AI2014-5

AIRCRAFT SERIOUS INCIDENT INVESTIGATION REPORT

HOKKAIDO AIR SYSTEM CO., LTD.
J A 0 3 H C

November 27, 2014

Japan Transport Safety Board

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.

Norihiro Goto
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

HOKKAIDO AIR SYSTEM CO., LTD.
SAAB 340B, JA03HC
EMERGENCY OPERATION TO AVOID COLLISION WITH THE TERRAIN ABOVE OKUSHIRI AIRPORT
AROUND 11:38 JST, JUNE 4, 2011

November 7, 2014

Adopted by the Japan Transport Safety Board

Chairman	Norihiro Goto
Member	Shinsuke Endoh
Member	Toshiyuki Ishikawa
Member	Sadao Tamura
Member	Yuki Shuto
Member	Keiji Tanaka

SYNOPSIS

< Summary of the Incident >

On June 4 (Saturday), 2011, a SAAB 340B, registered JA03HC, operated by Hokkaido Air System Co., Ltd., took off from Hakodate Airport as a scheduled Flight 2891. During the approach to Runway 31 of Okushiri Airport, the aircraft executed a go-around and once started climbing, but it soon reversed to descend. Consequently, at around 11:38 Japan Standard Time, its flight crew became aware of the situation and executed an emergency operation to avoid crash to the ground.

The aircraft flew back to Hakodate Airport, following some holdings over Okushiri Airport. There were a total of 13 persons on board: the Pilot-in-Command, the First Officer and a cabin attendant as well as 10 passengers, but no one was injured. In addition, there was no damage to the aircraft.

< Probable Causes >

In this serious incident, during the approach to Runway 31 of Okushiri Airport, the Aircraft executed a go-around and once started climbing but it soon reverted to descend and came close to the ground. Consequently, flight crewmembers came to realize the situation and executed an emergency operation to avoid crash to the ground.

It is highly probable that the Aircraft's descent and approach to the ground was caused by the following factors:

(1) The PIC followed the Flight Director command bar instructions, which indicated the descent because the altitude setting was not changed to the initial go around altitude, and subsequently the PIC made the Aircraft descend even lower than the FD command bar instructions.

(2) The PIC and the FO could not notice descending of the Aircraft and their recovery maneuvers got delayed.

It is highly probable that these findings resulted from the fact that the PIC could not perform a fundamental instrument flight, the PIC and the FO used the Autopilot/Flight Director System in an inappropriate manner without confirming the flight instruments and the flight modes, and the FO could not transiently carry out closer monitor of the flight instruments because of the other operations to be done.

Moreover, it is probable that the FO's operation of engaging an autopilot and changing the vertical mode to make the Aircraft climb by using the Autopilot/Flight Director System eventually became a factor to delay avoiding maneuvers against ground proximity.

It is probable that the Company didn't create a standard procedure, reflecting the contents of Aircraft Operating Manual, for its crewmembers to confirm and call out the changes mode, without noticing its importance and didn't carry out adequate training. Furthermore, it is probable that the PIC and the FO excessively relied on the autoflight system.

< Recommendations >

Based on the results of this serious incident investigation, the Japan Transport Safety Board recommends Hokkaido Air System Co., Ltd. to take necessary actions for the following matters, pursuant to Article 27-1 of the Act for Establishment of the Japan Transport Safety Board, in order to prevent a reoccurrence of similar serious incidents.

(1) Calling out and confirming the mode change for sure

Hokkaido Air System Co., Ltd. should make its flight crewmembers comply with the specifics of Airplane Operating Manual (confirmation and callouts of mode changes upon using the Autopilot/Flight Director system or on progress of automatic mode changes), as described in 2.13.4 without fail, and it should consider that Flight Training Guide shall be revised in some related matters.

(2) Appropriate use of autoflight system and management of pilots' skill

It is important for the Hokkaido Air System Co., Ltd. to increase the opportunities for training as well as utilizing simulator's session to improve raw data instrument skills. The Hokkaido Air System Co., Ltd. also should clarify the problems caused by excessive reliance on the autoflight system and consider to fully inform its flight crewmembers of specific countermeasures against them.

Abbreviations used in this report are as follows:

AFCS	: Automatic Flight Control System
AGL	: Above Ground Level
ALT	: Altitude
AOM	: Airplane Operating Manual
AP or A/P	: Autopilot
APA	: Altitude Preselect Alerter
APR	: Automatic Power Reserve
APP	: Autopilot Panel
APPR	: Approach
Arnd	: Around
A/S	: Airspeed
BP	: Both Pilots
CA	: Cabin Attendant
CAB	: Civil Aviation Bureau
Cap	: Capture
CHP	: Course Heading Panel
CLB or CLM	: Climb
CRM	: Crew Resource Management
CTOT	: Constant Torque on Takeoff
CVR	: Cockpit Voice Recorder
C'K	: Check
DFDR	: Digital Flight Data Recorder
DME	: Distance Measuring Equipment
EADI	: Electronic Attitude Director Indicator
EFIS	: Electronic Flight Instrument System
EGPWS	: Enhanced Ground Proximity Warning System
FAA	: Federal Aviation Administration
FAF	: Final Approach Fix
FCC	: Flight Control Computer
FD	: Flight Director
FMS	: Flight Management System
fpm or FPM	: feet per minute
FTG	: Flight Training Guide
GA	: Go Around
GPS	: Global Positioning System
GPWS	: Ground Proximity Warning System
G/S	: Glide Slope
HDG	: Heading
IAS	: Indicated Airspeed
ILS	: Instrument Landing System
LOC	: Localizer
LOFT	: Line Oriented Flight Training
MAC	: Mean Aerodynamic Chord

MAP	: Missed Approach Point
MAX	: Maximum
MDA	: Minimum Descent Altitude
MED	: Medium
MSP	: Mode Select Panel
M/A	: Missed Approach
NDB	: Non-directional Radio Beacon
OM	: Operations Manual
PF	: Pilot Flying
PIC	: Pilot-In-Command
PM	: Pilot Monitoring
Presel	: Preselect
Ptch	: Pitch
RAG	: Remote Air-Ground Communication
RQD	: Required
RWY	: Runway
SPD	: Speed
TAWS	: Terrain Awareness and Warning System
Trck	: Track
VDP	: Visual Descent Point
VHF	: Very High Frequency
VOR	: VHF Omni-directional Radio Range
V_{REF}	: Reference Landing Speed
VS	: Vertical Speed
V_{TG}	: Target Speed
YD	: Yaw Damper

Unit Conversion Table

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

1. PROCESS AND PROGRESS OF THE INVESTIGATION

1.1 Summary of the Serious Incident

On June 4 (Saturday), 2011, a SAAB 340B, registered JA03HC, operated by Hokkaido Air System Co., Ltd., took off from Hakodate Airport as a scheduled Flight 2891. During the approach to Runway 31 of Okushiri Airport, the aircraft executed a go-around and once started climbing, but it soon reversed to descend. Consequently, at around 11:38 Japan Standard Time (JST: UTC + 9 hr, unless otherwise stated, all times are indicated in JST on a 24-hour clock), its flight crew became aware of the situation and executed an emergency operation to avoid crash to the ground.

The aircraft flew back to Hakodate Airport, following some holdings over Okushiri Airport.

There were a total of 13 persons on board: the Pilot-in-Command, the First Officer and a cabin attendant as well as 10 passengers, but no one was injured. In addition, 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 Clause 5, Article 166-4 of the Ordinance for Enforcement of the Civil Aeronautics Act of Japan as a case equivalent to "A case where aircraft crew executed an emergency operation during navigation in order to avoid crash into water or contact on the ground" and is classified as an aircraft serious incident.

1.2.1 Investigation Organization

On June 10, 2011, the Japan Transport Safety Board designated an investigator-in-charge and two investigators to investigate this serious incident.

1.2.2 Representative of the Relevant State

An accredited representative of Sweden, 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

June 11 - 12, 2011	Interviews
June 20, 2011	Examination of the flight control computer
July 12, 2011	Reproductive investigation with simulator
July 20, 2011	Interviews
December 22, 2011	Reproductive investigation with simulator

1.2.4 Provision of Factual Information to the Civil Aviation Bureau

On September 22, 2011, the factual information about the movement of the autopilot/flight director system was provided to the Civil Aviation Bureau of the Ministry of Land, Infrastructure, Transport and Tourism (hereinafter referred to as "the CAB").

1.2.5 Comments from Parties Relevant to the Cause of the Serious Incident

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

1.2.6 Comments from the Related States

Comments were invited from the related State.

2. FACTUAL INFORMATION

2.1 History of the Flight

On June 4, 2011, a SAAB-SCANIA SAAB 340B, registered JA03HC (hereinafter referred to as "the Aircraft"), operated by Hokkaido Air System Co., Ltd. (hereinafter referred to as "the Company"), took off from Hakodate Airport as a scheduled Flight 2891. During the approach to Runway 31 of Okushiri Airport, the Aircraft executed a go-around and once started climbing, but it soon reversed to descend and at around 11:38, its flight crew became aware of the situation and executed an emergency operation to avoid crash to the ground.

The outline of the flight plan for the Aircraft was as follows:

Flight rules: Instrument flight rules (IFR)
Departure aerodrome: Hakodate Airport
Estimated off-block time: 11:10
Cruising speed: 265 kt
Cruising altitude: 10,000 ft
Route: ESASI (position reporting point) - V9 (airway) - ORE (Okushiri VOR/DME)
Destination aerodrome: Okushiri Airport
Total estimated elapsed time (EET): 0 hr. 24 min.
Fuel load expressed in endurance: 3 hrs. and 38 min.

In the cockpit of the Aircraft, the PIC took the left seat as PF (the pilot flying: pilot mainly in charge of flying), while the First Officer sat in the right seat as PM (the pilot monitoring: pilot mainly in charge of duties other than flying).

The history of the flight from the beginning of the approach to Runway 31 of Okushiri Airport, followed by the execution of the go-around, then finally returning to Hakodate Airport was summarized as below, based on the digital flight data recorder (hereinafter referred to as "DFDR") records, the terrain awareness and warning system (hereinafter referred to as "TAWS"; See 2.8) records and the air traffic control communication records as well as the statements of the PIC, the FO and a cabin attendant.

2.1.1 History of the Flight Based on DFDR, TAWS, and ATC Communication Records

Hereafter, the names of the DFDR record items are shown with quotation marks " ", while letters in boxes show the mode indications on the Electronic Attitude Director Indicator (EADI; See 2 (1) of Attachment "Functions and Indications of Autoflight") based on the Autopilot/Flight Director System (hereinafter referred to as "AP/FD system"; See Attachment "Functions and Indications of Autoflight").

11:27:14 The Aircraft contacted Okushiri Remote*[1] while cruising at an altitude of 10,000 ft (in terms of pressure altitude, same applies hereinafter) using the AP/FD System, reporting that it will carry out VOR/DME RWY31 approach.

11:34:10 When the Aircraft was passing an altitude of about 2,000 ft, the flaps were set from 0° to 15°.

Around 11:34.25 The landing gears was extended, and the flaps were set from 15° to 20°.

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*1 Remote is a call sign for Remote Air-Ground Communication (RAG) facilities. At airports where air traffic control or aerodrome air-ground support services are unavailable, RAG-based air traffic information and air traffic clearances are provided or relayed from different facilities. RAG services for Okushiri Airport are provided by Shin-Chitose Airport Office.

11:34:34 The AP/FD system captured final approach course of 322°.

11:34:39 Okushiri Remote gave the flight crew the advice of “Obstruction not reported on the runway” and they read back it.

11:35:39 When the Aircraft was passing an altitude of about 750 ft, the vertical mode of the AP/FD system captured a minimum descent altitude (hereinafter referred to as “MDA”) of 600 ft, and the mode changed from $\boxed{\text{VS}}$ for flying with the descent rate maintained to $\boxed{\text{ALTS}}$ for flying at the selected altitude.

Figure A MDA captured

11:35:55 The Aircraft leveled off at 600 ft.

11:36:06 Okushiri Remote notified a wind direction of 150° and a wind speed of 11 kt (a maximum 16 kt and a minimum 8 kt) to the Aircraft.

11:37:28 The autopilot was disengaged. At this time, the lateral mode of the AP/FD system was recorded as “Go Arnd Roll” and changed to $\boxed{\text{GA}}$. Meanwhile, the vertical mode did not change to $\boxed{\text{GA}}$ nor was “Go Arnd Ptch” indicated. The system remained $\boxed{\text{ALTS}}$ with “ALT Presel Cap/Trck” of maintaining the selected altitude left unchanged. Then, the Aircraft began climbing.

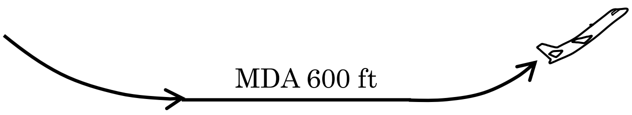


Figure B Go-around

11:37:33 to 37:35 The engine torque values increased and reached about 100 %.

11:37:40 The landing gears were retracted.

11:37:41 The lateral mode changed from $\boxed{\text{GA}}$ to $\boxed{\text{HDG}}$, flying along the selected heading. The vertical mode continued $\boxed{\text{ALTS}}$.

11:37:43 The flaps were set to 7° and the altitude reached about 750 ft.

11:37:45 The Aircraft started left turn.

11:37:47 The Aircraft began descending from an altitude of about 750 ft.

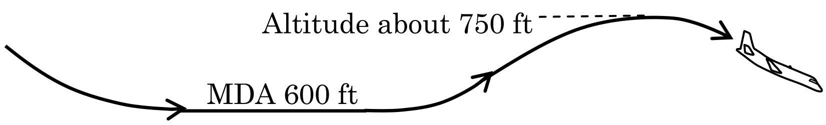


Figure C Descent after go-around

11:37:48 The flaps were set to 0°.

11:37:50 The Aircraft attitude came to a minimum pitch angle (a maximum nose down angle) of -6.3° in this approach and the altitude reached about 700 ft.

11:37:52 The Aircraft continued to descend. The autopilot ON was recorded at about 650 ft. At this time, the lateral mode remained HDG and the vertical mode was ALTS for maintaining the MDA of 600 ft.

11:37:54 The vertical mode of ALTS was disappeared. The Aircraft further continued to descend. The altitude was about 560 ft and the radio altitude was about 330 ft.

Around 11:37:55 At about an airspeed 190 kt, the vertical mode turned to H CLM (CLM SPD HIGH) for climbing at a high speed, but shortly after that, the vertical mode changed to VS for flying with the descent rate maintained. The radio altitude was about 320 ft.

11:37:57 At an airspeed of about 200 kt, the power lever was retarded. TAWS called out “SINK RATE” as a caution against an excessive descent rate, and the engine torque momentarily decreased to about 50 %. The radio altitude was about 270 ft.

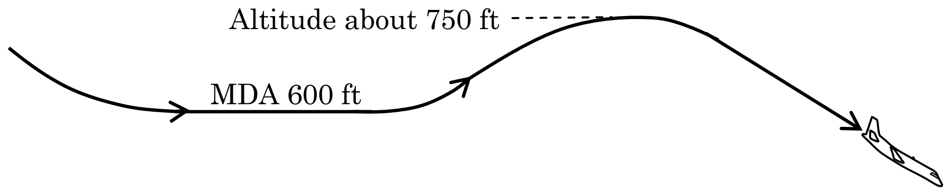


Figure D TAWS activated

11:37:59 The vertical mode turned to M CLM for climbing at a medium speed. The radio altitude was about 160 ft.

11:38:00 The power lever was advanced to the maximum power setting position.

11:38:01 TAWS called out “TOO LOW TERRAIN” as a caution against a proximity with the ground.

11:38:02 The DFDR recorded a radio altitude of 92 ft (87.8 ft in terms of the TAWS radio altitude), showing a minimum value in this approach, and at the same time, the engine torque turned to 118 % (the maximum value which can be recorded on the DFDR) for 4 seconds. At this time, the airspeed was recorded of the maximum value of 213 kt.

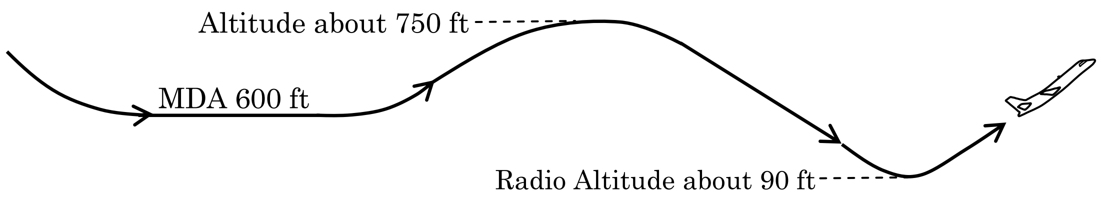


Figure E Recovery maneuver

11:38:03 The pitch angle increased to 9.5° in a second and the vertical acceleration increased to the maximum value of about 4.1 G. The bank angle recorded the maximum value of -28.5° (a negative figure shows left bank) and TAWS called out “BANK ANGLE” as a caution against an excessive bank angle.

11:38:06 The autopilot was disengaged.

11:39:05 The Aircraft reported having executed a go-around to Okushiri Remote.

Later, the Aircraft returned to Hakodate Airport, after holding for a while above Okushiri Airport at about 4,000 ft.

2.1.2 History of the Flight Based on Statements of Flight Crewmembers

(1) PIC

On the day when the serious incident occurred, areas from Hakodate to Okushiri were in weather conditions in which fogs were likely to emerge. Therefore, the Aircraft took off from Hakodate Airport on the condition that it might have to return to the airport, depending on the situation. According to information obtained during the flight, even lower clouds were moving into an area over Okushiri Airport.

Weather observations at Okushiri Airport showed a wind direction of about 150° and a wind speed of 10 kt or more. The MDA for approaches to Runway 31 is 600 ft, while is lower than that of Runway 13. Therefore, the Aircraft can descend lower in Runway 31 than in Runway 13, making it easier to identify the runway. Further, because Runway 31 is upslope, the PIC understood that the landing distance was not much longer, even if tail winds were expected. As a result, the PIC decided to make VOR/DME approach to Runway31 and reported his intention to Okushiri Remote.

The PIC confirmed with the FO in the approach briefing that he would descend to the MDA earlier than usual to identify the runway.

The Aircraft began approaching Okushiri Airport, and then after capturing a final approach course of 322° and setting an altitude of 600 ft to APA (See 2 (4) of Attachment "Functions and Indications of Autoflight"), descended using the VS mode. When the Aircraft approached the MDA 600 ft, the altitude was captured, indicated by that the white (armed) $\boxed{\text{ALTS}}$ turned to steady green $\boxed{\text{ALTS}}$ following flashing green; accordingly, the Aircraft captured an altitude of 600 ft. The speed had come to the target speed of the standard speed plus 5 kt.

It was completely a flight in clouds. There was somewhat rough air including some gust wind. An instrument indication showed a tail wind of about 18 kt, and the PIC felt that the Aircraft was approaching to the runway earlier than usual. The PIC gave a simple briefing to the FO on an initial go-around procedure (Go-around, Power set, Flap 7, Positive, Gear up, Yaw damper on) at a place slightly short of the visual descent point (hereinafter referred to as "VDP"), just because PIC thought that he was far more likely to make a go-around.

The PIC did not remember whether he set initial missed approach altitude of 4,000 ft to APA in preparation for a go around. The PIC comments that those procedures of presetting the initial missed approach altitude to APA have not been strictly prescribed as a standard normal procedure.

The PIC initiated a go-around by pressing the go-around button on the power lever, as he was not able to establish visual contact with the runway. As a result, the autopilot was disengaged, resulting in manual flying of the Aircraft but with the FD command bar still displayed on the EADI. At this point, the lateral mode displayed in the upper left side of EADI changed to $\boxed{\text{GA}}$, but the PIC had no memories about the vertical mode displayed in the upper right side. The Airplane Operating Manual (hereinafter referred to as "AOM") specifies that pilots should call out and confirm the mode at every mode changing. however, in case of execute a go-around, pilots in the Company were not given any instructions and training of calling out and confirming the mode; they are instructed to confirm $\boxed{\text{GA}}$ indication on EADI when displayed on the screen.

The PIC ordered the FO to perform “Power set, Flap 7”. The FO called out “Positive” (climbing). Following this call, the PIC ordered the FO to perform “Gear up, Yaw damper on”.

After the landing gears were retracted, the FO changed the mode on the mode select panel (hereinafter referred to as “MSP”) and set a heading of 230° on the course heading panel (hereinafter referred to as “CHP”), saying “I’ll set HDG, IAS and 230°” before the PIC gave him orders. The PIC began making the Aircraft turn to left gradually following the left-turn direction of FD command bar which was changed by this mode changing.

The PIC was confounded by this FO’s operation, because the timing of mode change was different from the PIC’s planning that he had planed to order the PM to set “HDG” and “IAS” at the timing when the speed increased to some event with the landing gears retracted. Following this, the lateral mode changed from $\boxed{\text{GA}}$ to $\boxed{\text{HDG}}$, but the PIC, being preoccupied with following the FD command bar, did not call out nor confirm change of the vertical mode.

With regard to the allocation of tasks upon changing mode without using autopilot, PF orders PM to change modes and PF monitors PM’s operation. The PIC allowed the FO to take his action in advance, but it led the PIC to fail to confirm changing of mode.

The PIC followed the FD command bar directions, in order not to fall into a state of vertigo (spatial disorientation, to be described later in 2.13.11). The PIC had been instructed, “Fly following FD” for a long time. Regardless of whether the autopilot is engaged or not, the PIC basically flies following FD. The PIC told that he might have taken it for granted that the vertical mode had naturally changed to $\boxed{\text{IAS}}$ because the FO called out “HDG” and “IAS”.

During the left turn, the PIC had some doubt that the attitude of the Aircraft was slightly nose down, but he continued turning. The PIC was advised as “Flap-up speed” by the FO, and the PIC responded reflexively and ordered “Flap zero”. At this time, the PIC told that he felt a change in the wind noise, and the Aircraft might be getting faster due to its low pitch attitude.

The PIC uttered a word of surprise “Huh?” because he felt that the Aircraft was not in a desired state, and upon getting FO’s advice “The aircraft is not climbing”, he came to realize the Aircraft was descending. Shortly after he thought “I have to fly with Raw Data*2”, TAWS got triggered and he pulled the control column, feeling imminent danger. The PIC saw a sight of ground form momentarily. At that time, the FO was also pulling the control column together.

While climbing, the PIC was told by the FO, “I have control”, and he initially felt skeptical about FO’s proposal, but he had second thought that the FO was having probably gotten the picture of the flight and its situation imperturbably, and he gave the FO the control of the Aircraft.

The PIC did not remember his operation after the go-around such as power levers,

*2 Raw Data mean values shown by such instruments as the attitude indicator, the airspeed indicator, the altimeter, the vertical speed indicator, and they represent the most important pieces of information allowing the operator to confirm the aircraft condition.

AP/FD system on MSP and altitude setting on APA, and he did not also get realized that the autopilot was engaged when the Aircraft was coming close to the ground.

Later, the Aircraft flew holdings for a while above Okushiri Airport, but the PIC decided to return to Hakodate Airport because he didn't have any improving prospect of weather conditions.

Upon arriving at Hakodate Airport, the PIC reported to his supervisor (hereinafter referred to as "Manager A") by telephone that "SINK RATE" on TAWS was activated when the Aircraft executed a go-around at Okushiri Airport.

