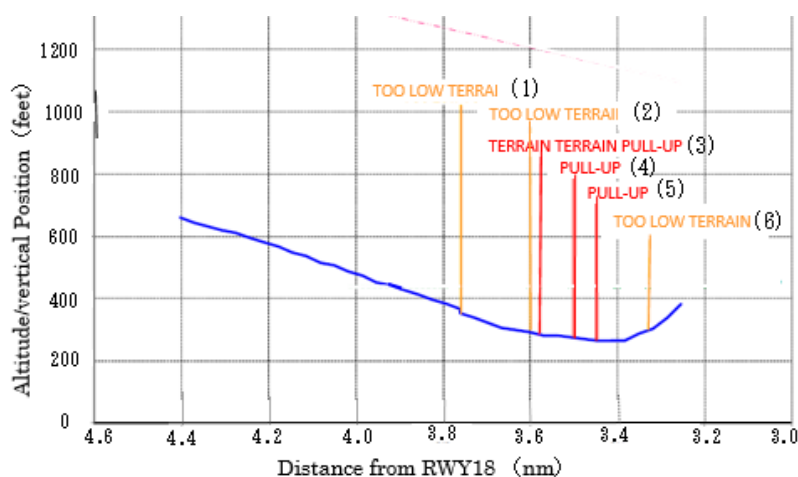
### 2.15.2 Records of EGPWS

After the serious incident, EGPWS was recovered from the Aircraft to download the data at the manufacturer laboratory, and the following data of **Table 2** was retrieved.

The time in **Table 2** was gained by synchronizing the time course of "190000", when (1) "TOO LOW TERRAIN" issued in the data provided from the manufacturer, and the time of "11:47:26" when TOO LOW TERRAIN warning issued in the record of FDR. According to the manufacturer, (2) "TOO LOW TERRAIN" in **Table 2** and **Figure 12** possibly halted halfway or did not sound at all because PULL-UP warning which has a higher priority issued at 11:47:32 immediately after the (2) began.

**Table 2 Data Recorded in EGPWS (Time Axis)**

Time Course	EGPWS	Number	Time
180000			11:47:25
190000	TOO LOW TERRAIN	(1)	11:47:26
200000			11:47:27
210000			11:47:28
220000			11:47:29
230000			11:47:30
240000	TOO LOW TERRAIN	(2)	11:47:31
250000	TERRAIN TERRAIN PULL-UP	(3)	11:47:32
260000			11:47:33
270000	PULL-UP	(4)	11:47:34
280000			11:47:35
290000	PULL-UP	(5)	11:47:36
300000			11:47:37
310000			11:47:38
320000			11:47:39
330000	TOO LOW TERRAIN	(6)	11:47:40
340000			11:47:41
350000			11:47:42



**Figure 12 Data Recorded in EGPWS (Distance Axis)**

### 2.15.3 Response When the EGPWS Warning Issues

FCOM stipulates the procedure when PULL-UP warning issues as below. (excerpt)

*Simultaneously*

*AP .....OFF*

*PITCH.....PULL UP*

*Pull to full backstick and maintain in that position*

*THRUST LEVERS .....TOGA*

*SPEED BRAKES LEVER.....CHECK RETRACTED*

*BANK .....WINGS LEVEL or ADJUST*

(omitted)

In addition, FCOM describes the procedure when TERRAIN warning issues as below.  
(excerpt)

*Adjust the flight path or initiate a go-around.*

#### **2.15.4 The View of the Aircraft Manufacturer Relevant to EGPWS Warning issuance**

The manufacturer of the Aircraft outlines the issuance of EGPWS warning as below.

The issuance of TERRAIN warning and PULL-UP warning have been recorded in FDR and EGPWS, and there are pilots' statements that they heard TERRAIN warning sounded. Consequently, the wiring between the EGPWS and the Aircraft's audio system was operational.

Besides, from the fact that Stall Warning or Wind-shear warning<sup>\*70</sup> which has higher priority to EGPWS warning did not issue when the serious incident occurred, PULL-UP warning issued and its warning area was displayed on ND display and the PULL UP lamp of the GPWS button turned on.

#### **2.16 Investigation by using flight simulator**

Investigation with using the flight simulator of the type of the Aircraft was performed. Incorporating the operation by the Captain on the basis of the FDR records, instructions and notifications from the Final Controller on the basis of ATC communication records, Checklist reading out in a standard manner and other elements, JTSCB examined the reproductive operating situation when the serious incident occurred, the situation when EGPWS warning issued, the ATC communication by the Final Controller and the workload of flight crewmembers, and confirmed as follows:

1. Regarding the situation of EGPWS warnings issuance, aural warnings, displays on ND and lighting of GPWS button were concentrated in a short period.
2. Under the continuous instructions by the Final Controller, PNF has some difficulties in the Checklist reading out and other duties, and often cannot perform it in a timely manner.

#### **2.17 Education and Training for Flight Crewmembers**

##### **2.17.1 Education and Training of the Type of the Aircraft**

The Company has placed FCOM P and FCOM descriptions as the base of the operation and given great importance on FMA monitoring at all times through the education and training; however, regarding the callout of the FMA mode changed, it held some exceptional cases about callout<sup>\*71</sup> in

---

\*70 "The Stall or Wind-shear warning" has priority to EGPWS warnings and Stall or Wind-shear warning inhibits EGPWS warning.

\*71 "Some exceptional case about callout" means such as callouts of AT mode during a takeoff.

some training materials.

### **2.17.2 Requirements for airport qualification**

The Company has stipulated training matters relevant to airport qualification for a captain in Operation Manual (hereinafter referred to as "OM"). The Airport is placed at the same category as other domestic airports the Company provides in service. A captain learns by self-study various matters relevant to airports using airport documents the Company provided, then when he or she passes the evaluation the Company defines, he or she can be qualified to fly for those airports.

In addition, the Company, as well as other domestic airline companies, did not have any provisions regarding mandatory experience of PAR approach in the Airport under line flight trainings by the type of the aircraft. The Company also did not take any measures that it provided practical occasions to perform PAR approach at the Airport for those who had not experienced PAR in the past.

### **2.17.3 PAR approach Experience of the Captain and the First Officer in the Past**

The Captain had experienced PAR approaches several times in the past; however, his latest PAR approach experience was about five years ago with a different type of aircraft and at a different airport. For the Captain, the approach in the serious incident was the first PAR approach for RWY 18 at the Airport with the type of the aircraft.

The Captain stated that a few days before the serious incident occurred he was asked to perform PAR approach for the Controller's training purpose when he intended to make an ILS approach for RWY 36 at the Airport, yet he performed the ILS approach as initially planned at that time. The Captain, on that day, reviewed and learned how to perform PAR approach by himself preparing for the next opportunity of PAR approach

On the other hand, as for the First Officer, she has already experienced PAR approach for RWY 36 at the Airport with the type of the aircraft once or twice; however, she had never experienced PAR approach for RWY 18, it was the first experience for her at that time.

## **2.18 Report from the Captain after the Serious Incident**

### **2.18.1 Confirmation by the Captain and the First Officer**

The Captain and the First Officer discussed some events happened in the serious incident after the Aircraft parked at the gate. They confirmed each other that the Aircraft descended from an altitude of 1000 ft, when TERRAIN warning sounded and then they executed missed approach; they did not hear PULL-UP warning and others. The Captain stated that he reported to the manager by phone, who was in charge of flight operation for the Company (hereinafter referred to as "the Manager") that while approaching for RWY 18 at the Airport, the altitude of the Aircraft went down

and TERRAIN warning of EGPWS warning issued and he executed a missed approach.

Meanwhile the Manager who received a report from the Captain, stated that he received that the altitude of the Aircraft went down during PAR approach and the Captain executed a missed approach, but he did not remember being reported of the EGPWS warning issuance, then he approved of the continuous flying of the Aircraft for the next service.

### **2.18.2 Reporting requirement for a Captain**

Regarding the items to be reported by a captain, OM and the operation manual supplement (hereinafter referred to as OMS) describe as below.

*A Captain shall submit the Captain Report of required items among the events occurred during the flight operation to a section manager of the flight crew department immediately after he completed his flight duties*

*The format of the reports are classified: the Captain Report, the Air Safety Report, the report required to the Company from the regulatory authorities, the report required by the Company and others. The events to be reported are exemplified as below:*

- *A case where aircraft crew executed an emergency operation in order to avoid crash into the ground or water or contact on the ground or water during a flight*
- *A case when significantly deviated from the path or altitude directed by ATC organization*
- *A case when avoidance maneuver is performed due to GPWS warning (Pull Up)*
- *A case when the altitude, speed, or attitude drastically changed in an unintended situation*

The report describing the objective and precise fact shall be immediately submitted to a section manager in flight crew department in a prescribed format. In the case of event which required urgent report, the captain shall provisionally report it by means of FAX and such, then report once again in a prescribed manner after returning to the base.

### **2.18.3 In-house Processing to Captain Report**

The Company has stipulated in the Company Regulations that when it received an in-flight event report from a captain, relevant department should examine whether contents of the captain report are applicable to specific events defined in OM/OMS; moreover, if it decides the further analysis is required in the course of in-house review, it should take actions of grounding the aircraft and

recovering QAR<sup>\*72</sup>.

## 2.19 Task of Ground Controlled Approach Facility

### 2.19.1 Situation in Naha Ground Controlled Approach Facility at the Time of the Serious Incident

The normal arrangement of the Controllers positions in the Radar Room of Naha Ground Controlled Approach Facility is shown in Photo 1. When the serious incident occurred, the Pattern Controller and the Coordinator took their seats respectively and the Final Trainee took the Final Controller's position while the Final Supervisor took her seat behind<sup>\*73</sup> the Final Trainee as a supervisor of the Final Trainee.

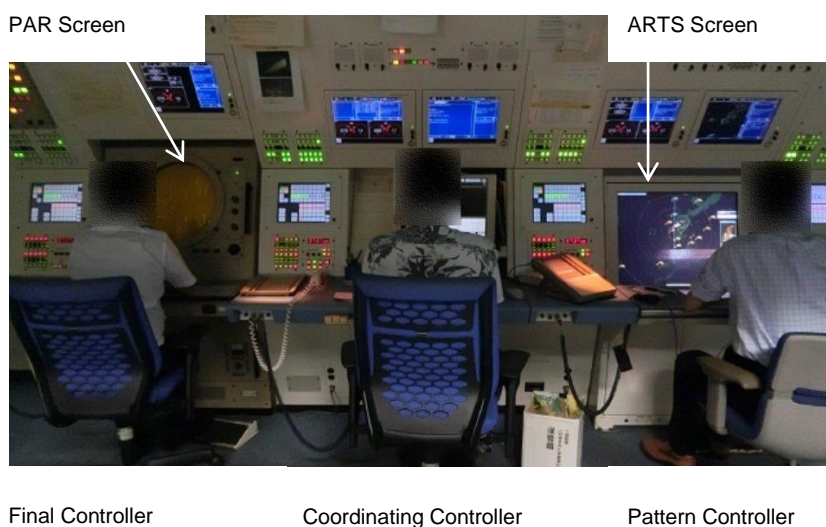


Photo 1 Arrangement of the Controller positions in Naha Ground Controlled Approach Facility

### 2.19.2 Duty of the Controllers in the Ground Controlled Approach Facility

The Ground Controlled Approach (GCA) Facility provides arrival aircraft being appropriately separated by Radar Approach Control Facility with radar-guidance and relays a landing clearance and other information issued by Aerodrome Control Facility to the arrival aircraft. Normally the GCA Facility instructs aircraft to contact Aerodrome Control Facility after landing.

The duties of controllers in the Ground Controlled Approach Facility are summarized as below:

#### (1) Duty of a Pattern Controller

Aircraft performing PAR approach is transferred to a pattern controller in the Ground

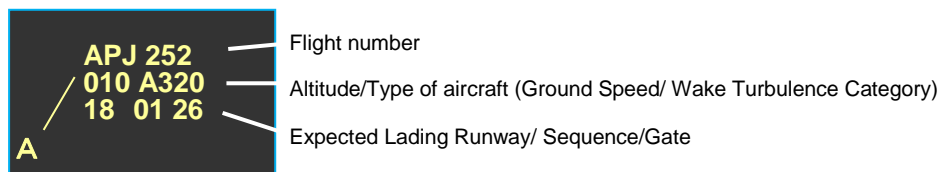
<sup>\*72</sup> QAR is an on-board device, as a company's option, to manage a company's flight in the way of higher quality control and safety management. Various flight data in QAR are recorded in removable media such as optical disk, semiconductor memory, etc. The recorded media can be recovered from the aircraft after a series of flights.

<sup>\*73</sup> The Final Supervisor took her seat behind the Final Trainee. She overrides the transmission from the Final Trainee and notifies the aircraft of instructions when needed.

Controlled Approach Facility via Naha Approach to the Naha Arrival in the Radar Approach Control Facility. A Pattern Controller monitors ARTS Screen and guides aircraft for a final approach course.

The data such as altitude, airspeed of each aircraft is displayed on the data block shown in **Figure 13**. A pattern controller mainly maintains separation of aircraft, as a rough guide, by about 10 nm and provides a radar-guidance and monitors an altitude, and might perform other tasks depending on the case. Normally, a pattern controller transfers aircraft to a Final Controller at the location between 10 and 7 nm from the Airport.

The ARTS-F<sup>\*74</sup> installed in a pattern controller position has functions<sup>\*75</sup> of monitoring warnings such as MSAW as mentioned later in 2.21.2. Data in ARTS Screen is updated every four seconds.



**Figure 13 Example of Data Block of the Controlled Aircraft**

## (2) Duty of a Final Controller

A Final Controller is transferred the control of aircraft which maintains a glide-path-capture altitude from a Pattern Controller. A Final Controller provides radar-guidance exclusively for one aircraft. A Final Controller gives Don't Acknowledge Instruction to aircraft following the Communication Check. Standards for Air Traffic Control Procedure<sup>\*76</sup> stipulates that a Final Controller, after establishing communication with the aircraft, should give transmissions in every five seconds or less, in which instructions of heading and descent rate to maintain a final approach course and a glide-path, an issuance of landing clearance, and other instructions are included.

Normally, an instruction for an altitude prior to meeting a glide-path is issued by a Naha Arrival or a Pattern Controller. Thus, there is no prescription in Standards for Air Traffic Control Procedure that a Final Controller gives instructions to the aircraft on maintaining its altitude. Accordingly, a Final Controller provides the aircraft with heading instructions and

<sup>\*74</sup> The ARTS-F installed in a Pattern Controller position displays aircraft target under the control of not only a Pattern Controller but also a Final Controller. The ARTS-F also installed in the positions of Naha Tower, Naha Arrival and so forth.

<sup>\*75</sup> Other than MSAW, Conflicting Alert, No Transgression Zone Alert and so forth are there as a function of monitoring warning in ARTS-F.

<sup>\*76</sup> "Standards for Air Traffic Control Procedure" means "III Standards for Air Traffic Control Procedure" in the Chapter 5 of Air Traffic Services Procedure in the Air Traffic Service Procedure Handbook. Procedures and others relevant to Air Traffic Control are stipulated.

guides it to a final approach course until the aircraft meets a glide-path. After the aircraft meets a glide-path, the Final Controller gives instructions on heading and descent rate to maintain a final approach course and a glide-path. A Final Controller relays and issues a landing clearance and others which Naha Tower issues, as a rough guide, at about 5 nm point.

