

AI2005-3

AIRCRAFT SERIOUS INCIDENT INVESTIGATION REPORT

BETWEEN
JAPAN AIRLINES (present-JAPAN AIRLINES INTERNATIONAL)
FLIGHT 933
BOEING 747-100B SUD, JA8176
AND
US PACIFIC AIR FORCES, 5th AIR FORCE, 18 WG
McDONNELL DOUGLAS F-15C
(ONE OF A TWO-SHIP FORMATION)
A NEAR COLLISION OVER THE SEA APPROX. 12NM NORTH OF
NAHA AIRPORT, OKINAWA, JAPAN
NOVEMBER 5, 2003

May 27, 2005

Aircraft and Railway Accidents Investigation Commission
Ministry of Land, Infrastructure and Transport

The investigation for this report was conducted by Aircraft and Railway Accidents Investigation Commission about the aircraft serious incident of between Japan Airlines (present-Japan Airlines International) flight 933, Boeing 747-100B SUD, JA8176 and US Pacific Air Forces, 5th Air Force, 18 WG, McDonnell Douglas F15-C (One Of A Two-Ship Formation), in accordance with Aircraft and Railway Accident Investigation Commission Establishment Law and Annex 13 to the Convention of International Civil Aviation for the purpose of determining cause of the aircraft serious incident and contributing to the prevention of incidents and not for the purpose of blaming responsibility of the incident.

This English version report has been published and translated by Aircraft and Railway Accident Investigation Commission to make its reading easier for those who are not familiar with Japanese as well as English speaking people. Although efforts are made to translate as accurate as possible, only the Japanese version is authentic. If there is difference in meaning of the texts between the Japanese version and the English version, texts in the Japanese version are correct.

Junzo Sato,
Chairman,
Aircraft and Railway Accidents Investigation Commission

**AIRCRAFT SERIOUS INCIDENT INVESTIGATION REPORT
BETWEEN
NIPPON AIRLINES (present-JAPAN AIRLINES INTERNATIONAL)
FLIGHT 933
BOEING 747-100B SUD, JA8176
AND
US PACIFIC FORCES, 5TH AIR FORCE, 18 WG
McDONNELL DOUGLAS F-15C
(ONE OF A TWO-SHIP FORMATION)
A NEAR COLLISION OVER THE SEA APPROX. 12 NM NORTH OF NAHA
AIRPORT, OKINAWA, JAPAN
AT ABOUT 10:44 JST, NOVEMBER 5, 2003**

April 27, 2005

**Decision by the Aircraft and Railway Accidents Investigation
Commission (Air Sub-committee Meeting)**

Chairman	Junzo Sato
Member	Yukio Kusuki
Member	Susumu Kato
Member	Sumio Matsuura
Member	Yukiko Kakimoto
Member	Akiko Matsuo

1 PROCESS AND PROGRESS OF THE SERIOUS INCIDENT INVESTIGATION

1.1 SUMMARY OF THE SERIOUS INCIDENT

On November 7, 2003, the captain of Japan Airlines flight JAL933, a Boeing 747-100B SUD, registration JA8176, submitted a Near Collision Report to the Minister of the Land, Infrastructure and Transport under the provisions of Civil Aeronautics Law Article 76-2 and Civil Aeronautics Regulations Article 166-5. This matter was therefore treated as a serious incident.

On Wednesday November 5, 2003, the Boeing 747, operated as a scheduled passenger flight JAL933 under Instrument Flight Rules (IFR), was descending from an altitude of 3,000 ft to 1,200 ft over the sea of north of Naha Airport for approach to Naha Airport's runway 18.

On the other hand, a two-ship formation of Boeing (ex-McDonnell Douglas) F-15Cs of the US Pacific Air Forces (USPAF) 5th Air Force, 18 WG, was flying outside the north downwind of runway 05R of Kadena Airfield to land at the airfield in accordance with Visual Flight Rules (VFR), but then the F-15Cs were instructed to turn right to break the pattern by Kadena Tower due to other landing traffic.

JA8176 had sighted the two-ship formation of F-15Cs before they started their turns, but as they turned right and flew towards it, it took avoiding maneuver upon receiving a Resolution Advisory (RA) issued by its Traffic Alert and Collision Avoidance System (TCAS). While the F-15Cs continued north-bound and climbing, they maintained visual contact with JA8176.

JA8176 and one of the two-ship formation of F-15Cs were at their closest proximity at around 10:44 over the sea approximately 12 nm north of Naha Airport.

There were a total of 509 persons on board JA8176 — 494 passengers, the captain and 14 crewmembers, and one pilot each on board the F-15Cs. There were no injuries to the occupants of any of the aircraft, and no aircraft sustained damage.

1.2 Outline of Serious Incident Investigation

1.2.1 Organization of the Investigation

On November 7, 2003, Aircraft and Railway Accidents Investigation Commission (ARAIC) assigned an investigator-in-charge and three investigators for the investigation of the serious incident.

1.2.2 Participation of Accredited Representative or Adviser

ARAIC forwarded the notification of the serious incident to the United States, the state of design and manufacture of the accident. However, the United States did not designate any accredited representative or adviser to participate in the investigation.

1.2.3 The Implementation of the Investigation

November 8, 2003	Interview with the captain of JAL933
November 11, 2003	Interviews with the first officer and the flight engineer of JAL933
November 17, 2003–April 13, 2004	Investigation by U.S. Forces Japan (USFJ) through Japan Civil Aviation Bureau (JCAB)
November 10, 2003–July 21, 2004	Analysis of Air Route Surveillance Radar (ARSR) recordings and Airborne Integrated Data System (AIDS) recording of JA8176

1.2.4 Hearings from the Persons relevant to the Cause of the Serious Incident Hearings

Hearings from persons relevant to the cause of the serious incident were held.

2 FACTUAL INFORMATION

2.1 Progress of the Flight

2.1.1 Summary of the Near Collision Report and USFJ Report

(1) Summary of the Near Collision Report

The summary of the Near Collision Report submitted by the captain of JAL933 (present-Japan Airlines International), a Boeing 747-100B SUD, JA8176 (“Aircraft-A”) on the near collision with one aircraft of the two-ship formation is as follows:

Registration Number and Type of Aircraft: JA8176, B747-100B SUD

Date and Time of Incident: November 5, 2003, 10:45 JST.

Position of Incident: 12–13 nm north-north-east of Naha VORTAC.

Weather Conditions: Visual Meteorological Conditions (VMC).

Relationship to Clouds and Sun: No clouds, against the sun.

Description of other aircraft: Fixed-wing jet airplane,
Number of engines unknown.

Position of other aircraft and distance between aircraft at first sighting:
At 11 o'clock, 7–8 nm horizontal separation.

Position of other aircraft and distance between aircraft at the closest proximity:
At 10 o'clock, above, 2–3 nm horizontal separation.

Relative flight path: Opposite heading immediately after crossing courses,
Altitude difference approx. 200–300 ft.

Avoiding action taken by either aircraft: Avoiding action taken by own aircraft.

Proximity information: Visual contact had been made with the other aircraft.
The other aircraft had been flying on almost the same heading a little to the right of directly ahead (**Note 1**), then it suddenly turned right and flew towards own aircraft.

Note 1: Since Aircraft-A was flying on a heading of 170°, it is considered that the other aircraft appeared for Aircraft-A to be slightly right of straight ahead during a period since just before it started turning until it completed its right turn (see Fig.1-1.)

(2) Summary of the USFJ Report

Since the incident occurred 12–13nm north of Naha Airport and Aircraft-A was under the air traffic control of Okinawa Approach operated by USFJ immediately before the incident occurred, enquiries regarding the serious incident were made to

USFJ through JCAB on November 17, 2003, and a report relating to the two-ship formation of McDonnell Douglas F-15Cs of the USPAF, 5th Air Force, 18 WG and a civil Boeing 747 was submitted by the USFJ through JCAB on December 24, 2003.

