



DUTCH  
SAFETY BOARD

# **Preliminary report** Crash involving Malaysia Airlines Boeing 777-200 flight MH17

Hrabove, Ukraine - 17 July 2014

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## Crash involving Malaysia Airlines Boeing 777-200 flight MH17

Hrabove, Ukraine - 17 July 2014

*The Hague, September 2014*

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# PRELIMINARY REPORT

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The International Civil Aviation Organization (ICAO), is a specialized agency of the United Nations, created in 1944 upon the signing of the Convention on International Civil Aviation. ICAO works with 191 Member States to develop international Standards and Recommended Practices (SARPs) for safe, efficient and secure flight operation worldwide. These Standards and Recommended Practices are reflected in Annexes. In Annex 13 - Aircraft Accident and Incident Investigation - to the Convention of International Civil Aviation, Standards and Recommended practices are described for the conducting of civil aviation accident investigation.

In accordance with paragraph 3.1 of ICAO Annex 13, the sole objective of this investigation is the prevention of similar accidents and incidents. It is not the purpose of this activity to apportion blame or liability in respect of any party.

The State of Occurrence shall institute an investigation into the circumstances of the accident and be responsible for the conduct of the investigation, but it may delegate the whole or any part of the conducting of such investigation to another State by mutual arrangement and consent (paragraph 5.1).

In the case of this occurrence, Ukraine requested the Netherlands to conduct the delegated investigation. This was formally agreed upon, in writing, on 23 July 2014. The investigation is conducted by the Dutch Safety Board.

According to paragraph 7.1 of the Annex, a preliminary report shall be submitted to appropriate States and to ICAO within 30 days after the occurrence.

For the purpose of drafting the preliminary report of what is a complex investigation, the date of publication of the preliminary report was extended by approximately three weeks.

When the aircraft involved in an accident is of a maximum mass of over 2250 kg, the State conducting the investigation shall send the Preliminary Report to:

- the State of Registry or the State of Occurrence, as appropriate;
- the State of the Operator;
- the State of Design;
- the State of Manufacture;
- any State that provided relevant information, significant facilities or experts;
- the International Civil Aviation Organization.

This preliminary report contains the initial information of the investigation into the occurrence involving a B777-200 registered as 9M-MRD performing flight MH17 from Amsterdam Airport Schiphol to Kuala Lumpur International Airport on 17 July 2014. This information is published to inform the aviation industry and the public of the general

circumstances of this occurrence and the investigation progress to date. The information must necessarily be regarded as tentative and subject to alteration or correction if additional evidence becomes available.

The draft preliminary report has been sent to the Accredited Representatives of the States that participate in the investigation, Malaysia, Ukraine, the Russian Federation, the United Kingdom, the United States of America and Australia for review. All Accredited Representatives have sent a reaction. The Dutch Safety Board assessed the provided suggestions and amended the report where appropriate.

This preliminary report is published under what are complex circumstances to conduct the investigation. It is possible that the scope may change as the investigation progresses. Further work will at least include the following areas of interest to substantiate the factual information regarding:

- analyses of data, including CVR, FDR and other sources, recorded onboard the aircraft;
- analyses of recorded ATC surveillance data and radio communication;
- analyses of the meteorological circumstances;
- forensic examination of wreckage, if recovered and possible foreign objects, if found;
- result of the pathological investigation;
- analyses of the in-flight break up sequence;
- assessment of the operator's and State of Occurrence's management of flight safety over a region of conflict or high security risk;
- any other areas that are identified during the investigation.

All times in this report are given in UTC.<sup>1</sup>

Ukraine local time (Eastern European Daylight Saving Time) was 3 hours ahead of UTC (UTC+3).

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<sup>1</sup> Coordinated Universal Time (UTC) is the basis for world time standard.

<b>Preliminary report</b> .....	<b>3</b>
<b>1. Introduction</b> .....	<b>7</b>
1.1 General information .....	7
1.2 The investigation .....	7
<b>2. Findings</b> .....	<b>11</b>
2.1 History of the flight.....	11
2.2 Injuries to persons .....	12
2.3 Damage to the aircraft .....	13
2.4 Air Traffic Management.....	13
2.4.1 General information .....	13
2.4.2 Standard flight levels.....	13
2.4.3 Airspace restrictions .....	13
2.5 Air Traffic Control .....	14
2.5.1 ATC surveillance data .....	14
2.5.2 ATC communication .....	14
2.5.3 Other traffic .....	14
2.5.4 ATC transcript.....	14
2.6 Personnel information .....	16
2.7 Aircraft information .....	16
2.8 Meteorological information.....	17
2.9 Flight recorders .....	18
2.9.1 Recovery.....	18
2.9.2 Cockpit voice recorder.....	19
2.9.3 Flight data recorder.....	20
2.10 Wreckage and impact information.....	21
2.10.1 Wreckage distribution .....	21
2.10.2 Cockpit and forward area damage .....	22
2.10.3 The main wreckage site (main site).....	25
2.10.4 Aft part of the fuselage .....	26
<b>3. Summary of Findings</b> .....	<b>29</b>
<b>4. Safety actions</b> .....	<b>31</b>
<b>5. Further investigations</b> .....	<b>32</b>
<b>Appendix A. Preliminary FDR data</b> .....	<b>33</b>

## Dutch Safety Board

Chairman: T.H.J. Joustra  
E.R. Muller  
M.B.A. van Asselt

B.J.A.M. Welten (Extraordinary Board Member)

General Secretary: M. Visser

Visiting address: Anna van Saksenlaan 50  
2593 HT The Hague  
The Netherlands

Postal address: PO Box 95404  
2509 CK The Hague  
The Netherlands

Telephone: +31 (0)70 333 7000

Fax: +31 (0)70 333 7077

Website: [www.safetyboard.nl](http://www.safetyboard.nl)

NB: This report is published in the Dutch and English languages. If there is a difference in interpretation between the Dutch and English versions, the English text will prevail.

# 1 INTRODUCTION

## 1.1 General information



Figure 1: Archive photo of aircraft involved. (source: Mir Zafriz, Planespotters.net)

Occurrence number:	LV2014080
Aircraft type and registration:	Boeing 777-2H6ER, 9M-MRD
No & Type of Engines:	2 x Rolls-Royce Trent 892B
Location:	Near Hrabove, Ukraine
Date and time (UTC):	17 July 2014 at 13.20 hrs
Type of flight:	Scheduled passenger flight
Persons on board:	Crew - 15 (4 flight crew, 11 cabin crew); Passengers - 283
Injuries:	Crew - 15 (fatal); Passengers - 283 (fatal)
Nature of damage:	Aircraft destroyed

## 1.2 The investigation

On 18 July 2014 around 06.00 hrs the National Bureau of Air Accident Investigation of Ukraine (NBAAI) sent a notification that on 17 July 2014, at 13.20 hrs, a Boeing 777-200 with registration 9M-MRD of Malaysia Airlines disappeared to the west of TAMAK waypoint. The NBAAI was notified by the Ukrainian State Air Traffic Service Enterprise (UkSATSE) that communication with the flight crew had been lost. A signal from the aircraft's Emergency Locator Transmitter (ELT) had been received and its approximate position had been determined.

According to paragraph 4.1 of ICAO Annex 13 - *Aircraft Accident and Incident Investigation*, the notification was sent to Malaysia (State of Registry and State of the Operator), the

United States of America (State of Design and State of Manufacture) and the International Civil Aviation Organization (ICAO). The notification was also sent to the Netherlands and Australia as states having suffered fatalities.

