AI2012-1

AIRCRAFT SERIOUS INCIDENT INVESTIGATION REPORT

AIR NIPPON CO., LTD.

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January 27, 2012

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

AIR NIPPON CO., LTD.
BOEING 737-800, JA55AN
AT AN ALTITUDE OF ABOUT 6,800 FT, AT ABOUT 30 KM EAST OF ASAHIKAWA CITY, HOKKAIDO PREFECTURE
AROUND 13:38 JST, OCTOBER 26, 2010

January 13, 2012

Adopted by the Japan Transport Safety Board

Chairman	Norihiro Goto
Member	Shinsuke Endoh
Member	Toshiyuki Ishikawa
Member	Sadao Tamura
Member	Yuki Shuto
Member	Toshiaki Shinagawa

Abbreviations applied in this report are as follows.

AOM	: Aircraft Operating Manual
ATC	: Air Traffic Control
CFIT	: Controlled Flight Into Terrain
CRM	: Crew Resource Management
CVR	: Cockpit Voice Recorder
DFDR	: Digital Flight Data Recorder
DME	: Distance Measuring Equipment
EGPES	: Enhanced Ground Proximity Warning System
E-MSAW	: Enroute-Minimum Safe Altitude Warning
IECS	: Integrated Enroute Control System
MEA	: Minimum Enroute Altitude
MSAW	: Minimum Safe Altitude Warning
MVA	: Minimum Vectoring Altitude
ND	: Navigation Display
OJT	: On t~~T~~he Job Training
PF	: Pilot Flying
PFD	: Primary Flight Display
PNF	: Pilot Not Flying
QAR	: Quick Access Recorder
TCAS	: Traffic Collision Avoidance System
TRM	: Team Resource Management
VOR	: VHF Omni-directional Radio Range
VSD	: Vertical Situation Display

Unit Conversion Table

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

1. PROCESS AND PROGRESS OF THE INVESTIGATION

1.1 Summary of the Serious Incident

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

On Tuesday, October 26, 2010, a Boeing 737-800, registered JA55AN, operated by Air Nippon Co., Ltd., took off from Chubu Centrair International Airport for Asahikawa Airport as the scheduled flight 325 of All Nippon Airways Co., Ltd., under the wet lease agreement with All Nippon Airways Co.,Ltd., When the aircraft was descending toward Asahikawa Airport following an air traffic controller's instructions near the destination aerodrome, its ground proximity warning system issued a warning at about 6,800 ft about 30 km east of Asahikawa City, Hokkaido Prefecture. The aircraft took an emergency maneuver and landed at Asahikawa Airport at 14:05 Japan Standard Time (JST: UTC+ 9hr, unless otherwise stated all times are indicated in JST on a 24-hour clock).

There were 57 persons on board, consisting of the PIC, five other crewmembers, and 51 passengers, but no one was injured.

1.2 Outline of the Serious Incident Investigation

1.2.1 Investigation Organization

On October 26, 2010, the Japan Transport Safety Board (JTSB) designated an investigator-in-charge and two other investigators to investigate this serious incident.

1.2.2 Representatives from Relevant State

The JTSB notified this serious incident to the United States of America as the State of Design and Manufacture of the aircraft involved in this serious incident, but no accredited representative was designated.

1.2.3 Implementation of the Investigation

October 27 and 28, 2010	Interviews
March 14, 2011	Reproductive investigation with simulator
April 28, 2011	Interviews

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

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

1.2.5 Comments from the Relevant State

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

2. FACTUAL INFORMATION

2.1 History of the Flight

At 12:21 on October 26, 2010, a Boeing 737-800, registered JA55AN (hereinafter referred to as "the Aircraft A"), operated by Air Nippon Co., Ltd. (hereinafter referred to as "the Company"), took off from Chubu Centrair International Airport for Asahikawa Airport. When the Aircraft A was descending toward Asahikawa Airport per air traffic controller's instructions near the destination aerodrome, the aircraft flew close to the ground and its enhanced ground proximity warning system (EGPWS) detailed in 2.10.6, issued a warning at about 6,800 ft about 30 km east of Asahikawa City, Hokkaido Prefecture followed by emergency maneuvers.

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

Flight rules:	Instrument flight rules (IFR)
Departure aerodrome:	Chubu Centrair International Airport
Estimated off-block time:	12:10
Cruising speed:	453 kt
Cruising altitude:	Flight Level (FL) 370
Route:	(Omitted) – CHE (Chitose VOR/DME) – Airway V7 – AWE (Asahikawa VOR/DME)
Destination aerodrome:	Asahikawa Airport
Total estimated elapsed time:	1 h and 21 min
Fuel load expressed in endurance :	4 h and 47 min

Two pilots, a Pilot in Command (PIC) and a First Officer (FO), were on board the Aircraft A as flight crew. The PIC sat in the left seat as the PF (pilot flying: pilot mainly in charge of flying) and the FO in the right seat as the PNF (pilot not flying: pilot mainly in charge of duties other than flying).

The history of the Aircraft A's flight up to the time of the serious incident is summarized as below, based on the records of ATC communication, the digital flight data recorder (DFDR), and EGPWS as well as the statements of the flight crew and air traffic controllers.

2.1.1 History of the Flight based on Records of ATC Communication, DFDR and EGPWS.

Around 13:20	The Aircraft A started descent from FL 370 about 100 nm before Asahikawa Airport.
Around 13:24	The Aircraft A flew over CHE at about 27,000 ft.
13:25:31	The Sapporo Air Traffic Control Center (hereinafter referred to as "Sapporo Control") instructed the Aircraft A to descend to 11,000 ft.
13:27:10	Sapporo Control instructed the Aircraft A to hold over AWE (holding in the air*[1]) and notified that an expected approach time would be around 13:37. The Aircraft A read back it.
About 13:28	The Aircraft A's speed brake handle was pulled.
About 13:31	The Aircraft A flew over ASIBE (a reporting point) 15 nm southwest of Asahikawa Airport at about 17,700 ft.

*1 Holding in the air means a situation in which the aircraft waits while flying in a certain pattern in areas over an approach fix or a preceding fix when it cannot make an approach following cruising/descending due to air traffic congestion, the need to see an improvement in the weather condition and a cancellation of runway closure.

13:32:57	The preceding aircraft bound for Asahikawa Airport (hereinafter referred to as "the Aircraft B") requested Sapporo Control to hold over AWE due to a minor trouble. Sapporo Control instructed the Aircraft B to hold there at 8,000 ft.
13:33:19	When the Aircraft A was descending at about 13,800 ft 4 nm before Asahikawa Airport, Sapporo Control instructed the Aircraft A to descend to 9,000 ft and notified it that the Aircraft A would be the first in approach sequence and to be vectored for further descent. The Aircraft A read back.
13:33:42	Sapporo Control instructed the Aircraft A to turn right to heading 090° for descent. The Aircraft A read back it.
13:33:54	Sapporo Control verified the Aircraft A to fly a heading 090 and it would be vectored to AWE. The Aircraft acknowledged.
About 13:34	The Aircraft A flew over AWE at about 12,500 ft and continued descent with its heading 090° .
13:35:55	When the Aircraft A was descending at about 9,800 ft near 8 nm east of Asahikawa Airport, Sapporo Control instructed the Aircraft A to descend to 5,000 ft. The Aircraft A read back it.
13:36:20	The altitude of the Aircraft A was about 9,200 ft which is below the MVA*2 (10,000 ft) for this area at a point 10 nm east of Asahikawa Airport, but it continued to descend conforming to instructions from Sapporo Control.
13:37:01	When the Aircraft A was descending at about 7,700 ft in the area about 13 nm east of Asahikawa Airport, it requested Sapporo Control to turn right to return to Asahikawa Airport.
13:37:06	Sapporo Control instructed the Aircraft A to make a right turn and fly heading 200. The Aircraft A read back it.
13:37:14	The Aircraft A started a right turn while descending at about 7,200 ft.
13:37:22	EGPWS issued "CAUTION TERRAIN" alert (to be detailed in 2.10.6). At this moment, the maximum display range of the navigation display*3 (ND) had been set to 20 nm on the PIC's side and 40 nm on the FO's side.
13:37:26	The speed brake handle was moved to the previous position.
13:37:27	The ND range on the FO's side was set to 20 nm.
13:37:32	EGPWS issued "TERRAIN" warning (to be detailed in 2.10.6). At this moment, the radio altitude recorded on the DFDR was about 3,200 ft.
13:37:34	EGPWS issued "PULL UP" warning (to be detailed in 2.10.6).

*2 MVA, which stands for the minimum vectoring altitude, means a minimum altitude which an air traffic controller can designate for a radar-vectored aircraft. This altitude conforms to the IFR vertical separation standard. But because the radar covering characteristics and the reception characteristics of enroute radio navigation facilities differ from system to system, figures which are lower or higher than the designated minimum enroute altitude (MEA) may be shown. This altitude only applies to radar vector, not to the flights with a pilot navigation. A map with the MVA figures overlaid (the MVA chart) can be shown on the radar display at the integrated enroute control system by selecting the buttons.

*3 The navigation display is one of the display systems installed at the pilots' seats. This display illustrates navigational data memorized in the flight management system (FMS), such as aerodromes, runways, flight support facilities like VOR and DME, airways and flight routes, by using images created with symbol generators, and also the wind direction and velocity, the distance to the next position and the estimated arrival time. Meteorological radar images can overlap other information.

13:37:34 to 37:36	The autopilot system was disengaged. With the pull input of the control column the pitch angle of the aircraft began to increase. The auto throttle was disengaged. The throttle levers for both engines were forwarded.
13:37:37	The roll angle began to return to the level. The Aircraft A stopped descent and started to climb.
13:37:46	The EGPWS "PULL UP" warning stopped. At this moment, the radio altitude recorded on the DFDR was about 2,200 ft.
13:37:48	The pitch angle began to decrease from the maximum value of about 18º.
13:37:50	With the throttle levers for both engines retarded the rate of climb decreased.
13:37:55	The Aircraft A started a right turn again.
13:38:02 to 38:03	EGPWS issued "TERRAIN" warning again. With a large amount of control column pull input the pitch angle began to increase again. The throttle levers for both engines were forwarded again.
13:38:04	EGPWS issued "PULL UP" warning.
13:38:05	The Aircraft A came closest to the peak of Mt. Pippu with an elevation of 2,197 m (7,208 ft). At this moment, the radio altitude recorded on the DFDR was 713 ft (about 217 m), while the radio altitude recorded on EGPWS was 654.5 ft (about 200 m).
13:38:07	The "PULL UP" warning stopped.
13:38:31	The Aircraft A reported to Sapporo Control that it would continue to avoid a collision with the terrain and requested a continued radar vector.
13:38:39	Sapporo Control instructed the Aircraft A to maintain heading 200° and 10,000 ft.
13:38:43	The Aircraft A continued to climb and exceeded the area MVA altitude of 10,000 ft.
13:40:24	The Aircraft A reported to Sapporo Control that it was ready to start an approach as the danger of collision with the terrain was cleared.
13:40:35	Sapporo Control instructed the Aircraft A to descend to 5,000 ft.
About 13:40	The Aircraft A started descent from about 10,000 ft. Around this time, winds were blowing from around 260º at about 50 kt and the Aircraft A was once again nearing a mountainous area with an elevation of 2,000 m or higher.
13:41:17	Because of the delayed arrival of the Aircraft A, Sapporo Control coordinated with the Aerodrome Control Position, Asahikawa Airport Office (hereinafter referred to as "the Daisetsu Tower") in order to have an aircraft there depart ahead of the Aircraft A at 6,000 ft.
13:41:20	Sapporo Control instructed the Aircraft A to descend to 7,000 ft. The Aircraft A read back it.
13:41:29	Sapporo Control instructed the Aircraft A to fly heading 280. The Aircraft A read back it.
13:44:40	The Aircraft A explained what happened until then in Japanese to Sapporo Control.

13:45:16	Sapporo Control instructed the Aircraft A to fly directly to AWE.
14:05	The Aircraft A landed on runway 34, Asahikawa Airport.

2.1.2 Statements of Flight Crew

(1) PIC

The PIC had only three months of experience as a pilot in that capacity. He flew from Chubu Centrair International Airport to Asahikawa Airport as the destination aerodrome under the restrictions for BASIC 1 PICs*4 designated by the Company (with slightly stringent weather restrictions). When the PIC obtained meteorological information about Asahikawa Airport, the weather condition there was close to the approach limitations allowed for BASIC 1 PICs. Therefore, when asked by Sapporo Control about which approach procedure to choose, the PIC requested an ILS RWY34 precision approach with low minima under a tail wind condition.

Before arriving at AWE, the Aircraft A was expected to hold over AWE with its second approach sequence. Later, the PIC was told by Sapporo Control that its approach sequence had been raised to the first, allowing it to approach before an aircraft holding at 8,000 ft over AWE.

The PIC received instructions before reaching AWE to fly heading 090° and descend to 5,000 ft. At this time, the FO read back the instructions half questioning its validity. The PIC recalls the altitude was 12,000 to 13,000 ft at that time.

The PIC was somewhat reluctant to accept the instructions due to a mountainous area on the eastern side. But the PIC assured himself that it would be a vectoring for descending and that the separation with the ground would be secured because the controller (Sapporo Control) had instructed descending to 5,000 ft applying the MVA. He thought that the given heading was to have a separation with other aircraft. Because the controller appeared to be busy communicating with other aircraft, he thought it would be necessary to increase the rate of descent to return to AWE as soon as possible so that he retarded the thrust lever to the idle with the flap setting 1 at 210 to 220 kt, and quickly deployed the speed brake to the full. The rate of descent was about 2,000 fpm (feet per minutes).

Around the time when the Aircraft A came to 8 nm east of AWE, the PIC was wondering whether its descent was big enough due to no further instructions. Further, the PIC felt concerned that the controller might have forgotten them or that their aircraft might have disappeared from the radar display. As a result, the PIC thought it would be dangerous for them to fly further, at 10 nm east of AWE at about 8,500 ft and requested the controller to allow it to return straight to Asahikawa. Then, the PIC received instructions to fly heading 200.

While the Aircraft A was turning to the heading 200°, "CAUTION TERRAIN" alert was issued at about 8,000 ft. Therefore, the PIC stopped using the speed brake to reduce the rate of descent and shifted from descending with idling power to descending with power applied on the V/S mode at 1,000 fpm. The PIC concluded this flight configuration would be better to follow the instructions for descending by reducing the rate of approach toward the

*4 The BASIC 1 PIC denotes a category awarded to pilots upon promotion to that capacity at the Company. When the total flight time as a PIC surpasses 100 hours, a pilot takes an examination for promotion to a higher category. Upon successful examination, he will be qualified as a CAT I PIC. Whether a pilot can land aircraft on a destination aerodrome or not is determined by his category and its applied weather conditions.

terrain and maintaining the separation with the other aircraft.

Upon issuance of "PULL UP" warning later, the PIC disengaged the auto pilot in accordance with the procedures and increased power to a maximum level and raised the pitch to 20°. The altitude at this moment was about 7,000 ft.

Later, the Aircraft A climbed slightly reducing power due to the termination of the EGPWS warning. But with another "PULL UP" warning at about 8,000 ft, the PIC increased power to a maximum level once again and climbed to 10,000 ft. After stabilizing the aircraft the PIC engaged the auto pilot. The PIC made a brief cabin announcement saying that the aircraft had climbed. The PIC also asked the controller to explain what has happened, but because the PIC had difficulty communicating with him, the PIC thought that an explanation should be sought after landing. After that, the Aircraft A flew an ILS RWY34 approach and landed.

The PIC's selected ND mode was the weather radar mode (hereinafter referred to as "the WXR mode") and it was not overlaid with the VSD*5 window.

The PIC was not aware that the FO was using the VSD window during the descent so that he did not receive any advice from him based on VSD information. The PIC did not actively use the VSD for checking the geographical features and for navigation, because the Company issued no guidelines on its use and the lower half of the ND was covered by VSD window when used making it useless because it depicts vertical cross section of flight path not suitable for navigation under radar vector situation where direction is often changed by the controller's direction.

(2) FO

Before reaching AWE, the Aircraft A received the information from the controller that it stood second on approach sequence and it was expected to hold. The Aircraft A reduced its speed and its rate of descent and tried to reach AWE at about 210 kt at 13,000 to 14,000 ft. The Aircraft A received the information from the controller that it became the first on the approach sequence, when it was flying about 10 nm to AWE.

Before reaching AWE, the Aircraft A received instructions to fly heading 090 and descend initially to 7,000 ft and then to 5,000 ft. The FO recalls that the altitude then was 12,000 to 13,000 ft.

When the FO was worrying about the danger to keep flying at about 8,500 ft 10 nm east of AWE, the PIC directed him to request a direct flight to AWE. The controller instructed the Aircraft A to fly heading 200° .

Almost at the same time when the Aircraft A started turning, "CAUTION TERRAIN" message was issued quickly followed by the "PULL UP" warning. The PIC disengaged the auto pilot in accordance with the procedures and increased power to a maximum level and raised the pitch. The FO confirmed this operation.

