AA2009-7

# AIRCRAFT ACCIDENT INVESTIGATION REPORT

CHINA AIRLINES
B 1 8 6 1 6

August 28, 2009

Japan Transport Safety Board

The investigation for this report was conducted by the Japan Transport Safety Board, JTSB, about the aircraft accident of China Airlines, Boeing 737-800 registration B18616 in accordance with the act for the Establishment of the Japan Transport Safety Board and Annex 13 to the Convention on the International Civil Aviation for the purpose of determining causes of the aircraft accident and contributing to the prevention of accidents/incidents and not for the purpose of blaming responsibility of the accident.

This English version of this report has been published and translated by the JTSB to make its reading easier for English speaking people who are not familiar with Japanese. Although efforts are made to translate as accurately as possible, only the Japanese version is authentic. If there is any difference in the meaning of the texts between the Japanese and English versions, the text in the Japanese version prevails.

Norihiro Goto,
Chairman,
Japan Transport Safety Board

# AIRCRAFT ACCIDENT INVESTIGATION REPORT

CHINA AIRLINES (TAIWAN)
BOEING 737-800, B18616
SPOT 41 AT NAHA AIRPORT
AUGUST 20, 2007, AT ABOUT 10:33 JST

August 21, 2009
Adopted by the Japan Transport Safety Board
(Aircraft Subcommittee)

| | |
|---|---|
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# 1. PROCESS AND PROGRESS OF AIRCRAFT ACCIDENT INVESTIGATION

## 1.1 Summary of the Accident

On August 20, 2007, a Boeing 737-800, registered B18616, operated by China Airlines took off from Taiwan Taoyuan International Airport on a regularly scheduled Flight 120 of the company, and landed at Naha Airport. At about 10:33, immediately after the aircraft stopped at Spot 41, fuel that was leaking from the fuel tank on the right wing caught fire and the aircraft was engulfed in flames.

There were 165 people on board, consisting of the Captain, seven other crewmembers, and 157 passengers (including two infants). Everyone on board was evacuated from the aircraft and there were no dead and wounded.

The aircraft was badly damaged and destroyed by fire, leaving only part of the airframe intact.

## 1.2 Outline of the Accident Investigation

### 1.2.1 Investigation Organization

On August 20, 2007, the Aircraft and Railway Accidents Investigation Commission (ARAIC) designated an investigator-in-charge and three other investigators to investigate this accident. The ARAIC designated another investigator on December 3, 2007, and two more investigators on July 1, 2008.

### 1.2.2 Representatives and Advisers from Foreign Investigation Authorities

An accredited representative of the United States of America (NTSB: National Transportation Safety Board), as the State of Design and Manufacture of the aircraft involved in this accident, and an accredited representative of Taiwan (Aviation Safety Council (ASC)), as the authority responsible for the operator of the aircraft, as well as their advisers, participated in the investigation including the on-site investigation at Naha Airport.

### 1.2.3 Implementation of the Investigation

| | |
|---|---|
| August 20–26, 2007 | On-site investigation and interviews |
| August 30, 2007 | Witnessing the inspection of the downstop assembly |
| August 31, 2007 – April 24, 2008 | Investigation in Taiwan (commissioned to the ASC) |
| November 19, 2007 | Examination of wreckage and other relevant items |
| December 26, 2007 – August 19, 2008 | |

Measurement and analysis of engine nacelle temperatures and measurement and analysis of the downstop and related components (commissioned to the Japan Aerospace Exploration Agency)

### 1.2.4 Provision of Information to Civil Aviation Bureau of Japan (JCAB)

On August 24, 2007, the ARAIC provided the JCAB with information regarding the puncture hole through which fuel had leaked out, which was found through the on-site investigation.

### 1.2.5 Interim Report

On August 29, 2008, the ARAIC submitted an interim report to the Minister of Land, Infrastructure, Transport and Tourism based on the facts found up to that date, and the report was made available to the public.

### 1.2.6 Comments from Parties Relevant to the Cause of the Accident

Comments were taken from parties relevant to the cause of the accident.

### 1.2.7 Comments from the Participating Investigation Authorities

Comments were invited from the participating representatives of the United States of America and Taiwan.

# 2. FACTUAL INFORMATION

## 2.1 History of the Flight

On August 20, 2007, at 08:23 (09:23 JST), the Boeing 737-800, registered B18616 (hereinafter referred to as "the Aircraft"), operated by China Airlines (hereinafter referred to as "the Company"), took off from Taiwan Taoyuan International Airport on a regularly scheduled Flight 120 of the Company, and at 10:27 (hereinafter, time is indicated in JST, UTC + 9 h), landed at Naha Airport.

In the cockpit of the Aircraft, the Captain sat in the left seat as the PF (pilot flying: primarily responsible for flying) and the First Officer sat in the right seat as the PM (pilot monitoring: primarily responsible for duties other than flying).

The flight plan for the Aircraft submitted to the Taiwan Taoyuan International Airport Office of the Civil Aeronautics Administration of Taiwan is outlined below.

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|---|---|
| Flight rules: | Instrument flight rules (IFR) |
| Departure aerodrome: | Taiwan Taoyuan International Airport |
| Estimated off-block time: | 09:15 |
| Destination aerodrome: | Naha Airport |
| Cruising speed: | 465 kt |
| Cruising altitude: | FL370 |
| Route: | APU (ANPU VOR/DME) – R595 (airway) – MYC (MIYAKOJIMA VORTAC) – V91 (airway) – NHC (NAHA VORTAC) |
| Total estimated elapsed time (EET): | 1 h and 06 min |
| Alternate aerodrome: | Kagoshima Airport |
| Fuel load expressed in endurance: | 2 h and 54 min |

Based on the Records of Digital Flight Data Recorder (DFDR), Quick Access Recorder (QAR) and Cockpit Voice Recorder (CVR), ATC Communication Records, Statements of Persons Involved, Video Camera Images and so on, the history of the flight up to the time of the accident is summarized as follows.

### 2.1.1 History of the Flight Based on the Records of DFDR, QAR and CVR, ATC Communication Records, Statements of Persons Involved, Video Camera Images and so on

| | |
|---|---|
| 10:26:52 | The Aircraft landed (touched down) on Runway 18. |
| 10:27:14 | The Aircraft began turning left on the runway to enter Taxiway E6. |
| 10:27:49 | The No. 5 slat began retracting while the Aircraft was in transit from Taxiway E6 to Taxiway A5. |

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| 10:28:09 | The No. 5 slat retracted completely after the Aircraft entered Taxiway A5. |
| 10:31:36 | The Aircraft turned to the right to leave Taxiway A1 and aligned its nose with the Aircraft Stand Lead-in Lines for Spot 41. |
| 10:31:57 | The Aircraft stopped (zero ground speed) in Spot 41. |
| 10:32:00 | Engine shutdown procedures were performed for both engines. |
| 10:32:44 | A ground crew member switched on the interphone on the Aircraft's nose. |
| About 10:32:53 | Fire broke out somewhere in an area aft of the No. 2 (right) engine and spread to the right wing leading edge near the No. 5 slat and the apron surface below the No. 2 engine. |
| About 10:33 | Several air traffic controllers (hereinafter referred to as "the Controllers") the airport traffic control tower (hereinafter referred to as "the Tower") saw black smoke and confirmed a fire on the Aircraft on the ITV monitors (showing images from the airport monitoring cameras). *1 |
| 10:33:05 | The assistant maintenance engineer reported the fire breaking to the Captain over the interphone (saying, "Cockpit, Ground, Number Two Engine Fire!"). |
| 10:33:42 | Having received the fire report, the Captain visually confirmed himself black smoke and informed the cabin crew of the emergency situation, saying, "Attention! Crew On Station!" |
| 10:33:52 | The Captain instructed the cabin crew to prepare for an evacuation, saying, "Crew... uh... prepare for evacuation." |
| 10:33:58 | The Controller (the coordinator) started simultaneous reporting of the fire over the crash phone*2 to the three relevant departments: the command room (hereinafter referred to as "the Fire Command Room") of the No. 1 Naha Office of the Air Safety Foundation (hereinafter referred to as "the Airport Fire Station") building, the Air Traffic Services Flight Information Officer (hereinafter referred to as "the Flight Information Officer"), and the Air Self-Defense Force Base Operations*3 (hereinafter referred to as "the BOPS"). |
| 10:34:12 | The Controller reported the fire to the Aircraft. |
| About 10:34:24 | Evacuation began with the first person on Evacuation Slide (hereinafter |

*1 Some apron areas at Naha Airport are out of sight from the Tower. These areas are monitored through three ITV cameras.

*2 The crash phone is an emergency telephone system used by the Tower to simultaneously report an emergency situation to all relevant departments. For the locations and other details of the crash phones at Naha Airport, refer to "2.8 Communication Information (6)."

*3 BOPS refers to the Base Operations Squadron, Air Base Group, 83rd Air Wing, Japan Air Self-Defense Force (JASDF).

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| | referred to as "Slide") 3R[4]. |
| About 10:34:25 | Slide 1L was deployed. |
| About 10:34:32 | Slide 1R was deployed. |
| About 10:34:36 | Slide 3L was deployed |
| About 10:34:37 | Evacuation began on Slide 1R. |
| About 10:34:47 | Evacuation began on Slide 3L. |
| 10:34:47 | JTA Flight 602 (Boeing 737-400, registered JA8597) landed on Runway 18. |
| 10:34:49 | The APU fire extinguisher lever was pulled and rotated. |
| 10:34:55 | CVR came to a stop. |
| About 10:35 | Two fire engines and one water truck (hereinafter referred to as "the airport fire engines") of the Airport Fire Station left the garage.<br>An off-duty staff of the Naha City Fire Department Headquarters, who was near the airport, reported the fire to the Headquarters office (hereinafter referred to as "The Naha City Fire Department"). |
| 10:35:15 | Simultaneous reporting over the crash phone ended. |
| About 10:35:42 | Evacuation on Slide 1R was completed. |
| 10:35:46 | JTA Flight 602 made initial contact with the ground controller at Taxiway E4. |
| 10:35:49 | The ground controller cleared JTA Flight 602 to taxi to Spot 27. |
| 10:35:55 | The No. 2 airport fire engine (call sign "No. 2 Hoan Bosai") called the Tower over the MCA (multi-channel access system) radio (saying, "This is No. 2 Hoan Bosai. Over") (first recorded communication) but there was no response to the call. (During the time around this call, the airport fire engines were at a stop, facing JTA Flight 602, which was on its way from Taxiway E4 to Taxiway A3.) |
| About 10:35:58 | Evacuation on Slide 3R ended. |
| About 10:36 | Fire engines of the Fire Fighting Sub-squadron, Civil Engineering Squadron, Air Base Group, 83rd Air Wing, JASDF (hereinafter referred to as "the JASDF Fire-fighting Squad") left the garage. |
| About 10:36:00 | Evacuation on Slide 3L ended. |
| About 10:36:02 | The First Officer began his escape through the right-hand side window of the cockpit using an evacuation assist rope. |
| About 10:36:06 | Evacuation on Slide 1L ended. |
| About 10:36:11 | The first explosion occurred on the right wing. |
| About 10:36:12 | The First Officer, still on the rope, fell to the ground due to the blast of |

*4 "3R" stands for the right exit of aft cabin. "1L" and "1R" stand for the left exit and the right exit of front cabin respectively. "3L" stands for the left exit of aft cabin

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| | the explosion. |
| 10:36:15 | The Tower called the ANA No. 2 tug vehicle over the MCA radio. (Note: The ANA No. 2 tug vehicle was not in the group to communicate with the Tower.) |
| About 10:36:20 | The Captain escaped through the right-hand cockpit window using an evacuation assist rope. |
| 10:36:24 | The No. 2 airport fire engine made the second call to the Tower over the MCA radio, saying, "This is No. 2 Hoan Bosai. Over." There was no response to the call. |
| 10:36:31 | The ANA No. 1 tug vehicle called the Tower over the MCA radio. |
| About 10:36:54 | The second explosion occurred below the right wing or around the bottom of the fuselage. |
| About 10:37 | The Naha City Fire Department dispatched the first group of fire engines. |
| 10:37:11 | The third explosion occurred around the bottom of the Aircraft. |
| 10:37:42 | The ground controller instructed JTA Flight 602 (on Taxiway A2) to hold at the No. 4 stop line. |
| 10:38:17 | The Tower made the first call to the airport fire engines over the MCA radio, but there was no response to the call. |
| About 10:38:25 | The No. 6 airport fire engine began discharging fire-extinguishing foam from a point aft of the Aircraft on the right side (in Spot 41). |
| About 10:38:26 | The fuselage bent at around the wing location, and its tail portion touched the ground. |
| 10:38:58 | The No. 2 airport fire engine began discharging fire-extinguishing foam from a point forward of the Aircraft (in Spot 41). |
| About 10:39:48 | The right wing tilted down and its tip slowly came in contact with the ground surface. |
| 10:39:50 | The Tower made the second call to the airport fire engines over the MCA radio, but there was no response to the call. |
| About 10:40 | The Naha City Fire Department dispatched the second group of fire engines. |
| About 10:42 | The JASDF fire-fighting squad's fire engines began fire-fighting operations in Spot 41. |
| 10:43:45 | The Tower made the third call to the airport fire engines over the MCA radio, but there was no response to the call. |
| About 10:44 | The Naha City Fire Department's fire engines began fire-fighting operations in Spot 41. |
| 10:57:28 | The No. 5 airport fire engine (water truck) called the Tower over the |

MCA radio for permission to use the fire hydrant near the runway.

About 11:37 Fire-fighting operations were completed.

All uncertain times within the range not exceeding second are preceded by "About" in the above list.

(See Figure 14 and Attachments 1~ 6)

### 2.1.2 Statements of Flight Crew Members about the History of Flight

(1) Captain

There was no fire alarm or the like during the pre-flight check of the Aircraft, during the flight or after the landing. I found no indication of abnormal fuel consumption during the flight, either. Everything was normal until the accident occurred.

After landing at Naha Airport Runway 18, we completed the after-landing checklist. We taxied to Spot 41 and stopped the Aircraft there following the instructions from a ground crew member (marshalling staff). When we completed the parking checklist and were waiting for a message*5 from the ground crew member, I heard, through the headset, the ground crew member shouting, "Fire! Fire!" I looked out the left cockpit window and saw thick black smoke aft on the left side. I immediately pulled and rotated the fire-extinguisher lever for the No. 1 engine. There were no alarm indications in the cockpit at that time. I broadcasted an announcement through the PA (passenger address system), saying, "Attention! Crew On Station! Attention! Crew On Station!" Then, I continued the PA broadcast, saying, "Passenger Evacuation! Passenger Evacuation!" Following this, I stopped the APU by pulling and rotating the APU fire-extinguisher lever and I also pulled and rotated the No. 2 engine fire-extinguisher lever. I performed the evacuation procedures together with the First Officer. Upon completion of the procedures, I made an announcement in Chinese, saying, "Cabin crew, proceed with emergency evacuation immediately after all passengers have been evacuated from the Aircraft."

When I spotted the Chief Purser on the ground through the left cockpit window, I concluded that all of the passengers and cabin crew members had evacuated from the Aircraft. Thinking that we would not be able to escape through the cabin, I instructed the First Officer to exit through the right cockpit window. After the First Officer escaped from the window, I saw that the black smoke and flames on the left-hand side of the Aircraft had increased in strength. I immediately escaped

*5 After establishing interphone connection, maintenance engineers are supposed to tell pilots, "Chocks are set. Release parking brake." and the pilots are supposed to respond, "Remaining fuel xxx (actual quantity of remaining fuel), Ship condition xxx (actual condition of the aircraft)."

through the right cockpit window.

(2) First Officer

I sat in the right seat in the cockpit. In the Company, it is stipulated that the Captain shall perform taxiing. After landing, we headed for Spot 41 through Taxiway E6 and the parallel taxiway. At around the end of the parallel taxiway, I started the APU. The Aircraft was stopped in the spot following the instructions from the ground crew member (marshalling staff). Even after the stop, there was no "Chock in place" message from the ground crew member.

When I picked up the "Parking Checklist" for implementation, I heard the ground crew member shouting, "Fire! Fire!" I looked out the right window and saw only the wing tip but no smoke. The Captain instructed, "Attention!, Crew On Station!" The ground controller called us, saying, "You have fire." I responded, "I need assistance." It took a long time for the airport fire engines to arrive . As instructed by the Captain, I escaped through the right cockpit window. Before reaching the ground, I was knocked down by a blast of an explosion. I called out for the Captain, who was still in the cockpit.

I joined the Company only recently. I really do not know the cabin crew members very well, but they were pretty good at carrying out the evacuation.

### 2.1.3 Statements of Cabin Crew Members about the Accident

(1) Chief Purser

I was responsible for the 1L door. There were six cabin crew members, including me.

After the Aircraft stopped in the assigned spot and then the seat belt sign turned off, I used the All Call function of the interphone to give an instruction to all cabin crew members, saying, "Door Mode Switch from Flight to Park Position." After many of the passengers had left their seats and were waiting on the aisle carrying their baggage, I heard the Captain and a ground crew member talking loudly. I heard voices saying, "Fire! Fire!" and "Repeat, Repeat" from the cockpit. The next moment, the Captain broadcast an announcement, saying, "Attention! Crew On Station! Attention! Crew On Station!" which indicated an emergency situation. The cabin crew members were on standby, in front of their assigned doors. At that time, I saw nothing abnormal in the cabin, but through the window I saw small amounts of black smoke rising from the fuselage below the wing. As that part was located near the engine and fuel tank, I judged that it was a serious situation in which everyone would be confined to the Aircraft due to fire. So I immediately returned to my station and instructed the cabin crew members over the PA, saying, "Cabin Crew, All Doors in

Flight." At almost the same time, I heard the Captain's instruction to the cabin crew, saying, "Passenger Evacuation! Passenger Evacuation!" Therefore, we started the evacuation procedure immediately. After confirming that the slide was deployed, I provided guidance to passengers in Chinese and English, saying, "Come this way," "jump / slide / run," and "No Baggage, No High heel." During the evacuation, none of the passengers panicked and there was no crying or yelling in the cabin. After confirming that all passengers had left the Aircraft, I asked the cabin crew member responsible for the 1R door to report to the Captain that evacuation had been completed. To carry out double-check the entire cabin, I walked through the cabin from the fore end, while a male cabin crew member walked through the cabin from the aft end, both of us moving toward the center of the cabin. When we met near the midpoint along the length of the Aircraft, there was the second announcement from the Captain, saying, "Cabin crew. Evacuate immediately! Evacuate immediately!" I immediately returned to the 1L Station and jumped down the slide.

The evacuation manual stipulates that two passengers shall be appointed and posted at the ground end of a slide to help other passengers come down the slide and leave from the leeward side. However, I did not appoint such passengers, as I did not have the time to give the necessary explanation to them. Since Slide 1L was near the smoke and the flames were gaining strength, ground crew members could not get close to the slide to guide passengers. Instead, they guided passengers from a distance by gesturing towards the arrival lobby of the international terminal.

(2) Other cabin crew members

There were six cabin crew members: The two crew members, responsible for the 1L and the 1R doors, were seated at the forward end of the cabin. The four crew members, consisting of the two responsible for the 3L and the 3R doors, and the other two, were seated at the aft end of the cabin.

- In response to the "Attention! Crew On Station!" announcement broadcast from the cockpit, the cabin crew set the girt bars of the doors. A couple of seconds later, another announcement was broadcast from the cockpit, saying, "Passenger Evacuation!" in response to which the cabin crew started the evacuation procedures. The emergency doors in the midsection of the cabin could not be opened, as passengers standing in the aisle blocked access to these doors.
- In an emergency, if there are no further instructions from the cockpit following an "Attention! Crew On Station!" message, the cabin crew must decide for themselves whether or not to take evacuation action depending on the seriousness of the situation.
- One of the cabin crew members at the forward end of the cabin assisted in opening the 1L door after opening the 1R door. There was no visible smoke

outside. As many as 20 to 30 passengers exited the Aircraft through the 1R door. The cabin crew member responsible for the 1R door escaped through the 1R door after the Chief Purser came back from a halfway point in the cabin. There were no assistants at the ground end of the slide. The cabin crew member found no passengers on the ground, but found the ground crew members. While the cabin crew member and the Chief Purser were making their escape together, an explosion occurred. The two crew members ran to the international terminal building but could not find any other crew members there. Thus, they went back to a place near the nose of the Aircraft.

- A male cabin crew member sitting at the aft end of the cabin opened both the 3L and 3R doors. At least 30 passengers escaped through these doors. When the cabin crew member opened the doors, he did not notice any smoke. After the passengers were evacuated, he walked through the cabin to its midway point to confirm that there were no passengers remaining. At the midway point of the cabin, he met up with the Chief Purser who had walked through the cabin from the forward end.
- One of the cabin crew members sitting at the aft end of the cabin escaped through the 3L door without any assistance at the ground end of the slide. There was an explosion while she was escaping from the Aircraft.
- The three cabin crew members sitting at the aft end of the cabin escaped through the 3R door as they saw flames on the left-hand side of the Aircraft, and then took refuge at a place near the end of the domestic terminal building. They received no assistance at the ground end of the slide.

(Figure 14 Cabin Assignment.)

### 2.1.4 Statements of Ground Crew Members about the Accident

(1) Ramp coordinator (RC)

On the day of the accident, I was serving as the ramp coordinator responsible for managing overall ground support operations. I was standing by in Spot 41 at a place on the left-hand side of the point at which the nose of the Aircraft was to stop. When the Aircraft stopped in the spot, I reported to the Operations (Flight Administration Department of Japan Transocean Air (hereinafter referred to as "JTA"), the company providing ground support services to the Company under contract) over the handheld radio (MCA radio), saying, "China Airlines Flight 120, Block-in time, 10:32." When I approached the assistant maintenance engineer who was standing on the right-hand side of the Aircraft's nose to ask him about the ship condition, he pointed his finger at the right engine. I looked at the engine and saw that fuel was flowing out at a tremendous rate. From behind the engine, small flames rose four to five seconds later,

and in another four to five seconds, large flames rose. I then reported to Operations over the handheld radio (MCA radio), saying, "Operations, this is China RC. China Airlines' engine on fire. Please notify the relevant sections, fire-fighting services and CAB (Civil Aviation Bureau of Japan)." Operations understood this.

Ground crew members voluntarily guided the passengers who had evacuated from the Aircraft.

(2) Maintenance engineer

I was on standby along with the assistant maintenance engineer in Spot 41 on the right-hand side of the point where the Aircraft's nose was to stop. When the Aircraft was passing a point about 30 m short of the spot, I noticed an abnormality. Something that looked like fuel was leaking in torrents, like a heavy rain, from the wing root portion on the outboard side of the No. 2 engine. After the Aircraft's engines were shut down, I immediately approached the Aircraft and caught some of the leakage in my hand. Identifying it as fuel, I said to the assistant maintenance engineer, "It's fuel." Just a moment later, the fuel on the ground aft of the engine caught fire. I rushed toward the Aircraft's nose and instructed the assistant maintenance engineer to notify the Captain of the fire over the interphone. I moved to a place in front of the cockpit and made hand gestures indicating 'evacuation.' However, I did not know if the pilots noticed my gestures because the light reflected on the window glass prevented me from seeing them. I took out a fire extinguisher from the vehicle and discharged fire-extinguishing agent towards the No. 2 engine and the area around the wing attaching portion. I then went to the terminal building for a larger fire extinguisher, and tried to extinguish the fire with the help of two other ground crew members.

(3) Assistant maintenance engineer

Shortly after the Aircraft left the taxiway and aligned itself with the Aircraft Stand Lead-in Lines, I noticed that the ground beneath the Aircraft was wet. I then saw liquid falling in torrents from the underside of the No. 2 engine cowling, and I identified it as leaking fuel. It formed a cascade falling from the bottom of the engine fan cowl in a width of about 30 cm lengthwise. The Aircraft stopped in Spot 41 following the guidance of the marshalling staff. The China Airlines' maintenance engineer pointed to the wet ground and the area around the wing leading edge, signaling me to shut down the engines. After the engines were shut down, the marshalling staff set chocks under the nose wheels according to my instruction, and I then turned on the interphone switch at the Aircraft's nose.

I signaled the operator of an airport stairs vehicle waiting on the left-hand side of the Aircraft to approach the Aircraft. I also signaled the driver of the fuel truck and the operator of the belt loader, both waiting on the right-hand side of the Aircraft, to

approach the Aircraft. Then the marshalling staff carried the chocks for the main landing-gear wheels following my instruction, walking down the right-hand side of the Aircraft, and when he reached a point near the air intake of the No. 2 engine, a single loud boom erupted from inside the area near the tail of the engine and then flames appeared outside along with a noise. The flames were coming from an area near the core exhaust outlet of the No. 2 engine. These flames, however, were not spewing out. I instructed the fuel truck and the belt loader to back away and I then went to the opposite side of the Aircraft to give the same instruction to the stairs vehicle, which had already reached the Aircraft's door. I then alerted the Aircraft's cockpit, saying, "Number two engine fire, extinguisher pull." The cockpit responded by asking, "Engine fire?" I said again in a firm voice, "Fire, extinguisher handle pull out." In a little while, white smoke started coming out from the engine, seeing which I realized that fire-extinguishing agent had been discharged. However, the flames were not extinguished. I then shouted over the interphone many times, saying, "Evacuate, please" (in English) and "Escape" (in Japanese). Soon after that, four doors opened and evacuation began. The slide on the No. 2 engine side was deployed near where I was standing, so I assisted with the evacuation. At about the time when the evacuation was completed, someone arrived with a fire extinguisher. Just as the person was about to start extinguishing fire, there was an explosion and something like a panel flew toward me from the No. 2 engine. I was knocked face down on the ground by an explosion blast, but I was not injured. The passengers escaped to two places: the grassy area at the international terminal located in front of the Aircraft and the domestic terminal building located on the right-hand side of the Aircraft.

To me, it seemed like two or three minutes from the time when the Aircraft stopped in its spot to the time when the flames appeared. There was a fairly strong southerly wind at the time.

(4) Driver of the No. 2 ramp bus

There were three ramp buses to transport aircraft passengers, and one of the buses would make another trip to transport any remaining passengers when needed. I was on duty driving the No. 2 ramp bus.

When the Aircraft reached the midpoint or a point about 50 m short of the end of the straight line (Aircraft Stand Lead-in Lines) along which the Aircraft was moving toward its spot, I noticed an abnormal condition. The exhaust outflow (blast) of the engine was blowing fuel from the Aircraft in a spray state, making the area appear misted. The fuel was flowing downward from the root of the wing in a range of 50 cm or above in width. What I mean by "in a spray state" is that the engine exhaust was carrying the fuel. Fuel was swiftly flowing out in large amounts from around the root of the wing. I can say that fuel was flowing out from around the root of the wing

because I was in the bus and could see the location clearly from an elevated point of view.

Just before the Aircraft stopped in its spot, I used the transceiver to call the driver of the No. 1 ramp bus, which was about 5 m in front and on the right-hand side of my bus, and I told the driver that fuel was leaking from the Aircraft and the bus must not approach it. I told this because my bus blocked the driver's view of the Aircraft. Even after the Aircraft had stopped in its spot, exhaust blast continued blowing fuel aft while the engine was running. When the engine was stopped, I mean the engine was turning at a low speed without coming to a complete stop, the leaking fuel began flowing down, now in a liquid state, along the engine cowling.

About one minute after the Aircraft had come to a stop, I saw flames coming out, probably with an igniting sound, from the rear of the engine. I think that I heard the sound, but I am not sure of it since I was in the bus. The rear of the engine seemed to have been engulfed by flames. When the engine started burning, I felt threatened and drove my bus to a place alongside Spot 36 on the ANA end.

Flames spread to the fuel that had spilled on the ground, and then, being fanned by the wind, they progressed while surrounding the bottom of the fuselage.

After a while, the doors opened, the slides were deployed and evacuation began. The passengers that escaped from the aft part of the Aircraft were going toward the right-hand side. I guided these passengers towards the ANA end of the terminal building by way of Spot 36. When the last several passengers had escaped from the Aircraft toward the aft right-hand side and were about 30 m away, there was an explosion accompanied by a very strong blast. To avoid this, I made a retreat with my bus from a place alongside Spot 36 toward the east corner and waited there for further instructions.

I did not transport any escaping passengers in my bus.

(See Figure 4)

### 2.1.5 Statements of Controllers about the Accident

(1) The ground controller who was on duty immediately before the fire breaking

I was on duty as a ground controller from around 9:20. It was when the Aircraft was on Taxiway E6 that control of the Aircraft was transferred from the tower controller to me. The assigned radio frequency was 121.8 MHz. I received a message, saying, "Ground, Dynasty 120, on Echo 6. Request taxi to Spot 41." I first mistakenly specified Spot 46 but corrected it to Spot 41 after reconfirmation from Dynasty. After giving instructions, saying, "Taxi to Spot 41," there was no further communication with the Aircraft. There were no noticeable abnormalities with the Aircraft while it was at any position in my view. The time when the Aircraft completed parking in its

spot, I was to be replaced by the next controller. I took charge of clearance delivery by switching positions with the controller sitting next to me. After changing control position, I visually noticed the smoke first in the Tower. Since Spot 41 is not directly visible from the Tower, I confirmed through the ITV monitor in the Tower that the Aircraft was on fire. I asked for permission of the ground controller, saying, "Excuse me" because the ITV is under the charge of the ground controller. I immediately informed everyone in the Tower of the fire. There were five Controllers on duty in the Tower at that time. All of them confirmed the Aircraft burning on the ITV monitor. The coordination controller in charge of the crash phone performed the emergency call through the crash phone. (There are crash phones at the coordinator position and the supervisor position.) The points of contact established for reporting through the crash phone are the Airport Fire Station, the Flight Information Officer and the BOPS. The Tower had not received any reports of the fire from anywhere outside the Tower up to that time.

(2) The ground controller who was on duty at the time of the fire breaking

Immediately after I took the seat for the ground controller, the controller who was on the previous shift said to me, "A smoke is rising up, over there!" and I looked at it also. The smoke peaked below the radome on the Joint Airport Administration building. From zoomed-in images on the ITV monitor, the previous shift's controller and I confirmed together that the Aircraft was on fire. The volume of smoke was rapidly growing larger and larger. I said to the coordinator, "Pick up the crash phone." and then "There's smoke rising from the China Airlines aircraft."

The coordinator confirmed the fire on the ITV monitor while picking up the crash phone. Having been unaware of the situation until that moment, the coordinator took about five seconds, I think, to react to my request.

When an emergency situation arises, usually the pilots issue a request such as "Call for fire engines." But we did not receive any such request at that time. Since the Tower had called for airport fire engines at its own discretion, I called the Aircraft to report that 'we have called for fire engines as a first measure.' I think that the response from the Aircraft was "Fire", "Evacuate immediately" and "Request fire equipment." Since the response had a tone of urgency, I responded by saying something like "Now we are calling, stand by."

At the time that JTA Flight 602 (Boeing 737-400) touched down on Runway 18, I saw the airport fire engines gathering in front of the Airport Fire Station building (which is in front of the Tower). I considered making JTA Flight 602 hold on Taxiway E4 in order to secure a path for the airport fire engines. After a while, the MCA radio received transmission signals from somewhere, but I could not hear any message. Just as I was about to request to resend the message on the MCA radio, I had a call

from JTA Flight 602. When JTA Flight 602 was on Taxiway E4, I visually noticed that it was facing the airport fire engines that were in front of the Airport Fire Station (that is, on the apron in front of the Tower). I wondered why the vehicles were still there despite a considerable lapse of time since the crash-phone report, although I first thought that 'they might have been waiting for additional vehicles to join them' as the fire scale was huge.

After a while, I saw the airport fire engines starting to move north on the apron. Judging that 'they would not enter Taxiway A without permission from the ATC,' I cleared JTA Flight 602 to taxi to Spot 27. However, the fire engines would have to cross both Aircraft Stand Taxilanes C2 and C1 before reaching further north beyond Spot 15, so they might have to make a detour if the situation went on. Therefore, with the intention of giving the airport fire engines clearance to move on Taxiway A later as soon as getting in contact with them over the MCA radio, I instructed JTA Flight 602 to hold at the No. 4 stop line on Taxiway A when JTA Flight 602 passed alongside Taxiway E3 following the information such as "We have a fire in Spot 41. Airport fire engines may move ahead of you."

After that, we could not get response from the airport fire engines for our MCA radio call, but since I saw on the ITV monitor that the first airport fire engine had arrived at Spot 41, I cleared JTA Flight 602 to taxi to its assigned spot. I did not hear any message from the fire engines addressed to the Tower through the MCA radio. I asked the other persons working in the Tower at the time if they had heard any calls for the Tower from the airport fire engine through the MCA speakers, but everyone answered no.