The summary of the USFJ report is as follows:

Condition and Causes	Air Traffic Services	
Aircraft Information		
Aircraft Type	F-15C	Civil 747
Callsign	Knife 01	—
Altitude	1,300 ft	1,500 ft
Flight Plan	VFR	IFR
Controlling Air Traffic Services Unit	Kadena Tower	Naha Tower
Type of Controlling Facility	Tower	Tower
Air Traffic Services	VFR Pattern	Monitoring
Phase of Operation	Level flight in tower pattern	Descending on final approach
Operator	Air Force	Civilian

(See Figure 3 and 4)

2.1.2 Flight History based on ARSR Recordings, AIDS Recordings, Statements of the Flight Crew of Aircraft-A, and USFJ Report

Aircraft-A took off from Tokyo International Airport at 08:34 JST on November 5, 2003 with a total of 509 persons on board comprising the captain, 14 crewmembers, and 494 passengers. The captain sitting on the left pilot seat and acted as Pilot Not Flying (PNF: pilot carrying out duties other than piloting the aircraft), the first officer sitting on the right pilot seat and assumed Pilot Flying (PF: pilot in control of the aircraft) duties, and the flight engineer (FE) sitting on the flight engineer's seat.

Aircraft-A was vectored to the west side of the final approach course around 20 nm north of Naha VORTAC (NHC) by Okinawa Approach and was then instructed to turn to a heading of 240°.

Aircraft-A was then instructed by Okinawa Approach to descend to 1,200 ft, turn left heading 170° and intercept the final approach course to NHC, which had a magnetic course of 190°.

Aircraft-A, before encountering with the F-15C (one of a two-ship formation: "Aircraft-B"), was flying on a heading of 170° and descending through around 3,000ft with rate of descent around 1,000 ft/min.

Aircraft-B, before encountering with Aircraft-A, under the control of Kadena Tower, descended once from 1,400 ft to 1,200 ft. After that, it began to turn right and then turned left once before it turned right again and started to climb. At that time, TCAS advisories were issued on Aircraft-A.

At around 10:43:56 hrs, Aircraft-A started to take right bank.

At around 10:43:57 hrs, a TCAS Traffic Advisory (TA) “traffic, traffic” aural advisory was issued on Aircraft-A. At that time, Aircraft-B started right climbing turn following its right turn at 1,200 ft.

At around 10:43:59 hrs, a TCAS Resolution Advisory (RA) “descend, descend” aural advisory was issued on Aircraft-A, and the rate of descent of Aircraft-A was increased in response to the RA. Aircraft-A was descending through an altitude of around 1,300 ft and Aircraft-B was climbing through an altitude of around 1,270 ft.

At around 10:44:00 hrs, Aircraft-A was descending through and Aircraft-B was climbing through the same altitude of around 1,300 ft.

At around 10:44:07 hrs, Aircraft-A changed its pitch angle to positive and started to return its bank angle from 20° right to wings level.

At around 10:44:08 hrs, an RA “adjust vertical speed, adjust” aural advisory was issued on Aircraft-A at an altitude of around 1,030 ft. Aircraft-B had completed its right turn and was climbing through 1,550 ft.

At around 10:44:11 hrs, Aircraft-A was on a heading of around 190°.

At around 10:44:14 hrs, Aircraft-A leveled off at 900 ft. Aircraft-B was climbing through 1,800 ft.

At around 10:44:15 hrs, Aircraft-A began to change its heading from 190° to 180°.

At around 10:44:16 hrs, Aircraft-A and Aircraft-B were at their closest horizontal separation.

At around 10:44:19 hrs, Aircraft-A took its bank angle of 8° left.

At around 10:44:36 hrs, Aircraft-A was on a heading of around 180°.

At around 10:44:42 hrs, Aircraft-A started to take bank to the right.

At around 10:44:57 hrs, Aircraft-A was on a heading of 190°.

According to the statements of the flight crew of Aircraft-A and the USFJ report, the circumstances under which both aircraft came to be in close proximity of each other and took avoiding action were as follows:

(1) Captain of Aircraft-A

“Naha Approach instructed us as ‘Cleared for VORTAC approach, contact Naha Tower.’ Just as I was changing my radio frequency, the flight engineer called out as ‘traffic.’ At that time, two airplanes were flying with wing level slightly right of straight ahead. We were flying against the sun and I had insight a two-ship

formation as black delta-winged shapes. We were flying on a heading of around 170° and descending through 1,500–1,600ft, but they clearly appeared to be at lower altitude than us and were flying in almost the same direction as ours at a slight diagonal across our flight path. There would be no problem if they continued flying straight, but I saw one of them suddenly inclined his level wing. I couldn't find which way it was banking, so I continued watching it before calling Naha Tower. When it turned head on to us, it didn't appear to be above us. Immediately after that, it appeared to climb. I thought that we were in danger because I found the shape of the aircraft bigger and bigger and flying towards us. At that time, a TCAS TA aural advisory was issued, and I found an intruder indicating '-02' or '-03' within 5 nm range on the TCAS, which indicated that the possible intruder was flying 200–300ft below us. Immediately after that, a TCAS RA 'descend' aural advisory was issued. I saw the aircraft passing from the right forward below us to the left above us.

"The first officer followed the TCAS RA advisory by manually pitching down while turning right at an altitude of around 1,200–1,300 ft. The changing rate of the pitch angle was so gentle as if we were changing pitch angle while climbing after normal take-off. Just before our pitch angle was set and the rate of descent was increased by these maneuvers, the other aircraft disappeared beyond the forward cockpit windshield and flew past. It happened in an instant. We confirmed ourselves our actual change in altitude after the disappearance of the other aircraft.

I didn't suppose it was necessary for the first officer to perform a great maneuver because the other aircraft had not appeared to be stationary at a point beyond the windshield and it would not be seen on a collision course. I had been watching it since it had been flying straight at first until it had turned towards us, so I had been prepared for avoidance.

"After that, I heard an RA 'adjust vertical speed, adjust' aural advisory. After the other aircraft had passed away, I advised the first officer to stop descent. Then the first officer increased power from idle-power position and the aircraft raised the nose and leveled off at an altitude of around 1,000 ft. I reported to Naha Tower that we had descended and were maintaining at an altitude of 1,000 ft following an RA although Okinawa Approach had instructed us to maintain at an altitude of 1,200 ft.

"As a result of the avoiding right turn conducted by the first officer, our heading had changed from 170° to 190°, and we joined the final approach course (NHC R-010) without any great maneuvering.

"After arriving at Haneda Airport, I heard from one of ATC officers of Naha Tower that Okinawa Approach tried to contact us on the emergency frequency of 121.5 MHz. Although one of our radio frequencies was tuned on 121.5 MHz, none of the three flight crew remembered such a call. It may be because the TCAS RA 'descend' aural

advisory was issued at the time.”

(2) First Officer of Aircraft-A

“At approximately 16 nm from NHC we were instructed by Okinawa Approach to ‘fly heading 170°, descend to 1,200 ft, cleared for VORTAC approach,’ and so we took up a heading of 170°. While we were descending, the captain or the flight engineer – I’m not sure which one did – called out ‘traffic in sight’. After that, a TA ‘traffic, traffic’ aural advisory sounded. The TCAS information display showed traffic to the left of our aircraft, at which time we were descending through 1,500–1,600 ft. A few seconds later, the RA ‘descend’ aural advisory sounded, so I followed the RA by increasing our rate of descent and setting engine power to idle. I had sighted the traffic before the RA aural advisory was issued. As we were flying on a heading of 170° to pick up the final approach course of 190°, I realized that we would take slightly off the final approach course without great deviation if we turned right then. Also, I realized that the traffic would be approaching us on a head-on course or at a slight angle, so I took into account of the rule of right-of-way and increased rate of descent while starting right turn by taking right bank. According to the RA ‘adjust vertical speed, adjust’ aural advisory, I increased engine power and leveled off at approximately 900–1,000 ft. I’m not sure whether it was during our descent or just after we leveled off but I had insight two small fighter aircraft to our left in a steep climb.

“When I reached to a level flight and things had settled down, I noticed that the time interval from the TA to the RA was unusually short. I guessed that this was because the flight path of the traffic had changed during that time.”

