

AI2020-1

**AIRCRAFT SERIOUS INCIDENT
INVESTIGATION REPORT**

**CHINA AIRLINES
B 1 8 6 6 7**

January 30, 2020

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

TAKEDA Nobuo
Chairman
Japan Transport Safety Board

Note:

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

AIRCRAFT SERIOUS INCIDENT INVESTIGATION REPORT

SHORTAGE OF FUEL REQUIRING URGENT MEASURES CHINA AIRLINES

BOEING 737-800, B18667

ABOUT 15 NM NORTH OF TOYAMA AIRPORT, JAPAN
AT AN ALTITUDE OF ABOUT 9,600 FT
AROUND 12:36 JST, JULY 8, 2018

January 10, 2020

Adopted by the Japan Transport Safety Board

Chairman	TAKEDA Nobuo
Member	MIYASHITA Toru
Member	KAKISHIMA Yoshiko
Member	MARUI Yuichi
Member	MIYAZAWA Yoshikazu
Member	NAKANISHI Miwa

1. PROCESS AND PROGRESS OF THE AIRCRAFT SERIOUS INCIDENT INVESTIGATION

1.1 Summary of the Serious Incident	<p>On Sunday, July 8, 2018, a Boeing 737-800, registered B18667, operated by China Airlines, as a scheduled flight 170, changed the destination to Chubu Centrair International Airport, because the aircraft performed approaching to Toyama airport three times, but it could not land at the airport due to wind.</p> <p>The aircraft declared an emergency due to insufficient remaining fuel quantity while flying to Chubu Centrair International Airport and landed at the airport at 13:10.</p>
1.2 Outline of the Serious Incident Investigation	<p>The occurrence covered by this report falls under the category of “Shortage of fuel requiring urgent measures” as stipulated in Article 166-4 (xii) of the Ordinance for Enforcement of the Civil Aeronautics Act of Japan (Ordinance of Ministry of Transport No. 56 of July 31, 1952), and is classified as a serious incident.</p> <p>Japan Transport Safety Board designated an investigator-in-charge and one investigator on July 8, 2018 to investigate this serious incident. JTSA additionally designated another investigator on July 20, 2018.</p> <p>An accredited representative of Taiwan, as the State of Registry and Operator of the aircraft involved in this serious accident, participated in the investigation. Although this serious incident was notified to the United States of America, as the State of Design and Manufacturer of the aircraft, the USA did not designate an accredited representative.</p> <p>Comments were invited from parties relevant to the cause of this serious incident and the Relevant States.</p>

2. FACTUAL INFORMATION

2.1 History of	According to the statements of the flight crew and the air traffic controller
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<p>the Flight</p>	<p>(hereinafter referred to as “the Controller”) at Tokyo Area Control Center (hereinafter referred to as “Tokyo ACC”), the records of FDR (Flight Data Recorder), ATC communication records and radar track records, the history of the flight is summarized as follows.</p> <p>On July 8, 2018 at 9:09 in Japan Standard Time (JST: UTC+9 hours; unless otherwise noted, all times are indicated in JST in this report on a 24-hour clock), the Boeing 737-800, registered B18667, operated by China Airlines, with the captain sitting in the left seat as PF*¹ and the first officer sitting in the right seat as PM*¹, took off from Taiwan Taoyuan International Airport in Taipei, Taiwan. The flight crew, before approaching Toyama airport, performed approach briefing after obtaining weather information of Toyama airport and got prepared for landing on runway either 20 or 02, whichever the aircraft may land on.</p> <p>The aircraft conducted a circling approach to runway 02 in the first attempt of approaching. The aircraft executed go-around at 12:00:00 because the descent rate exceeded the stable approach criteria stipulated in the FOM (Flight Operation Manual) of the operator affected by a gusty wind at an altitude of about 400 ft. The remaining fuel quantity of the aircraft at the time of the go-around was about 8,600 lb.</p> <p>The aircraft conducted the second circling approach to runway 02 again. Then, the aircraft executed go-around again at 12:14:40 because the approaching speed at an altitude of about 100 ft exceeded the criteria. The remaining fuel quantity at the time of the second go-around was about 7,300 lb.</p> <p>The aircraft conducted the third approaching to runway 20 because a wind condition was suitable, and an expected remaining fuel quantity, if the third approach ended in go-around, exceeded the total of the fuel quantity needed to fly to the alternate airport and the final reserve fuel quantity. However, the aircraft executed go-around again at an altitude of about 1,000 ft at 12:27:47 because the descent rate exceeded the criteria affected by a strong tail wind. The remaining fuel quantity at the time of the go-around was about 6,000 lb. The landing at Toyama airport was abandoned and the change of the destination airport to Chubu Centrair International Airport (hereinafter referred to as “Chubu Airport”) was informed Toyama airport traffic control tower (hereinafter referred to as “Toyama Tower”). Toyama Tower instructed the aircraft to contact Tokyo ACC.</p> <p>At 12:31:35, the aircraft called in Tokyo ACC and requested the change of the destination airport to Chubu Airport.</p> <p>At 12:33:04, Tokyo ACC informed the aircraft that it conducted radar identification and the location of the aircraft was 12 nm north of Toyama</p>
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*¹ PF and PM are terms used to identify pilots with the roles assigned to each pilot in aircraft operated by two persons. PF is an abbreviation of Pilot Flying and is mainly responsible for maneuvering the aircraft. PM is an abbreviation of Pilot Monitoring and mainly monitors flight status of the aircraft and cross-checks operations of PF, and undertakes other non-operational roles.