The NBAAI commenced an investigation on the day of the occurrence. The investigation was delegated to the Dutch Safety Board on 23 July 2014. The investigation is ongoing and a final report will be published in due course. The Dutch Safety Board was assisted by experts from Australia (ATSB), France (BEA), Germany (BFU), Indonesia (NTSC), Italy (ANSV), Malaysia (DCA), the Russian Federation (Federal Air Transport Agency), Interstate Aviation Committee (IAC)<sup>2</sup>, Ukraine (NBAAI), the United Kingdom (AAIB), the United States of America (NTSB) and the European Aviation Safety Agency (EASA). In addition, several other countries offered their support to the Dutch Safety Board investigation team. At the time of their offer, no immediate support was needed, but their offer was much appreciated. The International Civil Aviation Organization (ICAO) has advised the Dutch Safety Board in procedural matters to ensure full compliance with the standards and recommended practices set forth in Annex 13.

The occurrence took place over open farmland south and west of the village of Hrabove in eastern Ukraine. At the time of the occurrence an armed civil conflict was ongoing in Ukraine, between armed groups and Ukrainian armed forces. The aircraft parts came down in the area that was under control of the armed groups.

Coordinated access to the wreckage site by the international team of air safety investigators has not yet been possible. It is the intention of the Dutch Safety Board to visit the site whenever it is possible to safely conduct further investigation of the wreckage. However, investigators of the NBAAI made a number of short visits to the site between 19 July 2014 and 21 July 2014, and took photographs of items of wreckage. These photographs were made available to the investigation team. The investigator-in-charge (IIC) of the Dutch Safety Board investigation also received photographs and a report from the Malaysian investigation team, regarding the team's onsite investigation. That investigation was carried out on their own initiative between 22 July 2014 and 24 July 2014. The information received is used in this Dutch Safety Board investigation.

The investigation team conducted their investigation from Kiev (Ukraine) for three weeks. After this period the team was relocated to the Dutch Safety Board office in the Netherlands. In accordance with ICAO Annex 13, the Dutch Safety Board investigation team includes Accredited Representatives<sup>3</sup> and Technical Advisers from Malaysia (State of Operator and State of Registry), Ukraine (State of Occurrence), the Russian Federation (State that provided information on request), the United Kingdom (State of Design and Manufacture of the engines) the United States of America (State of Design and Manufacture of the aircraft) and Australia (State that provided information on request).

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<sup>2</sup> The Interstate Aviation Committee (IAC) is a regional organization involved in civil aircraft accident investigation in the states of the Commonwealth of Independent States (CIS).

<sup>3</sup> A person designated by a state for the purpose of participating in an investigation conducted by another state.



The investigation is making use of a wide range of information, including:

- aircraft maintenance data obtained from the operator;
- flight operational data obtained from the operator and various international service providers:
  - NOTAMs;<sup>4</sup>
  - Flight plan;
  - Weather;
  - Crew status;
- images available publicly and obtained from the NBAAI, Australian Federal Police (AFP) and DCA;
- satellite imagery taken in the days after the occurrence;
- Air Traffic Control (ATC) surveillance data obtained from UkSATSE;
- ATC surveillance data obtained from the Russian Federation;
- Flight Data Recorder (FDR) and Cockpit Voice Recorder (CVR) data from the aircraft.

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<sup>4</sup> A Notice to Airmen (NOTAM) is a notice issued by an aviation authority to alert aircraft pilots of potential hazards along a flight route or at a location that could affect the safety of the flight. NOTAMs are unclassified notices or advisories distributed by means of telecommunication that contain information concerning the establishment, conditions or change in any aeronautical facility, service, procedure or hazard, the timely knowledge of which is essential to personnel and systems concerned with flight operations.

## 2 FINDINGS

2.1	History of the flight.....	11
2.2	Injuries to persons .....	12
2.3	Damage to the aircraft .....	13
2.4	Air Traffic Management.....	13
2.4.1	General information .....	13
2.4.2	Standard flight levels.....	13
2.4.3	Airspace restrictions .....	13
2.5	Air Traffic Control .....	14
2.5.1	ATC surveillance data .....	14
2.5.2	ATC communication .....	14
2.5.3	Other traffic .....	14
2.5.4	ATC transcript.....	14
2.6	Personnel information .....	16
2.7	Aircraft information .....	16
2.8	Meteorological information.....	17
2.9	Flight recorders .....	18
2.9.1	Recovery.....	18
2.9.2	Cockpit voice recorder.....	19
2.9.3	Flight data recorder.....	20
2.10	Wreckage and impact information.....	21
2.10.1	Wreckage distribution .....	21
2.10.2	Cockpit and forward area damage .....	22
2.10.3	The main wreckage site (main site).....	25
2.10.4	Aft part of the fuselage .....	26

### 2.1 History of the flight

On 17 July 2014, a Malaysia Airlines Boeing 777-2H6ER operating as flight MH17, departed Amsterdam Airport Schiphol in the Netherlands at 10.31 hrs on a scheduled passenger flight to Kuala Lumpur International Airport in Malaysia. Malaysia Airlines had determined and filed the flight plan for flight MH17, which was approved by all involved air traffic control centres for their concerned regions. According to the flight plan, flight MH17 would initially fly at Flight Level 330 (FL330)<sup>5</sup> above Ukraine until the waypoint PEKIT, which is on the Flight Information Region (FIR) boundary between Kiev FIR (UKBV) and Dnipropetrovs'k FIR (UKDV). From waypoint PEKIT the flight plan indicates FL350 for the remaining part over Ukraine.

According to ATC data, at 12.53 hrs the aircraft was flying within the Dnipropetrovs'k FIR, Control Sector 2, at FL330, controlled by Dnipro Control. At that time, Dnipro Control asked whether MH17 was able to climb to FL350 in accordance with the flight plan of MH17 and also to clear a potential separation conflict with other traffic in the area, another Boeing 777 flying at FL330 and approaching from behind.

The crew replied they were unable to comply and requested to maintain at FL330. This was agreed by Dnipro Control. As an alternative to solve the separation conflict, the other traffic climbed to FL350. According to ATC data, at 13.00 hrs the crew of flight MH17 requested to divert the track 20 NM to the left, due to weather. This also was agreed by Dnipro Control, after which the crew requested whether FL340 was available. Dnipro control informed MH17 that FL340 was not available at that moment and instructed the flight to maintain FL330 for a while. At 13.07 hrs the flight was transferred to Dnipropetrovs'k CTA 4, also with call sign Dnipro Control.

At 13.19:53 hrs, radar data showed that the aircraft was 3.6 NM north of centreline of airway L980 having deviated left of track, when Dnipro Control directed the crew to alter their route directly to waypoint RND due to other traffic. The crew acknowledged at 13.19:56 hrs. At 13.20:00 hrs, Dnipro Control transmitted an onward ATC clearance to proceed direct to TIKNA after RND, no acknowledgement was received.

Data from the Flight Data Recorder and the Digital Cockpit Voice Recorder both stopped at 13.20:03 hrs. No distress messages were received from the aircraft.

<sup>5</sup> FL330 equals approximately 33,000 feet (10,058 kilometer).