I had another aircraft under my control, an ANA Boeing 767, which was being towed at the time. The ANA Boeing 767 was moving from Spot 52 to Spot 36. I had heard the previous shift's ground controller giving instructions to the Boeing 767 to "Go to Spot 36 after the China Airlines aircraft has entered Spot 41." I maintained communication with the tug vehicle for the Boeing 767, using the MCA radio. There was a southerly wind at that time, which appeared to be carrying smoke towards the Boeing 767 based on the Tower observation. So, I notified the tug vehicle about the fire in Spot 41, and asked if it would be possible to continue towing. Since the response option was 'holding,' I checked the present position of the Boeing 767 (a point alongside Spot 44) and cancelled the previously issued clearance for towing. Thereafter a while, at about the smoke began to subside slightly, and about at that time the tug vehicle asked for permission to resume towing. However, I declined to issue clearance, as I judged that the safety of Taxiway A leading to Spot 36 could not be secured (due to possible debris scattered on the taxiway alongside Spot 41). Later, when the tug vehicle asked for permission to return the aircraft to Spot 52 by push

back, I issued clearance.
(See Figure 1and Photograph 4)

### 2.1.6 Statements of Airport Fire Station Staff about the Accident

(1) Staff A (the chief) : Operator of the No. 2 airport fire engine (3000-liter-class chemical fire engine)

While I (operator of No.2 airport fire engine) was stationed on the 1st floor of the Airport Fire Station building together with Staff B (operator of the No. 5 airport fire engine (8000-liter-class water truck)) and Staff C (driver of the No. 6 airport fire engine), we heard a crash-phone call through the monitor speaker. The only part of the message that was audible to me was "Outbreak of engine fire (or Outbreak of fire) in Spot 41," so I did not know the type of aircraft involved. I do not remember what time I heard the message. I quickly got in the passenger seat (operator's seat) of the No. 2 vehicle and waited for the driver, who was in the Fire Command Room on the 2nd floor of the Airport Fire Station building when I received the crash-phone call. As I remember, the airport fire engines left the garage in the order of No. 2, No. 6 and No. 5 vehicle. When the airport fire engines were outside the garage, I ordered them to stop, and then I called the Tower once on the MCA radio, saying, "Tower, this is No. 2 Hoan Bosai. Over." ("No. 2 Hoan Bosai" is the radio call sign of the No. 2 airport fire engine.) However, there was no response. Since there is no audible sidetone on the MCA radio, there is no means to check if the signals are being transmitted. Seeing a Boeing 737 taxiing just on the transient section from Taxiway E4 to Taxiway A, I was worried that rushing into the area ahead of the airplane could cause problems. I also thought that we had to obtain clearance from the Tower to move on the taxiway, so I tried again, but failed to establish communication with the Tower. Nevertheless, since we could not carry out our duties unless we moved towards the fire site, I indicated the direction to our driver, saying, "Go this way," and we turned our vehicle in that direction. We then started driving by way of the JSDF apron towards the fire site. After some distance, we entered Taxiway A, but on the way, I saw an aircraft ahead that looked like a Boeing 747, so we reentered the JSDF apron. I then saw the No. 5 and No. 6 vehicles passing ahead of us to enter Taxiway A, and driving away via Taxiway A, so we returned to Taxiway A and followed these vehicles to the fire site. I did not use the MCA radio after arriving there. The No. 6 vehicle took up its position on the aft side of the Aircraft's No. 2 engine, and the No. 2 vehicle drove around the Aircraft and positioned itself forward of the Aircraft's nose. I operated the turret to extinguish flames on the fuselage and No. 2 engine. I instructed our driver to move our vehicle closer to the Aircraft, and our engine moved to take up position again. When the 3,000 liters of water was used up, I instructed the driver to have the vehicle

refilled with water. The fire engine has fire-extinguishing agent ready for two discharge operations by ordinary, so it can discharge fire-extinguishing foam another time if it is refilled with water even after the water being used up once. Although my memory is rather vague, our vehicle was probably refilled from a water truck that was positioned behind us on the right-hand side. After the refill, we repositioned ourselves in front of the Aircraft's nose on the No. 1 engine side and continued discharging.

(2) Staff D: Operator of the No. 6 airport fire engine (12,500-liter-class chemical fire engine)

Staff E and F were in the Fire Command Room on the 2nd floor of the Airport Fire Station building from 09:30 to 10:30 on August 20, A team of two is on duty in the Fire Command Room and is replaced by another team at the end of the one-hour period. Staff G and I were on duty at the time in the garage on the 1st floor. When we went up to the Fire Command Room to take our turn, which meant that Staff D, E, F and G were all in the Fire Command Room, I saw black smoke in the north through the window. The smoke was gray at first but soon turned black. I could not identify Spot 41 as the site of the rising smoke at that time. At almost the same time as I noticed the smoke, the crash phone rang. It was I who picked up the crash phone although the two staff members from the previous shift (09:30-10:30) were still seated at the command post in the Fire Command Room. The call transmitted the message "Boeing 737 in Spot 41, No. 2 engine, Fire." I immediately broadcast an announcement through the speakers for inside and outside the station, saying, "Position, Spot 41, Boeing 737, No. 2 engine, fire, order out, order out." Staff F and G immediately rushed to the airport fire engines. Since the day's vehicle assignment of Staff E, who was at the command post, was the driver of a medical transport vehicle, I said, "Please take care of the rest," and I ran for the No. 6 airport fire engine to take on the duties of operator. The driver (Staff C) was already in his seat when I climbed into the vehicle. There was an airplane on Taxiway E4 when the three vehicles moved out, so Staff A in the No. 2 airport fire engine called the Tower prior to entering the taxiway, but there was no response from the Tower. While waiting near the P2 holding position, I thought that we would be too late to fight the fire if we continued to wait there, so I ordered the driver (Staff C), saying "Go ahead and pass the No. 2 vehicle," while understanding that the No. 2 airport fire engine was the command vehicle. However, our vehicle did not start right away. During this delay, the No. 2 airport fire engine moved in front of us, preventing us from moving ahead. As we were fully aware of the fire, we should have entered the taxiway and gone ahead. Instead, perhaps because we were loosing our cool, we were stuck at a standstill attempting to obtain clearance from the Tower. Since we could not establish contact with the Tower

after all, we decided to take the automobile route on the apron. However, after driving some distance, the No. 2 airport fire engine appropriately reentered the taxiway, probably because its driver (Staff G) felt that going through the apron would cause too long of a delay in carrying out our duties. We then rushed to the fire site. When we arrived at the spot, the aft half of the Aircraft had fallen to the ground and the left half was in flames. There was no information as to whether or not any passengers or crew members were still on the Aircraft. We could not confirm this by ourselves, either. Even after the flames on the right side of the Aircraft were extinguished and the bottom of the Aircraft's central portion burned low due to the fire-fighting operation using the turret for that area, we continued fire fighting in order to cool down the Aircraft. After that, I dismounted from the vehicle and extended the hand line (fire fighting hose) to reach the fire on the left-hand side area of the Aircraft that had been blocked from view. Later, when two fire engines from the ASDF fire-fighting squad arrived at the site, I gestured to the vehicles to get into position both at the rear of the Aircraft on the left-hand side and at the right-hand side of the Aircraft to extinguish the fire beneath the wings. I also used the hand line of a fire engine from the ASDF fire-fighting squad for fire-fighting operations. I did many other things such as discharging fire-extinguishing foam on the right-hand side of the Aircraft and subsequently extending the ladder to support other members' activities. While doing all these things, I broke down with heat stroke. I handed my fire suit over to a support staff member there at the time, and I went back to the office. However, because I felt 'I should not be in the office,' I returned to the site although I was eventually transported to the first-aid station. I was provided first aid by the staff of The Naha City Fire Department and the Japan Maritime Self-Defense Force (JMSDF). I was then taken to the Okinawa Cooperative Hospital.

(See Figure 2 and Photograph 1)

### 2.1.7 Passenger Questionnaire on Circumstances Related to the Accident

A questionnaire survey was conducted for the 157 passengers (including two infants). From among the total 65 passengers who answered the questions, 39 had been in the forward section of the cabin (Seats 1–16), 18 had been in the aft section of the cabin (Seats 17–31) and 8 did not remember their seat location. The answers are outlined below.

① About 70% of the respondents noticed abnormal conditions before the crew instructed them to start emergency evacuation. These conditions were black smoke and abnormal smell.

② About 12% of the respondents heard an announcement by the cabin crew about the abnormal conditions, while about 59% of the respondents did not.

③ About 54% of the respondents did not hear an instruction for emergency evacuation,

while about 27% of the respondents heard the instruction. Among the affirmative respondents, about 50% understood the instruction, while about 28% did not. Some respondents did not know about the emergency situation until they came to the exit.

④ Around the time when the emergency evacuation instruction was given, about 75% of the respondents had already left their seat, and among these, about 47% were carrying their baggage.

⑤ About 60% of the respondents brought their baggage with them when they escaped. None of them were restrained to carry their baggage as they escaped.

⑥ About 51% of the respondents were given instructions by the cabin crew at the exits, while about 31% were not.

⑦ About 25% of the respondents saw assistants at the ground end of the slides, while about 12% of the respondents helped other passengers there.

⑧ About 44% of the respondents were guided to evacuation areas.

⑨ Freely given answers included the following: People were in a turmoil in the cabin; the cabin crew did not give information or instructions, or were slow in providing them; the cabin crew were slow to respond and take action; some passengers noticed abnormal conditions and told cabin crew members but they did not realize the passengers' advice; some passengers prompted the crew to open the doors; none of the passengers ran or pushed in front of others in the cabin before evacuation; passengers were detained for long time in the evacuation areas due to lack of competence on the part of the responsible personnel in giving instructions and responding to passengers' requests.

(See Figures 15 and Attachment 6)

The accident occurred in Spot 41 at Naha Airport (Aerodrome reference point: Lat. 26°11'31"N, Long. 127°38'52"E) at 10:33 on August 20, 2007.

## 2.2 Deaths, Injuries and Missing Persons

No one from among the passengers, crew members and other persons relevant to the accident was injured or killed in the accident.

## 2.3 Damage to the Aircraft

### 2.3.1 Extent of Damage

The Aircraft was destroyed by fire and explosions of the wing fuel tanks.

### 2.3.2 Damage to the Aircraft Components

(1) Fuselage: The fuselage had broken off at the part immediately forward of the wing roots with the forward half largely tilted to the left and the bottom touching the

ground. The fuselage was longitudinally bent at the part immediately aft of the wing roots and its aft half lay tilted to the left with the tail touching the ground. The cockpit and nose landing gear were intact, but in the forward fuselage, the cabin interior was burned and the upper skin and floor in this area were consumed by fire. The lower fuselage near the wing roots was destroyed and burned by fire. The cabin interior in the aft half of the fuselage was entirely burned to the extent that there was no trace of the original shape, and the top and left-side skins as well as the floor in this section were lost in the fire. The aft galley remained intact.

(2) Left wing: The left wing, which was almost entirely burned and had lost its original shape, lay over the engine resting on the ground. The wing portion between the engine and fuselage was destroyed by explosion of the fuel tank and the burnt main landing gear was tilted forward. The top skin of the wing between the fuselage and engine had been torn off and lay on the ground about 7 m to the left of the wing tip.

(3) Right wing: The main landing gear was burned and stood upright, while both the engine and the wing tip were resting on the ground. The underside of the wing between the engine and fuselage was broken and burned due to the fuel tank explosion. The wing portion from the engine mounting area to the wing tip remained nearly intact.

(4) Engines: The cowling of the No. 1 (left) engine was consumed by the fire and the engine itself was entirely burned. The leading edge of the air intake that was made of a different material from that of the other part of the cowling remained unconsumed. The fuselage-side cowling of the No. 2 (right) engine was consumed by the fire and the engine itself was partially burned at the fuselage-side and fan sections. The pylon was burned on the outside surface but the interior was neither burned nor broken.

(5) Empennage: The left skin of the vertical stabilizer/rudder and the skin of the left horizontal stabilizer/elevator were both almost entirely consumed by the fire. The skin of the right horizontal stabilizer/elevator and the right-side skin of the vertical stabilizer/elevator remained intact.

(See Photograph 1~ 3)

## 2.4 Other Damage

The pavement in and around Spot 41 was partially damaged as a result of the explosions and the burning of fuel that had spilled on the ground.

(See Figures 3)

## 2.5 Personnel Information

(1) Captain Male, Age 47

Airline Transport Pilot Certificate

Type rating for Boeing 737-800 June 17, 2006
Validity Until June 16, 2011
Class 1 Aviation Medical Certificate
Validity Until September 30,2007
Total flight time 7,941 h 17 min
Flight time in the last 30 days 67 h 55 min
Total flight time on the type of aircraft 3,823 h 38 min
Flight time in the last 30 days 67 h 55 min

(2) First Officer Male, Age 26
Commercial Pilot Certificate
Type rating for Boeing 737-800 F/O March 12, 2007
Validity Until March 11, 2012
Instrument flight certificate Included in the Commercial Pilot Certificate
Class 1 Aviation Medical Certificate
Validity Until May 31, 2008
Total flight time 890 h 38 min
Flight time in the last 30 days 65 h 25 min
Total flight time on the type of aircraft 182 h 30 min
Flight time in the last 30 days 65 h 25 min

(3) Chief Purser Female, Age 42
Position assignment Seat/Responsible for 1L/1L door
Period of experience 20 years and 2 months
Date of most recent emergency training May 29, 2007
Cabin crew member Male, Age 53
Position assignment Seat/Responsible for 3R/--- door
Period of experience 23 years and 10 months
Date of most recent emergency training September 20, 2006
Cabin crew member Female, Age 32
Position assignment Seat/Responsible for 1R/1R door
Period of experience 9 years and 8 months
Date of most recent emergency training November 14, 2006
Cabin crew member Female, Age 31
Position assignment Seat/Responsible for 3L/--- door
Period of experience 9 years
Date of most recent emergency training September 22, 2006
Cabin crew member Female, Age 26
Position assignment Seat/Responsible for 3R/3L door
Period of experience 6 years and 7 months

Date of most recent emergency training January 16, 2007

Cabin crew member Female, Age 27

Position assignment Seat/Responsible for 3L/3R door

Period of experience 9 months

Date of most recent emergency training December 11, 2006

## 2.6 Aircraft Information

### 2.6.1 Aircraft

Type Boeing 737-800

Serial number 30175

Date of manufacture June 22, 2002

Certificate of airworthiness 96-07-116

Validity Until July 15, 2008

Category of airworthiness TRANSPORT

Total time in service 13,664 h 21 min

Time in service since last periodical check

(RE5 check on August 4, 2007) 130 h 56 min

(See Figures 5)

### 2.6.2 Engines

| | No. 1 | No. 2 |
|---|---|---|
| Type | CFMI CFM 56-7B26 | |
| Serial number | 891151 | 891152 |
| Date of manufacture | June 26, 2002 | June 26, 2002 |
| Total time in service | 13,664 h 21 min | 13,664 h 21 min |
| Time in service since last periodical check (RE5 check on August 4, 2007) | | |
| | 130 h 56 min | 130 h 56 min |

### 2.6.3 Weight and Balance

When the accident occurred, the Aircraft's weight is estimated to have been about 141,545 lbs and the position of its center of gravity is estimated to have been 23.0% MAC, both of which are estimated to have been within the allowable limits (i.e., maximum landing weight of 144,000 lbs and allowable center-of-gravity range of 9.5–30.5% MAC based on the estimated Aircraft weight at the time of the accident).

### 2.6.4 Fuel and Lubricating Oil

The fuel used in the Aircraft was JET A-1 and the lubricating oil used was ESSO

2380.

### 2.6.5 Passenger Seats and Doors

There were a total of 158 passenger seats in the Aircraft's cabin, consisting of the eight business-class seats in the foremost section that were arranged in two rows on the right and left sides of the isle, each row consisting of two seats, and the 150 economy-class seats that were arranged aft of the business-class seats in 25 rows on both the right and left sides of the isle, each row consisting of three seats.

There were four doors in total, one each on the left and right sides at the forward end of the cabin and one each on the left and right sides at the aft end of the cabin. In addition, there were four emergency exits in total, two each on the left and right sides in the midway section of the cabin.

(See Figure 14)

## 2.7 Meteorological Information

Weather observations provided for Naha Airport around the time of the accident were as follows:

10:00 Wind direction 140°; Wind velocity 8 kt; Visibility 10 km or more
Cloud: Amount 1/8, Type Cumulus, Cloud base 1,500 ft
Amount 7/8, Type Stratocumulus, Cloud base 8,000 ft
Temperature 28°C; Dew point 24°C
Altimeter setting (QNH) 29.86 inHg

10:30 Wind direction 160°; Wind velocity 9 kt; Visibility 10 km or more
Cloud: Amount 1/8, Type Cumulus, Cloud base 1,500 ft
Amount 3/8, Type Stratocumulus, Cloud base 6,000 ft
Amount 7/8, Type Altocumulus, Cloud base 8,000 ft
Temperature 29°C; Dew point 25°C
Altimeter setting (QNH) 29.86 inHg

11:00 Wind direction 160°; Wind velocity 9 kt; Visibility 10 km or more
Cloud: Amount 2/8, Type Cumulus, Cloud base 1,500 ft
Amount 4/8, Type Stratocumulus, Cloud base 6,000 ft
Amount 7/8, Type Altocumulus, Cloud base 8,000 ft
Temperature 29°C; Dew point 25°C
Altimeter setting (QNH) 29.87 inHg

11:30 Wind direction 180°; Wind velocity 9 kt; Wind direction variable 120–220°; Visibility 10 km or more
Cloud: Amount 1/8, Type Cumulus, Cloud base 1,500 ft
Amount 4/8, Type Stratocumulus, Cloud base 5,000 ft

Amount 7/8, Type Altocumulus, Cloud base 8,000 ft
Temperature 29°C; Dew point 25°C
Altimeter setting (QNH) 29.84 inHg

## 2.8 Communication Information

(1) Communications that the Aircraft established with the Tower (the ground controller, on 121.8 MHz) after landing were maintained under good conditions.

(2) MCA radio communications could not be established between the Tower and the airport fire engines. However, the MCA radios installed in both the Tower and the airport fire engines did not show any abnormal conditions. The communication records included several calls with the initial part of the message (call sign of the receiving party) missing.

It is characteristic of the MCA radio to take up to several seconds before the connection sequence is completed after the transmission button (PTT key) is pressed, even when communication channels are not crowded. During this period, communication is not possible. If no available channel is found during the connection sequence, the radio system displays a waiting indication and is placed in standby mode.

(3) Allocation of MCA radio

The Naha Airport Office of the Osaka Regional Civil Aviation Bureau of the Ministry of Land, Infrastructure, Transport and Tourism (hereinafter referred to as "the Airport Office") changed its MCA radio communication system from the conventional analogue system to the digital system and the new digital system was used for the first time on the day of the accident.

Operation of the MCA radio communication system dedicated for Naha Airport is under contract to a private radio communication company. The system is divided into 19 major groups, including the Airport Office, airlines and so forth, and each major group is subdivided into 15 minor groups. The system is used for communication between parties within the same minor group or major group. Both the airport fire engines and the Tower are registered as parties of the same major group, so they can communicate with each other by selecting the major group communication mode instead of the minor group communication mode. Communication between different major groups is not possible except between the Tower and the aircraft tug vehicles.

(4) Reporting channel through the MCA radio communication system

The Tower uses the MCA radio to communicate with vehicles including aircraft tug vehicles and airport fire engines, and the ground controller undertakes such communications as a rule.

The ground crew (only the ramp coordinator) carries a portable MCA radio. If an emergency report must be made to the Airport Office, the crew will contact the company it belongs to by using the MCA radio. The company then reports to the Flight Information Officer, who then informs relevant divisions of the reported event over direct lines.

(5) Provisions for emergency reporting

The Safety Management Regulation for Naha Airport Restricted Area, issued by the Airport Office (NAUNJO No. 181 dated November 22, 2006), stipulates the following (excerpts):

*(Reporting of accidents or similar events and site preservation)*

*Article 10: When a person causes or learns of the occurrence of any of the following events in the restricted areas, the person shall immediately report the event to the responsible division according to the following classification.*

| *Classification* | *Report to* |
|---|---|
| *When learning of the occurrence of a fire* | *Air Safety and Disaster Prevention Division or Flight Information Officer* |

(6) Emergency reporting channel over the crash-phone

Five crash-phone sets are installed at four places: the Tower (supervisor and coordinator posts), the Flight Information Officer (operations management post), the Fire Command Room (command post) and the BOPS, and any report by a crash phone in the Tower is simultaneously sent to all crash phones in the other places. In addition, crash-phone monitor speakers are installed in the office of the Air Safety and Disaster Prevention Division (hereinafter referred to as "the Disaster Prevention Div."), the Airport Fire Station (in the office of the Air Safety Foundation, the garage and the Fire Command Room) and the office of the Fire-Fighting Squad of the Japan Self-Defense Force.

(7) Record of the reports made during initial stage of the accident

a. Controllers on duty in the Tower confirmed the outbreak of the fire both visually and then through the ITV monitor, and the responsible controller reported the fire over the crash phone to the relevant divisions. The crash-phone call took 77 seconds to be completed.

b. The Airport Fire Station staff member who answered the crash-phone call rushed from the Fire Command Room to take duty on an airport fire engine after saying, "Please take care of the rest," without mentioning to the other staff members in the Fire Command Room about the reporting procedure indicated on the Aviation

Accident Reporting Diagram (specifying that the Fire Command Room should make reports to the Okinawa Prefecture Police Headquarters and the Naha City Fire Department Headquarters through direct lines and to the other relevant agencies through the emergency sequential reporting system). The staff member who remained on duty in the Fire Command Room did not make the reports according to the reporting procedure.

A Disaster Prevention Div. staff member, who monitored the crash-phone message in the office, took it that the message was reported by a phone call from the Naha City Fire Department. This staff member then checked with the Airport Fire Station staff member on duty in the Fire Command Room only regarding whether or not a report had been made to the Okinawa Prefecture Police Headquarters. Upon being advised of this, the Airport Fire Station staff member made a report to the Okinawa Prefecture Police Headquarters, but not to the Naha City Fire Department. Subsequently, the Disaster Prevention Div. staff member made a report to the Naha Medical Association (standby request) and the Airport Fire Station staff member on duty in the Fire Command Room made a report to the Naha Airport Fire-Fighting and Rescue Support Party over the telephone, not via the emergency sequential calling system, which established for use in reporting emergencies to outside organizations.

(See Figures 11~ 13 and Photograph 4)

## 2.9 Information on the Airport and Its Ground Facilities

(1) Naha Airport is a public airport and, at the same time, the stations for the air units of JASDF and JMSDF. The Airport Office carries out the air traffic control and the management of the runway, taxiways and civil aprons, while JASDF and JMSDF manage their own aprons.

(2) The runway physical characteristics are the 18/36 direction, 3,000 m length and 45 m width. A parallel taxiway is on the east of the runway. The apron where the accident occurred slopes downward along the Aircraft Stand Lead-in Lines toward the west to accommodate drainage. The elevation of the airport is 11 ft.

(3) East of the parallel taxiway, there are open spots for international flights, the terminal building for domestic flights, the Airport Joint Administration building (topped with a weather radar radome), the JMSDF apron, the JASDF apron, the Control Tower (and the Airport Fire Station on its runway side), the BOPS and the JASDF Fire-Fighting Squad in that order as viewed from north to south.

(4) The distance from the fire engine garage of the Airport Fire Station to Spot 41 is about 1,860 m (assuming a route consisting of the following: the segment of line perpendicular to the centerline of Taxiway A that connects the fire engine garage and

the taxiway centerline, Taxiway A and the Aircraft Stand Lead-in Lines leading to Spot 41).

(5) Since the terminal building for domestic flights is between the Control Tower and Spot 41, a Boeing 737 in Spot 41 cannot be seen from the Tower, not even its vertical stabilizer/rudder. To compensate for the blocked view, ITV cameras are installed to check the conditions there through the ITV monitor installed in the Tower.

(6) There are a number of ITV cameras installed at Naha Airport for monitoring by multiple departments. Recording of images from these cameras starts only when the record button is operated.
(See Figure 1 and Photograph 4)

## 2.10 DFDR, CVR and Other Data Recorders

The Aircraft was equipped with a DFDR (Part No. FA2100-4043-00) and a CVR (Part No. FA2100-1020-00), both made by L-3 Communications of the United States of America.

The DFDR retained normally recorded parameters up to the moment that the engines were stopped. The DFDR suffered no damage to the part housing the storage medium.

The CVR, capable of 2-hour recording, retained the data of events that occurred up until the time a little after the APU was shut down.

In addition to these recorders, the Aircraft was equipped with a quick access recorder (QAR), which normally retained the data associated with events that occurred up to the moment that the engines were stopped.

The time was determined by correlating the DFDR-recorded VHF transmission keying signals during communications with ATC with the NTT (Nippon Telegraph and Telephone Corporation) speaking clock recorded on the ATC communication records.

## 2.11 Accident Site and Wreckage Information

### 2.11.1 Accident Site Information

The Aircraft stood parked in Spot 41 and burned out. At the time of the accident, Spot 42 immediately north of Spot 41, and Spots 35 and 36 immediately south of Spot 41, were free of any parked aircraft.

The apron surface had numerous dents caused by broken pieces from the airframe bottom structure, which became detached from the airplane due to several explosions of the right- and left-wing fuel tanks and then hit the surface. Burning of the Aircraft also left a large pile of burnt residue on the apron. In the area between the right engine and the right wing joint to the fuselage, there were scattered pieces of cargo (fruit and fish), which had fallen out of the cargo compartment damaged by the fuel tank explosions.

Fuel continued leaking from the right wing tip.

### 2.11.2 Handling of the Wreckage

Fuel continued leaking from the right wing tip, as a large amount of fuel remained in the outboard fuel tank in the right wing and the tank was tipped toward the wing tip touching on the ground. The fuel was drained out for the safety ensuring. During this operation, the fuel tank inspection panels on the bottom surface of the wing were all removed.

## 2.12 Inspection of the Right Wing

### 2.12.1 Location of Fuel Leakage

Through the inspection conducted based on the eyewitness statements described in 2.1.4 and other information, indicating that fuel had been leaking from the right engine area and the wing leading edge near the engine immediately before the breakout of the fire, a puncture hole was found in a slat's track can on August 22, 2007, two days after the accident. The track can housed the inboard main track of the No. 5 slat on the right wing leading edge and protruded inside the fuel tank from the wing forward spar.

### 2.12.2 Conditions of the Puncture Hole

Inspection of the puncture hole and surrounding area revealed the following.

(a) The puncture hole was found on the bottom of the track can and extended from a point about 60 mm to a point about 100 mm, both from the aft end of the track can, showing signs of being pushed from inside.
(The track can was made of aluminum alloy and measured 220 mm in length, 80 mm in height at the highest portion and 65 mm in width at the widest portion.)

(b) The puncture hole including the cracks measured 41 mm in maximum length and 23 mm in maximum width.

(c) A piece of hardware headed by a nut protruded through the puncture hole toward the inside of the fuel tank.

(d) The inside of the track can was inspected using a borescope from the slat side. The inspection revealed that the hardware protruding toward the inside of the fuel tank was the downstop assembly consisting of a bolt, washer, downstop (on the bolt-head side), stop location, sleeve and nut. One flat of the bolt head was in contact with the bottom surface of the main track. One flat of the downstop (on the bolt-head side) was in contact with the inside surface of the track can. The downstop (on the nut side) was found lying inside the track can at a place close to the puncture hole but not in contact with the bottom surface of the main track.

(See Photograph 5 ~ 7)

### 2.12.3 Conditions of the Downstop Assembly

The No. 5 slat was removed from the wing in order to inspect the area around the slat.

A washer was found lying just below the opening provided in the front end of the wing forward spar, through which the main track passed.

During recovery of the downstop assembly, which had been protruding from the track can, and the downstop, which had been lying inside the track can, the stop location came off the bolt and fell inside the track can and a loose piece of the track can near the puncture hole became detached from the track can.

(See Figure 7 and Photograph 5)

## 2.13 Maintenance Information

### 2.13.1 Maintenance Work

The manufacturer of the Aircraft did not carry out any removal or installation operations on or related to the inboard main track of the No. 5 slat after the Aircraft had been assembled.

According to the maintenance records of the Company, the Aircraft underwent scheduled maintenance (C Check) at the Company base at Taiwan Taoyuan International Airport from July 6 to 13, 2007. During this period, on July 6, a maintenance work was performed to prevent the loosening of the nut on the downstop assembly in accordance with a Engineering Order (EO) that was prepared based on the Service Letter (737-SL-57-084A), and for which there were no abnormalities entered on the job record. The EO was issued only for the inboard main track of the No. 5 slat, not for any of the other main tracks.

The maintenance records showed no other operations that had been carried out on this particular downstop assembly prior to the operation mentioned above.

According to the investigation conducted by the Civil Aeronautics Administration of Taiwan, a maintenance engineer and a maintenance supervisor, both working for the Company, carried out the maintenance work in question. An assistant supported them. The process of the work as stated by the engineer and the supervisor is summarized below.

The maintenance engineer received the necessary parts kit at the Parts Control Station and confirmed that its part number was the same as the one specified on the EO job card. The engineer then received thread locking compound (loosening prevention agent) at the Consumables Control Station. The engineer also received a torque wrench, which he then set to 70 in-lbs (the specified torque was 50–80 in-lbs).

The maintenance engineer detached the slat track although its work steps were was not indicated in the EO job card. The slat had been in a half-extended position. The engineer first opened several panels and then, with the help of the assistant, detached the slat track fore-end. This allowed the main tracks to move freely, so the engineer could align the downstop assembly with the location of access hole. The engineer could then properly carry out the maintenance work. The job required only the replacement of the nut on the downstop assembly for the No. 5 slat, so the maintenance engineer removed the nut while having the

bolt head held by the assistant. After coating the bolt and a new nut with the thread locking compound using a brush, the engineer installed the nut and tightened it with a torque of 70 in-lbs using the torque wrench. The engineer did not remove the entire downstop assembly. The access hole was too small to provide a view of the entire downstop assembly during this operation.

The maintenance job was straightforward and simple to perform, but the maintenance engineer did not turn his attention to the washer, nor was he aware of whether any components had not been properly installed at the time he completed the job. The maintenance engineer did not report to the supervisor that the front bolt of slat track needed to be detached during the maintenance work and he did not remember whether or not there were any loose parts or clearance after finishing the job.

It was sometime between 10:00 and 11:00 that the maintenance engineer received the job order at the Production Control Center. The job was completed sometime between 14:00 and 15:00. The maintenance engineer did the job and also had lunch during this span of time.

After completion of the job, the maintenance engineer handed the supervisor the EO job card with a stamp and his signature. As the job area had already been restored, the supervisor stamped and signed the EO job card after checking it.

### 2.13.2 Maintenance Staff of the Company

The Company stipulates that all newcomer maintenance engineers are rated as Level A0. They are rated as Levels A1, A2, B and C in order according to the Company's qualification program as their skills improve.

The said job order specified Level A2 as the required qualification level for the job. The maintenance staff members engaged in this specific maintenance job are as follows.

(1) Maintenance engineer: Male, Age 39, holds a Airframe/Engine license from the Civil Aeronautics Administration of Taiwan
Period in service with the Company: 10 years
In-house maintenance engineer qualification for Level B work: Eligible for AB6 (A300-600), A320, A330 and A340

(2) Maintenance supervisor: Male, Age 42, holds a Airframe/Engine license from the Civil Aeronautics Administration of Taiwan
Period in service with the Company: 17 years
In-house maintenance engineer qualification for Level B work: Eligible for 737-800, A330, A340, MD11, 747-400, AB6(A300-600)

According to the Company's rules, a maintenance engineer authorized to perform Level B work may carry out Level A1 maintenance works even on the aircraft type for which

not qualified as Level B. However, the same maintenance engineer required to be under a qualified foreman's supervision to perform Level A2 maintenance works.

For the above-mentioned maintenance engineer, the Aircraft was the second aircraft of this type for which he had carried out the maintenance work specified by the same EO, while for the maintenance supervisor, the Aircraft was the first aircraft of this type for which he was in charge of accomplishing the EO.

### 2.13.3 Maintenance Quality Control of the Company

According to the Company' rules, it is generally sufficient for the person carrying the work to check themselves, under their own responsibility with the exception that, for certain work, a duplicate inspection (Required Inspection Item, R Ⅱ) to be performed by a maintenance engineer authorized to perform Level C work is required.

The rules stipulate that, in order to decide which maintenance task requires duplicate inspection, the effect of incorrect implementation on the airworthiness and operation of the aircraft (level three) and the risk of incorrect implementation (level two) should be taken into account.

