CONSULTATION PART A: CAUSES OF THE CRASH

State / Organisation	Page	Section / Paragraph	Text to be corrected (first... last word)	Argumentation / substantiation	Dutch Safety Board response
Russian Federation / FATA	7	Summary	The in-flight disintegration of the airworthy aeroplane operated by a licensed and qualified flight crew was the result of the detonation of a 9M314-model warhead containing pre-formed fragments. Other possible scenarios that could have led to the disintegration and crash of the aeroplane were considered, analysed and excluded.	**Proposed text:** 1. Here and further in the text of the report it is worthwhile indicating the exact name of the type of weapon which hit the aircraft. 2. Replace «9M314» with «9H314», as the one corresponding to the warhead of 9M38 air-to-ground rocket. 3. The second sentence (25 - 26 lines) shall be reworded as follows: «There exist other scenarios that could lead to in-flight break-up of the aircraft. **Argumentation:** 1. The report does not provide any sufficient substantiation that the aircraft was hit by a ground-to-air rocket with 9H314 warhead. The characteristic pre-formed fragments i.e. «butterfly or bow-tie» are only part of 9H314M warhead of the ground-to-air 9M38M1 rocket. The report does not contain any sufficient data refuting the scenario of hitting the aircraft with an air-to-air rocket. 2. Based on the investigation results, the report does not provide sufficient substantiation that the rocket was launched from the area of Snezhnoye. The investigation does not take account of the data provided by Almaz-Antei. The respective substantiation is provided in the cover letter and comments to the related parts of the draft final report.	General: The summary has been amended in a number of places to reflect the comments. Points 1 and 2 to this comment: Work by the Dutch Safety Board, NLR, TNO and JSC Concern Almaz-Antey regarding the identification of the weapon used resulted in the following: • The warhead identified as the only one having bow-tie shape fragments is the 9N314M (in Cyrillic text, the 9H314M). • The 9N314M warhead uses the 9M38M1 missile but it is known that it also uses the 9M38 missile. The 9M38 can be launched from the TELAR of the Buk and Buk M1 system, while the 9M38M1 can be launched from the Buk M1 and Buk M1-2. For readability the generic term Buk is used in the report. Point 3 to this comment. The comment is not adopted as it is correct to state that the other scenarios are all excluded. See also the information described in the Dutch Safety Board's report 'About the investigation' and its Appendix L.
Ukraine / NBAAI	7	Summary	The 9M314-model warhead was launched from a Buk, Buk-M1 or Buk-M1-2 surface-to-air missile system in an area of about 250 km^2 south of Snizhne, Ukraine, which was controlled, at that time, by the illegal armed groups.	Territory de-facto was at time of the accident by the effective control of illegal armed groups, which needs to be mentioned in the report.	The Dutch Safety Board does not provide any political interpretation of the conflict and strives to use politically neutral terms as much as possible. Interpretations by other parties are those parties' responsibilities.
Ukraine / NBAAI	39	2.9.1	Air Traffic Services for flight MH17 were provided by air traffic controllers of Lviv, Kyiv and Dnipropetrovsk ACCs. UKSATSE air traffic controllers are licensed, qualified and accordingly trained. The regulations and procedures of air traffic service provision are based on ICAO Standards and Recommended Practices.	The (following) text should be added as general information regarding the air traffic service provision of flight MH17 in Ukrainian airspace.	As the training an qualifications of the air traffic controllers have not been included in the investigation, the matter will be addressed in a similar manner to that of the cabin crew.

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Ukraine / NBAAI	40	2.9.4	along ~~the border with Crimea~~ administrative border of the Autonomous Republic of Crimea	Crimea is the internationally recognized territory of Ukraine, which was additionally confirmed by UN General Assembly Resolution 68/262 'On territorial integrity of Ukraine').	The Dutch Safety Board has chosen to use a neutral term; Crimea.
Russian Federation / FATA	48	2.9.5.3	According to ICAO Annex 11 Air Traffic Services, paragraph 6.4.1 *Automatic recording of surveillance data*, States are required to automatically record surveillance data from primary and secondary radar equipment systems for use in accident and incident investigations, search and rescue, and air traffic control and surveillance systems evaluation and training. These recordings shall be retained for a period of at least thirty days and for accident and incident investigation for a longer period until it is evident that they will no longer be required. As the accident had occurred outside Russian Federation territory, the Federal Air Transport Agency of the Russian Federation stated that no radar data was saved nor was it required to be so by national regulations. It was confirmed that had the event occurred in Russian Federation territory, the data would have been saved according to Russian Federation regulations. The Russian Federation was requested to provide its national regulations. As to date these regulations have not been received. It is noted that the provisions in ICAO Annex 14 paragraph 6.4.1 are not restricted to State's boundaries. Due to the national regulations from the Russian Federation being different to the standard in ICAO Annex 14 paragraph 6.4.1, ICAO requires that this difference between the national version of a specific standard and ICAO's text be reported to ICAO. The Russian Federation has not filed a difference to this paragraph with ICAO.	**Proposed text:** Delete this text and replace it with the following: 'The Russian Federation has requirements for automatic recording of surveillance data in the national legislation that are fully compliant with ICAO Annex 14. The explicit explanations and extracts from the national regulations were sent to the investigator in charge on May 6, 2015. ICAO Annex 14 does not specifically say that 'raw' data must be saved. The Russian Federation saved the necessary surveillance data in the format of a video file thus fully complying with the requirements of ICAO Annex 14». **Argumentation:** In accordance with the item 3.6.8 of the Federal Aviation Rules 'Air Traffic Management' the radio exchange between ATS units and aircraft pilots, voice exchange between ATS unit controllers, weather briefings of pilots and ATC controllers, pre-flight inspections, weather data transmitted on radio channels as well as radar and flight data shall be recorded by special equipment. The recorded data must be kept and used for the purpose of ATS within 14 days if using analogue recording equipment and within 30 days if using digital recording equipment. The ICAO documents do not provide any definition of the term 'ATS surveillance system'. Pursuant to item 8.1.2. of the ICAO Doc 4444, the surveillance system comprises integration of all data necessary for air traffic services. In this regard, the video file with the air situation from the radar screen provided by the Russian Federation can be qualified as 'surveillance data', which retention is required by the item 6.4.1.1 Annex 11 to the Chicago Convention. The Russian Federation is in full compliance with the requirements of the item 6.4.1.1 of Annex 11 to the Chicago Convention. All data at disposal of the Russian side was properly made available to DSB and used in the course of the investigation.	The text in ICAO Annex 11, paragraph 6.4.9 refers to 'automatic recording'. The Dutch Safety Board's position is that this includes the recording of all data, including raw data. ICAO was consulted on this matter and ICAO concurs with the Dutch Safety Board's position. The report's text has been modified to better state the Dutch Safety Board's conclusion.
Ukraine / NBAAI	50	2.11.1	On 21 July 2014, the recorders were handed over to a Malaysian official in Donetsk by representatives of the illegal armed group controlling the area. No evidence or indications of manipulation of the recorders were found.	It would be useful to know whether there has been any verification of this statement (that no evidence or indications of manipulation of the recorders were found) by expert reports. The armed groups operating in certain areas of Donetsk and Luhansk Regions of Ukraine that are not controlled by the government do not have any legal status.	The Dutch Safety Board does not provide any political interpretation of the conflict and strives to use politically neutral terms as much as possible. Interpretations by other parties are those parties' responsibilities.
Ukraine / NBAAI	59	2.11.7	~~NATO AWACS aeroplanes did not have information pertinent to the investigation~~. NATO AWACS aeroplanes detected the signal of an anti-aircraft system (SA-3 type of surface to air missile) at a range of several hundred kilometres from the site of the accident.	On page 59 line 17-20, there is a reference to a fact that 'the AWACS aeroplanes detected the signal of an anti-aircraft system at a range of several hundred kilometres from the site of the accident. This signal was automatically classified by the AWACS aeroplanes as an SA-3 type of surface to air missile.' It is unclear why this fact has not been taken into account. There is nothing in the report to suggest that this fact is not accurate or does not relate to the accident, except the statement from the NATO specialist that 'there is no data from the AWACS which would be relevant to the investigation of the crash.'	This letter to the German parliament that the comment refers to makes use of material that cannot be verified or further clarified by the Dutch Safety Board. The response from NATO to the Dutch Safety Board's questions contains sufficient explanation. Consequently, the extract of the letter has been withdrawn from the report.