A Final Controller is required to guide aircraft to fly along a final approach course and on a glide-path in a stabilized condition when it finally reach a guidance limit altitude. After radar-guidance is terminated, the aircraft is instructed to establish communications with Naha Tower after landing.

Moreover, Standards for Air Traffic Control Procedure stipulates that a Final Controller shall notify an aircraft of its deviation when it proceeds outside of the Radar Safety Zone as mentioned later in 2.20 and give an instruction to execute a missed approach as mentioned later in 2.20.2.

### (3) Duty of a Coordinating Controller

A Coordinating Controller in the Ground Controlled Approach Facility makes contacts with other coordinating controller coordinators in the Terminal Control Facility and Aerodrome Control Facility, regulates separation of aircraft to transfer, and makes coordination when a missed approach occurs and other occasions.

### (4) Feature of PAR Screen

As shown in **Photo 2-1**, when a Final Controller observes the target of aircraft vertically in the elevation indication and horizontally in the azimuth indication in PAR Screen, he or she can identify the deviation of the aircraft from a glide path and a final approach course, respectively, in which the target of aircraft in PAR Screen is displayed without a data block; there is no digitalized altitude information.

In addition, the target of aircraft is displayed by the rod-like target in PAR Screen, while precipitation areas, clouds, marine vessels and terrains and others are also displayed due to the characteristic of the radar system. The **Photo 2-1**, shot in a good weather condition with no clouds, clearly shows the target of aircraft. On the other hand, the **Photo 2-2**, shot in a bad weather condition, turns to be difficult for a Final Controller to identify and track the target because radar echoes of precipitation areas and clouds are appeared in PAR Screen. PAR approach for RWY 18 is usually performed when meteorological conditions are not good enough to make other approaches. Accordingly, PAR approach is performed mostly in a bad weather condition as shown in **Photo 2-2**.

A Final Controller is required to make an adjustment of the PAR Screen to get the best

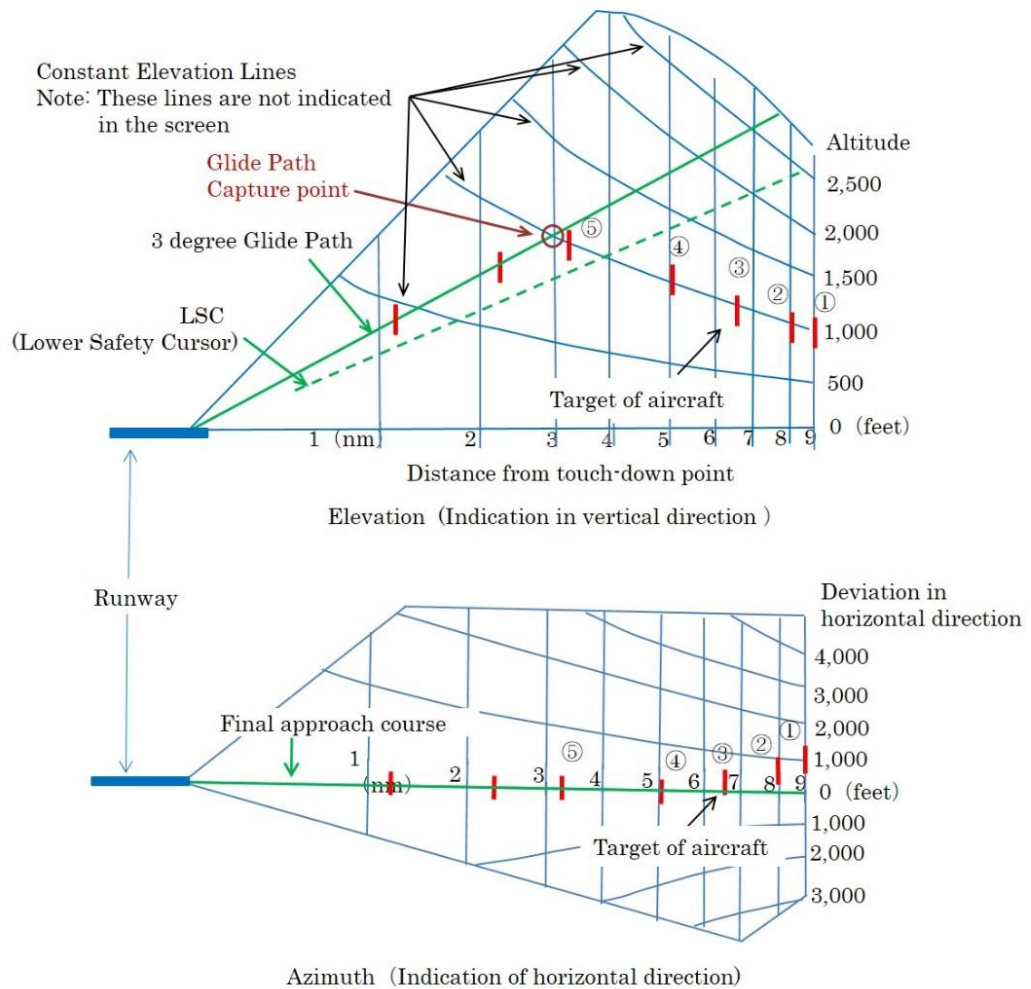


picture of the target in every moment using both hands. The bad weather makes the adjustment harder. In addition, a Final Controller operates a PTT (push-to talk) switch to transmit instructions with his or her feet and shall give continuous instructions to aircraft. In this way, a Final Controller is required to be highly capable in his or her duties.

Moreover, as shown in the **Figure 14**, the horizontal distance axis in the elevation indication in PAR Screen is expanded toward the direction to the runway. The vertical height axis is set to be seen a final approach as a straight line. In this way, the Constant Elevation Lines to the glide-path capture point are described as not horizontal straight lines but curved lines, accordingly the track of the target aircraft maintaining its altitude is shown as the aircraft climbing close to the Airport.

As shown in **Photo 2-1**, the line indicating upper limit of the Radar Safety Zone and the line indicating the lower limit of the Radar Safety Zone in the front side of glide-path capture point are not displayed in the observed PAR Screen. The Constant Elevation Lines shown in **Figure 14** are not also displayed.

Since PAR Screen does not have a displaying function that issues Low Altitude Warning, Low Altitude Warning is not displayed or sounds in the Final Controller position. Please note that (2) to (5) in **Figure 14** are standard instructions as samples which a Final Controller issues.



- (1) Transfer from the Pattern Controller to the Final Controller
- (2) Report of position. (This shall be done more than once per a mile in distance from touchdown point.)
- (3) Provision of radar-guidance (Heading instructions)
- (4) Report of landing clearance from Naha Tower to the arrival aircraft Announcement of approach to glide-path-capture point (It should be issued 10 to 30 seconds before reaching to the final point of initiating descent.) Alert for a confirmation of landing gears extension
- (5) Issuance of instruction of beginning descent

**Figure 14 Summarized drawing of PAR Screen Display**

(JTSB has compiled from curriculum of GCA training course)

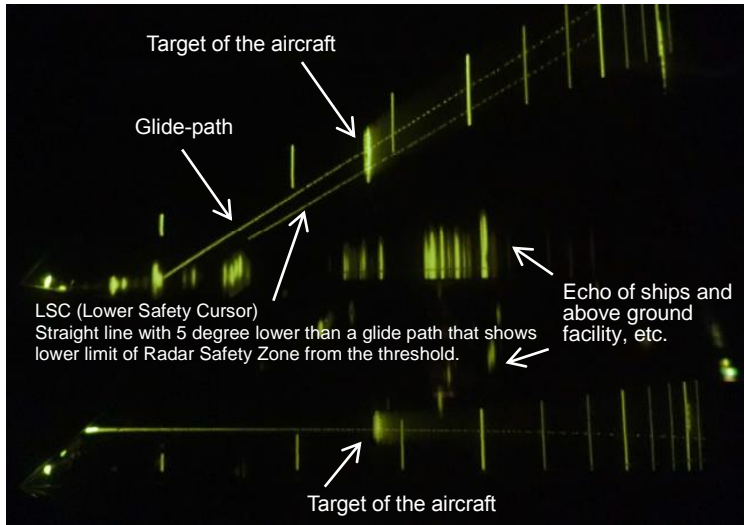


Photo 2-1. Example of Actual PAR Screen.

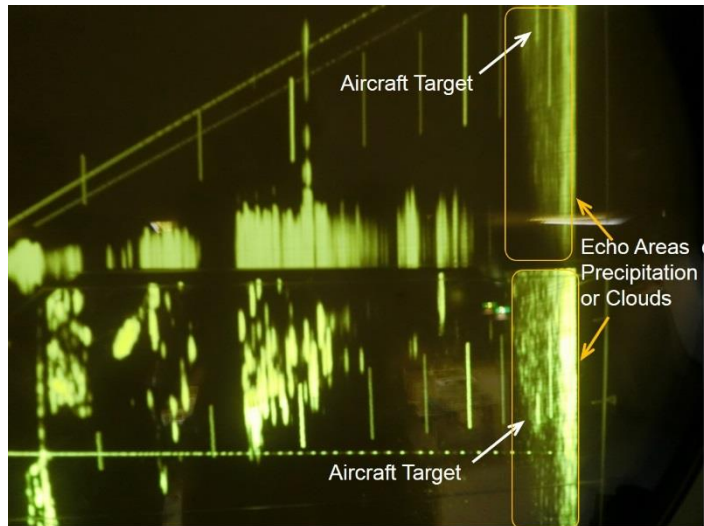


Photo 2-2. Example of PAR Screen in Bad Weather.

## 2.20 Radar Safety Zone

### 2.20.1 Definition of Radar Safety Zone

Radar Safety Zone is described in 2 Definition in ( I ) General in Standards for Air Traffic Control Procedure, as follows : (excerpt)

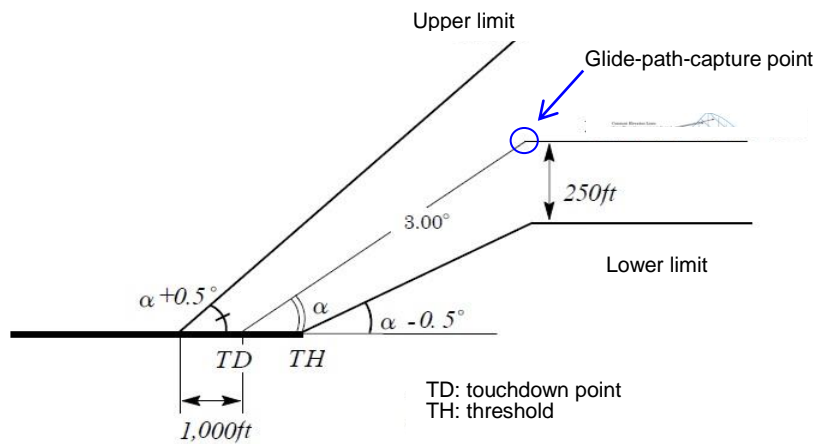
#### ***Rader safety zone***

*It is the zone shown in PAR Screen relevant to the glide path (in the elevation indication), in which aircraft can expect to continue approaching in a safe manner when performing precision radar approach.*

*Upper limit: Positive slope with 0.5 degree larger angle than a glide-path starting from the point of*

1,000 ft inside from touchdown point.

*Lower limit: Integrated line of positive slope with 0.5 degree smaller angle than a glide-path starting from the runway approach end and line indicating 250 ft lower than the altitude of beginning final descent.*



**Figure 15 Radar Safety Zone**

(JTSB has compiled from curriculum of GCA training course)

In the case that the altitude of beginning final descent is 1,000 ft, the lower limit altitude of the Radar Safety Zone before beginning the final descent: meeting glide-path is 750 ft. Accordingly, when the serious incident occurred, the lower limit of altitude of the Radar Safety Zone applied to the Aircraft which was flying before a glide-path-capture point is 750 ft.

### 2.20.2 Action When Deviated from Radar Safety Zone

The followings are described in Abort Approach in (16) Suspension of Final Approach 10 Radar Approach (IV) Standard of Radar Service in Standards for Air Traffic Control Procedure (excerpts):

(a) *When an aircraft is suspected in performing an unsafe radar approach: when radar identification of aircraft was lost, when radar identification of an aircraft was uncertain, when a malfunction happened to the radar system in use, when deviated from the Radar Safety Zone and others, the Controller shall notify the aircraft of it and take following actions:*

(omitted)

(b) *In the case that an aircraft is making a final approach, the Controller shall instruct to execute a missed approach or to direct a specific procedure with a magnetic heading and an altitude to follow, except: when the aircraft reports having runway in sight or when the aircraft has already passed through its decision altitude while performing precision radar approach.*

*[Reason] IF RUNWAY NOT IN SIGHT, EXECUTE MISSED APPROACH.*

*[Example] Too high/low for safe approach. If runway not in sight, execute missed approach.*

### **2.20.3 Education and Training for the Controllers in Naha Ground Controlled Approach Facility**

Naha Ground Controlled Approach Facility states about education and training for the Controllers in the facility as below:

The facility recognizes that they monitor primarily the aircraft's azimuth and give instructions when it is flying before a glide-path-capture point, and after it met a glide-path they start monitoring both the azimuth and the elevation and give instructions.

The facility provides the Controllers with education and training in which they should pay sufficient attention to not only the azimuth indication but also the elevation indication because they are required to give instructions when to begin descent without delay to an aircraft which is approaching a glide-path-capture point. The facility; however, had never experienced such type of event as the aircraft under the control of a Final Controller, which is flying before meeting a glide-path, began descent without ATC instruction of "Begin Descent." The facility, not even considering such situation, had not provided any education and training in which they should give specific attention to an aircraft flying before meeting a glide-path deviated from the Radar Safety Zone.

## **2.21 Minimum Safe Altitude Warning (MSAW)**

### **2.21.1 Object of MSAW Function**

#### **(1) Rules of the ICAO**

The following contents is described in the ICAO PANS-ATM<sup>\*77</sup> 15.7.4 Minimum safe altitude warning (MSAW) procedures:

The object of MSAW function of ATC radar data processing system is to assist in the prevention of CFIT<sup>\*78</sup> accidents by generating in a timely manner a warning of the possible infringement of a minimum safe altitude.

In the MSAW function, the reported altitudes from transponder-equipped aircraft with pressure-altitude reporting capability are monitored against defined minimum safe altitudes. When the altitude of the aircraft is detected or predicted to be less than the applicable minimum safe altitude, an acoustic and visual warning will be generated to the Controllers within whose jurisdiction area the aircraft is operating.

If an MSAW is generated to the aircraft when being provided radar-guidance, the Controller shall take prompt actions such as instructing it to climb immediately to the applicable safe altitude.

---

<sup>\*77</sup> "PANS-ATM" is ICAO Doc. 4444 that stipulates procedures and others in Air Traffic Control facility.

<sup>\*78</sup> "CFIT" occurs when an airworthy aircraft under the complete control of flight crew is in advertently flown in to terrain, water without properly being monitored or operated.

In other cases, the Controller shall immediately advise that an MSAW has been generated and instruct to check the altitude of the aircraft.