(3) Flight Engineer of Aircraft-A

“While descending to final, I moved my seat center-forward from the original position. As I was watching towards Naha Airport, I had insight two aircraft ahead and reported to the captain as ‘there is traffic’. At that time, the two aircraft were still around 5–6 nm distant from us and it seemed as if they were traveling across our flight path from left to right, so I supposed there would be no problem if they continued as they were. At that time, both of them reflected the sunlight and were glittering. As I saw them taking bank left, the glittering disappeared and they changed to gradually approaching black dots. I could only find one of them approaching us. I wasn’t tense then, but since an RA ‘descend’ aural advisory was followed by the TA ‘traffic’ aural advisory a few seconds later, I felt we might be in danger. I was not able to watch the TCAS information display from my position, but I had sighted the other traffic. As the first officer reduced power to idle to descend following the RA, a gear warning horn sounded. Normally, the warning horn would be stopped sounding soon, but it was continued for a while because of traffic and then

it was cancelled. In the meantime the shape of the other aircraft gradually grew. Although I was not sure exactly whether it was at the same altitude as mine or not, it passed through upwards us from slightly right ahead to our left, and I felt relieved. Then the RA 'adjust vertical speed, adjust' aural advisory was issued once."

(4) Progress of the Flight according to the USFJ report

"Flight of two F-15s (call-sign: Knife01 and 02) were operating northwest of Kadena airbase in the VFR pattern. The formation of F-15s was on outside downwind attempting to set up for a visual straight-in approach to runway 05R at Kadena. Based on inbound HH-60 traffic to Kadena, the controller-in-training initially issued directions to the F-15s to turn base, attempting to land the F-15s inside of the HH-60. The controller-trainer overrode this direction and then directed that Knife execute a right 360-degree turn to develop spacing between the F-15s and the HH-60.

"The turn took the F-15s, who were currently at an altitude 1,300 ft, towards a JAL airliner (altitude 1,900 ft, and now on Naha Tower frequency) that was on final for Naha runway 18. The F-15s were visual with the JAL airliner as they started their turn to the right. With the F-15s at 5 DME from Kadena VORTAC (KAD), the controller-trainer re-issued new direction for Knife flight to begin a left 360-degree turn and a climb to 3,000 ft to follow the HH-60. The controller-trainer called out traffic to the F-15s "12 o'clock 2 miles southbound 1,500 ft." The F-15s, initially started a climbing turn to the left and reported the airliner in sight. Knife 01 did not want to turn in front of the airliner so instead turned back to the right and continued North, maintained visual separation with the JAL airliner passing left to left, and continued the climb to 3,000 ft. Radar indications from both Okinawa Approach and the F-15s indicated the two aircraft came within approximately 1 mile of each other. Based on information provided by Knife flight, altitude separation at this time was approximately 1,200 ft (JAL at 1,300 ft, Knife at 2,500 ft)."

Aircraft-A and Aircraft-B approached to the closest proximity over the sea around 12 nm north of Naha Airport at around 10:44:16 hrs.

(See Figure 1-1, 1-2, 2, and Photo 1 and 2)

2.2 Injuries to Persons

There were no injuries to persons on board either Aircraft-A or Aircraft-B.

2.3 Damage to Aircraft

Neither Aircraft-A nor Aircraft-B was damaged.

2.4 Meteorological Information

2.4.1 Aerodrome Aeronautical Weather Observations

- (1) The aeronautical weather observations for Naha Airport, which is located approximately 12 nm south of the point at which the serious incident occurred, at around the time of the serious incident were as follows:

Time of Observation	10:30 JST	11:00 JST
Wind Direction	160 degrees	150 degrees
Wind Speed	13 kt	12 kt
Visibility	Greater than 30 km	Greater than 30 km
Cloud	FEW (Note 2) 1,800 ft SCT (Note 3) 2,500 ft	FEW 1,800 ft SCT 2,500 ft
Temperature	29°C	29°C
Dew point	23°C	23°C
QNH	30.01 inHg	30.01 inHg

- (2) The aeronautical weather observation for Kadena Airfield, which is located approximately 6 nm southeast of the point at which the serious incident occurred, at around the time of serious incident were as follows:

Time of Observation	10:00 JST	11:00 JST
Wind Direction	160 degrees	160 degrees
Wind Speed	11 kt	10 kt, Maximum 16 kt
Visibility	More than 10 km	More than 10 km
Cloud	SCT 2,500 ft	SCT 2,000 ft, SCT 3,000 ft
Temperature	28°C	28°C
Dew point	24°C	24°C
QNH	30.02 inHg	30.01 inHg

Note 2: FEW means a small amount of cloud.

Note 3: SCT means scattered clouds.

2.4.2 Flight Crew Observations

According to the statement of the captain of Aircraft-A, the flight visibility at the time of the serious incident was around 10 nm.

2.5 Air Navigation Facilities

Air navigation radio aids, ATC radar systems and air-ground radio communication systems relevant to the operations of Aircraft-A and Aircraft-B were operating normally at

the time of the serious incident.

2.6 Communications

Aircraft-A had established radio contact with Okinawa Approach before the serious incident occurred, and it then established radio contact with Naha Tower at around 10:44:16 hrs. Aircraft-B had established radio contact with Kadena Tower. Radio communications with both aircraft were normal.

2.7 Provision of Traffic Information by ATC Facilities

To position it behind the HH-60, Kadena Tower instructed Aircraft-B to make a 360-degree left turn and to start to climb to 3,000 ft at 5 DME from KAD and then provided traffic information regarding Aircraft-A “12 o’clock, 2 miles, southbound at 1,500 ft”.

Naha Tower was monitoring on 121.5 MHz, and according to the ATC voice communication recordings, at around 10:44:00 hrs, Okinawa Approach provided traffic information to Aircraft-A as “Japan Air Flight 933 Heavy (**Note 4**), this is Okinawa Approach, use caution traffic at 12 o’clock, (unreadable) nm, proceeding to north, two fighter F-15, altitude 1,500 ft”.

Note 4: ‘Heavy’ is an aircraft wake turbulence classification and is applicable to aircraft with a maximum take-off weight more than 255,000 lb. (FAA regulation.)

2.8 Information from the Digital Flight Data Recorder (DFDR) and Cockpit Voice Recorder (CVR) etc.

Aircraft-A was equipped with a Honeywell DFDR, serial number 980-4100-BXUS, and a Collins CVR, serial number 980-4100-BXUS.

DFDR recordings older than 25 hours, and CVR older than 30 minutes, are overwritten.

The near collision report was submitted through Japan Airlines two days after the serious incident occurred. Since neither the DFDR nor the CVR had been removed from Aircraft-A during that time and Aircraft-A had been in operation for more than 25 hours after the serious incident, the data recorded at around the time of the serious incident had been overwritten. The DFDR and CVR were therefore not ordered to remove from Aircraft-A.

Data from a flight recorder and a voice recorder of Aircraft-B, and radar data from Okinawa Approach were not provided by USFJ.

2.8.1 Correction of AIDS Time Data of Aircraft-A

Since DFDR data of Aircraft-A had been overwritten, data from AIDS of Aircraft-A, which recorded during its operation, was used. Because time data recorded in AIDS does not always present exact time, correction of the recorded time data is required. As compared the altitude data from Air Route Surveillance Radar (ARSR), which had time data, with the

altitude data recorded in the AIDS of Aircraft-A, the AIDS time data was corrected by applying seven-second delay.

Further, previous investigations for another case shows that TCAS data except for TA and RA aural advisories are recorded in AIDS three seconds earlier than other data.

The AIDS data were therefore corrected by applying a 10-second delay. (Corrected time = AIDS time – 10 seconds)

2.8.2 Information related to TCAS on Aircraft-A

Aircraft-A was equipped with a Collins model TTL-920 TCAS, system version 7. The TCAS operated normally.

2.9 Analysis of Data of Air Route Surveillance Radar (ARSR) and AIDS

Position and altitude on Aircraft-A and Aircraft-B were recorded at 10-second intervals in the ARSR data. However, data on Aircraft-B was missing for 17 seconds between 10:43:42 hrs and 10:43:59 hrs, and for 48 seconds between 10:44:01 hrs and 10:44:49 hrs.

Altitudes and tracks for Aircraft-A were reconstructed based on the ARSR data and the corrected AIDS data. Altitudes and tracks for Aircraft-B were reconstructed based on the ARSR data. (See Figure 2)

Further, as comparing each track of Aircraft-A, one was based on position data from ARSR and one was based on position data from the AIDS of Aircraft-A with a 7-second time correction, it was found that they had almost perfect agreement.