After that, the EGPWS warning was terminated. However, after a short time, the "PULL UP" warning was issued again when the rate of climb decreased. Therefore, the PIC raised the pitch once again.

The FO had a vague idea that no danger exists within range of 10 to 15 nm east of Asahikawa Airport.

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*5 The VSD, which stands for vertical situation display, is a window which depicts the estimated and actual flight routes and issues a warning whenever a danger of a ground contact exists showing the cross section of the estimated flight route and situation from the present location.

Because of bad weather, the FO's ND setting was the WXR mode. Any threat geographical features can be confirmed on the TERRAIN mode, but he did not use this mode believing that the controller would instruct appropriate altitudes during the radar vector. But he had some experience of approach using this mode.

The FO habitually used the VSD window in takeoff and approach phases because it was effective for confirming obstacles, but on that day, he began to use the VSD with an 80 nm range before AWE. The TCAS*6 detected other aircraft on the left side of AWE. While the Aircraft A was descending toward the east, a mountain located ahead was displayed on the VSD. He felt no sense of danger while descending. He felt that the mountains were near, but did not expect the Aircraft A would fly toward them under the radar vector condition because they were 10 nm away.

The FO was thinking about the timing of an advice to the PIC. But he actually did not do so, because the PIC instructed him to request Asahikawa to fly back to AWE and also he felt relieved when no mountain was shown on the display in areas up to 5 nm ahead after trying VSD ranges several times.

Even when the mountains appeared later on the VSD with the range changed to 20 nm, he thought that a safety margin existed and he did not try to ask the PIC to stop the descent.

Because of his longer working experience with the Company than that of the PIC as well as his assumption of PIC's awareness of the geographical features in Asahikawa area, he tried not to step out of line about the PIC's decisions.

The CRM training (to be detailed in 2.10.11) stresses coordination among crews. The FO had an interpretation that important decisions are left to the PIC so that his role was to provide necessary information for him, not stepping out of each other's line.

2.1.3 Statements of Air Traffic Controllers

(1) Radar Position Controller (hereinafter referred to as "the Radar Controller")

The Radar Controller was at the Coordinator position for the Hokkaido East Sector (hereinafter referred to as "the East Sector") from around 12:30 before the occurrence of this serious incident. On the day of the incident, there were a fairly large number of flight progress strips*7. In particular, there were a greater number of incoming flights from the Russian airspace than usual. Sorting the strips and necessary coordination with other organizations made him think it was a busy day.

Later, the Radar Controller took the East Sector Radar Position around 13:10.

With two arriving aircraft to Asahikawa Airport the Radar Controller had a talk with the controller at the Radar Coordination Position (hereinafter referred to as "the Coordinator") and designated the Aircraft B as the first flight to land and the Aircraft A as the second. Because there were no departing aircraft from Asahikawa Airport, the Radar Controller issued an approach clearance for the Aircraft B as the first flight to land before it reached ASIBE (a reporting point). As the Aircraft B started an approach, he calculated to let

*6 TCAS, which stands for the traffic collision avoidance system, is completely independent of ground facilities and, based on information obtained from response signals of an ATC transponder. The system helps avoid collisions between aircraft while providing pilots with information about the location of the threat aircraft, necessary evasive maneuvers and other information.

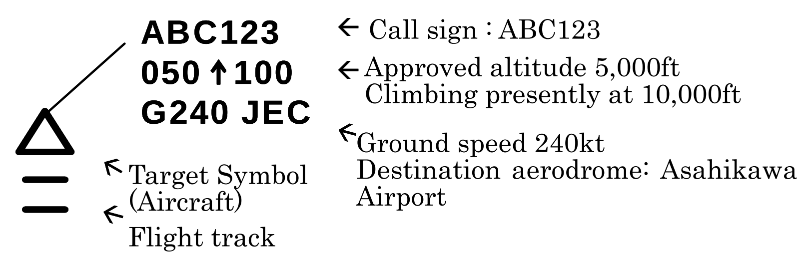
*7 A flight progress strip is a strip on which relevant aircraft data (call signs, altitudes, routes and others) are listed in an easier-to-understand manner, based on flight plans approved by air traffic controllers. Nowadays strips are computerized and they are shown on a flight progress strips display.

down the Aircraft A to an altitude from which the Aircraft B departed and put the Aircraft A in the AWE holding pattern and then let it down. He handed over the Aircraft B to the Daisetsu Tower when it reached near AWE.

After a little while, the Coordinator transferred the information from the Daisetsu Tower to the Radar Controller saying that the Aircraft B would return to his frequency without making an approach. When the Radar Controller contacted the Aircraft B to confirm this information, the Aircraft B requested to hold over AWE for about 10 minutes due to its minor trouble. Therefore, the Radar Controller arranged with the Coordinator and decided to change the approach sequence to Asahikawa Airport. This was because the Radar Controller calculated that the total approach delay would be minimized. At that time, the Aircraft A was near ASIBE and the Aircraft B was maintaining 8,000 ft, but it was flying northward and not yet entered an AWE holding pattern. Because of Aircraft B's minor trouble, the Radar Controller tried to minimize communication with the aircraft.

As the Aircraft A was flying northeastwardly from Chitose via Airway V7, the Radar Controller thought that a separation with the holding Aircraft B could be secured more quickly if the Aircraft A was vectored to the east rather than the west and he intended to let down the Aircraft A on a due east course (heading 090°). Because the Aircraft B was holding at an 8,000 ft, he thought that the Aircraft A's approach would be secured if it was let down to 7,000 ft, and also thought that the lower its altitude was, the easier its approach would be. Therefore, he issued an instruction for the Aircraft A to descend to 5,000 ft at a place where a horizontal separation with the Aircraft B can be secured. He thought he had had a talk with the Coordinator for vectoring the Aircraft A to the east, however, he had not confirmed the MVA.

Data blocks displayed on air traffic control radar display



He thought about providing a separation with the holding Aircraft B and planned to vector the Aircraft A three times to return it to AWE when it descended to 7,000 ft or below. Because he was busy communicating with other aircraft, he decided to field them first, and with the confirmation of the Aircraft A's altitude he intended to decide the timing for its return to AWE.

The Aircraft A was descending as the Radar Controller intended, but the Aircraft A requested to fly straight to AWE. Because it did not reach below 7,000 ft as yet, he hesitated to issue immediate instruction to have it return to AWE and gave it a new heading of 200° . Shortly after this instruction the altitude indicator in the data blocks for the Aircraft A showed an upward arrow suggesting the Aircraft A was climbing. At that time, the pilot reported that the Aircraft A would climb to 10,000 ft and the Radar Controller felt something was wrong and tried to contact with the Aircraft A to confirm the situation but to no avail due to poor reception. Therefore, the Radar Controller approved the Aircraft A to climb to 10,000 ft. He wondered about its climb to 10,000 ft. He realized, by confirming the MVA chart on the radar display, that he had instructed the Aircraft A to descend below the MVA, however, he failed to confirm the MVA on the southern side.

At this moment, the Coordinator had received a request of a departure clearance from the Daisetsu Tower that an aircraft had been ready to depart ahead of arriving aircraft so that he issued the clearance. The Aircraft A was already flying to the south, while the Radar Controller believed that an area of higher MVA was located further to the east so that he instructed the Aircraft A to descend to 7,000 ft. After that he instructed it to fly directly to AWE.

The Radar Controller confirmed that it would take more than 10 minutes for the Aircraft B to check its trouble, so that the Radar Controller had an alternative of having the two aircrafts hold over AWE and sought for necessary steps only after communication with other aircraft becomes less busy. But his only option at that time was to have the Aircraft A descend to an altitude which is lower than that of the Aircraft B.

Air traffic in the East Sector was busy, but it was not excessively busy to control.

(2) Coordinator

The Coordinator was at the East Sector station from 13:15 to 14:00.

Using runway at Asahikawa Airport then was 16. There were two inbound flights with a short interval. The preceding Aircraft B was designated as the first to fly a Runway 16 VOR approach for landing and the Aircraft A as the second. Due to the bad weather, the Aircraft A requested an ILS approach to Runway 34. Because this approach takes long, the Coordinator expected that it would have to hold over AWE. She coordinated with the Daisetsu Tower for its opposite runway use. Daisetsu Tower accepted this approach.

The Coordinator gave an approach clearance to the Aircraft B and transferred communication to the Daisetsu Tower. But soon it requested her saying that due to the Aircraft B's request to hold over AWE, it would return the communication to her. A little while later, the Aircraft B requested an approval for holding at 8,000 ft due to a minor trouble. The Coordinator did not ask the Aircraft B what the specific problem was. Because there were many flight progress strips to be dealt with, it took longer than usual for her to grasp the situation.

The Coordinator talked with the Radar Controller about the Aircraft A's let down by radar vector, however, because both of them were tied up with many duties having less time for detailed coordination, they did not touch on vectoring direction or applied MVA.

The Coordinator decided to change aircraft approach sequence making the Aircraft A the first due to its approach readiness and made an adjustment with the Daisetsu Tower. Later, when she glanced at the radar display, the radar-vectored Aircraft A was turning and, its altitude was showing intermittently on the display. When the altitude was indicated instantly on the display, the Coordinator realized that the arrow on the display was pointing upward. The Coordinator did not want it to climb, and asked the Radar Controller why it was climbing. Later, the pilot of the Aircraft A asked if he could speak in Japanese. Due to its climb, the Coordinator suspected of something wrong. Communication with the Aircraft A was weak and lacked clarity. But at that moment, the Coordinator realized that the Aircraft A had been vectored to a lower-than-MVA altitude – 10,000 ft.

When the Radar Controller instructed the Aircraft A to take east-bound heading, the Coordinator did not think of the MVA because the area was not usually used by incoming aircraft to Asahikawa and because her attention was focused on the need to descend the Aircraft A below the Aircraft B. Aircrafts arriving from the south usually approach via Airway V7 and ASIBE. It was the Coordinator's first experience to vector an aircraft for an approach while other aircraft was holding high above AWE.

When the Coordinator changed approach sequence of the two aircrafts, with the intention of keeping the aircraft with a minor trouble holding there, she thought that it would be difficult to raise the Aircraft B to 9,000 ft while lowering the Aircraft A to 8,000 ft, so that she intended to give the Aircraft A a radar-vector leaving the Aircraft B as it was. The Coordinator had usually confirmed the MVA before giving vectoring instructions.

The Coordinator thought that Asahikawa Airport was the only airport where inbound and outbound aircraft needed adjustments and close attention, so that she believed that the problems at hand could be handled. But contrary to her expectation she actually had to respond numerous calls from other air traffic control facilities. Workload was fairly heavy for the Radar Controller, but the Coordinator did not think that traffic was too busy to cope with. She believed it reasonable to vector the Aircraft A to descend and give approach clearance.

A judgment on whether to provide assistance to other controller is the controller's discretion at the position. The Coordinator did not think it necessary then.

The serious incident occurred at about 6,800 ft at about 30 km east of Asahikawa City, Hokkaido Prefecture around 13:38.
(See Figure 1 Estimated Flight Route (1), Figure 2 Estimated Flight Route (2), Figure 3 DFDR Record, Attachment ATC Records of the East Sector)

2.2 Injuries to Persons

No one was injured.

2.3 Damage to the Aircraft

The Aircraft A suffered no damage.

2.4 Personnel Information

(1) PIC	Male, Age 34
Airline Transport Pilot Certificate (Airplane)	November 24, 2009
Type rating for B737	January 11, 2008
Class 1 Aviation Medical Certificate	
Validity	April 13, 2011
Total flight time	4,058 h 16 min
Flight time in the last 30 days	50 h 59 min
Total flight time on the type of aircraft	1,225 h 20 min
Flight time in the last 30 days on the type of aircraft	50 h 59 min
(2) FO	Male, Age 48
Airline Transport Pilot Certificate (Airplane)	February 15, 1993
Type rating for B737	October 25, 1989
Class 1 Aviation Medical Certificate	
Validity	May 9, 2011
Total flight time	14,484 h 34 min
Flight time in the last 30 days	42 h 02 min
Total flight time on the type of aircraft	10,776 h 57 min
Flight time in the last 30 days on the type of aircraft	42 h 02 min

2.5 Aircraft Information

2.5.1 Aircraft

Type	Boeing 737-800
Serial number	33892
Date of manufacture	April 17, 2009
Certificate of airworthiness	2009-015
Validity	A period on and after May 21, 2009 while a maintenance rule (All Nippon Airways Co., Ltd.) applies
Total flight time	3,416 h 02 min
Total number of flights	3,005
Flight time since last periodical check (C1 check on October 16, 2010)	53 h 37 min

(See Figure 4 Three Angle View of Boeing 737-800)

2.6 Air Traffic Controllers

(1) the Radar Controller Male, Age 30

Air Traffic Controller Qualification Certificate	
Aerodrome control service	October 1,2004
Air route traffic control service	March 7, 2006
Air route approach control service	March 7, 2006
Rader area control service	January 23, 2008
Medical Certificate	
Validity	June 30, 2011
Aviation English Language Proficiency Certificate	
Validity	March 4, 2013

(2) the Coordinator Female, Age 41

Air Traffic Controller Qualification Certificate	
Aerodrome control service	April 1, 1999
Approach control service	September 30, 1999
Terminal radar control service	September 30, 1999
Air route traffic control service	October 3, 2006
Air route approach control service	October 3, 2006
Radar area control service	September 3, 2007
Medical Certificate	
Validity	June 30, 2011
Aviation English Language Proficiency Certificate	
Validity	March 4, 2011

2.7 Meteorological Information

Aeronautical weather observations for Asahikawa Airport around the time of the serious incident were as follows:

13:00 Wind direction 180° Wind velocity 13 kt Visibility 8 km
Shower rain and snow

Cloud	Amount FEW	Type Stratus	Cloud base	500 ft
	Amount BKN	Type Stratus	Cloud base	1,500 ft
	Amount BKN	Type Cumulus	Cloud base	2,500 ft

Temperature 2 °C Dew point 0 °C

Altimeter setting (QNH) 29.52 inHg

Remarks: Visibility from southeast to southwest is 3,000 m

14:00 Wind direction 170°, 150° – 220° variable Wind velocity 8 kt Visibility 15 km

Shower rain and snow

Cloud	Amount FEW	Type Stratus	Cloud base	500 ft
	Amount BKN	Type Stratus	Cloud base	1,200 ft
	Amount BKN	Type Cumulus	Cloud base	3,500 ft

Temperature 3 °C Dew point 2 °C

Altimeter setting (QNH) 29.51 inHg

2.8 Information on DFDR and Cockpit Voice Recorder

The Aircraft A was equipped with a DFDR (part number: 980-4700-042) made by Honeywell of the United States of America.

Even after the occurrence of this serious incident, the Aircraft A continued several legs of flights, with the DFDR and the CVR (hereinafter Referred to as "CVR") on board. The record at the time of this serious incident was retained on the DFDR (with a recording period of 25 hours). However, it was already known that the CVR (with a recording period of two hours) data had been overwritten, CVR was not removed from the aircraft.

The time was determined by correlating the DFDR recorded VHF transmission keying signals with the time signal recorded on the ATC communication record.

2.9 Reproductive Investigation with Simulator

JTSB has investigated the situation at the time of the serious incident reproduced by a Boeing 737-700 simulator*[8] with the cooperation of the Company's pilots.

2.9.1 Contents of Investigation

In the investigation, focus was directed at how the EGPWS issues warnings and how the ND or VSD change their indications during a flight while the type aircraft flies the route similar to the serious incident.

*[8] The Aircraft A is a Boeing 737-800, while the functions of its EGPWS are partially different from those of the 737-700 simulator. However, major components for the aircraft and the simulator are identical.

2.9.2 Results of Investigation

When the virtual flight was made in a situation similar to the serious incident, the NDs indication on the PIC's side and the FO's side were as follows during a descent in heading 090° from a point over around Asahikawa Airport. Only the FO-side VSD was turned on.

Figure A to Figure E as inserted below show ND indications when the situation was reproduced. Figure A is a case when the VSD is selected in WXR mode, while Figure B and Figure D are cases where the VSD is not selected in a situation when the WXR mode was switched to the terrain mode. Figure C and Figure E are cases where the VSD is selected in a situation when the WXR mode was switched to the terrain mode.

(1) While descending toward a mountainous area to the east from over Asahikawa Airport, the ND on the FO's side showed a geographical feature (a mountain ahead) on the VSD with a 20 nm range selected even at about 10,800 ft at around a point 6.3 nm from AWE. (See Figure A)

At about 8,100 ft at around a point 12.7 nm from AWE, the peak of the geographical feature shown on the VSD with a 10 nm range began to change to yellow. At this moment, the ND remained on the WXR mode.

Figure A ND-1 on the FO side

(2) The ND on the PIC's side showed the "Caution Terrain" heads-up message of the TERRAIN" (EGPWS) in yellow around heading 099° just after the start of a right turn from heading 090° . At the same time, the WXR mode was switched to the terrain mode. (See Figure B)

About five seconds later, a geographical feature shown in yellow began to appear on the ND from around heading 109° .