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Ukraine / NBAAI	60	2.12.1	Additional sentence: Ukrainian side was unable to provide immediate, safe, secure and unrestricted access to the crash site and the surrounding area for the appropriate investigating authorities, including the Dutch Safety Board experts, after the crash, because this area was controlled by illegal armed groups.	An additional sentence needs to be added considering the current situation in the field at that particular moment.	The Dutch Safety Board does not provide any political interpretation of the conflict and strives to use politically neutral terms as much as possible. Interpretations by other parties are those parties' responsibilities. The brief description of the situation contained in the report is therefore deemed to be adequate.
Ukraine / NBAAI	60	2.12.1	permission from ~~local authorities~~ illegal armed groups	It is unclear what kind of local authorities gave the permission. If it is (most probably) about the illegal armed groups - it should be properly indicated. If it is Ukrainian local authorities - it should be made clear as well.	The Dutch Safety Board does not provide any political interpretation of the conflict and strives to use politically neutral terms as much as possible. Interpretations by other parties are those parties' responsibilities.
Russian Federation / FATA	76	2.16.1	In total 72 selected objects were further examined; 16 foreign objects found in the bodies of the flight crew members and one passenger, together with 56 foreign objects recovered from the wreckage.	**Proposed text:** 1. Insert the following text after this text: 'There were found two foreign objects in the shape similar to «butterfly or bow-tie». However, the analysis of these objects in relation to weight and dimensions does not provide sufficient basis for attributing them to the warhead 9N314M pre-formed fragmentation known as 'bow-tie' of 9M38M1 rocket. 2. Insert the specification (table, diagram or similar) of all found high-energy objects with indication of their characteristics (shape, size, steel grade). **Argumentation:** 1. The report does not specify the number of «butterfly or bow-tie» shape fragments found. The report neither indicates from which locations in the aircraft structure (bodies of pilots, passengers or other) they were extracted. It is also necessary to indicate who, where and when found the high energy objects providing the inventory of the supporting documentation. The reported ratio of the high energy objects of various fractions extracted from the aircraft structure does not correspond to the expected results for 9N314M warhead of 9M38M1 rocket. The expected ratio of the three fractions is as follows: – 0,238 Bow-tie 13 x 13 x 8,2 mm; – 0,238 Filler 6 x 6 x 8,2 mm; – 0,524 Square 8 x 8 x 5 mm. 2. The report does not analyze the characteristics of the foreign objects (by shape, steel grade and quantity), which does not provide sufficient substantiation to conclude that the fragments extracted from the aircraft structure belong to 9H314M warhead of 9M38M1 rocket.	The Dutch Safety Board partially agrees with point 1 of the comment. As a result, texts in Sections 1.13, 1.16 and 2.5 have been improved to include more details on the fragments expected in a 9N314M warhead and the four distinctly shaped fragments recovered. However, the reported ratios between the different shapes cannot be correlated with those fragments recovered as it is not possible to recover all of the fragments from a detonation at an altitude of 10 km. In addition, JSC Concern Almaz-Antey indicated that the actual number of pre-formed fragments differs slightly from one warhead to another during manufacture, making the ratios in the comment an approximation and not an exact set of figures. Regarding point 2 of the comment. Whilst four pre-formed fragments were recovered in a form close to their original shape, size and mass, many of the fragments found were not in their original form (i.e. bow-tie, filler or square). This was the result of abrasion, break-up, chipping and shattering of the fragments after penetrating the aircraft skin and passing through the aeroplane's internal structure and the cockpit's interior. Studying the detailed chemical composition of the steel is not relevant to the investigation as the high-energy objects are usually made from low-grade metal (unalloyed steel) originating from different batches, different sources, different manufacturing locations and over different periods of time. Matching the fragments found with reference material from an intact warhead would not be possible because of these differences. Considering changes due to deformation, abrasion, chipping and shattering on explosion and impact, the bow-tie fragments found in the wreckage originally had the shape, size and mass of the fragments used in the 9N314M warhead. These fragments are very distinct and they are found in this type of warhead.

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Russian Federation / FATA	76	2.16.2	2.16.2 Examinations of the selected objects.	**Proposed text:** 1. This section shall be complemented with information on the steel grade used in the discovered high-energy objects. 2. This section shall also consider the testing results of various types of warheads provided by Almaz-Antei. **Argumentation:** 1. The investigation did not identify the steel grade from which the pre-formed fragments were manufactured. Such analysis was absolutely necessary for each type of fragments in particular because 9M38 and 9M38M1 rocket warheads use different type of steel grades for pre-formed fragments of different fractions (light and heavy). It is impossible to state that the pre-formed fragments belong to the same warhead type until steel grades of each type of pre-formed fragments (two light and one heavy fractions) are identified and substance residue on all entry holes in different locations of the aircraft structure is compared. 2. During the investigation of the high energy objects, there were identified no fragments of light fraction - 'parallelepiped' (Filler 6 x 6 x 8,2 mm). Given that in the course of the investigation, NFI did not identify the steel grade of pre-formed fragments of light fraction - 'parallelepiped' (Square 8 x 8 x 5 mm) and heavy fraction (Bow-tie 13 x 13 x 8,2 mm) it is impossible to ultimately identify the warhead type.	Point 1 to this comment: Studying the detailed chemical composition of the steel is not relevant to the investigation as the high-energy objects are usually made from low-grade metal (unalloyed steel) originating from different batches, different sources, different manufacturing locations and over different periods of time. Matching the fragments found with reference material from an intact warhead would not be possible because of these differences. Point 2 to this comment: Considering changes due to deformation, abrasion, chipping and shattering on explosion and impact, the bow-tie fragments found in the wreckage originally had the shape, size and mass of the fragments used in the 9N314M warhead. These fragments are very distinct and they are found in this type of warhead.