2.10 Other Information

2.10.1 Actions taken by JAL after the Serious Incident

According to the statement of the captain of Aircraft-A, he wrote a near collision report during the return flight (JAL flight 930) from Naha Airport on November 5, 2003. When he arrived at Tokyo International Airport, he met persons from Flight Crew Department and Operation Engineering Section of Crew Support Department of his company, described the serious incident and handed over the near collision report.

However, JAL did not remove the DFDR or the CVR after receiving the near collision report from the captain.

On the morning on November 6, 2003, JAL submitted a verbal summary report outlining the near collision to CAB headquarters office.

On November 7, 2003, JAL submitted the near collision report stipulated in Article 76-2 of the Civil Aeronautic Regulations to CAB.

3 ANALYSIS

3.1 Personnel Information

The captain and the first officer of Aircraft-A had valid aircrew proficiency certificates and valid aircrew medical certificates. Necessary information relating to the commander of Aircraft-B was not provided by USFJ.

3.2 Weather Conditions

It was determined that the weather conditions at the time of the serious incident were Visual Meteorological Conditions (VMC) with good visibility and there were no factors that would have hindered visual contact with other aircraft.

3.3 Other Aircraft in the Near Collision Report submitted by the Captain of Aircraft-A

In consideration of the followings, it is estimated that other aircraft mentioned in the near collision report submitted by the captain of Aircraft-A was Aircraft-B.

- (1) The track of other aircraft based on the ARSR data and the statements of the flight crew of Aircraft-A coincide with the track of Aircraft-B as described in the USFJ report.
- (2) The shape of other aircraft in the statements by the flight crew of Aircraft-A is similar to the characteristics of Aircraft-B. Further, the commander of Aircraft-B recognized a Boeing 747, and there were no Boeing 747 aircraft except Aircraft-A in the vicinity of Aircraft-B.

3.4 Preservation of DFDR and CVR Recordings

The data of Aircraft-A recorded on the DFDR and CVR are necessary in discovering the causes of an accident or serious incident, so it is vital that they be preserved. However, the data were not preserved in this serious incident.

It was not clearly specified at that time in the Operation Manual of JAL company that DFDR and CVR shall be preserved when 'it is recognized that there is a risk of collision with another aircraft during operation (Article 2-2 of the Aircraft and Railway Accidents Investigation Commission Establishment Law)' and it is considered that this is the reason why the recordings were not preserved.

Aircraft operators should rapidly and positively preserve the DFDR and CVR as evidence for an investigation when a captain submits a report relating to an accident or a serious incident.

3.5 Analysis of the ARSR recordings on Aircraft-B and Estimation of the Near Collision

In the ARSR recordings, data on Aircraft-B were missing for 17 seconds in which the time

of the TA and the first RA issued by the TCAS of Aircraft-A were included and for 48 seconds in which the time of the closest proximity was included. Therefore, in the analysis of the 48-second period in which the time of the closest proximity was included, their relative positions at which the closest proximity occurred was estimated by assuming that Aircraft-B was climbing at a constant rate of climb of around 3,000 ft/min and flying straight ahead at a constant ground speed.

According to the USFJ report, at around the time that Aircraft-B approached Aircraft-A, Aircraft-B made a left turn followed by a right turn and then a right turn again in a short period as instructed by the controller of Kadena Tower and by the pilot's own judgment. However, the flight path of those turns could not be clarified because there were no detailed radar data to verify those turns.

It is considered possible the estimated flight path may differ from actual flight path because the analysis of the flight path of Aircraft-B during the 48-second time period was estimated by assuming above. Described below is a putative flight path for Aircraft-B that might be closer to the actual path than the estimated flight path based on the above assumptions.

(1) Vertical separation at the time of the closest proximity

It is described in Section 2.1.2(4) that Aircraft-A was flying at 1,300 ft and Aircraft-B was flying at 2,500 ft, which gave vertical separation of 1,200 ft at the time of the closest proximity based on information provided by Knife flight. On the other hand, according to the presumed flight path indicated in Figure 2, the altitude of Aircraft-A was around 900 ft and the altitude of Aircraft-B was around 1,900 ft, which gave vertical separation of 1,000 ft (300 m) at the time of the closest proximity.

Regarding the discrepancy of the altitude of Aircraft-B, it is considered that Aircraft-B's pilot would have referred to his altimeter and the altitude of 2,500 ft is considered closer to the actual altitude. It is therefore considered possible that the vertical separation at the time of the closest proximity was greater than the 300 m shown in Figure 2.

(2) Horizontal separation at the time of the closest proximity

According to the submitted near collision report, the captain of Aircraft-A stated that Aircraft-B was at around 10 o'clock, the TCAS RA sounded and the first officer made the aircraft to descend according to the RA at the time of the closest approach, and the other aircraft disappeared beyond the forward windshield and passed by before the rate of descent was increased. It is considered that it was already impossible for the captain of Aircraft-A to find Aircraft-B beyond the windshield before the time of the closest proximity because the nose Aircraft-A was lowered, and so the captain felt that the horizontal distance from Aircraft-B was 2–3 nm when Aircraft-B disappeared beyond the forward windshield.

Since it is estimated that the relative position and distance at the time of the closest proximity described in near collision report are therefore not those at the time of the closest proximity, it is considered that the distance described in USFJ report (within approximately 1 nm) is closer to the true value. It is therefore considered possible that the horizontal separation at the time of the closest proximity was greater than the 500m shown in Figure 2.

(See Figure 2)

3.6 Probability of a Midair Collision

- (1) A TA was issued on Aircraft-A at around 10:43:57 hrs. According to the flight crews' statements, they had made visual contact with Aircraft-B before the TA was issued.

At around 10:43:59 hrs, an RA 'descend, descend' was issued on Aircraft-A, and it is estimated that the distance between both of the aircraft was around 2.1 nm (around 3.9 km) at that time. According to the statement of the first officer, the time interval between the TA and the RA was short. According to the AIDS recordings, the RA was issued 2 seconds after the issuance of the TA. It is considered that this was because Aircraft-B had made a right turn in front of Aircraft-A to avoid it and so the condition for an RA to be issued was satisfied short time after the TA was issued.

Further, because Aircraft-A was descending through around 1,300 ft and Aircraft-B was climbing through around 1,270 ft, it is considered that the TCAS of Aircraft A determined that Aircraft-B was climbing when the RA was issued on Aircraft-A and selected a further descent avoidance action for Aircraft-A which had been already descending.

At around 10:44:00 hrs, the descending Aircraft-A and the climbing Aircraft-B passed each other at the same altitude of around 1,300 ft. After passing through the same altitude, the altitude difference between them were gradually increased, and at around 10:44:08 hrs, an RA "adjust vertical speed, adjust" was issued on Aircraft-A. Aircraft-A was further descending through 1,030 ft and Aircraft-B was already climbing through around 1,550 ft at that time, and it is estimated that the distance between both of the aircraft was around 1.1 nm (around 2.1 km) then.

It is estimated that Aircraft-A thereafter continued to descend to around 900 ft, and Aircraft-B continued to climb to around 3,500 ft.

- (2) It is considered that the time of the closest proximity between Aircraft-A and Aircraft-B was around 10:44:16 hrs, at which time the horizontal separation was greater than 0.3 nm (around 500 m) and the vertical separation was greater than around 1,000 ft (around 300 m).

At the time of the closest proximity, it is considered that both of the aircraft passed

each other in almost opposite directions.

- (3) In this serious incident, both of the aircraft had visual contact each other from some distance away. As Aircraft-B took avoiding action while maintaining visual separation with Aircraft-A and the descending Aircraft-A increased its rate of descent according to the TCAS RA, it is considered that both of the aircraft did not approach each other to the extent that there was a risk of collision or near-midair collision.