Figure B ND-1 on the PIC's side

(3) Around the same time as the phenomena mentioned in (2), the ND on the FO's side showed the "TERRAIN" in yellow around heading 099°, 15.9 nm from AWE at about 7,200 ft just after the start of a right turn. Simultaneously, the WXR mode was switched to the terrain mode. The geographical feature shown in yellow on the VSD was within a range of 2 nm. (See Figure C)

The geographical feature shown in yellow began to appear on the ND from around heading 109°, 16.3 nm from AWE.

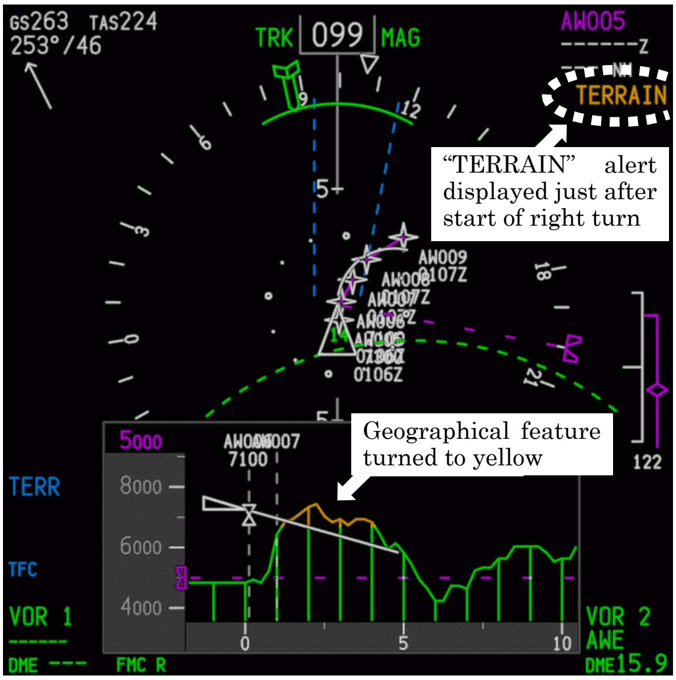
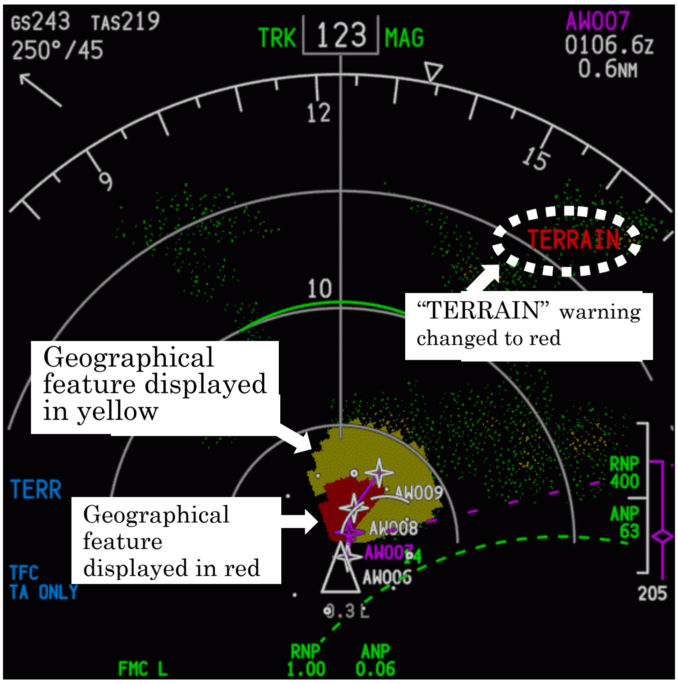


Figure C ND-2 on the FO side

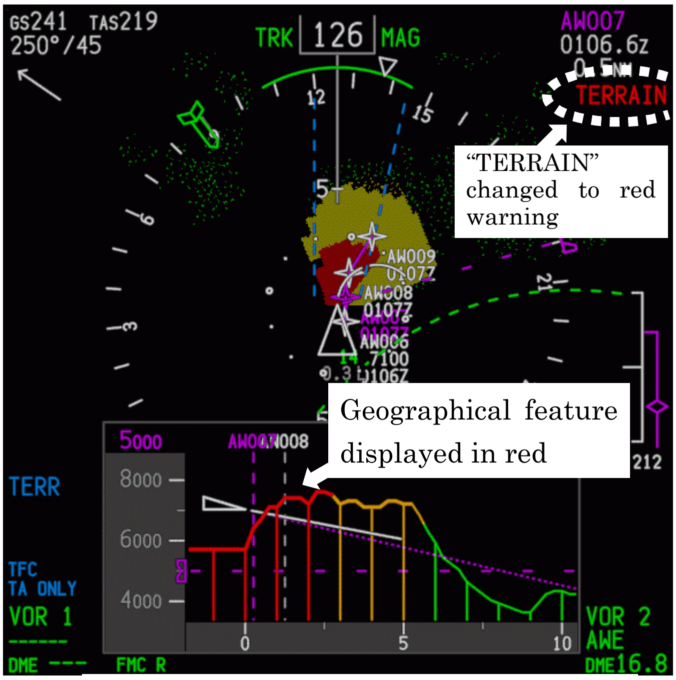
(4) On the PIC's ND, the color of the "TERRAIN" indication (the "Terrain" warning by EGPWS) changed to red from around heading 118°. The geographical feature began to be shown in red from around heading 121°. (See Figure D)



FigureD ND-2 on the PIC's side

(5) Around the same time as the phenomena mentioned in (4), the color of the "TERRAIN" message on the ND on the FO's side changed to red from around heading 119° , 16.6 nm from AWE. The geographical feature on the VSD began to be shown in red around heading 126, 16.8 nm from AWE. (See Figure E)

A collision evasive maneuver was performed and ten-odd seconds later, the "TERRAIN" indication and the red geographical features disappeared from the ND.



FigureE ND-3 on the FOside

2.10 Additional Information

2.10.1 Information on Air Traffic

From about 13:30 to 13:38 before the occurrence of this serious incident, the East Sector was providing air traffic control services for an average of nine aircraft.

(1) Records of communication at the radar position

13:33:14	The Radar Controller instructed the Aircraft B which had developed a minor trouble to hold over AWE.
13:33:19	The Radar Controller instructed the Aircraft A to descend to 9,000 ft.
13:33:31	An aircraft bound for Asahikawa Airport requested to climb due to turbulence.
13:33:42	The Radar Controller instructed the Aircraft A to fly heading 090° .
13:34:49	The Radar Controller established communication with an aircraft bound for Narita International Airport.
13:35:05	The Radar Controller established communication with an aircraft departing from Monbetsu Airport.
13:35:40	The Radar Controller identified the aircraft bound for Narita International Airport on the radar display.
13:35:55	The Radar Controller instructed the Aircraft A to descend to 5,000 ft.

(2) Records of Communication at the Coordinator Station

From about 13:31:31

to13:32:24 The Coordinator changed the landing order responding to the Aircraft B's holding request and adjusting an approach procedure for the Aircraft A.

From about 13:34:30

to 13:34:54 The Coordinator changed the landing and departure orders and adjusted a separation between the Aircraft A and a departing aircraft.

(See Figure 5 Communication situations of the East Sector)

2.10.2 Air Traffic Control Procedure Standard (Chapter 5 Air Traffic Control Service Processing Handbook, Air Traffic Service Procedure Handbook)

The Air Traffic Control Procedure Standard stipulates the MVA as follows:

(2) a Vectoring shall be made at the minimum vectoring altitude prescribed in the "b" below or at a higher altitude (omitted).

b (a) The minimum vectoring altitude shall be determined based on a standard described in (b) for each of the areas divided for radar control services (referred to as "segments" in (b)) of the region covered by an air traffic control facility involved in vectoring, considering the geographical features, radar performances, flight routes, air traffic characteristics and division of jobs for air traffic control.

(b) The minimum vectoring altitude shall be set at an altitude of the height of the highest obstacle located in an area enclosed by a line drawn around the segment involved with distances listed below from the outer edge of the segment plus figures equal to or higher than the standards described in β.

α (α) 3 nm from the outer edge of a segment within a distance of less than 40 nm from a radar site

(β) 5 nm from the outer edge of a segment within a distance of more than 40 nm from a radar site

β (α) 1,000 ft in case an aerodrome surveillance radar is used

(β) 2,000 ft in case an air route surveillance radar is used

(See Figure 6 MVA in the vicinity of the the serious incident site)

2.10.3 Education and Training Regarding MVA

(1) Training at Aeronautical Safety College

One year long basic training at the Aeronautical Safety College encompasses five hours of classroom learning on radar vectoring including MVA. A specialized training course for about a month at the Iwanuma Training Center includes about 16.5 hours of drill training on radar vectoring including MVA.

(2) Specialized Training at Local Facilities

During the specialized training at local facilities, classroom learning and drill training for radar vectoring including MVA are provided in accordance with the Detailed Enforcement Regulation for Air Traffic Controller Examination described below.

Detailed Enforcement Regulation for Air Traffic Controller Examination (Excerpt)

Article 16 The Head of an air traffic control facility shall formulate details for implementing specialized training at the air traffic control facility involved about subjects listed in the columns of the attached tables No. 1 and No. 2, for each of the subjects listed in the attached table No. 2 in the Regulation and report this to the Director-General of the Civil Aviation Bureau.

2 The Head of an air traffic control facility shall provide specialized training in accordance with the details for training mentioned above.

Attached table No.1 (Excerpt)

Air route traffic control service

3. Air route traffic control procedure

e. Radar coverage, radar minimum vectoring altitude and confirming point

(3) MVA-Related Training for Air Traffic Controllers

MVA-related training for air traffic controllers at Sapporo Control are as follows:

A. the Radar Controller

He received specialized radar control training for the Hokkaido area in November 2006 and for the Misawa area in August 2008. This training (classroom learning) included map drawing considering the MVA. A periodical check (on-site) in July 2010 confirmed that his radar vectoring was properly done in accordance with MVA.

B. the Coordinator

She received specialized radar control training for the Hokkaido area in March 2007 and for the Misawa area in January 2008. This training (classroom learning) included map drawing considering the MVA. A periodical check (on-site) in July 2010 confirmed that her radar vectoring was properly done in accordance with MVA.

2.10.4 Air Traffic Control Services When the Serious Incident Occurred

(1) Outline of services at East Sector

This serious incident occurred in the East Sector, one of the segments of the Sapporo Control district.

The East Sector extends over the greater part of Hokkaido except a part of its eastern area. The number of aircraft handled by this sector is about 170 a day. As far as jet aircrafts flying north and south are concerned, it takes about 25 minutes to fly over the sector at a cruising speed.

The East Sector provides services for flights connecting the Russian and Narita airspace as well as flights departing from and arriving at Asahikawa, Wakkanai, Monbetsu, Rishiri and other airports. Because of geographical characteristics, notably the existence of several high mountains, it is difficult to capture and track aircraft with the radar around Wakkanai. The overflight aircraft from the Russian airspace needs altitude conversion from the meter to the foot increasing the air traffic controller's workload per aircraft. Because there are many airports which lack aerodrome traffic control services, the air traffic controllers at East Sector instruct air or ground holding from time to time in order to field conflicting inbound and outbound flights.

(See Figure 7 Aircraft controlled by Hokkaido East Sector)

(2) Layout of air traffic controllers' positions and job assignment

A basic position layout at the East Sector includes two positions for the radar and the coordinator. At the time of the occurrence of the serious incident, each station was manned by one controller.

Basic duties for those at these stations are stipulated in the ATC Service Operation Procedure, Sapporo Air Traffic Control Center. The content of the Procedures are as follows:

A radar controller communicates with aircraft flying in a controlled airspace and issues ATC clearance or ATC instructions when necessary, to identify an aircraft and maintain inter-aircraft separation. The radar controller takes care of data input into IECS*[9] from the

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*[9] IECS, which stands for the Integrated Enroute Control System, consists of a radar display, a flight progress strips display and others. The system has various air traffic control support functions, such as arrival order control and route deviation alerts. This system being installed at each of the air traffic control centers, helps

radar display.

A coordinator monitors radar controller's radio communication, and assists in maintaining the aircraft identification on the radar display and confirming a separation, while maintaining oral coordination with the neighboring sectors or air traffic control facilities. The coordinator takes care of data input into IECS, mainly from the flight progress strip screen.

(See Figure 8 Integrated Enroute Control System (IECS))

2.10.5 TRM (Team Resource Management) Training

(1) The Radar Controller participated in a course specifically designed for training instructors, which comprised of classroom learning and practical drill training regarding the TRM in January 2010 and so did the Coordinator in June 2003.

(2) Details of the TRM training provided at those occasions were as follows:

1. Purpose of training

The training is aimed at making the maximum possible use of each controller's ability and managing human errors with a favorable teamwork and creating an environment for providing safe and effective air traffic control services by enhancing the ability of the team as a whole.

2. Programs of training

JTRM (the Japanese version of the TRM) consists of two major parts, human factors (classroom studies and lectures) and drills (TRM skill).

As a method for TRM training (practical drills), the facilitative method, mainly aimed at drawing participants' opinions rather than unilaterally providing techniques or knowledge to them, is used. Four instructors are in charge of the drills.

Actual drills consist of eight components (modules) listed below. Brainstorming (a method to pick up problems by letting participants mutually express their views briefly about a certain topic in order to induce an idea among them), group discussion and initiative games are mixed with each other in the training.

(1) Introduction

Participants learn the outline of the purpose and the effects of the TRM training.

(2) Teamwork

Participants recognize the characteristics of teamwork in air traffic control services and deepen understanding about the establishment of an effective teamwork.

(3) Role of Team

Participants deepen understanding about the effects on teamwork when leadership is successfully displayed or when it is not.

(4) Communication

Participants deepen understanding about improved communication within a team and communication with related air traffic control facilities and pilots, and its effects on safety enhancement.

(5) Situational Awareness

Participants deepen awareness concerning the traffic condition, operating conditions of instruments, the air traffic control condition and such, as well as

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reduce workload for air traffic controllers and improve the air traffic control performances.

understanding about factors which influence these elements.

(6) Decision Making

Participants deepen understanding about the decision making process as an individual or a team and its mechanism.

(7) Stress Management

Participants deepen understanding about the stress felt by air traffic controllers and its effects on traffic control services and ways to cope with it within a team.

(8) Conclusion

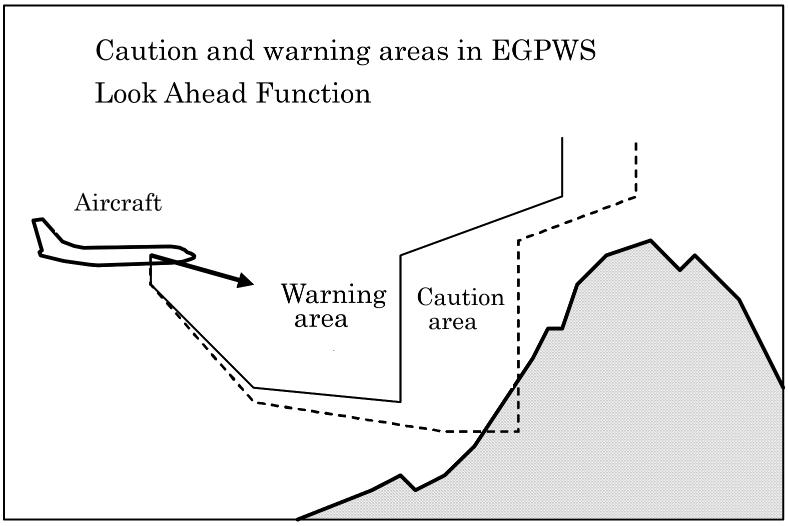
Participants deepen understanding about the effects of the TRM training based on their experience in the modules as a whole.

2.10.6 EGPWS and Others

EGPWS denotes an enhanced model of the GPWS (the ground proximity warning system). Because EGPWS has a global geographical database, it can effectively issue threat cautions and warnings in advance with various graphical methods and sounds by comparing its location with the target geographical features.

There are several different modes designed for each of the flight phases. Two functions mentioned below were activated in this serious incident.

(1) Look Ahead Function



EGPWS issues the CAUTION TERRAIN alert when database geographical features come into the caution sector of forward surveillance area, when in the warning area the TERRAIN warning followed by the PULL UP warning.

The CAUTION TERRAIN alert is issued when a collision with the terrain is expected approximately in 40 to 60 seconds. The TERRAIN message is shown in yellow on the ND and the CAUTION TERRAIN is aurally issued on the EGPWS of the Aircraft A. At this moment, ND will automatically switch to the terrain mode regardless of selected mode on the ND.

The TERRAIN and PULL UP warnings are issued when a collision with the terrain is expected in approximately 20 to 30 seconds. In the case of the Aircraft A, the TERRAIN message is shown in red on the ND and geographical features within 2,000 ft of its altitude are illustrated with colored dots or areas in green, yellow or red depending on the degree of threat. The PULL UP warning is shown in red on the PFD*10. The aural messages of "TERRAIN TERRAIN" will be issued first followed by the repeated "PULL UP" aural warning.