VOR/DME (TOE), and it instructed the aircraft to climb to FL*2150.

At 12:36:11, the aircraft conducted an emergency communication (communication commencing with urgent signal of PAN-PAN, PAN-PAN, PAN-PAN) to Tokyo ACC and requested clearance to Chubu Airport (see Figure 1 and 2 (i)). According to the flight crew, he informed Tokyo ACC that the remaining fuel quantity was in a tight situation before this emergency communication, however, he did not receive an explicit response. On the other hand, according to the ATC communication records, transmission that was said to have been conducted prior to the emergency communication was not confirmed. Furthermore, emergency communication from the aircraft at this time was in low and muffled and the voice was unclear overlapped by back noises. Tokyo ACC was unable to hear the transmission and asked for the call sign (flight number) again. The aircraft responded with the call sign and requested clearance to Chubu Airport. The transmission sent again by the aircraft this time included the call sign and request for clearance, and did not include the urgent signal. Taking the busy situations in the airspace into consideration, Tokyo ACC intended to issue clearance after ATC communications with other aircraft calmed down, and commenced radar vectoring of the aircraft firstly at magnetic heading of 140° in order to let it join the flow of other arriving aircraft from the northern Japan to Chubu Airport and Kansai-Osaka Airport.

The flight crew wondered why the aircraft was instructed to fly at the magnetic heading of 140° because Chubu Airport was located in southern direction from the aircraft. Besides, flight log (flight route planned prior to the departure) showed that flight route to Chubu Airport, the alternate airport, was via Komatsu VORTAC (KMC), which was in the opposite direction from the flight instruction of 140° magnetic heading.

At 12:36:49, the aircraft conducted the second emergency communication, and simultaneously requested short cut to Chubu Airport due to running short remaining fuel quantity (see Figure 1 and 2 (ii)). ATC communication records showed that the emergency communication from the aircraft at this time was again in low and muffled and the voice was unclear. Tokyo ACC was unable to recognize the urgent signal, and again asked the aircraft for its desired flight route to Chubu Airport, but the aircraft reverted with request to repeat the message again. Then, Tokyo ACC instructed the flight at magnetic heading of 140° again. The aircraft responded saying that they understood the instruction.

The flight crew was concerned about remaining fuel quantity that was running short because the flight at the magnetic heading of 140° was in the direction of the airspace over mountainous areas.

At 12:37:29, Tokyo ACC instructed the aircraft to climb to FL230 to obtain better condition of communications because communications from the aircraft were overall hard to hear and partially unclear.

*2 FL denotes the pressure altitude in the standard atmosphere and is expressed in the value dividing the reading (in ft) on the altimeter by 100, when the altimeter is set to 29.92 inHg. It is generally used in Japan when flight altitude is 14,000 ft or higher. For instance, FL150 is equal to the altitude of 15,000 ft.