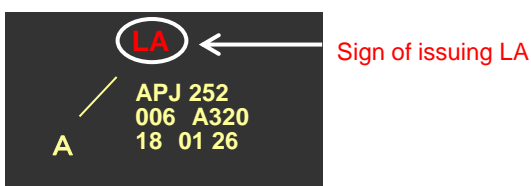
## (2) Controller notifications in FAA

The FAA document that defines Rules for Air Traffic Control<sup>\*79</sup> stipulated in the section defining Duty Priority Orders (2-1-2 DUTY PRIORITY) that the Controller should give the first priority to issuing safety alerts as well as separating aircraft, and in the section defining Safety Alert (2-1-6 SAFETY ALERT) that the Controller shall issue a safety alert to the aircraft if the Controller is aware with generating of MSAW or checking in PAR Screen and other ways that the aircraft places it in unsafe proximity to terrain or water surface and if he or she is aware that the aircraft is an unsafe altitude.

### 2.21.2 Low Altitude Warning

MSAW monitoring area is defined by airports and types of approach respectively; therefore, MSAW monitoring area of PAR RWY 18 in the Airport is established in the airspace between 15.74 and 0.81 nm from the approach end of the runway.

Warning against lower altitude of an aircraft, in approach monitoring function of MSAW is incorporated in ARTS, has two categories<sup>\*80</sup>: one is AC which was issued when the current aircraft altitude became lower than the configured altitude, the other is AP which was issued when the predicted aircraft altitude became lower than the configured altitude. These warnings are generally referred to as "LOW ALTITUDE WARNING" (hereinafter referred to as "LA"). When an LA is issued, the letters of "LA" are displayed in red on ARTS Screen as shown in the **Figure 16** and aural warning of "LOW ALTITUDE WARNING" sounds following buzzers in three times.



**Figure 16 Example of Data block display when an LA is issued**

### 2.21.3 Regulations relevant to LA

Standards for Air Traffic Control Procedure stipulates that when the alert of LA is displayed in the ARTS Screen and an aural warning was generated for an IFR aircraft within the MSAW

---

<sup>\*79</sup> "FAA document that defines Rules for Air Traffic Control" is "FAA Order J0 7110.65V Air Traffic Control."

<sup>\*80</sup> There is a difference in thresholds to trigger a warning between AC: issued when the current aircraft altitude became lower than the configured altitude and AP: issued when the predicted aircraft altitude became lower than the configured altitude.

monitoring area, the Air Traffic Control Facility which establishes ATC communication with the aircraft shall notify the warning of the aircraft and give it an altitude alert as below:

★ *LOW ALTITUDE WARNING, CHECK YOUR ALTITUDE IMMEDIATELY.*

#### **2.21.4 MSAW Record at the Time of Occurrence of Serious Incident**

According to the records of MSAW in ARTS-F of Naha Ground Controlled Approach Facility, AC in MSAW issued at 11:47:09 and lasted until 11:48:11, and then AP in MSAW issued at 11:47:13 and lasted at 11:48:04 in the MSAW monitoring area.

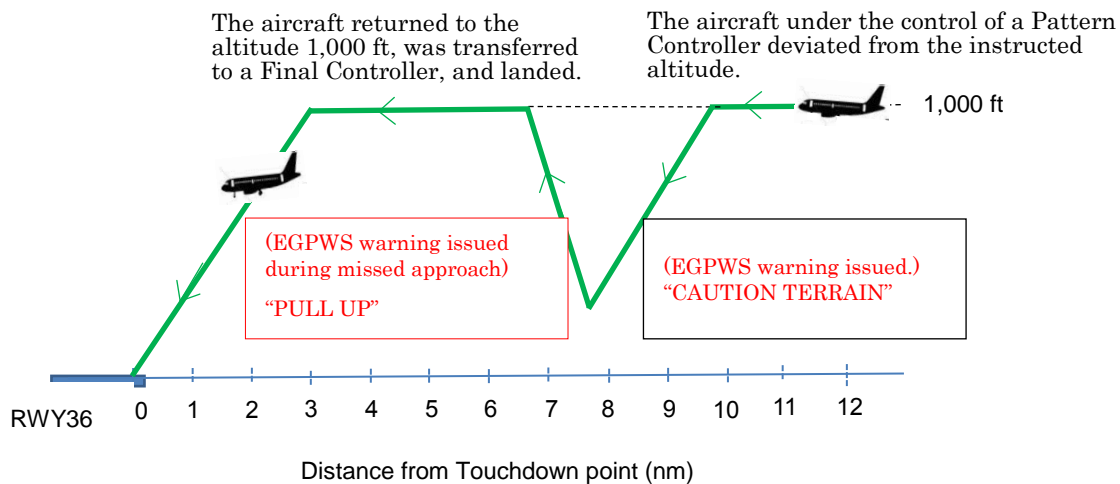
### **2.22 Notification Procedures when LA is issued**

#### **2.22.1 Similar Event in the Past**

In October 2012, a similar event to the serious incident occurred: an aircraft performing PAR approach to RWY 36 of the Airport deviated from the instructed altitude and the flight crewmember noticed the situation and recovered the altitude. According to the information from the operator, the situation at that time would be seemed as follows.

The aircraft under the control of a Pattern Controller maintained the instructed altitude of 1,000 ft with AP engaged; however, it began descent at the point of about 9 nm from the runway threshold. Subsequently, "CAUTION TERRAIN" of the EGPWS warnings was issued around the altitude of 400 ft, and then the flight crewmember who noticed it immediately executed a recovery operation to get altitude. "PULL UP" of the EGPWS warnings was issued during the recovery operation. While recovering, the Pattern Controller gave an instruction of maintaining the altitude of 1,000 ft. After returning to 1,000 ft, the aircraft continued PAR approach and landed at the Airport. The recorded lowest altitude was 327 ft according to the operator.

According to Civil Aviation Bureau, Ministry of Land, Infrastructure, Transport and Tourism, (hereinafter referred to as "CAB") the MSAW system was set up to inhibit LA at the position of the Pattern Controller at that time. However, since Naha Tower at that time noticed the LA warning with aural warning and notified it to the Pattern controller; consequently, the Pattern Controller instructed the aircraft to maintain the assigned altitude. (see **Figure 17**)



**Figure 17 Trajectory Image of the Similar Event Based on the information from the Operator.**

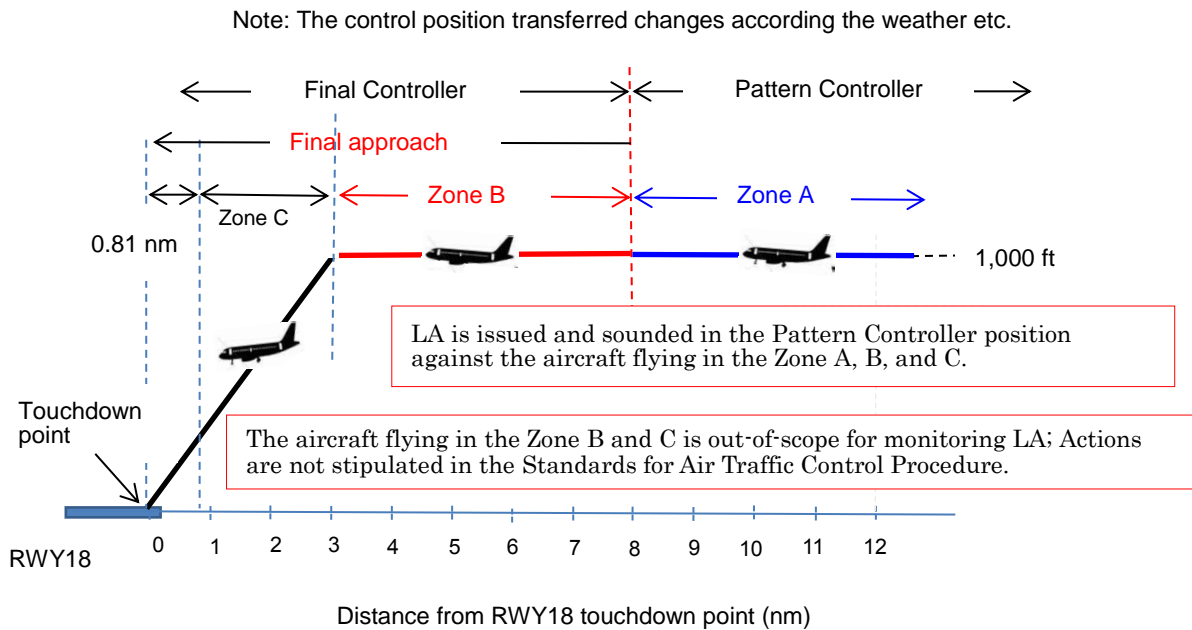
### 2.22.2 Notification Procedures when the Serious Incident occurred

Responding to the event described in 2.22.1, in June 2013, CAB revised the Standards for Air Traffic Control Procedure to clarify handling procedure for MSAW in Ground Controlled Approach Facility, which had not been stipulated until then. With the revision, the procedures in the event an LA issued to an aircraft under the control of the Pattern Controller clearly specified, and a paragraph was stipulated that an aircraft under the control of the Final Controller is out-of-scope for monitoring LA. The contents is as below.

In **Figure 18**, an aircraft in Zone A shows is under the control of the Pattern Controller and aircraft in Zone B or C is under the control of the Final Controller. The aircraft in Zone A, B and C are all displayed in the ARTS Screen in the Pattern Controller position. If the aircraft descends or is predicted to descend lower than the configured altitude within the designated area, an LA will be issued and aural warnings will sound.

According to the revised Standards for Air Traffic Control Procedure, an aircraft in Zone A is an object to be monitored and the procedures when an LA is issued are stipulated in the Standards, on the other hand, because an aircraft in Zone B or C is out-of-scope for monitoring LA, any actions to be taken is not stipulated in it.





**Figure 18 Image of Zone Classification for Issuing and Monitoring of LA**

Regarding the fact that no actions are stipulated in the revised Standards for Air Traffic Control Procedure in the event an LA is issued to an aircraft under the control of a Final Controller, Civil Aviation Bureau states as below.

Civil Aviation Bureau does not assume that an LA is issued against an aircraft in Zone C. It is because the Final Controller definitely monitors an aircraft in the elevation indication and can give a corrective instruction if there is a subtle deviation from a glide-path.

On the other hand, when it comes to the event if the aircraft in Zone B deviates from its altitude, an "LA" is not displayed in PAR Screen in current Naha Ground Controlled Approach Facility and no LA aural warning sounds in the Final Controller position.<sup>\*81</sup> With the function of current MSAW equipment, there is no methods left other than giving advice about LA, which was triggered by an aircraft in Zone B and issued in the Pattern Controller position, from the Pattern Controller to the Final Controller, in order that they can give an LA warning to the deviating aircraft in Zone B. Following the same way as when the serious incident occurred, Civil Aviation Bureau assumes that they can barely handle the situation in a timely manner. Accordingly, considering workload increment of the Pattern Controller and time spent on conveying message after recognition of LA issuance, it is inappropriate and difficult that the Bureau stipulates provisions to incorporate into the Final Controller's task in which the Final Controller at the position without functions of MSAW gives an LA warning to the aircraft which is monitored in the function of MSAW (at the ARTS-F in the Pattern Controller), given the present circumstances.

<sup>\*81</sup> "LA" is not displayed in PAR Screen and no LA aural warning sounds in the Final Controller position," refers to 2.19.2 (4).

## 3. ANALYSIS

### 3.1 Qualifications of Personnel

The Captain and the First Officer held both valid airman competence certificates and valid aviation medical certificates. As described in 2.17.2, the Company, as well as the other airlines in Japan, did not prescribe PAR approach experience at the Airport as a requirement in the training manual related to captain's airport qualification. The Captain at the time of occurrence of the serious incident satisfied the Airport qualification.

### 3.2 Aircraft Airworthiness Certificate

The Aircraft had valid airworthiness certificate and had been maintained and inspected as prescribed.

### 3.3 Relations to the Meteorological Conditions

As described in **Appended Figure 4**, it is probable that the front system lay around the main island of Okinawa and the final approach course of RWY 18 at the Airport was covered with radar echoes at the time of occurrence of the serious incident. As described in 2.6.2 regarding the weather condition at the Airport around 11:30 through 12:00, the visibility was getting worse, clouds were growing and cloud bases were coming lower.

As described in 2.1.2 (1) and (2), the Captain and the First Officer stated that they could not confirm visually the runway of the Airport and the sea surface. According to FDR records and others, the Aircraft made a go-around at 4 nm on their PAR final approach. Based on these facts, it is probable that the Aircraft was flying through clouds or in the considerably bad flight visibility of the PAR final approach at the time of occurrence of the serious incident.

Consequently, when the serious incident occurred, it is somewhat likely that the meteorological conditions at that time was one of contributing factors for delay in the recognitions of the Captain and the First Officer of the Aircraft's descent.

### 3.4 History of the Flight

#### 3.4.1 Situation at Time of Initiating Approach

As described in 2.1.2 (1), the approach procedure for the Aircraft was changed from VOR approach to PAR approach. On the other hand, the setting of VOR approach were left on the FMGC at the direction of the Captain. Therefore, it is probable that the ND screens of the Captain and the First Officer showed the data as illustrated in **Figure 4**, Section 2.10.2, including waypoints for VOR approach, 6.0 nm (CHATN) and 3.0 nm, and the position (distance) from NAHA VORTAC. In the light

of above mentioned facts, it is probable that it was possible for the Captain to understand the position of the Aircraft when the serious incident occurred.

As described in 2.1.1 and as shown in **Appended Figure 1** "Estimated Flight Route," the Aircraft was transferred from Naha Arrival to the Pattern Controller at Naha Ground Controlled Approach Facility at 11:41:12 and reached a pressure altitude of 1,000 ft around 20 nm north of the Airport at about 11:41:30. Accordingly, it is probable that the Aircraft was maintaining the altitude and was provided radar-guidance to the final approach course.

### **3.4.2 Transfer to Final Controller and Beginning of Descent**

It is probable that the Captain, who was following the standard procedures described in **Figure 2**, Section 2.9.2 and taking into consideration the distance from the runway, set the Aircraft for landing configuration and decelerated. Moreover, it is probable that, as shown in **Appended Figure 1**, the Aircraft extended the landing gears at the position of about 9 nm at 11:45:18, and the flaps were set to "3" at 11:45:43. In view of the fact that this series of the Captain's operations conformed to the rules of setting the aircraft for landing configuration and completing the Checklist before the time of beginning descent, it is probable that the Aircraft had been flying in accordance with the Captain's flight plan until this time.

As described in 2.1.2 (2), the First Officer stated that the Aircraft was transferred from the Pattern Controller to the Final Controller when the Captain ordered the First Officer to set the flaps to "FULL" and perform the Checklist. The First Officer did not set the flaps to "FULL" at this time but thought she did, and she, postponing the Checklist, began the Communication Check with the Final Controller. Judging from these, it is probable that the First Officer's workload then was high due to carrying out the Checklist and the communication with the Final Controller.

According to **Appended Figure 7** "List of ATC Communication Records, the Pressure Altitudes of the Aircraft and Others," the First Officer began to communicate with the Final Controller at 11:46:20, and the Final Controller gave the Don't Acknowledge Instruction to the Aircraft between 11:46:26 and 11:46:29.