In this serious incident, the Look Ahead Function worked well issuing the CAUTION

*10 The PFD (the primary flight display) is a multicolor display integrated with a speed indicator, an altimeter and other functions in addition to information from an attitude indicator. (See Figure 9)

TERRAIN alert at 13:37:22, the TERRAIN warning at 13:37:32 and two seconds later, the PULL UP warning.

(2) Mode 2 Function

This function issues warnings by detecting the proximity rate to the ground using the radio altitude, without consulting the geographical feature database. When the proximity rate to the ground comes within a range determined for each flying altitude, the TERRAIN warning will be issued. First of all, aural alert of "TERRAIN TERRAIN" is issued. If the aircraft remains within the range even after the aural warning stops, the PULL UP warning will be issued followed by the repeated aural warning of "PULL UP".

In this serious incident, the Mode 2 function worked issuing the TERRAIN warning at 13:38:02 when the Aircraft A was nearing the peak of Mt. Pippu, followed by the "PULL UP" warning two seconds later.

(See Figure 9 PFD and ND)

EGPWS mentioned above is said to be the most effective onboard CFIT prevention system, where an aircraft collide with the terrain even when its functions are normal. On the other hand, MSAW (ICAO Doc 4444 Air Traffic Management 15.7.4) is a ground based safety system aimed at monitoring an aircraft's abnormal proximity to the terrain with ground radars and issuing warnings when it is detected to have descended or is expected to descend below an established minimum safe altitude so that an air traffic controller can issue instructions or warnings to its pilot without delay in order to avoid a CFIT. There are two types for the system: type 1 (MSAW) is designed to work with airport surveillance radar while type 2 (E-MSAW) is designed to work with en route surveillance radar. In Japan, 13 MSAW systems have been installed at heavy traffic major airports. Asahikawa Airport has not been equipped with even airport surveillance radar. No E-MSAW system has been installed in Japan.

2.10.7 Company's Aircraft Operating Manual (AOM) Regarding GPWS Warnings

(1) Responses to Caution Terrain

B737NG AOM 2-3-2-(6)

(2) Activation of GPWS caution other than PULL UP caution

Accomplish the following maneuver for any of these aural alerts (some of them repeat), as the occasion demands, after confirming the situation

(Omitted)

<Pertinent aircraft type>

・AIRSPEED LOW

・CAUTION TERRAIN

(Omitted)

PF	*PNF*
Correct the flight path, airplane configuration, or airspeed until the aural caution stops.	

(Omitted)

(2) Responses to PULL UP Warning

B737NG AOM 2-3-2-(5)

(1) Activation of GPWS PULL UP warning

In case either of the following situations has occurred, immediately accomplish the following maneuver for any of these conditions.

Activation of "PULL UP," "TERRAIN TERRAIN PULL UP" or "OBSTACLE OBSTACLE PULL UP <800>" warning.

This excludes the case where the terrain can be confirmed in a daylight VMC condition and positive visual verification is made that no obstacle or terrain hazard exists.

Other cases where ground contact is expected.

PF	*PNF*
Autopilot......................DISENGAGE *Autothrottle..................DISENGAGE* *Aggressively apply max thrust* 1) *Roll wings level and rotate to an initial pitch attitude of 20°.* *Speedbrake........................DOWN* *In terrain remains a threat, continue rotation up to the pitch limit indicator or stick shaker or initial buffet.*	*Assure max thrust* 1). *Verify all required actions have been completed and call out any omissions.*
Do not change gear or flap configuration until terrain separation is assured. *Monitor radio altimeter for sustained or increasing terrain separation.* *When clear of terrain, slowly decrease pitch attitude and accelerate.*	*Monitor vertical speed and altitude. Call out any trend toward terrain contact.*

NOTE : Aft control column force increases as the airspeed decreases. Flight at intermittent stick shaker may be required to obtain a positive terrain separation. In all cases, the pitch attitude that results in intermittent stick shaker or initial buffet is the upper pitch attitude limit. Smooth, steady control will avoid pitch attitude overshoot and stall.

NOTE : Do not use flight director commands.

1) NOTE : Maximum thrust can be obtained by advancing the thrust levers full forward if the EEC's are in the normal mode. If terrain contact is imminent, advance thrust levers full forward.

2.10.8 PIC Qualifications Regarding Flight Meteorological Conditions at the Company

5-2 Setting of Company minima

5-2-5 Familiar minima and Unfamiliar minima

(Omitted)

b. Setting of Familiar minima

(Omitted)

(2) Familiar minima for BASIC1 and BACIC2 PICs are as follows:

		BASIC2 PICs	BASIC1 PICs
Landing minima	*Precision approach*	*Either of figures for CAT I PICs or DH250-1,200, whichever is higher.*	*Either of figures for CAT I PICs or DH300-1,600, whichever is higher.*
	Non-precision approach or circling approach	*Figures for CAT I PICs plus 50-400 (NOTE)*	*Figures for CAT I PICs plus 100-800 (NOTE)*

(NOTE) An upper limit shall be the alternate minima, however, upper limits about DH and MDH shall be 600 ft.

2.10.9 Company Minima at Asahikawa Airport

The Company's minima values for ILS RWY34 approach at Asahikawa Airport for CAT 1 PICs are 200 ft for DH and 550 m for RVR/CMV; BASIC1 PICs, 300 ft for DH and 1,600 m for RVR/CMV.

2. Landing minima

	Procedure	*Familiar Minima* *CAT*	(Omitted)	*BASIC1*	*Alternate Minima*	*Point for App Ban*
			DA/MDA-RVR/CMV		*CIG-VIS*	
S	ILS 34	*C*	(Omitted)	*1,600 m*	*800'-3,200 m*	*1,000' AFE*
	LOC Y/Z 34	*C*	(Omitted)	*2,200 m*	*1,000'-3,200 m*	
			MDA-VIS		*CIG-VIS*	
C	*VOR A/B*	*C*	(Omitted)	*3,200 m*	*1,000'-3,200 m*	*1,000' AFE*
	VOR C	*C*	(Omitted)	*3,200 m*		

2.10.10 Instrument Approach Procedures at Asahikawa Airport at the Time of the Serious Incident

From September 22 to November 17, 2010, the ILS-LOC system at Asahikawa Airport had been removed for renewal and the offset ILS RWY34 system had been installed as a replacement. The CAT I minima were 250 ft for DH and 600 m for RVR/CMV.

2.10.11 CRM Training

(1) The PIC had received CRM training on May 27, 2010 and the FO on June 24, 2010.

(2) Details of the training were as follows:

The PIC and the FO reviewed mainly Threat and Error Management and five CRM skills. They selected assertion out of communication skill.

A. Threat and Error Management

a. Threat and Error Model

b. Threat, Error, Undesired Aircraft State

c. Implementation of Threat and Error Management

B. Five CRM Skills

a. Communication (Assertion)

b. Team Building

c. Workload Management

d. Situational Awareness

e. Decision Making

(3) For the CRM skills, the Company's CRM classroom study materials for fiscal 2010 stipulated as follows. (Excerpt)

(1) Communication

Communication Skill is a base for improving each CRM skill.

A. The purpose of "Two-Way Communication" is to understand each other. To this end, it is important to speak openly about your doubts with each other without hesitation so that common situational awareness and its recognition as a team can be achieved.

B. (Omitted)

C. While the "Assertion" can be divided and expressed depending on situations and gradual phases such as "Speak openly without hesitation," "Frankly state your view," and "Carry through your opinion about safety," speaking openly at an earlier stage leads to preventive actions.

2.10.12 Aircraft A's Radio Altitude Indication

The Aircraft A's Operations Manual (5-10 Flight Instruments, Display, PFD) stipulates the radio altitude as follows:

Radio Altitude

The current radio altitude will be shown on the upper right corner of the attitude indication area when the radio altitude is less than 2,500 feet RA. (The rest is omitted)

3 ANALYSIS

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

3.2 The Radar Controller and the Coordinator held both valid competence certificates and valid aviation medical certificates.

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

3.4 Relation to Meteorological Phenomena

According to the aeronautical weather observations described in 2.7, shower rain and snow had been observed with visibility at 8 km at the time when this serious incident occurred. According to the statement described in 2.1.2 (1), with the obtained meteorological information at Asahikawa Airport being close to the approach limitations allowed for BASIC1 PICs, it is probable that the PIC selected the ILS RWY34 approach whose minima meets his approach criterion, instead of choosing current using runway.

However, it is highly probable that the weather condition had no direct bearing on this serious incident.

3.5 How the Ground Proximity developed

As described in 2.1.1, based on the ATC communication records and the DFDR and EGPWS records, it is certain that the Aircraft A's ground proximity during the descent developed as mentioned below.

(1) While descending at about 13,800 ft about 4 nm before Asahikawa Airport, the Aircraft A received an ATC instruction to continue descent to 9,000 ft. Rolling out to heading 090 after a right turn near Asahikawa Airport, it further continued to descend.
Later, while descending at about 9,900 ft about 8 nm east of Asahikawa Airport, the Aircraft A further continued to descend to 5,000 ft under ATC instruction.

(2) While descending at about 7,700 ft about 13 nm east of Asahikawa Airport, the Aircraft A requested Sapporo Control for returning to Asahikawa Airport after a right turn. It started a right descending turn per Sapporo Control's instruction with a rollout heading of 200º.

(3) A few seconds after the Aircraft A started the turning, EGPWS issued the "CAUTION TERRAIN" alert followed by the "TERRAIN" and "PULL UP" warnings 10 seconds later.

(4) The speed brake of the Aircraft A was retracted four seconds after the "CAUTION TERRAIN" alert and six seconds later when the "TERRAIN" and "PULL UP" warnings were issued by EGPWS, the Aircraft A took an evasive maneuver by rotating up and rolling wings level.

(5) After the EGPWS warnings came to a stop, the engine thrust slightly decreased, the rotation up was eased, and a right turn was resumed.

(6) With the renewed "TERRAIN" and "PULL UP" warnings, the Aircraft A took an evasive maneuver, by rotating up and increased engine thrust. At this moment the Aircraft A was closest to the peak of Mt. Pippu with an elevation of 2,197 m (7,208 ft). Its height from the ground as recorded on the DFDR and EGPWS was about 200 to 220 m. Later, the Aircraft A continued to climb even after the EGPWS warning arrested.

3.6 Condition of Air Traffic Controllers

3.6.1 The Radar Controller

(1) According to the statement described in 2.1.3 (1), it is probable that the Radar Controller tried to change the approach sequence for the Aircraft A because the Aircraft B was instructed to hold over AWE due to minor trouble. It is probable that the Radar Controller believed that total delay in their landing would be minimized if he had the Aircraft A descend below the Aircraft B by radar vectoring, rather than making them hold in the air.

However, radar vectoring needed to monitor both aircraft to establish a vertical separation between them seeking the timing for directing them to AWE. Therefore, it is probable that workload for this job was bigger than holding them over AWE. It is probable that there were several courses of action other than the radar vectoring, such as having the Aircraft B approach first while making the Aircraft A hold as initially planned or making the Aircraft A hold to seek next solution. Therefore, it is possible that this serious incident would have been avoided if the Radar Controller had chosen a safety-oriented course of action considering his workload.

(2) According to the statement described in 2.1.3 (1), the Radar Controller, with the Aircraft A flying northeastwardly, believed that a horizontal separation with the holding Aircraft B could be established more promptly by vectoring the Aircraft A to the east of AWE rather than to the west. But the east side of Asahikawa Airport stretches to one of the Hokkaido's highest mountainous regions. Therefore, even with the established horizontal separation, it is impossible to make the Aircraft A descend to 7,000 ft or below which is below the altitude of the Aircraft B in the area beyond 10 nm from AWE in light of the MVA limits indicated in Figure 6. Therefore, it is possible that the Radar Controller failed to confirm the MVA when he decided to vector the Aircraft A to the east (before the Aircraft A reaches over AWE).

(3) As described in 2.1.1, the Radar Controller instructed the Aircraft A to descend to 5,000 ft at 13:35:55. Following the instructions, the Aircraft A continued to descend even after its altitude became lower than the MVA (10,000 ft).

According to the statement described in 2.1.3 (1), when the Radar Controller started radar vectoring for the Aircraft A, his focus of attention was on keeping a separation with the holding Aircraft B ; as a result, it is probable that he forgot to confirm the MVA and made the Aircraft A descend to a lower altitude than the MVA.

(4) As described in 2.10.1, the Radar Controller (East Sector) was providing services for an average of nine aircraft. When he instructed the Aircraft A to descend to 9,000 ft and fly heading 090° at 13:33:19 and 13:33:42, he received a request from other aircraft for climbing to avoid turbulence. Given the fact that before the Radar Controller instructed the Aircraft A to descend to 5,000 ft at 13:35:55, he established communication and radar identification with two aircraft: an aircraft bound for Narita International Airport and an aircraft departing from Monbetsu Airport, it is possible that he forgot to confirm the MVA.

(5) According to the statement described in 2.1.3 (1), when the Aircraft A requested for approval for a direct flight to AWE about 14 nm east of AWE, the Radar Controller had not established a vertical separation with the Aircraft B yet. Therefore, it is probable that he could not let the Aircraft A return to AWE at this moment so that he instructed the Aircraft A to fly heading 200° . It is probable that his instruction expedited the Aircraft A's quick proximity to the mountain. It is probable that the EGPWS warnings were activated because the mountain was captured within an abnormally close range ahead of the Aircraft A as its flight direction changed after the right turn following the instructions to fly heading 200° .

(6) According to the statement described in 2.1.3 (1) and the ATC communication records, it is highly probable that the Radar Controller had not fully recognized the critical situation in which the Aircraft A made an evasive maneuver responding to the EGPWS warnings because he had difficulty catching words in the pilot's report due to weak radio reception.

Later, the Radar Controller instructed the Aircraft A to descend to 5,000 ft again at 13:40:35 when it was flying at about 10,000 ft in an area where the MVA is 10,000 ft. The Aircraft A started descending around 13:41 and was maintaining heading 200° as instructed. But the Radar Controller corrected the descent instruction for the Aircraft A to 7,000 ft (the MVA at 10,000 ft) at 13:41:20. As described in 2.1.1, winds were blowing from around 260° at about 50 knots this time, therefore, the Aircraft A was wind-drifted to the east and eventually, it got very close again to the mountainous area to the south of Mt. Pippu with an elevation of 2,000 m (about 6,500 ft) or higher.

According to the Radar Controller's statement, when the Aircraft A climbed to 10,000 ft, he wondered its behavior and confirmed the MVA chart for the first time, and he realized that he had made the Aircraft A descend lower than the MVA. But in just a few minutes later, the Radar Controller issued instructions twice again for the Aircraft A to descend lower than the MVA. Therefore, it is probable that the Radar Controller had failed to confirm the MVA even at this moment. It is probable that the Radar Controller forgot to check the MVA chart again due to the following reasons: because he was relieved upon receiving the pilot report in which the aircraft's danger of ground proximity had been cleared and it was ready to land; as his statement in 2.1.3 (1) suggests he possibly thought the high MVA area was located further east and he had no additional necessity of confirming the chart again.

As the constant display of the MVA chart on the screen prohibits discerning important information, controllers consulted the chart on demand basis. Given this necessity it is probable that the Radar Controller should have checked the chart when he had the Aircraft A descend again.

In view of these findings, it is probable that air traffic controllers need to recognize again that the confirming the MVA is a basic requirement for radar vector.

(7) As described in 2.10.4, the East Sector handles aircraft flying in a wide airspace over Hokkaido. Therefore, the radar display at the radar position needs to be set in such a manner as to show a wide range to include all aircraft which must be covered by the East Sector. Therefore, it is probable that the range selection is not necessarily appropriate for a radar vector to provide separation between departing or arriving aircraft at certain airports in the region. If traffic in a certain airports area can be allocated to another controller, it is probable that a Radar Controller's display range can be adjusted for better radar vectoring.

As described in 2.10.1, the Radar Controller (East Sector) was in charge of an average of nine aircraft before the serious incident. It is probable that he had to spend most of his time handling communication with these aircraft. It isd probable that the Coordinator was also busy dealing with other air traffic control facilities and could not continuously monitor the Radar Controller's duties.

In light of these findings, it is probable that the Radar Controller should have considered receiving support from other air traffic controllers in order to reduce his workload.

3.6.2 Coordinator

(1) According to the statement described in 2.1.3 (2), when the Radar Controller began to vector the Aircraft A to the east, the Coordinator's concern then was to vector the Aircraft A below the Aircraft B and did not pay attention to the MVA, resulting in a failure to give appropriate advice for the Radar Controller. After the Aircraft A made an evasive maneuver responding to the EGPWS warnings and when the Radar Controller instructed the Aircraft A again to descend to 5,000 ft, the Coordinator was making arrangement with the Daisetsu Tower for an aircraft departing from Asahikawa Airport. Therefore, it is probable that the Coordinator could not monitor the Radar Controller's descent instructions for the Aircraft A and could not provide any advice regarding the confirmation of the MVA.