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Russian Federation / FATA	78	2.17	2.17 Organisational and management information Factual information and its analysis relating to the decision making processes around the flight routes is contained in the separate Dutch Safety Board report entitled 'Flight MH17 and flying over conflict areas'. In that report, the following subjects relevant to this accident were investigated: • the selection of flight routes by Malaysia Airlines, with particular attention to the route across Ukraine; • the oversight by the Malaysian authorities, and - the management of airspace in Ukraine, with particular attention to the restriction of airspace made by the Ukrainian authorities.	**Proposed text:** Add the following information to this section: 'The Ukrainian authorities did not ensure the appropriate coordination between the military authority and Air Traffic Service unit for the purpose of advance introduction of flight restrictions over the armed conflict zone due to the intensification of Ukraine Air Defense activities (introduction of BUK-M1 anti-aircraft weapon systems to the conflict zone). On the date of the accident, Dnepropetrovsk FIR was unable to use primary radar data. The data from primary radars of Ukraine Armed Forces were neither available. This situation was creating additional risks, non-accountable by Ukraine authorities in case of possible disruptions on the ground or onboard the aircraft flying over the armed conflict zone. The adoption of the decision on the continuation of flights over the armed conflict zone with the lack of use of all the capabilities of the ground CNS facilities in case of possible disruptions, witnesses to the fact that the Ukrainian authorities did not take necessary actions to ensure flight safety over the armed conflict zone considering the recommendations of ICAO Doc 9554. **Argumentation:** 1. This section was compiled scholastically and did not reflect many important conclusions made in the draft final report 'Flight MH17 and flying over conflict areas'. 2. Annex 13 to the Chicago Convention does not provide for issuance of two reports on the results of the investigation separating the consideration of causes which lead to the same accident. It is therefore suggested to move all information related to the crash from 'Flight MH17 and flying over conflict areas' report to the final report.	The text in Section 2.17 is a summary of that part of the investigation that is contained in the newly added Part B of the Final Report.

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Russian Federation / FATA	78	2.18	2.18 Additional information This paragraph contains a number of relevant subjects that have not been addressed elsewhere in Section 2. These relate to: • a description to two different aeroplane systems; cabin pressurisation and cabin emergency oxygen system; • background information on possible external sources of damage, and • the preventative actions taken following the accident.	**Proposed text:** It is suggested to add the following subsection to this section 'Russian Federation's information on the movement and activity of Ukraine Air Defense Forces in the conflict zone' as follows: 'Pursuant to the information of the Russian Ministry of Defense presented at the official briefing on July 21, 2014, on the date of Boeing 777 crash, the Ukraine Air Defense command in the vicinity of Donetsk had at least three - four divisions of BUK-M1 anti-aircraft weapon systems which were capable of hitting targets at the range of 35 kilometers and at heights of up to 22 kilometers. By July 17, 2014 the activity of Ukraine radar stations 9S18 Kupol-M1 of BUK-M1 anti-aircraft weapon systems was at maximum. Thus, if on July 15, 2014 there were 7 active stations, then on July 16 there were 8 and on July 17, 2014 there were 9. Starting from July 18, 2014 the activity of these radar stations sharply decreased and equaled to 2-3 per day. According to the satellite pictures, presented by the Russian Ministry of Defense, on July 17, 2014 there was identified a Ukrainian BUK-M1 battery in the area of Zaroshchenskoye village (8 km south of Shakhtersk). The proposed text shall be complemented with respective satellite pictures. The briefing materials are available at: http://www.mid.ru/brp_4.nsf/newsline/f6c3bbd89ac2532d44257d1d00203ccf **Argumentation:** 1. The report should consider the risk of hitting the Boeing 777 (MH17) by a Ukrainian BUK anti-aircraft weapon system present in the conflict zone. 2. The Russian Federation is the only State providing the objective data on the movement and activity of anti-aircraft weapon systems on the crash date and the preceding period.	The report does not address the location and availability of weapons systems in the field; it only seeks to identify the causes of the crash. Issues regarding which parties were in possession of which weapon systems and the missile launching location are issues for the criminal investigation.
Russian Federation / FATA	86	2.19.4	At the second progress meeting with the international investigators on 6 and 7 May 2015, the Russian Federation presented work performed by the Russian organisation Almaz-Antey on the impact damage on the wreckage of flight MH17 and its possible source. Almaz-Antey determined the weapon system that was used in its simulation on the basis of public information and its own sources within the Russian military and its suppliers.	**General comment on section 2.19.4 «High-energy object analysis» of the report:** Almaz-Antei provided the data that did not identify the type of weapon system but rather characterized the damage and rocket trajectory if this rocket had indeed belonged to BUK anti-aircraft weapons system. The data on the aircraft structure damage was analyzed by Almaz-Antei on the basis of BUK performance data which were not publicly available and consequently not considered in the simulations accomplished by NLR and TNO. Unfortunately after receiving the information from Almaz-Antei, the data used by DSB (NLR and TNO) were neither considered nor amended. As a result, the warhead detonation and damage models used by DSB (NLR and TNO) are not taking into account the full coverage area of the fragment spay. The models were using the source data acceptable for evaluation of efficiency of battle applications. Such models evaluate only the damage on the outer skin (about 70 % of the surface) and damage degree of the most vital aircraft structure parts. The main result of such simulation is the probability of hitting (terminated/damaged/did not terminate). Meanwhile, the full objective picture of the damage on the whole of the outer skin is not provided (up to 30 % of damage is not considered) as well as the damage to the inside cockpit equipment and aircraft structure bodywork.	It is noted that the presentation made by the Russian Federation was not intended to identify the weapon used. However, the new information on the characteristics of the warhead that JSC Concern Almaz-Antey provided the Dutch Safety Board with, was used by both TNO and NLR in their simulation models. In addition, it is a well known fact in the study of terminal ballistics of fragments that a fragment hitting a plate at an oblique angle (not perpendicular to the plate) changes its direction of travel after penetration. The initial angle is typically reduced after penetration. This change in angle is dependent on several factors and can be as small as several degrees or as large as the original oblique angle. As a result, it is usually not possible to obtain accurate data on the direction of travel of fragments outside the structure by studying parts inside the structure. The presentation by JSC Concern Almaz-Antey that was contained in the Appendices to the draft Final Report has been withdrawn from the definitive version.