As described in **Table 1**, Section 2.14, the FDR records show that the AP/FD vertical mode had been "Other" until 11:46:27 but was "VS mode" at 11:46:28. Based on this, it is probable that the Captain pulled the VS knob at 11:46:28. In addition, **Table 1** suggests that the pitch angle and the vertical speed began to decrease at 11:46:30. The pressure altitude had stayed at 1,002 ft until 11:46:32, became 994 ft at 11:46:33 and continued decreasing. Judging from this, it is probable that the Aircraft began descent at 11:46:33.

### **3.4.3 Situation at Time of Beginning of Carrying out the Checklist**

As described in 3.4.2, the First Officer had postponed carrying out on the Checklist. It is probable that she began to read out and confirm the Checklist at about 11:46:30, after the Final Controller gave her the Don't Acknowledge Instruction.

As described in 2.11.4, it is probable that the first three items in the Checklist can be read out and confirmed during short intervals among ATC communications and that the First Officer was able to read out and confirm them. As described in 2.1.2 (2), it is probable that the First Officer advised the Captain, "TOO LOW," when she noticed the indication "-900 fpm" in the VS Window while checking these three items.

It is probable that the First Officer gave this advice because she had not known that the vertical speed had been set in the VS Window and thought the rate would make the Aircraft descend too low. However, it is probable that the First officer resumed carrying out the Checklist when there was no response from the Captain, determining it would be better to proceed through the Checklist.

It is probable that the Aircraft had been already descending but that when giving the advice, the First Officer was preoccupied with the task of monitoring the Captain's operations and carrying out and completing the Checklist and did not look at the FMA mode or the altimeter, thinking that AP maintained the Aircraft at an altitude of 1,000 ft. Moreover, as described in 2.1.2 (1), the Captain did not remember the First Officer's advice "TOO LOW" regarding the preset in the VS Window. Judging from these, it is probable that the Captain was concentrating on the Final Controller's radar-guidance and did not pay attention to the altitude of the Aircraft.

### **3.4.4 Situation at Completion of the Checklist**

As described in 2.11.4, the last item in the Checklist "ECAM MEMO" requires the PF to confirm, "LANDING NO BLUE," responding to the PNF's reading out.

As described in 2.1.2 (2), the First Officer stated that she thought she had set the flaps to "FULL" before beginning the first communication with the Final Controller; however, she realized the flaps had not been set to the "FULL" position when she was about to read out the last item in the Checklist. Since the First Officer thought she set the flaps to "Full" position after receiving another direction from the Captain, she called "FLAPS FULL," but she could not get his response partly because the Controller were continuously instructing him. Therefore, it is probable that the First Officer set the flap lever to FULL at 11:46:47 after she called again "FLAPS FULL." Then, after confirming that the ECAM MEMO displayed the sign "FLAPS FULL" in green, the First Officer tried to resume reading out the Checklist, but it is probable that she was unable to do so between 11:46:45 and 11:46:53 because the communication with the Final Controller continued during the time period. It is also probable that there was no communication for about three seconds after the Final Controller's call

about "5 nm from the touchdown point" at 11:46:53, and it is somewhat likely that the First Officer used this period to read out the "ECAM MEMO."

As described in 2.1.2 (2), the First Officer stated that completing the Checklist took time, and as described in 2.16, the investigation with simulator confirmed that the Checklist may not be timely carried out in the case of a PAR approach. As described in the Appended Figure 7, notifications and instructions were almost continuously issued from the Final Controller from 11:46:57. From these, it is probable that it took some time to finish the last item in the Checklist, consisting of the First Officer's reading out, "ECAM MEMO," the Captain's confirmation, "LANDING NO BLUE," and the First Officer's report of the completion of the Checklist.

### **3.4.5 The First Officer's Warning and Operation to Stop Descent**

As described in 2.1.2 (2), when completing the Checklist and putting it back into a storage, the First Officer realized the altitude of the Aircraft was decreasing and immediately made the TOO LOW Warning.

As described in **Table 1**, Section 2.14, the FDR records show the selected vertical speed had been "- 900" until 11:47:25, "- 800" at 11:47:26, and "0" at 11:47:27. Although the Captain did not mention the operation of pushing the VS knob, the First Officer saw the Captain performing that. Therefore, it is probable that the Captain pushed the knob to stop descent at 11:47:26. It is probable that when the Captain thought AP had kept the Aircraft flying at an altitude of 1,000 ft, he suddenly received the First Officer's Warning of the TOO LOW, that he recognized, from the altitude indicated by the PFD altimeter, that the Aircraft was descending and that he immediately pushed the VS knob to stop descent.

### **3.4.6 EGPWS Warning and the Situation at Go-Around**

As described in 2.1.2 (1) and (2), the Captain and the First Officer stating that they had heard the EGPWS TERRAIN warnings. As described in 2.14 and the **Table 2** in 2.15.2, it is also probable that the EGPWS TERRAIN warning was triggered at 11:47:26 almost at the same time when the Captain pushed VS knob.

Moreover, the Captain stated that he heard the instruction from the Controller almost the same time when the EGPWS TERRAIN warning was issued, it is highly probable that what he heard was "the Maintain 1,000 ft Call" from the Final Controller from 11:47:25 to 11:47:31 described in Appended Figure 7.

Afterward, as described in 2.14, thrust levers were set in "TOGA" position at 11:47:35, it is highly probable that the Captain initiates a go-around as an emergency operation in order to avoid crash into water.

## **3.5 The Captain's Knob Operation**

### **3.5.1 The Captain's Situation**

#### (1) Presetting operation of VS knob

As described in 2.1.2 (1), the Captain stated that when initiating descent using the VS mode, as his standard manner, he first preset his desired vertical speed in the VS Window, and then pulled the VS knob. Moreover, it is probable that the Captain had understood that the presetting value in the VS Window was effective for 45 seconds as described in 2.10.3 and that the Aircraft maintaining 1,000 ft would begin descent around 3.0 nm point from the runway as described in 2.9.2.

Therefore, it is probable that the Captain at that time was going to preset the VS Window shortly before the 3.0 nm point where the Controller instructed "Begin Descent", and then pull the VS knob to follow it. Since FDR does not retain any records of the time when a vertical speed value was set in the VS window, it was impossible to determine when the Captain made a presetting operation of the VS knob at the time of occurrence of the serious incident. As described in 2.14, however, the VS knob was pulled at the position of about 5.7 nm which had considerable distance from the planned initiating descent point of 3.0 nm; therefore, it is highly probable that the presetting operation of the VS knob was made in advance of pulling operation of the VS knob. With this, it is probable that the Captain at that time preset the vertical speed of - 900 fpm by VS knob without attentively confirming the position of the Aircraft.

#### (2) Callout when Presetting Operation of VS knob

As described in 2.11.3, regarding standard callouts for operations in FCU panel, FCOM stipulates that a pilot should call out "Set" when he or she sets numeric values with a knob. According to the manufacture, however, it does not clearly define any callouts for presetting operations of VS knob.

As described in 3.4.3, at the time of occurrence of the serious incident, it was not until the First Officer carried out the Checklist that she noticed the vertical speed set in VS Window. It is probable that the Captain at that time operated the VS knob in FCU panel without making a callout to the First Officer. It is probable that if the Captain had called out his presetting operation in VS Window, the First Officer could have advised him that the Aircraft was not enough close to the descent initiating point where he should operate the VS knob.

It is important that PF calls out his or her operations to get PNF to recognize and that PF and PNF share information. It is thought to be important that PF shall call out his or her operations when operating equipment to have PNF recognize his or her intention. For PNF, calling out from PF is not only useful to know what's going on but also helpful to realize what is to be monitored. Moreover, it would lead to reduce PNF's workload. It is probable that the Company, reviewing the serious incident,

should reconstruct its own operational policy and restudy its structure over educations and trainings, then should examine the ways of callout when operating equipment.

### (3) Operation of Pulling VS knob

As described in 3.4.2, it is probable that the Captain pulled the VS knob at 11:46:28.

As described in 2.1.2 (1), the Captain stated that he did not remember the operation of pulling the VS knob but that there was no doubt he himself as PF must have pulled it, considering the fact that the Aircraft descended. He also stated that he did not know what caused such a situation.

As described in 2.17.3, the Captain was asked for cooperation by ATC facility to perform PAR approach for the purpose of the Controllers' training a few days before the serious incident but then he declined the offer at that time. Afterward, the Captain studied PAR approach to prepare for ensuing such occasions by himself. For the Captain, PAR approach at the serious incident was the first experience with the type of the Aircraft and it was the first PAR approach in a long time. It is probable that the Captain at that time had a conscious desire to perform it accurately. Thus, it is probable that the Captain was flying while considering various upcoming operations: properly following the Controller's radar-guidance; having the Aircraft descend upon receiving the Controller's instruction of "begin descent": setting initial descent rate deeper to capture a glide-path in a short time.

When the Aircraft was transferred from the Pattern Controller to the Final Controller, it is somewhat likely that the Captain became more conscious about being in the stage of PAR final approach, he might create an image in his mind how to accurately control the Aircraft after meeting a glide-path. As a result, it is somewhat likely that the Captain pulled the VS knob without any intention for beginning descent, either at the timing as a series of operations or at the later timing following its presetting operation.

### **3.5.2 The First Officer's Notice**

As described in 2.1.2 (2), the First Officer stated that she did not notice that the Captain operated the VS knob. It is probable that the First Officer did not notice that the Captain operated VS knob located in the right side of the FCU panel because he did not call it out as described in 3.5.1 (2). As described in 2.1.1, the First Officer conducted the Communication Check with the Final Controller from 11:46:26 and received the Don't Acknowledge Instruction. As described in 3.4.2, the VS knob was almost simultaneously pulled at 11:46:28 during the Communication Check. It is probable that the First Officer in this period: just after the control of the Aircraft was transferred, being anxious about resuming the postponed Checklist, had to cope with a higher workload. It is probable that the First Officer's situation of higher workload was a contributing factor that she did not notice the Captain's VS knob operation without any callouts.

## **3.6 Flight Monitoring**

### **3.6.1 Background of Lack of Recognition of Descent**

As described in 2.11.1, the FCOM P of the Company stipulates, *"In all situations the priority is that the flight crew must continue flying the airplane and monitoring the airplane condition necessary for the flight."* However, it is probable that the Captain and the First Officer at the serious incident did not recognize the Aircraft was descending because of the following contributing factors:

It is probable that the descent of the Aircraft was triggered by the Captain's unintentional action as described in 3.5.1 (3), but that the Captain and the First Officer never assumed the Aircraft to begin descent, being convinced that AP was maintaining an altitude of 1,000 ft. Therefore, it is probable that they did not think that the vertical mode of AP/FD would change in that phase and did not recognize the FMA status described in 2.10.2 when the descent was commenced. Besides, it is probable that they did not monitor the pitch angle going down and the N1 Actual Engines indications being in a gradual decline as described in 2.14, because they did not think that the Aircraft was in a stage of initiating descent when the pitch angle or the N1 indications would start to change, and they did not notice the sounds of the engines was getting smaller, either. In addition, it is probable that at that time the Captain as PF put his right hand on the thrust levers; however, he was unable to notice the gradual decline in the N1 indications from the movement of the thrust levers. This is because, as described in 2.10.4, a position of thrust levers on the type of the Aircraft is fixed at the "CL" position while AT is engaged.

Moreover, as described in 2.10.5, in the type of the Aircraft, an "ALT ALERT" is issued an aural alert is sounded in the case that it deviates from the altitude set on the FCU; however, "ALT ALERT" is inhibited in the configuration that landing gears were extended such as the case when the serious incident occurred. The Aircraft began to deviate and descend from the altitude set on the FCU of 1,000 ft but the Aircraft at that time was configured with landing gears down which inhibits "ALT ALERT." Accordingly, it is highly probable that "ALT ALERT" was not issued and did not sound when the serious incident occurred.

Furthermore, as described in 2.1.2 (1), the Captain stated that he believed that the altitude of aircraft was monitored by the Controller, while a pilot assumed responsibility for maintaining the altitude. It is somewhat likely that the Captain thought that the Controller would instruct aircraft to verify its altitude if it deviates from an instructed altitude during PAR approach.

### **3.6.2 Relation with Automation System**

The second item in the GOLDEN RULES FOR PILOTS described in 2.12.2 is "Use the appropriate level of automation at all times." As described in 2.4, the Captain had about one-year experience of flying the type of the Aircraft and was accustomed to flying it using AP. As described in



2.1.2 (1), it is probable that he decided to use AP when starting to make an approach to the Airport, taking into consideration the worsening weather conditions and in order to reduce the workload.

If the Captain had manually maneuvered the Aircraft to perform the PAR approach when the serious incident occurred, it is probable that the Captain and the First Officer would have paid sufficient attention to maintaining an altitude of 1,000 ft. However, at the time of occurrence of the serious incident, it is probable that the Captain and the First Officer relied too much on AP, being less cautious in flying at as low as 1,000 ft, did not assume an unintentional descent at all. Accordingly, it is probable that they did not pay attention to any FMA modes and the basic instruments such as an altimeter and a vertical indicator.

As described in 2.13.1, "The WG Report in 2013" points to the risk that pilots over-rely on automated systems. While the use of such automated systems help pilots reduce their workloads, it might have some downsides such as the tendency of insufficient monitor of those systems. Pilots need to properly prioritize tasks, as described later, and fly the aircraft with sufficient caution.

### **3.6.3 Maintaining Attention**

#### **(1) Situations of the Captain and the First Officer**

As described in 3.5.1 (3), it is probable that the Captain at the serious incident had a conscious desire to perform PAR approach accurately and was flying while considering upcoming operations, and after transferred to the Final Controller he had been concentrated on the radar-guidance.

On the other hand, as described in 3.4.4, it is probable that the First Officer at that time was unable to read out the Checklist timely due to continuous ATC instructions and that it took a long time to complete its overall procedures of the Checklist. It is probable that eventually the First Officer paid lots of attention to monitoring the Captain's operations and completing the Checklist in her mind during this timeframe.

#### **(2) Prioritization of Tasks**

The first item of the GOLDEN RULES FOR PILOTS described in 2.12.1 requires for the crewmembers to concentrate on "Fly. Navigate. Communicate." as the highest priority and use appropriate task sharing. "The WG Report in 2013" mentioned in 2.13.2 also emphasizes the importance of task management.

As described in the above (1), it is probable that the Captain and the First Officer prioritized the radar-guidance by the Final Controller and completion of the Checklist over monitoring whether the Aircraft is safely flying with maintaining an altitude. However, it is probable, at this phase before meeting a glide-path, that they should have prioritized the monitoring task for the altitude to fly safely, and that they should have followed the radar-guidance by the Final Controller or attempted to

complete the Checklist after remaining vigilant in maintaining the altitude in the same manner as they do when they fly by manual maneuvering. The Company should improve its educational and training programs in order to provide the crewmembers with opportunities, such as at CRM training, to acquire the practice of prioritizing a task in an appropriate way.

### (3) Monitoring FMA

As shown in Figure 4, Section 2.10.2, flight crewmembers should verify "ALT" in FMA, presenting that an aircraft maintains the current altitude, to monitor an altitude when AP is engaged in the type of the aircraft. The third item of the GOLDEN RULES FOR PILOTS described in 2.12.3 is: "Understand the FMA at all times." As described in 2.11.2, FCOM P and FCOM of the Company also emphasize the importance of monitoring FMA.