### 2.13.4 Evaluation of the Engineering Order by ASC

A trial performance of the Engineering Order by the ASC showed the following facts.

(1) Before a mechanic can move the inboard main track of the No. 5 slat to access the downstop assembly, the mechanic opted to detach the front end of the main track. This is necessary for the mechanic to be able to align the downstop assembly with the location of the access hole. (This step of the job is not described in the Engineering Order job card.)

(2) The space available to access the downstop assembly is so restricted that the mechanic of the job cannot directly see the downstop assembly.

## 2.14 Fire Fighting Information

### 2.14.1 Fire-Fighting and Rescue System at Naha Airport

(1) Outline of the fire-fighting and rescue system at Naha Airport

As the responsible organization for airport administration, the Airport Office provides fire-fighting and rescue service for civil aviation aircraft at Naha Airport, whereas it is supposed to be assisted by the JASDF Naha Base in accordance with the "Agreement on Mutual Assistance in Fire-Fighting and Rescue Operations" concluded between itself and the JASDF Naha Base.

In addition, the Airport Office can seek support from the Naha City Fire Department Headquarters as needed, under the "Agreement on Fire-Fighting and Rescue Operations in and around Naha Airport" concluded with the chief of the Naha

City Fire Department.

The Airport Office commissions the No. 1 Naha Office of the Air Safety Foundation (the Airport Fire Station) to provide fire-fighting service under contract.

If a Disaster Prevention Div. staff member on duty in the Fire Command Room receives a report of an accident, the staff member is supposed to make a report by the direct lines to the Naha City Fire Department and the Okinawa Prefecture Police Headquarters, and make a report by the emergency sequential calling system to the 10 other agencies including the Naha Medical Association. The Disaster Prevention Div. staff member is also responsible for duties other than Fire Command Room service, which may necessitate leaving the Fire Command Room. If such a case occurs, a staff member of the Airport Fire Station assigned with the task of supporting the Fire Command Room duties is supposed to make the necessary reports.

(2) Fire engines, other equipment, and duty hours at Naha Airport

The fire engines and other equipment available for service are as listed below. The staff members of the Airport Fire Station are on duty round the clock at the station next to the Tower.

| | | | |
|---|---|---|---|
| Airport Fire Engines | Type | Quantity | Reach of discharge |
| | 12,500-liter-class chemical fire engine | 2 | About 80 m |
| | 3,000-liter-class chemical fire engine | 1 | About 60 m |
| | 8,000-liter-class water truck | 1 | |
| | Airport medical transport vehicle Type 125 | 1 | |
| | Large airport mobile lighting vehicle | 1 | |
| | Command vehicle | 1 | |
| | Liaison vehicle | 1 | |
| Fire-extinguishing agent | Loaded on fire engines | 1,800 liters | |
| | Stored at Airport Fire Station | 6,100 liters | |
| Note: On the day of the accident, only one of the two 12,500-liter-class chemical fire engines was available since the other one was under special maintenance. | | | |

According to the "Level of protection to be provided" prescribed in Chapter 9 "AERODROME OPERATIONAL SERVICES, EQUIPMENT AND INSTALLATIONS", Annex 14 "Aerodromes" to the Convention on International Civil Aviation, the Naha Airport falls into Aerodrome Category 9. The airport meets the standards of Aerodrome Category 9 with respect to the discharge rate of foam

solution, the quantity of water for foam production, and type and volume of fire-extinguishing agent.

(3) Fire-fighting and rescue exercises for aircraft accident

① At Naha Airport, fire-fighting and rescue exercise for aircraft accident is scheduled to be conducted once a year. The latest exercise was conducted on November 30, 2006, which was organized by the Airport Office and named the "2006 Comprehensive Fire-Fighting and Rescue Exercise for Aircraft Accidents" and participated in by the JASDF Fire-Fighting Squad, the Naha City Fire Department, the police station and other relevant organizations.

As part of the training for its firefighters, the Airport Fire Station conducts fire-fighting exercises using actual fire (pit training) once a year, water discharge test almost every day, and water discharge training one to three times a week.

② For their fire-fighting and rescue exercises, the Airport Fire Station sets up a standard of 20 seconds as the required time taken from the reception of a report over the crash phone to the dispatch of fire engines from the garage.

③ According to the Airport Fire Station, the maximum speed of the fire engines rushing to the fire site is about 80 km/h.

### 2.14.2 Performed Fire-Fighting Operations

(1) Requests for dispatching fire engines and response to the requests

At about 10:34, the controller (on coordination position) at the Tower notified the Airport Fire Station, the Flight Information Officer and the BOPS of the occurrence of fire on the Aircraft by the crash-phone call.

At about 10:35, the Airport Fire Station dispatched two chemical fire engines and one water truck. At about 10:38:25, these vehicles arrived at the fire site and started fire-fighting operations. In addition, the Airport Fire Station dispatched one medical transport vehicle at about 11:09.

At about 10:34, the Flight Information Officer was notified of the fire on the Aircraft by both a direct line from JTA and the crash-phone call, following which the officer carried out information collection and runway check tasks.

At about 10:35, the Naha City Fire Department received the first report of the fire from an off-duty staff member who could see smoke and flames from where he was standing on Senaga-jima Island near the southern end of Naha Airport. At about 10:37, the Naha City Fire Department dispatched the first group of seven vehicles consisting of three fire engines, an ambulance, a rescue equipment vehicle, a chemical fire engine and a command vehicle. At about 10:40, the Naha City Fire Department dispatched the second group of 17 vehicles consisting of six fire engines, three ambulances, a rescue equipment vehicle, a material and equipment transport vehicle,

a command vehicle, four liaison vehicles and a command and public information vehicle.

At about 10:44, the first six fire engines from the Naha City Fire Department arrived at the fire site and started fire-fighting operations.

At about 10:36, the JASDF Fire-Fighting Squad dispatched four vehicles including fire engines. At about 10:42, three chemical fire engines from the JASDF Fire-Fighting Squad arrived at the fire site and started fire-fighting operations.

The following vehicles were mobilized to fight the fire.

<table>
<tr><th>Organization</th><th colspan="3">Vehicle type / Number of vehicles</th><th colspan="2">Total</th></tr>
<tr><td>Airport Fire Station</td><td>Fire engine 2<br>Other 5</td><td colspan="2">7</td><td rowspan="4" colspan="2">Fire engine 17<br>Ambulance 12<br>Other 18<br>Total 47</td></tr>
<tr><td>Naha City Fire Department</td><td>Fire engine 10<br>Ambulance 7<br>Other 10</td><td>27</td><td rowspan="3">36</td></tr>
<tr><td>Fire department HQs and related organizations from neighboring municipalities (Tomigusuku, Urasoe, Itoman, Shimajiri, Tobu)</td><td>Fire engine 2<br>Ambulance 5<br>Other 2</td><td>9</td></tr>
<tr><td>JASDF Fire-Fighting Squad</td><td>Fire engine 3<br>Other 1</td><td colspan="2">4</td></tr>
</table>

(2) Progress of events from the mobilization of airport fire engines to the start of fire-fighting operations

The progress of events during the captioned period is summarized below, based on the statements from the Airport Fire Station staff members and Controllers, records of communications between the Tower and the Aircraft, records retained in the CVR, records of crash-phone calls, records of MCA radio communications and Video Camera Images

When the fire broke out on the Aircraft, four staff members of the Airport Fire Station were in the Fire Command Room, the two who were at the end of their shift of assistant duty in the Fire Command Room and another two who were going on shift for the same duty, as the time happened to coincide with that of the change in shift. There were three other staff members in the standby room. All seven staff members were to be mobilized in the event of a fire.

At about 10:34, the Airport Fire Station received a crash-phone call from the Tower, saying, "Fire in Spot 41, on the No. 2 engine of a Boeing 737." The call lasted 77 seconds from 10:33:58 to 10:35:15. Crash-phone calls can be received in the Fire Command Room, while they can be monitored in the standby room. The staff member who was the driver of the No. 7 vehicle (medical transport vehicle) remained in the Fire Command Room, and the six other staff members went on board the three fire engines: the chief, an operator and a driver went on board the No. 2 vehicle (chemical fire engine); an operator and a driver went on board the No. 6 vehicle (chemical fire engine); and a driver went on board the No. 5 vehicle (water truck). The three vehicles set out at almost the same time, about 10:35. The driver of the No. 7 vehicle set out at about 11:09 after making reports and requests to support-providing agencies. The director of the Naha Office of the Air Safety Foundation, who had visited the Airport Office on the job, returned to the Fire Command Room at about 10:38.

At the time that the three airport fire engines set out as the first dispatch from the garage and moved onward, JTA Flight 602 (Boeing 737-400) that had landed on Runway 18 at 10:34:47 was taxiing on Taxiway E4 after leaving the runway, and the airport fire engines and the aircraft were in positions directly facing each other. The ground controller visually noticed the airport fire engines setting out from the garage and gathering in front of the Airport Fire Station. JTA Flight 602 called the ground controller as initial contact with reporting their position on Taxiway E4; the ground controller cleared the aircraft to taxi to Spot 27. These communications took place during the period from 10:35:46 to 10:35:56. The three airport fire engines remained stopped just short of holding position P2 (about 50 m in front of the garage, where a JASDF Fire-Fighting Squad vehicle was on standby at that time). The operator of the No. 2 vehicle tried twice to establish communication with the Tower over the MCA radio for clearance to run on Taxiway A (including taxiway segments A3, A2 and A1 to reach the fire site). These calls were made at 10:35:55 and 10:36:24, but there was no response to the calls from the Tower. The ground controller heard a voice through the MCA radio speaker just before the communication with JTA Flight 602 ended, but could not understand any of the words. At 10:36:31, immediately after the operator of the No. 2 vehicle made a second attempt to establish contact with the Tower, the No. 1 ANA tug vehicle towing a Boeing 767 on Taxiway A0 contacted the Tower over the MCA radio, and the ground controller instructed the tug vehicle to hold on Taxiway A0. None of the Controllers in the Tower noticed the two calls from the Airport Fire Station through the MCA radio.

As there was no response from the Tower, the three airport fire engines decided to use the automobile paths in the apron areas as their route and started off toward the fire site. After a while, worrying that running on the automobile paths

would result in arriving late at the fire site, the three fire engines entered Taxiway A from the apron side after overtaking JTA Flight 602 taxiing on Taxiway A3 (apron taxiway) toward Spot 27. Shortly after the three fire engines began driving down Taxiway A, the No. 2 vehicle noticed an on-coming Boeing 767 about 1,300 m ahead on Taxiway A0 and retreated toward the apron to avoid it, but the other two vehicles continued running on the taxiway. Overtaken by these vehicles, the No. 2 vehicle drove along the taxiway following them.

The No. 6 and No. 2 fire engines started fire-fighting operations at 10:38:25 and 10:38:58, respectively. The ground controller attempted to contact with the airport fire engines through the MCA radio once while the vehicles were running on Taxiway A and twice while they were engaged in fire-fighting operations. However, there was no response to these calls.

(3) Fire-fighting operation by the Airport Fire Station

The three airport fire engines arrived at the fire site and started fire-fighting operations at about 10:38:25, that is, about 5 minutes and 32 seconds after the fire started and about 4 minutes and 27 seconds after the crash-phone call. Thereafter, the fire engines from the relevant organizations arrived at the fire site in the order described in (1) above and began fire-fighting operations. By the time the airport fire engines started fire-fighting operations, the flames had spread, covering the areas from the inboard portion of the right wing to the entire left wing and from the midway section of the fuselage to its aft portion, with blazing up and black smoke rising high in the sky.

After being informed that four cabin crew members remained in the Aircraft, the Naha City Fire Department crew searched inside the Aircraft three times between 11:00 and 11:29. At about 11:33, China Airlines staff confirmed that all passengers and crew members had evacuated from the Aircraft before the fire-fighting operation began.

At about 11:37, the fire was extinguished.

(See Figure 2, 11)

### 2.14.3 Japanese Regulations regarding Fire-Fighting Operations

(1) The Aviation Safety Services Regulation (Ku-So No. 130 issued on March 13, 1967) established by the Civil Aviation Bureau (JCAB), stipulates the response time to the site and vehicle movement rules as described below.

(Excerpts)

*Section 3: Fire-fighting and rescue services rules*

*(III) Emergency aerodrome fire services*

*5. Response time to the site*

*The fire-fighting and rescue services objective shall be to achieve a response time not exceeding two minutes to each end of runways in principle under optimum visibility and surface conditions, and to achieve it not exceeding three minutes under any conditions.*

*Section 4: Flight information services rules*

*III. Aerodrome information services*

*(VII) Vehicle movement rules in restricted areas*

*f. Giving priority to emergency vehicles*

*Any vehicle in a restricted area shall stop and give way to emergency vehicles if it is likely to block such vehicles' movement.*

*i. Speed limits*

*The following speed limits shall be applied to vehicles operated in restricted areas (excluding aerodrome boundary roads) and such vehicles shall strictly observe these speed limits. This requirement, however, is not applicable to emergency and other vehicles for which it is essential to operate at speeds exceeding these limits to fulfill the airport management and operation needs.*

*a) 30 km*

(Skipped)

*q. Vehicle movement in aircraft maneuvering areas*

*Vehicles shall get permission of the airport traffic control tower or the airport mobile communication station to enter aircraft maneuvering areas and, once in these areas, shall maintain contact with and obey instructions from either of the authorizing parties.*

(2) With regard to the entry of fire engines into runways and other maneuvering areas, Paragraph 12 (2), Chapter IV Emergency Operations, of the manual entitled "Procedures for Aviation Security and Disaster Prevention Operations at Naha Airport" established by the Airport Office stipulates as follows:.

*Fire engines shall obtain permissions from an air traffic controller when they need to enter runways, taxiways and other maneuvering areas on their mobilization.*

### 2.14.4 International Provisions regarding Fire-Fighting Operations

(1) Annex 11 to the Convention on International Civil Aviation prescribes the following items in the section "3.8 Control of persons and vehicles at aerodromes".

*Annex 11. AIR TRAFFIC SERVICE / 3.8 Control of persons and vehicles at aerodromes /*

*3.8.1 The movement of persons or vehicles including towed aircraft on the*

*manoeuvring area of an aerodrome shall be controlled by the aerodrome control tower as necessary to avoid hazard to them or to aircraft landing, taxiing or taking off.*

*3.8.3 Emergency vehicles proceeding to the assistance of an aircraft in distress shall be afforded priority over all other surface movement traffic.*

(2) Annex 14 to the Convention on International Civil Aviation prescribes the following items in the sections "9.2 Rescue and fire fighting", "9.5 Apron management service", and "9.7 Aerodrome vehicle operations".

*Annex 14 / Aerodromes / Chapter 9. AERODROME OPERATIONAL SERVICES, EQUIPMENT AND INSTALLATIONS /*

*9.2 Rescue and fire fighting*

*Response time*

*9.2.21 The operational objective of the rescue and fire fighting service shall be to achieve a response time not exceeding three minutes to any point of each operational runway, in optimum visibility and surface conditions.*

*9.2.22 Recommendation – The operational objective of the rescue and fire fighting service should be to achieve a response time not exceeding two minutes to any point of each operational runway, in optimum visibility and surface conditions.*

*9.2.23 Recommendation – The operational objective of the rescue and fire fighting service should be to achieve a response time not exceeding three minutes to any other part of the movement area, in optimum visibility and surface conditions.*

*Note 1 – Response time is considered to be the time between the initial call to the rescue and fire fighting service, and the time when the first responding vehicle(s) is (are) in position to apply foam at a rate of at least 50 per cent of the discharge rate specified in Table 9.2.*

*Communication and alerting systems*

*9.2.31 Recommendation – A discrete communication system should be provided linking a fire station with the control tower, any other fire station on the aerodrome and the rescue and fire fighting vehicles.*

*9.2.32 Recommendation – An alerting system for rescue and fire fighting personnel, capable of being operated from that station, should be provided at a fire station, any other fire station on the aerodrome and the aerodrome control tower.*

*9.5 Apron management service*

*9.5.5 An emergency vehicle responding to an emergency shall be given priority over all other surface movement traffic.*

*9.7 Aerodrome vehicle operations*

*9.7.1 A vehicle shall be operated:*

*a) on a manoeuvring area only as authorized by the aerodrome control tower; and*

*b) on an apron only as authorized by the appropriate designated authority.*

*9.7.2 The driver of a vehicle on the movement area shall comply with all mandatory instructions conveyed by markings and signs unless otherwise authorized by:*

*a) the aerodrome control tower when on the manoeuvring area; or*

*b) the appropr*iate *designated authority when on the apron.*

### 2.14.5 Travel Time of the Airport Fire Engines

On-site verification conducted by the Airport Fire Station after the accident found that it took about two minutes to drive from the garage via the taxiway to Spot 41 (travel distance 1,860 m).

Travel time along the same route is also estimated to be two minutes and eight seconds when calculated assuming a speed of 80 km/h for the taxiway and 30–50 km/h for other areas.

(See Figures 2)

## 2.15 Information on Search, Rescue and Evacuation related to Survival, Death and Injury

### 2.15.1 Progress of Emergency Evacuation

The emergency evacuation from the Aircraft progressed as outlined below when reproduced based on the CVR records as described in 2.1.1, statements of the Captain and the cabin crew members as described in 2.1.2, and the results of the passenger questionnaire.

At 10:33:05, the Captain was informed by an assistant maintenance engineer over the interphone that a fire had broken out. Having visually confirmed through the left window that black smoke was present in an aft area on the left side, the Captain made an announcement at 10:33:42 to notify the cabin crew of an emergency, saying, "Attention! Crew On Station!" and then another announcement, instructing the cabin crew to prepare for an emergency evacuation by saying, "Crew .. uh .. prepare for evacuation."

In response to the emergency announcement, the cabin crew members took their stand at the assigned doors and, when the Chief Purser instructed them by saying, "Cabin Crew All Doors in Flight," they switched the door mode to prepare for emergency evacuation.

As the Aircraft had come to a stop, the passengers were already preparing to disembark, standing up from their seats and carrying their baggage. When the air in the cabin began to smell abnormal odor and smoke entered the cabin, passengers were in turmoil and they prompted the cabin crew to open the doors. At about 10:34:24, evacuation started on Slide 3R, following which Slides 1L, 1R and 3L were deployed and evacuation started on these slides.

At about 10:35:42, evacuation on Slide 1R was completed and then, at about 10:36:06, evacuation on Slides 3R, 3L and 1L was completed. Following evacuation on these slides, the First Officer and the Captain escaped through the right window of the cockpit, completing the

evacuation of everyone from the Aircraft at about 10:36:20.

The evacuation was carried out without major trouble or problems, although the cabin crew's instructions to the passengers were not sufficiently conveyed or understood. Assistance at and around the ground end of the slides was carried out only partially. After-evacuation guidance to safe areas was also carried out only partially. Passengers and crew members were evacuated to the international terminal building and the domestic terminal building.

As people were evacuated to two different places, the whereabouts of four of the six cabin crew members was not immediately determined, which led the fire brigade member to search inside the Aircraft.

The evacuation took 2 minutes and 28 seconds after 10:33:52 when the Captain ordered preparation for emergency evacuation, and 3 minutes and 27 seconds after about 10:32:53 when the fire started.

The evacuation was carried out through the four slides deployed on both sides of the forward and aft ends of the fuselage and through the cockpit window. The four emergency exits in the midway section of the fuselage, over the wings, could not be opened and therefore could not be used, as passengers in the isle blocked access to them.

The number of evacuees that used each slide is as follows as counted from the Video Camera Images. The number of people who escaped while the VTR recordings were interrupted and therefore are not shown is indicated in the "Unknown" column.

| Location | 1R | 1L | 3R | 3L | Cockpit | Unknown | Total |
|---|---|---|---|---|---|---|---|
| Number of evacuees | 31 | 30 | 46 | 30 | 2 | 26 | 165 |

After emergency evacuation from the Aircraft, 77 persons (including four crew members) went to the international terminal building, while 88 persons (including two infants and four crew members) went to the domestic terminal building, so a total of 165 persons temporarily escaped to these buildings. Subsequently, those who had escaped to the domestic terminal building were transferred by bus to the international terminal building.

(See Attachment 6)

### 2.15.2 Emergency Evacuation Procedures

(1) The Aircraft Operation Manual of the Company stipulates the following.

*CHECKLIST CARDS*

*EVACUATION*

*Parking Brake* ····· *SET* *1* **6*

*Speedbrake* ····· *DOWN DETENT* *1*

*Flap Lever* ····· *40* *2*

*"ATTENTION CREW ON STATION"* ····· *ANNOUNCE* *1*

*ATC* ····· *INFORM* *2*

*Ground Crew* ····· *INFORM* *1*

*Press Mode Selector* ····· *MAN* *2*

*Outflow Valve Sw* ····· *OPEN* *2*

*Start Levers* ····· *CUTOFF* *1*

*Engine Fire Warning Sws* ····· *OVERRIDE, PULL & ROTATE* *1*

*APU Fire Warning Sw* ····· *OVERRIDE, PULL & ROTATE* *1*

*Evacuation*

*Required*

*" PASSENGER EVACUATION"* ····· *ANNOUNCE (END)* *1*

*Not required*

*" CANCEL ALERT"* ····· *ANNOUNCE* *1*

(2) The Safety & Emergency Procedures of the Company stipulates the following.

*SEP General Part Chapter 4*

*EVACUATION ORDERS*

*The command for an immediate evacuation is:*

*"Passenger Evacuation!" "Passenger Evacuation!"*

*(Skipped)*

*Important:*

*— All commands from the flight crew shall be given twice via PA*

*— In case the command "Passenger Evacuation" is not given by the captain (e.g. incapacitated/injured flight crew, defect of PA system etc.), and there is no doubt the necessity to evacuate (e.g. severe destruction of the aircraft, intense fire in the cabin), the purser orders the evacuation by the command: "Passenger Evacuation!" "Passenger Evacuation!"*

*— If under the above mentioned circumstances no command is given by the purser (e.g. incapacitated/injured) every cabin crew may start the evacuation.*

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*6 "1" stands for the left seat, while "2" stands for the right seat.

## 2.16 Tests and Research for Fact Finding

### 2.16.1 Examination by the Japan Aerospace Exploration Agency

(1) Detailed examination of the downstop assembly components

① Conditions

A piece of metal was found sticking to the surface across the bolt's threaded end and the nut.

The metal piece weighed 12.55 mg and came off when scratched lightly with a fingertip.

② Location of the nut

The distance between the bolt head's seating surface and the nut's seating surface measured 1.242 in.

③ Nut tightening torque

The nut was found tightened with a torque of 26.55 in-lbs when measured in the tightening direction.

④ Disassembly

After the nut was removed, the other components could be removed without using any tools.

⑤ Measurements and appearance of components (all measurements in inches)

a. Nut

The diameter of the nut measured 0.408 (specification: 0.386–0.420).

Material was sticking solidly to the surface across the top of the nut and the threads of the bolt.

b. Sleeve

The outside diameter of the sleeve measured as follows: 0.432 (specification: 0.432–0.433) at the section corresponding to the main track's hole; 0.393 and 0.396 (specification: 0.404–0.408 for both) at the nut-side and the bolt-head-side positioning ends, respectively. The length of the sleeve was 0.952 (specification: 0.952).

The sleeve showed no major damage except for a number of friction marks on the surface.

c. Downstop

The inside diameter of the nut-side downstop (retrieved independently) was 0.414 (specification: 0.410–0.420) at the positioning end and 0.438 (specification: 0.437–0.450) at the true circle portion.

The height of the locator fitting boss measured 0.063 on one side and 0.065 on the other side (specification: 0.062 for both) and the thickness measured 0.404 (specification: 0.404).

d. Washer

The nut-side washer (retrieved independently) measured 0.625 (specification: 0.620–0.640) in outside diameter, 0.256 (specification: 0.250–0.270) in inside diameter, and 0.103 (specification: 0.100) in thickness.

This washer showed signs of use, i.e., its one side surface had a contact mark of almost the same size as the nut, while the other side surface had a contact mark of almost the same size as the end of the sleeve.

⑥ Diameter of the nut and diameter of the hole in the downstop

As evident from ⑤a and ⑤c above, the actual diameter of the nut is 0.006 in smaller than the lower of the diameter measurements of the hole in the downstop, although the nut would be 0.000–0.010 in larger than the smallest diameter portion of the hole if it were of the maximum specification diameter. Nevertheless, it is possible for the nut to pass through the downstop even when the specification values of these diameters are compared. With the retrieved downstop, the difference between the measurement of its inside diameter and the nut's outside diameter is larger than that derived from the comparison between the specification diameters of both parts, making it possible to confirm that the nut had actually been able to pass through the downstop.

⑦ Detachment of the downstop assembly

If the washer is missing, even with the nut installed in position on the bolt, detachment of the nut-side downstop from the assembly and eventual detachment of the assembly from the main track can be reasonably explained by comparing the outside diameter of the nut, the inside diameter of the downstop and the inside diameter of the hole in the main track.

(See Figure 9-1, 9-2)

(2) Detailed examination of the main track

The thickness of the main track at the portion where the downstop assembly had been mounted measured 0.188 in at the area where the paint coating was gone and 0.196 in at the area where it remained, whereas the specification thickness of that portion is 0.18 in.

The diameter of the hole in the main track was 0.433 in, whereas the specification diameter is 0.4395 ± 0.0025 in.

There was a longitudinally running abrasion mark on the aft end's bottom surface of the main track. The abrasion mark measured 0.268 in, which nearly agreed with the length of a bolt head flat on the downstop assembly, 0.253 in.

(3) Detailed examination of the track can

The paint film on the inside surface around the puncture hole of the track can was found peeled off, and there were several traces of relatively deep damage in

that area that were located near the cracks that originated at two points. The fragment that had fallen off during the on-site investigation also had abrasion marks with missing paint, as well as an impression indicating that it would have received strong pressure from something.
(See Photographs 5 ~7)

(4) Researches on temperature distribution near the engine exhaust outlet (conducted on January 18, 2008)

① Surface temperature distribution

Measurement was carried out at Tokyo International Airport on three aircraft of the same type as the Aircraft that arrived in their assigned spot at 11:35, 13:05 and 15:35 on the day of the research, each for a period of about 5 minutes starting at about 2 minutes and 30 seconds after engine shutdown. The following is a summary of the analysis results based on the exhaust gas temperature (EGT) data, infrared thermal images and thermocouple-measured temperatures, which include margin of measurement errors.

The weather on the day of the investigation was cloudy, with a northerly wind of 3–5 m/s and ambient temperature at 4–5°C.

The temperature of the engine nacelle was 7–8°C, nearly the same as the ambient temperature.

The fan nozzle temperature measured 48–58°C at the rear end of the inner wall, reflecting the heat of the turbine located inward.

- The Exhaust Nozzle temperature measured 48–115°C on the outer surface.
- The Exhaust Plug measured 90–190°C.
- The turbine outlet guide vane (OGV) measured 250–300°C.
- The turbine inside was hotter and slower to cool than the other portions.
- The EGT dropped to 300–340°C after engine shutdown.
- The temperature difference between the upper and lower portions of the engine increased as time passed.
- The lower portion of the pylon was locally heated by convective current from the core.
- There were spaces between the Fan Nozzle inner wall and the Exhaust Nozzle through which the inside high-temperature section could be seen.

② Ignition of fuel

The Aircraft was loaded with JET A-1 fuel, which has a flash point of 38°C or above. Therefore, it is highly possible for the jet fuel to catch fire if it is warmed up to or above that temperature and produces a flame. As to spontaneous ignition temperature, the temperature at which jet fuel starts burning due to contact with

a hot component etc., that of JET A-1 is about 240°C, although this temperature is not included in the fuel specifications. The spontaneous ignition temperature is similar for other jet fuels, e.g., 247°C for kerosene-based JP-5 jet fuel and 249°C for kerosene. According to another source, a temperature between 370°C and 400°C is stated as the spontaneous ignition temperature.

This suggests that, if fuel in a liquid or gas state enters inside an engine and a combustible mixture is generated, it is highly probable that the mixture will ignite upon coming into contact with high-temperature parts. The EGT data indicates a temperature drop to 300–340°C after engine shutdown, whereas it also shows a temperature above 500°C immediately before engine shutdown. The combustor and the high-pressure turbine nozzles in the upstream section of the engine are exposed to further higher temperatures, and the high-pressure turbine nozzles and the turbine blades are very likely to stay hot even after shutdown of the engine because of their high thermal capacity. During the temperature measurement, it was noted that hot air was rising toward the pylon from the engine exhaust by natural convection and that the lower portion of the engine cooled quickly. This allows the estimation that air flow formed from outside air entered inside the engine from the lower portion of the engine exhaust, then was heated by the hot section, and flowed out through the upper portion of the engine exhaust. The video recording includes scenes of fuel exploding inside the engine, liquid fuel splashing aft and the spread of burning on the ground. These are consistent with the possibility that liquid fuel had stayed in the low-pressure turbine section in this engine designed with the bottom of the Exhaust Nozzle outlet located higher than the low-pressure turbine blade ends. If liquid fuel stays in the above-mentioned section and is ignited, it is possible for surface combustion to occur, causing intermittent explosions and splashing aft of fuel upon burning.

③ Flow paths of leaking fuel

It is considered probable that, following the rupture of the right-wing fuel tank, the leaking fuel flowed toward the slat on the leading edge at an unknown flow rate. This section of the leading edge is fitted with a cover for slat linkage and other parts that are designed to seal off leaking fuel. Some of the fuel leaking out over the surface of the skin there flows both longitudinally and laterally; longitudinally it flows aft toward the thickest-profile, downward-bulging portion of the wing, and laterally toward the root of the wing under the effect of the wing's dihedral angle. The fuel then reaches the engine pylon and falls downward. Another portion of leaking fuel is considered to either splash directly onto the engine or fall directly onto the ground.

Fuel adhering to the outer surface of the tailpipe tends to flow in two different

directions: aft for the portion of fuel adhering to the top half surface of the tailpipe, and forward for the portion of fuel adhering to the bottom half of the tailpipe. It is considered probable that some of the fuel flowing along the pylon falls onto the end section of the tail cone. It is also considered probable that this portion of fuel adhering to the bottom half of the tail cone's end section tends to flow forward and then possibly enters into the engine exhaust.

### 2.16.2 Records of Video Camera Images

Among the persons (large in number) who recorded scenes after the outbreak of fire on the Aircraft using their video cameras from the second floor of the domestic terminal building near to which the accident site was located, two persons provided records of video images. These recorded images contained scenes beginning with the time immediately after the deployment of Slide 3R at the right aft part of the Aircraft to the time when fire-fighting operations were carried out by the Airport Fire Station.

The video images were time-aligned by correlating the position of an aircraft on final approach to Runway 18, which happened to be included in the images, with the flight track data recorded through the Automated Radar Terminal System (ARTS) radar.

The CVR records covered the period of time up to 10:34:54, while the video images covered the period from 10:34:23 to 10:40:12.

(See Attachment 5)

## 2.17 Other Relevant Information

### 2.17.1 Difference in Fuel Quantity between Left- and Right-Wing Tanks

According to the DFDR records of the Aircraft, the left-wing fuel tanks held 5,530 lbs of fuel and the right-wing fuel tanks held 5,540 lbs of fuel when the Aircraft landed at Naha Airport, whereas the left-wing tanks held 5,440 lbs of fuel and the right-wing tanks held 5,370 lbs of fuel when the Aircraft stopped in its assigned spot (at 10:31), i.e., the right-wing tanks held 10 lbs more fuel than the left-wing tanks at the time of landing, but when the Aircraft was in its spot, the right-wing tanks held 70 lbs less fuel than the left-wing tanks.

There was almost no difference in tank fuel quantity between the left and right wings during the Aircraft's descent from the cruising altitude.

(See Figure 10)

### 2.17.2 Slat Mechanism

Slats constitute a high lift device used during takeoff and landing and four slats are installed on the leading edge of each wing, all numbered together starting with the most outboard one on the left wing. The No. 5 slat is therefore the most inboard slat on the right wing.

As the flap lever in the cockpit is operated, the slats are hydraulically moved according to the angle of the flaps to any of the three positions: stowed (RETRACT), half-lowered (EXTEND) and fully lowered (FULL EXTEND) position.

Each slat has an actuating mechanism consisting of two main tracks, two auxiliary tracks and a hydraulic actuator. As the slat is moved by the actuator fore and aft, the main tracks, each having a curved form lengthwise and an H-shaped cross section laterally, move guided between two sets of guide rollers that are installed on the immovable part of the leading edge forward of the forward spar.

The main tracks thus moved determine the down angle of the slat. Since the slat must move over a long distance fore and aft, each main track moves aft through a hole made in the wing forward spar when the slat is fully retracted. The spar forms the forward wall of the fuel tank, so a track can protruding into the fuel tank is provided to house each main track.