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Russian Federation / FATA	106	3.4.8	3.4.8 Weapon systems	**Proposed text:** Subsections 3.4.8.1 and 3.4.8.2 shall be reworked on the sequence of conclusions through the damage analysis, characteristics of high-energy objects, determination of weight and detonation point of the warhead and then determination of the type of rocket. **Argumentation:** In general, the version of hitting the aircraft with air-to-air rocket is practically not presented in the report. The approach to the analysis of the circumstances surrounding the hitting of the aircraft presented in this section is incorrect and insufficiently substantiating the reasons of hitting due to the following: 1. The report lists the conditions of aircraft hitting which more or less shall coincide with BUK type anti-aircraft rocket weapon system. 2. When considering air-to-air rockets, the report beforehand highlights only those used by Russia and Ukraine. The possibility of using rockets with fragmentation warheads manufactured by other States is not considered at all. The selection of rockets listed in Table 15 is made without a prior weight determination of the rocket warhead which hit the Boeing 777-200 (MH17).	Reference is made to other weapon systems that are common in the region. The text of the report has been amended to only introduce the Buk system when evidence of its missiles is presented. Air-to-air weapons are, based on the evidence, adequately addressed in the report. Only weapon systems that are common in the region are addressed because the Dutch Safety Board understood that there was very little likelihood that weapons from other parts of the world were in the inventory of any party in the region. The Dutch Safety Board is not aware of any evidence that suggests that other weapon systems both capable of causing the crash and containing the distinct pre-formed fragments were present in the region.
Russian Federation / FATA	108	3.4.8.2	As none of the air to air missile that have fragmentation warheads include butterfly or bow-tie shaped fragments, these missiles cannot have caused the damage to flight MH17. In addition, for an air to air missile with a fragmentation warhead to have been responsible for causing the damage found, another aeroplane would have to have been displayed on, at least, the primary radar data. The analysis in Section 3.3 of this report shows that no military aeroplanes were in the vicinity of flight MH17 at the time of the accident.	**Proposed text:** After this text, add the following text: «Meanwhile the use of air-to-air rocket shall not be ruled out. The modern short-range air-to-air rockets are fitted with fragmentation warheads with pre-formed fragments and seekers (passive, radar, lock on active radar or infrared homing with pixel waveband. They are capable of engaging the aircraft both from the rear (engine nozzle) or the front (most sensitive areas such as cockpit, nose radar etc) and inflicting the damage similar to the one observed on the front part of fuselage skin «. **Argumentation:** Considering the air-to-air rocket performance as well as the method of their delivery (by air), such rockets could have been used in the conflict zone in Eastern Ukraine.	In addition to the response to the comment regarding paragraph 3.4.8 above, it should be noted that analysis performed by TNO demonstrated that the damage pattern observed on the wreckage could not be reproduced when a 40 kg warhead (typical of an air-to-air weapon) was simulated.
Russian Federation / FATA	109	3.4.8.2	The high-energy object damage was not caused by an air to air missile because: • there was no military aircraft in the area of flight MH17 to launch such a missile; • no air to air missile warheads have butterfly or bow-tie shaped fragments, and • an infra-red guided missile would have caused damage to the aeroplane nearer the engines.	**Proposed text:** Delete this text from the report as non-substantial and unproved.	The air-to-air missile scenario was investigated and rejected with valid arguments that are discussed in the report. Most importantly, there is no known air-to-air missile that contains bow-tie shaped fragments. The text has been improved.

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Russian Federation / FATA	109	3.4.8.3	*3.4.8.3 Surface to air missile fire*	**General comment to Section 3.4.8.3 «Surface to air missile fire»:** This section includes the theoretical data and oversimplified information on the performance principle of a rocket with a fragmentation warhead. The data contained in this section can be equally applicable to both air-to-air and ground-to-air rockets. The conclusion that air-to-air rocket can only target engine is incorrect. Thus the information provided in this section does not give the substantiated answer as to why we are considering only ground-to-air rocket further in the report. This section shall not refer to ground-to-air rockets only.	The text referred to in the 2nd and 3rd paragraph is corrected. See also responses on paragraph 3.4.8.2 above (page 108 and 109).
Russian Federation / FATA	112	3.4.9	**3.4.9 Buk surface to air weapon system** Considering the location of the accident, all of the weapons considered were constructed by Soviet / Russian Federation companies. The Buk (beech tree in Russian) surface to air weapon system is the most common weapon in this region and is the only weapon system that contains pre-formed high-energy objects in the shape of a butterfly or bow-tie in its warhead.	**Proposed text:** Delete this text from the report. **Argumentation:** 1. The conclusion is made that BUK type anti-aircraft systems are using rockets with butterfly or bow-tie fragmented warheads. It is not considered though that BUK can use both 9M38 rocket (with 9N314 warhead containing fragments of two fractions without butterfly or bow-tie shape fragments) and 9M38M1 (with 9N314M warhead with fragments of three fractions including «butterfly or bow-tie»). 2. During the investigation, there was made no analysis of the ratio between the extracted fragments of various fractions from the aircraft structure. The absence of data on the steel grade of the high energy objects in the report does not provide any substantiation for the conclusion on the warhead type of the rocket.	See the response to the comment made regarding paragraph 2.16.1 above.
Russian Federation / FATA	114	3.4.9	The 9N314-model warhead contains butterfly or bow-tie, so-called 'filler' and square shapes (see Figure 32 for a sample image).	**Proposed text:** Delete this text from the report. **Argumentation:** This statement is not correct: the warhead with pre-formed fragments of three fractions are only used in 9H314M warhead of 9M38M1 rocket.	The warhead identified as the only one having bow-tie shape fragments is the 9N314M (in Cyrillic text, the 9H314M). This warhead is intended to be carried by the 9M38M1 missile but it is known to be also installed on the 9M38M. Therefore, the report refers to the 9N314M warhead and the 9M38M or 9M38M1 missile as launched by the Buk surface-to-air missile system.

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Russian Federation / FATA	115	3.4.10	The examination by the NFI of the high-energy objects found in the bodies of the flight crew members found that the objects were made of unalloyed steel consisting of iron with some silicon, manganese, copper, chromium and cobalt. One high energy objects consisted of a low alloy steel having an elemental composition of iron with some silicon, chromium and nickel. On the high-energy objects of unalloyed steel, aluminium, glass and other material was present in the form of thin layers or loose particles. On a number of high-energy objects layers of both aluminium and glass were found. The glass layers are considered to be cockpit glass due to their zirconium content. The layers of aluminium are considered to be from the aeroplane's aluminium structure. This indicates that metal parts passed through the cockpit windows and hit the pilots at high speed and with high temperature.	**Proposed text:** 1. In the first sentence after «the high-energy objects found in the bodies of the flight crew members» add in brackets the number (quantity) of high energy objects found in the bodies of flight crew members. 2. In the second sentence after «One high energy object …» add in brackets the characteristics of the high energy objects i.e. (shape, weight, steel grade). **Argumentation:** No evaluation of high energy objects has been done to identify the steel grade of which they had been manufactured. The provided data contain only general conclusions on the chemical composition of the material, which was used for making high energy objects. It is impossible to state that all fragments belong to the same warhead before determining the steel grade of all types of high energy objects (light and heavy fractions).	Text has been improved to include more details on the fragments expected in a 9N314M warhead and the fragments recovered from the bodies of the crew members. However, the reported ratios between the different shapes cannot be correlated with those fragments recovered as it is not possible to recover all of the fragments from a detonation at an altitude of 10 km. The fragments found are not in their original form (i.e. bow-tie, filler or square) due to abrasion, break-up, chipping and shattering of fragments after penetrating the aircraft skin and the surfaces on the inside. In addition, JSC Concern Almaz-Antey indicated that the actual number of pre-formed fragments differs from one warhead to another during manufacture. Studying the detailed chemical composition of the steel is not relevant to the investigation as the high-energy objects are usually made from low-grade metal (unalloyed steel) originating from different batches, different sources, different manufacturing locations and over different periods of time. Matching the fragments found with reference material from an intact warhead would not be possible because of these differences. Considering changes due to deformation, abrasion, chipping and shattering on explosion and impact, the bow-tie fragments found in the wreckage originally had the shape, size and mass of the fragments used in the 9N314M warhead. These fragments are very distinct and they are found in this type of warhead.