When the Aircraft A climbed to 10,000 ft the Coordinator stated that she came to realize that the Aircraft A had been vectored below the MVA. If she warned the Radar Controller about the MVA at that moment, it is probable that the Aircraft A would not have been descended below the MVA again.

(2) According to the statement described in 2.1.3 (2), when the serious incident occurred, Coordinator's workload was expected to increase. It is probable that it did actually, mainly due to aircraft handovers from other air traffic facilities and resulting duties as well as data input into the system following flight route changes. It is possible that the Coordinator could have prevented this serious incident from happening if she had secured enough time for coping with the aircraft arriving at Asahikawa Airport by asking support from other air traffic controllers.

3.6.3 Cooperation between Air Traffic Controllers

(1) According to the statements described in 2.1.3, when the Aircraft B returned to the East Sector frequency due to the minor trouble, the Radar Controller thought to refrain communication with the Aircraft B as much as possible and believed that the Aircraft A would be able to approach if it was descended to 7,000 ft. Meanwhile, the Coordinator hoped to leave the Aircraft B as it was and thought that she had to radar-vector the Aircraft A. Therefore, it is probable that the Radar Controller and the Coordinator had agreed on placing the Aircraft B on hold, and radar-vectoring the Aircraft A to an altitude below the Aircraft B holding at 8,000 ft followed by the approach sequence change of the Aircraft A. But the Radar Controller stated that he had thought that adjustment had already been made for vectoring the Aircraft A to the east, and he had not confirmed the MVA. Meanwhile, the Coordinator stated that she had not talked with the Radar Controller about the Aircraft A's radar vector to the east or about confirming the MVA. Therefore, it is probable that cooperation between the two controllers was insufficient concerning the radar vector instruction and the MVA confirmation.

(2) According to the statements described in 2.1.3, the Radar Controller stated that traffic was busy in areas covered by the East Sector but that it was not too heavy to cope with, while the Coordinator stated that workload at the Radar Position was considerably heavy but that traffic was not too heavy to cope with. Therefore, it is probable that the two controllers had accessed that traffic was not too heavy to cope with. But their workloads at the East Sector need to be considered in view of not only volume but also quality in air traffic control services. Because the contents of their jobs changed following the change in the approach sequence for the aircraft arriving at Asahikawa Airport, the two controllers had to spare their time for these additional jobs and as a result, it is possible that they lacked effective mutual cooperation and that the Coordinator could not correct the Radar Controller's instructions for the Aircraft A to descend to an altitude below the MVA.

3.7 Condition of the Flight Crew aboard the Aircraft A

3.7.1 PIC

(1) According to the statement described in 2.1.2 (1), the PIC was somewhat hesitant to follow the instructions as the Aircraft A was flying to a mountainous area under radar vector after the change of the landing sequence. But the PIC believed that the vectoring was aimed at descending and the controller was applying the MVA. Therefore, it is probable that the PIC continued the flight without reconfirmation.

(2) According to the statement described in 2.1.2 (1), the PIC made an evasive maneuver responding to the first EGPWS warning, reduced the engine power upon the deactivation of the warning, and the second EGPWS warning was activated.

As described in 2.10.7 (2), when the evasive maneuver is made responding to an EGPWS warning, pilots have to monitor radio altimeter for sustained or increasing terrain separation before completing the maneuver, as prescribed in the Company's manual. It is probable that if the Aircraft A had continued to climb without reducing its engine power in accordance with this manual, it would have had a sufficient separation with the ground and the second EGPWS warning would not have been activated.

However, as described in 2.10.12, the Radio Altitude (RA) is not displayed on the PFD unless it is below 2,500 ft. As described in 2.1.1, the first EGPWS warning was activated at about 3200 ft RA and deactivated at about 2,200 ft RA according to the DFDR records. Based on these findings, it is highly probable that when the PIC started the evasive maneuver responding to the "TERRAIN" and "PULL UP" warnings, the RA had not been displayed on the PFD as yet and it began to show only after the start of the evasive maneuver. As indicated by Figure 9, because the PFD displays only RA figures, it is not easy to recognize instant RA changes. It is highly probable that as the RA changes greatly in mountainous areas, it was even more difficult to read the fluctuating readings at a glance on the PFD.

As there is a possibility that when a warning stops, pilots may be tempted to discontinue the ongoing operations (the evasive maneuver) responding to the warning or to return to the previous state, as well as a difficulty to grasp a trend of fluctuation from the RA readings on the PFD, it is desirable to execute a ground proximity training with EGPWS warnings involved considering above mentioned factors.

3.7.2 FO

(1) According to the statement described in 2.1.2 (2), when the "CAUTION TERRAIN" was issued, a mountain ahead had been displayed on the FO's VSD. It is probable that if the FO had advised the PIC about the approach to the mountainous area based on this information, the PIC would have not only stopped the descent but to reduced the rate of descent.

(2) According to the statement described in 2.1.2 (2), the FO had a longer job history with the Company than the PIC. The FO stated that he was trying not to be pushy about the PIC's operations and he believed that the PIC had been aware of the geographical features in Asahikawa. Therefore, though he had became concerned about relations with the geographical features as the Aircraft A descended, it is probable that the FO did not give any advice to the PIC because he believed that the PIC's duties should not be disturbed by excessive advice. But it is probable that with the FO's advise about the existence of the mountainous areas with peaks of about 8,000 ft high upon the radar vectoring to the east, the PIC would have had a clear picture of the situation with the mountain ahead and the Aircraft A would have avoided ground proximity and the EGPWS warnings would not have been activated.

3.7.3 Cooperation between Flight Crew

(1) According to described in 2.1.2 the PIC and the FO had recognized that the Aircraft A was flying east toward the mountainous area upon commencement of the radar vector and they were reluctant to fly accordingly, it is highly probable that they did not talk about the situation with each other.

(2) According to described in 2.1.2, it is highly probable that at the time of the occurrence of the serious incident, they had selected the WXR mode on the ND due to bad weather. But since

they understood that the Aircraft A was being vectored toward the mountainous area, if either of them selected the terrain mode, it is possible that they would have detected the ground proximity sooner. Since the FO had the VSD on, it is probable that if they had been communicatively active for information sharing, the Aircraft A would not have approached so close to the mountainous area as the EGPWS issues warnings.

(3) According to the FO stated in 2.1.2 (2), he had a belief that an FO should play his/her part in a modest manner without violating other's turf in the cockpit and that the important decisions are left to the PIC. As a result, it is probable that the FO had not given any necessary advice to the PIC in this incident.

However, as described in 2.10.11, "Communication," one of the CRM training contents which the two received in fiscal 2010, urged them to "Speak openly without hesitation," and "Frankly state your view," stressing that speaking openly at an earlier stage leads to preventive actions. When the Aircraft A was vectored toward the mountainous area and directed to descend to a lower altitude, neither the PIC nor the FO expressed their views openly or talked about the situation with each other. It is probable that they did not fully practice what they had learned in the CRM training.

3.8 Preventive Actions

(1) Because the air traffic controllers did not confirmed the MVA when the Aircraft A was instructed to descend in the course of a radar vector, measures must be taken to enforce sure confirmation of the MVA. It is possible that lack of effective cooperation between the Radar Controller and the Coordinator led to their failed correction of the inappropriate descent instructions issued for the Aircraft A. Therefore, the TRM training needs to be improved so that air traffic controllers can fully cooperate with each other.

(2) The air traffic control procedure standard stipulates that a radar vectoring must be made at or above the MVA. In the serious incident, the Radar Controller instructed the Aircraft A to descend below the MVA, but he remained unaware of his mistake. Therefore, an introduction of a better controller support system is necessary so that in cases of an ATC instruction to descend an aircraft or an aircraft being descended below the MVA, controllers can easily become aware of the situation.

(3) Following the change in the aircraft approach sequence bound for Asahikawa Airport, it is probable that the Radar Controller had to spend his time and attention for the change process. It is probable that the Coordinator had been preoccupied with inputting necessary data into the ATC system and coordinating jobs with other air traffic control facilities. A decision on whether to seek support is at the discretion of air traffic controller who is on duty at each sector. In this case, both controllers made no requests for support. Therefore, the support systems need to be improving to provide effective support for controllers at an appropriate timing when workload is expected to increase each sector.

(4) Although the existence of the MVA is known, an actual application and specific values have not been officially published. Many foreign countries have already published their MVA data. It is appropriate for Japan to follow suit in order to increase pilots' MVA awareness. When considering specific release and application methods of the MVA data, it is desirable to listen to pilots' opinions.

(5) As a general rule, an aircraft has to follow ATC instructions while the Aircraft A was unexpectedly vectored to a mountainous area in this case. In case pilots have the least bit of

question about an ATC instruction, they always need to clear the question.

(6) It is probable that the Aircraft A's onboard EGPWS functioned normally, the flight crew could perform the evasive maneuver responding to the issued warnings and prevent the Aircraft A from crashing into the ground. But because the warnings once came to a stop were reactivated, the training should be improved to meet the GPWS warning situation so that pilots can perform proper evasive maneuver.

(7) The FO stated that he had a belief that FOs should play their part in a modest manner without violating each other's turf in the cockpit and that the important decisions are left to the PIC, and he did not provide appropriate advice for the PIC even in the serious incident. Neither the PIC nor the FO openly stated their views or talked about their situation with each other. This mental attitude is not compatible with the philosophy sought in the CRM. It is probable that what the PIC and the FO had received in their CRM training was not practiced in the actual situation. Therefore, continued efforts should be made to make the CRM training more workable.

4. CONCLUSIONS

4.1 Findings

As mentioned above, the analysis of the occurrence of this serious incident is summarized as follows:

(1) The Aircraft A requested Sapporo Control for returning to Asahikawa Airport with a right turn while descending at about 7,700 ft near a point, 13 nm east of Asahikawa Airport, and a right descending turn was started toward heading 200 under Sapporo Control's instructions.

Few seconds after the Aircraft A started the turn, the "CAUTION TERRAIN" alert-message was issued and 10 seconds later, the "TERRAIN" and "PULL UP" warnings were issued.

The Aircraft A performed an evasive maneuver following the EGPWS warnings.

(2) The Radar Controller decided to start radar vectoring for the Aircraft A because it would minimize a delay for landing. But it is possible that this serious incident could have been prevented from occurring, if he had selected to process the situation safely while considering the comprehensive workload of the sector.

(3) There is a mountainous area to the east of Asahikawa Airport and therefore, it is impossible to make a descent toward the area even if a horizontal separation is secured. It is probable that the Radar Controller made an inappropriate judgment when he radar-vectored the Aircraft A to the east.

(4) Because the Radar Controller had focused on securing a separation with the holding Aircraft B, it is probable that he forgot to check the MVA.

(5) It is probable that because of the Radar Controller's partial recognition of the Aircraft A's critical situation, his vague positive situational recognition and less awareness of the MVA, he forgot again to confirm the MVA when he instructed the Aircraft A to descend for the second time.

(6) The Coordinator was preoccupied with coordination with Asahikawa Airport; therefore, it is probable that she could not monitor the Radar Controller's instructions and could not provide any advice to him on confirming the MVA.

(7) It is possible that the Radar Controller and the Coordinator lacked effective cooperation with each other; hence, the Coordinator could not correct the Radar Controller's instructions for the Aircraft A to descend below the MVA.

(8) It is probable that because the PIC believed the controller was applying the MVA, he continued the flight without questioning the controller about the instructions.

(9) It is probable that if the FO had given advice to the PIC in an appropriate manner based on the information from the VSD, the ground proximity would not have occurred and the EGPWS warnings would not have been issued.

(10) It is highly probable that the PIC and the FO had recognition that the Aircraft A was being vectored to the east toward the mountainous area and they were somewhat reluctant to follow the instructions, but they did not talk about it.

4.2 Probable Causes

It is highly probable that this serious incident occurred because the Aircraft A experienced a ground proximity and its flight crew took an emergency maneuver responding to its EGPWS warnings during its descent toward its destination aerodrome, Asahikawa Airport, under the ATC instructions.

It is probable that the ground proximity occurred because: the Radar Controller instructed the Aircraft A to descend below the MVA without confirming it; its flight crew did not question the Radar Controller on the descent instruction in spite of awareness of being vectored to the east toward the mountainous area.

It is probable that the Radar Controller forgot to confirm the MVA because his attention was focused on securing a separation with the holding Aircraft B.

It is probable that the flight crew did not question the air traffic controller about the instructions because: the PIC believed the controller was applying the MVA; the FO gave no advice to the PIC in spite of his VSD based recognition of the approach to the mountainous area.

5. OPINIONS

It is highly probable that the serious incident occurred because an aircraft which belongs to Air Nippon Co., Ltd., experienced a ground proximity and its flight crew took an emergency maneuver responding to its EGPWS warnings during its descent toward its destination aerodrome, Asahikawa Airport, under the ATC instructions. It is probable that the ground proximity occurred because: an air controller instructed the aircraft to descend below the MVA without confirming it; its flight crew did not question the Radar Controller on the descent instruction in spite of awareness of being vectored to the east toward the mountainous area.

In view of the investigation results of the serious incident, the Japan Transport Safety Board, , states the following opinion to the Minister of Land, Infrastructure, Transport and Tourism pursuant to Article 28 of the Act for Establishment of the Japan Transport Safety Board in order to secure the safety of air traffic:

Efforts must be made to expedite the introduction of a system to better support air traffic controllers so that they can have situation awareness more easily when ATC instructions were issued for an aircraft to descend below the MVA, or when an aircraft descended below the MVA.

6 ACTIONS TAKEN

6.1 Responses Taken by Air Traffic Control Division, Air Traffic Service Department, Civil Aviation Bureau, MLIT

Upon receiving the factual information that an air traffic controller instructed an aircraft to descend below the MVA in a radar vectoring, the Air Traffic Control Division of the Air Traffic Service Department, the Civil Aviation Bureau, has issued an office circular titled “Better radar service performance with more safety consciousness including MVA reconfirmation” to all air traffic control facilities, in order to prevent similar occurrence and to provide air traffic control services in an even more appropriate manner while enhancing air traffic controllers’ safety awareness, emphasizing: the confirmation of the standards relevant to the MVA and corresponding regional characteristics; proper practice of basic actions; active use of assistance and other functions provided by air traffic control system in an appropriate manner; cooperation and complement among stations; and taking proactive actions against error occurrences.

6.2 Responses Taken by Sapporo Control

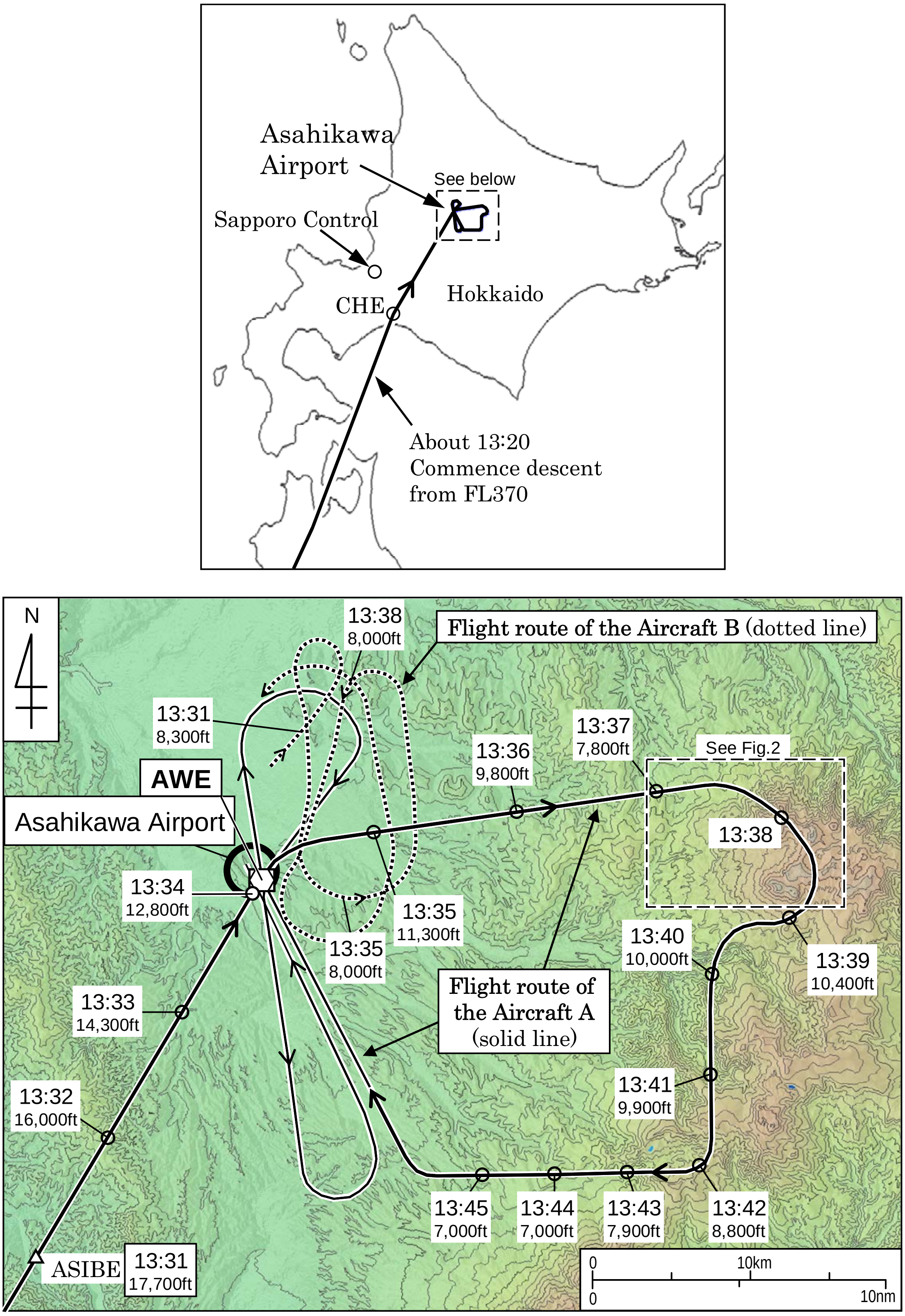
After the occurrence of this serious incident, Sapporo Control Office has taken safety measures as follows;

Sapporo Control Office urged air traffic controllers to fully understand the need to confirm the MVA, the heights of mountains and locations before starting their daily jobs so that actions for support may be taken in an appropriate manner. It has also notified controllers that it would strike out preventive actions such as generating training course materials for better understanding of regional characteristics and guidance materials for radar vectoring near aerodromes while tentatively reconfiguring radar system for displaying alert for aircraft flying below the MVA. The Office has set up a clear guideline when to start and end support for controllers at the coordinator position. The Office is presently studying the need to introduce new MVA alert functions for the controllers. The Office confirms whether the MVA is consulted in an individual’s periodical check.