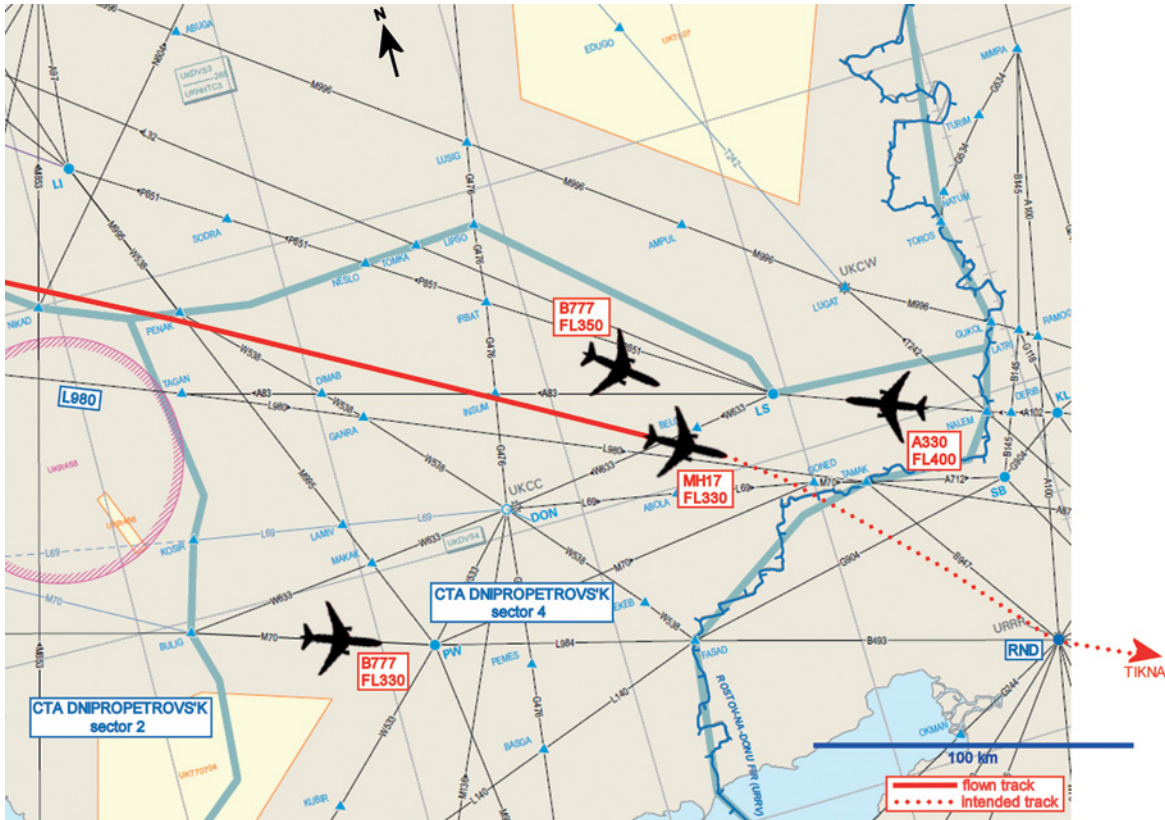


Figure 2: Image of the Dnipropetrovsk FIR, CTA 2 and 4, the flown (red line) and ATC cleared (dotted red line) route of flight MH17. Also the aircraft type and flight level of the three commercial aircraft flying in the same area are shown (see 2.5.3). The image depicts the situation at 13.20 hrs (source: UkSATSE).

## 2.2 Injuries to persons

Flight MH17 was carrying 283 passengers and 15 crew members. There were no survivors. The crew members were all citizens of Malaysia. The occupants of the aircraft were citizens of the following countries:

The Netherlands	193
Malaysia	43
Australia	27
Republic of Indonesia	12
United Kingdom	10
Federal Republic of Germany	4
Belgium	4
Republic of the Philippines	3
Canada	1
New Zealand	1

The nationalities indicated above reflect the information provided by the airline, based on the passports that were used for check-in. Some of the passengers had multiple nationalities causing differences in nationality numbers published in the media.

## **2.3 Damage to the aircraft**

The aircraft was destroyed. Wreckage was dispersed over a large area.

## **2.4 Air Traffic Management**

### **2.4.1 General information**

The functional entities involved in Air Traffic Management (ATM) in Ukraine are: the Ministry of Infrastructure, the Ministry of Defence, the State Aviation Authority of Ukraine (SAAU) and the Ukrainian State Air Traffic Service Enterprise (UkSATSE) which is the State en-route Air Navigation Service Provider (ANSP). Ukraine is a member of Eurocontrol and organises its ATM in accordance with the concept of the Flexible Use of Airspace. The concept of flexible use includes civil-military coordination and this is facilitated in Ukraine by having joint civil-military departments within UkSATSE.

### **2.4.2 Standard flight levels**

For IFR air traffic the general principle of standard flight levels apply: odd thousands of feet (flight levels 310, 330, 350) when on a magnetic track of 0° through 179° degrees and even thousands of feet (flight levels 300, 320, 340) when on a magnetic track of 180° through 359°. Other flight levels may be available by ATC clearance.

For flight MH17, following route L980 on an eastbound track, it was kept to the odd standard flight levels as depicted in its flight plan for this part of its routing: FL330 and FL350.

### **2.4.3 Airspace restrictions**

At the time of the occurrence, flight MH17 was flying through the Dnipropetrovsk (UKDV) FIR in the eastern part of the Ukraine. UkSATSE had issued NOTAMs that restricted access to the airspace below FL320 in the southern part of the FIR due to hostilities between armed groups and Ukrainian armed forces.

NOTAM A1383/14 established a Temporary Reserved Area from the surface to FL260 within its defined area in the east of Ukraine. The NOTAM was valid from 00.00 hrs on 1 July 2014 until 23.59 hrs on 28 July 2014. The text of the NOTAM states that state aircraft of Ukraine were authorized and that Civil Aircraft need to have permission of the headquarters of the Ukraine armed forces to fly in the area mentioned in the NOTAM below FL260.

NOTAM A1492/14 established a Temporary Restricted Area from FL260 to FL320 within an area covering the eastern part of the Temporary Reserved Area established by NOTAM A1383/14. NOTAM A1492/14 was valid from 18.00 hrs on 14 July 2014 until 23.59 hrs on 14 August 2014. The restriction did not apply for flights of Ukraine state aircraft.

At the time of the occurrence, flight MH17 was flying at FL330 in unrestricted airspace above the restricted area mentioned by the latest NOTAM.

## 2.5 Air Traffic Control

### 2.5.1 ATC surveillance data

For this investigation ATC surveillance data was obtained from both Ukraine (UkSATSE) and the Russian Federation. The data obtained was the following:

- Primary surveillance radar recorded by the Russian surveillance aids
- Secondary surveillance radar (SSR / Mode S)<sup>6</sup>
- Automatic Dependant Surveillance – Broadcast (ADS-B)<sup>7</sup> ground based reception.

Preliminary information shows that Ukrainian and Russian ATC surveillance radar identified flight MH17 as a B777-200 at FL330. Analyses of recorded ATC surveillance data is ongoing.

### 2.5.2 ATC communication

At the time of the occurrence flight MH17 was under control of Dnipropetrovs'k air traffic control centre (Dnipro Radar). Shortly after 13.20 hrs, both Ukraine and Russian Federation Radar lost contact with the aircraft. The last radio transmission made by the crew began at 13.19:56 hrs and ended at 13.19:59 hrs. Dnipropetrovs'k air traffic control centre made a radio transmission to flight MH17 which began at 13.20:00 hrs and ended at 13.20:05 hrs. The crew did not respond to this transmission or subsequent transmissions. No distress message was received from the aircraft at any point in time by ATC.

### 2.5.3 Other traffic

According to information received from the NBAAI, recorded ATC surveillance information revealed that three other commercial airliners overflew the same restricted airspace as flight MH17 around the time of the occurrence. Two of those aircraft were cruising eastbound and one was cruising westbound. All were under control of Dnipro Radar. At 13.20 hrs the distance between MH17 and the closest of the three aircraft was approximately 30 kilometres. Analyses is ongoing.

### 2.5.4 ATC transcript

UkSATSE provided the recording and a transcript of the radio (RAD) and telephone communications regarding flight MH17. At 13.08 hrs flight MH17 reported to Dnipro Radar (DNP), sector 4, flying at FL330. After checking over the telephone (TEL, translated from Russian) with Rostov Control (RST, Russia), at 13.19:49 hrs flight MH17 was cleared to proceed via waypoint RND, this was confirmed by the crew. At 13.20:00 hrs Dnipro cleared flight MH17 to fly direct to waypoint TIKNA after passing RND, this clearance was not read back. From that time until 13.35:50 hrs, DNP called MH17 several times, but no answer was received. The crew of another aircraft that was flying in the neighborhood, was asked if they had MH17 in sight or if the aircraft was visible on the aircraft instruments. The crew of this aircraft answered that they did not see the aircraft and that the aircraft instruments did not show flight MH17.

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<sup>6</sup> SSR determines information about the aircraft's identification, position, altitude based on the return of a signal sent from the ground station to which the aircraft replies.