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Russian Federation / FATA	115	3.4.10	The high-energy object found in the wreckage of flight MH17 as described in 2.16 and shown in figure 33 is consistent with the fragments found in the 9N314-model warhead carried on the 9M38-series of missiles as installed on the Buk, Buk-M1 or Buk-M1-2 surface to air missile system. Due to the absence of reference material from the mentioned 9N314-model warhead pre-formed fragments a metallurgical link could not be made.	**Proposed text:** Delete this text from the report. **Argumentation:** 1. It is inappropriate to list all known modifications of BUK anti-aircraft weapon systems such as BUK, BUK-M1, BUK-M1-2 as pre-formed fragments like «butterfly or bow-tie» are used only in 9M38M1 rockets. The reference to the lack of data on 9N314 warhead is also inappropriate as Almaz-Antei has provided the necessary data on the composition of 9N314 and 9N314M warheads. Almaz-Antei was not asked to provide any additional data. 2. The butterfly or bow-tie shaped fragments showed on the photos in the report did not coincide with warhead fragments of BUK M1 rocket by weight, shape and geometrical dimensions. During the first meeting in February 2015, one bow-tie fragment was weighed and turned out to be 5.5 grams. JSC Almaz Antei ran a test which showed that after penetrating a 5 mm steel obstacle a bow-tie or butterfly fragment should weigh at least 7.2 grams. The evaluations showed that under such a degree of deformation the actual shape of the BUK M1 warhead fragment should differ from the one provided in the report.	Point 1 to this comment: The warhead identified as the only one having bow-tie shape fragments is the 9N314M (in Cyrillic text, the 9H314M). This warhead is intended to be carried by the 9M38M1 missile but it is known to be also installed on the 9M38M. Therefore, the report refers to the 9N314M warhead and the 9M38M or 9M38M1 missile as launched by the Buk surface-to-air missile system. Point 2 to this comment: Considering changes due to deformation, abrasion, chipping and shattering on explosion and impact, the bow-tie fragments found in the wreckage originally had the shape, size and mass of the fragments used in the 9N314M warhead. These fragments are very distinct and they are found in this type of warhead. Regarding the comment in general: JSC Concern Almaz-Antey provided the Dutch Safety Board with new information on the characteristics of the warhead. This information was used independently in different simulation models. The test performed by the Russian Federation/JSC Concern Almaz-Antey was not announced beforehand. So, formally it could not be a part of the international investigation into the crash of flight MH17, since the Dutch Safety Board and the other States did not have the opportunity to validate the test. It is necessary to inform the State that is conducting the investigation in advance and to send an invitation to that State and possibly to the other participating States to obtain suggestions for the conduct of the work and/or to be present at these tests or simulations. Nevertheless, the Dutch Safety Board seriously considered the input of the Russian Federation into the investigation. See also the information described in the Dutch Safety Board's report 'About the investigation' and its Appendix L.
Russian Federation / FATA	116	Findings	The number, shape and size of the high-energy objects found in the wreckage of flight MH17 are consistent with the pre-formed fragments in the 9N314-model warhead carried on the 9M38-series of missiles as installed on the Buk, Buk-M1 or Buk-M1-2 surface to air missile system. High-energy objects found in the aeroplane and the bodies of the flight crew were mainly of unalloyed steel some of which showed evidence of having passed through the aeroplane's skin and cockpit windows. The material composition of these objects could not be matched to a 9N314-model warhead due to the absence of reference material from the pre-formed fragments in such a weapon.	**Proposed text:** Delete this text from the report. **Argumentation:** 1. It is inappropriate to list all known modifications of BUK anti-aircraft weapon systems such as BUK, BUK-M1, BUK-M1-2 as pre-formed fragments like «butterfly or bow-tie» are used only in 9M38M1 rockets. 2. No evaluation of high energy objects has been done to determine the steel grade of which they had been manufactured. The provided data contain only general conclusions on the chemical composition of the material, which was used for making high energy objects. It is impossible to state that all fragments belong to the same warhead before determining the steel grade of all types of high energy objects (light and heavy fractions).	See the response to the comment made regarding paragraph 2.16.1 above.

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Russian Federation / FATA	118	3.7.1	In order to establish the path through the air of the high-energy objects prior to them penetrating the aeroplane, the Dutch Safety Board requested NLR and TNO to analyse the damage as described in Section 2.12 against the 9N314-model warhead and 9M38-series of missiles as installed on the Buk, Buk-M1 or Buk-M1-2 surface to air missile system as found in paragraphs 3.4.8.3 and 3.4.9.	**Proposed text:** Replace this text with the following: «In order to accurately determine the trajectory of high energy objects, it is necessary to make a mock-up of the aircraft structure (both primary i.e. outer skin and secondary obstacles i.e. seats, floor etc. If such investigation is not done, this may lead to a great error in determining the blast point and approach direction of the rocket to the aircraft. The correct determination of a blast point will allow identifying the characteristics of the warhead and establish the type of the weapon'.» **Argumentation:** The part of the report similarly to section 3.4.8 lists the predetermined conditions of aircraft hitting which more or less shall coincide with BUK type ground-to-air rocket weapon system.	The Dutch Safety Board has made a reconstruction of the forward part of the aeroplane. It is a well known fact in the study of terminal ballistics of fragments that a fragment hitting a plate at an oblique angle (not perpendicular to the plate) changes its direction of travel after penetration. The initial angle is typically reduced after penetration. This change in angle is dependent on several factors and can be as small as several degrees or as large as the original oblique angle. As a result, it is usually not possible to obtain accurate data on the direction of travel of fragments outside the structure by studying parts inside the structure.
Russian Federation / FATA	118	3.7.1	The area that would be exposed to high-energy objects was calculated by using the dynamic primary fragmentation pattern described in paragraph 3.4.8.3 and applying that data to the known speed of flight MH17 and a 3D model of a Boeing 777. This created a simulation of the location and the boundaries of the area exposed to high-energy objects on the Boeing 777.	**Proposed text:** Replace this text with the following: «In order to evaluate the characteristics of the high energy objects which caused damage to the front part of the fuselage, it is necessary to investigate the damage in the damage area of the fuselage, including the characteristics of the area of the aircraft exposed to high energy objects. Further, these evaluations are necessary in order to link the high energy objects found inside the aircraft structure to the holes in the aircraft outer skin (by steel grade, size and shape).» **Argumentation:** When selecting the model for static detonation of the warhead, there were used the sources that did not correspond to the real warhead design. The reference to Figure 27 (Figure 51 in Appendix P) and Figure 28 (Figure 52 in Appendix P) section 3.4.8.3 is inappropriate because the performance of BUK warheads has a significant difference: 1. The warheads of 9M38 and 9M38M1 rockets have an individual angular area of a meridional angle of fragment fly-out. 2. The model uses meridional angles of fragment fly-out between 72 and 109 degrees, which corresponds to the evaluation model for battle damage. The angle ranges between 68 and 72 degrees and 109 and 124 degrees are not considered at all which does not allow simulating the full area exposed to the fragment spray.	For the calculations of the spray angles (fragment fly-out), JSC Concern Almaz-Antey provided the Dutch Safety Board with new information on the characteristics of the warhead. This information was used independently in different simulation models. The new results of these simulations are included in the report.
Russian Federation / FATA	119	3.7.2	3.7.2 Physical measurements	**General comment to this section:** When determining the penetration directions of the high energy objects, there were used only entry holes in the aircraft outer skin. There was made no matching of the damages on the outer skin and inside damages (cockpit structure, floor, ribs etc). The report shall be added with information on the nature of damage in the cockpit floor, control columns, captain's and first officer's seats as well as ribs in the front part of the fuselage.	The Dutch Safety Board has made a reconstruction of the forward part of the aeroplane. It is a well known fact in the study of terminal ballistics of fragments that a fragment hitting a plate at an oblique angle (not perpendicular to the plate) changes its direction of travel after penetration. The initial angle is typically reduced after penetration. This change in angle is dependent on several factors and can be as small as several degrees or as large as the original oblique angle. As a result, it is usually not possible to obtain accurate data on the direction of travel of fragments outside the structure by studying parts inside the structure.