6.3 Responses Taken by the Company

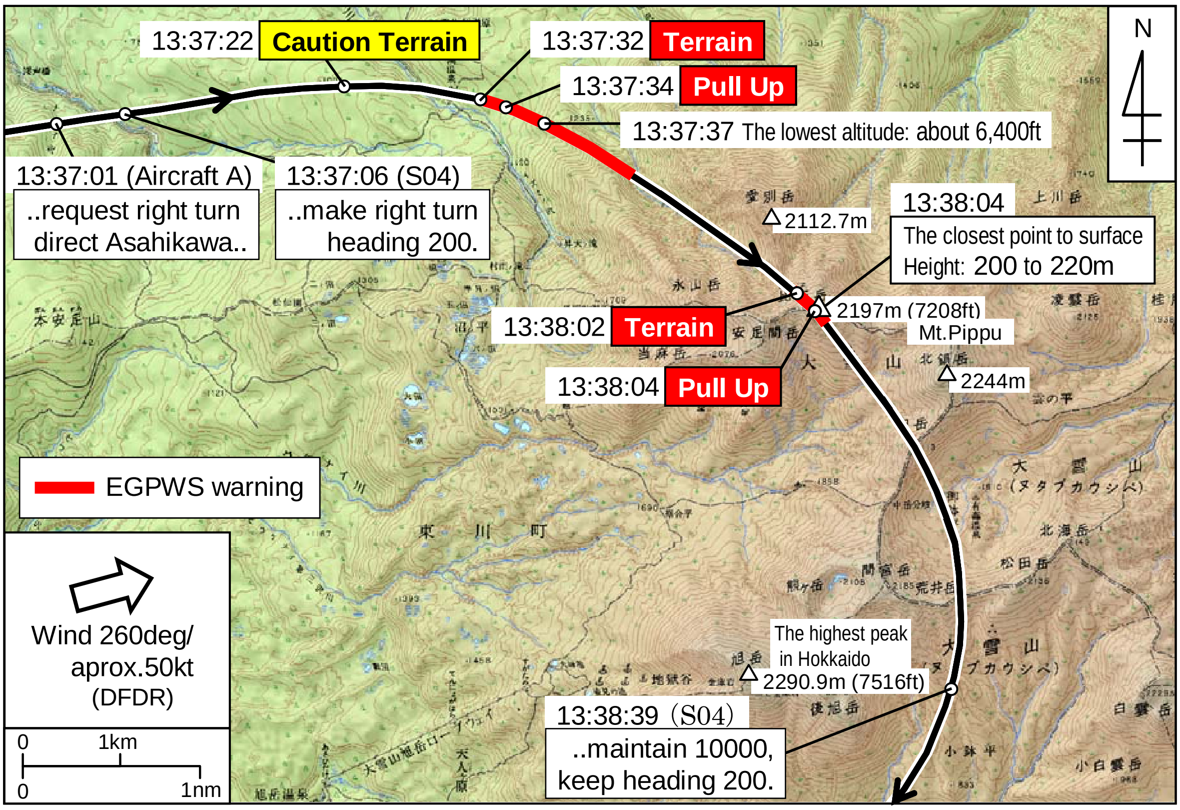
The Company has taken preventive actions in response to the occurrence of the serious incident by: issuing a document to deal with cases where they are questionable about air traffic controllers’ instructions; adding obstacle information around aerodromes to the route manual; urging flight crew to actively use the Terrain Mode; revising the EGPWS section of the AOM to deal with the EGPWS warnings; and improving the contents of the EGPWS-related training.

Figure 1 Estimated Flight Route (1)



The values of "ft" mean pressure altitude (rounded to the 100ft) corrected by QNH of Asahikawa airport.

Figure 2 Estimated Flight Route (2)