Each main track is provided with a downstop assembly at its aft end, which comes in contact with another downstop installed on the immovable leading edge of the wing at a place near the guide rollers forward of the wing forward spar, thus stopping the slat when it is fully extended (to the foremost position).

(See Figure 6, 7)

### 2.17.3 Downstop Assembly

The downstop assembly consists of eight parts (six different items), arranged in the following order: bolt, washer, downstop, sleeve, stop location, downstop, washer and nut.

Each downstop is a hexagonally shaped part with an eccentric hole through which the bolt passes. This allows the distance between the center of the hole and the flat of the hexagon to be changed at three levels according to the rotational angle. The sleeve is so designed as to retain both downstops at the same rotational angle by means of the machined flats on both ends where the downstops are engaged. The stop location is designed to engage with the triangular boss on the bolt-head-side downstop to keep the downstop rotational angle relative to the main track constant.

(See Figure 8)

### 2.17.4 Issues with the Downstop Assembly Experienced Prior to this Accident and Corrective Action Taken

According to the manufacturer, there were two reported cases of detachment of the nut on the downstop assembly installed on a main track up to December 2005 as problems with downstop assemblies, one of which had been accompanied by fuel leakage from the inboard track can for the No. 5 slat. The cause of the fuel leakage was determined to be a hole punctured in the track can by the nut that had come loose, fallen off the downstop assembly into the track can and then pushed by the main track.

To address the issues, the manufacturer released a Service Letter (No. 737-SL-57-084) dated December 15, 2005, recommending that, on the next convenient maintenance opportunity, the nut on the downstop assembly should be removed, the threads on the bolt be coated with thread locking compound and a new nut be installed and tightened with a torque of 50–80 in-lbs.

The above-mentioned Service Letter did not clearly indicate in its Suggested Operator Action section any particular slat track(s) to which the nut replacement was applied, while in the part immediately before the Suggested Operator Action section, there was a reference to the No. 5 slat track (in the part describing the action against fuel leakage from the inboard track can for the No. 5 slat). In the Background section, the Service Letter states that, while the fuel leakage was from the No. 5 slat track, "the main slat tracks at all other locations could be similarly affected." However, it is considered undeniable that the description allows misleading on the part of the readers, understanding that the suggested action only applies to the No. 5 slat, unless they read it carefully.

The Service Letter revision of March 28, 2006 (No. 737-SL-57-084-A) did not make any changes to the description of the action, but the Service Letter revision of July 10, 2007 (No. 737-SL-57-084-B) deleted the reference to the No. 5 slat track (i.e., action against fuel leakage from the inboard track can for the No. 5 slat) and the part instructing removal of the nut.

In the Airworthiness Directive (AD2007-18-51) issued after this accident, it was clearly stated that the slat tracks subject to the action were all the slat tracks (using the word "each"). In the Service Bulletin (No. 737-57A1301) issued in 2008 for conventional Boeing 737 models, B737-300/400/500, for the purpose of preventing detachment of the downstop assembly, the tracks of the No. 2/3/4/5 slats and the inboard tracks of the No. 1/6 slats were clearly indicated as the slat tracks subject to the action.

### 2.17.5 Other Traffic at the Airport around the Time of the Accident

(1) Within 10 minutes after the landing of the Aircraft, three other aircraft landed at the airport and one aircraft took off from the airport.

(2) Aircraft being towed around the time of the accident

A Boeing 767, being towed by the No. 1 ANA tug truck from Spot 52 to Spot 36, was towed back to Spot 52 from a point on its way, and a Boeing 737 was towed from Spot 23 to Spot 14 by the No. 1 JTA tug truck.

### 2.17.6 Interruption of CVR Operation

The CVR is powered by alternating current generated on the aircraft. The aircraft is normally supplied with alternating and direct current power from the onboard battery to maintain safe flight for at least 30 minutes even after the power from the generator and other

interruptible power supplies is lost. However, the CVR stopped its operation six seconds after the APU fire-extinguisher lever was pulled and rotated to stop the APU at 10:34:49, in succession to shutting down the Aircraft engines at 10:32 as described in 2.1.1.

# 3. ANALYSIS

## 3.1 Crew Qualifications

The Captain and the First Officer held both valid airman competence certificates and valid aviation medical certificates.

## 3.2 Airworthiness Certificate of the Aircraft

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

The maintenance of the downstop assembly for the inboard main track of the No. 5 slat, described in 2.13.1, is further discussed in 3.8.

## 3.3 Progress of Matters Resulting in the Fuel Leakage

As described in 2.12.1, a hole was punctured in the track can that housed the inboard main track of the No. 5 slat. It is certain that the fuel in the right-wing fuel tank leaked out through the hole.

It is also certain that the hole was punctured as follows: as described in 2.12.2, the downstop assembly having detached from the main track and fallen into the track can, it was pushed against the track can by the main track when the slat was retracted, the nut end of which then punctured the bottom of the track can.

Judging from the researches described in 2.16.1 (4), it is considered highly probable that, the fuel in the tank leaked out through the punctured hole and flowed by way of the inside of the track can toward the area forward of the wing forward spar.

Judging from the researches described in 2.16.1 (4), it is also considered highly probable that, the fuel that had collected inside the wing's immovable leading edge forward of the wing forward spar flowed out from the wing through gaps such as the one around the inspection panel on the bottom surface of the wing's immovable leading edge and the one between the slat and the wing's immovable leading edge.

## 3.4 Ignition of the Leaked Fuel

Judging from the researches described in 2.16.1 (4), it is considered probable that, most of the fuel that had leaked out mainly from the bottom surface of the right wing leading edge at the No. 5 slat section splashed onto the right engine exhaust pipe. As described in 2.1.4 (4), the leaked fuel was being blown aft by the blast from the fan while the engine was operating but, when the engine was stopped, it is considered highly probable that the leaking fuel splashed onto the exhaust pipe and pooled on the surface of the apron, and the fuel that had pooled on the apron surface then spread over the surface to the left and aft of the Aircraft due to both the wind blowing from the right of the Aircraft and the sloped surface of the apron

in that area.

Judging from the researches described in 2.16.1 (4), it is considered highly probable that, the leaked fuel came into contact with high-temperature areas of the right engine and was ignited under the conditions discussed above.

## 3.5 Spread of the Fire

It is considered highly probable that, as described in 2.1.1, the fire that had started at the right engine exhaust pipe primarily spread to the bottom surface around the No. 5 slat of the right wing leading edge, to the right engine exhaust pipe, to the apron surface below the right engine, and to the apron surface below the left wing. It is considered highly probable that the fire further spread to the left wing especially because of the burning fuel on the apron surface and the wind blowing from the right of the Aircraft.

In addition, as shown by the video images, the fuel on the ground then spread to the area below the empennage. It is considered highly probable that the flames from the fuel caused damage to the aft portion of the fuselage, the left horizontal stabilizer/elevator, and the left-side skin of the vertical stabilizer/rudder.

## 3.6 Instructions for the Emergency Evacuation

As described in 2.1.1, after the Aircraft had stopped, the Captain was informed of a fire by the assistant maintenance engineer and confirmed black smoke through the left window of the cockpit, and then, at 10:33:42 and 10:33:46, announced to the cabin crew, saying, "Attention! Crew on Station! Attention! Crew on Station!" At 10:33:52, the Captain made another announcement, saying, "Crew ... uh ... prepare for evacuation." Subsequently, at 10:33:59 the Chief Purser made an announcement, instructing the other cabin crew members to change the door mode, saying, "Cabin crew, all doors in flight."

According to the statements of the cabin crew members described in 2.1.3, at about the same time as the instruction was given for door mode change, they heard an instruction for emergency evacuation and then started evacuation procedures.

While the video images show scenes of the evacuation that started with the first evacuee on Slide 3R at about 10:34:24, the CVR records do not include any instructions for emergency evacuation prior to that time.

At 10:34:40, the First Officer started the "EVACUATION" checklist. At 10:34:45 and 10:34:49, the engine fire warning switches and APU fire warning switches were operated respectively for fire extinguishing purposes.

At 10:34:52, the First Officer said, "Evacuation Required, now Required."

Since the CVR stopped recording immediately after this, any subsequent announcements or other audible events could not be ascertained. Nevertheless, analyses of the video images and other data indicate that passengers had already started evacuation on all of

the slides before any instructions for emergency evacuation that might have been issued by the Captain after performing APU shutdown operation according to the checklist.

Judging from these, it is considered possible that cabin crew members who heard the Captain's instruction to prepare for evacuation took it as an instruction for emergency evacuation and changed the door mode and then proceeded with slide deployment.

As described in 2.15.2 (2), the Company's Safety & Emergency Procedures stipulates that in case the command for emergency procedures is not give by the captain and there is no doubt about the necessity to evacuate, the purser orders the evacuation, and that if no command is given by the purser, every cabin crew may start the evacuation.

Judging from the Captain's statements as described in 2.1.2 (1), it is considered highly probable that the Captain concluded that all of the passengers and cabin crew members had evacuated from the Aircraft since he spotted the Chief Purser on the ground, and therefore he instructed the First Officer to evacuate.

## 3.7 The Time When the Track Can Was Damaged

As described in 2.17.2, slats are used during takeoff and landing. The slats of the Aircraft were extended prior to the takeoff from Taiwan Taoyuan International Airport and were retracted after the takeoff. They were extended again prior to landing at Naha Airport and then were retracted after the landing.

As described in 2.17.1, there was no indication of an abnormal reduction in fuel quantity while the Aircraft was airborne. It is therefore considered highly probable that the Aircraft was free of fuel leakage when it took off from Taiwan Taoyuan International Airport and while it was subsequently in the air.

Since the hole would have been punctured through in the track can just before the fuel leakage according to the presumption as described in 3.3, it is considered highly probable that the track can was punctured while the Aircraft was taxiing at Naha Airport.

## 3.8 Maintenance Works on the Downstop Assembly

According to the records described in 2.13.1, the nut was replaced and the new nut was tightened with a torque of 70 in-lbs during scheduled maintenance in accordance with the Engineering Order job card that had been prepared based on the relevant Service Letter, whereas the measurement of its position as described in 2.16.1 (1) showed that the location of the nut on the retrieved downstop assembly was farther outward than what it should be when the assembly is normally installed on the main track.

With regard to this deviation from the normal position, it is considered probable that either the tightening operation was finished with the nut left in this position, or the nut had loosened during operation of the Aircraft and eventually reached this position even though it had been tightened with the correct torque.

In the latter case, if the nut is tightened without a washer in place, it goes as far as the end of the bolt threads without being blocked by the downstop and sleeve, bringing about consequences resembling those when the nut is tightened with a torque within the set range.

## 3.9 Detachment of the Downstop Assembly

It is considered highly probable that detachment of the downstop assembly occurred in the following sequence.

(1) The nut-side washer was missing.

Judging from the fact that the nut was on the bolt when it was retrieved and the washer was retrieved separately showing its normal shape as described in 2.12.2, and 2.12.3, the washer had not been reinstalled on the bolt.

(2) The nut-side downstop became detached.

Since the washer was not installed, the downstop fell off the downstop assembly with the nut in position on the bolt, as described in 2.16.1 (1).

(3) The downstop assembly fell off the main track.

Once the nut-side downstop became detached, the downstop assembly fell off the main track even with the nut still fitted on the bolt, as described in 2.16.1 (1).

## 3.10 Missing Washer

The missing washer was retrieved separately at the accident site. Considering that it had a mark indicating that it had been used and that, as described in 2.13.1, the manufacturer of the Aircraft has no record of any operations carried out on the downstop assembly after the Aircraft was assembled, nor has the Company any record of maintenance works carried out on the assembly except for the replacement of the nut, it is considered highly probable that the washer that had been installed during the assembly of the Aircraft fell off during the maintenance work on July 6, 2007 carried out to prevent loosening of the nut in accordance with the Service Letter issued by the manufacturer.

## 3.11 Measures Taken against Loosening of the Nut

As described in 2.17.4, the manufacturer's Service Letter was issued following reported cases of detachment of the nut and the Company decided on compliance with the recommendation. However, it is considered probable that the maintenance work in question easily involved the risk of parts falling off because the downstop assembly was located in such a difficult place for performing the operation that the operator had to remove and install the nut by grope, as described in 2.13.4.

In one of the later issued revisions to the Service Letter, the manufacturer deleted the removal of the nut from the operation. However, since it is to be expected that some airlines would have complied with the original Service Letter soon after its issue, the manufacturer

should have thoroughly studied and appropriately evaluated the difficulty of the job when preparing the Service Letter that instructed removal of the nut.

Also, following the receipt of the Service Letter, the Company itself should have appropriately evaluated the difficulty of the operation and studied the possible need for specific instructions regarding careful performance of the operation and confirmation of the component conditions after completion of the work when establishing its in-house Engineering Order job card.

## 3.12 Design of the Downstop Assembly

As described in 3.9, it is possible that if the nut-side washer has not been installed, the downstop on the same side could come off the downstop assembly, and the remaining assembly could then come off the main track. This accident demonstrates that such detachment can lead to a hole being punctured in the slat can, resulting in fuel leakage and possible fire.

Therefore, it is possible that the downstop assembly design may be unable to prevent detachment of the downstop assembly if the nut-side washer was not properly installed.

## 3.13 Fire Report

### 3.13.1 Fire Report from the Aircraft to the Tower (the ground controller)

According to the statements of the Captain and the First Officer as described in 2.1.2 (1) and (2) and the statement of the ground controller as described in 2.1.5 (2), there was no fire report from the Aircraft to the Tower. The reasons for this are considered probable to be as follows:

① Both the Captain and the First Officer were informed of the fire by the ground crew member without any prior warning inside the Aircraft, which caused a delay in realizing the situation.

② Since the ground crew member reported only a fire on the No. 2 engine using a few English words, the flight crew was not aware of the fuel leakage situation.

③ A fire warning bell sounded 14 seconds after the engine fire report from the ground crew member. It is considered highly probable that there was no indication inside the Aircraft associating the warning with an engine fire, and therefore the flight crew could not identify the consistency on the bell with the engine fire reported by the ground crew member.

④ It is considered probable that in the meantime, the Captain visually confirmed black smoke on the left of the Aircraft and decided to perform emergency evacuation, thus giving priority to performing the evacuation procedures over reporting to the ground controller.

After noticing the fire, the Captain and the First Officer started emergency

evacuation procedures. It is therefore considered probable that is inevitable neither of them immediately reported the fire to the ground controller.

### 3.13.2 Fire Report from the Ground Crew Member to the Airport Office

According to the statement of the ground crew member (ramp coordinator) as described in 2.1.4 (1), the coordinator reported through the MCA radio to the Operations (JTA Flight Administration) the fire (that started at about 10:32:53) immediately after its occurrence while watching fuel leaking out.

The Operations staff member who received the radio message passed it on to the Flight Information Officer over the direct line (at about 10:34).

Having received a crash-phone call from the Tower about the fire at almost the same time as receiving the direct call from the Operations staff member, the Flight Information Officer did not need to pass the direct-call message to the Tower.

### 3.13.3 Fire Report from the Tower to the Airport Fire Station and Other Relevant Divisions

According to the statements of the Controllers as described in 2.1.5 (1) and (2), they noticed black smoke and then confirmed the fire on the ITV monitor in the Tower. The fire was then reported over the crash phone to the Airport Fire Station and other relevant divisions. This crash-phone call started about one minute after the fire broke out.

According to the record of the crash-phone report, the report was started when the Controller's call was answered by the BOPS before any others, following which it was answered by the Flight Information Officer and the Airport Fire Station. Every person who answered the call read back the report for confirmation and the entire reporting process through the crash phone took one minute and 17 seconds from the time when the BOPS answered the call to the time when the report was finished.

With regard to the crash-phone reporting system, improvement in training is needed in terms of its effectiveness. Such training may include practice in performing pre-established procedures with certainty, assuming a variety of conceivable circumstances, e.g., the time, location of the event, situation, failure of communication means, presence of surface moving aircraft, and the topographical and meteorological characteristics of the airport.

## 3.14 Fire-Fighting Operations

### 3.14.1 Mobilization of the Airport Fire Station Staff

Based on the statements of the Airport Fire Station staff members as described in 2.1.6 (1) and (2) and the events involved in the mobilization of the airport fire engines as described in 2.14.2 (1) and (2), it is considered highly probable that the first three fire engines left the garage at about 10:35 after receiving the fire report over the crash phone (at

10:33:58–10:35:15).

As described in 2.14.1 (3) ②, the standard time from the reception of information over the crash phone to the dispatch of fire engines from the garage is 20 seconds. The record of the crash-phone call shows that the order to go into action was issued at 10:34:27. To meet the time standard of 20 seconds, the first vehicles would have had to leave the garage by 10:34:47.

According to the statement described in 2.1.6 (2), the Airport Fire Station staff member who answered the crash-phone call and gave the order for fire engines to go into action through the speakers for inside and outside the station then took on duty in the No. 6 airport fire engine. Another staff member remained in the Fire Command Room because of his assignment to duties as the driver of the medical transport vehicle, which was not authorized to go into action at that stage of mobilization.

### 3.14.2 Movement of the Airport Fire Engines to the Fire Site

As described in 2.14.2 (2), the progress on the mobilization of airport fire engines shows that the No. 6 airport fire engine arrived at the fire site before the other vehicles and started discharging fire-extinguishing foam at 10:38:25. It is assessed that the order to action was given at 10:34:27 during the crash-phone call (from 10:33:58 to 10:35:15) as described in 2.14.2 (2) and the discharge of fire-extinguishing foam started 4 minutes and 27 seconds after the start of the crash-phone call, or 3 minutes and 58 seconds after the issue of the mobilization order.

### 3.14.3 Views on the Response Time to the Site

(1) The regulations described in 2.14.3 (1) prescribe that "The fire-fighting and rescue services objective shall be to achieve a response time not exceeding two minutes to each end of runways in principle under optimum visibility and surface conditions, and to achieve it not exceeding three minutes under any conditions."

(2) As described in 2.14.4, Annex 14 to the Convention on International Civil Aviation prescribes the following: "operational objective" on the "response time", which is considered to be the time "between the initial call" and "the time when the first responding vehicle(s) is (are) in position to apply foam at a rate of at least 50 per cent of the discharge rate", shall be not to exceed "three minutes" as a standard and should be not to exceed "two minutes" as recommendation for "each operational runway", and should be not to exceed "three minutes" as recommendation for "any other part of the movement area." The fire site in this accident is classified as "any other part of the movement area."

The response time to the site described in 3.14.2 was evidently longer than the time of three minutes prescribed as the operational objective.

(3) As described in 2.14.5, it was estimated by calculation that the airport fire engines could reach Spot 41 in 2 minutes and 8 seconds after leaving the garage and it was proven by experimental verification that they could reach the spot in about 2 minutes. Adding the 20 seconds described in 2.14.1 (3) ② to the calculated time equals 2 minutes and 28 seconds, which suggests that even if the time of 29 seconds spent between the start of the crash-phone call and the mobilization order is taken into consideration, it is considered possible for the airport fire engines to have achieved the standard 3-minute response time.

(4) Stationary period of the airport fire engines

According to the statement of the Controller as described in 2.1.5 (2), the statements of Airport Fire Station staff members as described in 2.1.6 (1), (2) and the progress of the events as described in 2.14.2 (2), it is considered highly probable that the airport fire engines remained stationary for 1 minute and 37 seconds, from the time when it left the garage at 10:34:47 to the time when it attempted the second call to the Tower at 10:36:24 after it stopped and remained stationary at about 50 m from the garage.

## 3.15 Movement of Airport Fire Engines and Clearance from the Tower

### 3.15.1 Communication between the Airport Fire Engines and the Tower

According to the statements described in 2.1.5 (2) and 2.1.6 and the progress of events as described in 2.14.2 (2), it is considered highly probable that the following are the reasons why the No. 2 airport fire engine could not establish communication with the Tower when it called the Tower over the MCA radio for clearance to move on the taxiway.

(1) First attempt (at 10:35:55)

As described in 2.14.2 (2), the ground controller was communicating with JTA Flight 602 between 10:35:46 and 10:35:56. During this period, it is considered probable that the second VHF transmission from JTA Flight 602 coincided with the start of the MCA radio message from the airport fire engine, and as a result, the ground controller would have heard only the part after "No. 2" of the message "This is Hoan Bosai No. 2, Over" as retained in the MCA radio communication records rather than the whole message.

The intended party's call sign, "Tower", which was added to the beginning of the transmission from an airport fire engine, is indistinct in the MCA radio communication records. Therefore, it is considered highly probable that the word was not transmitted in its entirety even if it was attached to the beginning of the message.

According to the MCA radio communication records, the Tower called the "No. 2 ANA tug vehicle" at 10:36:15. Therefore, it is considered possible that the Tower assumed "Hoan Bosai" to be "ANA" or the Tower mistakenly called "No. 2 ANA tug vehicle" instead of the intended call sign "No. 1 ANA tug vehicle".

(2) Second attempt (at 10:36:24)

Among the events described in 2.14.2 (2), the MCA radio transmission from the airport fire engine was a message saying, "This is Hoan Bosai No. 2. Over." according to the MCA transceiver communication records, with indistinct part preceding this message. It is considered highly probable that the call sign, "Tower," with which the message should have started, was not transmitted in its entirety even if it was attached to the beginning of the message.

The MCA radio communication records show that the No. 1 ANA tug vehicle called the Tower at 10:36:31. It is considered possible that this call was a response to the call the Tower had made at 10:36:15 to the No. 2 ANA tug vehicle, mistakenly taking the Tower's call as a call to the No. 1 ANA tug vehicle.

As described in 2.8 (2), the MCA radio system has a specific characteristics, i.e., it can take up to about a second or several seconds from the time when the transmission button (PTT key) is pressed to the time when the connection sequence is completed, even when communication channels are not crowded. During this period of time, communication is not possible. In addition, the day of the accident was the first day of operation for this MCA radio system. It is therefore considered highly probable that the radio operator who was not familiar with the new system would have started speaking without leaving any pause after pressing the transmission button, which resulted in failure to transmit the initial part of the message, consequently the beginning of each message from the airport fire engine retained in the MCA radio communication records was indistinct..

### 3.15.2 Clearance from the Tower

The need for ground vehicles to obtain ATC clearance before moving on taxiways is prescribed in the Aviation Safety Services Regulation as described in 2.14.3 (1) and in Section 9.7 of Annex 14 to the Convention on International Civil Aviation as described in 2.14.4.

In this accident, however, there arose a state, as described in the statements of Airport Fire Station staff members in 2.1.6, in which the airport fire engines hesitated to enter the parallel taxiway where high-speed movement should have been possible because they could not establish contact with the Tower for clearance and thus wasted time without moving at all.

No one died in this accident, due to the emergency evacuation completed within a relatively short time despite the delay in fire-fighting activities.

As described in 2.14.4, Section 9.2 of Annex 14 to the Convention on International Civil Aviation prescribes that airport fire engines shall aim to reach an aircraft on fire within three minutes, while also recommending that the number of corners on the route be minimized.

Even with difficulties in establishing communications through MCA radios, the airport fire engines still had an alternative communication means available, i.e., making radio contact via the Fire Command Room, which they would have been able to reach using the dedicated channel. It is therefore considered probable that is necessary both the Tower and the airport fire engines should have tried every available means to communicate with each other.

The airport fire engines' radio system had only one channel for communication with the Tower and did not have an emergency priority connection feature, which deprived them of necessary communications and, as a result, affected the movement of these vehicles. It is therefore considered probable that is necessary every airport be equipped enough so as to secure communication in an emergency.

## 3.16 Actions by the Tower after Mobilization of the Airport Fire Engines

The statement of the ground controller as described in 2.1.5 (2), "I saw the airport fire engines gathering in front of the Airport Fire Station building. I considered making JTA Flight 602 hold on Taxiway E4 in order to secure a path for the airport fire engines," but "I saw the airport fire engines starting to move north on the apron. Judging that 'they would not enter Taxiway A without permission from the ATC,' I cleared JTA Flight 602 to taxi to Spot 27."

The Controller who was in the Tower with a good view of what was going on below should have given priority to actions related to the currently occurring fire on the Aircraft over the operations of other aircraft. In the situation where JTA Flight 602 constituted an obstacle to the airport fire engines on their way to the fire site as described in 2.14.2 (2), it is considered probable that is necessary the Controller should have given top priority to the actions related to the fire on the Aircraft, called and given the airport fire engines instructions for movement, and also given instructions to the potentially obstructing aircraft to hold at a place out of the way of the vehicles.

## 3.17 Omission of Fire Report to the Naha City Fire Department

As described in 2.8 (7), there was no report of the fire from the Airport Fire Station to the Naha City Fire Department.

Once an aircraft fire starts, except when the loaded fuel has already been consumed, the aircraft will completely burn up unless large-scale fire-fighting actions are swiftly initiated. Although the terminal building fortunately escaped fire in this accident due to such favorable conditions as the parked position of the Aircraft and the wind direction, there were too many other matters, such as passenger rescue activities, for the airport fire services to handle alone. For this reason and to minimize damages as well, it is essential to report any aircraft fire to local fire departments in an appropriate way to positively receive their support and at the

earliest possible time.

In an emergency, it is expected that staff members of the airport fire engines make mistakes and omissions because they must deal with many different matters concurrently. What is important for the staff members in such a situation is to be able to take the same actions as those that they have learned from their training. The Airport Fire Station needs to strengthen its emergency response system including the training methods.

Since the Airport Fire Station is aware of the temporary shortage of staffing due to the need to distribute a limited number of members to different jobs, it should develop a system that can ensure routine reporting and other initial emergency actions even with the minimum level of staffing.

## 3.18 Start and Spread of the Fire

Judging from the DFDR and CVR records, the statements of the relevant persons and the video camera records described in 2.1, as well as the findings described in 3.3–3.5, it is considered highly probable that the fire started and spread as follows.

(1) The downstop assembly of the main track became detached and fell off.

(2) When the slat was retracted, the arm pushed the bolt of the assembly and the bolt punctured a hole in the track can.

(3) The fuel leaking out through the punctured hole flowed along the wing's leading edge and reached the pylon.

(4) The fuel falling down from the area around the joint between the wing bottom and the pylon was blown aft by the blast of engine fan nozzle air in the form of a mist.
This condition continued while the Aircraft was taxiing and even after it parked, until the engines were shut down.

(5) As the blast weakened after the engines were shut down, the leaked fuel began falling straight down and splashing directly onto the exhaust pipe.

(6) After the above-mentioned conditions continued for a certain period of time, the heat of the exhaust pipe ignited the fuel, which started a fire.

(7) The fire spread over the fuel spilled on the ground.
There was a southerly wind at that time, which caused the fuel on the ground to flow from the right side to the left side of the Aircraft. The apron surface below the wings formed a slight concave on the left side of the Aircraft. In addition, the apron sloped down along the Aircraft Stand Lead-in Lines towards the aft end (west) of the Aircraft due to the location of the drainage. Due to the above reasons, a major fire spread from the surface below the right engine to the surface below the left wing after crossing the surface below the fuselage, and while part of the fire spread aft along the centerline of the fuselage.

(8) After the fire spread to the left side of the Aircraft, explosions occurred on the Aircraft

and the left side of the Aircraft burst into flames.

(9) The left aft portion of the Aircraft went up in flames a little while later.

(10) As viewed from the outside, the fire did not spread to the inside of the Aircraft (especially to its forward and aft end portions) until the time when fire-fighting operations started.

## 3.19 Factors Contributing to No Casualties

It is considered highly probable that the following factors contributed no casualties and wounded despite the huge scale of the fire and the delayed start of fire-fighting operations.

(1) Passenger preparedness for evacuation

Once the engines were shut down, the fire started after 53 seconds and the Captain's order to prepare for evacuation was issued after 1 minute and 52 seconds. Even within the limited time frame, an orderly evacuation was made possible due partly to the fact that the passengers had begun preparing for disembarkation immediately after the Aircraft stopped in its spot and were waiting in line in the aisle.

(2) Early recognition and reporting of the fire

Since the ground crew members were aware of an abnormal condition being suspected of fuel leakage with the Aircraft in such an early stage, while the Aircraft was still moving on the surface along the Aircraft Stand Lead-in Lines, they could notice the fire as soon as it started.

A ground crew member had already connected the interphone to the Aircraft when the fire started, so the ground crew member was able to report the start of the fire to the Captain immediately.

The ground crew member notified the Captain of the fire at almost the same time that it started, so the Captain was able to recognize the fire quickly and exactly even though there was no indication of fire in the cockpit.

(3) Safe evacuation

The Aircraft's emergency exits were positioned relatively low to the ground, which made it easy for the passengers to escape down the slides.

The accident occurred during the daytime under good weather, which helped facilitate the evacuation and the subsequent escape to safe places.

(4) Smooth evacuation

The evacuation was completed so quickly and safely that everyone was able to leave the Aircraft before the arrival of the fire services.

Voluntary assistance by ground crew members at the slides helped evacuees make a smooth escape.

The fire started after the Aircraft had parked, which facilitated discovery and reporting of the fire and prompt implementation of evacuation and assistance.

(5) Damages limited to the Aircraft

As the adjacent spots on both sides were empty, no other aircraft was affected by the explosions and smoke.

The disembarkation was not of a type using a boarding bridge, which eliminated the chance of the bridge and the terminal building suffering any damage.

## 3.20 Matters Contributing to Determination of the Cause of the Accident

(1) Since a wind was blowing almost squarely from the right to the left of the Aircraft, the source of the fuel leakage was maintained under sufficiently good conditions to identify the situation.

(2) There remained a condition that allowed clear recognition on the inappropriate installation of the downstop assembly of the slat during the maintenance work. It is considered highly probable that this condition was preserved because the tip of the right wing drooped and rested on the ground at 10:39:48, or 6 minutes and 55 seconds after the fire started (at 10:32:53), due to burning of the root of the wing, which stopped the fuel leaking from the hole punctured in the fuel tank and thus prevented further burning of the wing.

## 3.21 CVR Recording Duration

### 3.21.1 CVR Recording Duration in This Accident

As described in 2.1 and 2.17.6, the fire extinguisher levers for the engines and APU were pulled and rotated after shutdown of both engines. This resulted in the loss of power supply from the generator and, six seconds later, stopping of the CVR. As described in 2.17.6, the onboard battery should normally supply power for at least 30 minutes. Therefore it is considered probable that the CVR stopped six seconds later due to the fire. As a result, although it is considered probable that the interphone and PA systems were used and conversations continued in the cockpit during the period of about 1 minute and 20 seconds before the Captain escaped from the cockpit, they voices were not recorded.

In any accident investigation, CVR records are essential for reproducing the events. It is therefore desirable that CVR recording continue until the completion of emergency evacuation.

### 3.21.2 Actions Taken

On March 7, 2008, the Federal Aviation Administration (FAA) of the United States of America issued a revision to the design criteria, which includes the requirement for installation of a discrete power source that is capable of supplying power to the CVR and

cockpit area microphone for 10 minutes after the generator power is lost and also for an arrangement whereby the discrete power source automatically takes over when the normal power source is interrupted. The revision requires that all turbine engine aircraft manufactured on and after April 7, 2010 for operation by U.S. airlines meet the new design criteria. On November 18, 2008, the Civil Aviation Bureau of Japan revised the Airworthiness Standards, imposing an obligation just like the requirement by the revision to the FAA design criteria on those aircraft newly applying for type certification. However, it is considered necessary to study on the establishment of new rules to deal with those aircraft that will be manufactured under already granted type certification for operation by Japanese airlines.

# 4. PROBABLE CAUSE

It is considered highly probable that this accident occurred through the following causal chain: When the Aircraft retracted the slats after landing at Naha Airport, the track can that housed the inboard main track of the No. 5 slat on the right wing was punctured, creating a hole. Fuel leaked out through the hole, reaching the outside of the wing. A fire started when the leaked fuel came into contact with high-temperature areas on the right engine after the Aircraft stopped in its assigned spot, and the Aircraft burned out after several explosions.

With regard to the cause of the puncture in the track can, it is certain that the downstop assembly having detached from the aft end of the above-mentioned inboard main track fell off into the track can, and when the slat was retracted, the assembly was pressed by the track against the track can and punctured it.

With regard to the cause of the detachment of the downstop assembly, it is considered highly probable that during the maintenance works for preventing the nut from loosening, which the Company carried out on the downstop assembly about one and a half months prior to the accident based on the Service Letter from the manufacturer of the Aircraft, the washer on the nut side of the assembly fell off, following which the downstop on the nut side of the assembly fell off and then the downstop assembly eventually fell off the track.
It is considered highly probable that a factor contributing to the detachment of the downstop assembly was the design of the downstop assembly, which was unable to prevent the assembly from falling off if the washer is not installed.

With regard to the detachment of the washer, it is considered probable that the following factors contributed to this: Despite the fact that the nut was in a location difficult to access during the maintenance works, neither the manufacturer of the Aircraft nor the Company had paid sufficient attention to this when preparing the Service Letter and Engineering Order job card, respectively. Also, neither the maintenance operator nor the job supervisor reported the difficulty of the job to the one who had ordered the job.