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Russian Federation / FATA	120	3.7.2	In addition to the main high-energy object impact damage on the cockpit there are two further areas where impact damage is observed; the left engine cowling lip ring and the left wingtip. The left engine cowling lip ring is a hollow structure consisting of an aerodynamically shaped curved front and a flat plate rear. A number of objects have penetrated both parts of this structure. The size of most of this damage is significantly larger than the impact damage on the wreckage of the cockpit. On the upper surface of the left wingtip damage is observed from the front to the back, moving outwards as it moved rearward.	**Proposed text:** Add the following text after this text: 'The damage of left engine cowling lip ring allows drawing a conclusion that the left engine was inside the main fragment area i.e. these damages are not secondary. A similar conclusion can be made on the nature of damage on left wingtip and left part of the stabilizer'. **Argumentation:** The damage evaluation of left engine cowling lip ring, left wing tip (slats) and front part of the left side of the stabilizer was done rather causally. It is necessary to add the detailed description of the damage on left engine cowling lip ring, left wing tip (slats) and front part of the left side of the stabilizer.	The Dutch Safety Board has performed an in-depth evaluation of the damage. Although there were a number of perforations noted, there was no large scale damage found on the engine cowling lip ring and the left hand wing that was caused by high energy fragments in the primary fragmentation spray.
Russian Federation / FATA	124	3.7.3	3.7.3 NLR projection Using the dynamic primary fragmentation pattern described in paragraph 3.4.8.3, the known speed of the aeroplane and a 3D model of a Boeing 777, a simulation model of the location and the boundaries of the fragmentation on the fuselage of the Boeing 777 was constructed. Light was used to visualise the area of the fuselage exposed to the dynamic primary fragment spray of the warhead. This fragmentation visualisation model was used to match the observed high-energy object damage on the cockpit with the calculated fragment spray of the warhead from the point of view of location, boundary and impact angle. The best match for a detonation location of the warhead was obtained to the left and above of the cockpit, travelling at a high speed in the opposite direction to the direction of flight of the aircraft, coming slightly from below and from the right with respect to the aircraft forward axis.	**Proposed text:** Delete this text from the report. **Argumentation:** 1. The model used to NLR to simulate the area of the aircraft exposed to the fragment spray-out requires serious corrections. The area exposed to fragment spray obtained though a light method does not explain all damages on the outer skin of the front part of the aircraft, ribs (holes at the angle of nearly 90 degrees) and multiple damage on left engine cowling lip ring, left wing tip (slats) and front part of the left side of the stabilizer. 2. The simplified model of fragment spray used for preparation of the draft final report does not consider the actual area of fly-out either. The actual fragment spray created during the detonation of 9M38M1 rocket warhead in motion (considering the rocket speed of around 730 m/s) is a complex rotating figure. 3. The distribution pattern of 9H314M warhead (9M38M1 rocket) fragment spray is optimized with a functional delay. Given the summarized speeds of the rocket and the target in the range of 1000 - 1200 m/s, the main spay of fragments (over 40 % from the fragment mass) at the maximum speed of 2100-2300 m/s is directed perpendicularly to the rocket movement vector at the angles of 70-90 and 260-280 degrees. This peculiarity allows identifying individual features of target hitting by a warhead of a certain type.	In addition to responses elsewhere in this document, the following is noted: The NLR Fragmentation Simulation Model does explain the damage caused by the warhead's fragments on the front part of the aeroplane. Using this model, missile end conditions (position, angles, speed) were obtained that resulted in a match with the damage on the wreckage in terms of its location, boundaries and impact angles. The motion of the warhead due to missile speed is taken into account in the NLR Fragmentation Simulation Model. In this model, the fragment spray visualised by light is a complex rotating figure. The NLR Kinematic Fragment Spray Pattern Simulation expands on that by taking into account the influence of the deceleration due to aerodynamic drag of the fragments. The model used by TNO expands on that further by simulating the trajectory of all individual fragments. The results of all these models are consistent with each other. The comments regarding the damage to the aeroplane's structure whereby the perforation holes are almost parallel to the direction ('at the angle of 90 degrees) address an aircraft part that was photographed but was not recovered by the Dutch Safety Board. A photo of the part is shown in paragraph 2.12.2. The image contradicts the notion that the perforation holes are at 'an angle of nearly 90 degrees'. The justification for point 3 is noted. However, the information regarding the operation of the detonation device that JSC Concern Almaz-Antey provided to the investigation, following a request by the Dutch Safety Board, was included in the simulations performed by NLR / TNO. This confirmed the validity of the simulations performed.