1:50,000 scale Topographic Map by Geographical Survey Institute

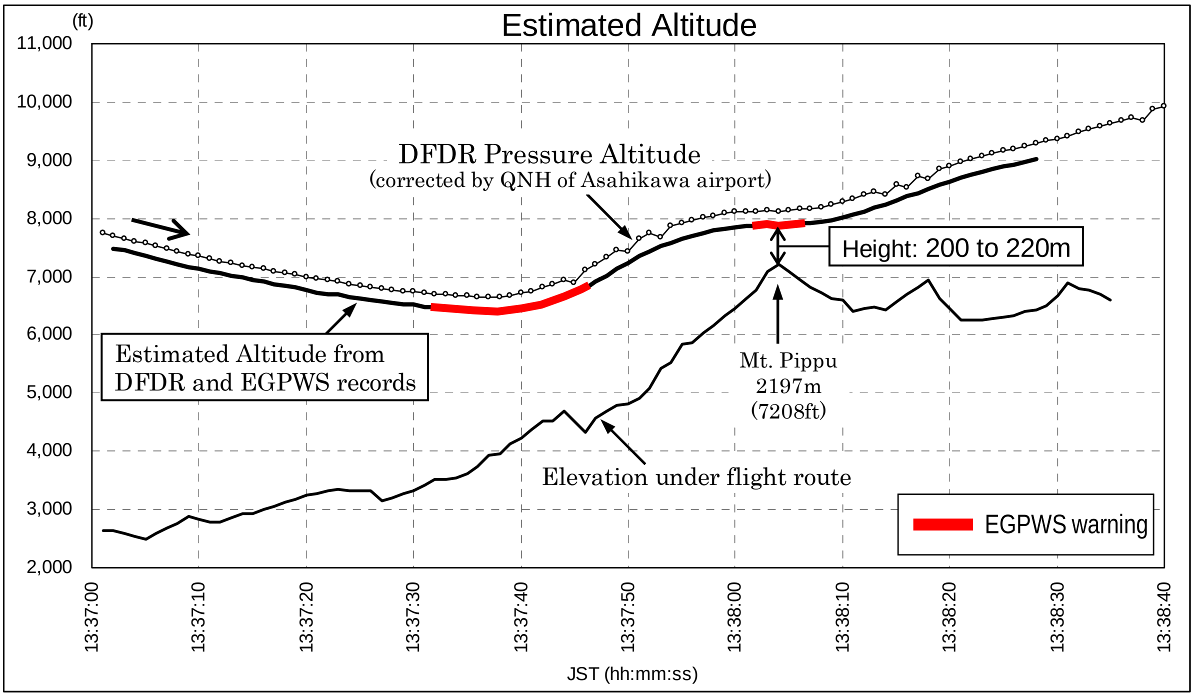


Figure 3 DFDR Record

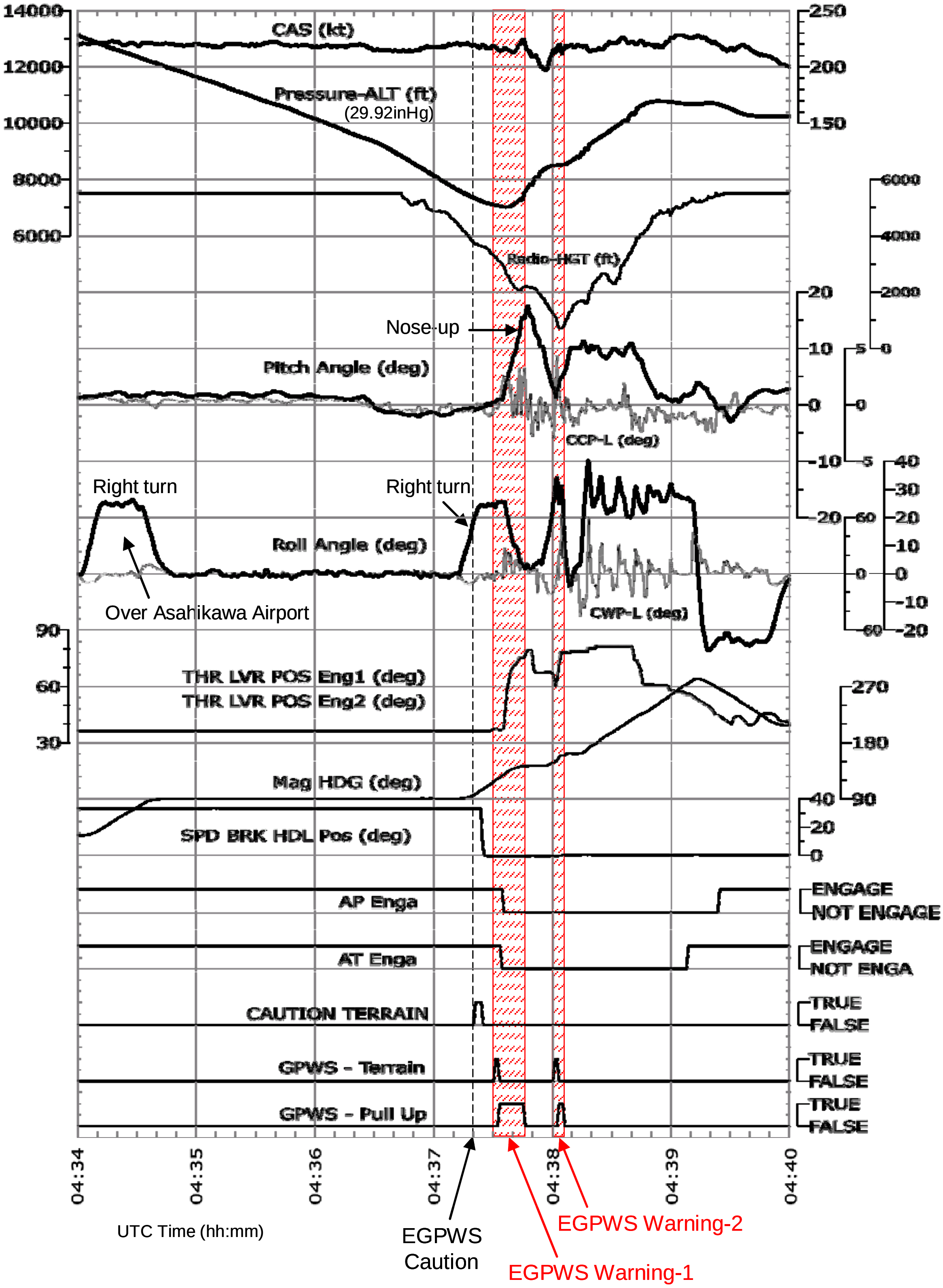


Figure 4　　Three Angle View of Boeing 737-800

Unit: m

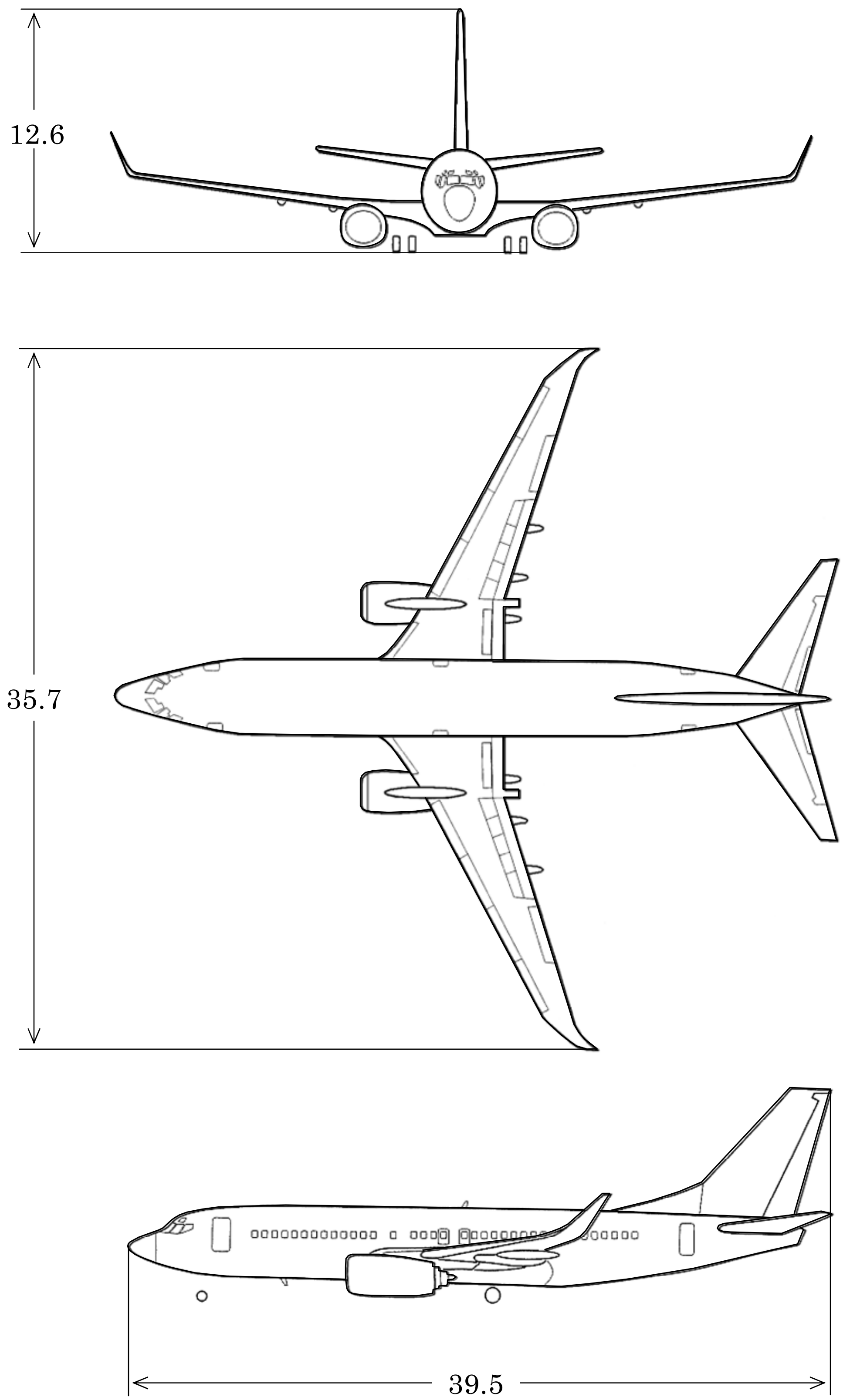


Figure 5 Communication situations of the East Sector

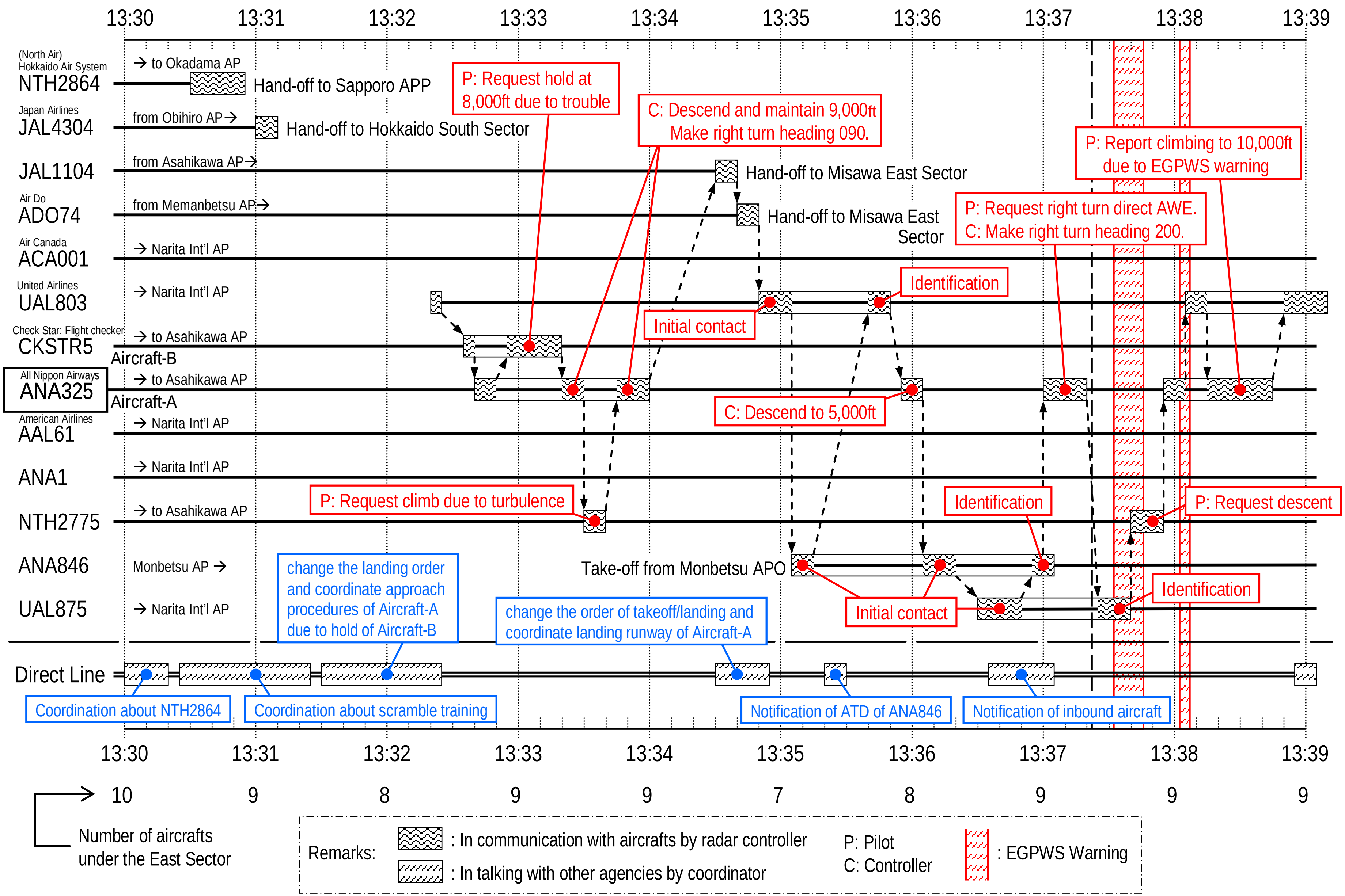
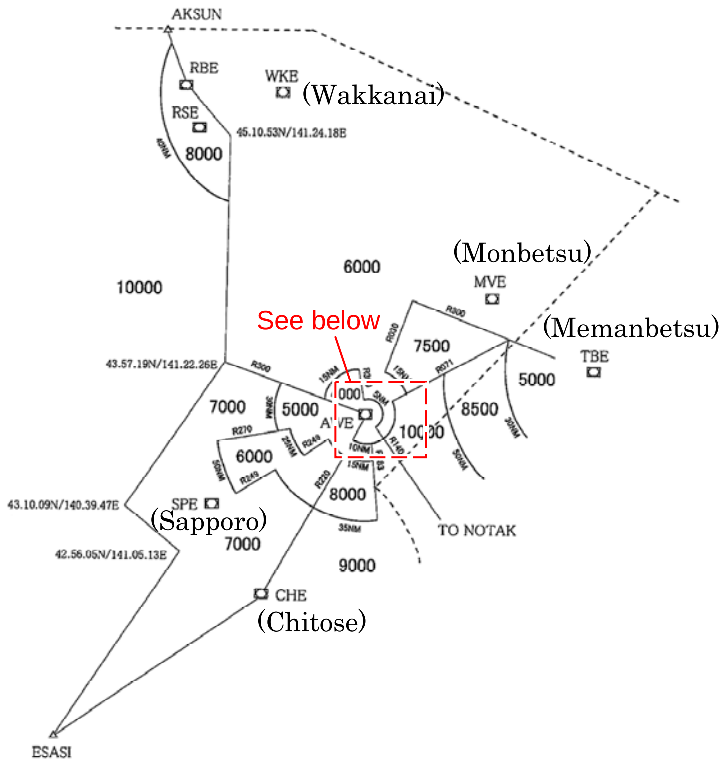
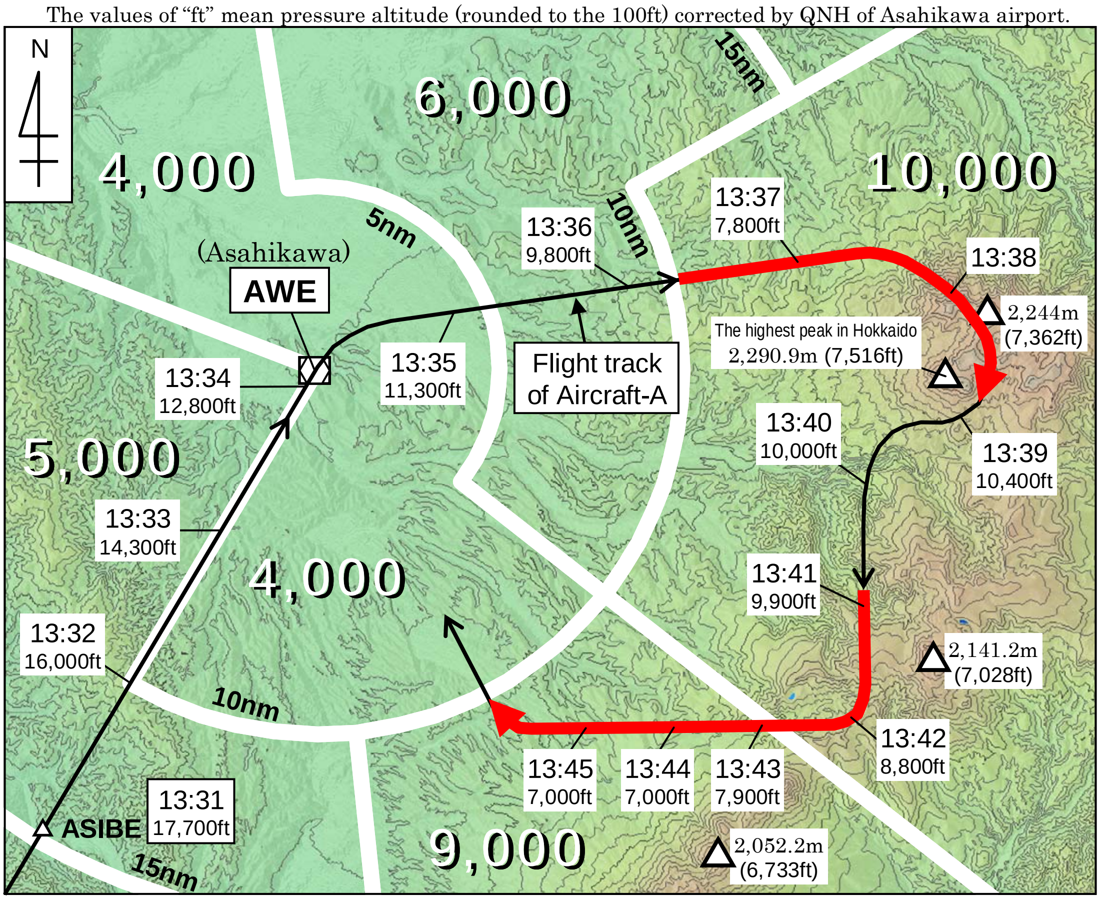


Figure 6 Minimum Vectoring Altitude (MVA) in the vicinity of the serious incident site

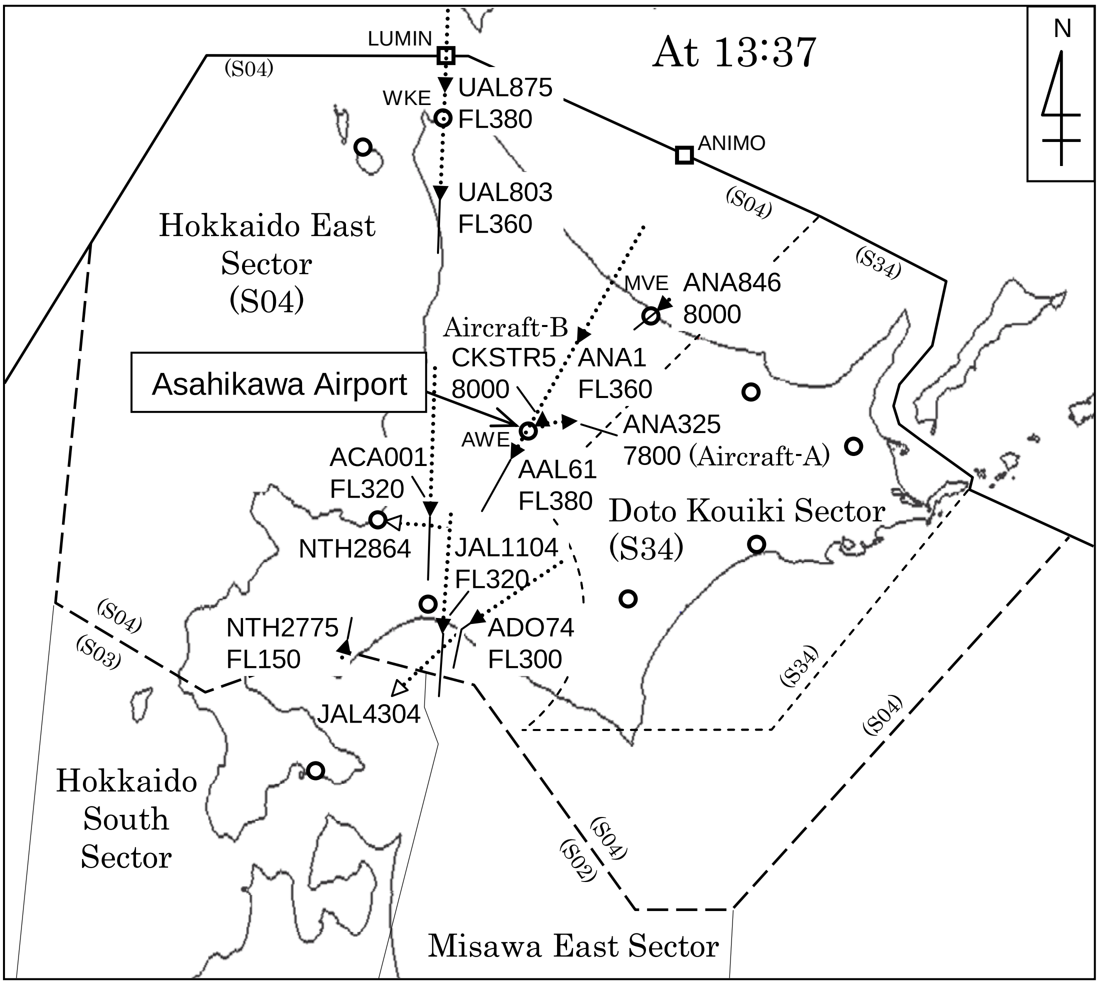


The values of "ft" mean pressure altitude (rounded to the 100ft) corrected by QNH of Asahikawa airport.



Bold and shadowed numbers show MVA (ft) : below MVA

Figure 7　Aircrafts controlled by the Hokkaido East Sector



Remarks:

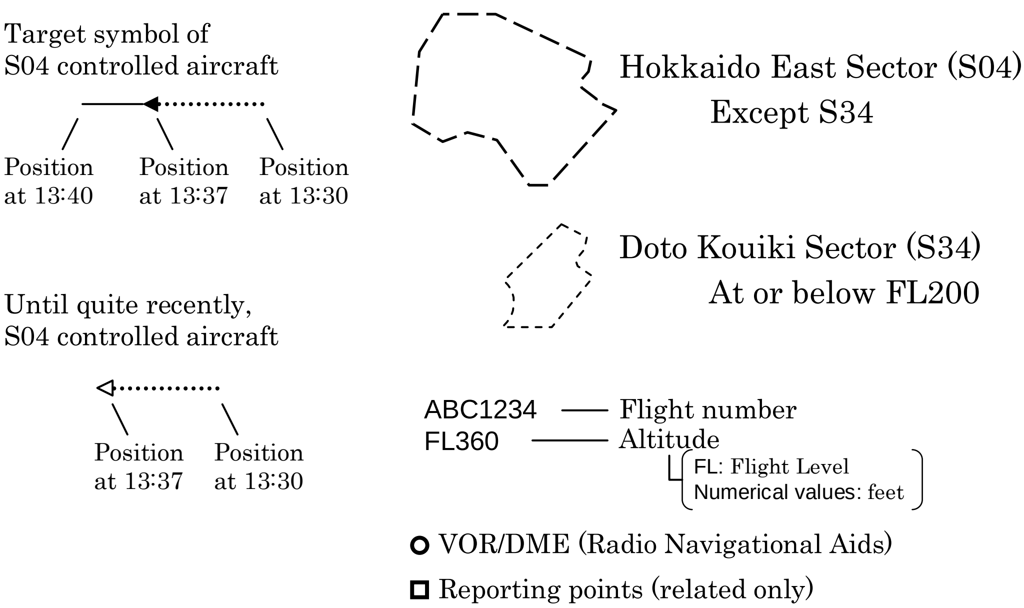


Figure 8 Integrated Enroute Control System (IECS)

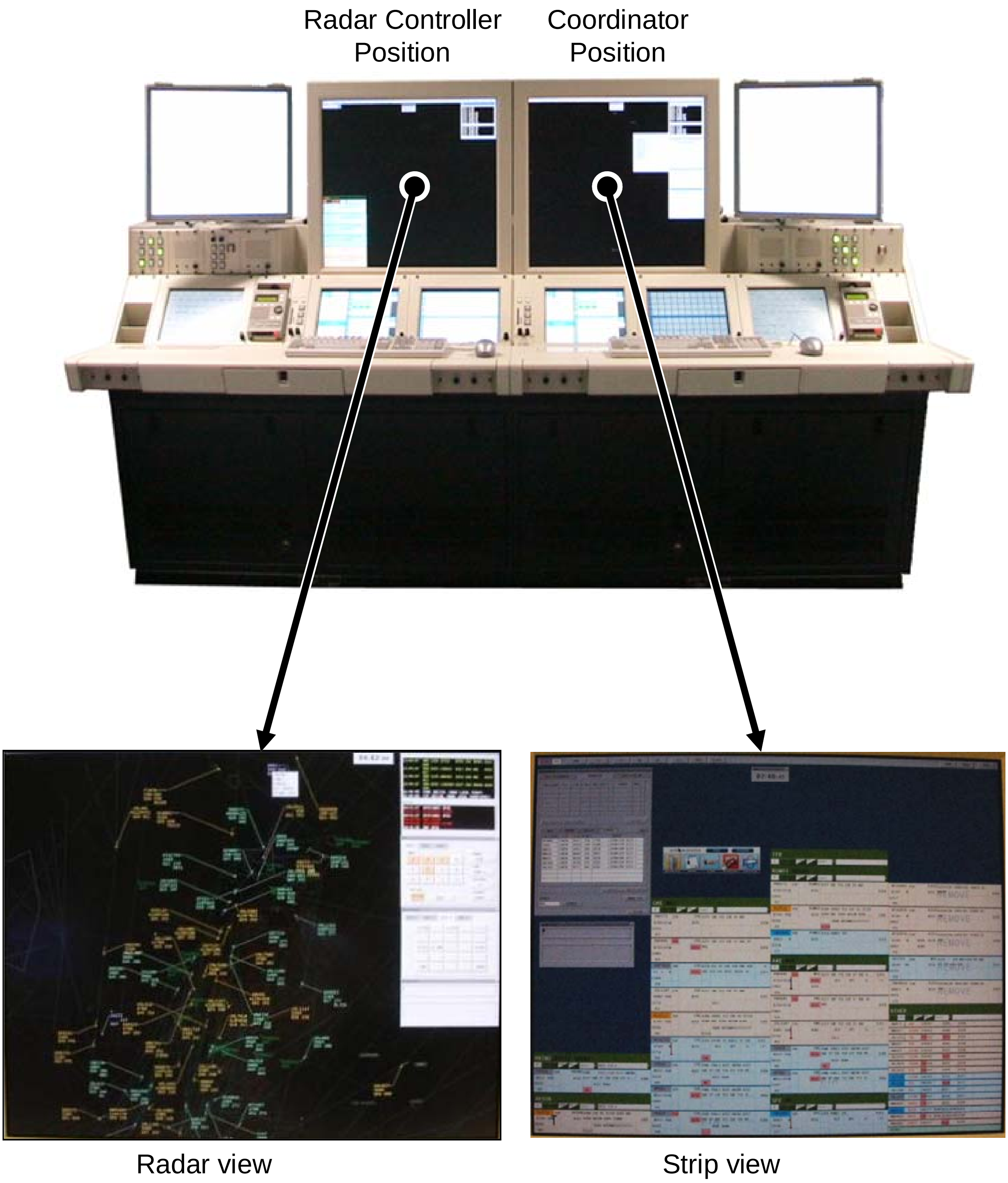
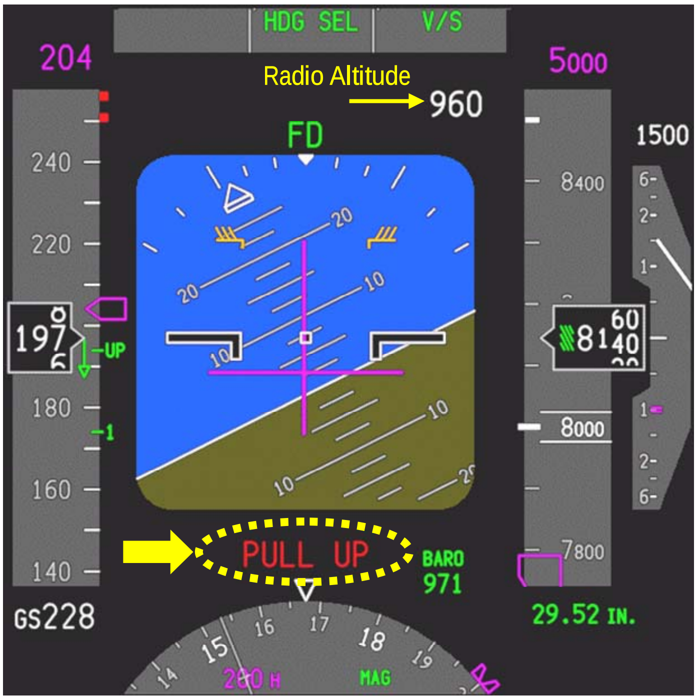