After that, the PIC completed his scheduled duty bound for Okadama Airport. The PIC could not find any supervisory personnel there because it was Saturday, when he returned to the company office. Then he made a call for Manger A and reported him the outline of that event at Okushiri Airport

The PIC usually flies around 50 to 55 hours a month, but those pilots including the PIC, who were living near the Okadama Airport where the company head office was relocated to on June first, were encouraged to fly more often than before. That was why the PIC did not entirely get no feeling of chronic fatigue.

(2) FO

During the approach to Okushiri Airport, the PIC executed a missed approach at the VDP due to no visual contact with the ground. At that time, the FO performed his work along with the PIC's order "Go-around, Power set, Flap 7, Gear up". The FO does not remember what was indicated on EADI and how the FD command bar was directing, but he confirmed that the Aircraft had established the initial climb by monitoring the vertical speed indicator, the engine torque, the speed and other data.

Shortly after that, the FO thought that the Aircraft needed to turn to the left promptly because strong tail winds were blowing. Then, he pressed the HDG and IAS buttons on MSP after calling out "HDG, IAS" to the PIC, and set a heading of 230°. This is because the FO remembered that he once had been instructed to change to IAS mode prior to increasing speed, he felt the PIC was preoccupied with something and also he believed those actions of setting HDG and IAS mode without PIC's order were one of the prescribed procedures. However, the FO did not confirm the change of the mode indication on EADI when he set HDG and IAS mode.

After confirming the retraction of the landing gears, the FO checked the airspeed indicator and called out "Flap up speed," and then, as he received the "Flap zero" order from the PIC, he moved the flap handle to 0° from 7°. The speed at this time was slightly high at about 150 kt. The FO had been instructed to keep an eye on the flaps because the left and right flaps might become asymmetry. Therefore, he was watching the flap indicator for two to three seconds. He felt the Aircraft was accelerating and his body pressed back to the seat in the situation that outside was totally invisible due to clouds. Accordingly, he had no unusual sense such as those felt in a descent.

The autopilot is usually engaged upon completing flaps retractions. Therefore, the FO was waiting for the PIC's orders while keeping his left hand on the autopilot lever. At this time, the FO heard the PIC's voice "Huh?" and when he saw the vertical speed indicator, he found the Aircraft was descending at a high rate of about 1,500 fpm, rapidly increasing speed to more than 200kt. The altitude was about 500 ft. The FO told the PIC "Not climbing", but he thought that he could not wait any moment to avoid imminent crash, and he pulled his control column. Before he pulled the control column, TAWS issued the "SINK RATE" alarm. The FO pulled the control column with all his strength because the it was extremely heavy to pull. The FO could see the green ground surface all of a sudden through the left side window. The Aircraft was extremely fast.

The FO had no memories that he operated the autopilot, but he said that if relevant data are left on the records, he might have engaged the autopilot unintentionally, though it is unknown when he did so. The vertical mode on EADI was $\boxed{\text{M CLM}}$ while climbing, and an altitude of 4,000 ft had been set on the APA, but he does not remember who made the operation, the PIC or himself. The FO did not operate the power lever.

Around when the Aircraft turned to 230° and while he was continuing PM duties, the FO concluded it safer that he should control the Aircraft himself because he was in control of the situation. Then, he told the PIC "I have (control)" and took over the control of the Aircraft from him.

The Aircraft started holdings above Okushiri Airport and the FO handed over control back to the PIC and returned to his jobs as the PM.

The FO made it a point to set the initial go around altitude to the APA in advance. Though he was aware that the initial go around altitude of 4,000 ft had not been set to the APA while flying at the MDA of 600 ft in this case, the FO missed a chance to provide an advice to the PIC because a specific timing for setting the data had not been clearly shown. Eventually, he forgot to do so. He didn't know that executing a go-around with setting 600 ft on APA would invite such a hazardous situation as this event due to recaptured ALTS.

The FO had never experienced the maneuver training using simulator to go through the situation triggered by TAWS.

Because it could not anticipate a recovery of weather, they decided to return to Hakodate Airport, and the FO played a role as PF because the FO was asked by the PIC to take over control due to his fatigue, and they returned to Hakodate Airport.

After arriving at Hakodate Airport, the FO told the PIC that the occurrence may fall under a category of serious incidents, because they carried out an emergency operation to avoid crash to the ground even if no "PULL UP" warning was issued. The FO asked the PIC to go to the office to see and talk to a person in charge of the company and deliver his scared feeling when he had caught the sight of ground. The FO stayed in the Aircraft to prepare for the next flight. The PIC came back and told the FO that no specific instructions were given by the company (Manager A) about ensuing their flight duties, and therefore, the PIC and the FO performed their preassigned duties.

When the FO returned to Okadama Airport and finished his duty on that day, he decided that he should wait for the Manager A to show up at the office and talk directly with him, because the FO felt that the company (Manager A) was not aware of the seriousness of the occurrence at Okushiri Airport. After they met, the FO explained the situation of the flight involved to Manager A and stressed the necessity of analyzing the DFDR records. The FO was told by Manager A to take some notes of the history of the flight involved. He was informed that the DFDR records would be analyzed two days later, on Monday.

The FO felt no fatigue because it was a day- off on the previous day.

(3) Cabin Attendant

When the Aircraft was approaching Okushiri Airport, the Cabin Attendant (hereinafter referred to as "CA") was sitting backward in a crew seat located in the forward cabin and felt no strong shaking.

When the Aircraft began climbing, the CA felt as usual during a go-around. However, later, the Aircraft took a steep climb and the CA felt the body strongly pressed downward and could not raise her head. She saw something green in a moment through the window of the passengers' front row but it soon disappeared and the outlook scenery returned to white of cloud again. The whole condition in the cabin remained quiet and calm, and there was no disturbance among the passengers.

This serious incident occurred at around 11:38, on June 4, 2011, at an altitude of about 90 ft (about 27 m) over Okushiri Airport (Latitude 42° 04'18" N, Longitude 139° 25'58" E).

(See Figure 1 Estimated Flight Route, Figure 2 VOR/DME RWY 31 Approach Procedure, Figure 3-1 TAWS Records (1), Figure 3-2 TAWS Records (2), Figure 4-1 DFDR Records (1), and Figure 4-2 DFDR Records (2).)

2.2 Damage to the Aircraft

None

2.3 Personnel Information

(1) PIC Male, Age 41	
Airline transport pilot certificate (Airplane)	June 8, 2009
Type rating for SAAB 340B	May 14, 2004
Class 1 aviation medical certificate	
Validity	June 8, 2011
Total flight time	5,144 hrs. 35 min.
Flight time in the last 30 days	76 hrs. 20 min.
Total flight time on the type of aircraft	4,602 hrs. 46 min.
Flight time in the last 30 days	76 hrs. 20 min.
(2) FO Male, Age 30	
Commercial pilot certificate (Airplane)	May 12, 2006
Type rating for SAAB 340B	May 18, 2007
Instrument Flight Certificate	October 30, 2006
Class 1 aviation medical certificate	
Validity	June 5, 2011
Total flight time	2,980 hrs. 45 min.
Flight time in the last 30 days	58 hrs. 12 min.
Total flight time on the type of aircraft	2,661 hrs. 55 min.
Flight time in the last 30 days	58 hrs. 12 min.

2.4 Aircraft Information

2.4.1 Aircraft

Type	SAAB 340B
Serial number	340B-458

Date of manufacture	April 27, 1999
Certificate of airworthiness	No. *DAI*-21-026
Validity	The period in which the maintenance manual (Japan Air Commuter Co., Ltd.) is applicable from April 10, 2009
Category of airworthiness	Airplane, Transport T
Total flight time	20,928 hrs. 43 min.
Flight time since last periodical inspection (E2 inspection on April 22, 2011)	185 hrs. 49 min.

(See Figure 5 Three angle view of SAAB 340B)

2.4.2 Engines

Type General Electric CT 7-9B

	No. 1 Engine	No. 2 Engine
Serial number	GE-E 785513	GE –E 785654
Date of manufacture	December 11, 1992	March 25, 1996
Total time in service	23,668 hrs. 55 min.	20,055 hrs. 40 min.
Total cycles	32,766 cycles	28, 929 cycles

2.4.3 Weight and Balance

When the serious incident occurred, the Aircraft weight is estimated to have been 24,000 lb and the position of the center of gravity (CG) is estimated to have been 24.7 % MAC (Mean Aerodynamic Chord), both of which were estimated to have been within the allowable ranges (the maximum landing weight of 28,500 lb, and the CG range of 15.7 % to 37.8 % MAC corresponding to the weight at the time of the serious incident).

2.4.4 Inspection and Maintenance after Occurrence of This Serious Incident

(1) Aircraft

The maximum vertical acceleration the Aircraft received at the time when this serious incident occurred was about 4.1 G, exceeding the limit value of 2.5 G. This was found three days later, on June 7; therefore, the Aircraft was removed from services. But before then, a total of 27 flights had been operated by the Aircraft and abnormal condition of the aircraft had not been reported.

No anomaly was found in inspections and maintenance related to the excess of the vertical acceleration. Operations of the Aircraft were resumed on June 8.

(2) Engines

The maximum engine torque at the time of this serious incident was 144% for the left engine and 150% for the right engine, both exceeding the limit value of 107%. Five days later, on June 9, it was found that teardown inspections were required for both engines, and the Aircraft was removed from services. Before then, a total of 34 flights had been operated by the Aircraft and abnormal condition of the engines had not been reported.

No anomalies were observed as a result of teardown inspection of the both engines.

(3) Flight Control Computer

The performance check of the flight control computer (hereinafter referred to as “FCC”) removed from the Aircraft was carried out, but anomalies were not found.

2.5 Meteorological Information

On the day when this serious incident occurred, a low pressure located west of Hokkaido was moving eastward, while the west coast of Hokkaido had been covered with low clouds. Rainfalls were observed sporadically and fogs were rising in places.

Aviation weather observations at Okushiri Airport around the time when this serious incident occurred were as follows:

11 : 30 Wind direction 150°, Wind velocity 12 kt, Visibility 2,000 m, Mist
Cloud: Amount 3/8, Cloud base 100 ft
Amount 6/8, Cloud base 200 ft
Temperature 13°C, Dew point 11° C
Altimeter setting (QNH) 29.68 inHg

11 : 54 Wind direction 140°, Wind velocity 12 kt, Visibility 4,000 m, Rain
Cloud: Amount 2/8, Cloud base 100 ft
Amount 6/8, Cloud base 200 ft
Temperature 13°C, Dew point 12° C
Altimeter setting (QNH) 29.67 inHg

2.6 Aerodrome Information

Okushiri Airport, at an elevation of 161 ft, has Runway 13/31 with a length of 1,500 m and a width of 45 m. Runway 31 has an upward slope of 0.7 % to 0.9 %. Because an instrument landing system (ILS) allowing precision approach is not installed at the airport, a non-precision approach procedure using Okushiri VOR/DME has been established. MDA of the approach is 760 ft for Runway 13 and 600 ft for Runway 31.

Any approach light systems are not installed in both sides of runway, while runway edge lights, runway threshold lights and such are put on the runway. In addition, three ALBs, approach light beacons, which highlight some remarkable spots in the approach area for arriving aircrafts, are installed at intervals of 270 m along the approach course of runway 31 which the Aircraft tried to make an approach for. All these aerodrome lighting systems were normally operated when this serious incident occurred.

The VOR/DME RWY31, the approach procedure conducted by the Aircraft, requires following a magnetic bearing of 162° from Okushiri VOR/DME and after making a left turn within 10 nm, to enter a final approach of a magnetic course of 322° toward Runway 31. After descending to the MDA of 600 ft, if the runway is in sight before the VDP located 1.4 nm short of Okushiri VOR/DME, aircraft may descend and land. If the runway can not be in sight before the VDP, aircraft shall turn left and climb at a missed approach point located 0.8 nm short of Okushiri VOR/DME, and climb to an altitude of 3,000 ft or above on a magnetic bearing of 230°, and then make a left turn within 10 nm to return to over Okushiri VOR/DME and hold at an altitude of 4,000 ft.

(See Figure 1 Estimated Flight Route, Figure 2 VOR/DME RWY 31 Approach Procedure, Figure 3-1 TAWS Records (1).)

2.7 Information on DFDR and Cockpit Voice Recorder (CVR)

The Aircraft was equipped with a DFDR (parts number: 980-4700-003) made by Honeywell of the United States of America and a cockpit voice recorder (hereinafter referred to as “CVR”), parts number: S200-0012-00) made by L-3 Communications of the United States of America.

Even after the occurrence of this serious incident, the Aircraft continued service for several flights, with the DFDR and the CVR kept on board. The records at the time of this serious incident had been retained on the DFDR, with a maximum recording time of 25 hours. As it was obvious that the data on the CVR, with a recording time of up to two hours, had been overwritten, the CVR was not removed from the Aircraft.

The time of the DFDR was corrected by correlating the VHF transmission keying signals on the DFDR with the time signals recorded on the ATC communication records.

2.8 Information on TAWS

The Aircraft was equipped with an Enhanced Ground Proximity Warning System made by Honeywell of the United States of America.

TAWS is a system designed to issue cautions or warnings with voice and image display when the aircraft gets a close proximity to the terrain, by comparing and examining its position based on GPS and an internal terrain database. The name “TAWS” is a generic term for ground proximity warning systems which satisfy performance stipulated by the Federal Aviation Administration (FAA) of the United States of America. They are generally called “GPWS” or “EGPWS”, an enhanced type.

The following TAWS modes were activated when this serious incident occurred:

(1) Mode 1

This mode is activated to indicate the excessive descent rate against the above ground level (AGL). The aural caution “SINK RATE” will sound and the TERRAIN/BELOW G/S light will blink.

If the descent rate reaches to a further boundary, the aural warning “PULL UP” will sound and the TERRAIN light will blink.

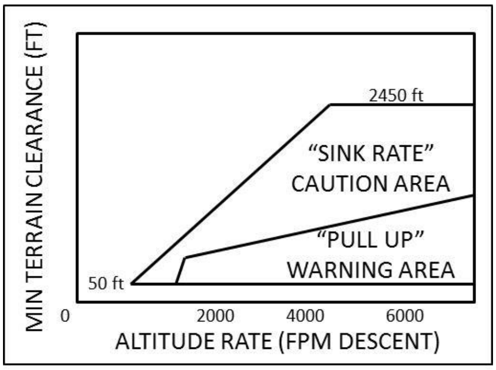


Figure F TAWS Mode 1

(2) Mode 4B

This mode is activated to indicate the proximity to the terrain, with the landing gears down and flaps not in landing configuration.

When the airspeed and the ground altitude reach to certain boundary, the aural cautions “TOO LOW TERRAIN” or “TOO LOW FLAPS” will sound. In both cases, the TERRAIN/BELOW G/S lights will blink.

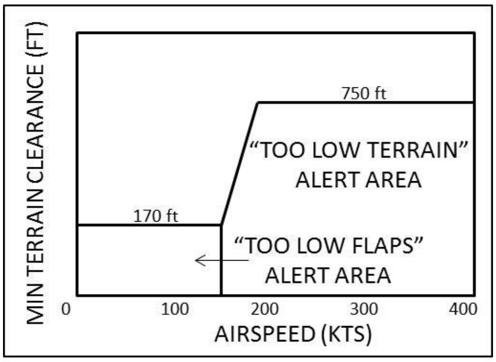
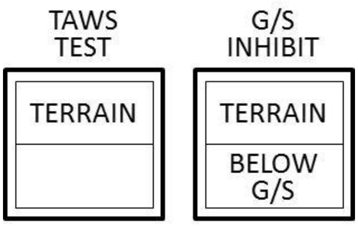


Figure G TAWS Mode 4B



(The drawing shows the lights layout for the left seat. The lights for the right seat are placed symmetrically.)

Figure H TERRAIN/BELOW G/S Lights

(3) Mode 6

This mode is activated to indicate the excessive bank angle against the AGL. The aural caution "BANK ANGLE" will sound.

When the autopilot is engaged, the bank angle boundary of caution will become shallower.

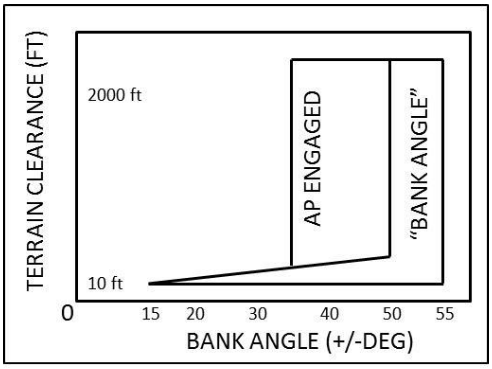


Figure I TAWS Mode 6

2.9 Simulating Investigation with Flight Simulator

An investigation was carried out with the situation at the time of this serious incident simulated with a full flight simulator for the same type of aircraft. The flight conditions for the simulation such as the aircraft weight, the center of gravity, temperature, air pressure and other factors were almost equivalent to the ones at the time of the incident, based on the DFDR records. The results of the simulation are as follows:

(1) While the aircraft was descending on the VS mode with autopilot engaged, the MDA of 600 ft was set to APA, and then it leveled off at and maintained the altitude of 600 ft. The vertical mode switched to the ALTS Track Mode (ALTS was indicated on the EADI).

Figure J EADI Display

(2) In the situation described above, the go-around button was pressed with the altitude of 600 ft kept on APA, the engine power was increased with the power levers and CTOT was activated. Then autopilot was disengaged, and the vertical mode on EADI changed to GA from ALTS at once, but it immediately returned to ALTS. The FD command bar also momentarily indicated +6.4° as the go-around pitch, but it soon returned to the previous position.

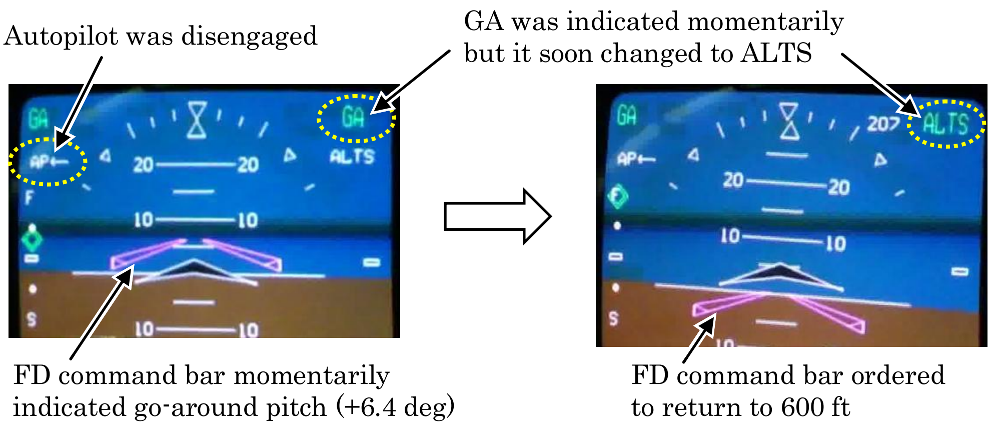


Figure K　EADI Display During Go-around Was Performed

(3) In the situation described above, when the aircraft was manually controlled to climb, the FD command bar indicated a pitch down to return to 600 ft. Upon operating the aircraft to follow the command, the aircraft began to descend.

(4) In the situation described above, when autopilot was engaged during a descent to 600 ft, after the vertical mode on EADI changed to ALT from ALTS, it immediately captured 600 ft. Following the mode change, ALTS was blinked.

(5) While ALTS was blinking, when an altitude higher than the current altitude (for example, 4,000 ft) was set to APA, the vertical mode on EADI changed to the VS mode. Autopilot continued descending, keeping the rate of descent at the time.

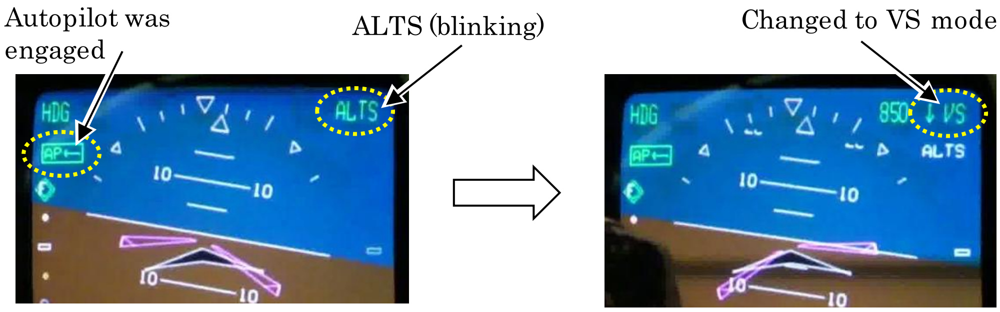


Figure L　Autopilot engaged and APA mode changed

(6) Later, the CLIMB, VS and CLIMB buttons on the MSP were pressed in that order, then, the vertical mode on EADI correspondingly changed to H CLM, VS and M CLM.

For pulling the control column to avoid a collision with the terrain, when autopilot was engaged, the control column was heavier than when autopilot was disengaged, and also it took longer for the avoidance maneuver.

(7) When a go-around from a level flight was made without supporting the control column on a manual control, the maximum pitch angle was about +17° and the climb rate was about 3,000 fpm as maximum. If the engine power was increased, the aircraft tended to pitch up. Therefore, it was needed to push the control column in order to adjust the pitch angle to +6.4° as appropriate for a go-around.

2.10 Skill Management for Flight Crewmembers

2.10.1 Outsourcing of Training

The Company had outsourced part of training for type rating changes to a different airline (Company A). This simulator-based training and competency assessment had been done by the instructors and the check pilots of the Company with a simulator owned by Company A.

2.10.2 Training and Reviews

(1) PIC

The PIC had taken periodic trainings and periodic assessment pursuant to the regulations of the Company.

Details of trainings and assessments for the PIC since a PIC upgrade assessment in May 2009 up to the occurrence of this serious incident were as follows:

May 14, 2009	PIC upgrade assessment check with simulator
June 8, 2009	PIC upgrade assessment check with actual aircraft
September 15, 2009	PIC upgrade route check
October 1, 2009	Upgraded to PIC
October 27, 2009	Non-periodical oral assessment for winter operations
December 21, 2009	Periodic training with simulator
December 22, 2009	Competence check with simulator
December 29, 2009	Periodic ground training
May 22, 2010	Competence check with simulator
October 15, 2010	Periodic route check
November, 2, 2010	Periodic ground training
November 9, 2010	Periodic training with simulator
November 10, 2010	Competence check with simulator
April 19, 2011	Periodic route check

General evaluations on these checks, which results were categolized into Good, Passing, Failures, were almost "Good", the highest mark on the scale of three, but the following remarks were attached:

- During ILS approach, control was depended only on the FD.
- Pitch control during go-around maneuver was slightly poor.

The PIC received "Passing" twice. Follow-up training was given to him on each occasion, but remarks on the trainings were severe in some cases.

(2) FO

The FO had received periodic trainings and periodic checks pursuant to the regulations of the Company.

Details of trainings and assessments for the FO since April 2010 up to the occurrence of this serious incident were as follows:

April 12, 2010	Periodic training with simulator
April 13, 2010	Competence check with simulator
May 2, 2010	Periodic ground training
August 25, 2010	Periodic route check
May 2, 2011	Periodic training with simulator
May 4, 2011	Competence check with simulator

The FO received "Good" for the general evaluations on all these checks.

2.11 Flight Schedule and Actual Records of Duty

(1) Scheduled flight hours, scheduled duty hours and scheduled landings

Flight hours, duty hours and the number of landings scheduled for the PIC and the FO on the day of the serious incident were as follows:

Table 1 Flight Schedule

	Scheduled flight hours for consecutive 24 hours	Scheduled duty hours for consecutive 24 hours	Scheduled landings on one calendar day
Limits (*)	8 hrs.	12 hrs.	10 times
PIC	5 hrs. 35 min.	9 hrs. 55 min.	6 times
FO	3 hrs. 40 min.	7 hrs. 00 min.	6 times

* : To be described in 3.13.8 (3)

In this table, the scheduled flight times denote those for the consecutive 24 hours traced back from 13:40 as the scheduled arrival time of the final flight for their duties on the day of the serious incident. The scheduled duty times denote those for the consecutive 24 hours traced back from 14:00 at the end of their work on the day.