<sup>7</sup> ADS-B is an aircraft based technology whereby information from the aircraft is broadcasted to ground stations.

Time	From	To	Means	Text
13:08:00	MH17	DNP	RAD	Dnipro Radar, MALASIAN one seven, flight level 330
	DNP	MH17	RAD	MALASIAN one seven, Dnipro Radar, good day, radar contact
	MH17	DNP	RAD	MALASIAN one seven
13:19:21	DNP	RST	TEL	Yes
	RST	DNP	TEL	So. Dniepr, Rostov one. Can you give a course (direction) for Malaysian to Rostov to the RND point, we have three of those there
	DNP	RST	TEL	To the Malaysian that is seventeen?
	RST	DNP	TEL	Yes, we will return it back then to TIKNA
	DNP	RST	TEL	Great (ok)
	RST	DNP	TEL	Yes, thanks
13:19:49	DNP	MH17	RAD	MALASIAN one seven, due traffic proceed direct to point ROMEO NOVEMBER DELTA
13:19:56	MH17	DNP	RAD	ROMEO NOVEMBER DELTA, MALASIAN one seven
13:20:00	DNP	MH17	RAD	MALASIAN one seven, and after point ROMEO NOVEMBER DELTA expect direct to TIKNA
13:21:10	DNP	MH17	RAD	MALASIAN one seven, how do you read me? MALASIAN one seven, Dnipro Radar
13:21:36	DNP	MH17	RAD	MALASIAN one seven, Dnipro Radar
13:22:02	DNP	MH17	RAD	MALASIAN one seven, Dnipro Radar
13:22:05	RST	DNP	TEL	Listening (to) you, its Rostov
	DNP	RST	TEL	Rostov, do you observe the Malaysian by... by the response?
	RST	DNP	TEL	No, it seems that its target started falling apart.
	DNP	RST	TEL	Well, its not responding for our calls too
	RST	DNP	TEL	And not responding for the calls, yes?
	DNP	RST	TEL	Yes. And we don't see it yet. So you gave them a turn, they confirmed and...
	RST	DNP	TEL	And that's all, yes?
	DNP	RST	TEL	Yes its disappeared
	RST	DNP	TEL	Wait, I'll ask
	DNP	RST	TEL	Don't you observe anything on primary?
	RST	DNP	TEL	Yes, yes, yes, nothing. We see nothing
	DNP	RST	TEL	Ok then, we are calling them here now

Tabel 1: Transcript of radio- and telephone communication.

At the time of the occurrence, the aircraft was flying in unrestricted airspace, under control of ATC, following the route and flying the altitude as cleared by ATC.

## 2.6 Personnel information

Because of the duration of the flight the flight crew consisted of four persons, two pilots and two relief pilots. According to the information received from Malaysia Airlines all flight crew members were appropriately qualified to operate a Boeing 777 in commercial passenger operation and had valid medical certificates. Both captains had over 10,000 flying hours of which more than 7,000 hours were on Boeing 777 aircraft. Both first officers had more than 3,000 flying hours, of which a little over 200 hours were on Boeing 777 aircraft.

The cabin crew consisted of eleven persons.

According to the information received from Malaysia Airlines the crew was properly licensed and had valid medical certificates to conduct the flight.

## 2.7 Aircraft information

The aircraft, a Boeing 777-2H6ER, was a wide-body passenger transport aircraft powered by two Rolls-Royce Trent 892B engines. It was manufactured in the United States of America in 1997 and had serial number 28411.

According to data received from the operator the aircraft was released to service on 16 November 2013 after an overhaul had been accomplished.<sup>8</sup> The last maintenance check, a short inspection<sup>9</sup> was performed on 16 April 2014.

The inbound flight to Amsterdam Airport Schiphol preceded the accident flight. Technical documents obtained from the handling agent at Schiphol revealed that during the turnaround at Amsterdam Airport Schiphol engine oil was added to engine number 1 (left engine). In the documents it was noted that the oil consumption during the inbound flight was within limits. No technical complaints about the aircraft or its systems were reported. In the transit check document it was certified that the refuelling and transit check had been carried out for its flight to Kuala Lumpur International Airport.

According to the documents, the aircraft was in an airworthy condition at departure, there were no known technical malfunctions.

<sup>8</sup> This maintenance was a D-check inspection. Malaysian Airlines regulations require this check to be carried out every 8 years.

<sup>9</sup> This maintenance was a A-check inspection. Malaysian Airlines performs this inspection every 550 flight hours.



## 2.8 Meteorological information

Weather information was obtained from the Royal Netherlands Meteorological Institute (KNMI) and the UK Met Office.

At the time of the occurrence, an active trough with cumulonimbus cloud and thunderstorm activity was affecting Ukraine, with the most intense activity along a line extending north-westwards from Crimea towards Western Ukraine. More isolated thunderstorms were apparent closer to the location of the occurrence, with some lightning strikes recorded to the southwest of Donetsk.

Analyses of ground observations show that in the vicinity of the occurrence multiple thundershowers were reported. Just to the west-south-west of the last known position of the aircraft, cumulonimbus (CB) clouds reaching up to FL350 were present at the time.

According to meteorological actual reports, the conditions were generally cloudy across the area, with the observations recording a broken cloud layer at around 10,000 feet. Visibilities across the region were good, at 10 km or more, and the lowest reported cloud bases were some scattered layers at 3300 feet at UKDD (Dnipropetrovs'k, Ukraine) and UKDE (Zaporizhzhia / Mokraya, Ukraine).

The winds at the surface were north or north-easterly, and tended to gradually veer with height, eventually settling on a south-westerly direction from around 23,000 feet, after which they increased in speed with height towards the tropopause, which was indicated around 40,000 feet. The reported wind at FL320 was from 166 degrees at 13 kts.

In the area three different types of weather could be distinguished, which is depicted in figure 3.

The green area (includes the area of occurrence) contains mainly Cumulus and Towering Cumulus clouds. The cloud coverage is between 3/8 and 6/8, the cloud base is around 3,000 to 5,000 feet. The tops of the clouds reach around FL100 (10,000 feet).

The orange area contains mainly Cumulonimbus clouds (rainclouds). The cloud coverage is mostly 8/8. The cloud base is around 3,000 to 5,000 feet, with the tops of the clouds reaching FL350 (35,000 feet).

The red area contains mainly Altostratus and Cirrus clouds, with cloud coverage being mostly 8/8, and the cloud base around 10,000 to 20,000 feet. The red area contains mostly thin layered clouds reaching 20,000 to 30,000 feet at places.