Figure 9 PFD and ND

PFD (Primary Flight Display)



PULL UP warning during right climbing turn at 27 degrees bank angle

- ・Airspeed: 197kt
- ・Ground speed: 228kt
- ・Press. Alt: 8,140ft
- ・Radio Alt: 960ft
- ・Heading: 168deg
- ・V/S: 1,500ft/min
- ・QNH setting: 29.52inHg

ND (Navigation Display) – selected VSD

TERRAIN warning during right descending turn

- ・Heading: 134deg (Track angle: 124deg due to wind from 4o'clock)
- ・16.2nm from AWE

VSD in the box shows that terrain exists about 1nm ahead of the aircraft, maneuver is required to avoid impact. (: aircraft)

- ・Pressure Altitude: about 7,300ft

Note: waypoints (AW006 to AW009) were not displayed at the serious incident, due to set to review by simulator.

Attachment ATC Records of the East Sector

JST	Origin	Contents
		(omitted)
13:27:10	S04	All Nippon 325, hold over Asahikawa VOR, expect approach 0437.
13:27:16	**ANA325**	**All Nippon 325, hold over Asahikawa, expect 0437.**
13:27:29	S04	All Nippon 1, radar contact, 10 miles south of ANIMO (waypoint), maintain FL360.
13:27:37	ANA1	All Nippon 1, maintain 360.
13:28:30	S04	Delta 91Alpha, contact Sapporo Control 124 decimal 5.
13:28:35	DAL91A	124 point 5, Delta 91Alpha.
13:28:38	S04	Check, 1245, twenty four point five.
13:28:41	DAL91A	Twenty four point five, Delta 91Alpha.
13:28:49	S04	Check Star 5, contact Daisetsu Tower 118 decimal 55.
13:28:53	CKSTR5	Check Star 5, contact Daisetsu Tower 11855.
13:29:26	NTH2775	Sapporo Control, North Air 2775, leaving 11700, climbing 13000.
13:29:32	S04	North Air 2775, Sapporo Control, roger, area QNH 2963.
13:29:37	NTH2775	2963, North Air 2775.
13:30:27	NTH2864	Sapporo Control, North Air 2864, request further descend or switch to Sapporo Radar.
13:30:34	S04	North Air 2864, descend and maintain 9000.
13:30:37	NTH2864	9000, North Air 2864.
13:30:44	S04	North Air 2864, now contact Sapporo Approach 119 decimal 22.
13:30:49	NTH2864	119 decimal 22, North Air 2864.
13:31:01	S04	Japan Air 4304, contact Sapporo Control 119 decimal 3.
13:31:05	JAL4304	Switch 1193, Japan Air 4304.
13:32:20	S04	United 803, Sapporo Control.
13:32:36	CKSTR5	Sapporo Control, Check Star 5, requesting.
13:32:38	S04	All Ni…All Nippon 325, stand by please.
13:32:53	CKSTR5	Sapporo Control, Check Star 5, requesting.
13:32:55	S04	Check Star 5, go ahead.
13:32:57	CKSTR5	Check Star 5, request hold over Asahikawa VOR 8000, stand by my intention.

JST	Origin	Contents
13:33:04	S04	Check Star 5, understand, cancel approach clearance. Confirm due to weather?
13:33:12	CKSTR5	Check Star 5, due to minor trouble.
13:33:14	S04	Roger, sequence changed, you'll be No.2, stand by EFC(Expect Further Clearance).
13:33:17	CKSTR5	Check Star 5, roger, standing by.
13:33:19	S04	All Nippon 325, descend and maintain 9000. You'll be No.1, but ah…vector you for descending purpose.
13:33:25	**ANA325**	**All Nippon 325, roger, --- maintain 9000.**
13:33:31	NTH2775	Sapporo Control, North Air 2775, request FL150 due to turbulence.
13:33:36	S04	North Air 2775, climb and maintain FL150.
13:33:39	NTH2775	FL150, thank you, North Air 2775.
13:33:42	S04	All Nippon 325, make right turn heading 090 for descending purpose.
13:33:49	**ANA325**	**All Nippon 325, roger, make right turn heading 090.**
13:33:54	S04	090, now vector you to high station for ILS.
13:33:58	**ANA325**	**All Nippon 325, thank you.**
13:34:31	S04	Japan Air 1104, contact Sapporo Control 124 decimal 5.
13:34:36	JAL1104	Sapporo Control 1245, Japan Air 1104.
13:34:40	S04	Air Do 74, contact Sapporo Control 124 decimal 5.
13:34:45	ADO74	124 decimal 5, Air Do 74.
13:34:49	UAL803	Control, United 803, switching 10600 meters past LUMIN (waypoint).
13:34:54	S04	United 803, squawk 6146.
13:35:02	UAL803	6146, roger.
13:35:05	ANA846	Sapporo Control, All Ni--- eight---(fragmentary transmission)
13:35:09	S04	All Nippon 845, Sapporo Control, radio cutting, area QNH 2964.
13:35:40	S04	United 803, radar contact, now 15 miles south of Whiskey-Kilo-Echo(WKE: Wakkanai VOR/DME) maintain 360.
13:35:47	UAL803	OK, maintain FL360, United 803.
13:35:55	S04	All Nippon 325, descend and maintain.. 5000.
13:35:59	**ANA325**	**All Nippon 325, descend and maintain 5000, thank you.**

JST	Origin	Contents
13:36:02	ANA846	Sapporo Control, All Nippon 846, leaving 5600, climbing FL220.
13:36:08	S04	All Nippon 846, Sapporo Control, loud and clear. I say again, area QNH 2964, not yet in radar.
13:36:14	ANA846	2964, All Nippon 846.
13:36:29	UAL875	Control, United 875, over--- LUMIN (waypoint).
13:36:33	S04	United 875, Sapporo Control, squawk 6175.
13:36:44	UAL875	6175, United 875.
13:36:47	S04	Affirm, 875, 6175.
13:36:54	S04	All Nippon 846, radar contact 8 miles north-east of Monbetsu VOR, report altitude.
13:37:00	ANA846	All Nippon eight---(overlapping)
13:37:01	**ANA325**	**Sapporo Control, All Nippon 325, request right turn direct Asahikawa please.**
13:37:06	S04	All Ni…All Nippon 325, roger, make right turn heading.. 200.
13:37:12	**ANA325**	**All Nippon 325, roger, right turn heading 200.**
13:37:26	S04	United 875, radar contact 10 miles north of Whiskey-Kilo-Echo (WKE: Wakkanai VOR/DME), maintain FL380.
13:37:34	UAL875	Maintain FL380, United 875.
13:37:41	NTH2775	Sapporo Control, North Air 2775, request 13000.
13:37:45	S04	North Air 2775, descend and maintain 13000, QNH 2964.
13:37:51	NTH2775	13000, 2964, North Air 2775.
13:37:55	S04	All Nippon…All Nippon 325, resume own navigation, direct Asahikawa VOR.
13:38:02	**ANA325**	**All Nippon three..** “..**TERRAIN**..” (in background sound)
13:38:07	UAL803	Control, United 803 request.
13:38:10	S04	United 803, stand by.
13:38:12	S04	All Nippon 325, I say again own navigation, direct Asahikawa VOR.
13:38:16	**ANA325**	**All Nippon 325, we terrain…occurred. Request radar vector. We are climbing 10000.**
13:38:27	S04	All Nippon 325, confirm ready for approach?

JST	Origin	Contents
13:38:31	**ANA325**	**All Nippon 325, stand by please. We are evacuating terrain area. Request radar vector continue please.**
13:38:39	S04	ALL Nippon 325, roger, maintain 10000, keep heading 200.
13:38:44	**ANA325**	**All Nippon 325, roger, keep heading 200 and 10000.**
13:38:51	S04	United 803, go ahead.
13:38:53	UAL803	United 803, request FL380.
13:38:56	S04	Roger, United 803, climb and maintain FL380.
13:39:02	UAL803	United 803, climb FL380.
13:39:05	S04	United 803, also we have a revised clearance for you.
13:39:13	UAL803	OK, ready to copy.
13:39:15	S04	Oh, roger..United 803 also United 875 monitor this revised clearance. United 803 after Charlie-Hotel-Echo(CHE), Victor twenty two(V22), Mike-Quebec-Echo(MQE) and Yankee-Three-Zero(Y30), direct KASMI, go ahead.
13:39:41	UAL803	OK, after Charlie-Hotel-Echo(CHE), Victor twenty two(V22), Mike-Kilo-Xray (MKX), Yankee thirty(Y30), direct KASMI, United 803.
13:39:50	S04	United 803, after.. after Victor twenty two(V22), navigates Mike-Quebec-Echo (MQE), Mike-Quebec-Echo (MQE).
13:39:58	NTH2775	(overlapping) Sapporo Control, ---75, after MOIWA (waypoint) request direct Asahikawa VOR, due to weather.
13:40:06	S04	North Air 2775, stand by, please.
13:40:08	UAL803	(overlapping)--- Mike-Quebec-Echo (MQE), Y30, then direct KASMI, United 803.
13:40:13	S04	United eigh.. United 803, that's correct.
13:40:17	S04	North Air 2775, stand by please.
13:40:20	NTH2775	Roger.
13:40:24	**ANA325**	**Sapporo Control, All Nippon 325, we are clear terrain area. We are ready for approach to Asahikawa airport.** **Request present position direct Asahikawa and approach clearance, please.**

JST	Origin	Contents
13:40:35	S04	All Nippon 325, you need descend to 7000. We have a holding aircraft over Asahikawa at 8000. Descend and maintain 5000.
13:40:42	**ANA325**	**All Nippon 32..5, roger, descend and maintain 5000.** **We can approach.. available on this altitude.**
13:40:53	S04	Roger.
13:40:58	UAL875	Sapporo Control, United 875, approach 400.
13:41:04	S04	United 875, sorry, say again please.
13:41:06	UAL875	Request level 400.
13:41:08	ANA9	Sapporo Control, All Nippon 9, Good afternoon, FL381.
13:41:13	S04	All Nippon 9, Sapporo Control, squawk 6074.
13:41:16	ANA9	6074.
13:41:18	S04	United 875, stand by, break.
13:41:20	S04	All Nippon 325, descend and maintain 7000, this time 7000.
13:41:24	**ANA325**	**All Nippon 325, descend and maintain 7000. We can accept right turn.**
13:41:29	S04	All Nippon 325, this time proceed to.. now right turn heading 280, stand by approach.
13:41:36	**ANA325**	**All Nippon 325, roger, right turn heading 280, descend and maintain 7000.**
13:41:54	S04	North Air 2775, say again your request. Due to weather, confirm?
13:41:58	NTH2775	Affirm, due to weather after MOIWA (waypoint) direct Asahikawa VOR.
13:42:02	S04	North Air 2775, stand by.
13:42:04	NTH2775	Stand by.
13:42:07	S04	United 875, climbing FL400, did you copy the revised clearance?
13:42:12	UAL875	United 875, climbing leaving 380 climbing 400 and say again the clearance.

JST	Origin	Contents
13:42:21	S04	United 875, clearance is after Charlie-Hotel-Echo(CHE), Victor twenty two (V22), Mike-Quebec-Echo(MQE), Yankee-Three-Zero(Y30), direct KASMI (waypoint), go ahead.
13:42:37	UAL875	Understand, after Charlie-Hotel-Echo(CHE) Victor twenty two(V22), Mike-Quebec-Echo(MQE), Yankee-Three-Zero (Y30), direct KASMI.
13:42:47	S04	United 875, read back is correct.
13:42:57	S04	All Nippon 9, radar contact 10 miles south west of ANIMO (waypoint), maintain FL380.
13:43:02	ANA9	Maintain FL380, All Nippon 9.
13:43:18	S04	Air Canada 001, contact Sapporo Control 124 decimal 5.
13:43:22	ACA001	Twenty four five, Air Canada 001. Good day.
13:43:24	S04	Good day. Break, break, North Air 2775, unable your direct due to military operation. Left side deviation is approved. Which do you take?
13:43:32	NTH2775	North Air 2775, thank you operation, flight plan.. request flight planned route.
13:43:38	S04	Roger, maintain flight planned route.
13:43:39	NTH2775	North Air 2775, maintain flight planned route.
13:43:43	DAL183	Sapporo Control, Delta 183, LUMIN (waypoint) --- 348, request 380.
13:43:50	S04	Delta 183, Sapporo Control, this time squawk change, 6102, 6-1-0-6.
13:43:57	DAL183	Delta 183.
13:44:07	S04	All station holding over Asahikawa VOR, sequence change. We have a departure before all of you initially climbing 6000, use caution.
13:44:27	**ANA325**	**Sapporo Control, All Nippon 32---.**
13:44:32	S04	Calling 325, inbound Asahikawa?
13:44:34	**ANA325**	**Sorry, 325.** ***Ah.. May I talk in Japanese?***
13:44:39	S04	*Please go ahead.*

JST	Origin	Contents
13:44:40	**ANA325**	***Okay, uh.. maintain 7,000ft, 12nm south-east of AWE. We intend to direct to AWE with permission. The situation is.. uh.. few moments ago, we commenced descent according to radar controller's instruction, were heading to mountain range. The GPWS warnings were arisen, therefore we climbed. We are maintaining current altitude 10,000ft..*** (rest is inaudible due to noise)
13:45:17	S04	All Nippon 325, *sorry, but uh..voice..uh..radio is slightly weak. Ah.. I got you're maintaining 7,000ft now. Ah.. direct and hold over AWE.*
13:45:30	**ANA325**	*Roger,* ---(inaudible due to noise)--- *direct and hold over AWE.*
		(the rest is omitted)

JST (Japan Standard Time) is the time corrected by the time tone recorded with ATC communication.

---	Inaudible part
Italic	Japanese speaking part
( )	Note

<u>Remarks:</u>

S04	Sapporo Control	Sapporo ACC – Hokkaido East Sector
ACA001	Air Canada 001	Air Canada, for RJAA
ADO74	Air Do 74	Hokkaido International Airlines, from RJCM
ANA1	All Nippon 1	All Nippon Airways, for RJAA
ANA9	All Nippon 9	All Nippon Airways, for RJAA
ANA325	**All Nippon 325**	All Nippon Airways, for RJEC (**Aircraft A**)
ANA846	All Nippon 846	All Nippon Airways, from RJEB
CKSTR5	Check Star 5	Flight Inspector, for RJEC (**Aircraft B**)
DAL183	Delta 183	Delta Air Lines, for RJBB
DAL91A	Delta 91A	Delta Air Lines, for RJAA
JAL1104	Japan Air 1104	Japan Airlines, from RJEC
JAL4303	Japan Air 4303	Japan Airlines, from RJCB
NTH2775	North Air 2775	Hokkaido Air System, for RJEC
NTH2864	North Air 2864	Hokkaido Air System, for RJCO
UAL803	United 803	United Airlines, for RJAA
UAL875	United 875	United Airlines, for RJAA
FL	Flight Level	
VOR	VHF Omni-directional radio Range	
DME	Distance Measuring Equipment	