(2) Flight shift

The PIC was off duty on May 31. His work shifts for four days from June 1 through the serious incident occurrence day were as follows:

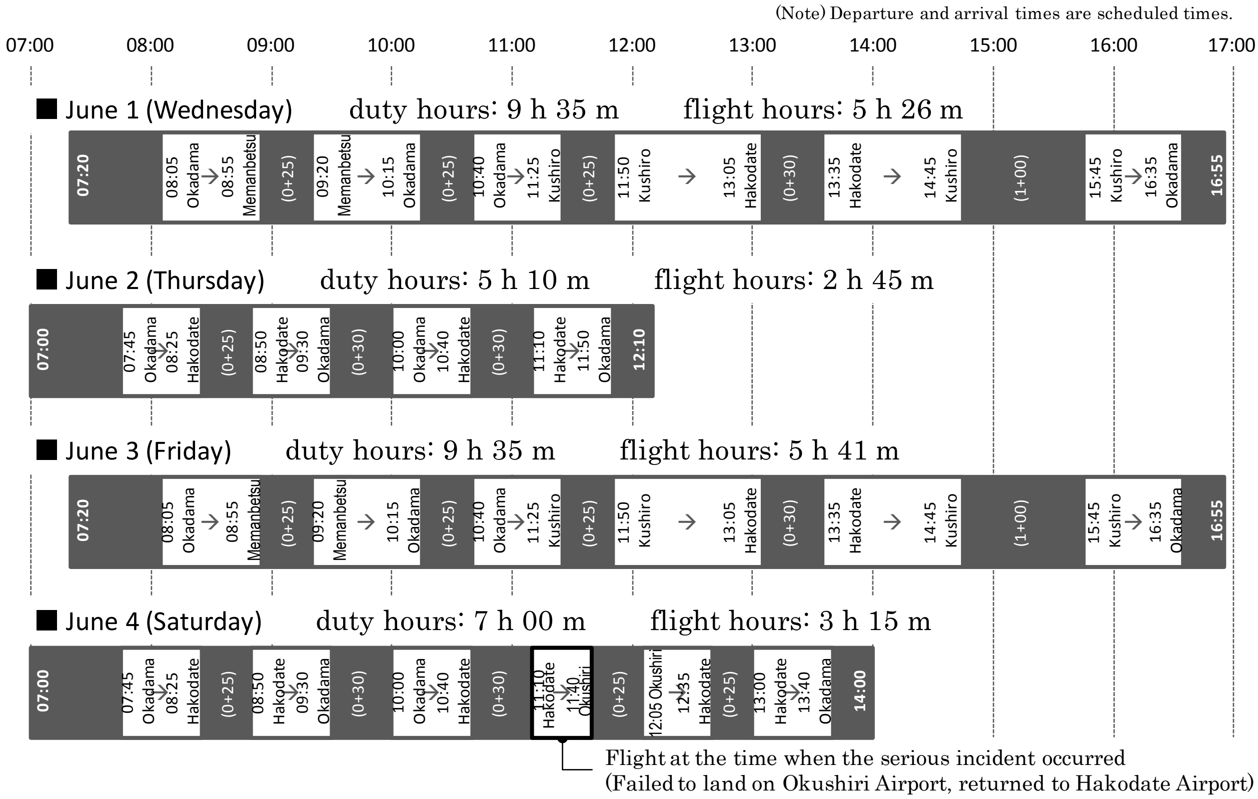


Figure M PIC's Flight Shift

The FO was off duty on June 3. His work shift for the day on the serious incident was same as the PIC's of June 4 shown above.

(3) Flight records

The flight records of the PIC and the FO before the serious incident were as follows:

Table 2 Flight Records

	1 calendar month (May)	3 calendar months (March through May)	1 calendar year (June 2010 through May 2011)
Limits (*)	100 hrs.	270 hrs.	1,000 hrs.
PIC	70 hrs. 53 min. 96 legs (the number of flights)	177 hrs. 39 min.	664 hrs. 11 min.
FO	57 hrs. 18 min. 73 legs	163 hrs. 53 min.	690 hrs. 23 min.

* : To be described in 2.13.8 (3)

The PIC's flight hours and the number of legs in May 2011 were both the second busiest among all of the 23 pilots of the Company.

2.12 Actions Taken by the Company after Occurrence of The Serious Incident

It had taken six days for the Civil Aviation Bureau (hereinafter referred to as "CAB") to identify the occurrence as a serious incident on June 10 since the flight 2891 of June 4 was operated. Actions taken by the Company during the period are outlined as below.

June 4 (Saturday) < the serious incident occurrence day >

Afternoon The flight 2891 returned to Hakodate Airport. The PIC called the Manager A at his home from Hakodate Airport and reported that TAWS issued "SINK RATE" when the Aircraft made a go-around at Okushiri Airport and the crewmembers maneuvered responding to the alert.

The Manager A did not take the occurrence as a serious situation because there was no such information indicating that there was an emergency maneuver or a warning of the "PULL UP"; therefore, he did not reach to the idea to stop the further flights of the Aircraft and provided relevant information to other divisions of the company. The manager only ordered the PIC to take notes of the situation about the flight involved.

Without reporting the occurrence to dispatcher or mechanics, nor asking them to inspect the aircraft, the PIC and the FO took duties aboard the Aircraft for the flight 2872 (bound from Hakodate Airport to Okadama Airport) as scheduled, and finished their flight duties planned for the day.

Evening As the FO felt that the Company was not aware of the seriousness of the occurrence, when the Manager A showed up at the office for his flight duty, the FO asked the Manager A to analyze the DFDR data of the Aircraft.

The Manager A decided to conduct the analysis of the DFDR data on Monday and told the FO to take notes of the history about the flight involved.

June 5 (Sunday) <The following day of the serious incident occurrence>

Evening When the Manager A showed up at the office and looked at the FO's note, he came to know that the FO pulled the control column as he felt a danger and he saw the terrain. The Manager A thought that the recognitions of the PIC and the FO differed on the occurrence, and he believed an analysis of the DFDR data would reveal what actually had happened.

June 6 (Monday) <Two days after the serious incident occurrence>

Morning The Manager A asked another managerial staff to request the Company A to analyze the DFDR data of the Aircraft.

The Company asked the Company A to analyze the DFDR data.

June 7 (Tuesday) <Three days after the serious incident occurrence>

Afternoon The Company was notified by Company A that the DFDR data had shown a maximum vertical acceleration of about 4.1 G (the limit value: 2.5 G) and a maximum torque value of 118 % for both engines (the limit value: 107 %). The Company was also advised to stopped operations of the Aircraft because an aircraft inspection was required. Accordingly, the Company stopped the operation of the Aircraft and conducted the aircraft inspection.

The Company reported to the CAB that the Aircraft had surpassed its operational limitation when maneuvered to pull up the aircraft in responding to the "SINK RATE" caution of TAWS while the Aircraft was executing a go-around.

June 8 (Wednesday) <Four days after the serious incident occurrence>

Morning The Company carried out the operation inspection on both engines of the Aircraft and found no anomalies. Accordingly, the Company returned the Aircraft to operation.

Afternoon The Company suspended the PIC and the FO from flight duties to confirm the situation of the flight involved in accordance with instructions by the CAB.

June 9 (Thursday) <Five days after the serious incident occurrence>

Morning The Company received the results of a detailed analysis of the DFDR data from the engine manufacturer via Company A, which showed a maximum left engine torque of 144 % and a maximum right engine torque of 150 %, far in the excess of the maximum torque value of 118 % revealed in the initial analysis. Accordingly, the Company stopped the Aircraft from further operations in order to conduct an inspection and reported this to the CAB. Consequently, the Aircraft had been used for 34 flights in total since the occurrence of this serious incident on June 4.

Night The Company reported to the CAB about the history of the flight involved.

June 10 (Friday) <Six days after the serious incident occurrence>

Early Morning The Company reported its actions taken after the serious incident occurrence to the CAB.

Morning The Company submitted the results of the analysis of the DFDR data to the CAB.

Afternoon The Company submitted the estimated flight track to the CAB.

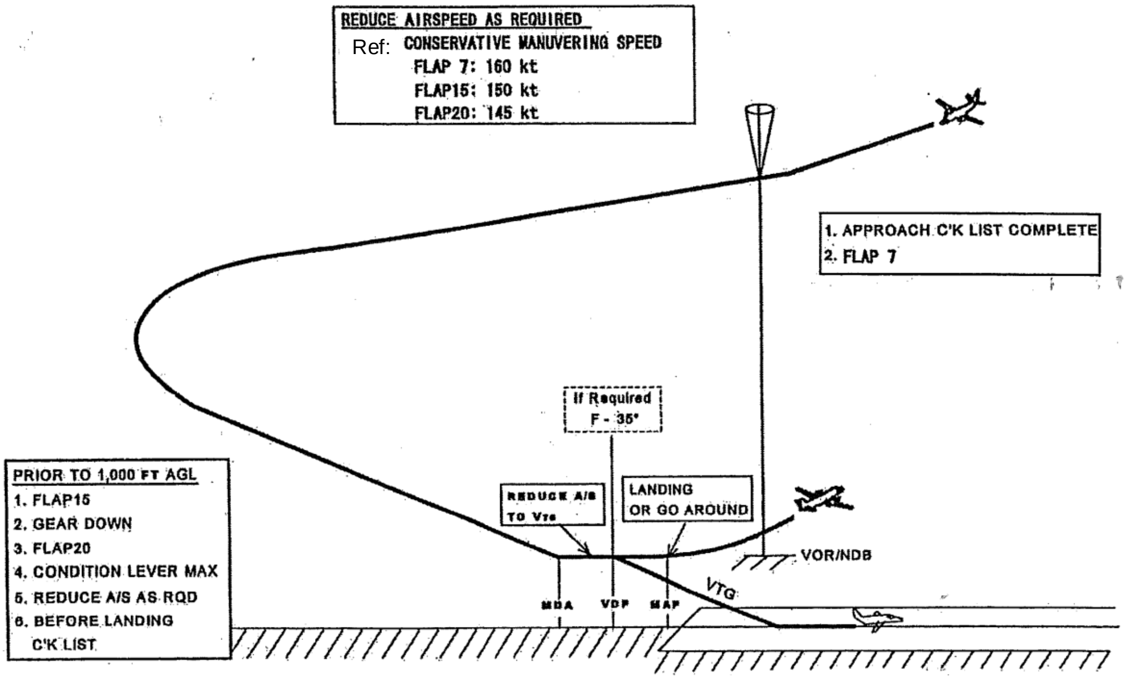
Evening The Company was informed by the CAB that the occurrence was designated as a serious incident.

2.13 Additional Information

2.13.1 Non-precision Approach Procedure

The AOM of the Company includes the following descriptions of the standard flight patterns for non-precision approach: (Excerpts)

Chapter S2 PROCEDURE AND TECHNIQUES



2.13.2 Go-around Procedures

(1) According to AOM, there is a following description relating to the setting of initial go around altitude on APA: (Excerpts)

Chapter S2 PROCEDURES AND TECHNIQUES

S2-5 SYSTEMS

S2-5-1 FD/AP

7. AUTOMATIC FLIGHT PROCEDURE

APS-85 Automatic Flight Procedure as a standard method for cases when Autopilot/Flight Guidance System will be used is shown below.

(Descriptions in the figure of "GO AROUND FROM APPROACH" among eight kinds of figures)

APPROACH

FD Switch .... ON BP

AP Lever .... ENGAGE PM

SPD Bug .... SET PF

- VREF +5

HDG Cursor .... SET PF

- Set to M/A Heading

APA .... SET PF

- Set to Initial Level Off Altitude after Go Around

In the Flight Training Guide (hereinafter referred to as "FTG") of the Company, there is also a following description relating to the setting of the initial go around altitude on APA: (Excerpts)

Chapter 3 NORMAL

3-6 LANDING

3-6-1 LANDING FOLLOWING ON NON-PRECISION APPROACH

Fig 3-6-1 1. After checking ALTS Capture (Flashing) at App. Min, set APA to M/A ALT.

Description concerning the setting of the initial go around altitude on APA described in AOM and FTG are summarized as follows:

- AOM

Chapter 2 Normal operating procedures ………………………………. Not described

Chapter 3 Operations procedure supplement

3-6 AUTOFLIGHT

3-6-1 AUTOFLIGHT NORMAL OPERATION

14. NAV-LOC MODE …….. (Not applicable to this case) ……….. Described

15. APPR MODE ………… (Not applicable to this case) ……….. Described

Chapter S2 PROCEDURE AND TECHNIQUES

S2-4 STANDARD FLIGHT PATTERN

S2-4-6 NON-PRECISION APPROACH (The approach procedure in this case) …………… Not described

S2-5 SYSTEMS

S2-5-1 FD/AP

7. AUTOMATIC FLIGHT PROCEDURE ………… Described only in figure

- FTG

Chapter 3 NORMAL

3-6 LANDING

3-6-1 LANDING FOLLOWING ON NON-PRECISION APPROACH (The approach procedure in this case) ……… No descriptions in text but described in figure

3-6-2 LANDING FOLLOWING ON ILS PRECISION APPROACH (Not applicable to this case)

1. ILS APPROACH (NORMAL) ………………………………. Not described

3. CIRCLING APPROACH FOLLOWING ON ILS APPROACH …. Described

3-6-4 CIRCLING APPROACH (Not applicable to this case)

5. Procedure to level off precisely by using AUTOPILOT ……….. Described

(2) The following descriptions of go-around are included in the AOM of the Company: (Excerpts)

Chapter 2 Normal Operating Procedures

2-8 LANDING

2-8-2 GO AROUND

PF	*PM*
- Call out "Go Around", Push GA Switch and advance POWER Levers to required position.	
- Call out "Power Set, Flap_".	*- Call out "Power Set" and set CTOT Switch to required position.*
- Establish Go Around Attitude	*- Call out "Flap_" and set FLAP Handle to required position.*
	- Check Positive Climb and call out "Positive".
- Check Positive Climb and call out "Gear Up"	
Landing Gear ………………………………………………………………………… *UP*	

MSP ……………………………………………………………………………. HDG IAS (1/2BANK)	
	*- When Flap Indication comes to required position, call out "Power Set, Gear Up (*1), Flap_". (*2).*
- After passing 400 ft AGL, set Flap at Zero and continue Takeoff Procedure.	
AFTER TAKE OFF Checklist ………………………………………… COMPLETE	

*(*1) As the purpose of this callout is confirming that the "Gear Up" has been completed on the indications and reporting the situation call out, "Up, Light Off" is acceptable.*

*(*2) As the purpose of this callout is confirming that the "Flap Setting" has been completed on the indications and reporting the situation call out, "_set" is acceptable.*

(3) The following descriptions relating to go-around are included in the FTG of the Company:
(Excerpts)

Chapter 3 NORMAL

3-6 Landing

3-6-7 GO AROUND

2. GO AROUND

(1) If PF decide to execute a go-around (Omitted)*, push GA Button on Power Lever (AP/YD will be disengaged) and set FD to GA Mode.*
At the same time, Pitch Attitude shall follow FD and be smoothly raised up.
(Omitted)

(3) When the speed exceeds Initial Go Around Speed while climbing at Go Around Pitch, set IAS Mode on FD to climb and maintain Go Around Speed. (Omitted) *The attitude can be easily stabilized when climbing on GA Mode. But Air Speed tends to increase excessively,* (Omitted)

GO AROUND

PF	*PM*
- Call out "Go Around" and Push GA Switch. *- Advance POWER Levers to required position.* *- Call out "Power Set, Flap_".* *- Establish Go Around Attitude.* *- Check Positive Climb and call out "Gear Up".* *- Call out "Heading (, Half Bank), IAS".*	 *- Call out "Power Set" and set CTOT Switch to required position.* *- Call out "Flap_" and set FLAP Handle to required position.* *- Check Positive Climb and call out "Positive".* *- Call out "Gear Up" and set LANDING GEAR Handle to UP position.* *- Call out "Heading(, Half Bank), IAS" and operate MSP.* (Omitted) *- Check Mode Annunciator on EADI and call out "Heading, IAS".*
Landing Gear ……………………………………………………… UP *MSP ……………………………………………………………… HDG IAS (1/2 BANK)*	
	- After decreasing workloads, at the timing when Landing Gear comes UP, Check

	FLAPS Indication is at required position, call out "Power Set, Gear Up, Flap_"
After passing 400 ft AGL, set Flap to ZERO and continue Takeoff Procedure.	
AFTER TAKEOFF Checklist .... COMPLETE	

2.13.3 Autoflight

(1) The following descriptions relating to Autoflight are included in the Operation Procedures Supplement of the AOM of the Company: (Excerpts)

Chapter 3 Operating Procedure Supplement

3-6 AUTOFLIGHT

3-6-1 AUTOFLIGHT NORMAL OPERATION

0. FD/AP MODE LOGIC

a. Vertical Modes:

GA: DISENGAGES YD AND AP. CANCELS ANY LAT OR VERT MODE (ALTS "CAP" AND ALTS "TRACK" MIGHT HOWEVER BE IMMEDIATELY RECAPTURED). CAUSES HDG HLD AND A FIXED 6.4° PITCH UP COMMAND. SELECTING HDG GIVES HDG/GA, ENGAGING AP RETURNS SYSTEM TO VS MODES. WHEN IN ALTS "CAP", LAT MODE WILL CHANGE TO GA AND VERT MODE WILL REMAIN ALTS UNTIL A NEW VERT MODE IS MANUALLY SELECTED.

11. ALTS MODE

Altitude Set Knob (APA) .... SET REQUIRED ALTITUDE

(Omitted) *Altitude Select and other Vertical Modes (VS, IAS, CLIMB) can be used simultaneously before Capture.* (Omitted)

NOTE: When APA Setting is changed during Capture Phase, FD/AP returns to Basic Mode VS.

16. GA MODE

GA Button on Power Lever .... PRESS

- *Check GA indicated on EADI*
- *AP-YD is disengaged*
- *FD commands Existing Heading and Fixed Pitch Attitude*
- *HDG Bug remains the Heading at the time.*

AP Re-engagement:

Re-engagement conditions : Minimum Engagement Height on AP is 200 ft AGL, and Speed is 1.3 Vs (slightly slower than V_2+10), but it is desirable to engage AP when a stable climb attitude is established after completing Gear Up and Flaps Up maneuver after Go Around.

AP/YD .... ENGAGE

- *Confirm EADI indications are as follows:*
  - *・Lateral Mode is GA*
  - *・Vertical Mode is VS*

HDG Button .... PRESS

- *Check HDG is indicated on EADI.*
- *FD/AP provides a command to acquire Preset HDG and hold it.*
  Monitor Systems while approaching Selected Go-Around Altitude.

(2) The following descriptions relating to Autoflight are included in the AOM of the Company:

(Excerpts)

Chapter S1 Systems

S1-3 AUTO FLIGHT

S1-3-1 GENERAL

4. MODE DESCRIPTION

(3) COMBINED MODE

(Omitted)

- GA, Go-Around Mode.

・FCC holds present Heading and commands Fixed Pitch Up Attitude (6.4°) on FD.

NOTE: When ALTS is set to "CAP" and "TRACK", these MODEs are immediately recaptured and FD dose not command Climb.

Chapter S2 PROCEDURES AND TECHNIQUES

S2-5 SYSTEMS

S2-5-1 FD/AP

3. APS-85 AUTOPILOT SYSTEM

<u>SPECIAL MODES</u>

GO AROUND:

(Omitted)

- When GA is selected, AP will be disengaged and the selected Lateral and Vertical Modes will be canceled, and Wings-Level and Fixed Pitch-Up Command will be provided.

2.13.4 Mode Confirmation and Callouts

The following descriptions about the mode confirmation and callouts are included in the Company's AOM: (Excerpts)

Chapter 2 Normal Operating Procedures

2-1 GENERAL

2-1-6 USE OF AP/FD AND EFIS、FMS MONITORING

(1) AUTO PILOT

Autopilot shall be used actively

(2) MSP and FMS MONITORING

When the mode is changed while Autopilot and Flight Director are in use, or when the mode automatically changed, the mode must be confirmed with the Mode Annunciator on EADI and called out in an appropriate manner.

The course, the vertical speed and the speed shall be monitored all the time.

Chapter S2 PROCEDURES AND TECHNIQUES

S2-2 FLIGHT PROCEDURES

S2-2-1 GENERAL

2. FLIGHT DIRECTOR/AUTOPILOT

(Omitted)

The FD/AP selection and the progress of the flight phase must be carefully monitored with EFIS for both PM and PF sides.

When FD/AP is in use, the PF shall perform all mode selections and BP shall *confirm and call them out by monitoring the EADI indications.*

In case when a manual flight is performed with only FD used, basically the PF shall order the PM to perform a mode selection and the PM shall select the mode, and BP shall call this out by monitoring the EADI indications.

S2-5 SYSTEMS

S2-5-1 FD/AP

7. AUTOMATIC FLIGHT PROCEDURE

(4) When only the FD will be used with AP disconnected, the PF shall order the PM to perform a mode selection.

(9) Once the mode was selected, this must be confirmed with the mode annunciator on EADI, not with the selector button.

The following descriptions relating to Callouts are included in the Company's FTG: (Excerpts)

2-3 CALLOUT

2-3-1 SRTO

Communications between the crewmembers with regard to Order shall be made in accordance with SRTO (Standard Response To Order).

(1) The PF shall order.

(2) The PM shall repeat (acknowledge) the PF's order.

(3) The PM shall perform a prescribed operation and confirm changes in the mode and the parameter and report this to the PF.

(4) The PF shall confirm the changes in the mode and the parameter.

2-3-2 Points of attention in Callouts

1. *What is important in Callouts is not to omit a confirmation. Make sure there will be no Callout unaccompanied with a confirmation.*
2. *Mode Description shall be called out by the crewmember who operated MSP, and the other crewmember shall basically be in charge of monitoring (No obligation for Callout). In SIM training, the trainee may call it out to be better accustomed with monitoring.*

2-3-3 MSP Operations and ROUTINE CALLOUT

Orders in MSP operations shall follow the Callouts as below.

Even when a crewmember operates MSP on his or her own, it must be called out as much as possible to obtain common understanding with the other crewmember.

1. When Autopilot is on

PF		*PM*
1) Operate MSP (Note 1) *2) Confirm Flight Mode / Parameter with EADI indications and call it out*	→	*3) Monitor Flight Mode / Parameter with EADI indications without fail. (Call this out if need be) (Note 2)*
4) Confirm the mode is an intended one by watching the aircraft response.		

Note 1: (Omitted)

Note 2: In such cases as when the flight mode did not change to one intended by the PF or when the flight mode changed and in these situations, it is believed to be necessary to maintain common understanding with the PF, or when an abnormal phenomenon is observed, the PM shall call this out.

2. When Autopilot is off

PF		*PM*
1) Order PM to operate MSP (Notes 3, 4)	→	*2) Operate MSP following PF's Order (Note 5)*
4) Confirm Flight Mode / Parameter on EADI indications and confirm the FD is indicating as per intended mode.	←	*3) Confirm Flight Mode and/or Parameter with EADI indications and call it out.*

Note 3 and Note 4: (Omitted)

Note 5: (Omitted) *Mode changes, such as a change from VOR Capture Mode to HDG Mode, must be performed by waiting for the PF's intention. Therefore, the PF basically shall order in these cases.*

According to the Company, the Aircraft was not equipped with automatic throttle and automatic go-around functions. When a go-around is performed, workloads for flight crewmembers increase and therefore, they were only required to call out the modes as much as possible. This point had been educated for crews in training, however relevant provisions in AOM were not revised and related information had not been fully conveyed in writing to personnel concerned, either.