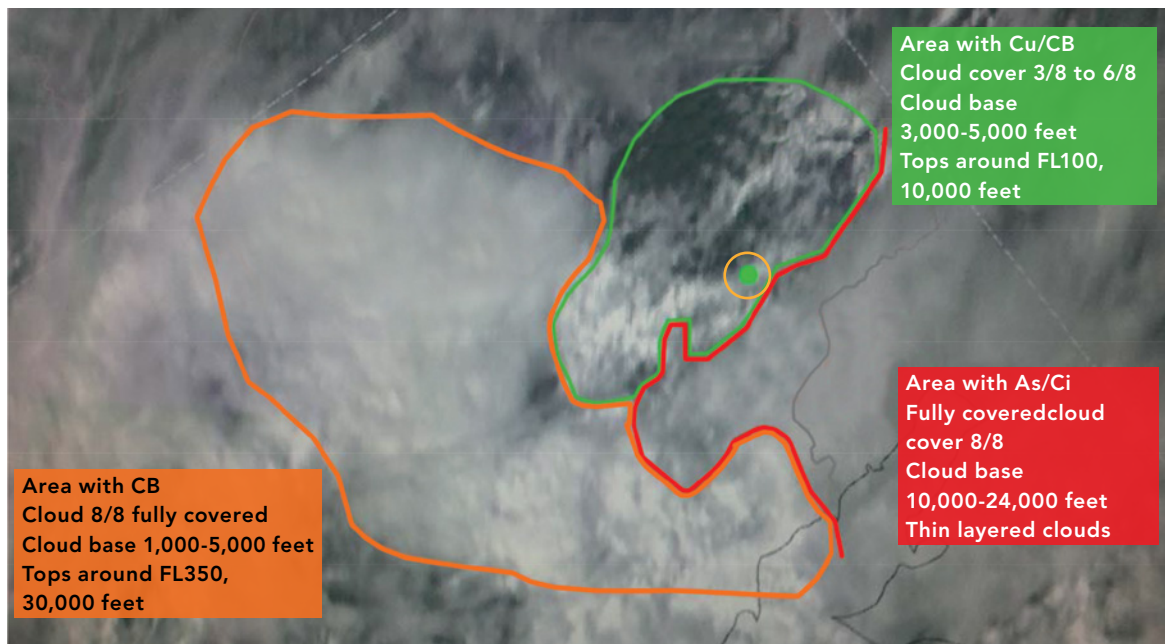


Figure 3: Cloud coverage for 17 July at 12.00 hrs.<sup>10</sup> The circled green dot indicates the last position of aircraft. The orange area south-west of the accident location contains mostly Cumulonimbus clouds with possible thundershowers. (Source: KNMI)

Analyses of the meteorological situation is ongoing.

## 2.9 Flight recorders

### 2.9.1 Recovery

The flight recorders were not recovered from the wreckage site by investigators of the Annex 13 investigation team, but individuals unknown to the team took them from the site. On 21 July 2014, the recorders were handed over to a Malaysian official in Donetsk by representatives of the armed group controlling the area. The recorders were transported by train from Donetsk to Kharkiv in custody of a Malaysian official and accompanied by Dutch officials and then transported to Kiev also in custody of a Malaysian official and accompanied by Dutch and ICAO officials. In Kiev the recorders were handed over to the Dutch Safety Board on 22 July 2014.

Immediately after the handover to the Dutch Safety Board, the recorders were transported to the Air Accidents Investigation Branch's laboratory at Farnborough, United Kingdom, accompanied by an international team of air safety investigators from Germany, Malaysia, the Netherlands, Ukraine, the United Kingdom, the United States of America and representatives of ICAO. At Farnborough a French investigator joined the team whereupon the work to download the data of both recorders was started. Later on an air safety investigator of the Interstate Aviation Committee also joined the team.

No evidence or indications of manipulation of the recorders were found.

<sup>10</sup> This image was chosen from the available satellite images. The time this image was made, was the most close to the time of the accident.

## 2.9.2 Cockpit voice recorder

### *Damage*

The housing of the CVR (figure 4) had been damaged and, although the model and serial numbers were unreadable on the data plate, the serial number 1366 - matching the one provided by Malaysia Airlines - was found stamped on the underside of the chassis. The external damage found on the CVR is consistent with impact damage, the internal memory module was intact. The recording capacity of this recorder is 30 minutes.

The full 30 minutes were successfully downloaded and contained valid data from the flight.



Figure 4: Cockpit voice recorder. (Source: AAIB)

### *Information*

The replay of the CVR matched ATC communications with the aircraft (see ATC transcript). The recording also included crew communication which gave no indication that there was anything abnormal with the flight. The CVR audio recording ended abruptly. A replay of the CVR did not identify any aircraft aural warnings or alerts of system malfunctions. Detailed analysis is ongoing.

No aural warnings or alerts of aircraft system malfunctions were heard on the cockpit voice recording, which ended at 13.20:03 hrs. Crew communication gave no indication that there was anything abnormal with the flight.

### 2.9.3 Flight data recorder

#### *Damage*

The label on the housing of the FDR (figure 5) showed that it was Allied Signal Model Number 980-4700-003 with Serial Number 2196. These details matched the details provided by Malaysia Airlines. The recorder was found damaged but the internal memory module was intact. The external damage found on the FDR was consistent with impact damage. The FDR, which can record 25 hours of operational data, was successfully downloaded and contained valid data from the occurrence flight.

#### *Identification*

Downloaded data from the flight was decoded using multiple software tools from different manufacturers. The data is consistent with other recorded information regarding the flight of Malaysia Airlines flight MH17. Furthermore the unique ICAO 24-bit aircraft address issued by the State of Registry (Malaysia) matched the recorded ICAO 24-bit aircraft address code on the FDR. The State of Registry registered the aircraft with this code as 9M-MRD.



Figure 5: Flight data recorder. (Source: AAIB)

#### *Information*

The data on the Flight Data Recorder indicated that the aircraft was flying at FL330, on a constant displayed heading of 115° and at a constant speed of 293 kts computed airspeed (groundspeed 494 kts, equals 915 kilometres per hour).

According to the data on the FDR, both engines were running at cruise power. All indications regarding the operation of the engines were normal.

No aircraft system warnings or cautions were detected. The data stopped abruptly at 13.20:03 hrs.

Relevant details from the FDR recordings are published in Appendix A (last 3 minutes). Detailed analysis is ongoing.

All engine parameters were normal for cruise flight. No aircraft system warnings or cautions for this flight were detected on the flight data recording until the recording ended at 13.20:03 hrs.

## 2.10 Wreckage and impact information

### 2.10.1 Wreckage distribution

Wreckage from flight MH17 was discovered spread over a large area near the towns of Rozsypne and Hrabove in eastern Ukraine. The main wreckage site was located 8.5 km on a bearing of 080° from the last known position of the aircraft in flight.

On the accident site, a large amount of photographs was made, which allowed identification of certain aircraft parts, including preliminary assessments of localization and the nature of damage on the fuselage skin and the engines.

The aircraft wreckage, identified from the on-site photographs and satellite images, consisted of many large and small pieces distributed over an area of approximately 10 km by 5 km (figure 6). Fuselage pieces, cargo and baggage were scattered throughout the wreckage site. There were many additional unidentified pieces that are not shown in the figure. For easy reference the wreckage site has been divided into sections as shown in figure 6. These sections match with the aircraft sections shown in figure 7.