Because Aircraft-B was climbing while turning right to avoid Aircraft-A, the TCAS of Aircraft-A issued a RA to descend. One second after the RA, both of the aircraft were at the same altitude of around 1,300 ft, and thereafter the altitude difference was gradually increased. Although it was predicted on the TCAS of Aircraft-A that Aircraft-B would enter the protected areas for TA and RA (**Note 5**) during the short period of its turn, it is estimated that Aircraft-B was not on a collision or near collision course. Also, according to the statement of Aircraft-A's captain, it is estimated that Aircraft-B was not on a collision course on which other aircraft would appear to remain at one spot.

Note 5: TCAS protected area for altitudes between 1,000 ft through 2,350 ft has following proximity time, protected area radius, and altitude threshold:

Proximity time	: TA	25 seconds,	RA	15 seconds
Protected area radius	: TA	0.33 nm,	RA	0.20 nm
Altitude threshold	: TA	850 ft,	RA	300 ft

3.7 Proximity and Avoidance Situations

- (1) According to the statement of the captain of Aircraft-A, who was acting as PNF, Aircraft-B was flying diagonally across the flight path of Aircraft-A straight ahead and a little to the right at a lower altitude. The captain stated that there would have been no problem if Aircraft-B had continued flying straight ahead but it turned to be head on to Aircraft-A and then appeared to start climbing.

According to the statement of the first officer, who was acting as PF, since Aircraft-A was on a heading of 170° to intercept the final approach course of 190°, he judged that a right turn would bring Aircraft-A onto the final approach course. Also, since he had confirmed Aircraft-B to be left of his course on the TCAS information display and had sighted Aircraft-B to his left, he increased the rate of descent according to the RA a few seconds after the issuance of TA and initiated a right bank.

On the other hand, based on the AIDS recordings, it is estimated that the first officer began to turn Aircraft-A to the right with a bank angle of 20° three seconds before the issuance of the descent RA. He then started to roll back from the 20° right bank. Passing through wings level, he kept the roll to an 8° left bank. Further, at

around the time when the TA was issued, it is estimated that the rate of descent was reduced from around 1,000 ft/min to 600 ft/min momentarily to level off at the assigned altitude of 1,200 ft, and then the rate of descent was attained to 2,400 ft/min eight seconds after the nose of the Aircraft-A was lowered to follow the descent RA.

From the circumstances above, it is considered that the first officer of Aircraft-A made a right turn with a bank angle of 20° three seconds before the issuance of the descent RA to intercept the final approach course with a magnetic heading of 190° to NHC. It is therefore estimated that the right turn made the direction of Aircraft-A to be coincided with the further direction to avoid Aircraft-B.

- (2) According to the USFJ report, when Aircraft-B started to turn right toward Aircraft-A as instructed by the controller-trainer of Kadena Tower, Aircraft-B was visual with Aircraft-A. Then, Aircraft-B momentarily started left climbing turn as instructed by the controller-trainer, but the pilot did not want to turn in front of a civil aircraft and he instead turned back to the right and, while maintaining visual separation with Aircraft-A, continued northbound and continued to climb to 3,000 ft.

On the other hand, based on the track data from the ARSR and AIDS, it is estimated that Aircraft-B executed a right climbing turn and continued to the north while climbing from 1,200 ft up to 3,500 ft at a rate of 3,000 ft/min.

From these considerations, it is estimated that the controller-trainer of Kadena Tower instructed Aircraft-B a right turn in order to make the F-15s to land after the approaching HH-60 to runway 05R, and this made Aircraft-B to deviate significantly from the controlled airspace of Kadena Tower with the result that it came near to the final approach course of Aircraft-A.

3.8 Provision of Air Traffic Information from Air Traffic Control Facilities

Regarding air traffic information provided by air traffic control facilities to both aircraft at around the time when both of the aircraft came in close proximity, it is estimated that the pilot of Aircraft-B received a traffic information regarding Aircraft-A from the Kadena Tower as he started right turn, and that he was therefore aware of the movements of Aircraft-A.

At around 10:44:00 hrs, Okinawa Approach issued a traffic information to Aircraft-A on the two-ship formation of F-15s on a frequency of 121.5 MHz, but it is estimated that flight crew of Aircraft-A were unable to monitor the traffic information because they were concentrating on responding to the TCAS alerts. However, according to the statement of the captain of Aircraft-A, he had made visual contact with Aircraft-B before the TA and had kept monitoring the movement of Aircraft-B, and it is estimated that it had no affect on the urgent dangerousness to the proximity for both aircraft that the crew of Aircraft-A were unable to monitor the traffic information.

3.9 Level of Risk

The flight crew of Aircraft-A had made visual contact with Aircraft-B and had been monitoring it well before the TCAS TA was issued. After that, Aircraft-A executed a normal controlled descent as an avoiding maneuver in response to the RA advisory. On the other hand, Aircraft-B received traffic information regarding Aircraft-A from Kadena Tower and understood the maneuver of Aircraft-A, and then while maintaining visual separation with Aircraft-A, made a right turn and then continued northbound in shallow climb. Based on these facts, there was no incipient danger at the approach, and the criteria relating to abnormal proximity, viz. “close proximity with a risk of collision or near-midair-collision with insufficient margin for avoidance action” and “to have been able to avoid a collision or near-midair-collision by abnormal avoidance action”, were not satisfied. It is therefore considered that this serious incident did not involve abnormal proximity.

Based on the proximity situation of both aircraft described in section 3.6 and 3.7, it is estimated that there was no possibility to arise a risk of collision or near-collision between both of the aircraft, and that each aircraft sufficiently monitored the movements of the other and took avoidance action by normal gentle maneuvers. Consequently there was no especial risk to operational safety in this serious incident, and so according to the classification of aircraft proximity by International Civil Aviation Organization (ICAO), this serious incident is classified as “No risk of collision”.

(See Attachment)

4 PROBABLE CAUSE

It is estimated in this serious incident that the controller-trainer of Kadena Tower instructed Aircraft-B to make a right turn in order to make the F-15s to land after an approaching traffic to runway 05R, and this made Aircraft-B to deviate significantly from the controlled airspace of Kadena Tower with the result that it came near to the final approach course of Aircraft-A.

However, because Aircraft-A had made visual contact with Aircraft-B and then made appropriate avoidance maneuver followed by its TCAS RA, and also because Aircraft-B made their maneuver while maintaining visual separation with Aircraft-A, a situation of abnormal proximity did not arise.

5 OPINION

Data recorded by DFDR and CVR are required for investigation of an accident or a serious incident and it is extremely important to preserve them when an accident or a serious incident occurs. However, the DFDR and CVR of Aircraft-A were not secured in this serious incident case.

It is necessary for operators to secure DFDR and CVR quickly and positively for the subsequent investigation when a report is submitted by a captain relating to an accident or a serious incident.

6 MATTERS FOR REFERENCE

6.1 Measures taken by USFJ

Regarding measures taken by USFJ after the serious incident, the following points were contained in the reply letter from USFJ dated December 24, 2003 in response to a letter dated November 17, 2003 on inquiry submitted through JCAB regarding the near collision report of Aircraft-A:

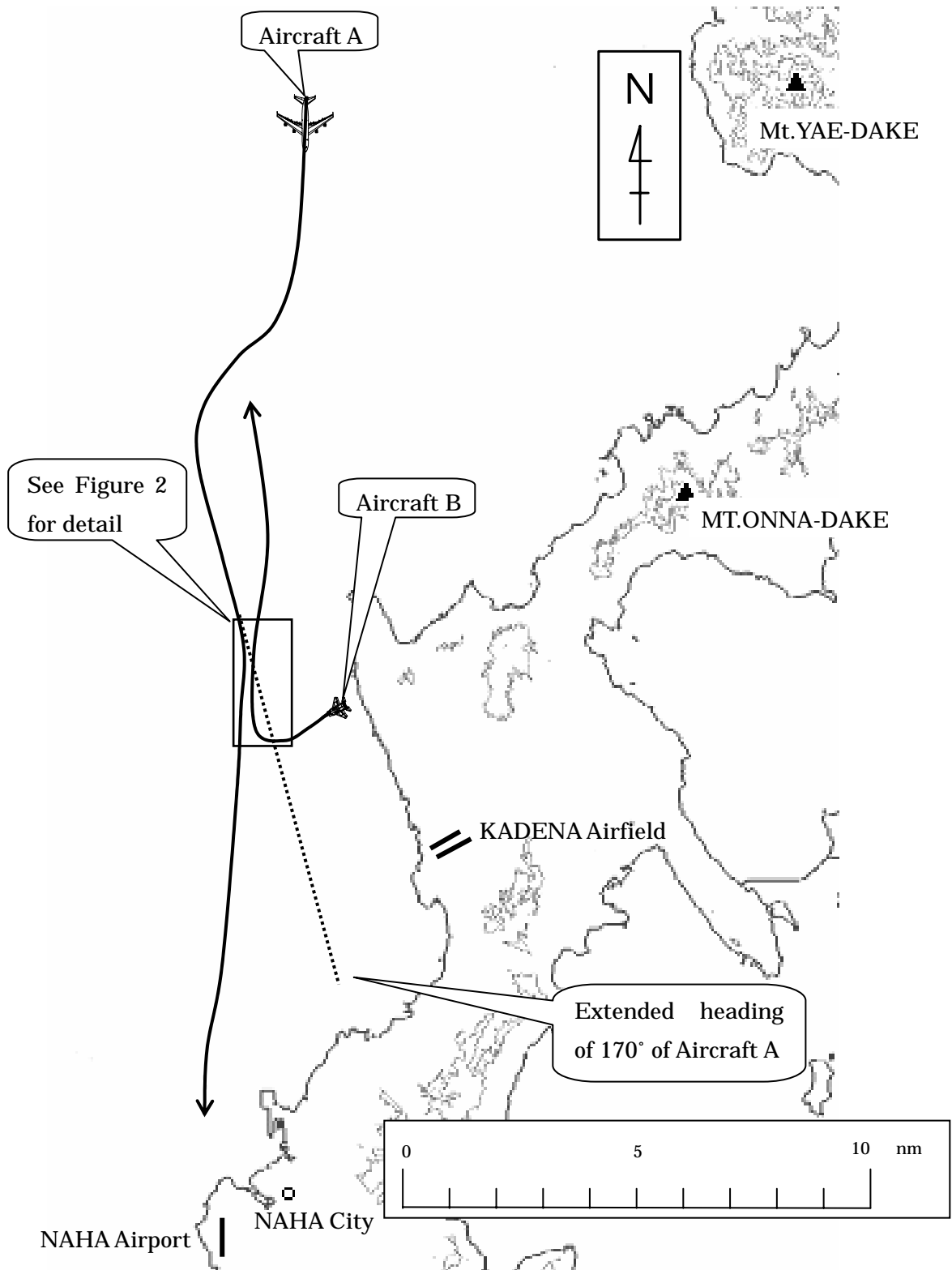
- (1) The controller-trainer of Kadena Tower involved received recurrent training.
- (2) All Pacific Air Force, 5th Air force, 18 Operation Group aircrews will be briefed to increase their awareness of civil air traffic on the civilian traffic corridors into and out of Okinawa.
- (3) Local tower pattern break out and de-confliction procedures of Kadena Airfield will be reviewed to assess conflict areas and new procedures will be developed if necessary.

Additionally it was contained in the reply letter from USFJ dated April 19, 2005 that the measures in (1) and (2) above had been accomplished and that it was found that new pattern break out and de-confliction procedures were not necessary as a result of the review in (3) above.

6.2 Measures taken by Japan Airlines International

Japan Airlines International (ex-Japan Airlines) revised its Operations Manual on October 01, 2004, to ensure the rapid and positive preserving of the DFDR and CVR.

Figure 1-1 Presumed Flight Path



(Source: Numeric Mapping Data by National Land Agency)

Figure 1-2 Detail of the presumed flight path of Aircraft B based on the USFJ report

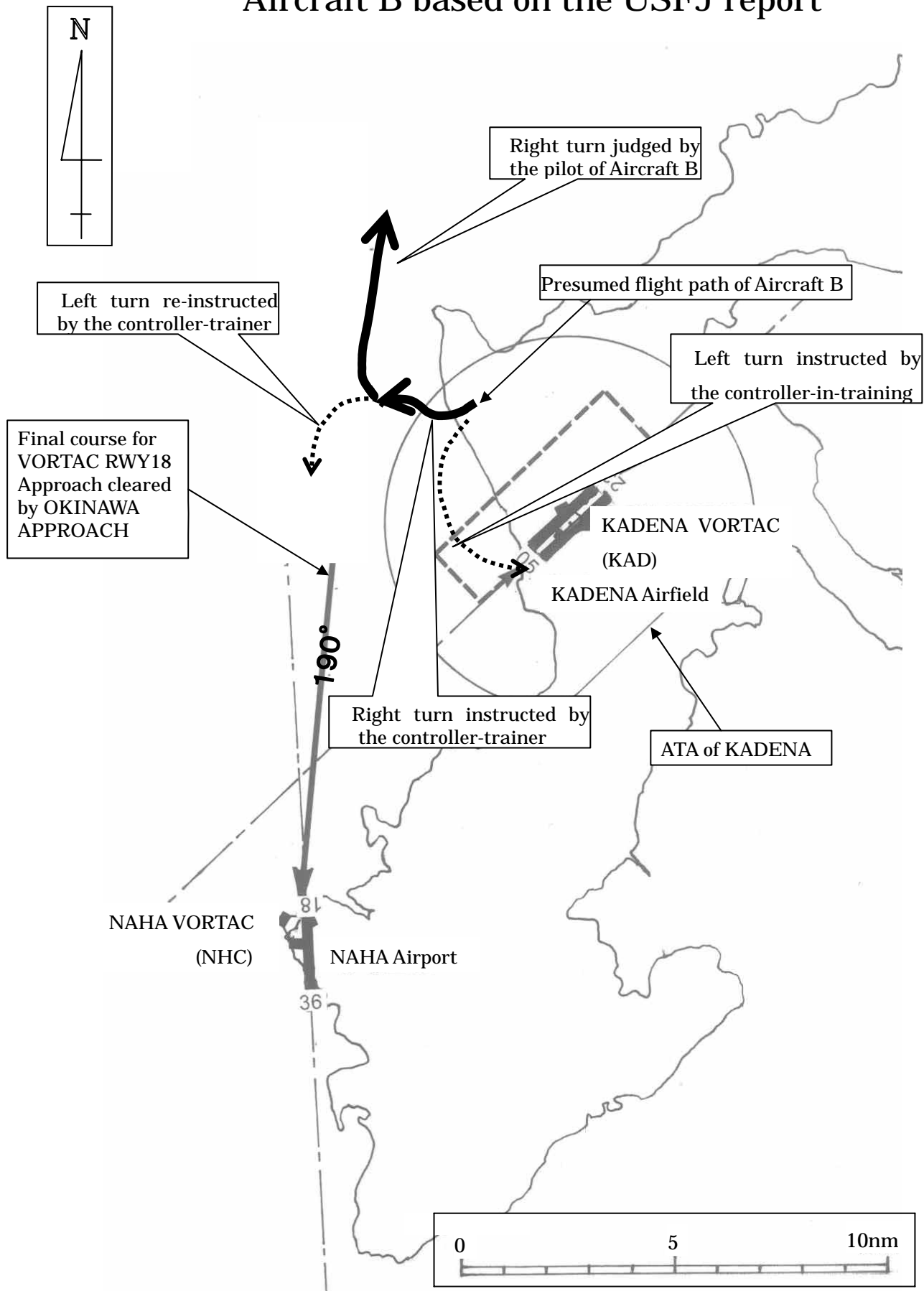


Figure 2 Presumed approach path for Aircraft A and Aircraft B based on ARSR and AIDS data