The Company should enhance its educational and training programs to ensure that its crewmembers devote more attention to monitoring FMA under any circumstances after prioritizing tasks as described in the above (2).

### (4) Improvement of Pilot's Monitoring Ability and Mutual Confirmation

As described in 2.13.3, "the Audit Report in 2016" emphasizes the importance of proper pilot monitoring, including actively cross-checking the actions of other crewmembers, when automated systems are engaged, and it requires that each pilot should improve his or her monitoring ability.

The Audit Report also mentions the FAA's plan to develop guidance aimed at enhancing crewmembers' ability to monitor flight status. It is desirable that each airline company should continuously carry out the review, regarding the ways of pilot monitoring, which contributes to further safety improvement while referring to some efforts developed in other countries.

## **3.7 EGPWS Warnings and the Captain's Operations At the Serious Incident**

### **3.7.1 Issuance of EGPWS Warnings**

#### (1) The Captain's Recognition

As described in 2.1.2 (1), the Captain stated that he did not hear the PULL-UP warnings when the serious incident occurred, but as described in 2.15.4, the FDR and EGPWS retained the records of the warnings and there is no system malfunction found; accordingly, it is highly probable that the warnings were issued.

As the Captain stated, it is probable that he knew that the pilot needed to follow the emergency avoidance procedure described in 2.15.3 when a "PULL-UP" warnings were issued, which includes turning AP off, manually pulling the side stick to the maximum nose-up position and maintaining it there. The Captain at the serious incident made a go-around with AP engaged; therefore, it is

somewhat likely that he did not recognize that the warnings sounded.

As described in 3.4.5, at 11:47:26 the Captain operated the VS knob in order to interrupt the descent, and almost at the same time, the TERRAIN warning was issued. As described in 2.1.2 (1), the Captain stated that he heard the TERRAIN warning and the controller's instruction of "TOO LOW FOR SAFE APPROACH," almost simultaneously. At that time, it is probable that the Captain was getting highly tensed up because he was surprised at TOO LOW Warning from the First Officer, recognizing its descent followed by pushing the VS knob, and then heard the TERRAIN warning.

As described in 2.1.2 (2), it is probable that the Captain at that time was trying to consider what sounded and what to do, gradually recognizing the situation and beginning to realize the necessity of operation to recover altitude. As described in 2.15.2, it is probable that the warning "TERRAIN, TERRAIN, PULL-UP" sounded at 11:47:32 and the second "PULL-UP" sounded at 11:47:34, but these warnings overlapped "the Acknowledge Call" from the Final Controller. It is somewhat likely that the Captain at that time did not recognize the PULL-UP warning because he was totally strained, concentrating on a go-around operation to recover altitude. In addition, the thrust levers were set to the TOGA position to initiate a go-around at 11:47:35, and it is probable that the Captain called out, "Go-around," to the First Officer immediately after that. It is somewhat likely that the Captain did not recognize the third "PULL-UP" at 11:47:36, either, which overlapped the go-around call.

## (2) The First Officer's Recognition

As with the Captain, the First Officer also stated that she did not remember hearing the PULL-UP warning.

It is probable that the First Officer was surprised and got tensed up when she recognized the Aircraft's descent. As described in 2.1.2 (2), the First Officer did not remember the Controller's instruction when the TERRAIN warning was issued. She stated that she remembered hearing something like "TOO LOW GO AROUND," around the time the Captain initiated the go-around procedure. On the other hand, the ATC communication records retained the Maintain 1,000 ft Call but not a go-around call.

In light of that, it is somewhat likely that the First Officer felt as if the Controller had instructed a go-around because she thought that the Aircraft should recover altitude as soon as possible after recognizing a deviation from the altitude of 1,000 ft, and for that purpose she firmly realized that they should make a go-around.

As described above, it is probable that the First Officer had been totally strained as was the case with the Captain until the Aircraft began to make a go-around and, beyond that, the PULL-UP warning might be overlapped by the Controller's instruction. Therefore, it is somewhat likely that the First Officer did not recognize the PULL-UP warning.

### **3.7.2 The Captain's Operations at the Serious Incident**

As described in 2.15.3, according to FCOM when a PULL-UP warning was issued, a pilot shall simultaneously perform the following items, disengaging the AP, pulling the side-stick to the maximum pitch-up position and setting the thrust levers to the TOGA position, It is probable that it is because the aircraft to which the PULL-UP warning was issued is close to the ground or water enough to perform a defined emergency operation, and then a pilot shall make aircraft climb in a safe and immediate manner to avoid crash into the ground or water.

As described in 2.1.1, AP of the Aircraft was engaged throughout the serious incident, and as described in 2.14, the Aircraft, deviating and descending from an altitude of 1,000 ft with a vertical speed of - 900 fpm in average, moved into a go-around at the stage of its vertical speeds was declining, which was produced by the Captain's operation of pushing VS knob. The altitude of the Aircraft marked a record low of 242 ft in FDR.

It is probable that the Captain decided to make a go-around with AP engaged as the emergency operation in order to avoid crash into sea surface at the serious incident.

### **3.8 The Captain's Report and Response of the Company**

As described in 2.18.1, after parking the Aircraft, the Captain and the First Officer discussed that the Aircraft unexpectedly descended during the final PAR approach to RWY 18 and made a go-around after the TERRAIN warning sounded. They also confirmed that they did not hear a PULL-UP warning. The Captain stated that he reported these points to the Manager over the phone. On the other hand, the Manager stated that he was told by the Captain that the altitude became low during a PAR approach and then he made a go-around. The Manager also stated that he did not remember being told about EGPWS warning issuance and that he approved continued operation of the Aircraft, accordingly.

It is probable that the Captain reported to the Manager in accordance with the OM description in 2.18.2, after mutually confirming about the event occurred during the approach with the First Officer, and then the Manager examined the Captain's report in accordance with the Company Regulations described in 2.18.3. As a result, it is probable that the Manager recognized that the Aircraft, not deviating from the altitude, made a go-around because of flying lower than the path during the approach. Besides, it is probable that the Manager determined that the event did not require any additional measures to be taken and approved continued operation of the Aircraft, remembering that the Captain's report did not include any EGPWS warning issuance.

As described above, both the Captain and the Manager followed the procedures stipulated, but it is probable that they examined neither the approach path nor the items regarding issuance of any warnings. As a result, it is probable that since the Company could recognize neither an altitude

deviation nor an issuance of the EGPWS warning, it did not take any necessary actions such as QAR analysis; consequently, the Aircraft continued the operation. Moreover, it is recognized that this caused the voice records in CVR during the serious incident to be overwritten because the CVR was not retrieved.

The Company should establish a system to accurately assess events reported by captains.

### **3.9 History of Flight Monitoring at Naha Ground Controlled Approach Facility**

#### **3.9.1 From Beginning of Descent through Deviation from Radar Safety Zone**

As described in Appended Figure 7, the Final Trainee began to communicate with the Aircraft at 11:46:20, gave the Don't Acknowledge Instruction from 11:46:26 to 11:46:29 and began to provide the Aircraft with radar-guidance. From 11:46:30 to 11:46:31, the Final Trainee informed that the Aircraft had passed the position of 6 nm, and from 11:46:32 to 11:46:38, gave heading instructions concerning directions. As described in 3.4.2, it is probable that the Aircraft began descent at 11:46:33 when the Final Trainee was giving the heading instruction.

Afterward, the Final Trainee gave the Aircraft such as wind information, heading instructions to align with the final course with its deviation and a report of its passing 5 nm, while he did not give any instructions regarding its altitude.

As described in 2.20.1, the minimum altitude of the Radar Safety Zone in the part of level-flight before the glide-path-capture point for RWY 18 at the Airport is 750 ft, but according to **Table 1**, Section 2.14, the Aircraft passed pressure altitude of 746 ft at 11:46:55. Therefore, it is probable that the Aircraft had already deviated from the Radar Safety Zone at this point and continued descending. It is probable, however, that the Final Supervisor and the Final Trainee did not notice that the Aircraft was descending.

#### **3.9.2 From Time of Issuing LA through Time of Go-Around**

As described in Appended Figure 7, at 11:47:09 when the Final Trainee reported a landing clearance to the Aircraft, it is probable that an LA was issued at the Pattern Controller's position and the aural warning also sounded. As described in 2.1.2 (3) and (4), the Final Supervisor and the Final Trainee stated that they heard an LA warning, which means that it is probable that both of them noticed that an LA was issued by aircraft under the control of either the Pattern Controller or the Final Controller. It is probable that the pressure altitude of the Aircraft was 558 ft, as shown in Appended Figure 7, when the LA was issued at the Pattern Controller's position at 11:47:09.

It is probable that the Pattern Controller who controlled the following aircraft of the Aircraft at that time recognized that an LA was issued and confirmed "LA" in its data block of the Aircraft on the ARTS Screen, waited for four seconds to update the data in the screen, as described in 2.19.2 (1), and

made sure to identify the LA issuance to it then advised the Final Trainee that the Aircraft was descending.

It is probable that the Final Trainee, who was advised by the Pattern Controller that the Aircraft was descending, confirmed that the Aircraft's altitude was shown lower than usual in the elevation indication and instructed "the Maintain 1,000 ft Call" at 11:47:25. It is probable that the pressure altitude of the Aircraft at that time was 322 ft as shown in Appended Figure 7.

As described in 2.1.2 (3), it is probable that the Final Supervisor instructed the Final Trainee to call again in the same manner to the Aircraft since it did not seem to stop descending even after the Final Trainee's instructing "the Maintain 1,000 ft Call." With this, it is probable that the Final Trainee gave "the Acknowledge Call" from 11:47:33 to 11:47:35 and gave the second instruction of maintaining 1,000 ft from 11:47:37 to 11:47:40.

After that, it is probable that the Final Supervisor and the Final Trainee received a go-around call from the Aircraft at 11:47:41, and then confirmed that it recovered the altitude on the PAR Screen.

### **3.10 Altitude Monitoring by Controllers**

#### **3.10.1 Features of PAR Screen**

It is somewhat likely that when the serious incident occurred there were some contributing factors which led the Final Controller to some difficulties in monitoring the altitudes on the PAR Screen as blow.

As described in 2.1.2 (3), the Final Supervisor stated that it is difficult to monitor the altitude of aircraft flying before a glide-path-capture point. It is probable that this is because an aircraft's altitude is not displayed in a digital format; it is displayed not by the point but by the rod-like target; and the Constant Elevation Line is not displayed in the elevation indication, as described in 2.19.2 (4). In addition, since the line, indicating the lower limit of the Radar Safety Zone in front side of glide-path-capture point, is not displayed in the PAR Screen, it is probable that it was not easy to notice the Aircraft descending below the Radar Safety Zone in a moment.

Moreover, since the final approach area of PAR approach was a bad weather condition when the serious incident occurred as described in 2.6, it is probable that some radar echoes of precipitation areas like Photo 2-2, Section 2.19.2 (4) was appeared in the PAR Screen. It is probable that advanced skills were required for the Final Controller to identify the aircraft target depending on weather conditions.

#### **3.10.2 Final Controller's Awareness of Altitude Monitoring**

As described in 2.8.2, the PAR approach is a precision approach provided with radar-guidance, and the pilot flies following the final controller's instructions and advice. As described in 2.20.2, the

Standards for Air Traffic Control Procedure stipulates that in case that he or she notices aircraft of deviating from the Radar Safety Zone, the final controller should take necessary actions, such as instructing the aircraft to execute a missed approach. Considering this, it is probable that a final controller should monitor both the course and the altitude all the time.

As described in 2.20.3, according to the Naha Ground Controlled Approach Facility, the Facility at the occurrence of the serious incident did not assume the case that aircraft, under the control of the final controller, flying before meeting a glide-path would begin descent without the Controller's instruction, had not provided controllers with any education or training to pay sufficient attention to the elevation indication to monitor the aircraft's altitude.

As described in 3.9.1, it is probable that the Aircraft descended and deviated from the Radar Safety Zone and continued descending at about 11:46:55. As shown in Appended Figure 7, the Final Trainee, after receiving the control of the Aircraft from the Pattern Controller (at 11:46:20), gave it heading instructions, wind information and landing clearance and others, but did not give any instructions relating to altitude for approximately one minute before instructing "the Maintain 1,000 ft Call" at 11:47:25. In addition, during that time period, it is probable that the Final Supervisor did not override the Final Trainee's ATC communication and did not advise the Final Trainee to instruct the Aircraft to maintain the altitude, either. It is probable that this is because they did not assume aircraft flying before meeting a glide-path-capture point to begin descent without any instructions to do so.

As described in 2.1.2 (3), the Final Supervisor stated that the final controller, after the control of aircraft is transferred from the pattern controller, usually focuses on the azimuth indication until aircraft approaches to the position of approximately 4.5 nm as there is also communication with the Naha Tower concerning the landing clearance. In addition, as described in 2.1.2 (4), the Final Trainee stated that at that time he focused on the azimuth indication in order to provide the Aircraft with a radar-guidance leading to the final approach

Given these facts, it is probable that the Final Supervisor and the Final Trainee at the serious incident concentrated on the azimuth indication, which made them less aware of monitoring altitudes in the elevation indication, and could not notice the Aircraft deviated from the Radar Safety Zone.

### **3.10.3 Actions Taken against LA Issuance**

As described in 2.22.2, according to the Civil Aviation Bureau, an LA is not issued to an aircraft in Zone C under the control of the final controller as shown in Figure 18, Section 2.22.2, and it is difficult to stipulate procedures to be taken when an LA is issued to an aircraft in Zone B. From these, it is probable that Standards for Air Traffic Control Procedures did not stipulate procedures to be taken by the final controller when an LA is issued to the aircraft under his or her control.

At the serious incident, an LA was issued to the Aircraft flying in Zone B. It is probable that the Controllers at the Naha Ground Controlled Approach Facility encountered this unexpected event for which no procedures had been stipulated and they dealt with the situation based on their own immediate judgment.

Meanwhile, the instruction of "MAINTAIN ONE THOUSAND," which was given to the Aircraft by the Final Trainee at the serious incident, is a phraseology to be also used when aircraft actually maintains an altitude of 1,000 ft. A pilot flying in Zone B in Figure 18, Section 2.22.2 assumes that an aircraft is maintaining an altitude of 1,000 ft. He or she might interpret the phraseology of "MAINTAIN ONE THOUSAND" as an instruction to maintain the current altitude of 1,000 ft. Therefore, it is probable that the instruction was not appropriate when the Controller tried to give an immediate warning about deviation of altitude to the pilot of aircraft descending.

#### **3.10.4 Risk Management against Descent of Aircraft under Control**

As described in 3.10.1, it is probable that depending on weather conditions at that time, it was not easy for the Final Controller to instantly notice that the Aircraft was descending and deviating below the Radar Safety Zone. As described in 3.10.2, Standards for Air Traffic Control Procedure stipulates that a final controller should take necessary actions in case that he or she notices aircraft under his or her control of deviating from the Radar Safety Zone. Nevertheless, the Naha Ground Controlled Approach Facility did not provide any educations or trainings to prepare for an event in which an aircraft before meeting glide-path-capture point began descent without any Controller's instruction. In addition, as described in 3.10.3, since any procedures taken by the Controllers are not stipulated when an LA issued to aircraft in Zone B, it is probable that when the serious incident occurred, the Controllers at the Naha Ground Controlled Approach Facility dealt with an unregulated and unexpected event based on their own immediate judgment. However, it is probable that the phrase the Final Controller used for the Aircraft was not appropriate for notifying it of deviation of the altitude.