2.13.5 TAWS

The following descriptions relating to operations when TAWS is activated are included in the Company's AOM: (Excerpts)

Chapter S2 PROCEDURES AND TECHNIQUES

S2-2 FLIGHT PROCEDURES

S2-2-1 GENERAL

12. TAWS WARNING IN FLIGHT

(1) When a TAWS caution is issued, PIC shall confirm the aircraft flight path, correct the path as necessary.

When it is doubtful, a climb shall be continued until the caution ceases.

(2) When a TAWS warning is issued, in order to quickly evaluate the warning, PIC must perform the following operations without hesitation.

- *Perform a Pull-up operation with power levers advanced to Full Power*
- *Quickly start a Maximum Performance Full Power Climb and continue the operation until the TAWS warning ceases and Pilot comes to understand in person Terrain Clearance has been secured.*

FTG has no descriptions relating to operations to be performed when TAWS is activated.

Regarding actions for cases when TAWS is activated, simulator-based flight training is not required as an obligation. The Company had not performed such training.

2.13.6 Training and Review

The following descriptions relating to the review result feedback system are included in the

Company's Flight Information: (Excerpts)

1. Objective

When the review result is "Pass", the specifics shall be fed back to the flight crew division to monitor the skills of the pilot involved so that necessary guidance as well as education and training can be made for the pilot to improve his or her skills.

5. Operating Procedure

(1) When the review result is "Pass", the inspection division shall send a copy of the review report to the flight crew division.

(2) The flight crew division shall work out and implement Follow-up education and training as necessary for the pilot based on the review result.

(3) The flight crew division director shall confirm the training result ("Follow-up" record sheet) and when the director judged the training has been finished as prescribed, shall finish the Follow-up program involved.

(4) After the Follow-up is finished, the director shall send a copy of the Follow-up record sheet to the inspection division.

6. Person conducting the training

Basically, training instructors (excluding ground instructors) shall conduct the training.

2.13.7 CRM

(1) Records of CRM Trainings

According to the rules of the Company, its flight crewmembers are required to receive CRM training (lectures) once in a fiscal year as part of recurrent training. In training for fiscal year 2010, the PIC received this training on January 31, 2011, and the FO on January 27, 2011. They had not received this training for fiscal year 2011 yet.

(2) LOFT

LOFT is training in a simulator using representative flight segments that may be expected in line operations. Scenarios including various kinds of probable trouble are used in this training, but the specifics will not be made known beforehand to the trainee involved. After the end of training, whether the trainee could handle the situation by demonstrating CRM skills as a team shall be examined.

Accordingly, LOFT is aimed at enabling trainees to demonstrating the CRM skills they obtained in lectures in actual flights. This is considered to be an effective means of training to have trainees fully obtain CRM related knowledge and methods.

LOFT is not a mandatory training for air carriers as required by Laws and Regurations. The Company had not introduced this training.

2.13.8 Operations Manual

(1) The Company's Operations Manual (OM) includes the following descriptions relating to PIC reports: (Excerpts)

3-8-1 PIC Report

PIC must submit a PIC report pursuant to the related laws and provisions and under this OM.

(Omitted)

When an accident or a serious incident occurred, or when an occurrence which is feared to be so designated is seen to have happened, PIC shall report the occurrence to the closest *flight operations person with a method which is available to him or her as quickly as possible, before submitting a PIC report mentioned above.*

(2) The Operations Information as a supplement to the OM includes the following descriptions relating to the handling of PIC reports: (Excerpts)

1. Submission of report

PIC shall report matters which fall under Chapter 3 "Reporting Matters" to the flight crew division director through a dispatcher quickly by using a prescribed form.

2. Actions for settlement

(2) Report to related authorities

CAPTAIN & EVENT REPORT is an in-house report. Matters which must be reported to related authorities in the name of PIC pursuant to laws, such as those regarding accidents, shall be notified in a separate report to the authorities as soon as possible after the occurrence, upon fully confirming the specifics which must be reported between related parties including PIC and the flight operations person who received his or her notification.

3. Reporting matters

(1) Matters which must be reported pursuant to the Civil Aeronautics Act of Japan and the Ordinance for Enforcement of the Civil Aeronautics Act of Japan

c. Occurrences (serious incidents) which fall under 76-2 of the Civil Aeronautics Act and 166-4 of the Ordinance for Enforcement of the Civil Aeronautics Act

(f) A case where aircraft crew executed an emergency operation during navigation in order to avoid crash into water or contact on the ground

(3) The Company's OM includes the following descriptions about flight crewmembers' duties and rest: (Excerpts)

3-9-2 Standards for Assignment

The company shall plan assignment for flight crewmembers under the following standards:

1. Flight time limit

(1) Not planning a flight duty exceeding 8 hours in the continued 24 hours

(2) Flight time shall not exceed 100 hours in one calendar month, 270 hours in three calendar months and 1,000 hours in one calendar year.

2. Duty time limit

(1) Not planning work exceeding 12 hours in the continued 24 hours

3. Landing frequency limit

Not planning landing with a frequency exceeding 10 times in one calendar day

4. Rest

(1) Providing a day off in the continued seven calendar days

(2) When flight time exceeds 8 hours, a period twice as long as the working hours involved shall be provided for rest.

2.13.9 Problems Related to Automation

The following descriptions are included in "The Interfaces Between Flightcrews and Modern Flight Deck Systems" issued in June 1996 by FAA following an aircraft accident which occurred at Nagoya Airport (currently Nagoya Airfield) in April 1994: (Excerpts)

(1) Automation surprise

Flightcrew Management and Direction of Automation

Pilot Understanding of the Automation

Automation surprises, where the automation behaves in ways the flightcrew does not expect or understand, are a too-frequent occurrence on highly automated airplanes. (Omitted) *We found that some of the automation surprise reflect an incomplete understanding of either the automation's capabilities and limitations, its display automations, or its intended use.* (Omitted)

If these concepts and their implementation are not well understood, flightcrews can easily become confused by autoflight system annunciations and behavior.

(2) Inappropriate Continued Use of Automated Systems

Flightcrew Management and Direction of Automation

Differing Pilot Decision about Automation Use

(Omitted) *Prior to the advent of reliable and highly capable automation, the typical pilot response to an abnormal situation (e.g., an equipment malfunction or an unexpected event) would have been to turn the automation off and fly the airplane manually. As the automation became more capable and reliable, it became easier and potentially safer to handle some of these situations with the assistance of the automation (e.g., one-engine-inoperative driftdown from cruise altitude, one-engine-inoperative approach or go-around). Other situations (e.g., an unexpected response from the autoflight system) were handled by either turning the automation off or reverting to a lower level of automation.*

More recently, there have been situations where flightcrews have either inappropriately continued to use the automation when they found themselves in an abnormal situation or, if the automation was initially off, turned the automation on to try to accomplish a recovery.

(3) Mode Awareness in Autoflight System

Flightcrew Situation Awareness

Autoflight System Mode Awareness

Actions and responses of any autoflight system vary depending on what autoflight mode(s) is active. Being aware of the active mode(s) and understanding the corresponding actions and responses is necessary for proper use of the autoflight system. During the course of this study, the HF (Human Factor) Team identified several factors that inhibit crew's awareness, knowledge, and understanding of autoflight system modes:

(Omitted)

- <u>*Indirect mode changes.*</u> *Mode changes that are not due to a direct flightcrew action are more likely to go unnoticed or create confusion.* (Omitted) *Because indirect mode changes do not involve either flightcrew input or confirmation at the time of the mode change, flightcrews may be unaware that a mode change has occurred. The mode change may result in significant differences between the flightcrew's expectations and the airplane's actual behavior.*

(4) Hazardous State in Situation Awareness

Flightcrew Situation Awareness

Hazardous States of Awareness

(Omitted)

Decreased vigilance can be caused or fostered by a number of factors, including:

- *Fatigue. Fatigue has been the subject of extensive research and is well recognized as a cause*

of decreased vigilance.
(Omitted)
- *Complacency. Automated systems have become very reliable and perform most tasks extremely well. As a result, flightcrews increasingly rely on the automation. Although high system reliability is desired, this high reliability affects flightcrew monitoring strategies in a potentially troublesome way. When a failure occurs or when the automation behavior violates expectations, the flightcrew may miss the failure, misunderstand the situation, or take longer to assess the information and respond appropriately. In other words, over-reliance on automation can breed complacency, which hampers the flightcrew's ability to recognize a failure or unexpected automation behavior.*

2.13.10 Improvement of Manual Flying Ability

The FAA issued the Safety Alert for Operators (SAFO) 13002 on January 4, 2013, expressing its concern about pilots' overreliance on autoflight systems and a resultant decrease in their knowledge and skills for flying the airplane manually. Noting that a continuous use of autoflight systems could degrade pilots' ability to quickly recover the airplane from an undesired state, the FAA recommended air carriers and others to take measures to improve pilots' ability to fly the aircraft manually.

2.13.11 Spatial Disorientation

Spatial disorientation, or vertigo, denotes an illusion in which the person becomes confused in spatial awareness (correct awareness about the position in space, direction, attitude and others of one's own in space), and it means a situation in which the pilot is unable to understand the attitude and the direction of movement of the aircraft. When the aircraft flies in clouds or at night, this phenomenon may occur in a situation where the pilot cannot visibly recognize the horizon. But it may also occur due to an illusion accompanied with deceleration or acceleration (the body acceleration illusion).

In an illusion in acceleration, when the acceleration along aircraft axis is greater, such as in takeoff and in a go-around, the pilot misunderstands the direction of the inertial force and gravity combined (to the back at an angle downward) as the direction of gravity and feels that the aircraft is in a nose up attitude.

In order not to enter spatial disorientation, it is important for pilots to properly monitor the aircraft condition while watching the attitude indicator and other instruments, without relying only on their sense.

3. ANALYSIS

3.1 Qualification of Personnel

The PIC and the FO held both valid airman competence certificates and valid aviation medical certificates.

3.2 Airworthiness Certificate of the Aircraft

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

3.3 Relations to Meteorological Phenomena

As described in 2.5, on the serious incident occurrence day, fogs were observed in the west coast of Hokkaido. Around the time when the serious incident occurred, visibility at Okushiri Airport was about 2,000 m and the prevailing height of clouds was 200 ft (the cloud base altitude is a height from the airport elevation of 161 ft; the altimeter-based height was about 360 ft), and clouds were also scattered at 100 ft (about 260 ft in the altimeter-height). Accordingly, it is highly probable that areas around the airport remained in a weather condition with many low clouds observed amid a low visibility.

However, it is highly probable that the meteorological condition at the time when the serious incident occurred was not the direct cause of this serious incident.

3.4 Conditions of Flight

3.4.1 Approach to Okushiri Airport

(1) Selection of runway

As described in 2.1.2 (1), it is highly probable that the PIC decided to make an approach to Runway 31 profiled lower MDA than Runway 13, which forced him accept adverse landing with tail wind, but will increase the chance of identifying and landing on the runway.

The Aircraft began VOR/DME approach to RWY31 with the AP/FD system. It is highly probable that the PIC and the FO realized the poor weather condition at Okushiri Airport and the high possibility of a go-around at that time.

(2) Descent to MDA

As described in 2.1.1, the vertical mode of the AP/FD system changed from $\boxed{\text{VS}}$ for descending with a constant rate to $\boxed{\text{ALTS}}$ for maintaining the altitude set in APA at 11:35:39, followed by a level flight at an altitude of 600 ft.

According to this finding and the statement in 2.1.2 (1), it is highly probable that the altitude of 600 ft as the MDA for VOR/MDE RWY31 approach had been set to APA.

3.4.2 Go-around from MDA

(1) Preparation and decision for a go-around

As described in 2.6, VOR/DME RWY31 missed approach procedure, when the runway can not be identified before reaching the VDP, is prescribed to make a climb for 4,000 ft with a wide left-turn. When a go-around is to be performed by using the FD, the initial go around altitude of 4,000 ft must be set to APA beforehand. As described in 2.13.2 (1), in AOM and FTG the procedure for setting the initial go around altitude to APA in the non-precision approach via VOR/DME this kind of case was prescribed as an appendix description only by some figures. According to the statements in 2.1.2, the FO normally made it a point to set the initial go around altitude to the APA, while the PIC believed that the preliminary setting of the initial go around altitude to APA was not strictly provided as a prescribed procedure. Neither the PIC nor the FO had memories that they had set the altitude of 4,000 ft to APA.

It is probable that both pilots were focused on identifying the runway because the prevailing weather condition wasn't good as described in 3.3. It is highly probable that they didn't change the altitude setting to APA, which remain unchanged of 600ft.

As described in 3.3 and 2.1.2, it is highly probable that the PIC decided to perform a go-around because he could not identify the runway before reaching the VDP while maintaining at the MDA of 600 ft.

(2) Go-around

As described in 2.1.1, the autopilot was disengaged at 11:37:28, and the Aircraft began climbing; therefore it is highly probable that the PIC as PF pressed the go-around button on the power lever. It is highly probable that the mode of the AP/FD system was still indicated on EADI, though autopilot was disengaged.

Upon disengaging autopilot, GA was indicated on EADI as the lateral mode to maintain the current heading of 320°. Meanwhile, it is highly probable that ALTS was displayed again on EADI as the vertical mode to maintain 600ft, following GA changing from ALTS for a moment. As described in 2.13.3 (1), it is highly probable that such quick vertical mode switching was caused by the immediate recapture of the altitude of 600 ft set to APA when the go-around button was pressed. Accordingly, it is highly probable that the FD vertical command bar directed not for climbing, but for returning to 600ft. As described in 2.9 (2), this event was confirmed to arise in a simulator-based reproductive investigation.

According to the statement in 2.1.2 (2) it is highly probable that the FO, following the PIC's instructions, set the engine output to 100 %, the flap lever from 20° to 7° and the landing gears to retract. It is highly probable that around that time, the FO checked EADI, the vertical speed indicator, the airspeed indicator, the engine instrument and others and he confirmed the Aircraft in initial climb phase.

As described in 2.13.4, according to AOM, when pilots found the automatic mode change, they made it a point to call the change to GA in lateral and vertical mode on EADI after recognized it. But the Company had a policy for pilots to call out the mode-change during a go-around as far as they could perform. This is based on the assumption that pilots will never skip to check the mode-change even if they may skip to call. It is highly probable that the PIC and the FO did not notice that the vertical mode could not be change to GA because they did not carry out the confirmation of mode-change in an appropriate manner.

Even if they forgot to set the initial go around altitude to APA while the Aircraft was flying at the MDA of 600ft, they could first fly by its own attitude indication to establish an initial climbing after executing go-around at first then they could resume to fly by following the FD command bar direction for continuous climb after setting the initial go around altitude to APA.

(3) Mode change during climbing

According to the descriptions in 2.1.1 and the statements in 2.1.2, it is highly probable that without any order from the PIC, the FO took his steps on the MSP, to set HDG, and IAS in the AP/FD mode and select its heading of 230°, upon informing the PIC of his these operations, without any order from the PIC, after the Aircraft began to climb following go-around, at 11:37:41.

As a result, it is highly probable that the lateral mode changed to HDG from GA, and the FD command bar directed to turn left for 230° under the missed approach procedure. But, according to the statement in 2.1.2 (2), it is highly probable that at this time, the FO did not confirm the change in the mode.

Meanwhile, the vertical mode was unchanged and remained ALTS even after the IAS button was pressed. It is highly probable that this was because the Aircraft kept on holding ALTS condition in which pilots cannot select any vertical modes capable of climb due to ALTS track mode continuing after resumed to level flight at the MDA. (See 4 of Attachment "Functions and Indications of Autoflight")

The PIC intended to order to set lateral made to HDG and vertical mode to IAS after the landing gears were retracted, but because the step taken by FO was earlier than the PIC's intention, he was confounded by the step the FO took and he started a left-turn following the FD command bar without confirming the vertical mode indication on EADI.

As described in 2.13.2 (2), AOM prescribed the procedure of setting HDG and IAS mode after the landing gears retracted. Meanwhile, as described in 2.13.4, AOM prescribed that the mode shall be changed by the PF's order as a general rule while autopilot is not engaged. The FTG of the Company also says that the PF shall order the mode to be selected and the PM shall play a role of handling the MSP to change the mode, and both of them shall call it out each other to confirm.

As described in 2.1.2, the PIC intended to issue an order for HDG/IAS when he though it is the time for himself to do so, on the other hand the FO carried out the voluntary setting on the MSP, saying "I'll set HDG, IAS" as he believed that those setting were one of fixed procedure, which didn't require the PIC's judgment. It is highly probable that the FO operated the MSP in order to enable the PIC to quickly establish an attitude for a left climbing turn under the VOR/DME RWY31 missed approach procedure amid strong tail winds. The timing for this operation was not necessarily inappropriate, but this caused the PIC to be confounded. The FO should have to wait for the PIC's order to set (or make an advice to the PIC) in accordance with AOM and FTG.

3.4.3 Descent after Go-around

(1) Nose down operation

According to the DFDR records, the nose (the pitch angle) started gradually lowering about four seconds after the go-around, following zero degress at 11:37:45, further decreased into negative zone (the nose down attitude). The peak altitude of the Aircraft became about 750 ft, it turned to descend from 11:37:47. It is highly probable that this phenomenon reflected the following factors.

According to the statement in 2.1.2 (1), the PIC had been trained and learned to fly folowing the FD command bar directions and had observed a primary policy of "Fly following FD". It is highly probable that without confirming both vertical and horizontal modes turned to GA on the EADI the PIC gradually pushed the control column forward following FD directions which led the Aircraft to return to the established altitude on the APA of 600ft with lowering pitch.

Pilots in this aircraft need to push the column forward to control the nose up tendency accompanying engine power increase. Therefore, it is probable that the PIC felt nothing so unusual for pushing the control column during the go-around to climb maintaining the appropriate go-around attitude of 6.4°.

Because it is difficult to assume that the PIC was concentrating on following the FD command bar and failed to recognize the background horizon (the pitch attitude) in EADI, it is possible that the PIC excessively depended on the AP/FD system and was subjected to its directions, while he was feeling something uncomfortable about the FD command bar directions, which did not indicate appropriate climbing attitude,

During the go-around, the flaps were retracted from 20° to 7° and then to 0°. According to the designer and manufacturer of the Aircraft, when the flaps are retracted, a nose down moment is generated. Therefore, it is highly probable that the Aircraft lowered its nose down at that time. It is probable that at around 11:37:45, the pitch trim was changed to the nose-down direction with the autopilot . due to the PIC's operation to adjust trim manually at that time.

It is highly probable that because the PIC did not confirm the basic flight instruments such as the altimeter, the airspeed indicator and the vertical speed indicator in an appropriate manner, he could not realize that the Aircraft didn't established its climb and he made the Aircraft descend without his intention. It is highly probable that the PIC could not perform a fundamental instrument flight at this time.

The objectives of operations during go-around is "climbing turn to the safety side." Therefore, the PIC should have realized that the objectives would not be achieved if he followed the FD command bar directions. It is somewhat likely that the PIC paid excessive attention to his own "FD Follow" principle and he became unaware of the objective of the operations.

(2) Spatial disorientation

As described in 2.1.1, the Aircraft began descending from an altitude of about 750 ft and about three seconds later, the attitude became -6.3° as a minimum pitch angle (a maximum nose-down angle). At this time, the Aircraft was descending at an altitude of about 700 ft, coming close to the altitude of 600 ft which was set to APA. Therefore, it is highly probable that the FD command bar had indicated a pitch angle leading to a level flight at 600 ft. If the PIC had continued operations following the FD command bar instruction, the altitude of 600 ft would have been maintained. However, according to the DFDR records, a certain nose down attitude continued for about 10 seconds from around 11:37:40. It is highly probable that the PIC made the Aircraft nose down even lower than the FD command bar instruction around this time.

According to the FO's statement in 2.1.2 (2), he felt his body pressed to the back of the seat due to acceleration and therefore, he did not feel the Aircraft was descending. In addition, according to the DFDR records, the longitudinal acceleration increased from around 11:37:33, and a value of about 0.2 G was held for about 24 seconds. It is possible that pilots might fall into " the body acceleration illusion", as described in 2.13.11 because of the longitudinal acceleration increment caused by increased engine power .

Regarding the fact that the operation to push the control column proved to be greater than indicated by the FD command bar, it is somewhat likely that because the PIC fell into a state of spatial disorientation induced by the body acceleration illusion then he felt that the Aircraft was in pitch up attitude. But it could not be determined how much the body acceleration illusion affected for his control of the Aircraft.

Only believing and following the indications of flight instruments enables pilots to evade the disorientation when pilots cannot confirm the aircraft attitude from outside visual information such as a horizon and so on, as with flying in clouds . Therefore, pilots need to fly cross checking their flying situation and the aircraft attitude with attitude directional indicator or other multiple basic flight instruments all the time, even when they follow the AP/FD system.

(3) Monitoring by PM

It is highly probable that the FO was required to pull his eyes away from flight instruments and transiently lower his head to CHP to select the heading after pressing the HDG button on MSP.

According to the statements in 2.1.2, since the FO advised to the PIC that the speed of the Aircraft is approaching flap-up speed, while climbing after the go-around, it is highly probable that the FO was confirming the airspeed indicator around that time. It is highly probable that the FO operated the flap to be retracted following the PIC's order and he was monitoring the flap position indicator for a few seconds while the operation.

Considering these conditions, it is probable that the FO could not monitor the instruments temporarily and failed to pay close attention to the instruments, and he could not realize that the nose of the Aircraft was going lower since the nose of the Aircraft went down gradually during that time.

The FO didn't realize that the Aircraft was descending, though it was necessary to establish its climbing attitude. It is probable that it was difficult for the FO to feel descending since the Aircraft was accelerating as described in 3.4.3 (2) and the FO assumed that the Aircraft would climb as usual since he had already checked the initial climb immediately after executing the go-around operation.

3.4.4 Autopilot Operation during Descent

(1) Awareness of descent and autopilot operation

The Aircraft continued to descend contrary to the intentions of the PIC and the FO, though it had tried to go-around.

According to the statements in 2.1.2, the PIC had continued to left turn despite his doubt that the attitude of the Aircraft was slightly nose down and he uttered words of surprise because he felt that the aircraft was not in a desired state. Then, the FO realized that the Aircraft was descending at about 1,500 fpm and he advised the PIC that the Aircraft was not climbing.

At 11:37:52, autopilot was engaged, but, according to the statement in 2.1.2 (2), the FO did not remember that he had engaged the autopilot. Engagement/disengagement operations of autopilot must be performed by the PM under the PF's order. The PIC believed that he was manually flying for himself after go-around and he was not aware that autopilot was engaged. In light of these, it is probable that autopilot was engaged by the FO.

It is possible the PIC felt the aircraft was not in a desired state because he felt a change in the wind noise of the Aircraft which was believed to climb (the wind noise became greater). However, according to the statement in 2.1.2 (1), because the PIC had doubt about the slight nose down attitude of the Aircraft before then, the PIC should have monitored the aircraft condition by checking multiple instruments without delay and taken corrective actions in an appropriate manner.

(2) Recapture of MDA

As described in 2.1.1, the lateral mode on the AP/FD system when autopilot was engaged was unchanged at $\boxed{\text{HDG}}$, selected by the FO after the go-around. Meanwhile, it is probable that the vertical mode was $\boxed{\text{ALTS}}$ maintaining MDA of 600ft because the vertical mode turned to recapturing the altitude of 600ft set on APA.