At 12:41:29, the aircraft conducted the third emergency communication and informed that remaining fuel quantity was getting critical because the remaining fuel quantity at the time of arrival to Chubu Airport calculated by Flight Management Computer (FMC) became close to the final reserve fuel quantity if the aircraft directly flew to the airport. The Controller recognized by this emergency communication that the aircraft was in an emergency and confirmed the emergency status with the aircraft. The emergency communication from the aircraft at this time was clear.

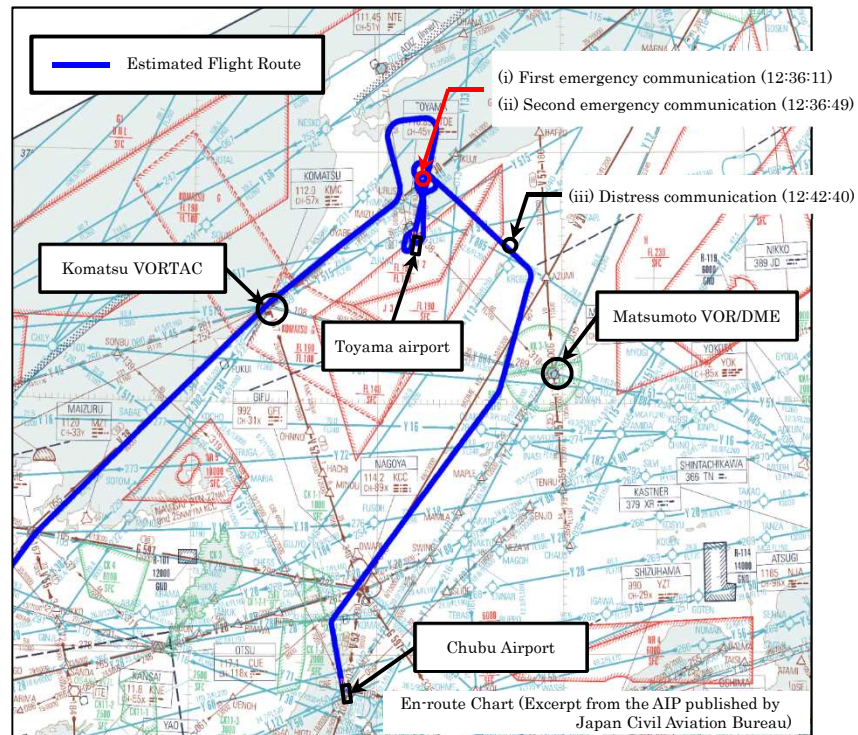


Figure 1: Estimated Flight Route

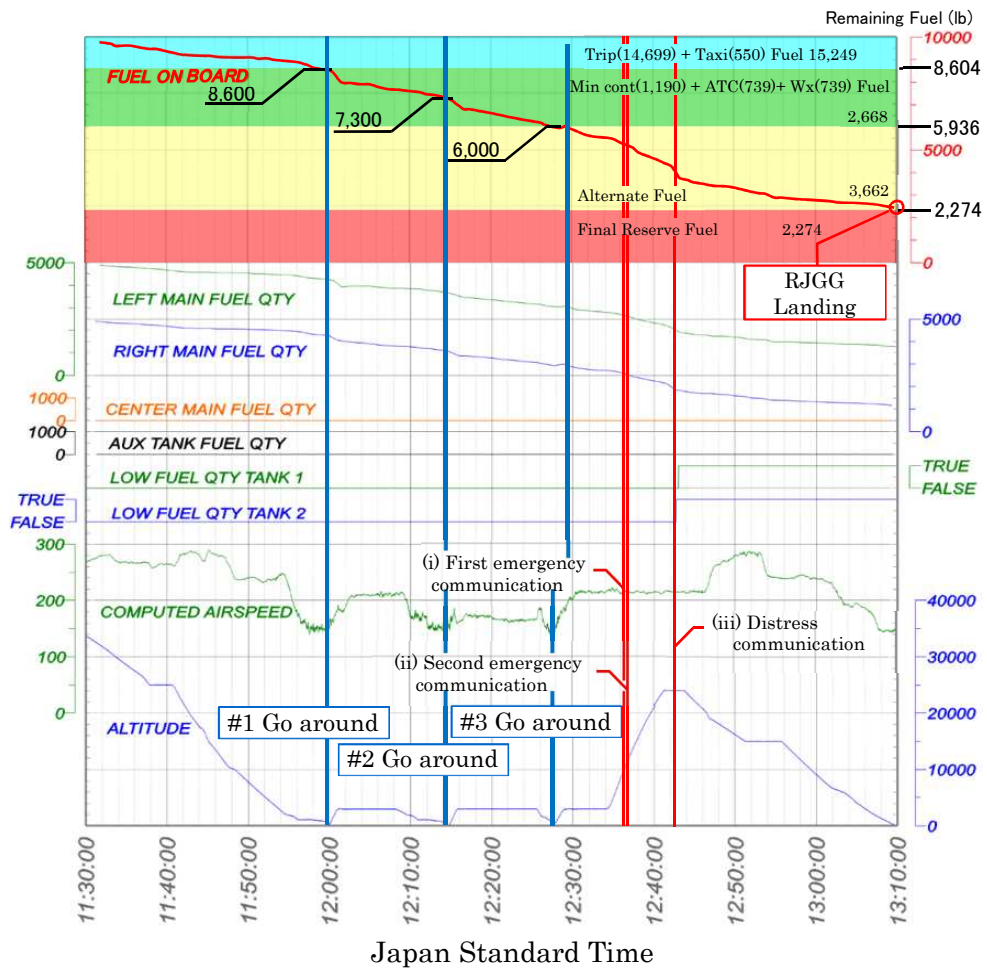


Figure 2: FDR Chart

At 12:42:40, the aircraft sent the distress communication (communication commencing with distress signal of MAYDAY, MAYDAY, MAYDAY) (see Figure 1 and 2(iii)). Tokyo ACC gave the priority on the air traffic control to the aircraft and instructed to fly directly to Chubu Airport.

The flight crew could not recall whether they informed, prior to the emergency communication, the MINIMUM FUEL (detailed in 2.7 (3)) stipulated to conduct in the FOM in flight from Toyama airport to Chubu Airport. It could not be confirmed from ATC communication records whether the aircraft informed MINIMUM FUEL in flight from Toyama airport to Chubu Airport.

The aircraft landed at Chubu Airport at 13:10 with the priority on the air traffic control being granted. The remaining fuel quantity after landing was 2,480 lb.

The serious incident occurred about 15 nm north of Toyama airport at an altitude of 9,600 ft (36°53' 14" N, 137° 12' 41" E) and the time of the occurrence was July 8, 2018 around 12:36.

2.2 Injuries to Persons	None
2.3 Damage to Aircraft	None

2.4 Personnel Information	<p>Captain Male, Age 46</p> <p>Airline transport pilot certificate (Airplane) April 10, 2010</p> <p>Type rating for Boeing 737 April 10, 2014</p> <p>Class 1 aviation medical certificate</p> <p>Validity July 31, 2018</p> <p>Aviation English Proficiency Certification level 4</p> <p>Validity September 16, 