# 5. SAFETY RECOMMENDATIONS

## 5.1 Preparation of Maintenance Job Instructions

The Japan Transport Safety Board recommends the Federal Aviation Administration of the United States of America to supervise the Boeing Company, the manufacturer of the Aircraft, to take the following actions:

When preparing maintenance job instructions for airlines such as Service Letters/Bulletins, the scopes of jobs should be clearly defined and the working conditions and environments including accessibilities to job areas should be appropriately evaluated in order to prevent maintenance errors.

## 5.2 Planning and Implementation of Maintenance Jobs

The Japan Transport Safety Board recommends the Civil Aeronautics Administration of Taiwan to supervise China Airlines to take the following actions:

When planning and implementing maintenance jobs, the scopes of jobs should be fully ascertained and the working conditions and environments should be appropriately evaluated, and the countermeasures to prevent maintenance errors including the actions taken in 2009 against the recurrence of this accident should be steadfastly implemented and enhanced.

# 6. REFERENTIAL MATTERS

## 6.1 Airworthiness Directives Requiring Inspection Issued by the Civil Aviation Bureau of Japan

(1) The Civil Aviation Bureau of Japan (JCAB) issued Airworthiness Directive TCD-7152-2007 on August 23, 2007, instructing all Japanese operators of Boeing 737-700/800 to conduct repetitive inspections on the downstop assembly on all aircraft of these models in their fleet.

(2) The JCAB issued Airworthiness Directive TCD-7153-2007 on August 26, 2007, instructing all Japanese operators of Boeing 737-600/700/700C/800/900/900ER to conduct a repeat inspection and take the necessary actions on the downstop assembly. The JCAB then issued another Airworthiness Directive, TCD-7153A-2007, on August 29, 2007, abolishing the previously issued Airworthiness Directive TCD-7153-2007, which instructed them to conduct repetitive inspections and take the necessary actions on the downstop assembly using a revised method that included a new process.

(3) The JCAB issued Airworthiness Directive TCD-7240-2008 on March 25, 2008, instructing all Japanese operators of Boeing 737-300/400/500 to conduct repetitive

inspections on the downstop assembly on all aircraft of these models in their fleet.

## 6.2 Airworthiness Directives Requiring Inspection Issued by the Aviation Authority of the State of Manufacture

(1) The FAA issued Emergency Airworthiness Directive AD2007-18-51 on August 25, 2007, instructing all U.S. operators of Boeing 737-600/700/700C/800/900/900ER to conduct repetitive inspections on the downstop assembly on all aircraft of these models in their fleet.

(2) The FAA issued Emergency Airworthiness Directive AD2007-18-52 on August 28, 2007, notifying all U.S. operators of Boeing 737-600/700/700C/800/900/900ER of the abolishment of the Airworthiness Directive dated August 25 and instructing these operators to conduct repetitive inspections and take the necessary actions on the downstop assembly on all aircraft of these models in their fleet using a revised method that included a new process.

(3) The FAA issued Emergency Airworthiness Directive AD2008-06-29 on March 11, 2008, instructing all U.S. operators of Boeing 737-300/400/500 to conduct repetitive inspections on the downstop assembly on all aircraft of these models in their fleet.

These actions taken by the FAA were also reflected on the relevant actions taken by the aviation authorities of other states including Japan in which aircraft of the same models are operated.

## 6.3 Airworthiness Directives Requiring Inspection Issued by the Authority Responsible for the Operator

(1) The Civil Aeronautics Administration (CAA) of Taiwan, the authority supervising the Company, issued Emergency Airworthiness Directive CAA-2007-08-010 on August 24, 2007, instructing all Taiwanese operators of Boeing 737-800 to conduct an inspection on the downstop assembly on all aircraft of this model in their fleet.

(2) The CAA issued Emergency Airworthiness Directive CAA-2007-08-010B on August 26, 2007, instructing all Taiwanese operators of Boeing 737-600/700/700C/800/900/900ER to conduct a repeat inspection and take the necessary actions on the downstop assembly on all aircraft of these models in their fleet. The CAA then issued another Emergency Airworthiness Directive, CAA-2007-08-010C, on August 29, revising the time limit of the inspection on the downstop assembly.

(3) The CAA issued Emergency Airworthiness Directive CAA-2007-08-010D on September 29, 2007, superseding Airworthiness Directive CAA-2007-08-010C and instructing all Taiwanese operators of Boeing 737-600/700/700C/800/900/900ER to conduct a repeat inspection on the downstop assembly using a revised method that

included a new process.

## 6.4 Actions Taken by the Manufacturer of the Aircraft

Following this accident, the Boeing Company as the manufacturer of the Aircraft made a change to the design of the downstop assembly and started applying the newly designed downstop assembly to its new production aircraft of the applicable models from August 2008. As measures for those aircraft already in service, Boeing released a Service Bulletin SB737-57A1302 on Dec 15, 2008 that provides operators with instructions to replace the existing downstop hardware with the new design hardware.
Intending to prevent leaking fuel from dropping on the engine fan nozzle, Boeing issued Service Bulletin on November 13, 2008, instructing modification to operators so as to secure drain path for leaking fuel in the area keeping away from engine fan nozzle area.

## 6.5 Actions Taken by the Operator of the Aircraft

Following this accident, in February and March, 2009, Operator revised definitions of job order document, maintenance manual and so forth as follows;

(1) Job order improvement

① Introduction of support system for job site.

② Revision of maintenance manuals.

(2) Difficulty reporting system

China Airlines developed three feedback systems for the purpose of reporting difficulties or problems on the job order.

① Supplementary Worksheet Procedure.

② Technical Support for Maintenance and Event.

③ System Engineer Technical Support Procedure.

## 6.6 Emergency Communication Function for MCA Radio

On September 6, 2007, the Naha Airport Office added an emergency communication function to the MCA radios used by Air Traffic Controllers. This function allows the Air Traffic Controllers to make a broadcast to all other parties in a group, automatically interrupting any ongoing communications.

## 6.7 Actions Taken by the Civil Aviation Bureau of Japan

On September 19, 2007, the Civil Aviation Bureau of the Ministry of Land, Infrastructure, Transport and Tourism ordered the Tokyo Regional Civil Aviation Bureau and the Osaka Regional Civil Aviation Bureau to undertake the following items with the aim of enhancing the fire-fighting and rescue systems at airports: review of the communication flows to relevant organizations for emergency reporting quickly responsive to crash-phone calls;

implementation of training for airport fire engines movement most adapted to in-apron accidents; and enhancement of coordination between airport fire service and ATC for swift and smooth fire-fighting operations on the airport premises. Following the order, both regional civil aviation bureaus reviewed the communication flows, conducted vehicle movement training, reviewed the operation and other manuals, and carried out communication training.

# 7. ASC COMMENTS

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July 22, 2009

Mr. Ikuo TAKAGI
Investigator-General for Aircraft Accident
Japan Transport Safety Board

Dear Mr. Takagi

Thank you for your letter and draft report of the accident involving China Airlines B737-800, registration B18616, which was destroyed by fire at Naha International Airport, Japan, on August 20, 2007.

As the Aviation Safety Council (ASC) Accredited Representative, I have reviewed with my advisors the draft report of the accident in accordance with the provisions of paragraphs 6.3 of Annex 13 of the Convention on International Civil Aviation. We find the report through and the conclusions fully supported by the factual content. We wish to express our appreciation for the level of participation afforded to our team. We also wish to congratulate the Japan Transport Safety Board (JTSB) for the excellent job of conducting the investigation and the ample consideration given to all the parties involved.

With respect to the following sections of the draft report, the ASC staff suggest the following changes, recommended insertions are underlined and deletions are shown with ~~strikeout~~.

**2. FACTUAL INFORMATION**

*2.16.1 ③*

We recommend that this paragraph be revised as follows to clarify the torque on the nut:

③ Nut ~~tightening~~ remaining torque

~~The nut was found tightened with a torque of 26.55 in-lbs when measured in the tightening direction.~~ The nut remaining torque was measured as torque value 26.55 in-lbs in the tightening direction on the downstop assembly, which was detached from the track and not in the tightening condition.

*3.20 (2)*

We recommend that this paragraph be revised as follows to clarify the condition that allowed the determination of the cause of the accident:

There remained a condition that allowed clear recognition on the ~~inappropriate installation of the downstop assembly of the slat during the maintenance work.~~ inspection of the right wing and detachment of the downstop assembly. The right wing portion from the engine mounting area to the wing tip remained nearly intact.

## 4. PROBABLE CAUSE

*(Paragraph 4 and 5)*

The manufacturer Service Letter 737-SL-57-084-A informed operator with action of manufacturer been initiated to create a permanent production and fleet solution for the issue of fuel leak from number 5 slat track can. The operator who received the Service Letter did not have the knowledge of the design of downstop which did not provide separate locking devices, and that their locking devices would be adversely affected by the environmental conditions associated with this Service Letter operation which a single failure of the falling common washer will bring on the consequences of unsafe condition of aircraft. Based on the belief of the fail-safe design of aircraft, before the event, it was not easy to ask the operator foresee the consequences of unsafe condition caused by a single failure of the downstop and arise necessary precaution to prevent all the unsafe conditions. However, the ASC staff also believes that consider necessary precaution to ensure the safety of all operations is the ultimate responsibility of the operator. Therefore, we recommend that these paragraphs be revised as follows:

*(Paragraph 4)*

It is presumed that a factor contributing to the detachment of the downstop assembly was the absence of a fail-safe mechanism design of the downstop assembly, which was unable to prevent the catastrophic consequence which arose from a single washer falling off. ~~assembly from falling off if the washer is not installed~~.

*(Paragraph 5)*

With regard to the detachment of the washer, it is considered likely that the following factors contributed to this: Despite the fact that the nut was in a location difficult to access during the maintenance works, ~~neither~~ the manufacturer of the Aircraft ~~nor the Company~~ had not paid sufficient attention to provide clearly defined job condition, job environment, including accessibility and necessary precautions ~~this~~ when preparing the Service Letter. ~~and Engineering Order job card, respectively.~~ In addition, although it would be difficult for the Company to develop remedy of the unsafe condition of detachment of downstop without thorough background information of designing the downstop which owned by the manufacturer, it is still considered that the Company had not considered all necessary precautions when preparing the Engineering Order. Also, neither the maintenance operator nor the job supervisor reported the difficulty of the job to the one who had ordered the job.

## 5. SAFETY RECOMMENDATIONS

*5.1 Preparation of Maintenance Job Instructions*

ASC staff fully support this recommendation. In addition, ASC staff also suggest that when

design the airplane, manufacturer should consider Human Factors issues that might adversely affect the maintenance operations. Therefore, we recommend that this recommendation be revised as follows:

5.1 ~~Preparation of Maintenance Job Instructions~~ During Designing of the Airplane and Preparation of Maintenance Information, Account to be taken to consider Maintenance Human Factors issues

The Japan Transport Safety Board recommends the Federal Aviation Administration of the United States of America to supervise the Boeing Company, the manufacturer of the Aircraft, to take following actions:
(1) When designing of the airplane, account should be taken to consider necessary Human Factors issues for maintenance technicians, such as ease of access, ease of maintenance, and working environment.
(2) When preparing maintenance information for airlines such as Service Letters/Bulletins, the scope of jobs should be clearly defined and the working conditions and environments including accessibilities to job areas should be appropriately evaluated in order to prevent maintenance errors.
(3) The issuance of Service Letters or Service Bulletins should be properly evaluated to comply with the ATA Specification 100 Standards. For Aircraft Support, the required coverage to maintain the aircraft in safe operating condition is issued via Service Bulletin, and in no case shall Service Letter be used in lieu of Service Bulletin.

Thank you again for providing us the opportunity to review your report. We look forward to receiving the final version of the report so that we can make it available to others in the Taiwan aviation community for information and accident prevention purposes.

Sincerely Yours,

Thomas Wang
Accredited Representative
Aviation Safety Council, Taiwan ROC.

# Figure 1 Estimated Flight Route and Taxiing Path

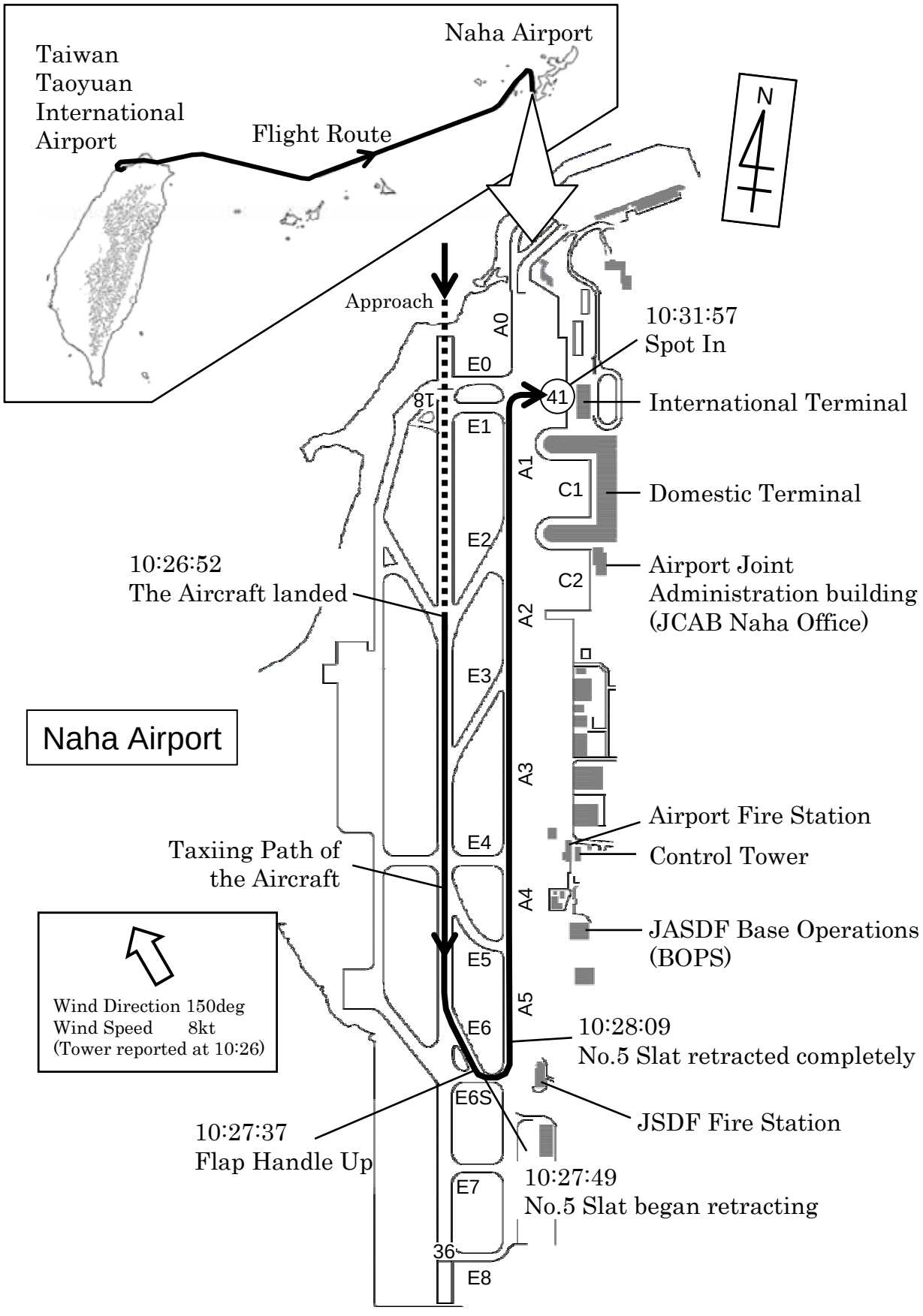


Figure 2　Estimated Tracks of
Airport Fire Engines and JTA602

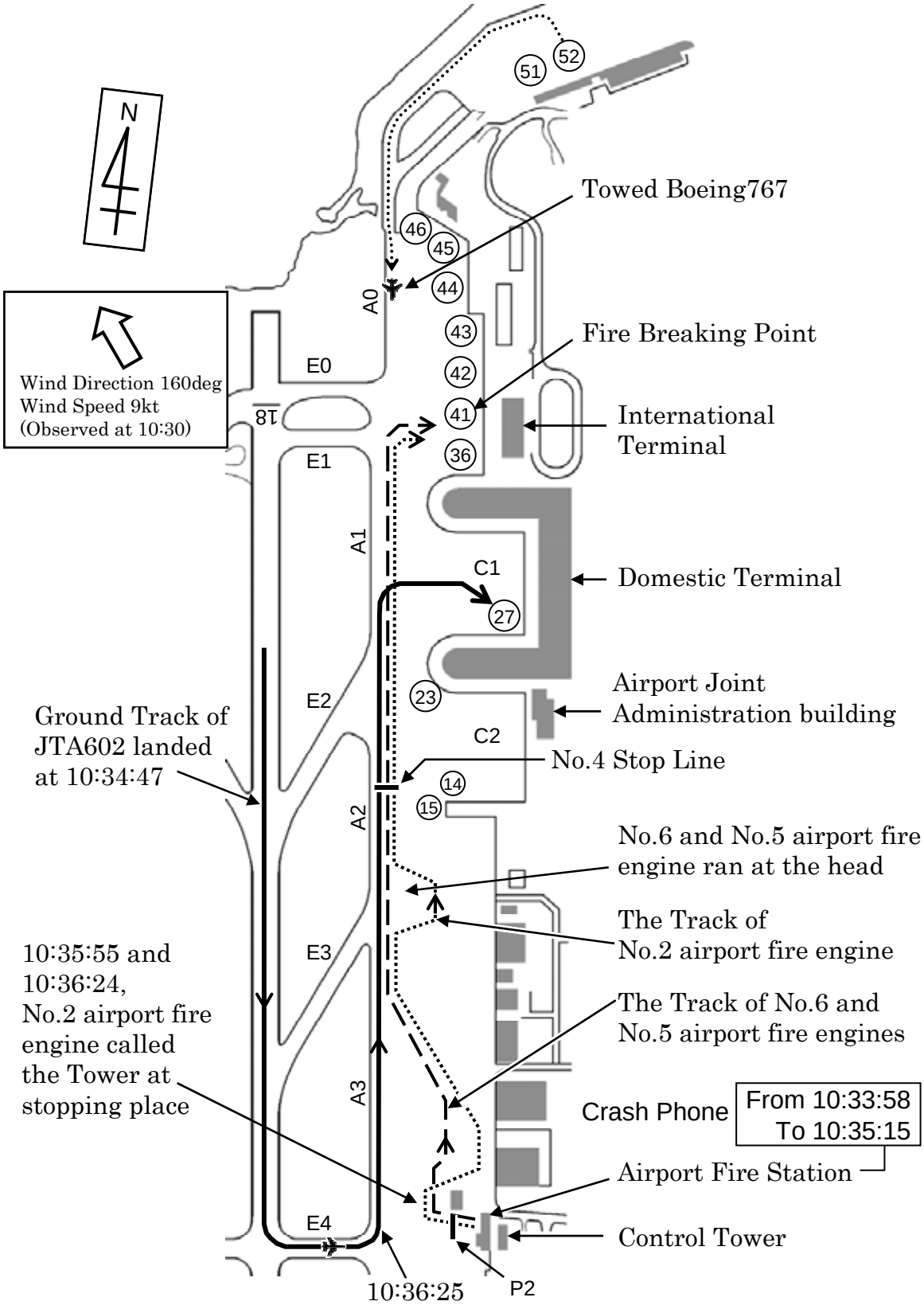
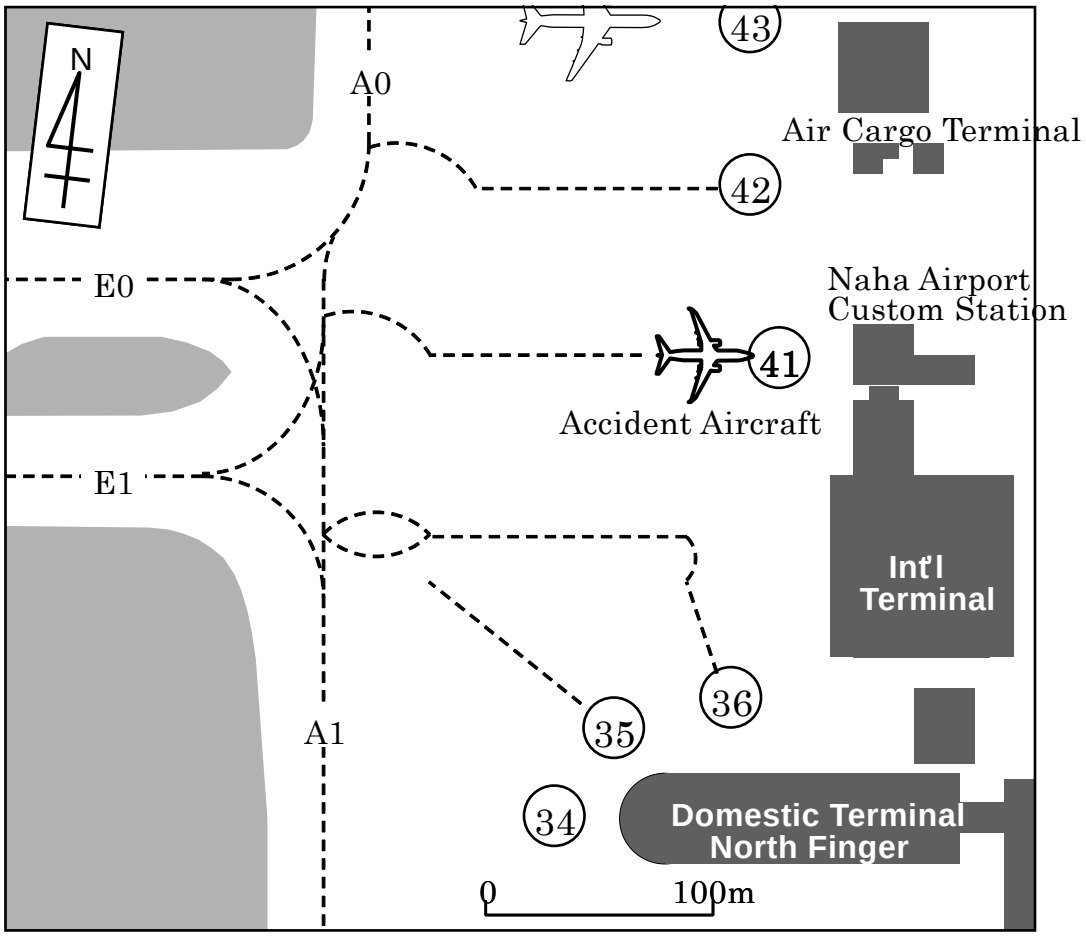


Figure 3 Parking Spot of the Aircraft and Damage to the Apron




Damage to the Apron

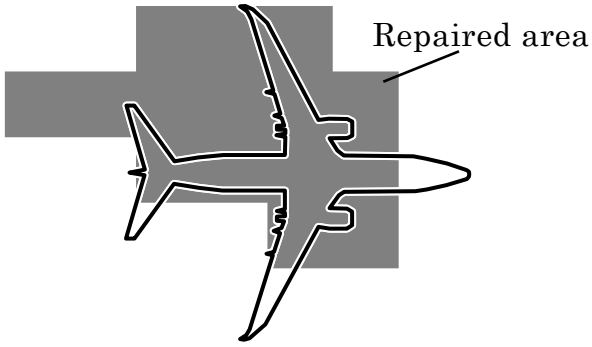


Figure 4　Arrangements of Ground Crew Members

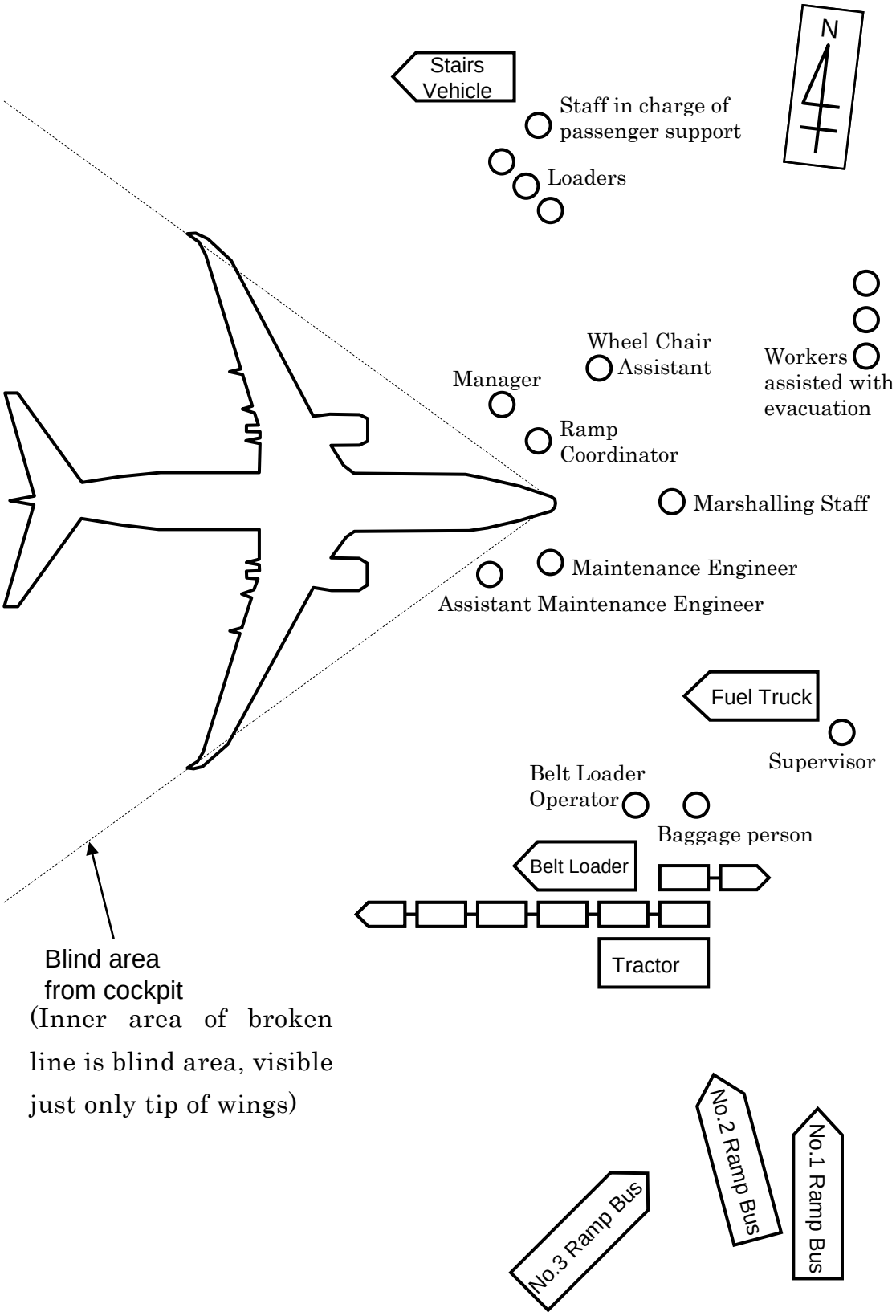
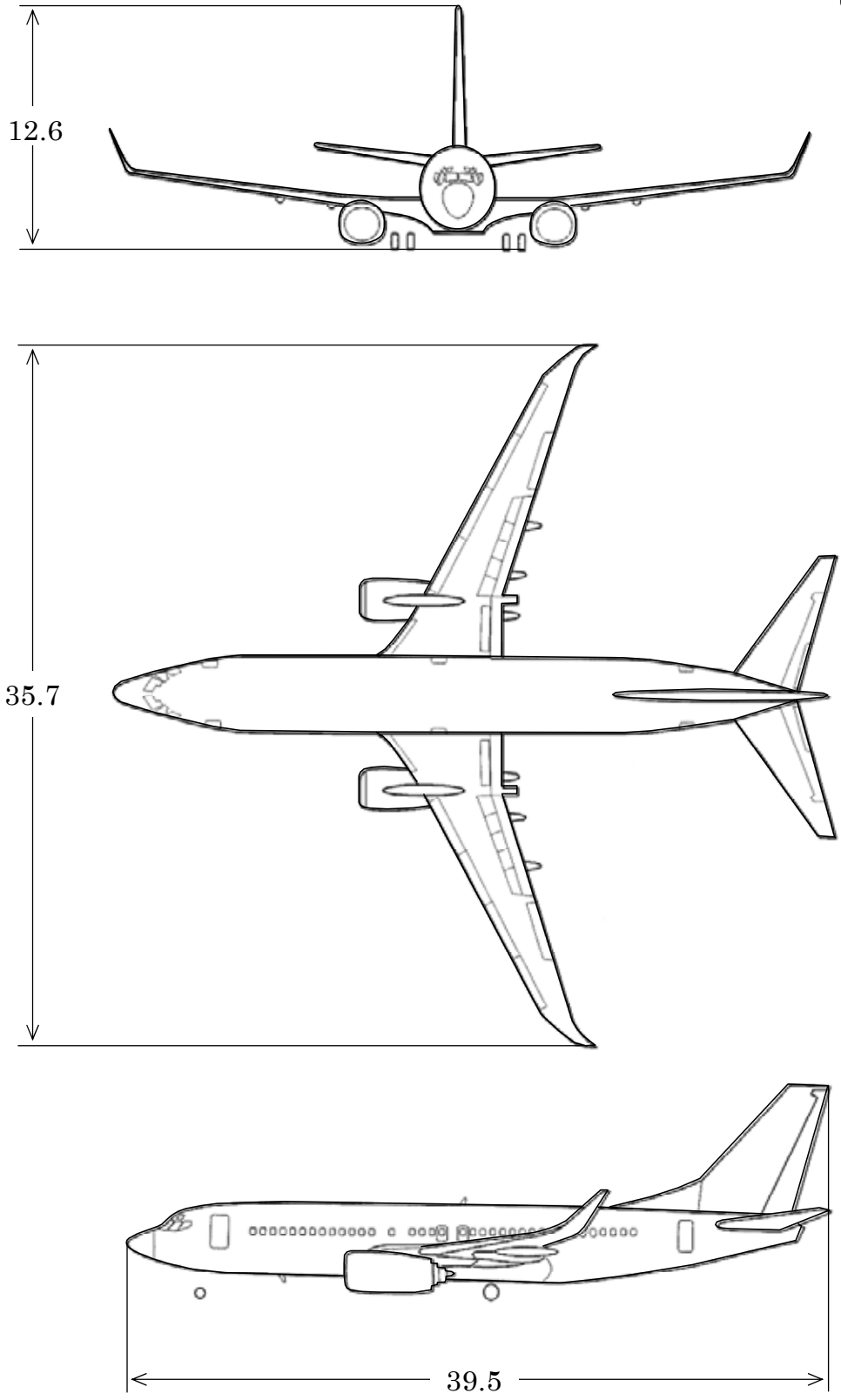