It is highly probable that reason why the vertical mode recaptured the altitude set on APA is that at first, the vertical mode turned to $\boxed{\text{ALT}}$ mode maintaining the current altitude since the FO engaged AP, as described in 4 of Attachment "Functions and Indications of Autoflight," but then the vertical mode quickly changed to the ALTS capture mode, since the altitude of 650ft during the descending with AP engaged was amid capture zone of the established altitude on APA, as shown in reproductive investigation using the simulator described in 2.9.

(3) Mode change during descent

As described in 2.1.1, after autopilot was engaged while the Aircraft was descending, at 11:37:54, the ALTS capture mode in the vertical mode on the AP/FD system was cancelled at altitude of about 560 ft and the mode changed to H CLM for climbing at a high speed, and then, turned to VS for maintaining the descent rate, and further after that, turned to M CLM for climbing at a medium speed.

It is highly probable that the ALTS capture, maintaining the established altitude on APA, was cancelled because the attitude set on APA was changed from the MDA of 600 ft to the initial go around altitude of 4,000 ft, since cancellation of ALTS capture is caused only by changing the altitude on APA. As described in 2.9 (5), this phenomenon could be reproduced and confirmed in the simulator investigation.

As described in 2.13.3 (1), when the altitude set on APA is changed in the ALTS capture, the vertical mode automatically changes to VS, which enables to select H CLM. It is probable that ALTS was changed to VS (this change was not recorded in the DFDR) by resetting the altitude set on APA to 4,000 ft, and was changed to H CLM by pressing CLIMB button and resumed to VS, and turned to M CLM by the pressing CLIMB button again. Any detailed changes of "VS" are not recorded in the DFDR, but it is highly probable that DFDR could not record all the operations because the recording cycle of the "VS", "CLM SPD HIGH" and "CLM SPD MED" conditions was as long as four seconds and pressing CLIMB button were repeated in a short period.

It is probable that these frequent changes in the vertical mode performed in about five seconds after ALTS was disengaged were caused by any of the following FO's action.

- The FO tried to use autopilot for climb by putting the autopilot lever engaged on APP, then change the vertical mode by operating MSP.
- The FO tried to make the FD command bar direct to climb, leaving autopilot disengaged, to change the vertical mode by operating MSP. (Because the FO was preparing for putting autopilot lever engaged with his left hand on the lever and waiting for the PIC's order, it is somewhat likely that he put the lever engaged almost in a reflex manner without having any clear intention.)

In any case, it is probable that the FO tried to make the Aircraft climb by using the AP/FD system.

The Aircraft continued descending with autopilot engaged and ALTS changed to VS in the vertical mode during descent. It is highly probable that the Aircraft descended continuously because the Aircraft could not respond to repeated mode changes in short period.

3.4.5 Approach to Terrain

(1) Power lever operation during descent

As described in 2.1.1, around 11:37:54 to 59 the vertical mode on MSP was operated. At 11:37:57 the power lever was momentarily retarded and the engine torque decreased to about 50 %.

When PF takes the left seat, PF will operate the power lever with his right hand. PM usually will not operate the power lever. According to the FO's statement in 2.1.2 (2), actually he said that he did not operate the power lever. Meanwhile, PF will operate the MSP with his right hand and PM with his left hand. The power lever and the MSP were operated in the same period of time. Therefore, it is highly probable that the FO operated the MSP as PM and the PIC operated the power lever as PF.

It is somewhat likely that because the PIC noticed that the Aircraft was getting faster than usual, he momentarily retarded the power lever, though the Aircraft should have reverted to climb from approaching to the ground.

(2) Emergency operation to avoid collision

As described in 2.1.1, TAWS issued the “SINK RATE” caution indicating an excessive descent rate at 11:37:57. Almost at the same time, the power lever was moved to the maximum. At 11:38:01, TAWS issued the “TOO LOW TERRAIN” caution indicating an approach to the ground. The radio altitude showed a minimum value of about 90 ft and the engine torque increased to 118% as a maximum DFDR recordable value.

It is highly probable that Since the PIC came to realize the Aircraft was in a dangerous situation following the TAWS caution indicating its approach to the ground at this time, the PIC advanced the power lever to the maximum to make the Aircraft climb.

As described in 2.1.1, at 11:38:03, the pitch angle of the Aircraft increased to 10.5° from 9.5° in a second in climb and the vertical acceleration recorded the maximum value of 4.1 G. It is highly probable that it’s because the vertical acceleration value exceeded the limit load factor when the PIC and the FO abruptly pulled back the control column together to raise the nose and the Aircraft turned to climb from descent rapidly.

As described in 2.9, pilots must applying more force than the control power of the AP/FD system to override and manually operate control surfaces. It is highly probable that the PIC and the FO felt the control column was heavier to pull back, because autopilot was engaged at that time.

Flying with autopilot was so slow to maneuver that it may affect the urgent maneuver to avoid ground proximity. The both pilots should immediately have disengaged autopilot in this case.

As described in 3.4.4 (1) and (3), it is probable that the FO’s operation, engaging autopilot and changing the vertical mode to make the Aircraft climb with the AP/FD system, eventually contributed to delaying the operation to avoid ground proximity.

3.5 Setting of Initial go around altitude in Approach

As described in 2.13.2 (1), AOM and FTG have some difference regarding the presence or absence of description about presetting the initial go around altitude during approach, that is, the Company didn’t standardize the contents. In regard to presetting the altitude on non-precision approach such as this case of VOR/DME approach, both AOM and FTG have some descriptions only in those charts but not in the text. Similar to this, those manual included some inconsistency.

According to the statement in 2.1.2 (1), the PIC understood that presetting of the initial go around altitude in advance was not been strictly prescribed as a standard procedure. Though the PIC and the FO started an approach to the airport with advance care for go-around against bad weather information of Okushiri Airport they had, they did not set the initial go around altitude to APA. Based on these findings, it is somewhat likely that the necessity of setting the initial go around altitude in approach had not been generally informed to its flight crewmembers and sufficient training had not been given to them.

Presetting the initial go around altitude after go-around to APA while approaching is one of the essential preparations that might reduce the workloads in case of go-around. Therefore, the Company needs to clarify the specific procedures to be carried out by PF and PM, so that the flight crewmembers can have common understanding about what they should do without being confounded.

3.6 Importance of Mode Callout and Confirmation

The PIC and FO didn't confirm that the lateral and vertical modes changed correctly at the time of go-around from the MDA of 600 ft and changing to the HDG/IAS mode from the go-around mode, in which the PIC pressed the go-around button and the FO changed HDG/IAS mode. Therefore, it is highly probable that the crewmembers could not understand that the vertical mode recaptured ALTS and the FD command bar (maintaining of 600 ft) was demanding the remarkably different directions from their intentions (go-around). Therefore, it is possible that the PIC and the FO had not contracted a habit to confirm the modes on the AP/FD system.

As described in 2.13.4, AOM requires that pilots should confirm the mode indication on EADI and appropriately call it out when they changed the mode while using the AP/FD system. But the Company specified that pilots are not always necessary to follow the description of AOM and they might be only required to follow it as long as they can incase of go-around. The Company had not intended to revise their rules and regulations including the inconsistency or take other necessary actions and inform their crewmembers by written documents. Due to these Company's self-judgment, the crewmembers came to recognize that they need not call out those mode changes during a go-around with high workloads. As a result, it is somewhat likely that the Company led its flight crewmembers to miss out an essential matter that have to be confirmed without fail.

As described in 2.13.4, AOM requires that both PF and PM must confirm the changes mode and call it out while using the AP/FD system. But FTG doesn't have definite requirements, using vague and inconsistent expressions, such as "Basically", "As long as possible", "As the need arises", "No obligation to call out" and "You may call it out."

Based on these findings, it is probable that the Company didn't create a standard procedure, reflecting the contents of AOM, for its crewmembers to confirm and call out the changes mode, without noticing its importance and didn't carry out adequate training.

FTG is normally used for crew training. Since the pairing of flight crewmembers varies in a day to day schedule, FTG should not include any operational descriptions which lead flight crewmembers to confuse whether they should do or not, when PF and PM handle various aspects. The Company should establish definitive operational procedures to secure a safe flight operation. It is important for PF and PM to understand and share the procedures.

When using the AP/FD system, what mode is to be selected, upon getting the picture of its operation, and ensuing confirmation of working status which consist with the flight crewmembers intention are important in any flight phases. Confirmation and call out of modes must be done to make sure of their operations, especially when lots of piloting operation overlapped at a time such as in a go-around.

The Company should make its flight crewmembers comply with the specifics of AOM (confirmation and callouts for mode changes, upon using the AP/FD system and automatic changing) as described in 2.13.4, without fail and the Company should also consider that FTG shall be revised in related matters.

The Company should restrain from informing its flight crewmembers of contradictory instructions in a vague manner, without revising the relevant rules and regulations, because those order by the Company might not only have a risk to led them to confuse, but also invite a jeopardized situations against a safe flight operation.

3.7 CRM

As described in 2.13.7, the PIC and the FO received CRM training for fiscal year 2010. This CRM training included programs for aircraft situational awareness and analyses, an appropriate judgment against recognized information, appropriate communication by sharing information and functioning as a team built under the PIC's command following mutual coordination among flight crewmembers. The CRM training of the Company was only composed of ground school sessions, and didn't include simulator sessions such as LOFT, which uses representation flight segments expected in line operations.

It is highly probable that the PIC and the FO had failed to exercise basic situational awareness, since they descent the Aircraft despite a phase of go-around and they did not notice the feet that the Aircraft was descending without proper check of flight instruments and modes of flight, in this serious incident. It is highly probable that the team of the PIC and the FO didn't share their intentions and tasks well because they didn't have good communication and coordination in an appropriate manner, such as changing mode and engaging autopilot by FO without the PIC's approval.

In order to enhance the effectiveness of CRM training, the Company should make its flight crewmembers not only understand what it mean and what crewmembers should tackle, but also entrench ability to perform CRM effectually in actual flights or training sessions close simulating of actual flights. As described in 2.10.1, the Company is in an environment where it can use a simulator. Therefore, the Company should positively consider introducing more effective training methods, such as LOFT.

Comprehensive management ability is required for the PIC to conduct a safe and efficient flight. PF and PM should complete their flight by performing their duties for sure, understanding their assigned duties among their whole tasks and communication comprehensively each other. Not to invite a critical situation or an accident even if human errors should be occurred, it is important to enhance all integrated capacity as a team, drawing assured basic capability of each flight crewmember, and it is also crucial to build a better team under the captain's leadership.

3.8 TAWS

3.8.1 TAWS Activated

(1) "SINK RATE" caution and "PULL UP" warning (Mode 1)

As described in 2.1.1, at 11:37:57, TAWS issued the "SINK RATE" caution indicating an excessive descent rate. This was a Mode 1 function described in 2.8 (1), but in this serious incident, there was no record that the system issued the "PULL UP" warning, another Mode 1 function, indicating that the descent rate has entered an even more dangerous area.

TAWS has a low pass filter and a notification protection time for its internal processing functions to avoid erroneous cautions or warnings along with the malfunctions. It is highly probable that TAWS issued only a caution, not a warning, because this processing functions made the "PULL UP" warning inactive in this case.

(2) "TOO LOW TERRAIN" caution (Mode 4B)

As described in 2.8 (2), one of the conditions of activating Mode 4B is that the landing gears are extracted. However as described in 2.1.1, the "TOO LOW TERRAIN" caution was issued by TAWS at 11:38:01 despite the fact that the landing gears had been retracted at that time. This was explained by the TAWS manufacturer as below.

- Mode 4B is dissolved from the active mode when the landing gears are retracted and the ground altitude becomes 700 ft AGL or more. The mode will remain in active when the ground altitude stays 700 ft AGL or less even if the landing gears are retracted.

The Aircraft retracted the landing gears after initiating a go-around, but it began descending before the ground altitude reaches 700 ft AGL(the TAWS records showed about 661.5 ft AGL). Therefore, it is highly probable that TAWS issued the "TOO LOW TERRAIN" caution with Mode 4B remained active.

(3) "BANK ANGLE" caution (Mode 6)

As described in 2.1.1, at 11:38:03 the Aircraft turned to left and reached 28.5° in bank angle at less than 100 ft AGL. It is highly probable that TAWS issued the "BANK ANGLE" caution since the Aircraft met condition to be triggered as described in 2.8 (3).

3.8.2 Clarification of Operation Procedure When TAWS is Activated

In this serious incident, all what TWAS issued were only some cautions and no warnings, but pilots had a very small amount of time to perform the avoidance maneuver from contact on the ground. .

When TAWS warnings are issued, an urgent handling should be done. Therefore, pilots are immediately required to perform the avoidance maneuver by manual control with autopilot disengaged. However only TAWS cautions were issued in this serious incident. The PIC and the FO tried to override the autopilot which remain engaged. Accordingly, they needed greater steering force and longer time than they needed with manual control to perform the avoidance maneuver from approaching the ground. When pilots realized a significant descent rate at a low altitude, as the case of this incident, recovery maneuver followed by immediate action of disengaging autopilot should have been done, even if a TAWS warning was not issued.

As described in 2.13.5, in AOM, the operational procedure in case of TAWS activations was prescribed only as a general description. The Company needs to consider clarifying its procedure taken by the PF and the PM in case of TAWS activations.

3.8.3 Introduction of Simulator Training for Cases with TAWS Activated

As described in 2.13.5, simulator-based flight training is not required as an obligation in case that TAWS was activated, and the Company had not performed such cooperate to training.

Once TAWS cautions or warnings were triggered, the PF and the PM should perform swift and correct operations under time-constraint situation. Therefore, it is important for flight crewmembers not only to obtain relevant knowledge through ground school but also to take simulator-based training to enhance the capability of correct situation awareness, judgments, operations and better coordination between crewmembers.

The Company can take advantage of utilizing a simulator in current situation. Therefore, it needs to implement effective improvement measures to introduce simulator training for cases with TAWS activated.

3.9 Autoflight System

(1) Operations of aircraft with autoflight system equipped

In order to use the autoflight system in a proper manner, it is prerequisite for pilots to understand its functions correctly and to closely monitor that it's working normally in accordance with their intentions. Specifically, the following points shall be monitored all the time:

- A selected mode is correctly shown on the display
- The aircraft is controlled in accordance with the selected mode
- The mode is changing appropriately in response to the flight condition

Pilots should confirm that the current state of the aircraft was in consistent with pilots' intentions. Pilots should immediately take proper actions such as changing its mode or suspending its usage, when they found it inappropriate to use autoflight system or follow its mode, or current flight was inconsistent with their assumptions

The mode indication automatically changes along with the flight phases. If pilots have full knowledge about its description of the modes and are prepared for mode-changes, they can easily find their improper operation or malfunctions of the system and address those readily. In particular, automatic mode changes are difficult to realize in some cases, and therefore, callouts and confirmation must be performed without fail. It is important for both PF and PM to share the common understanding of the current mode.

In light of the descriptions above, the situation in this serious incident is summarized as follows:

- The PIC did not confirm the mode that should change to go-around during performing the go-around, and flew following the FD command bar directions without proper setting to APA of the initial go around altitude.
- The FO tried to change the mode to HDG/IAS on MSP without confirming lateral and vertical mode indications of $\boxed{\text{GA}}$. Furthermore, he did not confirm the correct change in the mode following his operation on MSP.
- The PIC and the FO had been unaware that the aircraft was flying on an inappropriate mode, which led the Aircraft descend in spite of a go-around.

Therefore, it is highly probable that the PIC and the FO failed in their basic confirmation and monitoring practices in using the autoflight system of the Aircraft.

The Company should consider reviewing the contents of its education and training programs so that its flight crewmembers may fully understand the basic principles of the autoflight system without fail.

(2) Overreliance on autoflight system

According to the statement in 2.1.2 (1), the PIC was advised by the FO that the Aircraft was not climbing, and then he came to realize that it was descending. From this, it is possible that the PIC followed the directions of FD which wasn't set in a correctly, though he was feeling something strange. It is highly probable that the PIC had not confirmed other indications on EADI and the basic flight instruments such as airspeed indicator, altimeter and vertical speed indicator.

Facing their imminent dangerous situation of proximity to the ground, pilots should have quickly ascend the Aircraft with a manual operation. However, as described in 3.4.4 (3), it is probable that the FO tried to make the Aircraft climb by changing the mode on the autoflight system. Therefore, as described in 2.13.9 (2), it is probable that the crewmember tried to perform a recovery maneuver by improper continued usage of the autoflight system or engagement of autoflight system, even when they realized their abnormal situation.

Based on these findings, it is probable that the PIC and the FO excessively relied on the autoflight system, as described in 2.13.9 (4), mistakenly believing that because these modern autoflight system is highly reliable, everything would be fine only if they let it manage the flight, or that they can have the aircraft fly as they intended as long as they fly the aircraft following the FD command bar directions.

It is somewhat likely that such circumstance will impair pilots' ability to quickly recover the aircraft when pilots notice to meet an undesired state, as described in 2.13.10. Therefore, it is important for the Company to increase the opportunities for training as well as utilizing simulator's session to improve raw data instrument skills to avoid relying on autoflight system.

The Company also needs to clarify problems which might be caused by overreliance on the autoflight system and consider informing flight crewmembers of specific preventive measures.

3.10 Training, Review and Skill Management for Flight Crewmembers

As described in 2.10.2, the PIC and the FO had taken their trainings and reviews in accordance with the regulations.

As described in 2.13.6, when a pilot gets Grade "Passing"; meaning the minimum level to pass in a review session, follow-up trainings for the pilot are required. The company implemented follow-up trainings for the PIC as he got Grade "Passing" twice. The PIC had received some remarks about his flying skill but he took only ground school, and that about two months had passed before the Company implement the training.

Additionally, as described in 2.10.2 (1), some of the remarks for the PIC in review sessions, in which the PIC was commented about flying only by FD and poor pitch control during go-around, were associated with his flying skill and operation he exposed in this serious incident.

The PIC's flying skill and operation in this serious incident revealed that the problems mentioned in the remarks for him had not been fully corrected, and it is somewhat likely that the follow-up training based on the review result for him was not appropriate.

The Company should seek to maintain and improve pilots' skills while managing their ability in an appropriate manner, assessing them after training followed by implementing additional syllabuses for the pilots along with the performance, in order to fulfill its basic and important responsibilities for safe flight operations as an air carrier.

3.11 Fatigue

3.11.1 Flight assignments

As described in 2.11 (1) and (3), the flight assignments of the PIC and the FO, such as flight hours, duty hours, the number of landing and rest hours, as well as their actual flight records, were all within the Company's standards as described in 2.13.8 (3).

3.11.2 Fatigue of PIC and FO

As described in 2.11 (2), the PIC had been engaged in an early morning flight duty starting at 7:00 or 7:20 from June 1st through 4th after his days off. On the Company's flight schedules pilots can seldom take a rest during their flight duties due to short turnaround intervals, and they made takeoffs and landings in consecutive short haul flights that put them heavier mental burdens.

As described in 2.11 (3), the PIC's actual flight time in the previous month of the serious incident was the second most among the Company's flight crewmembers. In the statement in 2.1.2 (1), the PIC told that he couldn't say that he hadn't definitely felt some chronic fatigue. It is somewhat likely that the fatigue has some influence on the PIC when the serious incident occurred.

Meanwhile, the FO took a day off on the previous day of the serious incident, as described in 2.11 (2). In the statement in 2.1.2 (2), he said he had not felt any fatigue. Therefore, it is highly probable that the fatigue has no influence on the FO.

In general, fatigue may cause various influences on pilots' ability, impairing pilots' vigilance and judgment and taking longer time to response. The PIC only followed the FD directions without careful monitoring of the instruments in proper intervals, and it was highly probable that he could not perform appropriate action immediately even though he realized the descent of the Aircraft. It is somewhat likely that fatigue had some influence on his behavior, but it could not be determined how much fatigue had influenced on his flight operations and other actions.

3.12 The Company's Actions on Designation of Serious Incident

As described in 2.12, the Company received a report from the PIC that TAWS had issued the "SINK RATE" caution, but there was no "PULL UP" warning in his report. Therefore, it is probable that the Company did not understand that the occurrence can be classified as "a case where aircraft crew executed an emergency operation during navigation in order to avoid a crash into water or contact on the ground" as prescribed in Clause 5, Article 166-4 of the Ordinance for Enforcement of the Civil Aeronautics Act of Japan.

According to the statement in 2.1.2 (2), because the FO felt that the Company was not fully aware of the importance of the occurrence, he waited for Manager A until he came to the office for his flight duty and reported the situation directly to him. However, because the manager was not aware of the importance in the occurrence when he received a reporting call from the PIC, he did not take any immediate action about what the FO reported. Also it is probable that the manager did not try to seek a detailed explanation from the FO at that time because he had his flight duty to assume.

Later, Manager A understood that the DFDR data must be analyzed to clarify the objective situation of this serious incident, but he thought it was no urgent matter. The Company makes it a point of requesting Company A to analyze DFDR data because the Company has no facility for DFDR analysis. It was a Saturday when he was informed of the occurrence. As a result, it took a longer time for the Company to request Company A to do it. Information about this incident was not shared with relevant persons within the Company until it receives the analysis results. Therefore, it is probable that the Company took longer time to correctly recognize the analysis results.

As described in 2.4.4 and 2.12, the Aircraft was in a situation which requires inspections of aircraft and engine in view of its excessive vertical acceleration and engine torque values. But the Company did not perform these inspections and let it fly as it is. There are some differences in the event's report between the PIC and the FO, even so, it is probable that the Company would have been able to examine the specific contents of the flight in the early stages if Manager A had put top priority on securing safe flight and shared information within the Company.

4 CONCLUSIONS

4.1 Summary of Findings

(1) It is highly probable that weather condition around Okushiri Airport as the destination airport for the Aircraft was consistently unfavorable with many low clouds and low visibility. The Aircraft tried to approach Runway 31 with a lower MDA established. At that time, it is highly probable that the crewmember had set the MDA of 600 ft on APA. (3.3) (3.4.1)

(2) It is highly probable that the PIC decided to perform a go-around because he could not identify the runway while maintaining at the MDA of 600 ft. It is highly probable that the altitude set on APA was not changed to 4000ft of the initial go around altitude and was left 600 ft. Therefore, it is highly probable that the FD vertical command bar directed not for climbing but for returning to 600 ft as the MDA.

Autopilot was disengaged by a go-around operation. It is highly probable that the PIC and the FO failed to realize that the vertical mode did not change to $\boxed{\text{GA}}$, because they did not confirm the vertical mode on EADI in an appropriate manner.

It is highly probable that the FO operated MSP to set $\boxed{\text{HDG}}$ and $\boxed{\text{IAS}}$ modes and set its heading of 230° in order to make a left turn and climb. But the vertical mode did not change and remained at $\boxed{\text{ALTS}}$. It is highly probable that the PIC was confounded by this earlier step than the PIC's intention and he began a left-turn following the FD command bar without confirming the vertical mode indication. (3.4.2)

(3) It is possible that the PIC had to push the control column forward to control the nose up tendency accompanying engine power increase for go-around, and while feeling something uncomfortable about the FD command bar, he actually followed its directions. Therefore, it is highly probable that the PIC eventually made the Aircraft descend without his intention. It is highly probable that the PIC could not perform a fundamental instrument flight at this time.

The PIC continuously made the Aircraft nose down even lower than the FD command bar directions. It is possibly because the PIC fell into a state of spatial disorientation induced by the body acceleration illusion. But it could not be determined how much the body acceleration illusion affected his control of the Aircraft.