2019</p> <p>Total flight time 9,808 hours 09 minutes</p> <p>Total flight time on the type of aircraft 4,526 hours 52 minutes</p> <p>First Officer Male, Age 34</p> <p>Commercial pilot certificate (Airplane) January 2, 2018</p> <p>Type rating for Boeing 737 January 2, 2018</p> <p>Instrument flight certificate January 2, 2018</p> <p>Class 1 aviation medical certificate</p> <p>Validity June 30, 2019</p> <p>Aviation English Proficiency Certification level 5</p> <p>Validity December 4, 2023</p> <p>Total flight time 505 hours 59 minutes</p> <p>Total flight time on the type of aircraft 228 hours 17 minutes</p>
2.5 Aircraft Information	<p>Type Boeing 737-800</p> <p>Serial number 61777</p> <p>Date of manufacture February 23, 2017</p> <p>Certificate of airworthiness No. 107-02-037</p> <p>Validity February 23, 2019</p> <p>When the serious incident occurred, the weight and balance of the aircraft were within the allowable range.</p> <p>Flight time since the last periodic check (A8 check conducted on June 25, 2018) 74 hours 35 minutes</p>
2.6 Meteorological Information	<p>(1) Meteorological aerodrome routine report (METAR) at Toyama airport around the time of the serious incident were as follows:</p> <p>12:00 Wind direction 360°; Wind velocity 9 kt; Prevailing Visibility 10km or more</p> <p>Cloud: Amount FEW (1/8 – 2/8), Cloud base 1,000 ft Amount SCT (3/8 – 4/8), Cloud base 9,000 ft</p> <p>Temperature 28°C; Dew point 22°C ;</p> <p>Altimeter setting (QNH): 29.92 inHg</p> <p>(2) General weather forecasts in Toyama Prefecture</p> <p>General weather forecasts around the time of serious incident issued by Toyama Meteorological Observatory were as follows:</p> <p>A front was stationary over western and northern Japan.</p> <p>It would be cloudy or clear in the prefecture.</p> <p>It was forecasted that a front would continue to be stationary over the mainland of Japan, possibly leading to very unstable atmospheric conditions. Due to the conditions, it would be cloudy and occasionally clear, however, it would partly be raining or thunderstorm until around early at night.</p>