Figure 5　Three Angle View of the Boeing 737-800

Unit ： m



# Figure 6 Slat Mechanism

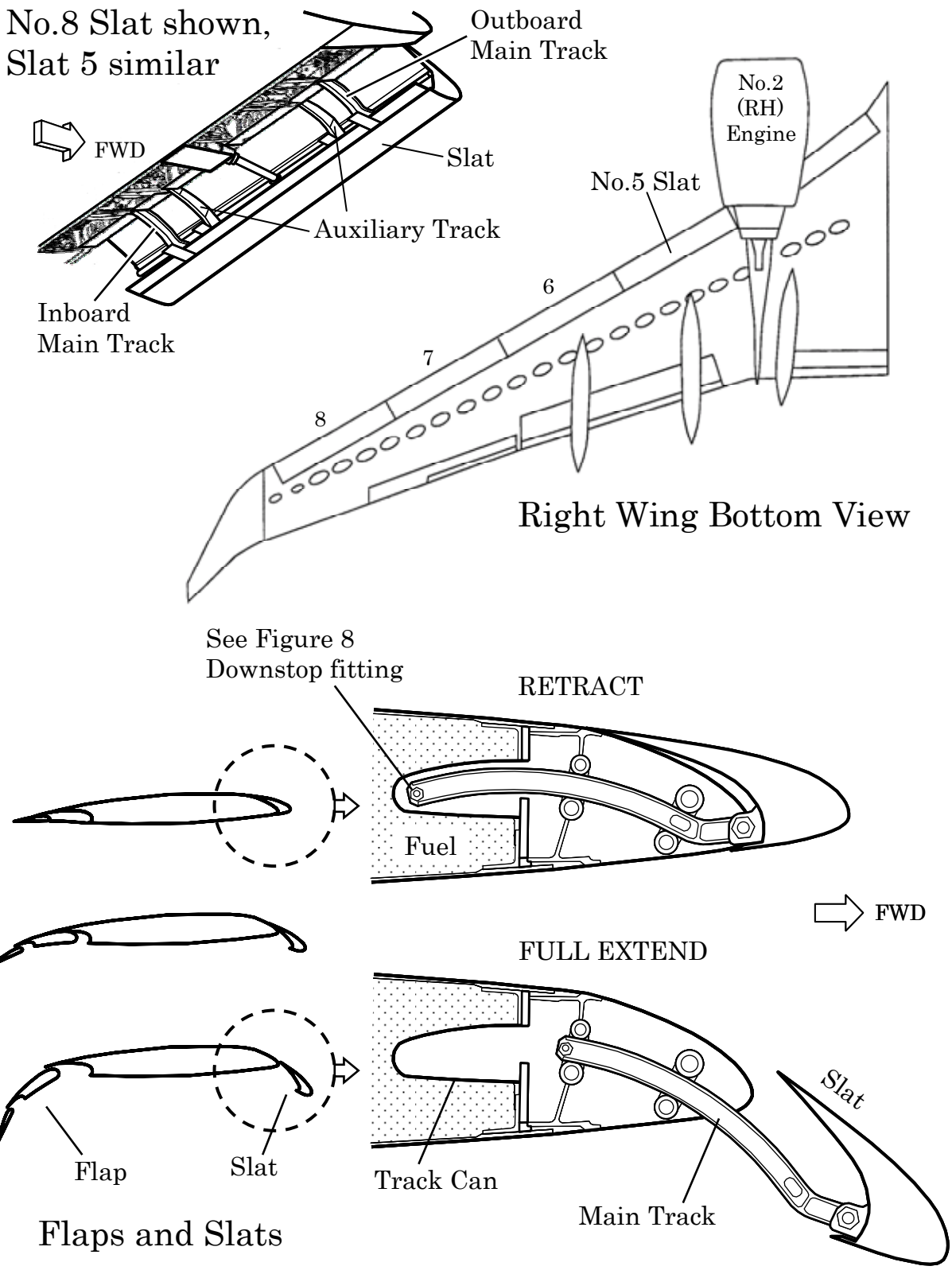
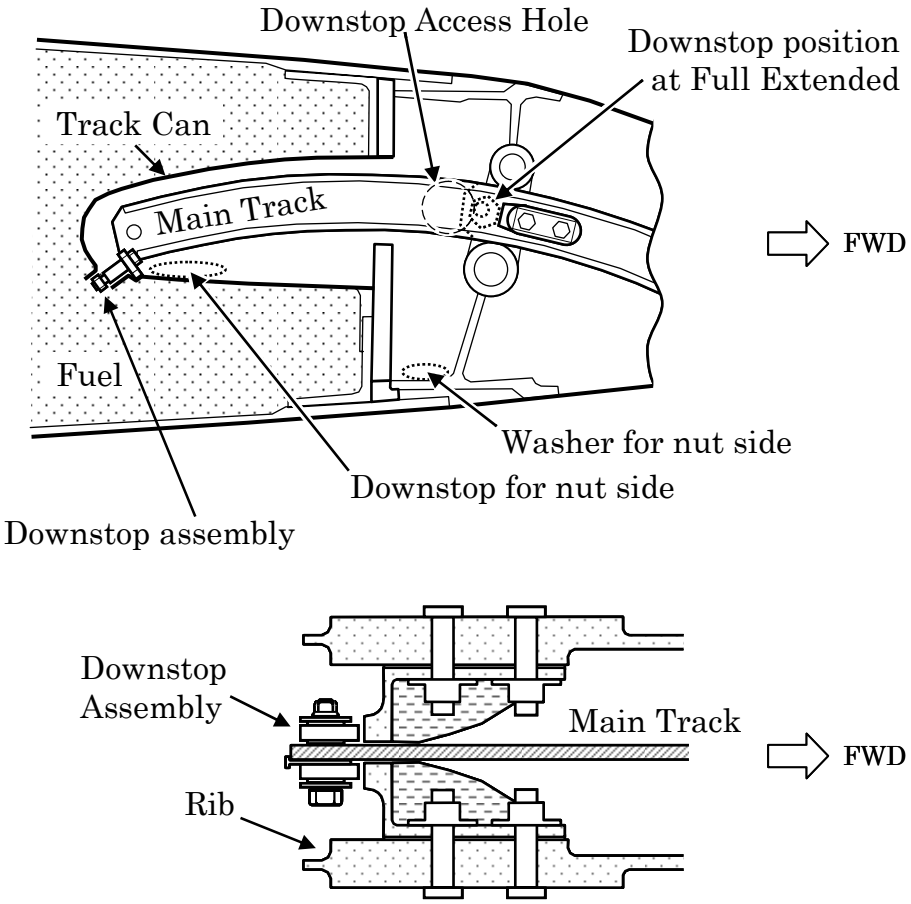


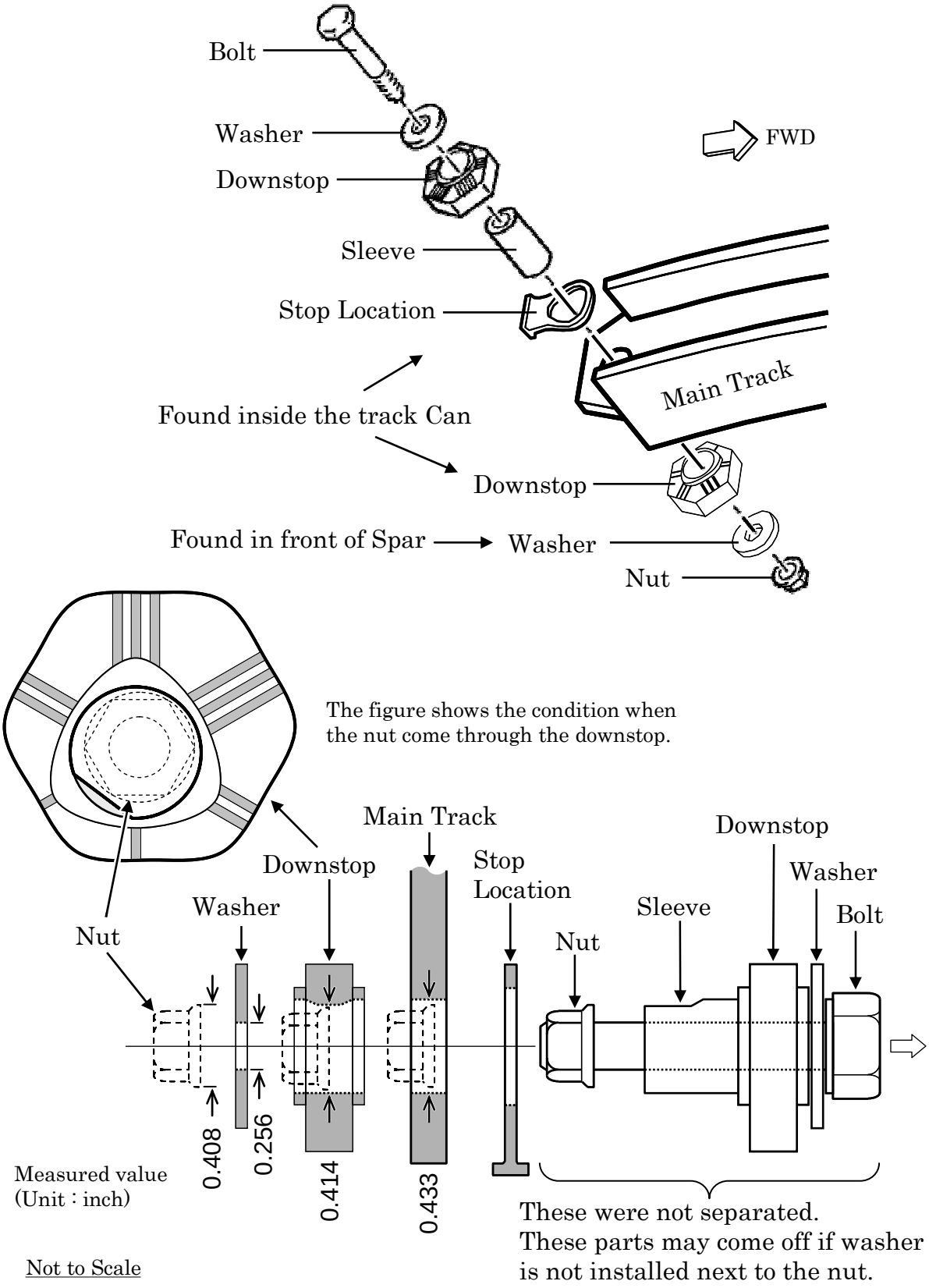
Figure 7　Downstop Assembly, Flap Handle Position and Flap/Slat Position




Flap Handle Position and Flap/Slat Position

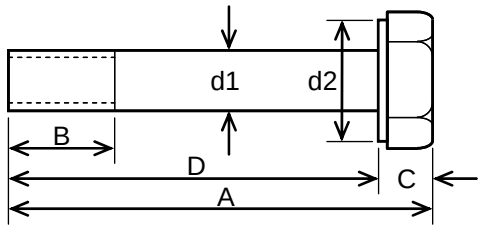
| Flap Handle (deg) | TE Flap (deg) | LE Slat (No.5 Slat) | LE Flap |
|---|---|---|---|
| 0 | 0 | RETRACT | RETRACT |
| 1 | 1 | EXTEND | EXTEND |
| 2 | 2 | | |
| 5 | 5 | | |
| 10 | 10 | | |
| 15 | 15 | | |
| 25 | 25 | | |
| 30 | 30 | FULL EXTEND | |
| 40 | 40 | | |

# Figure 8 Downstop Fitting



# Figure 9-1 Dimensions of Downstop Assembly (1)

Bolt (BACB30NR4K18)

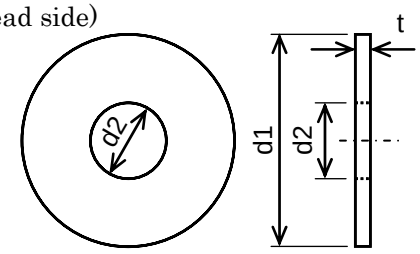



Bolt (unit : in)

| | meas | spec |
|---|---|---|
| A | **1.649** | **1.624~1.669** |
| B | **0.413** | **0.389** |
| C | **0.132** | **0.125~0.140** |
| D | **1.514** | **1.499~1.529** |
| d1 | **0.249** | **0.244~0.254** |
| d2 | **0.428** | --- |

Washer (BACW10P393CB)

(Bolt head side)

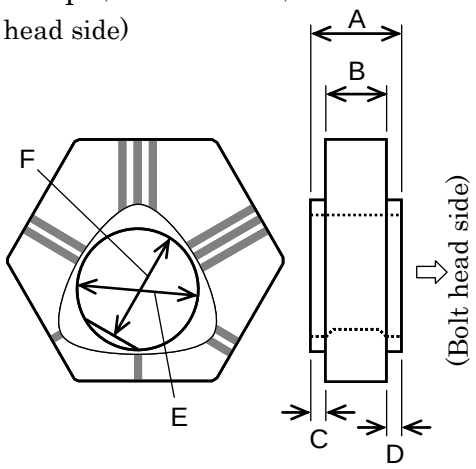



Washer (unit : in)

| | meas | spec |
|---|---|---|
| d1 | **0.625** | **0.620~0.640** |
| d2 | **0.256** | **0.250~0.270** |
| t | **0.104** | **0.100** |

Downstop (114A4103-3)

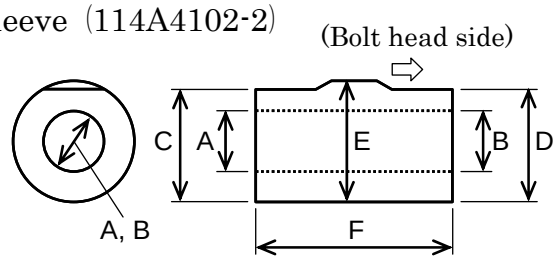
(Bolt head side)




Downstop (unit : in)

| | meas | spec |
|---|---|---|
| A | **0.406** | **0.404** |
| B | **0.283** | **0.280** |
| C | **0.065** | **0.062** |
| D | **0.063** | |
| E | **0.437** | **0.437~0.450** |
| F | **0.412** | **0.410~0.420** |

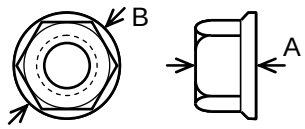
Sleeve (114A4102-2)




Sleeve (unit : in)

| | meas | spec |
|---|---|---|
| A | **0.249** | **0.252** |
| B | **0.249** | |
| C | **0.393** | **0.404~0.408** |
| D | **0.396** | |
| E | **0.432** | **0.432~0.433** |
| F | **0.952** | **0.952** |

Nut (BACN10YR4CM)



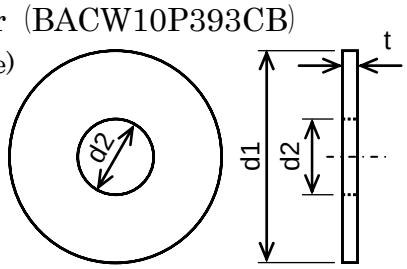

Nut (unit: in)

| | meas | spec |
|---|---|---|
| A | **0.216** | **0.204~0.219** |
| B | **0.408** | **0.386~0.420** |

# Figure 9-2 Dimensions of Downstop Assembly (2)

Washer (BACW10P393CB)

(Nut side)

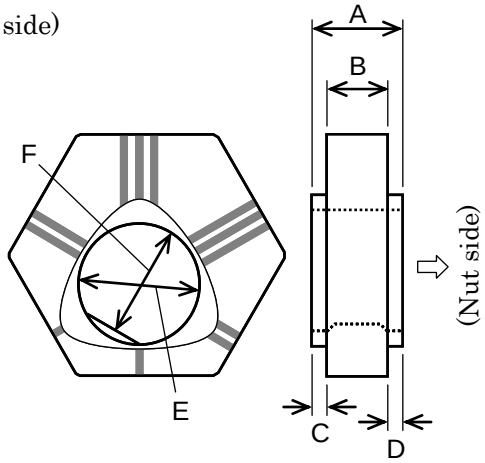



Washer (unit : in)

| | meas | spec |
|---|---|---|
| d1 | **0.625** | **0.620～0.640** |
| d2 | **0.256** | **0.250～0.270** |
| t | **0.103** | **0.100** |

Downstop (114A4103-3)

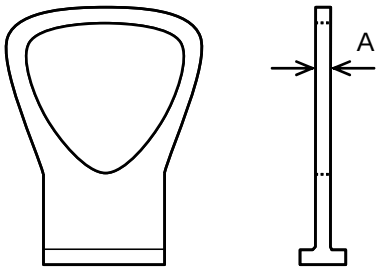
(Nut side)




Downstop (unit: in)

| | meas | spec |
|---|---|---|
| A | **0.404** | **0.404** |
| B | **0.284** | **0.280** |
| C | **0.063** | **0.062** |
| D | **0.065** | |
| E | **0.438** | **0.437～0.450** |
| F | **0.414** | **0.410～0.420** |

Stop Location (114A4101-1)




Stop Location (unit : in)

| | meas | spec |
|---|---|---|
| A | **0.077** | **0.062** |

# Figure 10 Change in Remaining Fuel of DFDR Records

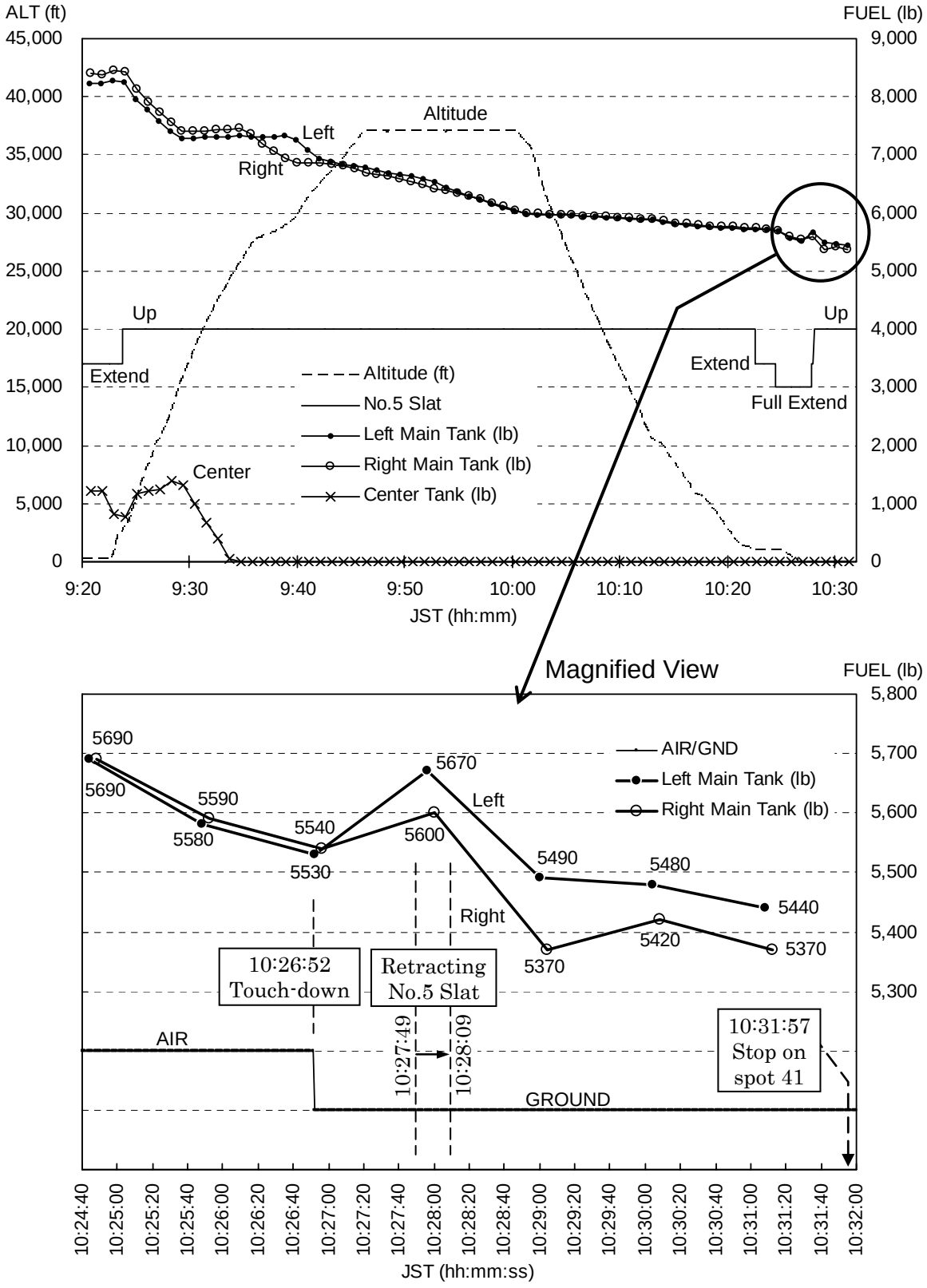
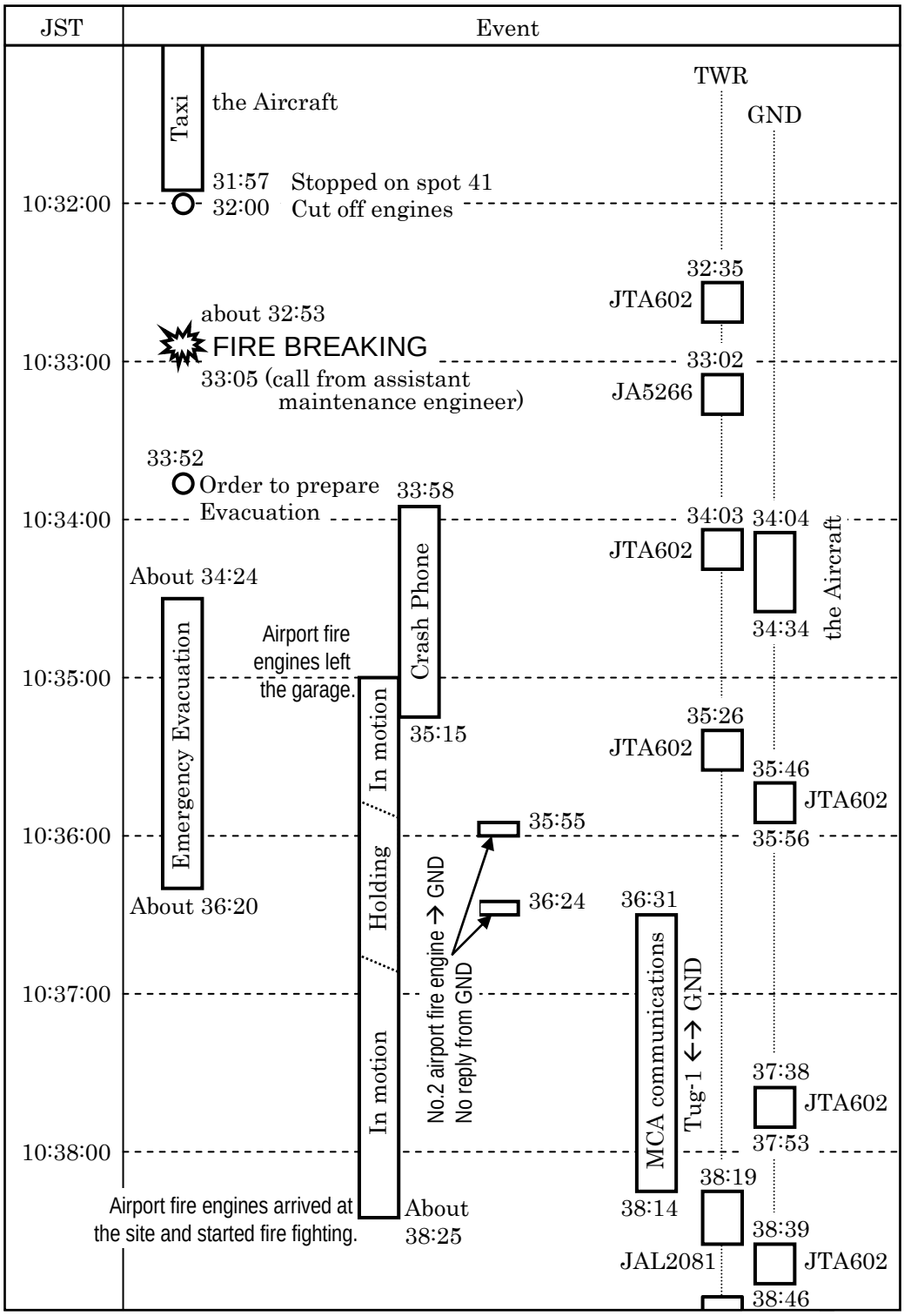
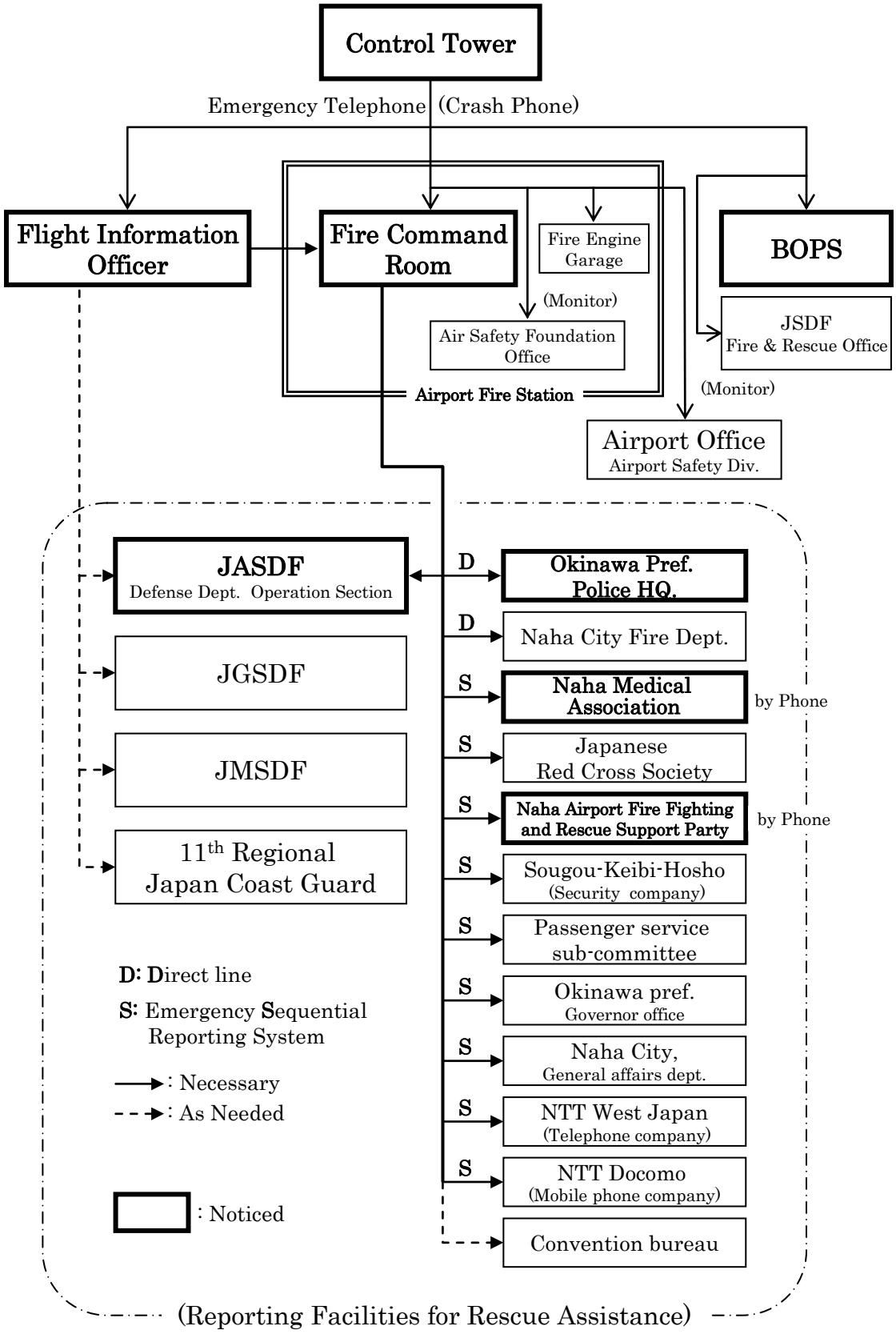


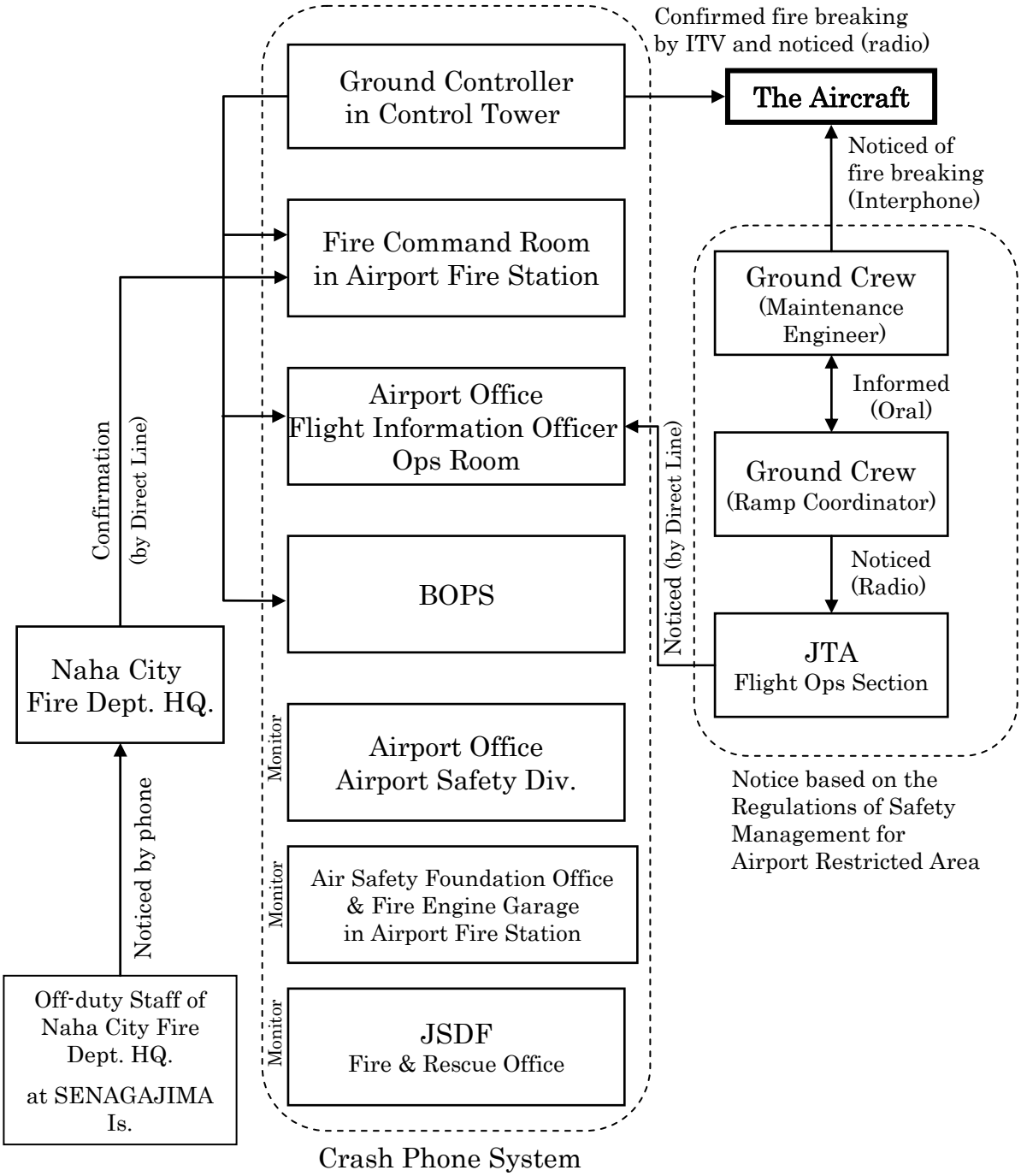
Figure 11 Time-line Chart from Fire Breaking to the Start of Fire Fighting Operations



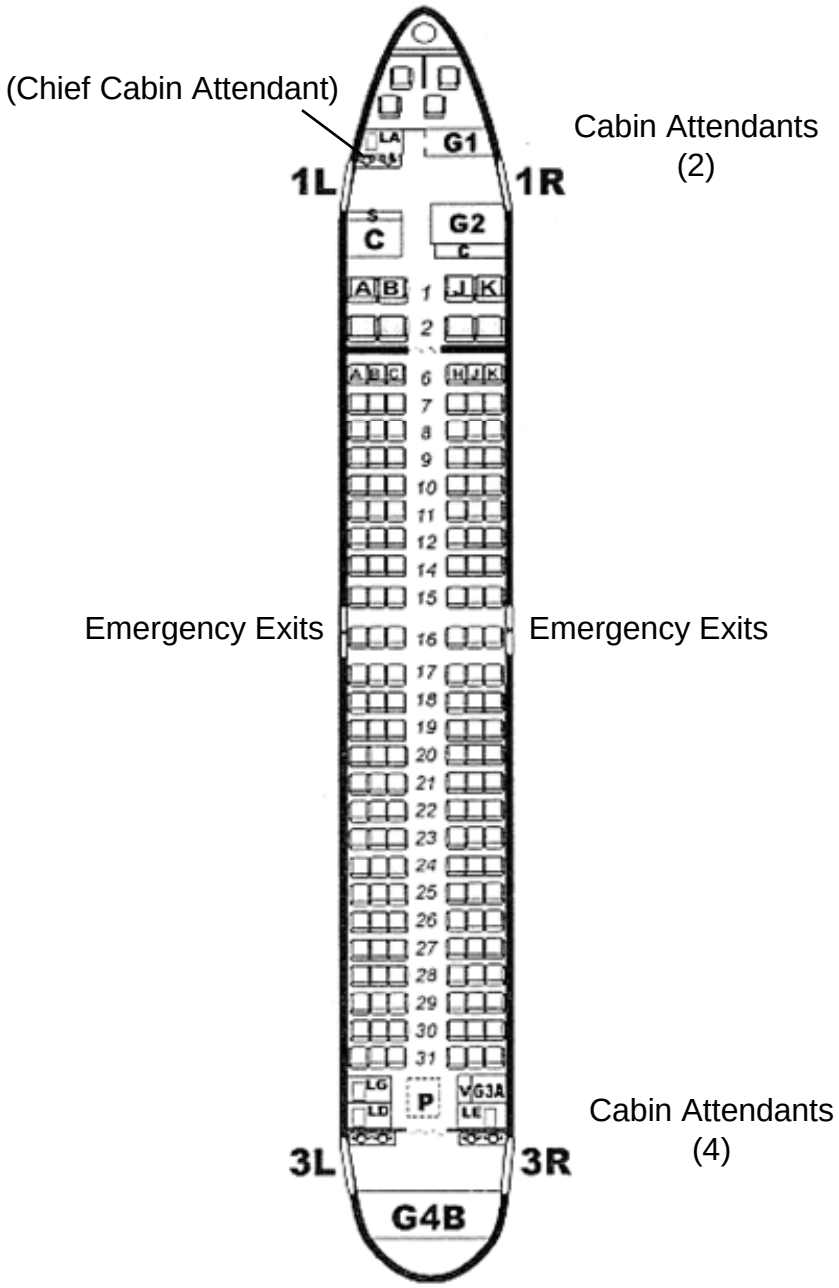
# Figure 12 Aviation Accident Reporting Diagram