The FO could not closely monitor the instruments transiently and did not realize that the Aircraft was descending. It is probably involved that the Aircraft was accelerating, and the FO had already checked the initial climb state immediately after executing the go-around operation and the FO assumed that the Aircraft would climb as usual. (3.4.3)

(4) As the PIC felt the Aircraft was not in a desired state, he uttered words of surprise, and then the FO realized the Aircraft was descending, and then he advised the PIC that it was not climbing.

It is probable that the FO tried to make the Aircraft climb by engaging the autopilot and operating the vertical mode on MSP and then changing the mode of AP/FD system. (3.4.4)

(5) The PIC momentarily retarded the power lever, but TAWS issued the "SINK RATE" caution and the power lever was moved to the maximum. Both the PIC and the FO pulled back the control columns and conducted recovery maneuver. In the course of that, the "TOO LOW TERRAIN" caution was issued and the radio altitude showed about 90 ft.

After that, the Aircraft began to climb after the pitch angle increased rapidly and the vertical acceleration marked 4.1 G. Because the recovery maneuver was conducted with autopilot engaged, it is highly probable that a significant force was required to control the Aircraft.

Further, it is probable that the operations of the FO, engaging autopilot and changing the vertical mode to make the Aircraft climb with the AP/FD system, eventually led to delaying the operation to avoid proximity. (3.4.5)

(6) Because AOM and FTG have some difference regarding the presence or absence of description about presetting and include some inconsistency, it is somewhat likely that the necessity of setting the initial go around altitude in approach had not been generally informed to its flight crewmembers and sufficient training had not been given to them. The Company needs to clarify the specific procedures to be carried out, so that PF and PM might be able to have common understanding. (3.5)

(7) The Company specified for go around that pilots always do not need to follow the description of AOM and they might be only required to follow it as long as they can. Meanwhile, FTG does not have definite requirements, using vague and inconsistent expressions about the mode callouts. It is probable that the Company didn't create a standard procedure, reflecting the contents of AOM, for its crewmembers to confirm and call out the changes mode, without noticing its importance and didn't carry out adequate training. The Company should make its flight crewmembers comply with the specifics of AOM about confirmation and callouts for mode changes without fail and consider that FTG shall be revised in related matters.

The Company should restrain from informing its flight crewmembers of contradictory instructions in a vague manner, without revising the relevant rules and regulations. (3.6)

(8) The PIC and the FO had failed to exercise basic situational awareness. It is highly probable that they didi not share their intention and tasks well because they didn't have good communication and coordination in an appropriate manner. (3.7)

(9) TAWS issued the "SINK RATE", "TOO LOW TERRAIN", and "BANK ANGLE" cautions, but the "PULL UP" warning was not issued. However, when pilots realized a significant descent rate at a low altitude, as the case of this incident, recovery maneuver followed by immediate action of disengaging autopilot should have been done.

The Company had not carried out simulator training for TAWS activation, but it needs to implement effective improvement measures. (3.8)

(10) It is highly probable that the PIC and the FO failed in their basic mode confirmation and monitoring practices in using the autoflight system. Accordingly, the Company should consider reviewing the contents of its education and training programs so that its flight crewmembers may fully understand the basic principles of the autoflight system without fail. It is probable that the PIC and the FO excessively relied on the autoflight system. It is important for the Company to increase the opportunities for training as well as utilizing simulator's session to improve raw data instrument skills, to recover the airplane quickly when pilots notice to meet an undesirable state. (3.9)

(11) It is possible that the follow-up training of the Company based on the review evaluation for him was not appropriate. The Company should assess pilots' skills properly after training and seek to maintain and improve their skills while managing their ability in an appropriate manner. (3.10)

(12) The flight assignments and actual flight records of the PIC and the FO were all within the standards of the Company. But it is somewhat likely that fatigue has some influence on the

PIC when the serious incident occurred. It is highly probable that the fatigue has no influence on the FO. (3.11)

(13) The Company was not fully aware of the importance in the occurrence from the report by the PIC and did not try to seek a detailed explanation from the FO. Accordingly, it is probable that the Company did not understand that this occurrence should be classified as a case where flight crew executed an emergency operation in order to avoid a crash on the ground, that is, as a serious incident. The Company believed that the DFDR data must be analyzed to clarify the objective situation. But, it is probable that it took a longer time to request data analyses and examine the results of the analyses.

The Aircraft was in a situation which requires aircraft and engine inspection in view of its excessive vertical acceleration and engine torque values. But the Company did not perform these inspections and and it continued flights with the Aircraft.

If the Company had put top priority on securing safe flight and shared the information within the Company, it is probable that the Company would have been able to examine specific contents of the flight in the early stages. (3.12)

4.2 Probable Causes

In this serious incident, during the approach to Runway 31 of Okushiri Airport, the Aircraft executed a go-around and once started climbing but it soon reverted to descend and came close to the ground. Consequently, flight crewmembers came to realize the situation and executed an emergency operation to avoid crash to the ground.

It is highly probable that the Aircraft's descent and approach to the ground was caused by the following factors:

(1) The PIC followed the Flight Director command bar instructions, which indicated the descent because the altitude setting was not changed to the initial go around altitude, and subsequently the PIC made the Aircraft descend even lower than the FD command bar instructions.

(2) The PIC and the FO could not notice descending of the Aircraft and their recovery maneuvers got delayed.

It is highly probable that these findings resulted from the fact that the PIC could not perform a fundamental instrument flight, the PIC and the FO used the Autopilot/Flight Director System in an inappropriate manner without confirming the flight instruments and the flight modes, and the FO could not transiently carry out closer monitor of the flight instruments because of the other operations to be done.

Moreover, it is probable that the FO's operation of engaging an autopilot and changing the vertical mode to make the Aircraft climb by using the Autopilot/Flight Director System eventually became a factor to delay recovery maneuvers against ground proximity.

It is probable that the Company didn't create a standard procedure, reflecting the contents of Aircraft Operating Manual, for its crewmembers to confirm and call out the changes mode, without noticing its importance and didn't carry out adequate training. Furthermore, it is probable that the PIC and the FO excessively relied on the autoflight system.

5 SAFETY ACTIONS

5.1 Safety Actions Taken

5.1.1 Actions Taken by the Company

(1) Initial go around altitude setting and mode confirmation

The Company released the FLIGHT CREW MEMO as an immediate notification to the flight crewmembers and encouraged them to remind their attention as follows; pilots shall set the missed approach altitude to APA before the beginning of missed approach, and pilots shall monitor and confirm the mode changes without fail when they operate on MSP and APA. Subsequently, the Company added the following descriptions to AOM S2-2-7 APPROACH:

When pilots perform an instrument approach by using the AP/FD system and operate on MSP and APA, they should monitor mode changes without fail and confirm that the indicating mode is appropriate in response to the current situation.

(Omitted)

An appropriate missed approach altitude shall be set to APA to prepare for a go-around before the beginning of missed approach.

In addition, the following descriptions were added to AOM S2-4-5 PRECISION APPROACH and AOM S2-4-6 NON-PRECISION APPROACH, all in figures:

In an figure for *S2-4-5 PRECISION APPROACH,*

AFTER PASSING THROUGH FAF

・SET MISSED APPROACH ALTITUDE TO APA

In an figure for *S2-4-6 NON-PRECISION APPROACH,*

PRIOR TO INITIATING GO AROUND

・SET MISSED APPROACH ALTITUDE TO APA

Moreover, the following descriptions were added to the text of FTG 3-6-1 "LANDING FROM NON-PRECISION APPROACH":

(3) Missed Approach Altitude shall be set before the beginning of Missed Approach.

Set Missed Approach Altitude at the following timings:

(a) When an airplane does not level off at MDA

(in case weather is not in MARGINAL condition)

Set missed approach altitude to APA without setting the altitude of MDA to level off, when pilots identify the Visual Reference and begin descent along with appropriate Path (3° Path).

(b) When an airplane levels off at MDA;

Case 1 (in case of the MDA with tens digit)

During descent set APA altitude to the nearest 100ft increment above MDA. Set missed approach altitude to APA upon turning to ALTS capture Mode. Confirm mode change to VS (Down) to select ALT mode at MDA. Confirm ALT mode and leveling off at MDA.

(c) When an airplane levels off at MDA;

Case 2 (in case of the MDA without tens digit)

During descent, set MDA altitude to APA. Aircraft will level off at MDA with ALTS mode. Use caution, however, as the pilot is likely to forget to set missed approach altitude.

There are the following two methods to set missed approach altitude to APA:

1) Set missed approach altitude to APA upon turning to ALTS capture mode. Confirm mode change to VS (Down) to select ALT mode at MDA. Confirm ALT mode and leveling off at MDA.

2) Set missed approach altitude to APA upon turning to ALTS track mode. Confirm mode change to ALT.

(2) In-house reporting system

As across-the-board effort, the Company ensured that all employees are surely informed of the existing voluntary report and proposal system, moreover it decided to hold monthly meetings to exchange opinions each other for employees from flight crew, flight operations and maintenance divisions so that it may tackle to foster its corporate culture which facilitates voluntary reports and to activate in-house communication. The Company decided to inform employee in the company about some of matters, which brought up in the existing voluntary report and proposal system, to be notified to them.

5.1.2 Actions Taken by the Tokyo Regional Civil Aviation Bureau of the Ministry of Land, Infrastructure, Transport and Tourism

5.1.2.1 Actions Taken for the Company by the Tokyo Regional CAB of the Ministry of Land, Infrastructure, Transport and Tourism

The Tokyo Regional CAB of the Ministry of Land, Infrastructure, Transport and Tourism (hereinafter referred to as "the Tokyo Regional CAB"), pursuant to Article 76-2 of the Civil Aeronautics Act of Japan, on June 11, 2011, issued a written reprimand to the Company for neglecting immediate report of the serious accident occurrence involved to the Minister of Land, Infrastructure, Transport and Tourism and continuing its operation after the event without sufficient confirmation of its airworthiness, and ordered to enhance the safety management system and develop the recurrence prevention measures.

The Tokyo Regional CAB also carried out an on-site inspection of the Company, pursuant to the Paragraph 2, Article 134 of the Civil Aeronautics Act of Japan, from June 13 through June 17, 2011, and found some concerns about the Company's structure regarding the safe flight operation, and thus, issued the following business improvement order, pursuant to Article 112 of the Civil Aeronautics Act of Japan, on June 29, 2011.

(1) Establishment of the Company's structure regarding safe flight operations

The general manager for safety should realize that he has general responsibility for the safe operations of the Company, and should carry out fundamental re-examination regarding the safety management system to fulfill its responsibility, such as making staffed with well informed and qualified persons who can totally perform their own duties as a leader and a manager in its division, so that the general manager for safety could take some reasonable countermeasures after he received the information about the matters which were involved with safe flight operation and occurred in the working fields of pilots, mechanics and others.

Besides this, the Company should implement education and training for all persons including the president so that they can understand how the Company's idea and policy about safety management are prescribed in its safety management manual and they can perform their practices properly, and the Company should rebuild their awareness of the importance of safety including compliance with related laws, rules and regulations.

(2) Intensive management of pilots' skills

While the Company should re-examine education, training and evaluation of the flight crewmembers to hold on and enhance their piloting skills for sure, such as implementing required intensive training in accordance with the rating of pilots in the evaluation, assessing them strictly after training and implementing additional training without delay in the case the Company found to be necessary, the Company should strengthen management of pilots' capability by means such as conducting regular supervised flights on a daily basis evaluation

5.1.2.2 Remedy by the Company

In response to the business improvement order by the Tokyo Regional CAB, the Company adopted the following remedy and reported the measures to the Director General of the bureau on July 29, 2011: Subsequently, the Company implemented specific measures one by one in accordance with the report.

(1) Establishment of structure regarding safe operations

The Company shall carry out the fundamental re-examination for the structure of the Company regarding the safety management system, and perform education and training for the senior members, equivalent to or higher than manager and intensively remind them of the importance of safety awareness.

The Company will summarize and implement the following measures immediately and surely working together in the Company and tackle continuously as verifying the progress, and will build a solid safety management system.

1) The fundamental re-examination of safety management system

The Company will carry out the rethink its double duty of the personnel in the safety promotion division and enhance the structure. The Company shall push ahead to strengthen its general function of the safety management system by appropriate personnel assignment.

- Strengthening of safety promotion division

Dissolving the double duty of the safety promotion manager and the flight operations manager

- Appropriate assignment of personnel

Review its staff assignment structure including reshuffling

2) Intensive education and training about the model of the safety management and enhancement of safety awareness

Maintain and enhance the system for safe operations by continuously implementing safety education and revise provisions relevant to the safety management regulations.

- Education and training for all employees

Education about the model and policy of the safety management, as well as safety awareness

- Enhancement of safety education based on safety management manual

Expand the range of personnel to be covered by "education for those engaged in jobs involved with safety management"

3) Enhancement of tackling with other efforts for safety management

Establish a system for safe operations by building a safety educational system and enhancing safety awareness across the board of the company.

・Building of safety education system

Divide education programs broadly into general and specialized education, and cultivate employees in continuous and step by step manner.

・Enhancing of safety awareness across the board of the company

- Launch a safety improvement campaign
- Hold a meeting to exchange views between employees and the general manager for safety

(2) Intensive management of pilots' skills

About the following measures the Company shall immediately implement for sure, tackle continuously, and intensively manage pilots' skills.

1) Clarification of the follow-up training in accordance with the rating of pilots in the evaluation and ensuing assessment.

Clarify how to deal with pilots in accordance with the rating of pilots in the all evaluation, achievement goal and status for follow-up trainings and the handling along with its rating.

- Handling of pilots in accordance with their rating

  Specification of the operating procedure for the follow-up training

- Clarification achievement goal and status of follow-up training

  Explanation of segmented guidelines in evaluation operations handling manual

- Assessment of follow-up training

  Clarification of the flow of the following ; Designation of the contents → Plan → Implement → Assessment → Process of judgment.

2) Reinforcement of routine skill management

Institutionalize the monitor flights, and analyze the conditions and results of the monitor flights. Hold an occasion like general meeting for enhancing skills for all flight crewmembers.

・Monitor flight system

- Institutionalize a monitor flight system

  Prescribe the specific operational procedure and formally launch a "monitor flight system"

- Analyzing results of monitor flights and studying about further steps

  Hold monthly meetings for analysis and decisions

・Holding meetings for enhancement of skills

Hold monthly meeting occasion on matters useful for routine flight operations, including cultivating of personnel

5.2 Safety Actions Required

Safety actions by the Company

(1) Calling out and confirmation of the mode for sure.

Because the PIC and the FO didn't confirm the correct changing of both the lateral and vertical mode upon going around from the MDA of 600ft and changing the mode from go-around to HDG/IAS, they could not understand that there was a conspicuous big difference between the crew's intentions (for going around) and the FD command bar directions (for maintaining 600ft).

Flight crewmembers are requested by AOM that they should confirm and call out the mode indication on EADI in an appropriate manner, upon changing the mode while using the AP/FD system. But they don't always need to follow AOM and it might be only necessary for them to call out the mode as long as they can.

AOM also urges both PF and PM to confirm the mode indication and call it out while using the AP/FD system, but the corresponding part of FTG does not necessarily require them to do so. Accordingly, the relevant descriptions were vague and inconsistent.

Based on the findings, it is probable that the procedures of mode confirmation and callout as well as importance of these procedures had not been specified as standard procedures of the Company in a manner of reflecting AOM, and education and training for these procedures were not sufficient.

It is important for flight crewmembers, with fully study and understanding about the operation of the AP/FD system at any phase of flight, to confirm their desired mode while using it following selection of intended mode depending on their task. Especially when lots of piloting tasks are concentrated such as in go-around, flight crewmembers should call it out and confirm it to verify their operations.

The Company should make its flight crewmembers comply with the specifics of AOM (confirmation and callouts of mode changes upon using the AP/FD system or on progress of automatic mode changes), as described in 2.13.4 without fail, and it should consider that FTG shall be revised in some related matters.

(2) Appropriate use of autoflight system and management of pilots' skill

It is possible that the PIC followed the FD command bar while feeling something uncomfortable about its directions and it is highly probable that he did not confirm the basic flight instruments. It is probable that the FO tried to make the Aircraft climb by changing the mode on the autoflight system, despite facing the imminent ground proximity situation. Based on these findings, it is probable that the PIC and the FO had over relied on the autoflight system.

Therefore, it is important for the Company to increase the opportunities for training as well as utilizing simulator's session to improve raw data instrument skills. The Company also should clarify the problems caused by over rely on the autoflight system and consider to fully inform its flight crewmembers of specific countermeasures against them.

6 RECOMMENDATIONS

Based on the results of this serious incident investigation, the Japan Transport Safety Board recommends Hokkaido Air System Co., Ltd. to take necessary actions for the following matters, pursuant to Article 27-1 of the Act for Establishment of the Japan Transport Safety Board, in order to prevent a reoccurrence of similar serious incidents.

(1) Calling out and confirming the mode change for sure

Because the PIC and the FO didn't confirm the correct changing of both the lateral and vertical mode upon going around from the MDA of 600ft and changing the mode from go-around to HDG/IAS, they couldn't understand that there was a conspicuous big difference between the crew's intentions (for going around) and the FD command bar directions (for maintaining 600ft).

Flight crewmembers are requested by the AOM that they should confirm and call out the mode indication on EADI in an appropriate manner upon changing the mode while using the AP/FD system. But they do not always need to follow AOM and it might be only necessary for them to call out the mode as long as they can.

Description of other parts in AOM also urges both PF and PM to confirm the mode indication and call it out while using the AP/FD system, but the corresponding part of FTG does not necessarily require them to do so. As a result, the relevant descriptions were vague and inconsistent.

Based on the findings, it is probable that the procedures of confirming and calling out the mode, as well as importance of these procedures, had not been specified as standard procedures of the Hokkaido Air System Co., Ltd. in a manner of reflecting AOM, and education and training for these procedures were not sufficient.

It is important for flight crewmembers, with fully understanding about the operation of the AP/FD system at any phase of flight, to confirm their desired mode while using it following selection of intended mode depending on their task. Especially when lots of piloting tasks are concentrated such as in go-around, flight crewmembers should call it out and confirm it to verify their operations.

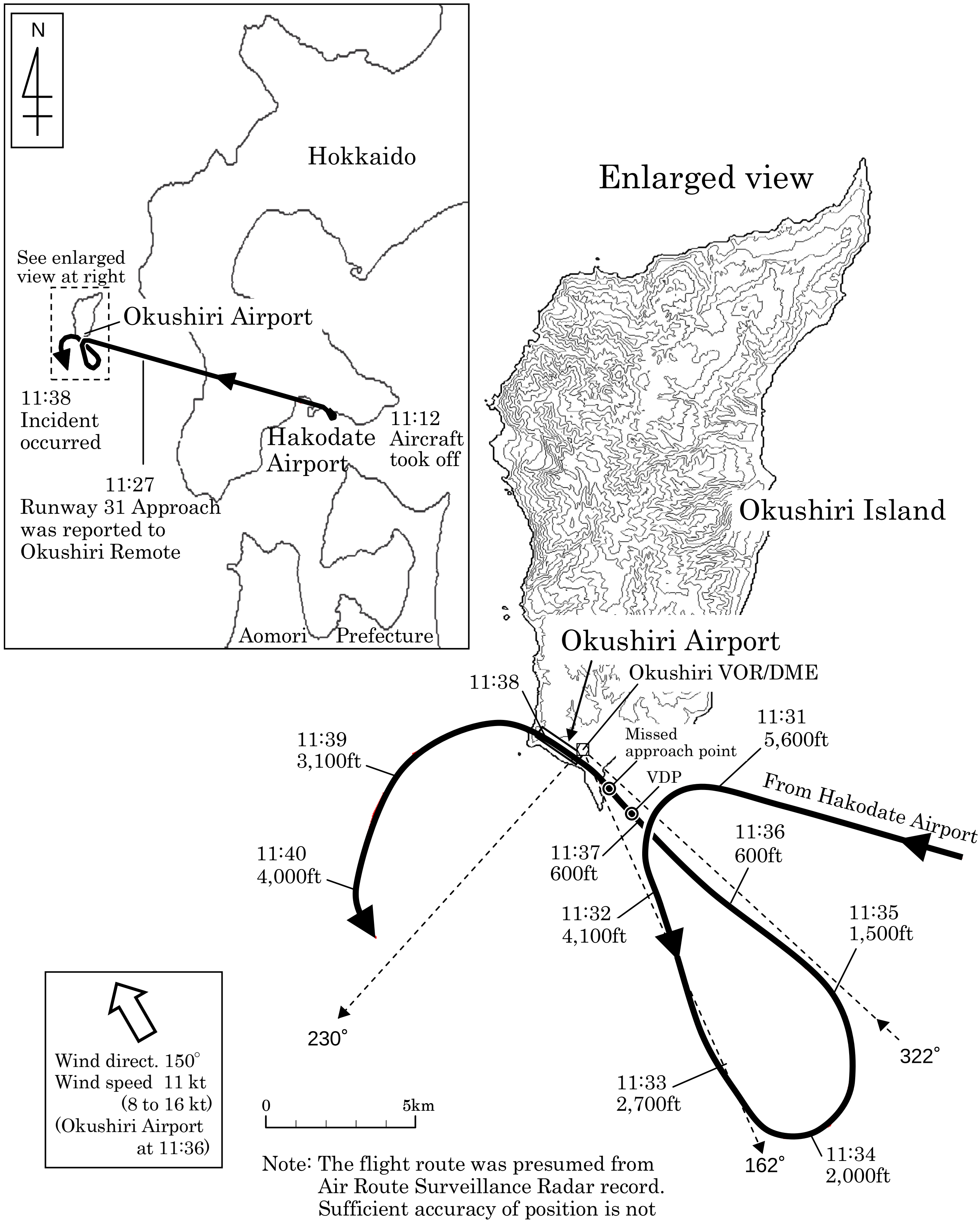
Hokkaido Air System Co., Ltd. should make its flight crewmembers comply with the specifics of AOM (confirmation and callouts of mode changes upon using the AP/FD system or on progress of automatic mode changes), as described in 2.13.4 without fail, and it should consider that FTG shall be revised in some related matters.

(2) Appropriate use of autoflight system and management of pilots' skill

It is possible that the PIC followed the FD command bar while feeling something uncomfortable about its instructions and it is highly probable that he did not confirm the basic flight instruments. It is probable that the FO tried to make the Aircraft climb by changing the mode on the autoflight system, despite facing the imminent ground proximity situation. Based on these findings, it is probable that the PIC and the FO had excessively relied on the autoflight system.