2.7 Additional Information	<p>(1) Flight Plan of the aircraft</p> <p>Flight rules: Instrument Flight Rules</p> <p>Departure aerodrome: Taiwan Taoyuan International Airport in Taipei</p> <p>Estimated off-block time: 08:50</p> <p>Cruising speed: 459 kt</p> <p>Cruising altitude: FL370</p> <p>Route: (omitted) – KMC (Komatsu VORTAC) – Airway V30 – URUSI (waypoint) – NANA0 (same as on the left)</p> <p>Destination aerodrome: Toyama airport</p> <p>Total estimated elapsed time: 2 hours 55 minutes</p> <p>Fuel load expressed in endurance: 4 hours 31 minutes</p> <p>Persons on board: 155</p> <p>Alternate aerodrome: Chubu Airport</p> <p>(2) Fuel Loaded in the Aircraft</p> <p>The actual quantity of fuel loaded in the aircraft before departure met the minimum loaded fuel quantity required by the FOM with following breakdown:</p> <ul style="list-style-type: none"> ● Fuel until destination (TRIP): 14,699 lb ● Fuel from destination to alternate airport (ALTERNATE): 3,662 lb ● Final reserve fuel not expected to consume (FINAL RESERVE): 2,274 lb ● Fuel taking contingency into consideration (MIN CONT): 1,190 lb ● Fuel instructed to reserve by ATC (ATC): 739 lb ● Fuel reserved for weather conditions (WX): 739 lb ● Fuel reserved by the operator’s judgment (EXTRA): 0 lb ● Fuel required for taxiing (TAXI): 550 lb <p style="text-align: right;">Total: 23,853 lb</p> <p>(3) FOM (Flight Operation Manual) of the Operator</p> <p>The following are regulated in the FOM of the operator. This regulation is in conformity with the Annex of the International Civil Aviation Organization (ICAO).</p> <p><i>5.13.3 Low Fuel Status</i></p> <p>A. (omitted)</p> <p>B. <i>When the estimated fuel remaining for landing at specific airport is around Final Reserve Fuel, an aircraft’s fuel supply has reached a state where little or no delay can be accepted. PIC shall declare “MINIMUM FUEL” to avoid further delay.</i></p> <p>C. <i>When it becomes obvious that the remaining fuel for landing at nearest airport will be less than Final Reserve Fuel, ATC must be advised by declaring “MAYDAY, MAYDAY, MAYDAY, FUEL”.</i></p>
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3. ANALYSIS