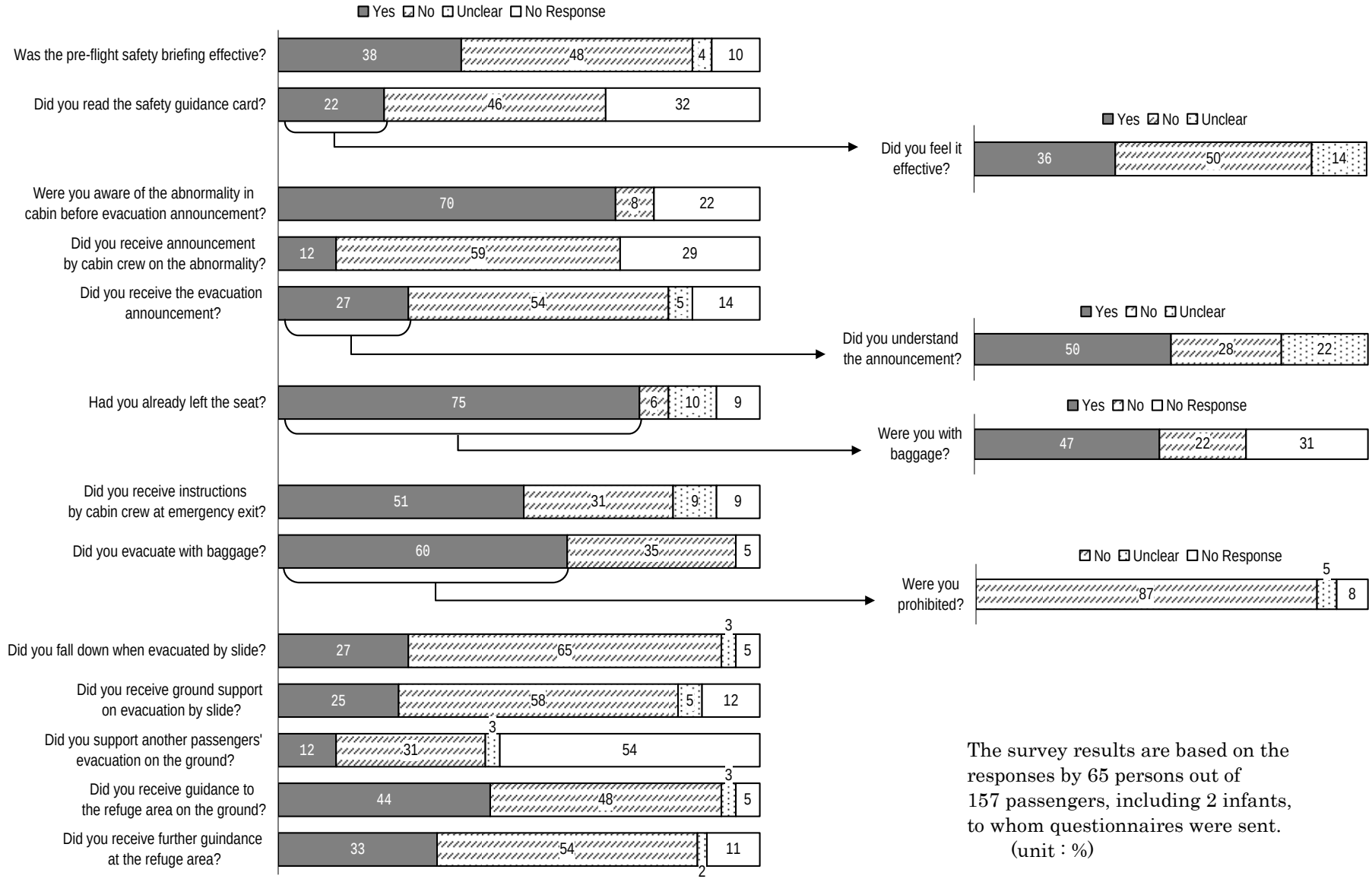
# Figure 13 Message Transfer at the Time of Accident



# Figure 14 Cabin Assignment



# Figure 15　Questionnaire Data from Passengers




The survey results are based on the responses by 65 persons out of 157 passengers, including 2 infants, to whom questionnaires were sent.

(unit : %)

# Photograph 1 Accident Aircraft

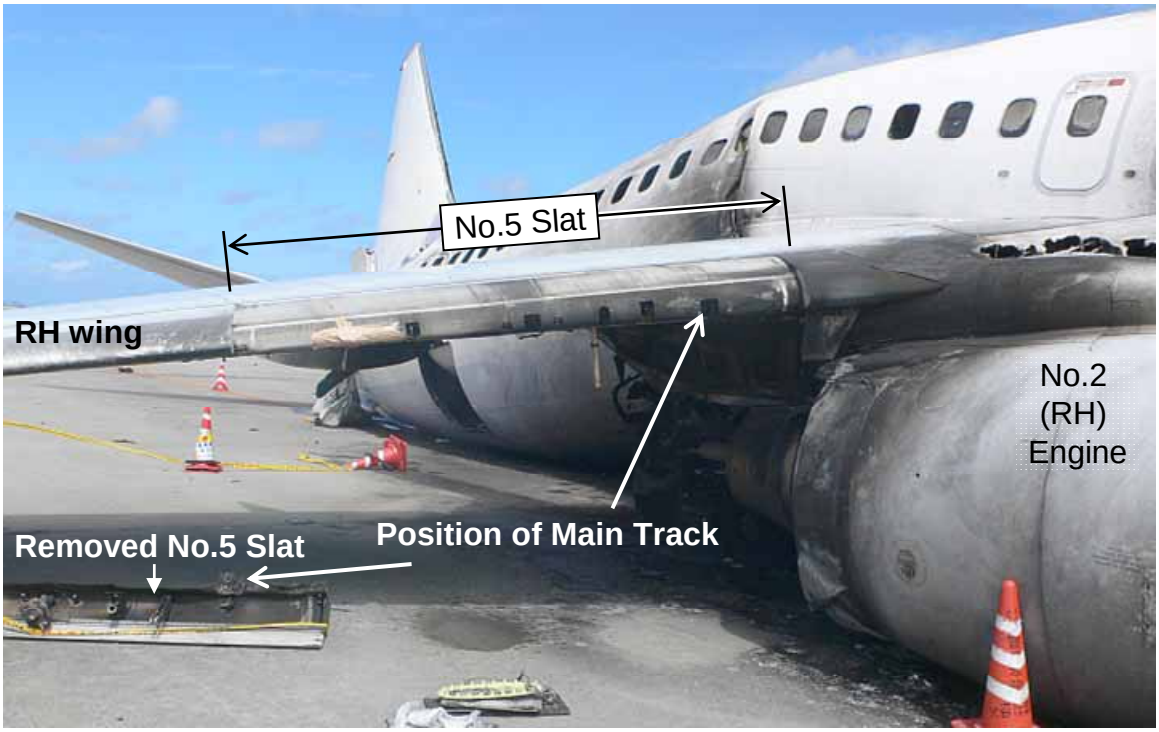
(RH side)

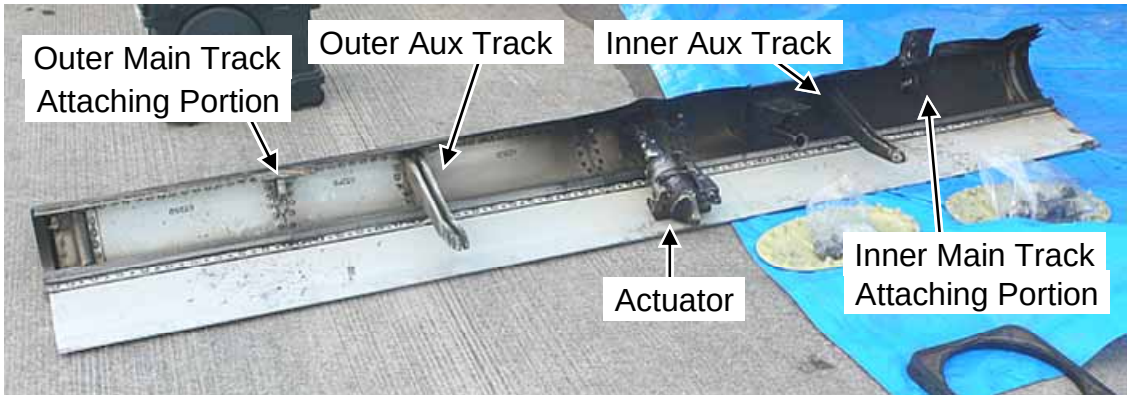
(LH side)


(Front)

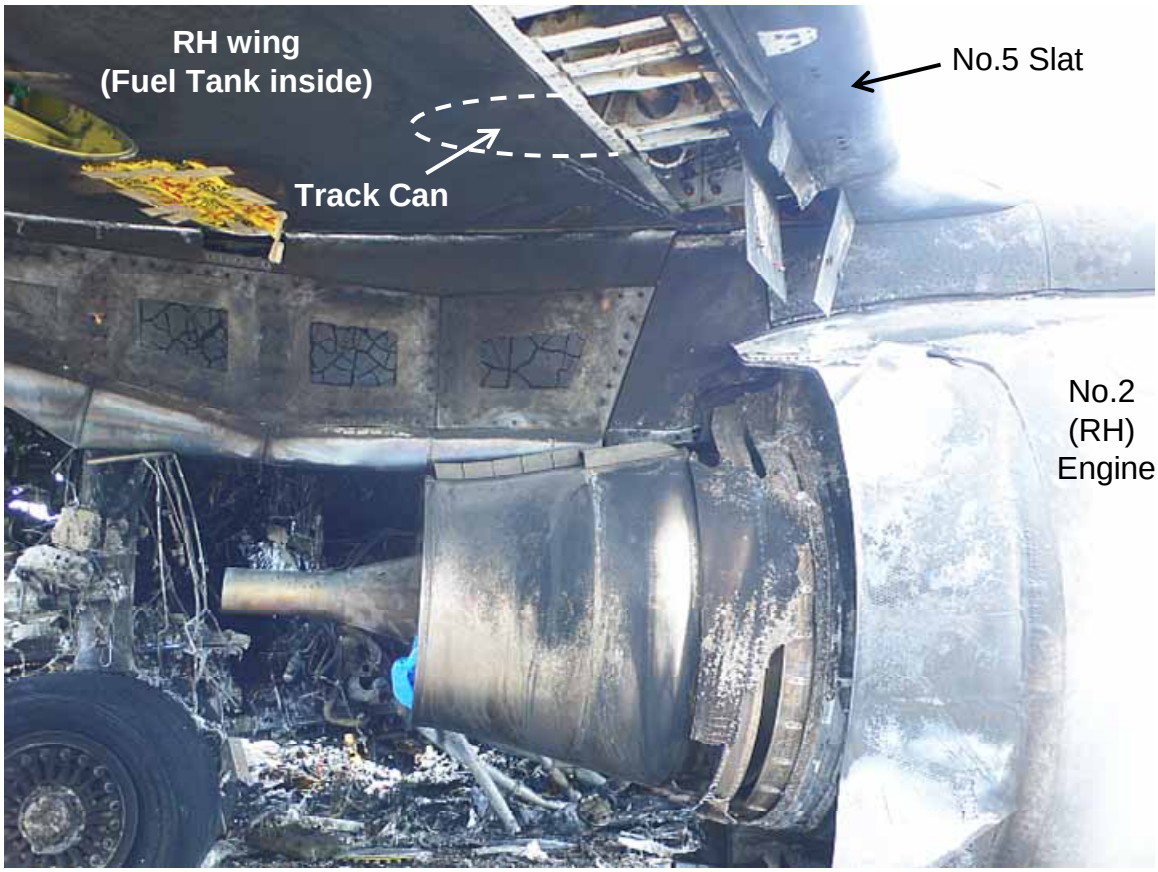
(Rear)

# Photograph 2　No.5 Slat

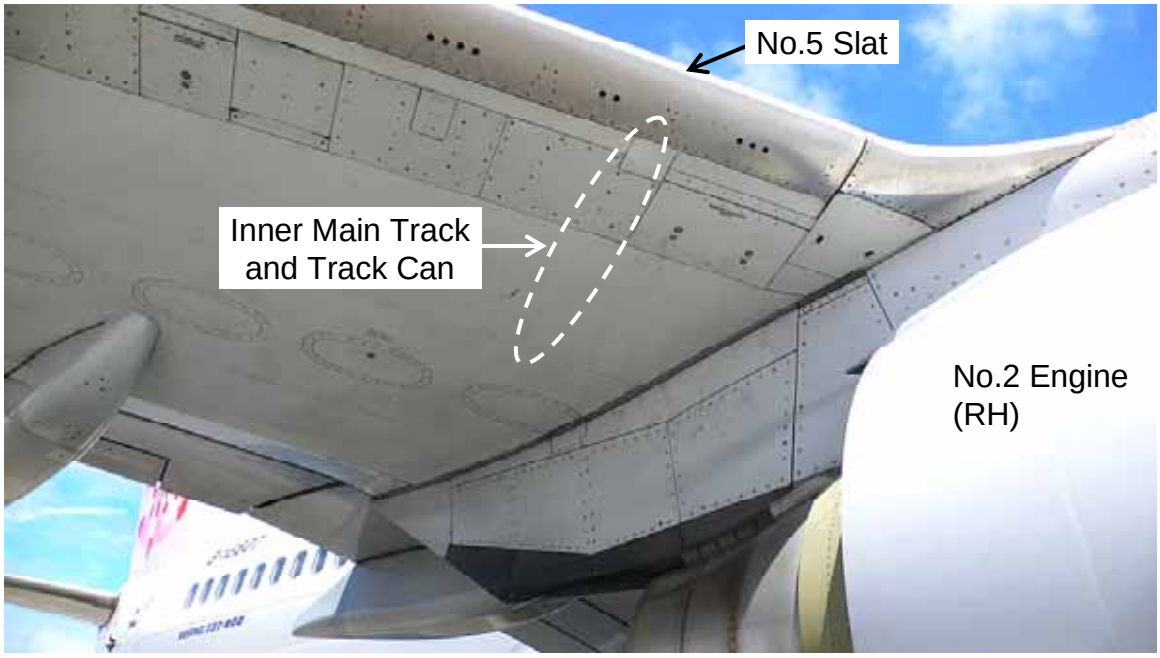


# Photograph 3　No.5 Slat and No.2 Engine

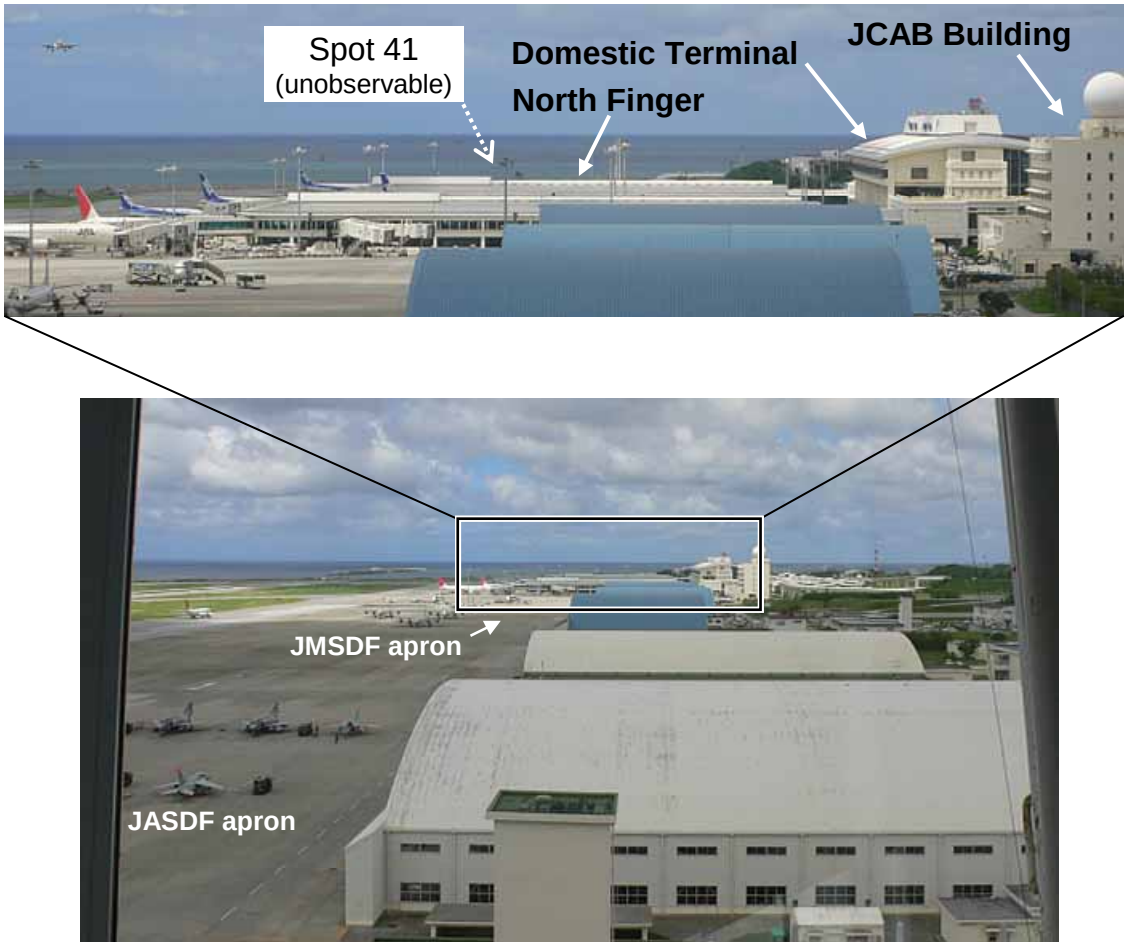



Accident Aircraft

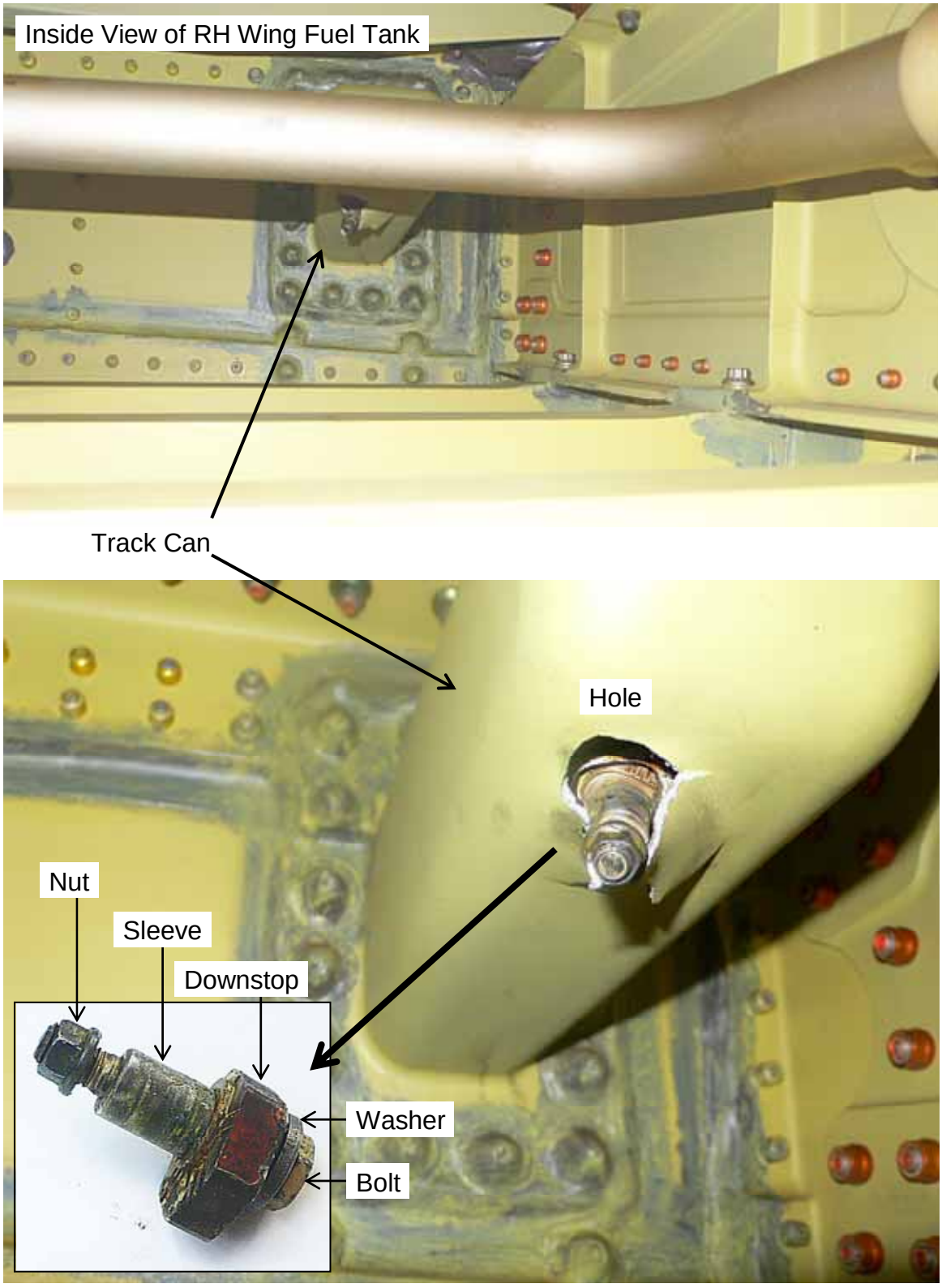



Same Type of the Aircraft

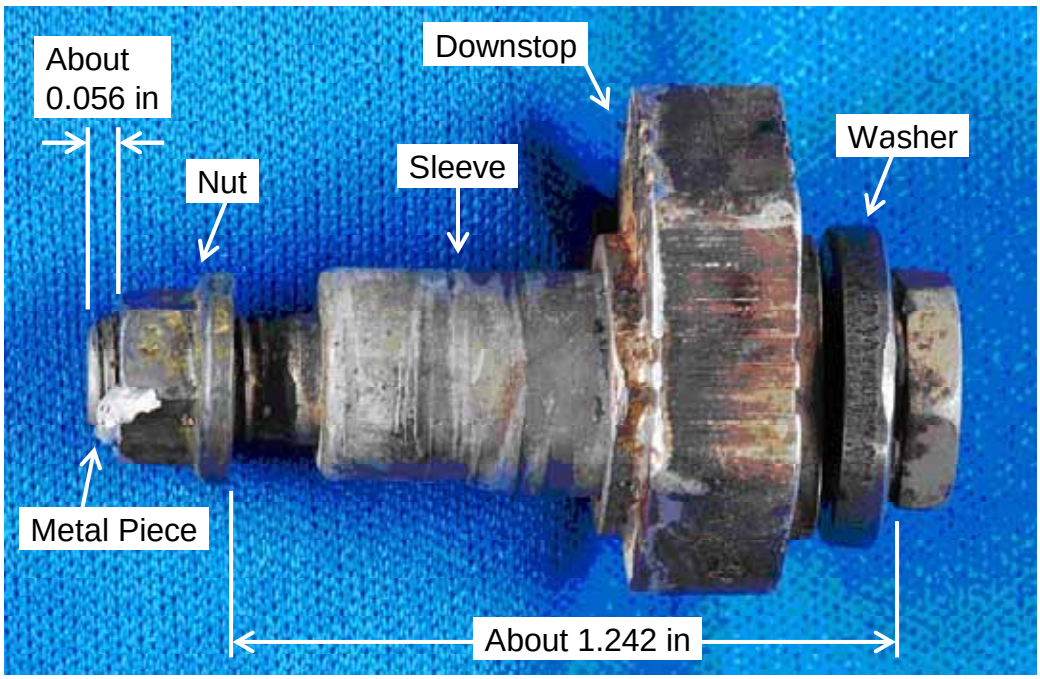
# Photograph 4　North View from Control Tower



## Photograph 5　Damaged Inner Track Can of No.5 Slat



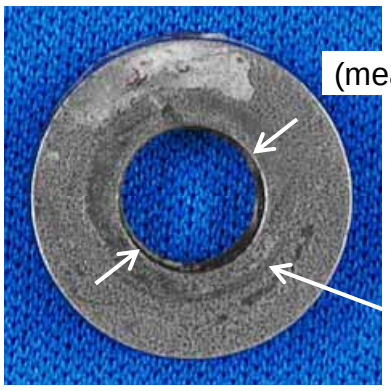
# Photograph 6 Downstop Assembly




These were not separated.

Removed Nut
(measured value 0.408 in)

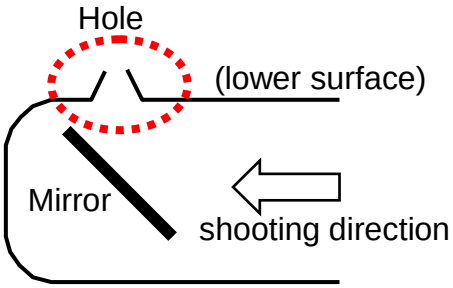
(Nut side)

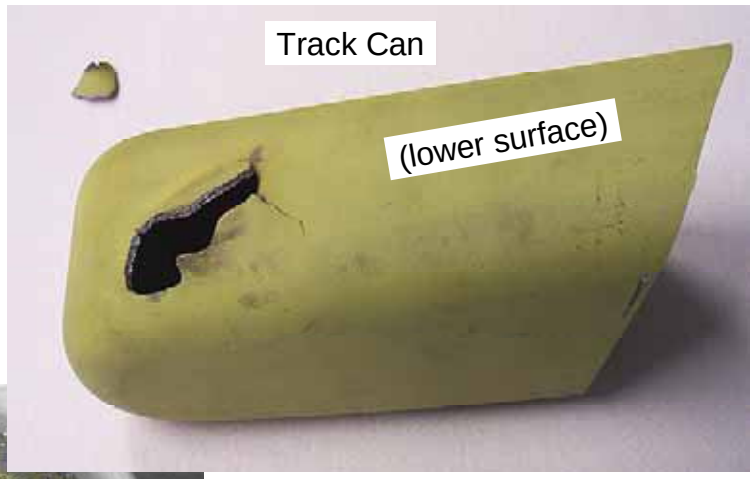


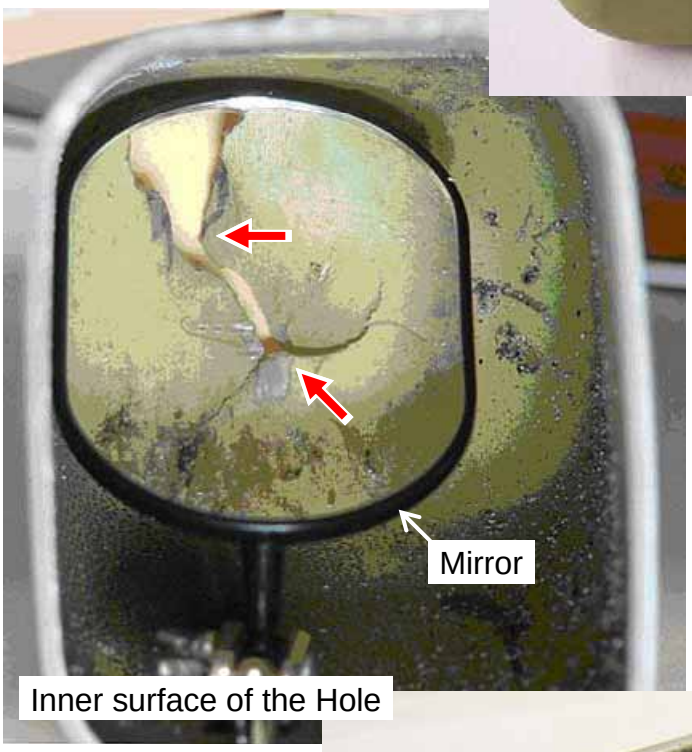

(Downstop side)

Retrieved Washer from the front of Spar
(used)

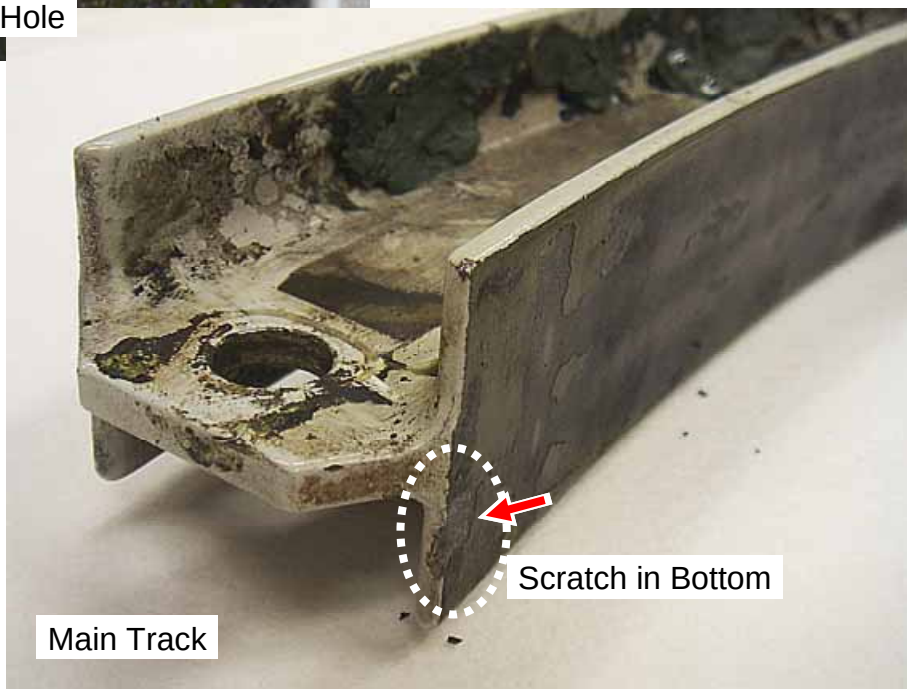
# Photograph 7 Track Can and Main Track




Inner surface of Tip



# Attachment 1　The Situation of the Aircraft after Landing

[　] : Chinese Conversation (ASC translated to English)
underline : Vocalized but not received
??? : unreadable