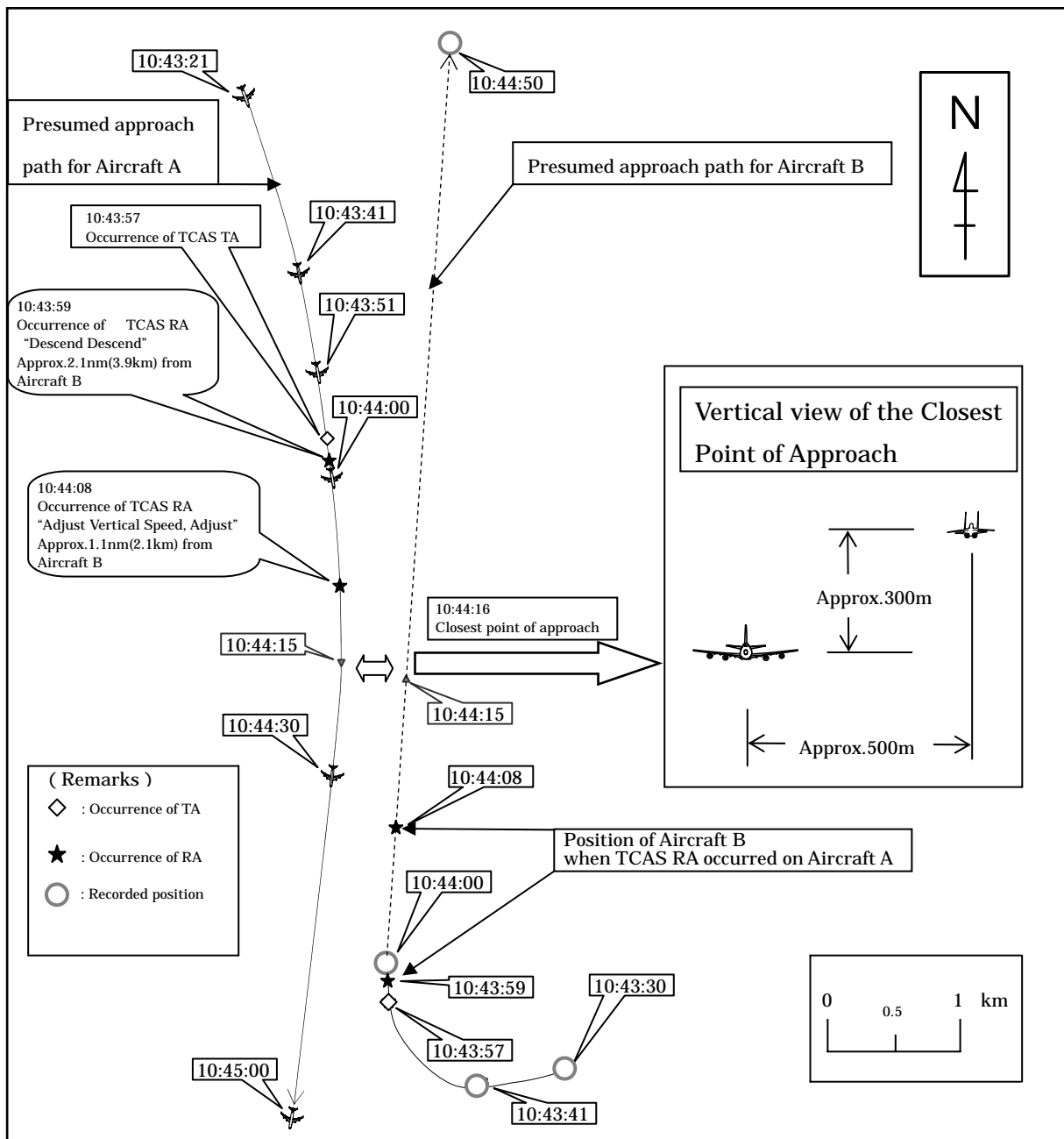
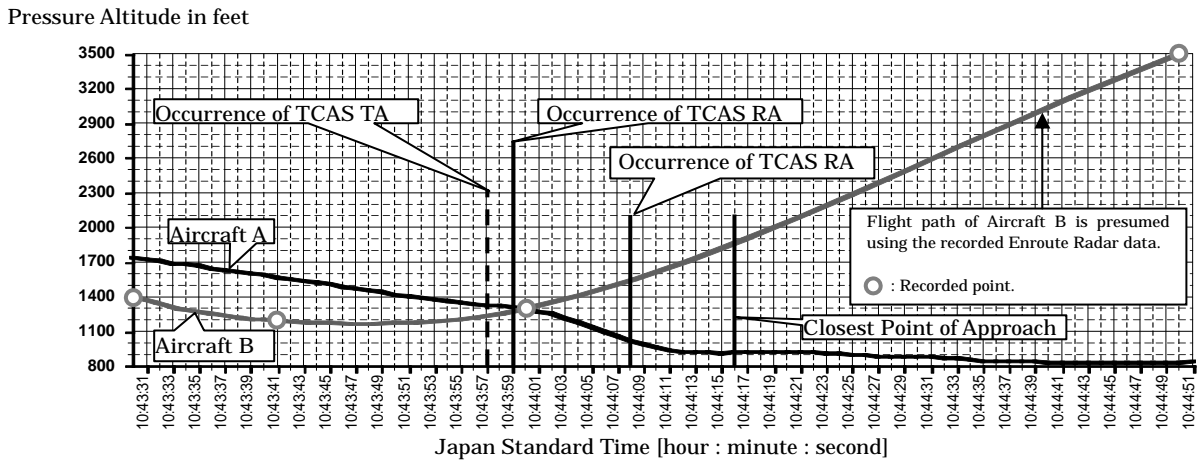


Figure 3 Three angle view of Boeing B747-100B SUD
(Aircraft A)

Unit : meter

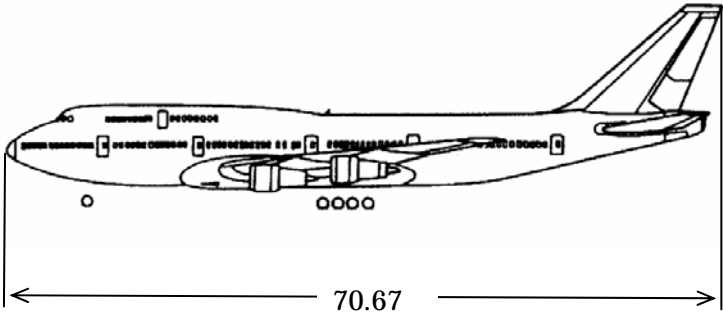
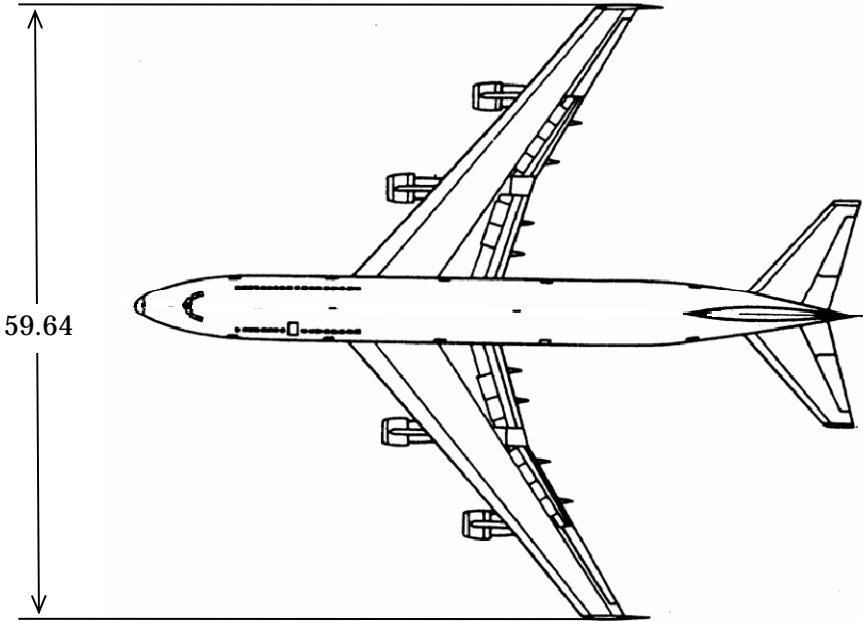
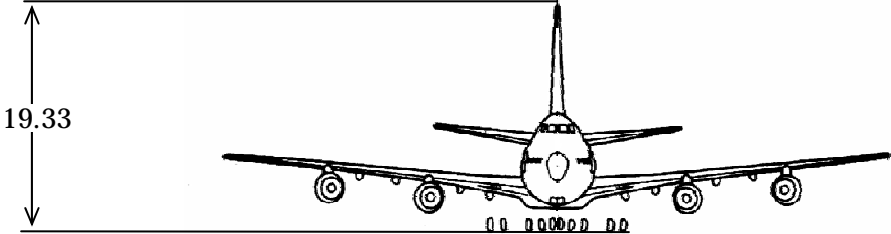