In light of above mentioned facts, it is probable that the risk management related to monitoring of aircraft's altitude at the Naha Ground Controlled Approach Facility was not sufficient, in which include the following aspects: they should identify it as a risk that aircraft before meeting glide-path might descend and deviate below the Radar Safety Zone; they should examine and implement adequate measures against the risk; they should assess the effectiveness of these measures; and they should estimate the necessity of improvement plans, based on the examination results. It is probable that insufficient risk management consequently contributed to the continuous descent of the Aircraft.

Because of this, the Naha Ground Controlled Approach Facility should assess the risk of a scenario that an aircraft before meeting glide-path might descend and deviate below the Radar Safety



Zone and conduct risk management such as developing appropriate measures. In addition, when the Facility develops the measures, it is desirable that the Facility, as taking into account current restrictions in its hardware and constraints when it comes to stipulate, examines the upgrade of the safety net including the application of MSAW function and others, as well as discusses operational measures such as requesting an aircraft to verify its altitude at the right timing,

## 4. CONCLUSIONS

### 4.1 Summaries of Analysis

#### 4.1.1 General Matters

- (1) The Captain and the First Officer held both valid airman competence certificates and valid aviation medical certificates and the Aircraft had valid airworthiness certificate and had been maintained and inspected as prescribed as well. (3.1, 3.2)\*<sup>82</sup>
- (2) It is probable that the meteorological condition at that time was one of contributing factors for delay in both pilots' recognition of the Aircraft's descent (3.3).

#### 4.1.2 History of Flight

- (1) The approach procedure for the Aircraft was changed from VOR approach to PAR approach. It is probable that the Aircraft reached a pressure altitude of 1,000 ft around 20 nm north of the Airport, and then maintaining the altitude, it was provided radar-guidance to the final approach course. (3.4.1)
- (2) The First Officer's workload was high due to carrying out the Checklist and the Communication Check with the Final Controller when the control of the Aircraft was transferred from the Pattern Controller to the Final Controller. It is probable that the Aircraft began descent because the Captain pulled the VS knob around this time. (3.4.2)
- (3) After the First Officer was given the Don't Acknowledge Instruction from the Final Controller, she began to read out the Checklist, and then noticed the indication "-900 fpm" in the VS Window. It is probable that the First Officer advised the Captain, "TOO LOW"; however, she determined it would be better to proceed thorough the Checklist. It is probable that the Aircraft had already

---

\*82 The number described in the end of each paragraph starting with (1) and so on in this section corresponds with the number in the Chapter 3. ANALYSIS.

descending but that the First Officer did not look at the FMA mode or the altimeter, thinking that AP maintained the Aircraft at an altitude of 1,000 ft. The Captain at that time did not remember the First Officer's advice "TOO LOW". Accordingly, it is probable that the Captain was concentrating on the Final Controller's radar-guidance and did not pay attention to the altitude of the Aircraft. (3.4.3)

- (4) The First Officer realized the flaps had not been set to the position when she was about to read out the last item in the Checklist. She set the flap lever to "FULL" after she called again "FLAPS FULL" to the Captain. Then, she tried to resume reading out the Checklist, but it is probable that she was unable to do so because the communication with the Final Controller continued during the time period. From these, it is probable that it took time to complete the Checklist. (3.4.4)
- (5) It is probable that the First Officer realized the altitude of the Aircraft was decreasing and immediately made the TOO LOW Warning when completing the Checklist and putting it back into a storage. It is probable that the Captain recognized that the Aircraft was descending, he immediately pushed the VS knob to stop descent. (3.4.5)
- (6) It is probable that the EGPWS TERRAIN warning was issued at the same time when the Captain pushed VS knob and what he heard was "the Maintain 1,000 ft Call" from the Final Controller almost at the same time. Afterward, it is highly probable that the Captain initiated a go-around as an emergency operation in order to avoid crash into water. (3.4.6)

#### **4.1.3 Items Relevant to Causes on Flight Operation**

- (1) It is probable that the Captain was going to preset the VS Window shortly before the point where the Controller instructed "Begin Descent", and then pull the VS knob to follow it. Since FDR does not retain any records of the time when a vertical speed value was set in the VS window, it was impossible to determine when the Captain made a presetting operation of the VS knob at the time of occurrence of the serious incident. However, it is highly probable that the VS knob was pulled at the position of about 5.7 nm which had considerable distance from the planned initiating descent point of 3.0 nm and that the presetting operation of the VS knob was made in advance of pulling operation of VS knob. With this, it is probable that the Captain at that time preset the vertical speed of - 900 fpm by VS knob without attentively confirming the position of the Aircraft. (3.5.1 (1))
- (2) It is probable that the Captain operated the VS knob in FCU panel without making a callout to

the First Officer. It is probable that if the Captain had called out his presetting operation in VS Window, the First Officer could have advised the Captain that the Aircraft was not enough close to the descent initiating point where he should operate the VS knob. It is thought to be important that PF shall call out his or her operations when operating equipment to have PNF recognize his or her intention. For PNF, calling-out from PF is not only useful to know what's going on but also helpful to realize what is to be monitored. Moreover, it would lead to reduce PNF's workload. It is probable that the Company, reviewing the serious incident, should reconstruct its own operational policy and restudy its structure over educations and trainings, then should examine the ways of callout when operating equipment. (3.5.1 (2))

(3) The Captain studied PAR approach to prepare for ensuing such occasions by himself. For the Captain, PAR approach was the first experience with the type of the Aircraft and it was the first PAR approach in a long time. Thus, it is probable that the Captain was flying while considering various upcoming operations with conscious desire to perform it accurately. It is probable that the Captain became more conscious about being in the stage of PAR final approach, he might create an image in his mind how to accurately control the Aircraft after meeting a glide-path. As a result, it is somewhat likely that the Captain pulled the VS knob without any callout and without any intention for beginning descent. (3.5.1 (3))

(4) It is probable that the First Officer did not notice that the Captain operated VS knob located in the right side of the FCU panel because he did not call it out. It is probable that the First Officer in this period had to cope with a higher workload. It is probable that the First Officer's situation of higher workload was a contributing factor that the First Officer did not notice the Captain's VS knob operation without any callouts. (3.5.2)

(5) It is probable that the Captain and the First Officer never assumed the Aircraft to begin descent, being convinced that AP was maintaining an altitude of 1,000 ft. Therefore, it is probable that they did not monitor the FMA status, the pitch angle going down and did not notice the sounds of the engines was getting smaller. Moreover, it is highly probable that "ALT ALERT" was not issued and did not sound when the serious incident occurred. Furthermore, the Captain stated that he believed that the altitude of aircraft was monitored by the Controller, while a pilot assumed responsibility for maintaining the altitude. It is somewhat likely that the Captain thought that the Controller would instruct aircraft to verify its altitude if it deviates from an instructed altitude during PAR approach.

From these contributing factors, it is probable that they did not recognize the Aircraft's descent. (3.6.1)

- (6) The second item in the GOLDEN RULES FOR PILOTS is "Use the appropriate level of automation at all times." It is probable that the Captain and the First Officer relied too much on AP, being less cautious in flying at as low as 1,000 ft, did not assume an unintentional descent at all. Accordingly, it is probable that they did not pay attention to any FMA modes and the basic instruments such as an altimeter and a vertical indicator. (3.6.2)
- (7) It is probable that the Captain had a conscious desire to perform PAR approach accurately and after transferred to the Final Controller he had been concentrated on the radar-guidance. On the other hand, it is probable that the First Officer was unable to read out the Checklist timely due to continuous ATC instructions and that it took a long time to complete its overall procedures of the Checklist. It is probable that eventually the First Officer paid lots of attention to monitoring the Captain's operations and completing the Checklist in her mind. (3.6.3 (1))
- (8) The first item of the GOLDEN RULES FOR PILOTS requires for the crewmembers to concentrate on "Fly. Navigate. Communicate." as the highest priority and use appropriate task sharing. "The WG Report in 2013" also emphasizes the importance of task management. It is probable that the Captain and the First Officer prioritized the radar-guidance by the Final Controller and completion of the Checklist, however, that they should have prioritized the monitoring task for the altitude to fly safely, and that they should have followed the radar-guidance by the Final Controller or attempted to complete the Checklist after remaining vigilant in maintaining the altitude in the same manner as they do when they fly by manual maneuvering. The Company should improve its educational and training programs in order to provide the crewmembers with opportunities, such as at CRM training, to acquire the practice of prioritizing a task in an appropriate way. (3.6.3 (2))
- (9) The third item of the GOLDEN RULES FOR PILOTS is "Understand the FMA at all times." The Company also emphasizes the importance of monitoring FMA. The Company should enhance its educational and training programs to ensure that its crewmembers devote more attention to monitoring the FMA under any circumstances after prioritizing a task. (3.6.3 (3))
- (10) "The Audit Report in 2016" emphasizes the importance of proper pilot monitoring, including actively cross-checking the actions of other crewmembers, when automated systems are engaged, and it requires that each pilot should improve his or her monitoring ability. It is desirable that each airline company should continuously carry out the review, regarding the ways of pilot monitoring, which contributes to further safety improvement while referring to some efforts developed in other countries. (3.6.3 (4))

#### **4.1.4 Other Items Disclosed**

- (1) The Captain stated that he did not hear the PULL-UP warnings when the serious incident occurred; however, it is probable that the warnings were issued. It is probable that the Captain at that time was getting highly tensed up because he was surprised at TOO LOW Warning from the First Officer, recognizing the Aircraft's descent, and the TERRAIN warnings sounded. It is somewhat likely that the Captain at that time did not recognize the PULL-UP warning because he was totally strained, concentrating on a go-around operation. (3.7.1 (1))
  
- (2) It is probable that the First Officer was surprised and got tensed up when she recognized the Aircraft's descent. It is probable that the First Officer thought that the Aircraft should recover altitude as soon as possible and she firmly realized that they should make a go-around. It is probable that the First Officer had been totally strained as was the case with the Captain until the Aircraft began to make a go-around and, beyond that, the PULL-UP warning might be overlapped by the Controller's instruction. Therefore, it is somewhat likely that the First Officer did not recognize the PULL-UP warning. (3.7.1 (2))
  
- (3) AP of the Aircraft was engaged throughout the serious incident, and the Aircraft was deviating and descending from an altitude of 1,000 ft with a vertical speed of - 900 fpm in average, moved into a go-around at the stage of its vertical speeds was declining, which was produced by the Captain's operation of pushing VS knob. It is probable that the Captain decided to make a go-around with AP engaged as the emergency operation in order to avoid crash into sea surface at the serious incident. (3.7.2)
  
- (4) It is probable that after parking the Aircraft, the Captain and the First Officer discussed and reported to the Manager of the Company in accordance with the OM description and that the Manager examined the Captain's report in accordance with the Company regulations. It is probable that both the Captain and the Manager followed the procedures stipulated, but it is probable that they examined neither the approach path nor the items regarding issuance of any warnings. As a result, it is probable that since the Company could recognize neither an altitude deviation nor an issuance of the EGPWS warning, it did not take any necessary actions such as QAR analysis; accordingly, the Aircraft continued the operation. The Company should establish a system to accurately assess events reported by captains. (3.8)

#### **4.1.5 Items Relevant to the Control Facility**

- (1) It is probable that the Final Trainee began to communicate with the Aircraft at 11:46:20 and it

began descent at 11:46:33. However, the Final Trainee did not give any instructions regarding its altitude after the Aircraft's descent. It is probable that the Aircraft deviated from the Radar Safety Zone at 11:46:55 and continued descending. It is probable, however, that the Final Supervisor and the Final Trainee did not notice that the Aircraft was descending. (3.9.1)

(2) It is probable that at 11:47:09 when the Final Trainee reported a landing clearance to the Aircraft at 11:47:09, an LA was issued at the Pattern Controller's position and the aural warning also sounded and that the Pattern Controller advised the Final Trainee that the Aircraft was descending. It is probable that the Final Trainee, who was advised by the Pattern Controller that the Aircraft was descending, confirmed that its altitude was shown lower than usual in the elevation indication and instructed "the Maintain 1,000 ft Call" at 11:47:25. After that, it is probable that the Final Supervisor and the Final Trainee received a go-around call from the Aircraft at 11:47:41, and then confirmed that it had recovered the altitude on the PAR Screen. (3.9.2)

(3) It is probable that it was not easy to notice the Aircraft descending below the Radar Safety Zone in a moment. It is probable that this is because aircraft's altitude is not displayed in a digital format; it is displayed not by the point but by the rod-like target; and the Constant Elevation Line is not displayed in the elevation indication, In addition, since the line, indicating the lower limit of the Radar Safety Zone in front side of glide-path-capture point, is not displayed in the PAR Screen, It is probable that advanced skills were required for the Final Controller to identify the aircraft target depending on some meteorological conditions. (3.10.1)

(4) The Standards for Air Traffic Control Procedure stipulates that in case that he or she notices an aircraft of deviating from the Radar Safety Zone, the final controller should take necessary actions, such as instructing the aircraft to execute a missed approach. However, Naha Ground Controlled Approach Facility did not assume such a case of the serious incident, had not provided controllers with any education or training to pay sufficient attention to the elevation indication to monitor the aircraft's altitude. The Final Supervisor and the Final Trainee at the serious incident did not assume the aircraft flying before meeting a glide-path-capture point to begin descent without any instructions and concentrated on the azimuth indication, which made them less aware of monitoring altitudes in the elevation indication, and could not notice the Aircraft deviated from the Radar Safety Zone. (3.10.2)

(5) Standards for Air Traffic Control Procedure did not stipulate procedures to be taken by the final

controller when an LA is issued to an aircraft under his or her control. It is probable that the Controllers at the Naha Ground Controlled Approach Facility encountered this unexpected event for which no procedures had been stipulated and they dealt with the situation based on their own immediate judgment. It is probable that the instruction "MAINTAIN ONE THOUSAND" was not appropriate when the Controller tried to give an immediate warning about deviation of altitude to the pilot of aircraft descending. (3.10.3)

- (6) It is probable that the risk management related to monitoring of an aircraft's altitude at the Naha Ground Controlled Approach Facility was not sufficient, in which include the following aspects: they should identify it as a risk that an aircraft before meeting glide-path might descend and deviate below the Radar Safety Zone; they should examine and implement adequate measures against the risk; they should assess the effectiveness of these measures; and they should estimate the necessity of improvement plans, based on the examination results. It is probable that insufficient risk management consequently contributed to the continuous descent of the Aircraft. Because of this, the Naha Ground Controlled Approach Facility should assess the risk of a scenario that an aircraft before meeting glide-path might descend and deviate below the Radar Safety Zone and conduct risk management such as developing appropriate measures. (3.10.4)

## **4.2 Probable Causes**

It is highly probable that the serious incident occurred because the Captain executed an emergency operation in order to avoid crash into water as the aircraft, making an approach for RWY 18 by precision approach radar-guidance at Naha Airport, began descent and continued.