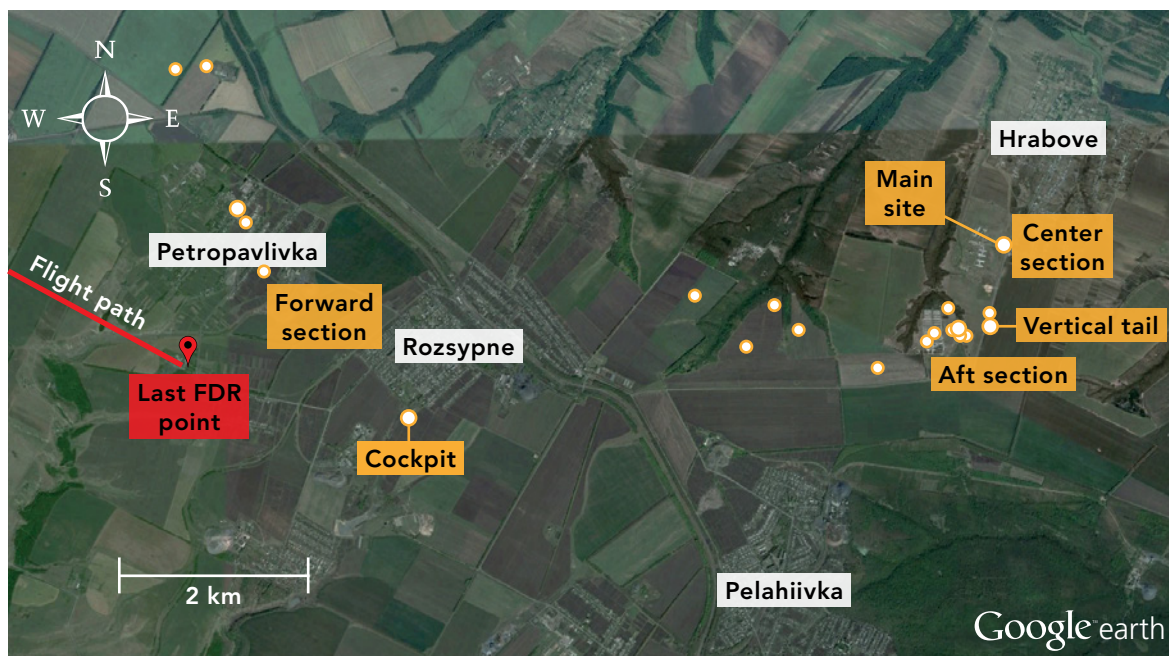
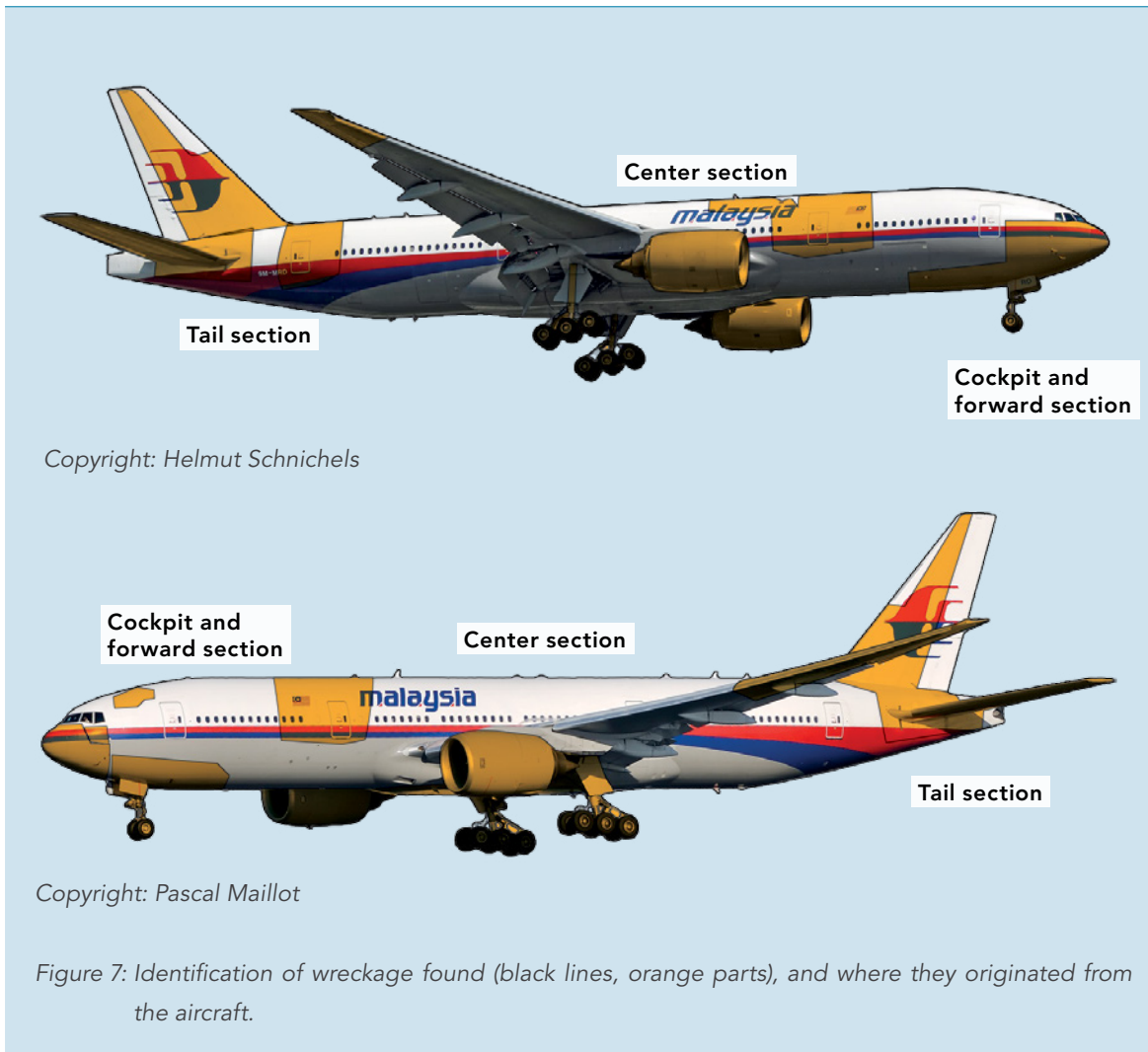


Figure 6: The last location of the aircraft in flight taken from the FDR. Wreckage distribution is grouped per section of the aircraft (Source: Google Earth, wreckage information Dutch Safety Board).



Some pictures of relevant parts of which the location was known, are discussed hereinafter.

### 2.10.2 Cockpit and forward area damage

Large parts from around the cockpit and forward section were found in the area closest to the last recorded FDR position (figure 6). Among these parts were portions of the cockpit, the forward cargo bay floor and the cockpit side wall. The remains of the cockpit were located at the southern end of Rozsypne, 2.3 km east from the last recorded FDR position.

Photographs from the some wreckage showed that a number of pieces contained multiple holes and indentations. An example of a piece of wreckage containing such damage was a piece of skin from below the left cockpit window (figure 8) found in the town of Petropavlivka.

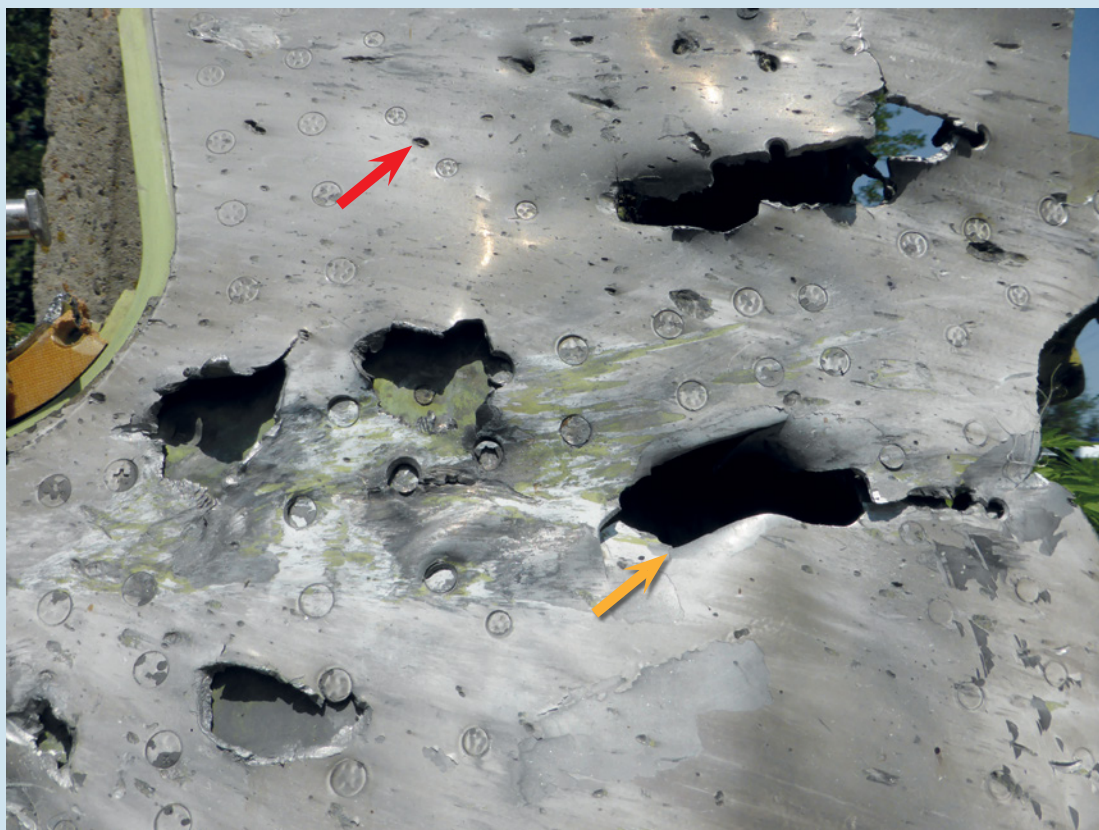


Figure 8: Forward fuselage skin from below the left cockpit window containing numerous small holes and indentations (above); enlarged image of the right upper corner of this skin (below) showing puncture holes (orange arrow) and pitting (red arrow). (Source: DCA and AFP)

Around 1.7 km north of the position where the cockpit window structure was found, was a section of the cockpit roof also showing holes indicating penetration from outside (figure 9).