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Russian Federation / FATA	125	3.7.4	A complex, so-called flyout simulation, was used to analyse the missile's final speed and attitude (based on the damage patterns) to try and calculate the surface launch location. Multiple iterations of this process were performed. It was calculated that a missile launch was from a location ahead and to the right of the aeroplane.	**Proposed text:** Delete this text from the report. **Argumentation:** It appears that during the simulation no consideration was given to the specifics of the proximity fuse. The main feature of the proximity fuse of 9M38 and 9M38M1 rockets is that on receiving the required number of response impulses by the reception antenna, a functional delay is activated. The time of the functional delay is optimized on such condition that when firing at head-on courses the detonation point would be at least 3 to 5 meters from the front part of the aircraft in the direction of the tail unit. The delay may change only in case the response signal of the proximity fuse disappears. (when a target is flying on crossing courses). In this case an immediate detonation of the warhead occurs. The distribution of fragment spray is optimized with a functional delay. Given the summarized speeds of the rocket and the target in the range of 1000 - 1200 m/s, the spay of fragments will be directed perpendicularly to the rocket movement vector. Thus, in the case of the encounter conditions between the aircraft and the rocket, described in section 3.7.4, the detonation point of the rocket warhead should have been 3-5 meters further from the front part of the aircraft towards the tail unit.	On request of the Dutch Safety Board, Almaz-Antey delivered information about the operation of the detonation device. On the basis of this information, NLR concluded that the operation of the proximity fuse coincided with the calculated detonation point from NLR / TNO. The damage matching process did not include design and function of the proximity fuse but was based on the actual damage caused to the aeroplane. The Dutch Safety Board was not provided with information on the warhead's fusing logic but does note that the detonation point calculated matches the evidence found.
Russian Federation / FATA	125	3.7.4	Using the fragment initial velocities and aerodynamic calculations, the deceleration due to aerodynamic drag of the various fragments was modelled and calculated. The results of these calculations were used to perform a complete kinematic simulation of the fragment spray pattern. This simulation includes missile speed, speed of the Boeing 777, initial fragment speeds and fragment deceleration and was used to validate the results obtained from the fragmentation visualization model. Both the location, the attitude and the airspeed of the warhead at the time of detonation of the fragmentation visualization model could be validated with this kinematic fragment spray pattern simulation. To visualise these results slow-motion movies of the simulation results were made. Figure 72 shows several frames of this simulation in a top down view. The red cylinder represents the fastest fragments and the yellow cylinder the slowest.	**Proposed text:** Delete this text from the report. **Argumentation:** Under the encounter conditions between the aircraft and the rocket considered in the report, the high energy objects with maximum concentration, speed and kinematic energy should move in the direction of the right side of the aircraft. Considering the actual characteristics of the 9M38M1 rocket warhead, the cockpit will be exposed to three sprays of high energy objects. The first and second are in the range of 270 - 290 degrees with the speed of 2000-2400 m/s and the third one is in the range of 273-278 degrees with the speed of 1400-1900 m/s. The impact of the three spays of high energy objects would create through penetration holes in the outer skin of the cockpit right side and break-up of right side cockpit windows. These damages are not present on the front part of the fuselage.	With the warhead detonating at a point within the volume of space that was calculated (see paragraph 3.8.5 of the report), it is not expected that the right hand side of the cockpit would be perforated. The complex construction of the fuselage including its furnishing, instruments, equipment and the occupants in the cockpit all form barriers that reduce the speed of the fragments and prevent perforation, from the inside out, on the aeroplane's right hand side. The fact that hundreds of fragments were found in the bodies of the three crew members in the cockpit illustrated that the path of the fragments was affected.

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Russian Federation / FATA	126	3.7.4	The fragment spray pattern cloud is in between these cylinders. In reality, the weapon disintegrates on detonation and would not be visible as it is in the lower two frames of figures 43 and 44. Extrapolating the missile trajectory in the kinematic fragment spray pattern simulation shows that the secondary fragmentation caused by this disintegration (i.e. parts of the missile other than the warhead) impacts the engine and the wing. This secondary fragmentation damage is consistent with the damage noted on the left engine cowling ring and the left wingtip.	**Proposed text:** Delete this text from the report. **Argumentation:** The draft final report shows only one damage on left engine cowling lip ring on Figure 27 (Front side engine cowling impact damage) and Figure 28 (Back side engine cowling impact damage). The conclusion is that this damage has been caused by secondary fragments (break-up of the nose part of the rocket). Nevertheless, the analysis of the number and shape of damage on the left engine cowling lip ring assumes that it has been caused by warhead fragments of various fractions and is the result of primary damage. Considering the distance of more than 20 meters from the detonation point the damage density of the left engine confirms that the left engine was within the main area of fragment spray. The similar conclusions can be made about the left wing tip and left part of the stabilizer.	Although the Dutch Safety Board has concluded that the majority of the damage mentioned was secondary damage, some primary damage may have been caused to the parts mentioned. The Final Report has been amended accordingly. The missile fragment that was recovered from inside in the left wing tip illustrated that this area, near the left engine, was exposed to secondary fragments. See paragraph 2.16.3.
Russian Federation / FATA	127	3.7.4	Figure 44 shows several frames of the movie with a perspective 1 view from the left hand side. The location and the boundaries where the fragments impact the fuselage match the damage to both left hand front window and the side panel ahead of the forward passenger door on the left hand side of the fuselage.	**Proposed text:** Delete this text from the report. **Argumentation:** In the case of the encounter conditions between the aircraft and the rocket, described in section 3.7.4, the detonation point of the rocket warhead should have been 3-5 meters further from the front part of the aircraft towards the tail unit.	The NLR Fragmentation Simulation Model does explain the damage caused by the warhead's fragments on the front part of the aeroplane. Using this model, missile end conditions (position, angles, speed) were obtained that resulted in a match with the damage on the wreckage in terms of its location, boundaries and impact angles. The motion of the warhead due to missile speed is taken into account in the NLR Fragmentation Simulation Model. In this model, the fragment spray visualised by light is a complex rotating figure. The NLR Kinematic Fragment Spray Pattern Simulation expands on that by taking into account the influence of the deceleration due to aerodynamic drag of the fragments. The model used by TNO expands on that further by simulating the trajectory of all individual fragments. The results of all these models are consistent with each other. At the request of the Dutch Safety Board, JSC Concern Almaz-Antey delivered information about the operation of the detonation device. On the basis of this information, NLR concluded that the operation of the proximity fuse coincided with the calculated detonation point from NLR / TNO. The damage matching process did not include design and function of the proximity fuse but was based on the actual damage caused to the aeroplane. The Dutch Safety Board was not provided with information on the warhead's fusing logic but does note that the detonation point calculated matches the evidence found.