It is probable that the aircraft began descent due to the captain's unintentional operation. It is also probable that the aircraft continued descending because the Captain and the First Officer were less aware of monitoring the altitude as they relied on autopilot system over maintaining of altitude and did not properly prioritize their tasks.

In addition, it is probable that insufficient risk management at the Naha Ground Controlled Approach Facility, relating to identification of that aircraft before meeting glide-path might descend and deviate below the Radar Safety Zone, consequently contributed to its continued descent of the Aircraft.

## 5. SAFETY ACTIONS

### 5.1 Safety Actions Taken

#### 5.1.1 Safety Actions Taken by the Company

Peach Aviation Co., Ltd. took the following measures in order to prevent similar incidents from occurring after the serious incident occurred:

##### 1. Holding Safety Meeting

The Company held the Safety Meeting targeted for all the flight crewmembers to present the extensive factual information concerning the serious incident and strongly reminded them of the importance of pilot monitoring while flying by AP and indispensable assertion by PNF.

In addition, the Company disposed of the training materials described in 2.16.1 to clearly ensure them to confirm FMA mode as described in 2.10.2. Accordingly, the Company defined that flight crewmembers should follow the FCOM procedure and call out the new mode without exception at any time when FMA mode changed.

##### 2. Conducting Self Inspection Flight

The Company conducted “Self Inspection Flight” in which it encouraged flight crewmembers to fly proactively under the themes on their line flights and flight crewmembers mutually confirm the status. Themes in 2014 were “Monitoring of flight instruments during flying with AP,” “Callout of FMA modes,” “Making a practice of assertion” and “Countermeasures against incorrect operations” and those in 2015 were “Adhering of basic operations in daily flight” and “Improving Consciousness to prevent defects”.

##### 3. Classroom lectures and provision of practical experience of PAR approach

As described in 2.16.2, the Company did not have any provisions regarding mandatory experience of PAR approach at Naha Airport during line flight trainings. Therefore, the Company took measures that it provided flight crewmembers with classroom lectures to remind them of knowledge and operational procedures of PAR approach and let them experience PAR approach at Naha Airport.

##### 4. Revision from PNF to PM

The Company revised the term of “PNF” to “PM” in the FCOM P to be consistent with the designer and manufacturer's manual of the type of the aircraft in order to remind the importance of monitoring duty.



## 5. Creating of the Procedure Handbook for Irregular Flight Operation

Regarding the procedure for irregular flight operation, the Company settled to share the information among the departments related to the flight operation and reconfirm among involved parties at the training to carry out for every two days a year for Emergency Cases in order that they can perform practical operation.

## 6. Establishment of the WGL (Wireless Ground Data Link)

The WGL<sup>\*83</sup> not installed in the Aircraft when the serious incident occurred; however, currently installed in all the aircraft in the Company as of January 2016, accordingly, the Company became possible to rapidly read the QAR data after an aircraft parked, and established the system that it can manage event occurrence by the data and compare it with the captain's report in a short time.

## 7. Training of return-to-flight-duty conducted for the Captain and the First Officer

After the serious incident occurred, the Company provided the Captain and the First Officer, who were temporarily suspended from their flight duties, with trainings of return-to-flight-duty. In classroom lectures of these trainings, they were provided with the review of the Principles of Pilots described in 2.11 and CRM training and other matters including workload management, and LOFT simulator training, in which they should properly handle various situations occurred during simulated line flight operations to make a practical use of lessons and methods in CRM.

In their simulator sessions, the Captain and the First Officer learned so-called "Two-Step Action" the Company recommended, in which a pilot would see and confirm then operate, to prevent him/her from operating the switches by mistake. They could review that they should perform secure operation and, monitor interactively and confirm each operation, prioritize their tasks in the congested situation and give an exact direction.

8. The Company confirmed that it should place flight safety the first priority. It set the goal that flight crewmembers should prioritize their tasks in any situations, monitor FMA at all times, and consequently they could establish a safer environment in the cockpit.

In order to achieve its goal, the Company determined that it would expand opportunities of CRM training to all flight crewmembers, which it provided for the Captain and the First Officer in their trainings of return-to-flight-duty and realized its effectiveness, and carry out this measure as of 2016.

---

<sup>\*83</sup> "WGL" also called Wireless QAR/DAR. The system equipped with the equipment is the system automatically download the QAR/DAR data via telephone line to airline server at the point when the airframe arrives its destination inside Japan and opens either door.

9. The Company stipulated in the manual that flight crewmembers should call out every operation including preset operation when operating on FCU panel, since it believed that expressing PF's intention to PM in a proper manner was important, and not only useful for PM to comprehend the situation but also helpful to monitor, and accordingly would lead PM to reduce his or her workload.

### **5.1.2 Safety Actions Taken by the Civil Aviation Bureau**

After reviewing this serious incident, Naha Ground Controlled Approach Facility assumes that an aircraft before meeting glide-path might descend and deviate below the Radar Safety Zone again in the future. It took the following preventive measures.

- (1) At the regular safety development committee held in May, 2014 it discussed and shared information about the serious incident, afterward it provided the information with all the Controllers and raised their awareness.
- (2) It drew up MSAW training materials in August, 2015, and provided necessary instructions about MSAW for current certified Controllers, and transferred Controllers, and approach Controllers who are supposed to get a license of GCA.
- (3) It held workshops for PAR approach for the operators; personnel in flight operation department and pilots. It had already held them on July 31, 2014, May 29, 2015 and June 24, 2016.
- (4) It had a discussion about risk assessments about aircraft which does not observe instructions from the Controllers and countermeasures against it in the safety development committee.

As a consequence, it decided to take some practical measures; a Final Controller shall always instruct "Maintain 1,000 ft" at the Communication Check and properly instruct "Maintain 1,000 ft" before issuing an instruction of beginning descent, and a Pattern Controller gives an alert to a Final Controller when necessary. Afterward it fully provided them with all the Controllers as a notification and gave an education to transferred Controllers, and approach Controllers who are supposed to get a license of GCA

- (5) As a reaction against issuance of MSAW, it decided that it would take a procedure to amend the handling procedures, in which a Final Controller should, wherever possible, issue a warning and raise an awareness when he or she find aircraft before beginning final descent in its final approach flying, surely, lower altitude than that in a normal manner.
- (6) It decided to make a proposal for revision of Standards for Air Traffic Control Procedure.

Air traffic control division of traffic control department in CAB are taking following measures.

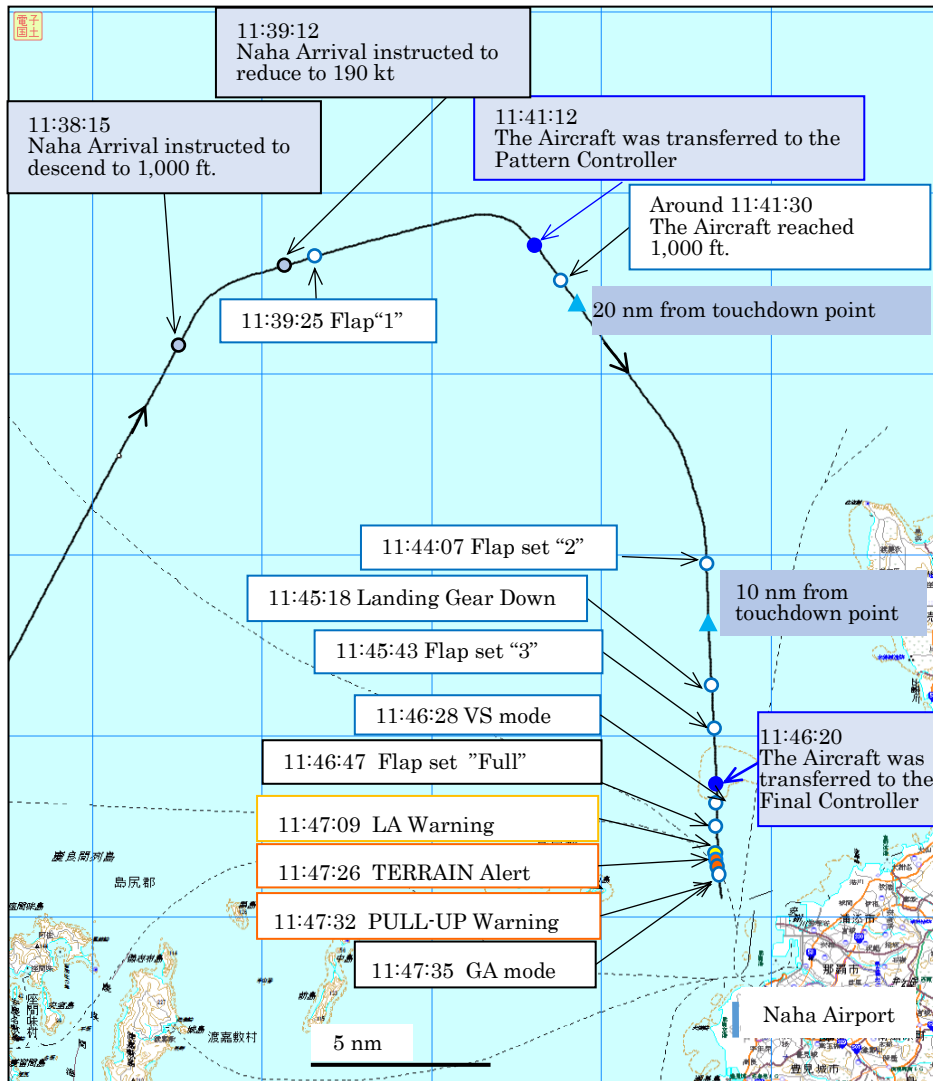
- (1) Making a study for revision of Standards for Air Traffic Control Procedure is laid out on the table about following matters, which would be applied from November, 2016;
  - Adding definition of terms related to PAR approach such as "the initiating point of the final

approach.”

- Adding items related to raising awareness of altitude during PAR approach

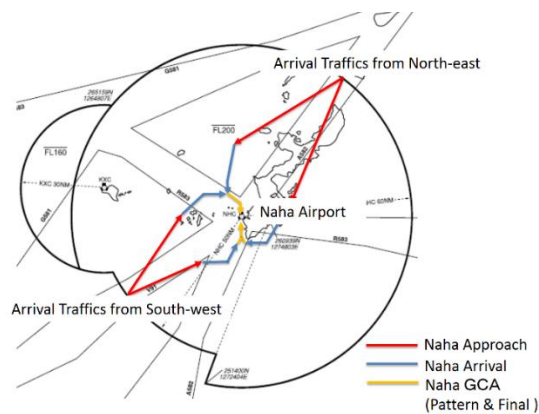
(2) Adding a line on the PAR screen in the newly developing system which shows the lower limit of Radar Safety Zone in the part before beginning final descent is in the process.

Appended Figure 1 Estimated Flight Route

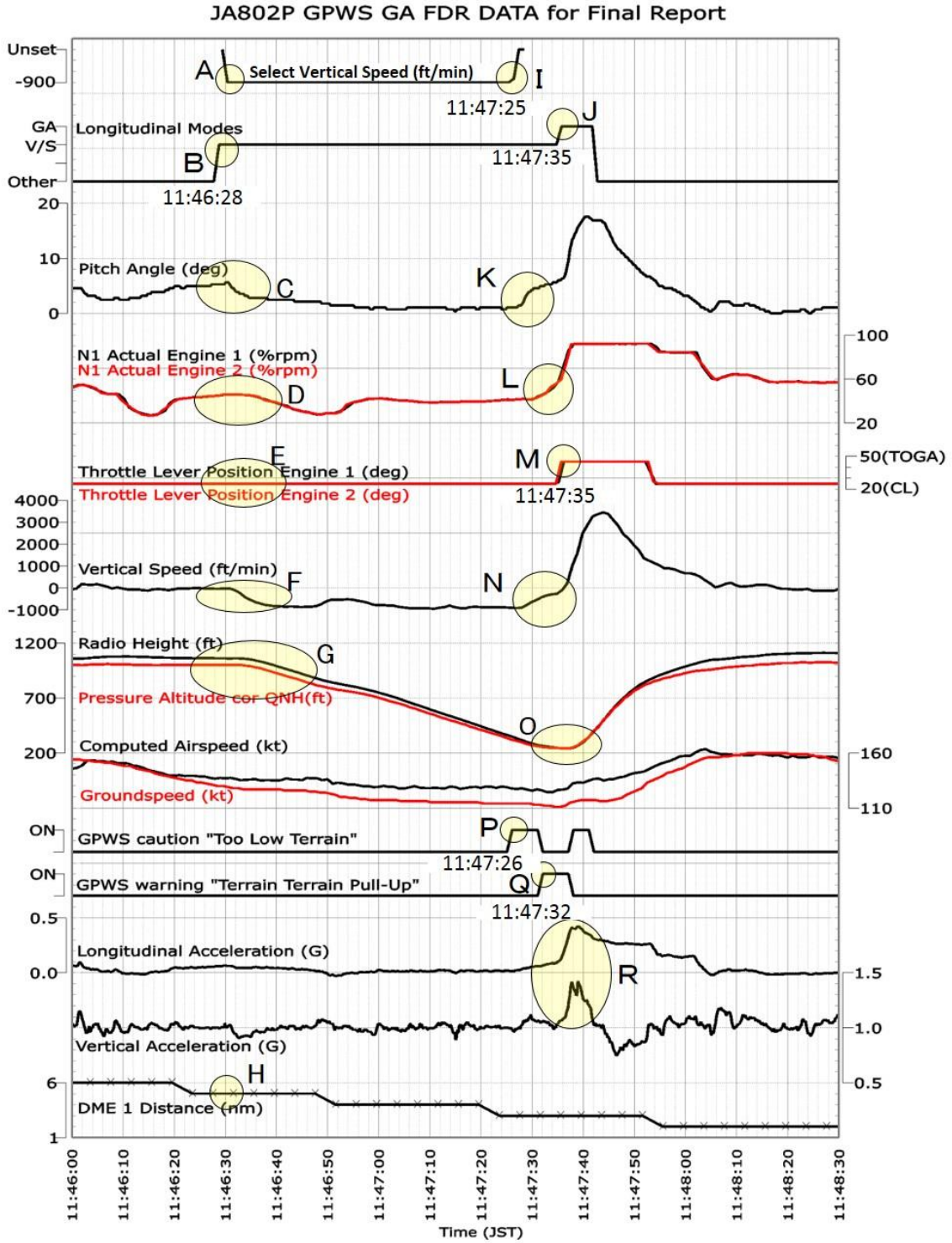


Appended Figure 2

Air Traffic Flow of Arrival Aircraft to Naha Airport (image)