Figure 9: Part of the inside cockpit roof, indicating penetration with objects from outside. (Source: DCA)

Noting that the investigation team has not yet had the opportunity to recover these components for forensic examination, photographs from the wreckage indicated that the material around the holes was deformed in a manner consistent with being punctured by high-energy objects. The characteristics of the material deformation around the puncture holes appear to indicate that the objects originated from outside the fuselage.



Puncture holes identified in images of the cockpit floor suggested that small objects entered from above the level of the cockpit floor (figure 10).

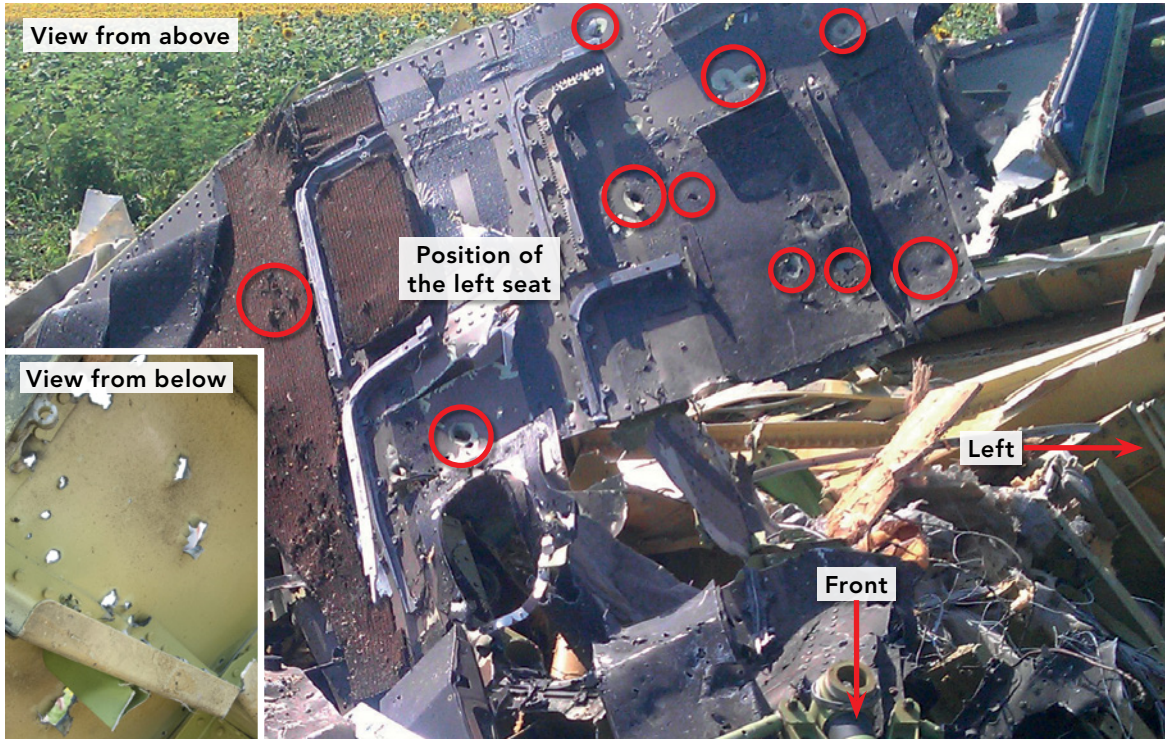


Figure 10: Cockpit floor with floor parts showing puncture holes (red circles) coming from above the floor.  
(Source: NBAAI)

Detailed examination of the structural damage is ongoing. Forensic examination will be performed if the wreckage can be recovered,

The pattern of damage observed in the forward fuselage and cockpit section of the aircraft was consistent with the damage that would be expected from a large number of high-energy objects that penetrated the aircraft from outside.

### 2.10.3 The main wreckage site (main site)

The main site was located at the south-western corner of the town of Hrabove, 8.5 km from the last recorded FDR position of the aircraft. This site contained parts of the wings, both engines, the main landing gear and a portion of the fuselage (figure 11). Aircraft parts distributed over the main site had been subjected to post crash fire.



Figure 11: Main wreckage site showing engine parts (1), wing with inspection hatches (2) and main landing gear (3). (Source: NBAAI)

#### 2.10.4 Aft part of the fuselage

The vertical tail (figure 12) was located in a field to the south of Hrabove, approximately 8 km from the last recorded FDR position. The vertical tail was still attached to a portion of the upper rear fuselage. The rudder and a portion of the vertical tail's leading edge were not attached. The remains of the rear fuselage, horizontal stabiliser centre section, and items from the cabin were found about 100 metres north of the vertical tail.

A section of aft fuselage skin from the right side (figure 13) was located 330 metres west of the vertical tail, and the left wing tip and right horizontal stabilizer were also in this location. The left horizontal stabilizer was found another 330 metres to the west.



Figure 12: Vertical tail. (Source: DCA)



Figure 13: Aft fuselage skin, right side, with partial registration of the aircraft. (Source: NBAAI)

The distribution of pieces of the aircraft over a large area indicates that the aircraft broke up in the air. The forward parts of the aircraft were found closest to the last recorded FDR point, indicating that these parts broke off from the aircraft first. The centre and aft parts of the aircraft were located significantly further to the east. This indicates that these parts continued in a down and forward trajectory before breaking up.

The fact that there were many pieces of aircraft structure distributed over a large area indicated that the aircraft broke up in the air.

## 3 SUMMARY OF FINDINGS

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### **Crew**

According to the information received from Malaysia Airlines the crew was properly licensed and had valid medical certificates to conduct the flight.

### **Aircraft**

According to the documents, the aircraft was in an airworthy condition at departure from Amsterdam Airport Schiphol, there were no known technical malfunctions.

### **CVR/FDR**

No evidence or indications of manipulation of the recorders were found.

No aural alerts or warnings of aircraft system malfunctions were heard on the Cockpit Voice Recorder. The communication between the flight crew members gave no indication of any malfunction or emergency prior to the occurrence.

The engine parameters were consistent with normal operation during the flight. No engine or aircraft system warnings or cautions were detected.

No technical malfunctions or warnings in relation to the event flight were found on Flight Data Recorder data.

Both recordings ended at 13.20:03.

### **ATC / Airspace**

At the time of the occurrence, flight MH17 was flying at FL330 in unrestricted airspace of the Dnipropetrovs'k (UKDV) FIR in the eastern part of the Ukraine, the aircraft flew on a constant heading, speed and altitude when the Flight Data Recording ended. UkSATSE had issued NOTAMs that restricted access to the airspace below FL320.

The last radio transmission made by the crew began at 13.19:56 hrs and ended at 13.19:59 hrs.

The last radio transmissions made by Dnipropetrovs'k air traffic control centre to flight MH17 began at 13.20:00 hrs and ended at 13.22:02 hrs. The crew did not respond to these transmissions.

No distress messages were received by the ATC.

According to radar data three commercial aircraft were in the same Control Area as flight MH17 at the time of the occurrence. All were under control of Dnipro Radar. At 13.20 hrs the distance between the closest aircraft and MH17 was approximately 30 km.

## **Damage**

Damage observed on the forward fuselage and cockpit section of the aircraft appears to indicate that there were impacts from a large number of high-energy objects from outside the aircraft.