TWR : Tower Controller
GND : Ground Controller
FDR : DFDR recorded data
CVR1 : CVR channel-1
CVR2 : CVR channel-2 (F/O microphone and headphone)
CVR3 : CVR channel-3 (CAP microphone and headphone)
CAM : CVR channel-4 (Cockpit area microphone)
RDO1 : Radio Communication as Captain
RDO2 : Radio Communication as First Officer
INT : Interphone Communication
MNT : Ground Staff Communication

| JST | Source | Conversations or Situations from CVR, DFDR and ATC | Aircraft Position |
|---|---|---|---|
| 10:26:52 | FDR | The Aircraft(CAL120) landed on Runway 18. | Runway |
| | CVR2 | Autobrakes disarmed. | Runway |
| 10:27:05 | TWR | Dynasty one-two-zero, turn left Echo-six, contact Ground one-two-one decimal eight. | Runway |
| | CAM | Eighty. | Runway |
| | CAM | Sixty. | Runway |
| | CVR3 | One-two-one decimal eight. | Runway |
| 10:27:13 | RDO2 | One-two-one eight and left turn Echo-six, Dynasty one-two-zero. | Runway |
| 10:27:14 | FDR | The aircraft began left turn to enter Taxiway E6 from Runway. | Runway |
| 10:27:17 | TWR | Affirmative. | |
| | CVR2 | Thirty. | |
| 10:27:25 | RDO2 | Morning Ground, Dynasty one-two-zero, vacating runway, Echo-six. | E6 |
| 10:27:29 | GND | Good morning Dynasty one-two-zero, Naha Ground, taxi to spot four-six. | E6 |
| 10:27:33 | RDO2 | Spot four-six, Dynasty one-two-zero. | E6 |
| | CVR3 | After landing item. | E6 |
| 10:27:37 | FDR | Flap handle moved to UP position from 30 | E6 |
| 10:27:49 | FDR | No.5 Slat began retracting. | |
| | CVR2 | Four-six. | |
| | CVR3 | Four-six, uh. | |
| 10:27:58 | RDO2 | Confirm parking bay four-six for one-two-zero? | |
| 10:28:02 | GND | Dynasty one-two-zero, your spot is forty one. | A5 |
| 10:28:05 | FDR | The Aircraft completed left turn from Taxiway E6 to A5. | A5 |
| | CVR1 | [Cabin Announcement by Chinese] | A5 |
| | CVR3 | Forty one. | A5 |
| 10:28:06 | RDO2 | Roger, four-one, Dynasty one-two-zero. | A5 |
| 10:28:09 | FDR | No.5 Slat retracted completely. | A5 |
| | CVR3 | [I heard he said four-six, isn't it?] | A5 |

| JST | Source | Conversations or Situations from CVR, DFDR and ATC | Aircraft Position |
|---|---|---|---|
| | CVR2 | ［I heard four-six, too.］ | A5 |
| 10:28:13 | CVR3 | After landing checklist. | A5 |
| | CVR2 | After landing, weather mode. | A5 |
| | CVR3 | Off. | A5 |
| | CVR2 | Speed brake. | A5 |
| | CVR3 | Down detent. | A5 |
| | CVR2 | Flaps. | A5 |
| | CVR3 | Up lights out. | A5 |
| 10:28:19 | CVR2 | After landing checklist, completed. | A5 |
| | CVR3 | Very good. | A5 |
| | CVR2 | ［Okay, four-one it passed approach end then on the right.］ | A5 |
| | CVR3 | ［We put landing gear down late like today. It is no use putting it down too early.］ | |
| | CVR2 | ［Because we are on track and make level low.］ | |
| | CVR3 | ［Don't we..uh.. I put the landing gear down at about six nautical miles.］ | |
| | CVR2 | ［Yep.］ | |
| | CVR1 | ［Don't we.. at six nautical miles..while completing the procedure.. it will be at about four nautical miles..four nautical miles .］ | |
| | | | |
| | CAM | ［After putting it down ???.］ | |
| | CAM | ［Everything will be okay at four nautical miles, isn't it?］ | |
| | CAM | ［Yep.］ | |
| | CAM | ［Preparing to descend, isn't it?］ | |
| | CVR1 | -- English Announcement initiated -- | |
| | CVR1 | -- Japanese Announcement initiated -- | |
| | CVR3 | ［The aircraft is so wobbly.］ | |
| | CVR2 | ［The aircraft we flew in previous leg is not this one.］ | |
| | CVR3 | ［Oh, not this one.］ | |
| | CVR2 | ［That one was in Taipei now.］ | |
| | CVR2 | ［It was very wobbly too.］ | |
| 10:30:04 | FDR | APU ON | A3-A2 |
| | CVR2 | A-P-U On bus. | |
| | CAM | -- "Click" sound -- | |
| 10:31:16 | FDR | The Aircraft began right turn to Spot 41 from Taxiway A1. | A1 |
| 10:31:36 | FDR | The Aircraft turned to the right and headed to Spot 41. | Apron |
| 10:31:57 | FDR | The Aircraft stopped in Spot 41 | Spot41 |
| 10:32:00 | FDR | DFDR and QAR recording terminated (Both engines cut off) | Spot41 |
| | CVR3 | On bus. | Spot41 |
| | CAM | -- "Click" sound -- (Cut off start lever) | Spot41 |
| | CVR3 | Parking item. | Spot41 |

| JST | Source | Conversations or Situations from CVR, DFDR and ATC | Aircraft Position |
|---|---|---|---|
| | CAM | -- Chime -- (Fasten seatbelt sign turned off) | Spot41 |
| | CVR1 | Cabin attendants, all doors in park. | Spot41 |
| | CVR1 | Park check. | Spot41 |
| 10:32:30 | CVR3 | Checklist. | Spot41 |
| | CAM and CVR3 | Parking (checklist),<br>- Fasten seat belts signs, --- off,<br>- Window probe heat, --- off,<br>- Anti-ice, --- off,<br>- Electric hydraulic pumps, --- off, | Spot41 |
| | CAM and CVR3 | - Cabin control, --- set,<br>- Anti-collision light, --- off,<br>- Start switches, --- off,<br>- Parking brake, --- release, ..ah, ..<br>- Start levers, - Transponder TCAS. | Spot41 |
| | CVR1 | -- Chime of Interphone -- | Spot41 |
| 10:32:40 | CAM | Parking checklist, completed. | Spot41 |
| | CVR1 | | Spot41 |
| | CVR1 | -- BGM playback initiated -- | Spot41 |
| | INT | Ground. | Spot41 |
| 10:33:03 | CVR3 | ［Hey, what is this?］ | Spot41 |
| 10:33:05 | MNT | Cockpit, Ground, number-two engine fire. | Spot41 |
| 10:33:09 | CAM | Okay? | Spot41 |
| 10:33:09 | MNT | Cockpit, Ground, number-two engine fire. | Spot41 |
| 10:33:11 | INT | Number..what? | Spot41 |
| 10:33:13 | MNT | Number-two! Number-two fire! | Spot41 |
| 10:33:17 | INT | Number-two fire! | Spot41 |
| 10:33:19 | CAM | -- Fire warning bell started to sound -- | Spot41 |
| 10:33:20 | CAM | -- "Click" sound -- | Spot41 |
| 10:33:21 | CAM | Engine number? | Spot41 |
| 10:33:25 | INT | Number-two fire, confirmed? | Spot41 |
| 10:33:26 | MNT | Number-two engine fire! Off! | Spot41 |
| 10:33:26 | CAM | -- Warning bell stopped to sound -- | Spot41 |
| 10:33:29 | MNT | Oh! | Spot41 |
| 10:33:30 | CVR2 | Engine number-one, number-one, number-one. Engine number-one. | Spot41 |
| 10:33:33 | INT | Okay, discharged already! | Spot41 |
| 10:33:35 | MNT | Discharge! | Spot41 |
| 10:33:35 | CVR2 | Crew on station. | Spot41 |
| 10:33:36 | MNT | Discharge, ???! | Spot41 |
| 10:33:38 | INT | Okay! | Spot41 |
| 10:33:40 | CVR2 | Attention, crew on station. | Spot41 |
| 10:33:41 | INT | Okay! | Spot41 |
| 10:33:42 | CVR3 | Attention, crew on station. Attention, crew on station! | Spot41 |

| JST | Source | Conversations or Situations from CVR, DFDR and ATC | Aircraft Position |
|---|---|---|---|
| 10:33:44 | CAM | -- Multiple "Click" sound -- | Spot41 |
| 10:33:46 | CVR3 | Attention, crew on station. Attention, crew on station! | Spot41 |
| 10:33:49 | CVR3 | Repeat,..uh.. | Spot41 |
| 10:33:50 | CAM | -- "Knock" sound -- | Spot41 |
| 10:33:52 | CVR3 | Crew..uh..prepare for evacuation. | Spot41 |
| 10:33:55 | MNT | ??? | Spot41 |
| 10:33:59 | CVR3 | Cabin crew, all door in flight. Cabin crew, all door in flight, door in flight. | Spot41 |
| 10:34:00 | MNT | Number-two, discharge! | Spot41 |
| 10:34:04 | GND | Dynasty one-two-one, Dynasty one-two-one, this is Naha Ground, how do you read? | Spot41 |
| 10:34:10 | RDO2 | Naha Ground, Dynasty one-two-zero. | Spot41 |
| 10:34:12 | GND | Dynasty one-two-zero, Tower observation, you have fire on cargo .. around cargo truck, so we are now calling to fire truck, remain...stand by for remain...ah, ..stand by. | Spot41 |
| 10:34:25 | RDO2 | Okay, please..uh..please uh..ground fire..we have wheel fire, please uh..have fire assistance, please. | Spot41 |
| 10:34:30 | GND | Dynasty one-two-one, understand. We are requesting fire cars. So, stand by please. | Spot41 |
| 10:34:36 | CVR3 | Okay! | Spot41 |
| 10:34:39 | CVR2 | Okay. | Spot41 |
| 10:34:40 | CVR2 | Parking brake, Speed brake, Flap lever, Attention crew on station, ..open, Start levers. | Spot41 |
| 10:34:44 | CVR3 | Uh.. Cutoff! | Spot41 |
| 10:34:45 | CVR2 | Engine fire warning switches.. Override, pull and rotate. | Spot41 |
| | CVR3 | Rotate! | Spot41 |
| 10:34:49 | CVR2 | APU fire warning switches, override, pull and rotate. | Spot41 |
| | CVR3 | Rotate! | Spot41 |
| 10:34:52 | CVR2 | Evacuation required, now required. | Spot41 |
| 10:34:53 | CVR | -- Big noise in Channel-1, 2 and 3 of CVR -- | Spot41 |
| 10:34:54 | CVR | -- End of CVR recording -- | Spot41 |
| 10:34:55 | CVR | -- CVR stopped working -- | Spot41 |

# Attachment 2　ATC Communication Records

| JST | TWR | | GND | |
|---|---|---|---|---|
| 10:25:08 | TWR | Dynasty one-two-zero, runway one-eight, cleared to land, wind one-five-zero at eight. | | |
| 10:25:12 | CAL120 | Runway one-eight, Dynasty one-two-zero. | | |
| 10:25:17 | TWR | Juliett-Alfa eight-seven..eight-zero, do you have traffic in sight? Seven-three-eight.. now.. three miles on final. Report traffic in sight. | | |
| | JA8780 | Uh, traffic in sight, eight-seven-eight-zero. | | |
| | TWR | Follow the traffic seven-three-eight. Report right base, runway one-eight, wind one-five-zero at eight. Succeeding traffic De-Haviland-eight, one..one-miles on final. You are number-two. | | |
| 10:25:37 | JA8780 | Roger, follow again. Report base, eight-seven-eight-zero. | | |
| 10:26:14 | CAL120 | Wind check, please. | | |
| 10:26:15 | TWR | One-five-zero at eight. | | |
| 10:26:17 | CAL120 | Thank you. | | |
| 10:26:52 | | < CAL120 landed on Runway 18. > | | |
| 10:27:05 | TWR | Dynasty one-two-zero, turn left Echo-six, contact Ground one-two-one decimal eight. | | |
| 10:27:13 | CAL120 | One-two-one eight, left turn Echo-six, Dynasty one-two-zero. | | |
| 10:27:17 | TWR | Affirmative. | | |
| 10:27:25 | | | CAL120 | Morning Ground, Dynasty one-two-zero, vacating runway, Echo-six. |
| 10:27:27 | TWR | Juliett-Alfa eight-seven-eight-zero, runway one-eight, cleared to land, wind one-six-zero at one-zero. | | |
| 10:27:29 | | | GND | Good morning Dynasty one-two-zero, Naha Ground, taxi to spot four-six. |
| 10:27:32 | JA8780 | Roger, runway one-eight, cleared to land, eight-seven-eight-zero. | | |
| 10:27:33 | | | CAL120 | Spot four-six, Dynasty one-two-zero. |
| 10:27:35 | TWR | Juliett-Alfa eight-seven-eight-zero, after landing, expedite taxi off the runway. You're succeeding inbound ??? five and a half miles on final, under G-C-A. | | |
| 10:27:45 | JA8780 | Roger, after landing, expedite taxi off the runway, eight-seven-eight-zero. | | |
| 10:27:48 | TWR | Thank you. | | |

| JST | TWR | | GND | |
|---|---|---|---|---|
| 10:27:58 | | | CAL120 | Confirm parking bay four-six for one-two-zero? |
| 10:28:02 | | | GND | Dynasty one-two-zero, your spot is forty one. |
| 10:28:06 | | | CAL120 | Roger, four-one, Dynasty one-two-zero. |
| 10:28:41 | | | JA5266 | Naha Ground, Juliett-Alfa five-two-six-six, (interference for 0.8 seconds) mission Kiro, spot one-zero-seven. |
| | | | GND | Juliett-Alfa five-two-six-six, Naha Ground, go ahead. |
| | | | JA5266 | Five-two-six-six, request taxi, runway one-eight intersection departure, Whiskey-two. |
| | | | GND | Juliett-Alfa five-two-six-six, roger, taxi to runway one-eight via Whiskey-two. |
| | | | JA5266 | Five-two-six-six, roger, Whiskey-two, runway one-eight, after airborne left turn Yonabaru nine-hundred. |
| 10:29:05 | | | GND | Yonabaru niner-hundred, copied. |
| 10:29:22 | TWR | Juliett-Alfa eight-seven-eight-zero, turn right Whiskey-four, contact Ground one-two-one decimal eight. | | |
| 10:29:27 | JA8780 | Roger, right Whiskey-four, contact Ground one-two-one-eight, eight-seven-eight-zero. | | |
| 10:29:36 | | | GND | Juliett-Alfa five-two-six-six, taxi to Whiskey-two, runway one-eight. Contact Tower one-one-eight decimal one. |
| 10:29:42 | JTA602 | Naha Tower, Jay-Ocean six-zero-two, leaving one-thousand six-hundred. Cleared for visual approach, runway one-eight, proceed final. Spot.. spot two-seven. | JA5266 | Five-two-six-six, roger, Whiskey-two. Contact Tower. Good day. |
| 10:29:45 | | | GND | Good day. |
| 10:29:51 | TWR | Jay-Ocean six-zero-two, Naha Tower, spot two-seven is copied. Runway one-eight, continue approach, wind one-seven-zero at one-zero. | | |
| 10:29:55 | | | JA8780 | Naha Ground, Juliett-Alfa eight-seven-eight-zero, Whiskey-four, request taxi one-zero-five. |
| 10:29:57 | JTA602 | Runway one-eight, continue approach, Jay-Ocean six-zero-two. | | |
| 10:30:01 | JA5266 | Naha Tower, Juliett-Alfa five-two-six-six, good morning,. Whiskey-two, ready. | GND | Juliett-Alfa eight-seven-eight-zero, Naha Ground, taxi to spot one-zero-five. |
| 10:30:04 | | | JA8780 | Naha Ground, spot one-zero-five, eight-seven-eight-zero. |

| JST | TWR | | GND | |
|---|---|---|---|---|
| 10:30:05 | TWR | Good morning, Juliett-Alfa five-two-six-six, Naha Tower, hold short of runway one-eight. | | |
| 10:30:09 | JA5266 | Juliett-Alfa five-two-six-six, roger, hold short of runway one-eight. | | |
| 10:30:43 | RAC802 | Naha Tower, Ryukyu-Air eight-zero-two, P-A-R full stop, spot one-one. | | |
| | TWR | Ryukyu-Air eight-zero-two, Naha Tower, turn left Echo-three, contact Ground one-two-one decimal eight. | | |
| | RAC802 | Turn left Echo-three, contact Ground one-two-one eight, Ryukyu-Air eight-zero-two, good day. | | |
| 10:30:55 | TWR | Good day. | | |
| 10:30:58 | | | RAC802 | Naha Ground, Ryukyu-Air eight-zero-two, pick up Echo-three, spot one-one. |
| 10:31:03 | | | GND | Ryukyu eight-zero-two, Naha Ground, taxi to spot one-one. |
| 10:31:06 | | | RAC802 | Taxi to spot one-one, Ryukyu-Air eight-zero-two. |
| 10:30:56 | TWR | Juliett-Alfa five-two-six-six, runway one-eight, line up and wait. | | |
| | JA5266 | Juliett-Alfa five-two-six-six, runway one-eight, line up and wait. | | |
| 10:31:23 | TWR | Juliett-Alfa five-two-six-six, left turn is approved, wind one-seven-zero at one-zero, runway one-eight, cleared for take-off. | | |
| | JA5266 | Juliett-Alfa five-two-six-six, runway one-eight, cleared for take-off. | | |
| 10:31:57 | | | | < CAL120 stopped in Spot 41. > |
| 10:32:35 | TWR | Jay-Ocean six-zero-two, runway one-eight, cleared to land. Wind one-seven-zero at one-two.. one-zero. | | |
| | JTA602 | Jay-Ocean six-zero-two, cleared to land, runway one-eight. | | |
| 10:33:02 | JA5266 | Naha Tower, Juliett-Alfa five-two-six-six, request to leave your frequency to contact Okinawa Approach for climb. | | |
| | TWR | Juliett-Alfa five-two-six-six, frequency change is approved. | | |
| | JA5266 | Thank you, good day. | | |
| | TWR | Good day. | | |
| 10:34:03 | TWR | Jay-Ocean six-zero-two, I say again, runway one-eight, cleared to land. wind one-seven-zero at niner. | | |

| JST | TWR | | GND | |
|---|---|---|---|---|
| 10:34:04 | | | GND | Dynasty one-two-one, Dynasty one-two-one, this is Naha Ground, how do you read? |
| 10:34:08 | JTA602 | Jay-Ocean six-zero-two, cleared to land, runway one-eight. | | |
| 10:34:10 | | | CAL120 | Naha Ground, Dynasty one-two-zero. |
| 10:34:12 | | | GND | Dynasty one-two-zero, Tower observation, you have fire on cargo .. around cargo truck, so we are now calling to fire truck, remain...stand by for remain...ah, ..stand by. |
| 10:34:25 | | | CAL120 | OK, please..uh..please uh..ground fire..we have wheel fire, please uh..have fire assistance, please. |
| 10:34:30 | | | GND | Dynasty one-two-one, understand. We are requesting fire cars. So, stand by please. |
| 10:35:26 | JTA602 | Naha Tower, Jay-Ocean six-zero-two, request Echo-four. | | |
| 10:35:29 | TWR | Jay-Ocean six-zero-two, Naha Tower, turn left Echo-four. Contact Ground one-two-one decimal eight. | | |
| 10:35:34 | JTA602 | Echo-four, one-two-one-eight, Jay-Ocean six-zero-two. | | |
| 10:35:46 | | | JTA602 | Naha Ground, Jay-Ocean six-zero-two, Echo-four. |
| 10:35:49 | | | GND | Jay-Ocean six-zero-two, Naha Ground, taxi to spot two-seven. |
| 10:35:53 | | | JTA602 | Taxi to spot two-seven, Jay-Ocean six-zero-two. |
| | | | | |
| 10:37:38 | | | GND | Jay-Ocean six-zero-two, Ground. |
| 10:37:40 | | | JTA602 | Naha Ground, Jay-Ocean six-zero-two, go ahead. |
| 10:37:42 | | | GND | Jay-Ocean six-zero-two, break. [ Ah.. the aircraft on spot41 is catching fire now. Hold short of the No.4 stop line because fire engines will move. ] |
| 10:37:50 | | | JTA602 | Roger, [ ah.. hold at No.4 stop line. ] Jay-Ocean six-zero-two. |
| 10:38:19 | JAL 2081 | Tower, Japan-Air two-zero-eight-one, now climbing to one-thousand. | | |
| 10:38:25 | TWR | Japan-Air two-zero-eight-one,.. roger. Remain this frequency, follow missed approach procedure. | | |

| JST | TWR | | GND | |
|---|---|---|---|---|
| 10:38:31 | JAL 2081 | Japan-Air two-zero-eight-one, follow missed approach procedures. | | |
| 10:38:39 | | | GND | Jay-Ocean six-zero-two, thank you ???. Continue taxi to spot two-seven. |
| 10:38:44 | | | JTA602 | Continue taxi to spot two-seven, Jay-Ocean six-zero-two. |
| 10:38:52 | TWR | Japan-Air two-zero-eight-one, fireworks on the..on the spot, so follow missed approach procedure. Contact Okinawa Approach, one-one-niner..correction, one-one-niner decimal one. | | |
| 10:39:03 | JAL 2081 | Japan-Air two-zero-eight-one, one-one-niner-one, good day. | | |
| 10:39:07 | TWR | Good day. | | |
| | | | | |

Underline : Vocalized but not received

[ ] : Japanese words

- TWR : Naha Tower
- GND : Naha Ground
- CAL120 : Dynasty one-two-zero
- JA8780 : Juliett-Alfa eight-seven-eight-zero
- JA5266 : Juliett-Alfa five-two-six-six
- JTA602 : Jay-Ocean six-zero-two
- RAC802 : Ryukyu-Air eight-zero-two
- JAL2081: Japan-Air two-zero-eight-one

# Attachment 3　Crash Phone Transcript

| JST (hh:mm:ss) | Transmitter | Contents |
|---|---|---|
| 10:33:58 | BOPS | Yes, Base Operation. |
| 10:33:59 | TWR | OK. Ah…, from Tower. Information ??? |
| 10:34:02 | ATS | Yes, ???... |
| 10:34:03 | TWR | Let me see, ah... "Dynasty" that parked in the spot no.41 just now is catching fire on its engine. |
| 10:34:08 | ASF | Fire on the engine… |
| 10:34:09 | TWR | Yes. |
| 10:34:10 | ASF | Understand, spot no.41? |
| 10:34:11 | TWR | That is correct. |
| 10:34:12 | (Unknown) | Yes. |
| 10:34:12 | ASF | please? |
| 10:34:15 | TWR | Ah, the right engine, it means no.2 engine. Burning. Spot no.41, Dynasty, Boeing 737. |
| 10:34:22 | ASF | Seven-Three-Seven. …..[Shout an order!! (for mobilization).] |
| 10:34:23 | (Unknown) | (Ringtone of cellular phone) |
| 10:34:25 | TWR | Ah.., how about Air Safety Foundation? Can you hear me? |
| 10:34:27 | ASF | (Announcement by speaker) [??? Mobilize. Boeing 737 in the spot no.41, ah.., number two, catching fire on the number |
| 10:34:43 | (Unknown) | (Ringtone of fixed-line phone) |
| 10:34:53 | BOPS | Hello? |
| | TWR | Hello? |
| 10:34:54 | BOPS | This is Base Operation, is that all? |
| 10:34:56 | TWR | Yes, that's correct. |
| | BOPS | What's the call sign, what's the number of Dynasty? |
| 10:34:58 | TWR | Dynasty One-Two…., One-Two-One! |
| 10:35:01 | BOPS | One-Two-One, was it after landing? |
| 10:35:02 | TWR | It was after landing, after parking in the spot. |
| 10:35:04 | BOPS | Understood. |
| 10:35:05 | TWR | All right. |
| 10:35:06 | BOPS | All right. |
| 10:35:07 | TWR | Ah, Hello? Call sign is Dynasty One-Two-Zero. It was Dynasty One-Two-Zero. |
| 10:35:15 | | (End of crash phone call) |

[Abbreviations]
BOPS: Base Operation (Japan Air Self-Defense Force)
TWR: Air Traffic Controller of Airport Traffic Control Tower
ATS: Air Traffic Services Flight Information Officer
ASF: Air Safety Foundation (Airport Fire Station)
??? : Unreadable
[ ] : Mobilization order of ASF monitored by crash phone

# Attachment 4　MCA Radio Transcrip

| JST (hh:mm:ss) | Transmitter | Contents |
|---|---|---|
| 10:35:46 | (Unknown) | (Noise during 4.1 seconds. There was a faint audio from behind. ) |
| 10:35:55 | ASF 2 | ??? (Noise). This is “Hoan Bosai two”, over. |
| 10:35:59 | (Unknown) | (Noise during 3.4 seconds.) |
| 10:36:05 | (Unknown) | (Noise during 2.3 seconds and another noise during 3.3 seconds.) |
| 10:36:13 | (Unknown) | ??? (Audio like interference.) |
| 10:36:15 | TWR | ??? “ANA No. 2 tug”, “ANA No. 2 tug”, this is “Tower”. |
| 10:36:18 | (Unknown) | ??? (Noise during 4.5 seconds.) |
| 10:36:24 | ASF 2 | ??? (Noise) This is “Hoan Bosai two”, over. ??? (Noise) |
| 10:36:31 | ANA 1 | This is “ANA No. 1 tug”. (Noise) |
| 10:36:41 | (Unknown) | (Noise during 4 seconds.) |
| 10:36:53 | TWR | “ANA No. 1 tug”, “ANA No. 1 tug”, this is “Tower”, how do you read? |
| 10:36:58 | ANA 1 | Yes, this is “ANA No. 1 tug”, go ahead. |
| 10:37:01 | (Unknown) | Hello??? (Audio like interference.) |
| 10:37:01 | TWR | “ANA No. 1 tug”, ah.., now… it seems … that Boeing 737 in spot 41 is catching fire. Now, fire engines are on the way to the scene. Can you continue toeing to spot 36? |
| 10:37:17 | ANA 1 | Ah…, yah, this is “ANA No. 1 tug”, ??? No.36 ???, holding short of spot 44. |
| 10:37:32 | (Unknown) | ??? (Audio like interference.) |
| 10:37:34 | TWR | “ANA No. 1 tug”, roger. Hold present position. |
| 10:37:41 | ANA 1 | Yes, ??? present position, “ANA No. 1 tug”, holding at the back of spot 44. |
| 10:37:51 | (Unknown) | ??? (Audio like interference.) |
| 10:37:52 | TWR | “ANA No. 1 tug”, roger. Then, are you holding on the north of Echo zero clearing line? |
| 10:37:59 | ANA 1 | Yes, north of Echo zero clearing line, over. |
| 10:38:04 | TWR | “ANA No. 1 tug”, roger. Then, hold present position for a while, until the fire getting into under control. |
| 10:38:14 | ANA 1 | ??? Will do. |
| 10:38:17 | TWR | Fire engine, fire engine, this is Tower, how do you read? |
| 10:38:53 | TWR | “JTA No. 1”, “JTA No. 1 tug”, this is “Tower”. |
| 10:39:48 | (Unknown) | ??? (Audio like interference.) |
| 10:39:50 | TWR | Fire engine, fire engine, this is “Tower”, how do you read? |
| 10:40:12 | TWR | “JTA No. 1 tug”, “JTA No. 1 tug”, how do you read? |
| | | (The rest is omitted.) |

[Abbreviations]
ASF 2: Hoan Bosai two (Call sign of the airport fire engine No.2)
ANA 1: All Nippon Airways No.1 tug
??? : Unreadable

# Attachment 5 Video Picture Analysis

| JST (hh:mm:ss) | Contents of "Video 1" and "Video 2" |
|---|---|
| 10:34:23 | (Start of "Video 1") |
| 10:34:24 | The Slide 3R was already deployed and the first person started |
| 10:34:25 | The Slide 1L was deployed. |
| 10:34:27 | The 1R door started to be opened. |
| 10:34:29 | The Slide 1R started to be deployed. |
| 10:34:32 | The Slide 1R deployment completed. Fifth person was on the way of evacuation by the Slide 3R. |
| 10:34:36 | The first person evacuated by the Slide 1R. The 3L Slide was deployed. |
| 10:35:21 | The right cockpit window was opened. (Start of "Video 2") |
| 10:35:26 | The airport staff got close to the right engine with discharging fire-extinguishing agent by the extinguisher. |
| 10:35:42 | The last person evacuating by the Slide 1R landed with ground support. |
| 10:35:45 | The airport staff fighting a fire on the right engine finished discharging fire-extinguishing agent. |
| 10:35:54 | The No.3 ramp bus started to move. |
| 10:35:58 | The last person evacuating by the Slide 3R landed. |
| 10:36:00 | The last person evacuating by the Slide 3L landed and started to run. |
| 10:36:02 | The First Officer started to evacuate via the right cockpit window. |
| 10:36:06 | The last person evacuating by the Slide 1L landed. |
| 10:36:11 | Explosion occurred at around under the right wing. (First time) |
| 10:36:12 | The First Officer evacuating via the right cockpit window fell to the ground. |
| 10:36:14 | The Captain started to evacuate via the right cockpit window. |
| 10:36:20 | The Captain evacuating via the right cockpit window landed. |
| 10:36:54 | Explosion occurred at around under the fuselage. (Second time) |
| 10:37:11 | Explosion occurred at around under the fuselage. (Third time) |
| 10:37:15 | The No.2 ramp bus started to move. |
| 10:37:20 | The No.1 ramp bus started to move. |
| 10:38:10 | An aircraft going around came into view beyond the smoke. ("Video 1") |
| 10:38:13 | Explosion occurred at around under the fuselage. (Fourth time) |
| 10:38:17 | An aircraft going around came into view beyond the smoke. ("Video 2") |
| 10:38:22 | The airport fire engine No.6 came into view on the extreme left of the video image. |
| 10:38:25 | The airport fire engine No.6 started to discharge fire-extinguishing foam from the right back of the Aircraft. |
| 10:38:26 | The fuselage bent at around the center portion, and its tail portion |
| 10:38:31 | The airport fire engine No.5 came into view next to the airport fire engine |
| 10:38:36 | The airport fire engine No.2 came into view on the extreme left of the video image and moved to the front of the Aircraft. |
| 10:38:46 | The fire-extinguishing foam of the airport fire engine No.6 became to reach the Aircraft. |
| 10:38:58 | The airport fire engine No.2 started to discharge the fire-extinguishing foam from the right front of the Aircraft. |
| 10:39:01 | The fire-extinguishing foam of the airport fire engine No.2 became to reach the Aircraft. |
| 10:39:13 | (End of "Video 2") |

| JST (hh:mm:ss) | Contents of "Video 1" and "Video 2" |
|---|---|
| 10:39:42 | The airport fire engine No.2 stopped discharging fire-extinguishing foam temporarily. |
| 10:39:48 | The right wing tilted down and its tip slowly came in contact with the ground surface. |
| 10:40:12 | (End of "Video 1") |

[Note] The time of "Video 1"(recording time: about five minutes and forty-nine seconds) and " Video 2 " (recording time: about three minutes and fifty-two seconds) was synchronized by comparing the movements of the going aircraft in the video screens and the air traffic control radar data of the going aircraft. And in addition, the times of both video screens were synchronized by comparing the times of the first burst. But an error of two seconds or so is contained in the time on the table.

# Attachment 6 Emergency Evacuation History

| JST (hh:mm:ss) | | Contents |
|---|---|---|
| 10:33:05 | C | An assistant maintenance engineer informed the cockpit of a fire breaking on the no.2 engine over the interphone. |
| 10:33:35 | C | The First Officer notified the Captain of the message as "Crew on station". |
| 10:33:40 | C | The First Officer notified the Captain of the message as "Attention, crew on station". |
| 10:33:42 | C | The Captain executed the passenger announcement as "Attention, crew on station. Attention, crew on station!" |
| 10:33:46 | C | The Captain executed the passenger announcement again as "Attention, crew on station. Attention, crew on station!" |
| 10:33:49 | C | The Captain began the passenger announcement as "Repeat,…uh..", but checked himself. |
| 10:33:52 | C | The Captain executed the passenger announcement as "Crew…uh… prepare for evacuation." |
| 10:33:59 | C | A cabin crew announced as "Cabin crew, all door in flight. Cabin crew, all door in flight, door in flight." |
| 10:34:24 | V | The first passenger started evacuation by the Slide 3R. |
| 10:34:25 | V | The Slide 1L was deployed. |
| 10:34:32 | V | The Slide 1R was deployed. |
| 10:34:36 | V | The Slide 3L was deployed. Passengers started evacuation by the |
| 10:34:40 | C | The First Officer started to read out the "EVACUATION" check list. |
| 10:34:52 | C | The First Officer read out the check list as "[Evacuation] – |
| 10:34:54 | C | (End of CVR recording) |
| 10:35:42 | V | The last person evacuating by the Slide 1R landed with ground support. |
| 10:35:58 | V | The last person evacuating by the Slide 3R landed. |
| 10:36:00 | V | The last person evacuating by the Slide 3L landed. |
| 10:36:06 | V | The last person evacuating by the Slide 1L landed. |
| 10:36:11 | V | Burst occurred at around under the right wing. (First time) |
| 10:36:12 | V | The First Officer evacuating via the right cockpit window fell to the ground. |
| 10:36:20 | V | The Captain evacuating via the right cockpit window landed and all persons on board completed evacuation. |

C: Contents based on the CVR recording
V: Contents based on the Video recording

*** The time required for the completion of all persons' evacuation from the captain's instruction on preparation of the emergency evacuation: Approximately two minutes and twenty-eight seconds

*** The time required for the completion of all persons' evacuation from the start of the first passenger's evacuation: Approximately one minute and fifty-six seconds

*** The time required for the evacuation by each door

3R: Approximately one minute and thirty-four seconds
1L: Approximately one minute and forty-one seconds
1R: Approximately one minute and ten seconds
3L: Approximately one minute and twenty-four seconds

[Note 1] “3R” item says the time interval between the start of the first person’s evacuation and the last person’s landing.

[Note 2] Each item except “3R” item says the time interval between the completion of the Slide deployment and the last person’s landing.