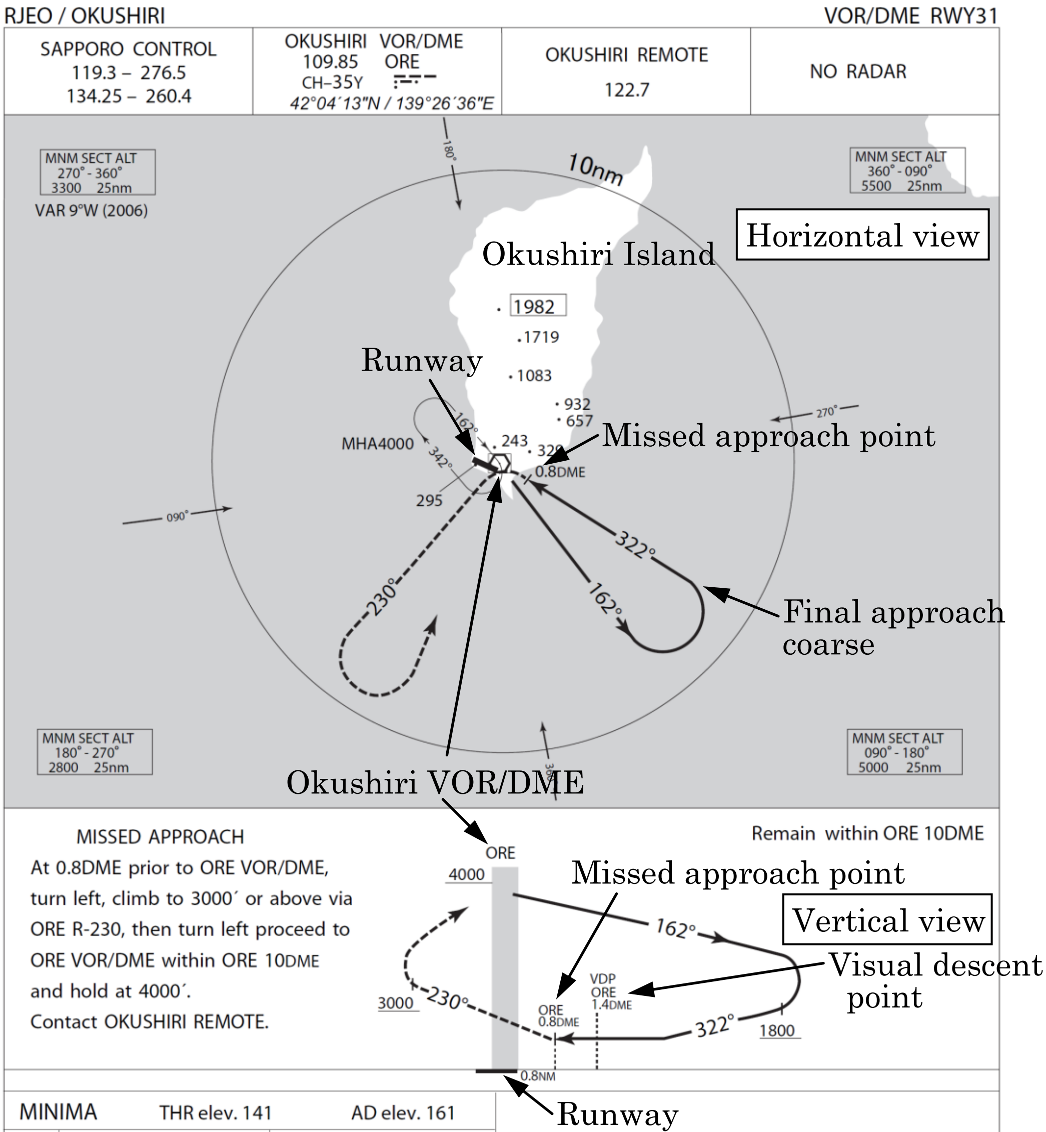
Therefore, it is important for the Hokkaido Air System Co., Ltd. to increase the opportunities for training as well as utilizing simulator's session to improve raw data instrument skills. The Hokkaido Air System Co., Ltd. also should clarify the problems caused by excessive reliance on the autoflight system and consider to fully inform its flight crewmembers of specific countermeasures against them.

Figure 1 Estimated Flight Route



Note: The flight route was presumed from Air Route Surveillance Radar record. Sufficient accuracy of position is not acquired in this scale.

Figure 2 VOR/DME RWY31 Approach Procedure



MINIMA	THR elev. 141		AD elev. 161	
CAT			CIRCLING	
	MDA(H)	CMV	MDA(H)	VIS
A	600 (459)	1500	600 (439)	1600
B			620 (459)	
C	–	–	–	–
D				

Circling to South side of RWY only.

Note: Remarks and arrows are added for explanations.

Figure 3-1 TAWS Records (1)

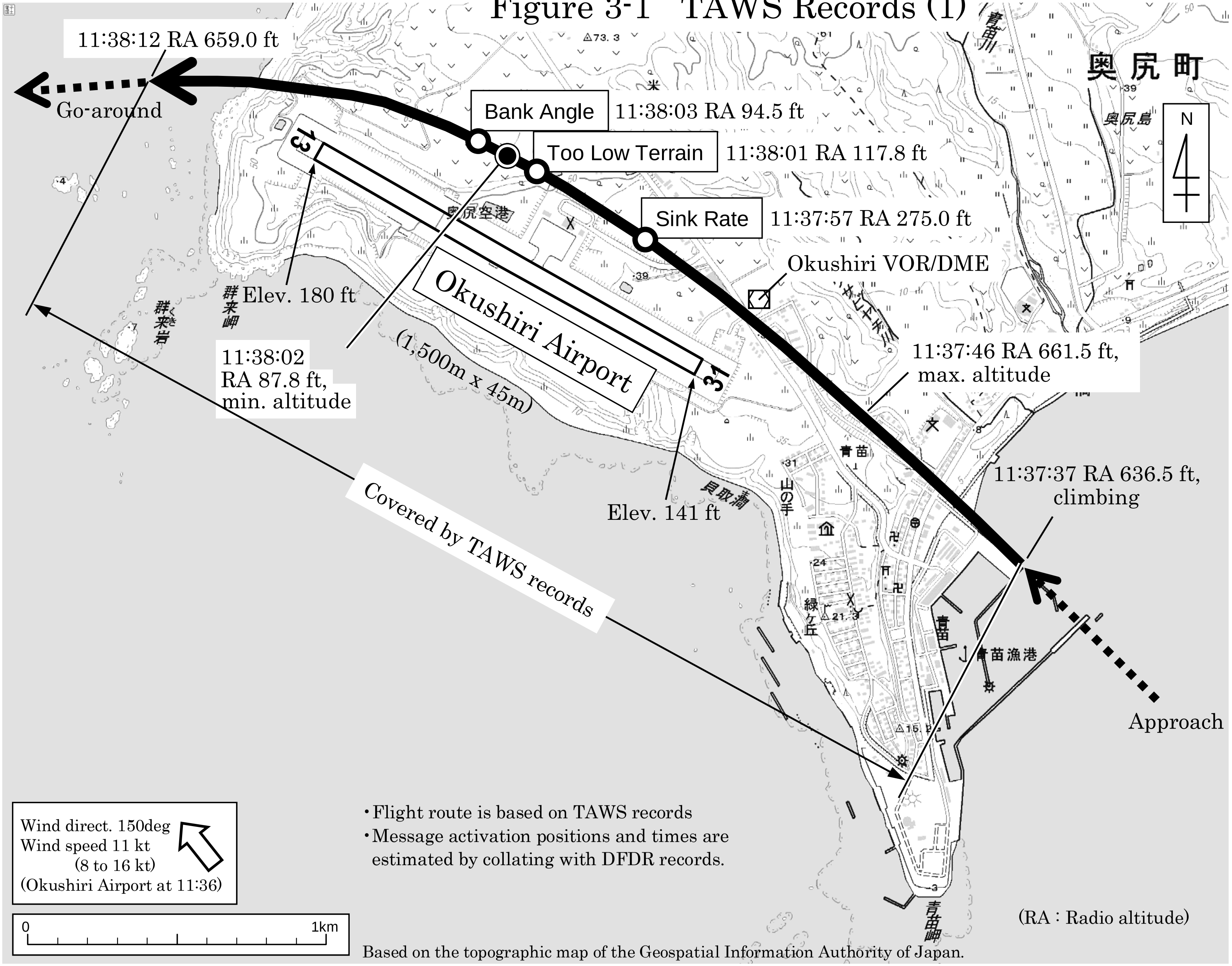


Figure 3-2 TAWS Records (2)

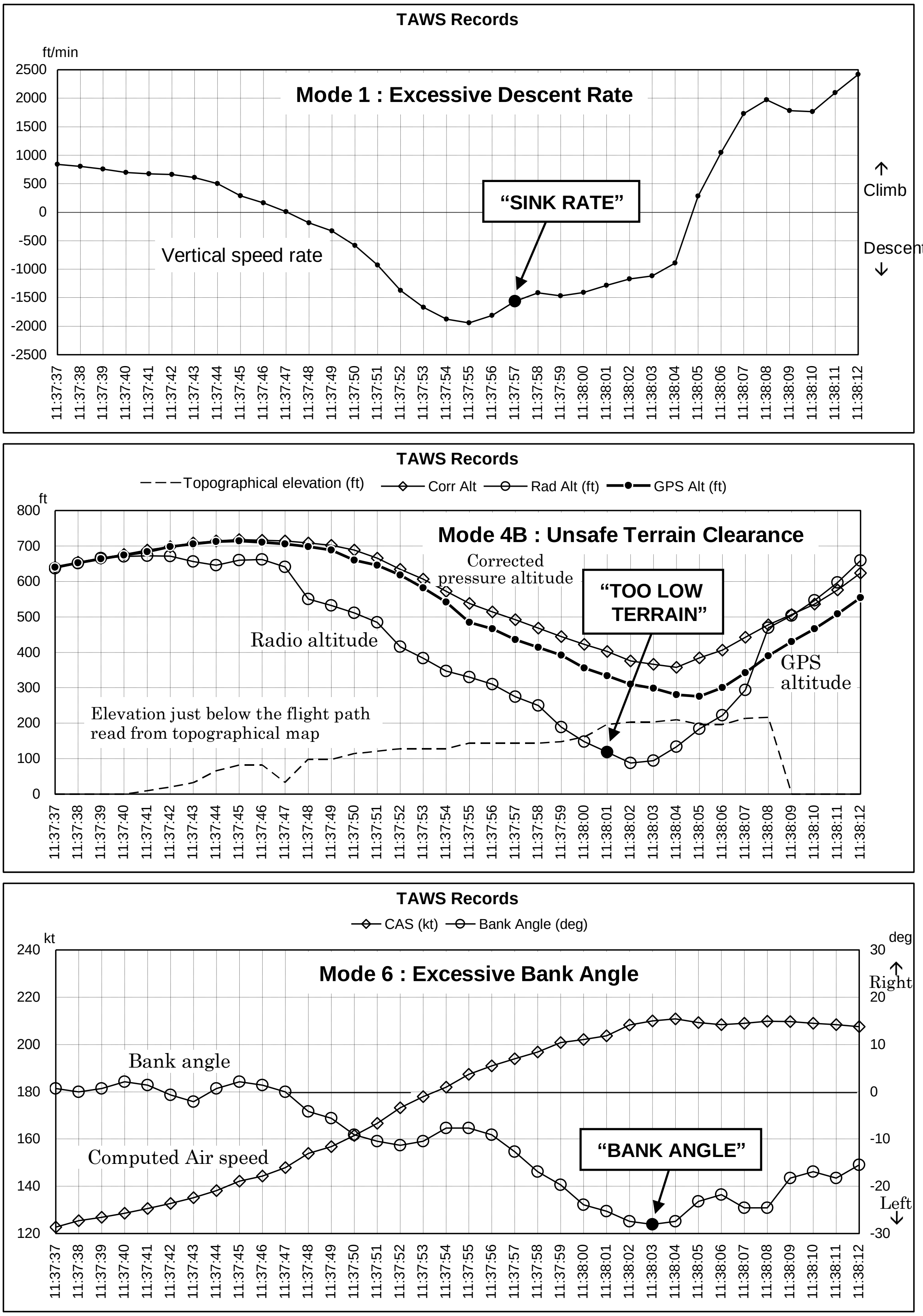


Figure 4-1 DFDR Records (1)

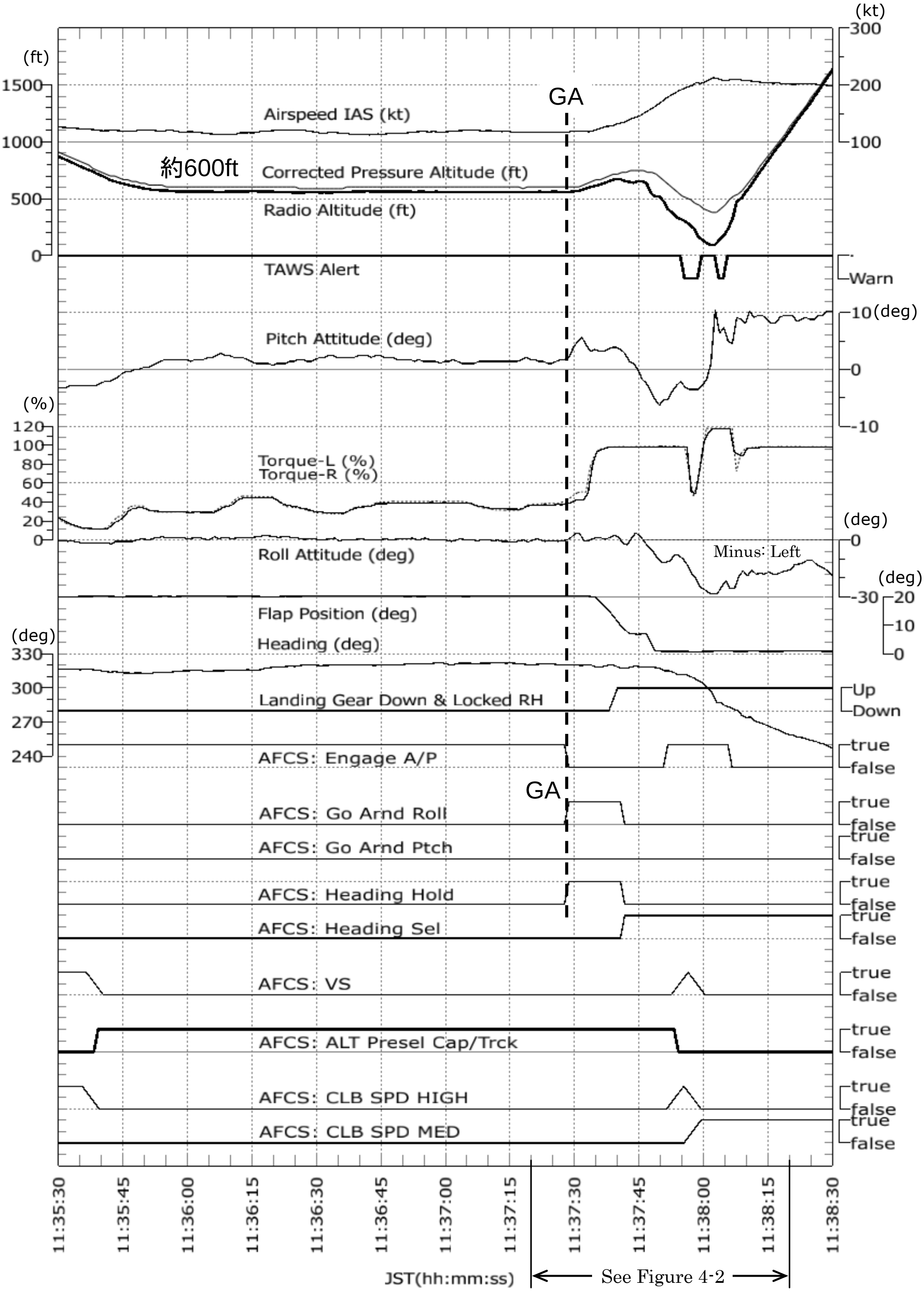


Figure 4-2 DFDR Records (2)

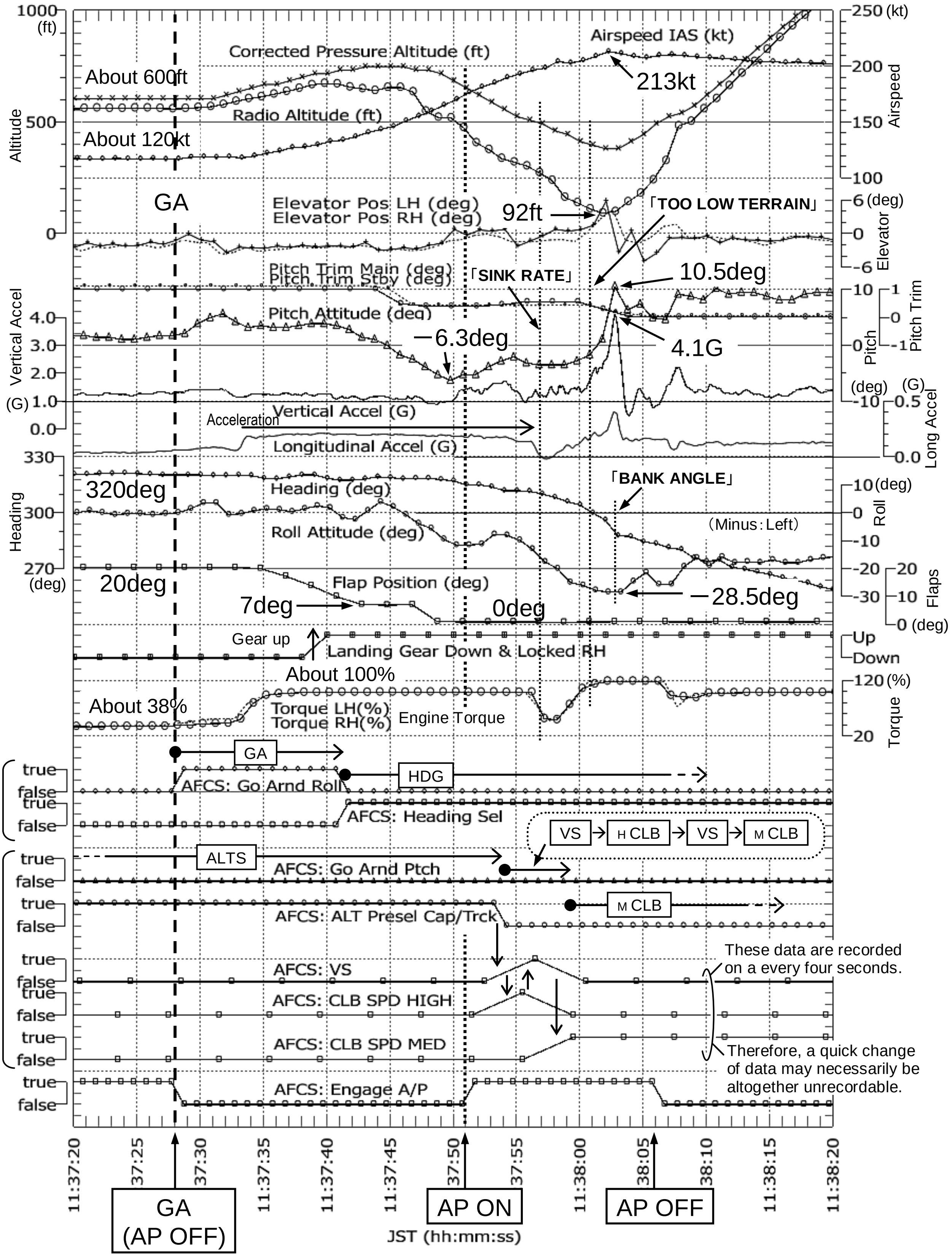
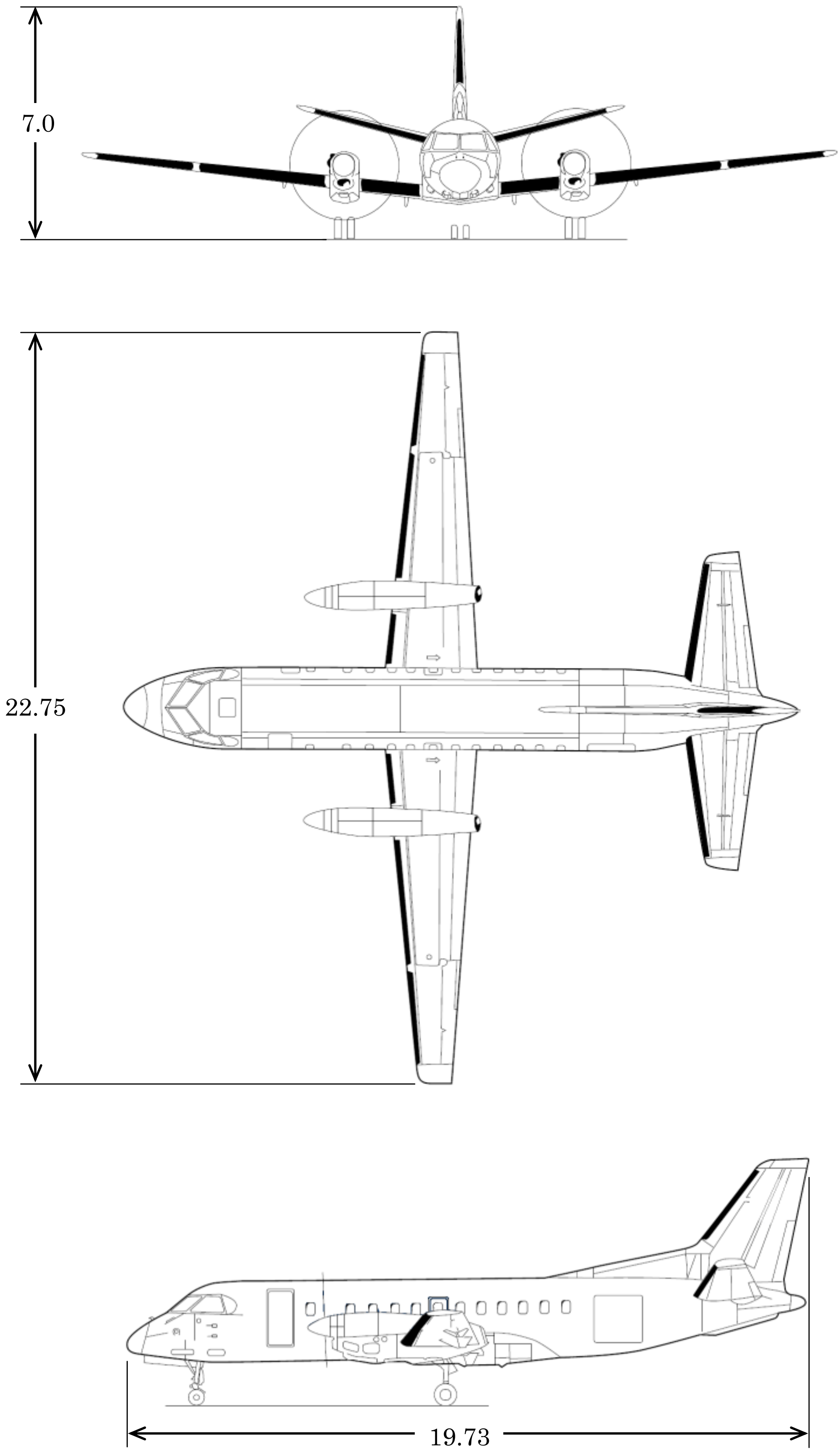


Figure 5　　Three angle view of SAAB 340B

Unit ： m



Attachment　Functions and Indications of Autoflight

1. AP/FD System

The AP/FD system is an automatic flight system which combines the functions of autopilot and flight director, both of which are controlled by an FCC. The computer calculates displacement amounts in the vertical and lateral directions based on aircraft attitude and other data, and sends the calculated signals to autoflight and flight director, so that an airplane can fly its desired track.

Autopilot is the function of the AP/FD system to pilot an aircraft automatically, so that an airplane can fly its desired track, as FCC's signals operate an actuator which drives control surface such as ailerons and rudders.