The pattern of damage observed in the forward fuselage and cockpit section of the aircraft was not consistent with the damage that would be expected from any known failure mode of the aircraft, its engines or systems.

The fact that there were many pieces of aircraft structure distributed over a large area, indicated that the aircraft broke up in the air.

Based on the preliminary findings to date, no indications of any technical or operational issues were found with the aircraft or crew prior to the ending of the CVR and FDR recording at 13.20:03 hrs.

The damage observed in the forward section of the aircraft appears to indicate that the aircraft was penetrated by a large number of high-energy objects from outside the aircraft. It is likely that this damage resulted in a loss of structural integrity of the aircraft, leading to an in-flight break up.

## 4 SAFETY ACTIONS

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### *Ukrainian State Air Traffic Service Enterprise (UkSATSE)*

- At 14.56 hrs on 17 July 2014 the UkSATSE issued NOTAM A1507/14, adding another restricted area over the existing (mentioned in NOTAM A1492/14) from FL320 to an unlimited altitude.
- At 00.07 hrs on 18 July 2014 the UkSATSE issued NOTAM A1517/14, which increased the size of the restricted area and imposed a limitation from the surface to an unlimited altitude.

### *International Civil Aviation Organization (ICAO)*

- On 29 July 2014 ICAO, in association with the International Air Transport Association (IATA), Airports Council International (ACI) and the Civil Air Navigation Services Organization (CANSO) announced the outcomes of an urgent meeting regarding the risks to civil aviation arising from conflict zones, which were that ICAO, with support of its industry partners, would:
  - immediately establish a senior-level task force composed of state and industry experts to address the civil aviation and national security aspects of this challenge, in particular how information can be effectively collected and disseminated.
  - submit the task force findings as urgently as possible to a special meeting of the ICAO Council for action.

ICAO will convene a high-level safety conference with all of its 191 member states in February 2015.

## 5 FURTHER INVESTIGATIONS

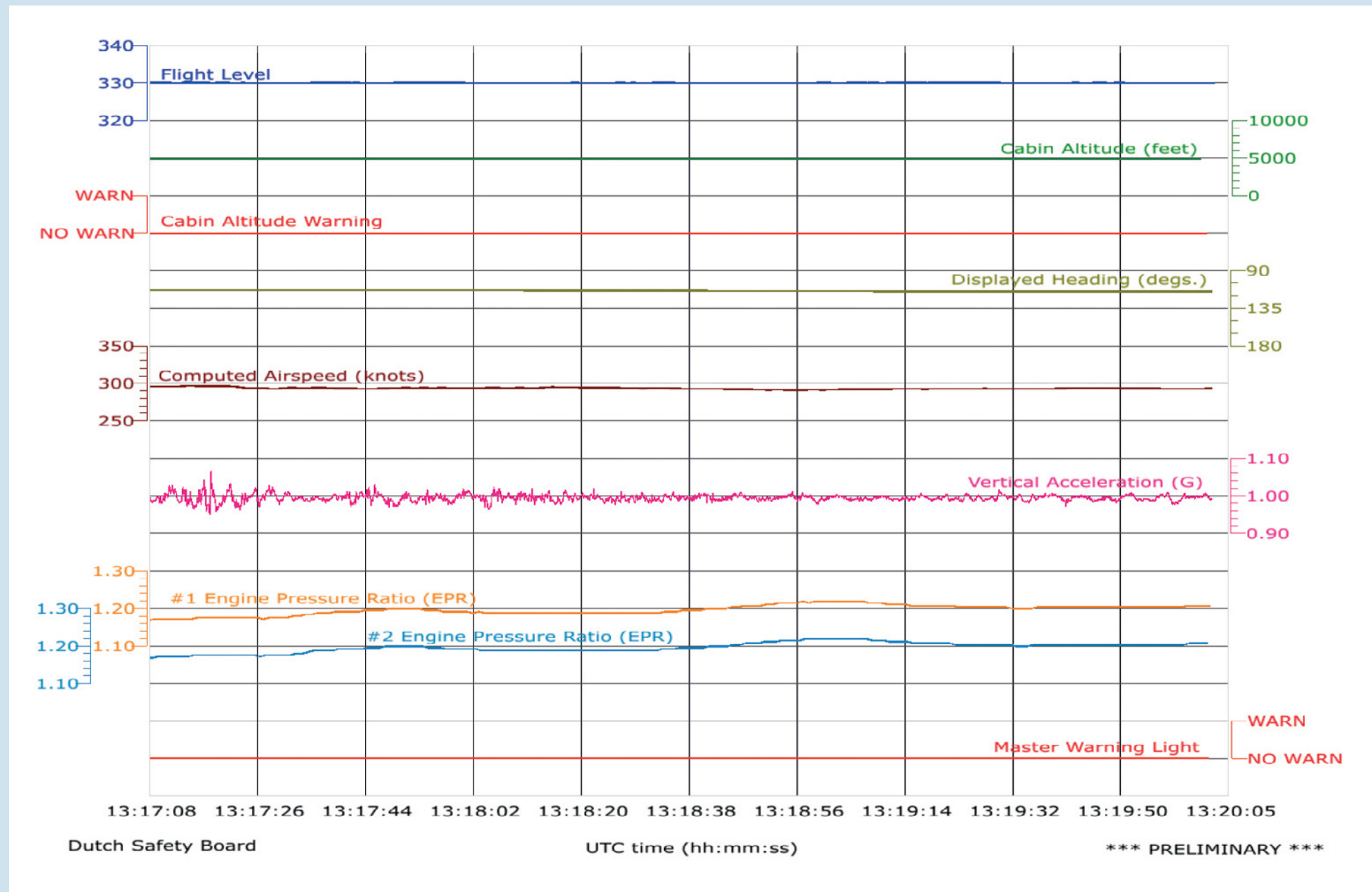
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This report is preliminary. The information must necessarily be regarded as tentative and subject to alteration or correction if additional evidence becomes available. Further work will at least include the following areas of interest to substantiate the factual information regarding:

- detailed analyses of data, including CVR, FDR and other sources, recorded onboard the aircraft;
- detailed analyses of recorded ATC surveillance data and radio communication;
- detailed analyses of the meteorological circumstances;
- forensic examination of wreckage if recovered and possible foreign objects, if found;
- results of the pathological investigation;
- analyses of the in-flight break up sequence;
- assessment of the operator's and State of Occurrence's management of flight safety over a region of conflict or high security risk;
- any other areas that are identified during the investigation.



PRELIMINARY FDR DATA



The sampling rate of the various parameters displayed, vary from 8 times per second to once per 4 seconds. This explains why not all lines end at the same moment. Shown between brackets below, are the sampling rates of the various parameters.

**Flight Level:**

Altitude in feet above mean sea level divided by 100 (1 x per sec).

**Cabin Altitude:**

Cabin pressure expressed as an equivalent altitude in feet above mean sea level (1 x per 4 sec).

**Cabin Altitude Warning:**

Warning initiated in the cockpit when cabin altitude exceeds a predefined limit (1 x per sec).

**Displayed Heading:**

Angle in degrees between the longitudinal axis (where the aircraft is pointed) and magnetic north as displayed on the primary flight display (1 x per sec).

**Computed Airspeed:**

Indicated airspeed in knots corrected for instrument errors and position error (1 x per sec).

**Vertical Acceleration:**

Acceleration of the aircraft in G's in the vertical axis (8 x per sec).

**Engine Pressure Ratio:**

A means of measuring the amount of thrust being produced by a jet engine (1 x per sec).

**Master Warning:**

Parameter indicating when the master warning light is illuminated (1 x per sec).

**Visiting Address**

Anna van Saksenlaan 50  
2593 HT The Hague  
T +31(0)70 333 70 00  
F +31(0)70 333 70 77

**Postal Address**

PO Box 95404  
2509 CK The Hague

[www.safetyboard.nl](http://www.safetyboard.nl)