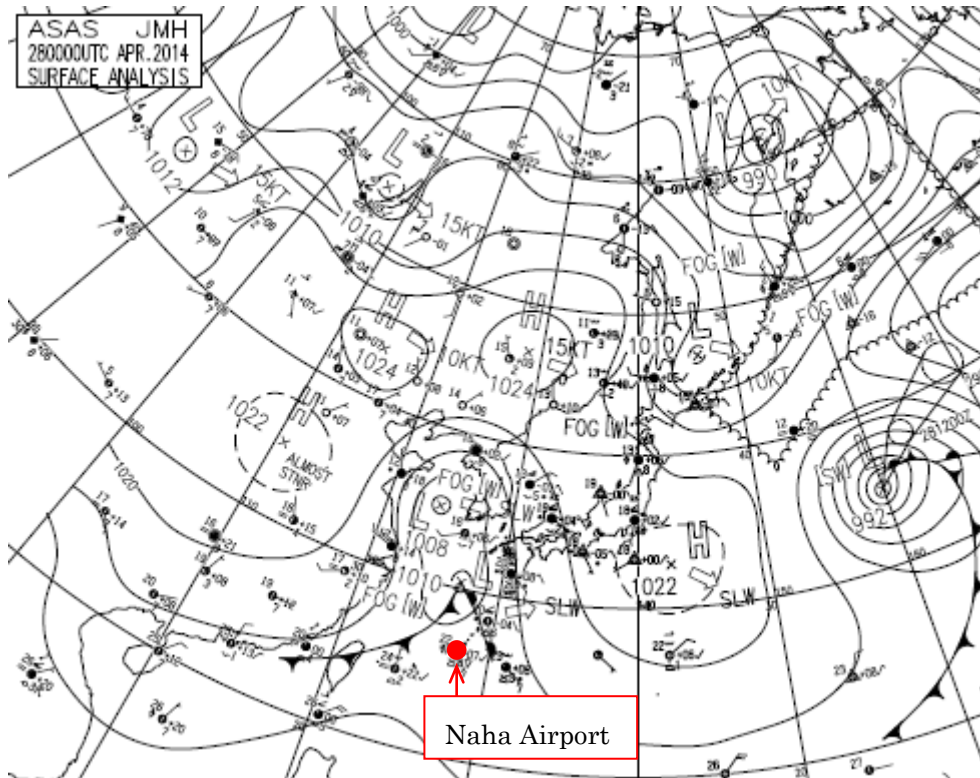


# Appended Figure 3 FDR Records

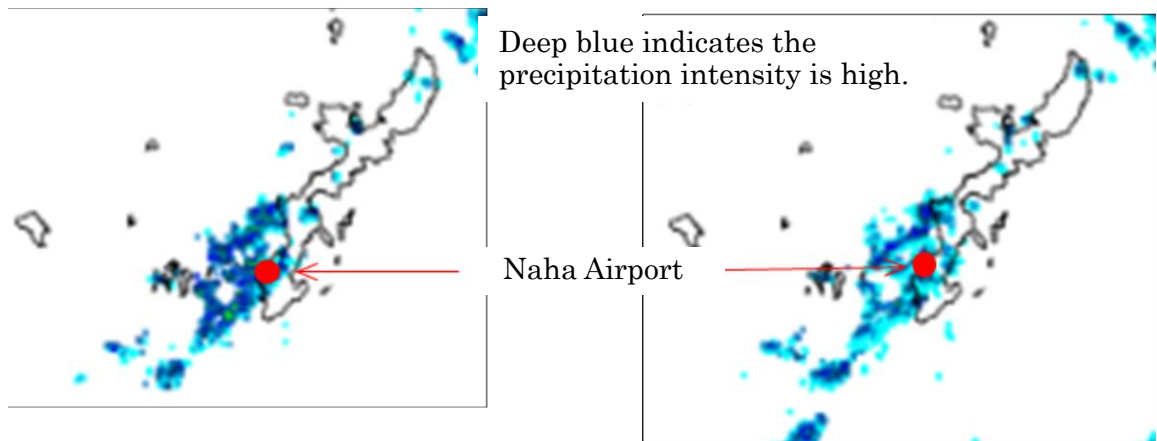


Legend: Form the Event A to R correspond with the descriptions in 2.14.

## Appended Figure 4 Meteorological Information



Asia Surface Weather Chart 09:00, April 28, 2014



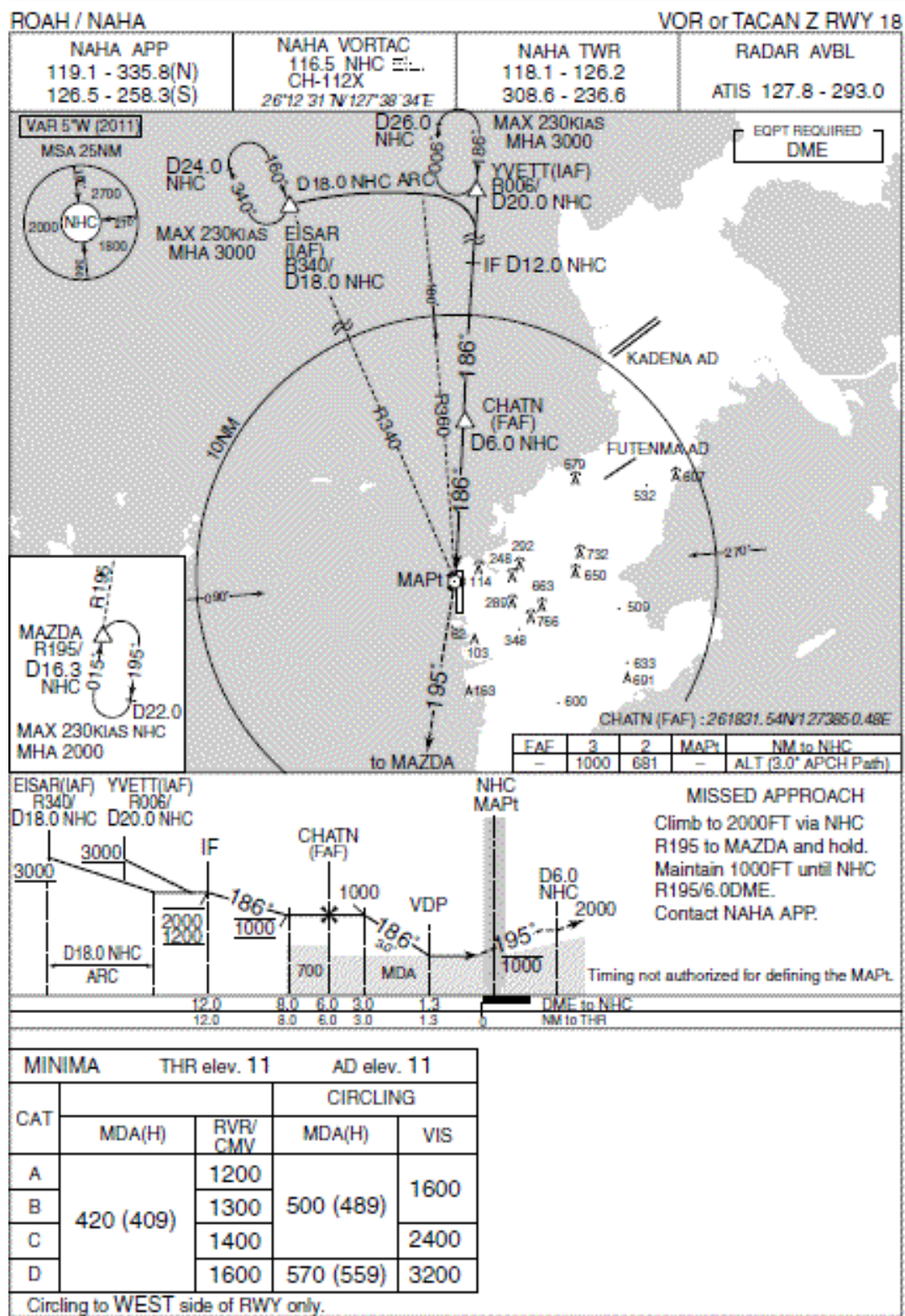
11:40, April 28, 2014

11:50, April 28, 2014

(Partially added to the source provided by the Japan Meteorological Agency.)

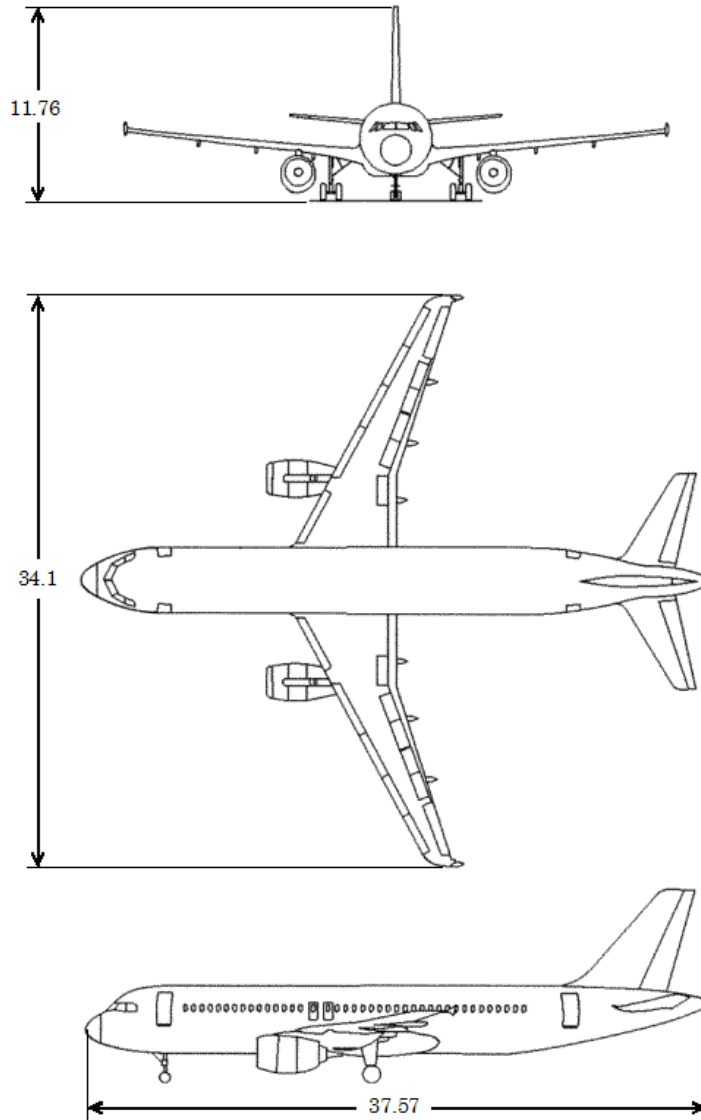
Radar Composite Chart (Radar Intensity)

Appended Figure 5 RWY 18, VOR Approach at Naha Airport



## Appended Figure 6 Three-View Drawing of Airbus 320-214

Unit: m



**Photograph 3 The Aircraft in the serious incident**





Appended Figure 7 List of ATC Communication Records and the Pressure Altitude of the Aircraft and Others.

Time	Final Controller	Selected Heading (deg)	Answers from the First Officer	Checklist and answers, and advices and warnings by the First Officer	Pressure altitude (ft)
			Operations by crewmembers		
11:46:19		185			1002
11:46:20	Air Peach Two Five Two, Naha final controller, radio check, how do you read?	185			1002
11:46:21		185			1002
11:46:22		185			1002
11:46:23		185			1002
11:46:24		185	Read you five,		1002
11:46:25		185	Air Peach Two		1002
11:46:26	Also reading you five. Do not acknowledge further transmission.	185	Five Two.		1002
11:46:27		185			1002
11:46:28		185	VS Knob PULL	LANDING CHECKLIST	
11:46:29		185			1002
11:46:30	Passed six miles from touchdown.	185			1002
11:46:31		185		CABIN CREW ADVISED	
11:46:32	Heading one eight five. Going right slowly. Turn ah, turn left, heading one eight two. Turn left heading one eight two. (HDG182)	185		A/THR SPEED	1002
11:46:33		185		A/BRK LOW	994
11:46:34		185			990
11:46:35		185		TOO LOW (advice)	978
11:46:36		183			970
11:46:37		181	HDG 181		954
11:46:38		181			942
11:46:39		181			926
11:46:40		181			914
11:46:41		181			898
11:46:42	Wind one seven zero at one two.	181			886
11:46:43		181			874
11:46:44		181			858
11:46:45	Slightly right of course.	181			842
11:46:46		181			830
11:46:47		181	FLAP FULL		814
11:46:48	Heading one eight two. (HDG182)	181			806
11:46:49		181			794
11:46:50	Slightly right, correcting course.	181			786
11:46:51		181			774
11:46:52		181			770
11:46:53	Five miles from touchdown.	181			762
11:46:54		181			754
11:46:55		181		ECAM MEMO	746
11:46:56		181			738
11:46:57	Turn left heading one eight zero. Slightly right and holding. (HDG180)	181			726
11:46:58		181			718
11:46:59		181		702	
11:47:00		181			690
11:47:01	Wind one eight zero at one two.	180	HDG 180		674
11:47:02		180			662
11:47:03	Slightly right.	180		LANDING NO BLUE	650
11:47:04		179	HDG 179		638

Time	Final Controller	Selected Heading (deg)	Answers from the First Officer	Checklist and answers	Pressure altitude (ft)	LA	Records of EGPWS warnings in EGPWS computer (sound triggered)
			Operations by crewmembers				
11:47:05		179		LANDING NO BLUE	618		
11:47:06	Runway One Eight, cleared to land. Wind one eight zero at one two.	180	HDG 180	LANDING CHECKLIST COMPLETE	606		
11:47:07		180			590		
11:47:08		180			574		
11:47:09		180			558	LA	
11:47:10		180			546		
11:47:11	Slightly right of course, correcting slowly.	180			526		
11:47:12		180			514	Pattern Controller	
11:47:13		180			498	advised the Final Controller that the Peach Aircraft was descending.	
11:47:14	Heading one eight zero.	180			486		
11:47:15	Slightly right, correcting. (HDG180)	180			470		
11:47:16		180		TOO LOW warning	458		
11:47:17		180			438		
11:47:18	Turn right heading one eight two. (HDG182)	180			426		
11:47:19		181	HDG 181		410		
11:47:20		181		TOO LOW warning	398		
11:47:21		181			382		
11:47:22	Four miles from touchdown.	181			370		
11:47:23		181			354		
11:47:24		181			338		
11:47:25		181			322		
11:47:26		181	VS Knob PUSH		310		TOO LOW TERRAIN
11:47:27	Ahh, maitain one thousand, maintain one thousand. You're too below for safety approach.	181			298		
11:47:28		181			282		
11:47:29		181			270		
11:47:30		181			262		
11:47:31		181			254		TOO LOW TERRAIN
11:47:32		181			250		TERRAIN TERRAIN PULL UP
11:47:33	Air Peach Two Five Two, acknowledge please.	181			246		
11:47:34		181			246		PULL UP
11:47:35		181	TOGA		242		
11:47:36		181			242		PULL UP
11:47:37	Air Peach Two Five Two, maintain one thousand. Too low for safety approach.	181			250		
11:47:38		181			270		
11:47:39		181			306		
11:47:40		181			338		TOO LOW TERRAIN
11:47:41		181	Air Peach Two		398		
11:47:42		Five Two,		434			
11:47:43		go-around.		502			

<Legend>

11:46:48 Black letters indicate instructions and notifications by the Final Trainee: Heading one eight two.

ECAM MEMO Blue broken lined frame indicates that the time unknown.

VS Knob PUSH Blue continuous lined frame indicates that the time determined by FDR

11:47:09 LA

11:47:26 EGPWS Alert

11:47:32 EGPWS Warning