3.1 Involvement of Weather	None
3.2 Involvement of Pilot	None
3.3 Involvement	None

of Aircraft	
3.4 Analysis of Findings	<p>(1) Attempt to Land at Toyama Airport</p> <p>The remaining fuel quantity at the time of commencing the first go-around was about 8,600 lb and the same of the second go-around was about 7,300 lb. From this, it is highly probable that fuel consumption per approach was about 1,300 lb.</p> <p>It is probable that, after the second go-around, the aircraft entered the third approach because the wind condition was suitable, and the estimated remaining fuel quantity after the third go-around exceeded the total of ALTERNATE and FINAL RESERVE. However, it is probable that the remaining fuel quantity after the third approach, if landing could not be made successfully, could be estimated to become about 6,000 lb because the estimated fuel consumption per approach at Toyama airport was about 1,300 lb.</p> <p>It is highly probable that the remaining fuel quantity became close to FINAL RESERVE when the aircraft landed at Chubu Airport because the remaining fuel quantity of about 6,000 lb was almost equal to the total of ALTERNATE and FINAL RESERVE.</p> <p>(2) Emergency Communication</p> <p>(i) First and Second Emergency Communication of the Aircraft</p> <p>After the third go-around at Toyama airport, the destination airport, the aircraft called in Tokyo ACC and requested the destination change to Chubu Airport. About five minutes later, the aircraft conducted the emergency communication. About 40 seconds thereafter, the aircraft conducted the second emergency communication and requested short-cut to Chubu Airport. From the remaining fuel quantity of 5,200 lb at this time, and it is probable that the aircraft reached a state where little or no delay could be accepted and the state had been continuing since the third go-around was conducted, it is probable that it should have declared MINIMUM FUEL at an earlier stage after conducting the third go-around in accordance with the stipulations of the FOM.</p> <p>(ii) Recognition of Emergency Communication</p> <p>Tokyo ACC asked the aircraft to repeat the call sign in response to the first emergency communication and the flight route to Chubu Airport in response to the second one because it was unable to recognize the urgent signal at the beginning of the emergency communications due to the unclear transmissions from the aircraft.</p> <p>However, it is highly probable that Tokyo ACC was unable to recognize the emergency communications because the urgent signal was not included in transmissions from the aircraft in the subsequent emergency communications between the aircraft and Tokyo ACC. It is probable that Tokyo ACC could have been able to recognize the emergency communication, if the aircraft repeatedly transmitted urgent signals, because the contents of the communication following the first and the second emergency signals were recognized by Tokyo ACC.</p> <p>According to the ATC communication records, it was confirmed that the</p>

communications from the aircraft were partially unclear. This means that clear communications continued during communications between the Aircraft and Toyama Tower and communications with Tokyo ACC after emergency communications. This means that it is somewhat likely that the unclear communications were temporarily caused by complex influences of altitude, topography, weather, or the like, not by malfunction of the radio equipment or the like because the clear communications between the aircraft and Toyama Tower prior to the unclear communications and the same with Tokyo ACC afterward were continuously conducted.

(iii) ATC Communications under Low Fuel Status

In this serious incident, the aircraft conducted the emergency communications and the distress communication based on the judgment of the critical fuel status. It is probable that the flight crew conducted the distress signal in order to gain the attention to the situation of critical fuel from Tokyo ACC. However, the terms of “PAN-PAN, PAN-PAN, PAN-PAN” and “MAYDAY, MAYDAY, MAYDAY” were used, not “MINIMUM FUEL” and “MAYDAY, MAYDAY, MAYDAY FUEL” that are regulated to use for the case of low fuel situation by FOM of the operator that conforms to ICAO regulations.

The terms in accordance with international standard and FOM that conforms to international standard should be used, because it is necessary to communicate accurately and promptly any time in air traffic control communication.

(3) Remaining Fuel Quantity of the Aircraft at the Time of Landing

The actual flight route of the aircraft from Toyama airport to Chubu Airport was different from the one via Komatsu VORTAC (KMC) planned by the flight log of the aircraft before flight. Calculation of the distance of the flight route showed that the flight route via Matsumoto VOR/DME (MBE) was shorter than the planned flight route.

It is highly probable that the aircraft was not in shortage of fuel, because it is probable that the flight of the aircraft to Chubu Airport had no delay, and the remaining fuel quantity after landing at Chubu Airport was not below FINAL RESERVE.

4. PROBABLE CAUSES

It is highly probable that the serious incident was caused by the landing conducted in the situation that the remaining fuel quantity was close to FINAL RESERVE after emergency communications.

It is somewhat likely that consuming a fair quantity of the reserve fuel when attempting to land at the destination airport multiple times contributed to the remaining fuel quantity at landing, which was close to FINAL RESERVE. Besides, it is highly probable that the aircraft was not in shortage of fuel since the remaining fuel quantity at the time of landing was not below FINAL RESERVE.