Figure 4 Three angle view of McDONNELL
DOUGLAS F-15C (Aircraft B)

Unit : meter

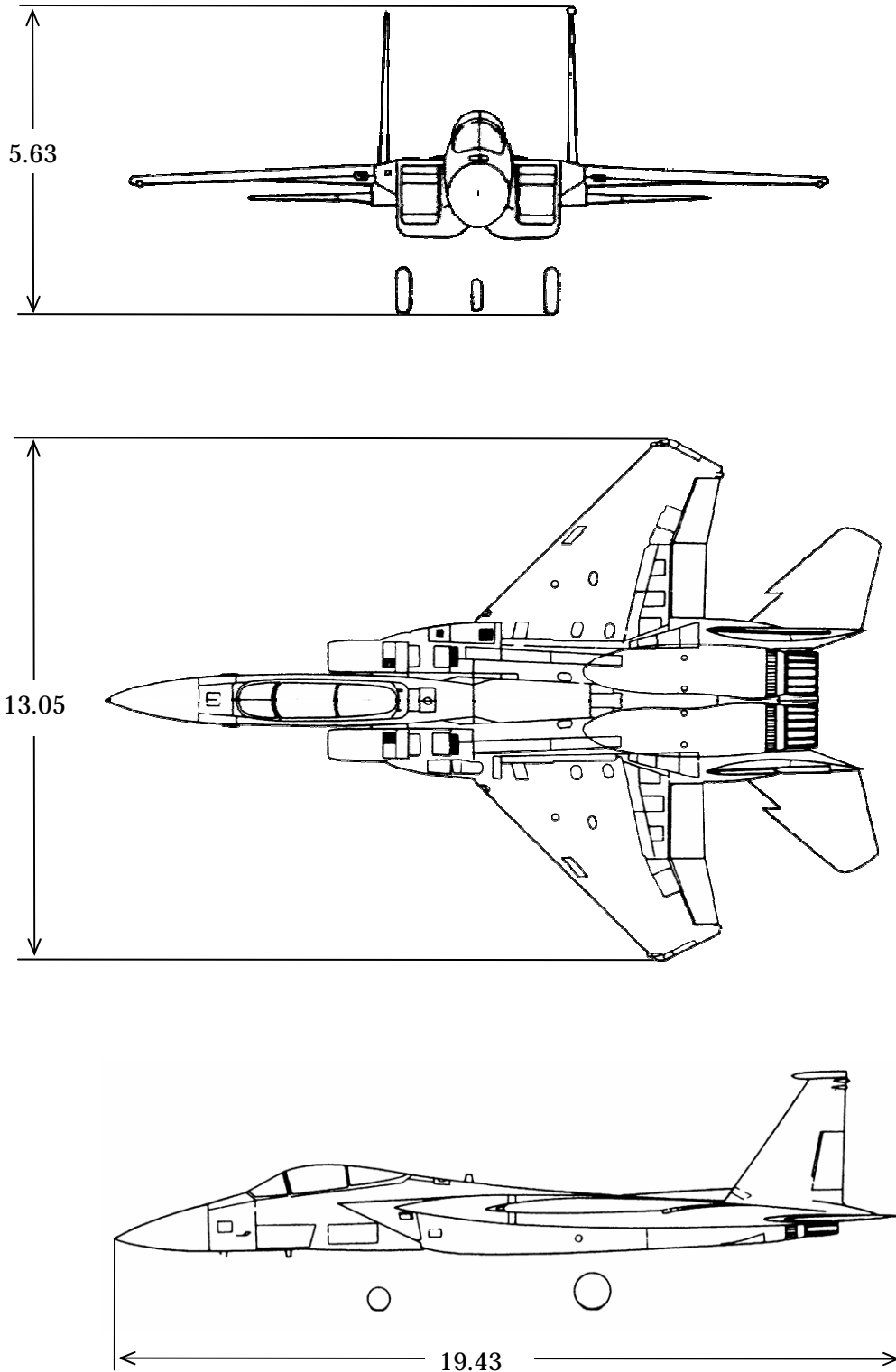
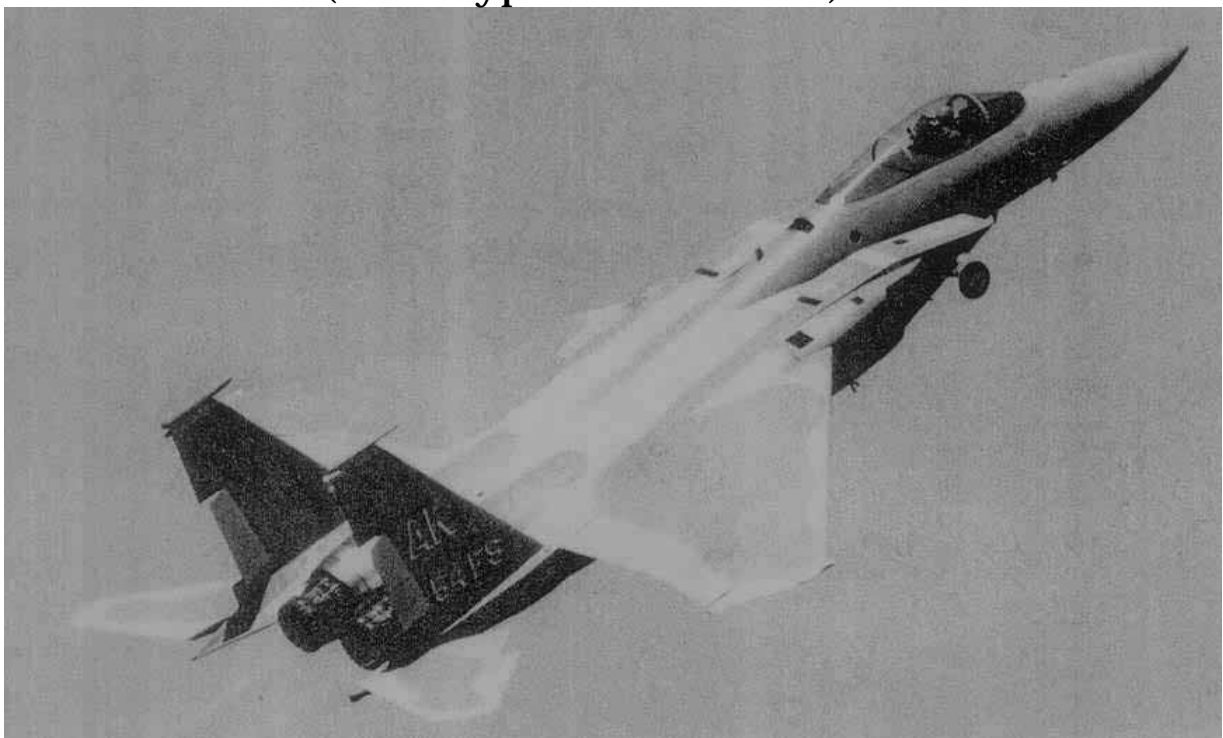


Figure 1 BOEING B747-100B SUD (Aircraft A)



Figure 2 McDONNELL DOUGLAS F-15C
(same type as Aircraft B)



(Source: "The World Aircraft Annual 2002" published by KANTOSHA, Japan)

Degree of risk involved

ICAO PANS-ATM, CHAPTER 1. DEFINITIONS	
Classification	Explanation
Risk of collision	The risk classification of an aircraft proximity in which serious risk of collision has existed.
Safety not assured	The risk classification of an aircraft proximity in which the safety of the aircraft may have been compromised.
No risk of collision	The risk classification of an aircraft proximity in which no risk of collision has existed.
Risk not determined	The risk classification of an aircraft proximity in which insufficient information was available to determine the risk involved, or inconclusive or conflicting evidence precluded such determination.

Remarks : It is described in subparagraph 16.3.2, ICAO Doc 4444, PANS-ATM, that the degree of risk involved in an aircraft proximity should be determined in the incident investigation and classified as mentioned above.