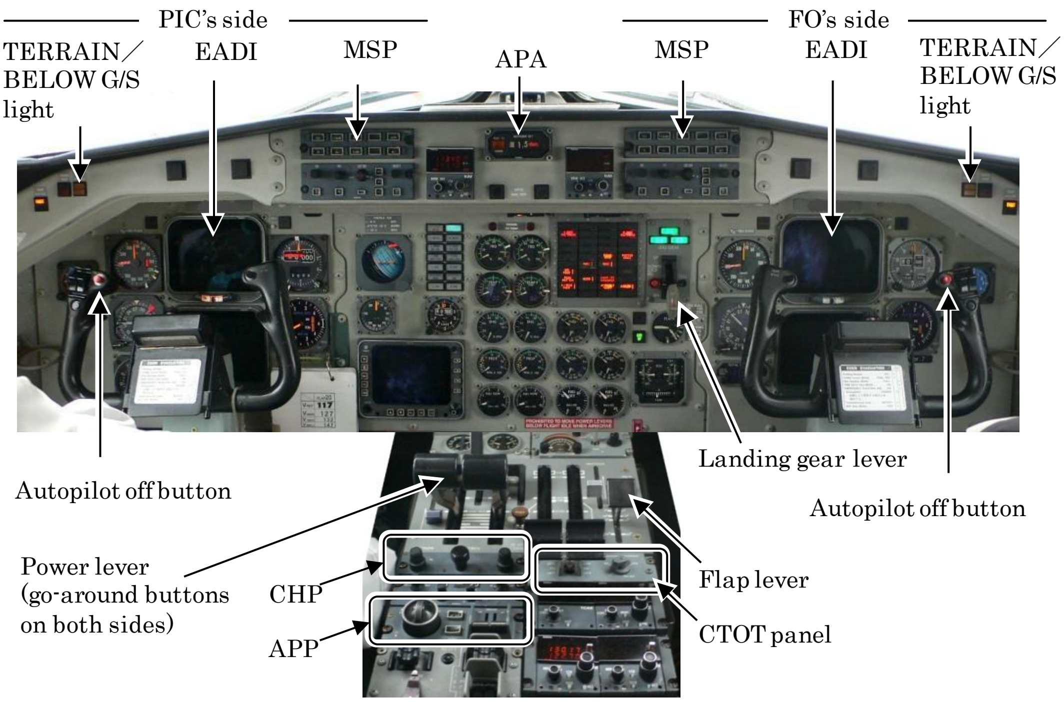
Flight director is the function of the AP/FD system to visibly show the direction to fly and its attitude to pilots by indicating the FD command bar on EADI in the cockpit as the FCC signals. Pilots can fly the airplane on the desired track by manually following the FD command bar instructions (coupling the airplane symbol with the FD command bar).

Pilots, while using autopilot, use the FD command bar displayed on EADI monitoring the aircraft's movement by other flight instruments, and won't fly an aircraft by only using autopilot in a normal flight.

Pilots are required to adjust the power lever to change or maintain its speed in accordance with the aircraft attitude because the Aircraft was not equipped with the autothrottle system which automatically controls the engine output. But during takeoff or go-around, pilots can get their necessary output without moving the power lever by setting the CTOT switch (to be described in Clause 5) to the APR position.

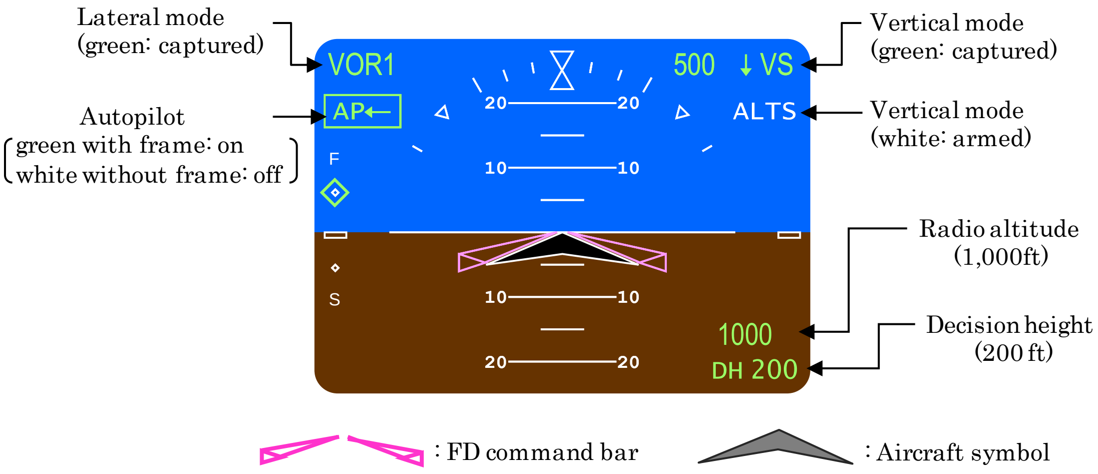
2. Configuration of AP/FD System

The cockpit of the Aircraft is equipped with integrated electronic instruments, such as EADI, while panels and other devices for operating the AP/FD system are installed as below.



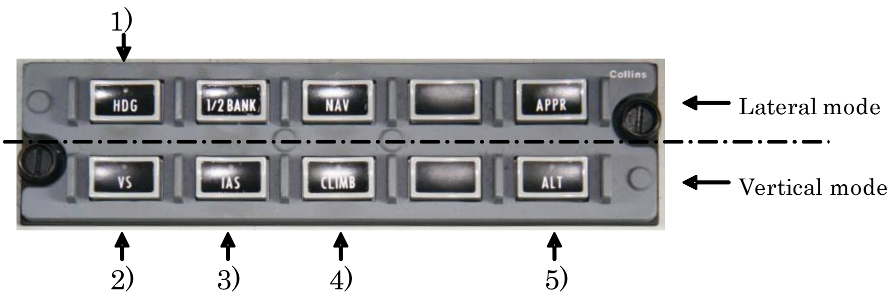
(1) EADI

EADI is an integrated instrument including the attitude indication symbol of aircraft, the FD command bar to show pitch and roll command signals from AP/FD system, current AP/FD modes or status varying colors, green or white, the radio altitude reading, etc. Following are specific indications on EADI:



(2) MSP

MSP is a panel for selecting the lateral and vertical modes of the AP/FD system, with lateral mode buttons placed in the upper column and vertical mode buttons in the lower column. Main buttons and their functions are outlined as follows:



1) HDG

The HDG mode is a function for flying with the heading maintained. The airplane can be directed to the desired direction by operating the HDG knob on CHP, to be described in (3), and the turn knob on APP, to be described in (6).

HDG will be displayed on the lateral mode area on EADI.

2) VS

The VS mode is a function for flying with a certain vertical speed rate maintained. The mode sets a vertical speed rate when a pilot pushes the vertical-synchro-button, to be described in (5), on the control wheel and then releases the button. The vertical speed rate can also be set by operating the pitch wheel on APP.

The vertical mode on EADI not only shows VS but also indicates the vertical speed rate value and climb/descent distinction with arrows. The FD command bar indicates the pitch angle for maintaining the set vertical speed rate.

3) IAS

The IAS mode is a function for flying with the instrument speed maintained. The mode sets a speed when a pilot pushes the vertical-synchro-button on the control wheel and releases the button. The mode can also be set by operating the speed setting knob of the airspeed indicator, to be described in (5). The vertical mode on EADI shows the set speed in addition to IAS while the FD command bar shows the pitch angle for maintaining the set speed.

4) CLIMB

The CLIMB mode is a function for flying with the speed maintained, just like IAS. But, this mode sets only a climb speed. The climb speed represents a value calculated by a computer based on the aircraft weight and the altitude. By repeatedly pressing the CLIMB button, the high (182kt), medium (160kt) and low (139kt) climb speeds can be selected, respectively.

The vertical mode on EADI indicates specific climb speeds on top of H CLM, M CLM and L CLM according to the three climb speeds. The FD command bar shows the pitch angle for maintaining the set climb speed.

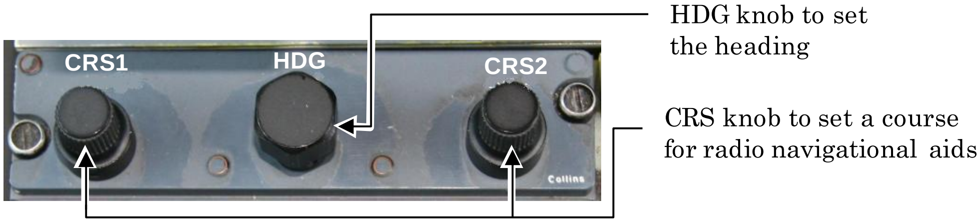
5) ALT

The ALT mode is a function for flying while maintaining an altitude other than the APA set altitude. The mode maintains an altitude when the ALT button is pressed.

ALT will be displayed in the vertical mode area on EADI, while the FD command bar shows the pitch angle for maintaining the set altitude.

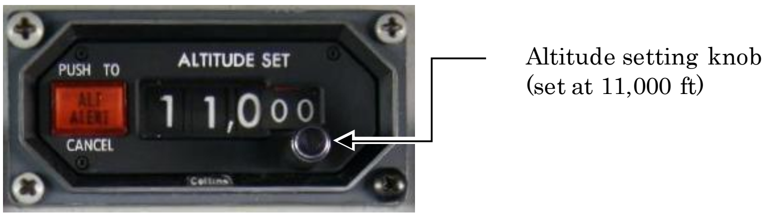
(3) CHP

CHP is a panel for setting courses such as the desired heading and VOR.



(4) APA

APA is a panel for setting a planned altitude to perform a level flight when autopilot or FD is in use. When the airplane approaches the planned level-off altitude, ALTS (in green) appears as capturing phase of the vertical mode on EADI, followed by ALTS (in white) as tracking phase upon reaching the level-off altitude, with some other information like recommended computer-calculated speed in cruise. The FD command bar indicates a pitch angle to maintain the established altitude.



(5) Speed setting knob and vertical-synchro-button

The speed setting knob is placed only in left IAS indicator to set a speed on the IAS mode of the AP/FD system. The left seat pilot can establish his desired speed by setting the speed bug in IAS indicator with this speed setting knob. The vertical-synchro-buttons are placed on the control wheel on both seats. When a pilot pushes the button and releases it while the AP/FD system is in use, the speed, the vertical speed rate and others can be set according to the vertical mode at that time.

(6) APP

APP is equipped with the turn knob, the pitch wheel, the autopilot lever and other devices.

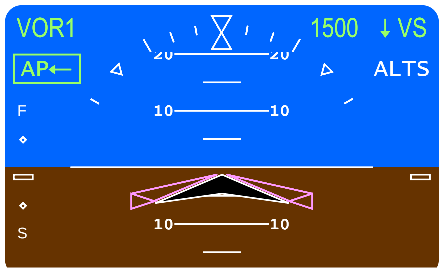
The turn knob is designed to set the turn direction manually on the HDG mode of the AP/FD system. A limit bank angle on autopilot is 27°. The pitch wheel can set the vertical speed rate in increments of 50 fpm. The vertical mode on the AP/FD system automatically turns to VS to maintain constant vertical speed rate by operating this wheel.

The autopilot lever is operated to engage or disengage autopilot. The system can also be disengaged by pressing the autopilot off button on the control wheel. When autopilot was disengaged, a warning sound will be activated for the pilot.

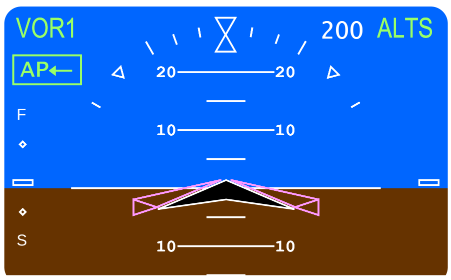
3. Examples of Mode Indications

The modes on the AP/FD system are roughly divided into lateral and vertical ones. The modes and their indications on EADI for a descent in non-precision approach, a level flight, a go-around and a subsequent climb are as follows:

(1) Descent (descent to MDA along with VOR course)



See the right display; autopilot AP← (in green) and FD are engaged. The lateral and vertical modes display VOR1 and VS, respectively. The airplane is tracking established VOR course and descending at 1,500 fpm. The airplane symbol is overlapping the FD command bar showing lower pitch than a horizon. It indicates that the AP/FD system is working in process of maintaining the descent rate of 1,500 fpm. The vertical mode is armed (on stand-by) at ALTS (in white) and when the airplane approaches to the planned altitude set on APA, soon it will be captured.



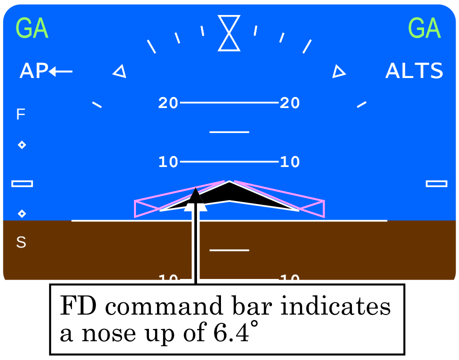
(2) Level flight (level flight at MDA)

Autopilot and FD are engaged. The lateral mode displays VOR1 tracking the established VOR course.

The vertical mode turned to ALTS, following level-off at the MDA set on APA and the recommended cruise speed of 200kt will be displayed. The FD command bar and the airplane symbol overlap each other, and a reasonable pitch angle for level flight is displayed.

(3) Go-around

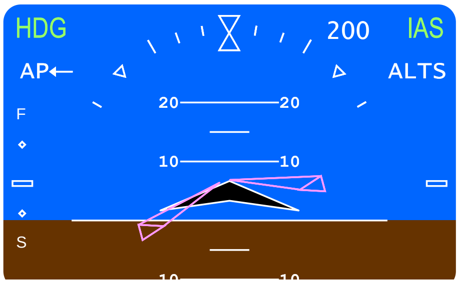
If the pilot pushes the GA button on the power lever, autopilot will be disengaged, and the AP← (in green) indication will change to a white sign without a frame. The FD command bar will remain displayed.



The lateral and vertical modes indicate GA, while the FD command bar automatically indicates the current heading and a pitch up of 6.4°. The ALTS sign on the vertical mode will be displayed in white showing its armed state. At this time, it is usual general procedure for pilots to preset an initial missed approach altitude before landing and a go-around by operating APA.

(4) Accelerating climb after go-around operation

Autopilot is disengaged, but the FD command bar remains displayed on EADI. When the pilot pushes the HDG button on MSP after a go-around operation, HDG will be displayed in the lateral mode on EADI, while a desired heading can be set by operating the HDG knob on CHP or the turn knob on APP.

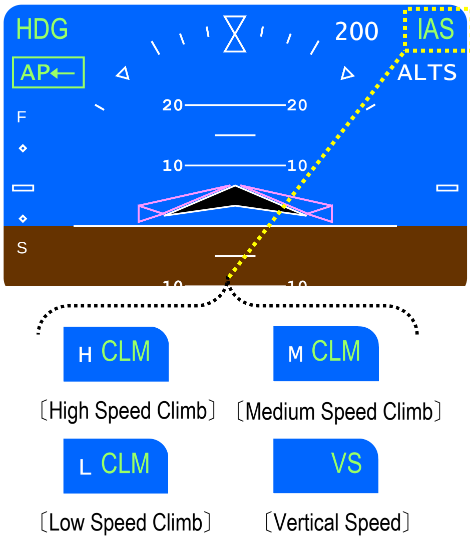


When the pilot pushes the IAS button on MSP, IAS is displayed on the vertical mode on EADI with additional information of the recommended cruise speed of 200kt. The climb speed can be set by operating the speed setting knob of the airspeed indicator or the vertical-synchro-button. There are VS, CLM and IAS in the vertical mode. However, since pilots need to change its configuration from landing to cruise phase status depending on its speed while accelerating climb after go around, they usually use IAS, so that they can set any desired speed to fly the Aircraft.

The FD command bar in a figure above indicates left climbing turn.

(5) Steady climb

When the airplane starts flying in steady climb after completion of go-around operation, autopilot will be engaged to free the pilot's loads. The lateral mode remains HDG, and autopilot controls the airplane to maintain the set heading. As for the vertical mode, besides IAS, the pilot can select VS, as well as CLM in which pilots can select one of the three FCC calculated climb speeds; high, medium and low.



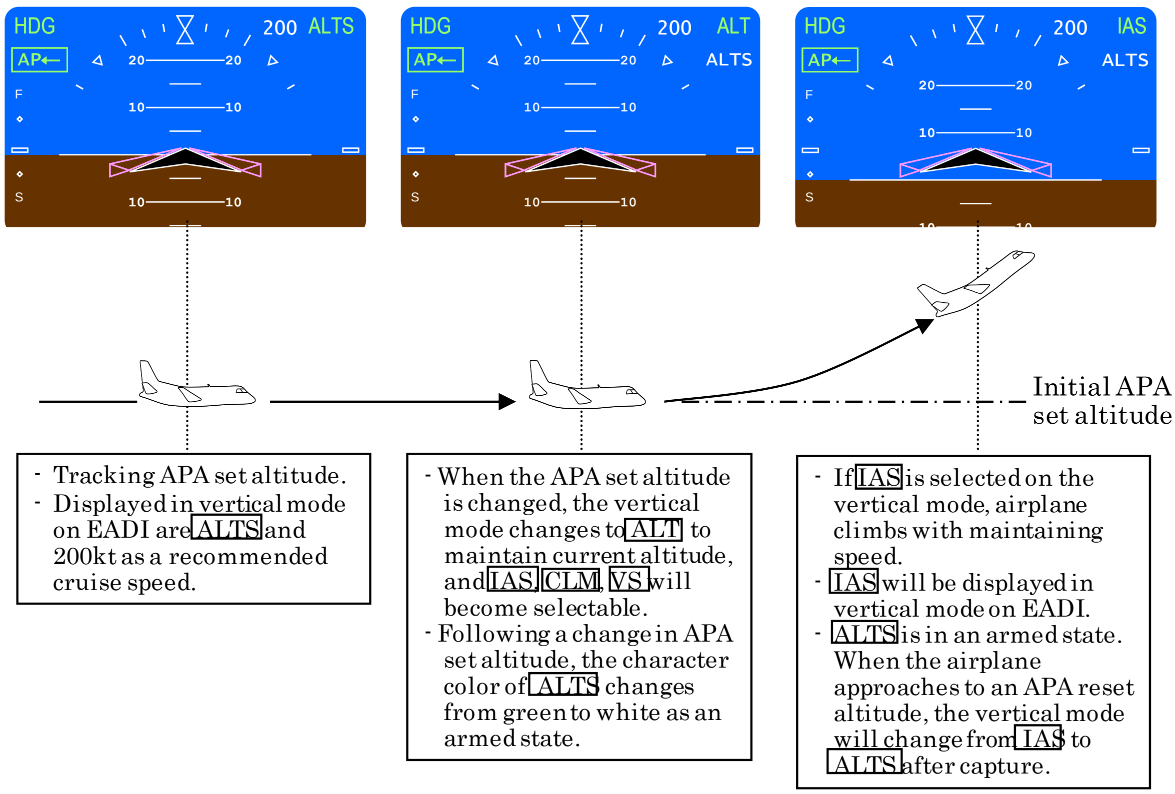
The Aircraft is not equipped with the autothrottle system. Therefore, the pilot must manually operate the power lever to maintain a desired speed.

The FD command bar in a figure above indicates a nose up of ＋6.4°.

4. Mode Changes on AP/FD System Following Altitude Changes

When the airplane is on a level flight at set altitude on APA, the vertical mode on the AP/FD system is in the ALTS tracking state to track the set altitude. EADI displays ALTS and a recommended cruise speed. While the APA set altitude is in the tracking state, the vertical mode does not deviate from the ALTS tracking state even if the aircraft climbs or descends, and the FD command bar directs to return to the set altitude. When autopilot is engaged, the aircraft automatically returns to the set altitude on APA.

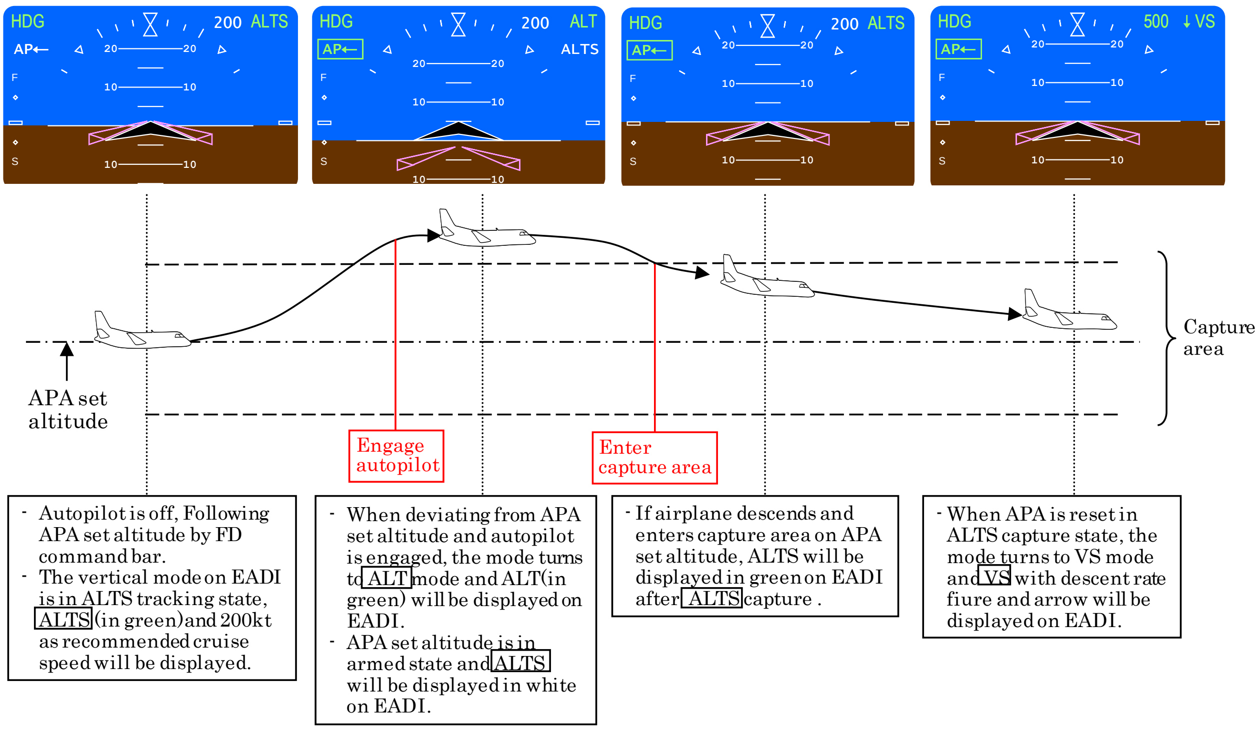
If pilots intend to change the flying altitude from a level flight with the vertical mode in the ALTS tracking state, they will set the desired altitude on APA. Then, the vertical mode automatically changes to ALT and pilots can select the necessary vertical mode (IAS, CLM or VS) for climb or descent. However, if the vertical mode remains in the ALTS tracking state without setting the altitude on APA, pilots can't select the vertical mode.



If pilots engage autopilot to free their workloads when the airplane is deviating from the set altitude because of unintended reasons such as turbulence during manual level flying on the set altitude on APA, the vertical mode will change to ALT mode to maintain the current altitude and ALT will be indicated on EADI. But, when the aircraft approaches to the APA set altitude and enters the capture area, the vertical mode will capture the APA set altitude and the vertical mode indication on EADI will change from ALT to ALTS. As a result, the aircraft with autopilot will automatically return to the APA set altitude and maintain the altitude

The capture area changes according to the vertical speed rate at a specific time. The higher the vertical speed rate regarding the APA set altitude is, the wider its capture area is, and vice versa.

When the APA set altitude is changed while the vertical mode is in the ALTS capture state, the vertical mode turns to VS mode with indication of VS and the vertical speed figure with an arrow (↓ or ↑) on EADI.



5. CTOT Panel

CTOT is a device to support to set power during take-off and go-around, and controls the fuel amount to maintain its torque value. The device works when the CTOT switch is on and the power lever is moved beyond 64°. Pilots can also get more power by operating the power lever manually to override this CTOT.

CTOT is not included in the AP/FD system.