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Russian Federation / FATA	127	3.7.4	The primary and the secondary damage on the wreckage of the aeroplane is consistent with the final missile speed and direction of a medium to large sized surface to air missile launched from a surface location ahead of the aeroplane. … The weapon approached the aeroplane from a near head-on position, to the aeroplane's left hand side and was in a slightly elevated angle at the moment of detonation.	**Proposed text:** Delete this text from the report. **Argumentation:** Considering the damage to the aircraft structure and the specifics of the actual spay pattern of 9M38M1 rocket warhead fragments, Almaz-Antei (BUK design bureau) ran a simulation and obtained different results: based on the source data shown in the report, 9M38M1 rocket should cross the aircraft heading at 72-78 degrees horizontally and at 20-22 degrees vertically.	The NLR Fragmentation Simulation Model does explain the damage caused by the warhead's fragments on the front part of the aeroplane. Using this model, missile end conditions (position, angles, speed) were obtained that resulted in a match with the damage on the wreckage in terms of its location, boundaries and impact angles. The motion of the warhead due to missile speed is taken into account in the NLR Fragmentation Simulation Model. In this model, the fragment spray visualised by light is a complex rotating figure. The NLR Kinematic Fragment Spray Pattern Simulation expands on that by taking into account the influence of the deceleration due to aerodynamic drag of the fragments. The model used by TNO expands on that further by simulating the trajectory of all individual fragments. The results of all these models are consistent with each other. At the request of the Dutch Safety Board, JSC Concern Almaz-Antey delivered information about the operation of the detonation device. On the basis of this information, NLR concluded that the operation of the proximity fuse coincided with the calculated detonation point from NLR / TNO. The damage matching process did not include design and function of the proximity fuse but was based on the actual damage caused to the aeroplane. The Dutch Safety Board was not provided with information on the warhead's fusing logic but does note that the detonation point calculated matches the evidence found.
Russian Federation / FATA	128	3.7.4	The size of the penetration damage on the wreckage of the cockpit is consistent with the size of the fragments of the 9N314-model warhead. The type of damage on the wreckage of the aeroplane's fuselage, left engine and left wingtip is consistent with the type of damage caused by a pre-formed fragmentation warhead; a 9N314-model warhead carried on the 9M38-series of missiles as installed on the Buk, Buk-M1 or Buk-M1-2 surface to air missile system. The bow-tie fragments found in the wreckage of the cockpit are consistent with the bow-tie fragments used by the 9N314-model warhead.	**Proposed text:** Delete this text from the report. **Argumentation:** 1. The report incorrectly lists all known modifications of BUK, BUK-M1, BUK-M1-2, which have different characteristics. 2. The conclusion about the warhead of 9N314 series is incorrect as this warhead does not use «butterfly or bow-tie» fragments. 3. The butterfly or bow-tie shaped fragments showed on the photos in the report did not coincide with warhead fragments of BUK rocket by weight, shape and geometrical dimensions. During the investigation, one bow-tie fragment was weighed and turned out to be 5.5 grams. JSC Almaz Antei ran a test which showed that after penetrating a 5 mm steel obstacle a bow-tie or butterfly fragment should weigh at least 7.2 grams.	Text has been improved to include more details on the fragments expected in a 9N314M warhead. The fragments found are not in their original form (i.e. bow-tie, filler or square) due to abrasion, break-up, chipping and shattering of fragments after penetrating the aircraft skin and the surfaces on the inside. In addition, JSC Concern Almaz-Antey indicated that the actual number of pre-formed fragments differs from one warhead to another during manufacture. Considering changes due to deformation, abrasion, chipping and shattering on explosion and impact, the bow-tie fragments found in the wreckage originally had the shape, size and mass of the fragments used in the 9N314M warhead. These fragments are very distinct and they are found in this type of warhead.
Russian Federation / FATA	130	3.7.5	The warhead's position at detonation takes into account the time between detonation of the warhead and the impact of the fragments. Table 15 shows the warhead position as stated according to NLR and TNO. The differences between the two calculated positions are small.	**General comment to section 3.7.5 of the report «Validation of NLR simulation by TNO»:** The detonation point was incorrectly determined and did not match the traces of impact from warhead fragments and blast wave on the aircraft wreckage. The identified detonation point by the movement direction of high energy objects as shown on Figure 23, 24 and 30 is not correct. The directions are not matching on all Figures.	It is noted that the presentation was not intended to identify the weapon used. The report is amended accordingly and the presentation by JSC Concern Almaz-Antey contained in the Appendices to the draft Final Report is therefore withdrawn. Regarding the rest of the comment, JSC Concern Almaz-Antey provided the Dutch Safety Board with new information on the characteristics of the warhead. This information was used independently in different simulation models. The results of these simulations are included in the Final Report.

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Russian Federation / FATA	131	3.8	Using the study performed by NLR (see paragraph 3.7.4) a launch area was calculated. This location was derived from the last recorded Flight Data Recorder position of the aeroplane. Due to a number of uncertainties the position from where the missile was fired can only be established in terms of a launch area. Uncertainties exist in the exact point and angles of detonation, the exact speed of the missile at detonation and the launch conditions. Over a grid of launch locations the launch angles were varied to obtain the boundary where the missile end speed and attitude angles would still be within the above mentioned range. The area obtained by this boundary is limited by missile kinematic performance, aerodynamics, seeker limits and takes into account several uncertainties in guidance and launch conditions. A missile launched from within this area can obtain the end speed and attitude (angles) range at the detonation point derived from the damage matching of the previous Sections. Outside this launch area these missile end conditions cannot be realised. The launch area is about 250 km^2 approximately 15 kilometres by 17 kilometres. It is located to the south of, and including, the village of Snizhne. Figure 47 shows this launch boundary on the map together with the flown track and last know Flight Data Recorder position of flight MH17.	**Proposed text:** Delete this text from the report and replace it with the following: «Considering that during the last three minutes Boeing 777-200 (MH17) was flying rectilinearly and evenly, the horizontal projection of the rocket trajectory was nearly a straight line. The trajectory was possibly twisting in the range of 2-4 degrees at the initial phase of rocket acceleration and at the stage of self-homing. In the vertical projection the rocket trajectory is divided into two stages: the acceleration segment and proportional approach by the location angle. As the BUK design bureau, Almaz-Antei has the capabilities to identify the launch area based on the performance data of 9M38 or 9M38M1 rockets. The limits of the launch area from west to east are dictated by the encounter conditions - the crossing angle with the aircraft heading in the horizontal plane (72-78 degrees) and maximum targeting errors (up to 2-4 degrees). The limits of the launch area from north to south are dictated by the encounter conditions - the crossing angle with the aircraft heading in the horizontal plane (20-22 degrees), downrange, and maximum targeting errors (up to 2-3 degrees). The simulation of the 9M38M1 rocket targeting process ran by Almaz-Antei indicates that crossing of the rocket and aircraft trajectories within the predetermined conditions is feasible only from the limited area south of Zaroshchenskoye village.».	The following remarks are made in addition to responses made elsewhere in this document. Regarding the possible position from where the weapon's flight path could have commenced, calculations were performed using an advanced six degrees of freedom missile fly out simulation using reliable tactical and technical performance data of the 9M38-series missile. The simulation model accounted for a large number of possible uncertainties in modelling and launch conditions by varying the relevant parameters within viable boundaries. This results in the area from within which the missile's flight path could have commenced, as described in the report. The simulation model that was used was validated using data provided by JSC Concern Almaz-Antey and was found to contain no errors or omissions. The differences in performance between the 9M38 and 9M38M1 missile have been accounted for. The area from within which the missile's flight path could have commenced was calculated by the Russian Federation based on NLR data, for both missile types are inside the area calculated by NLR in Section 3.8. The simulation referred to by the Russian Federation was presented by JSC Concern Almaz-Antey during the second progress meeting upon request from NLR. Almaz-Antey provided a simulation with the detonation location as calculated by NLR/TNO. The three simulations of the calculated areas from which a 9N314M warhead carried on a 9M38-series missile as installed on the Buk surface-to-air missile system are based on the observed damage on the aeroplane and the position of the associated detonation location to that. The simulation run by JSC Concern Almaz-Antey with a launch area near Zaroshchenskoye resulted in a fly-past configuration that would create a damage pattern that did not match the observed damage on the aeroplane or the associated detonation location. See also the Dutch Safety Board's response to the comment on paragraph 3.7.3 (page 124).

State / Organisation	Page	Section / Paragraph	Text to be corrected (first... last word)	Argumentation / substantiation	Dutch Safety Board response
Russian Federation / FATA	133	3.9	The meeting concluded with concurrence by all parties on the following points: • flight MH17 was struck by a surface to air missile whilst in flight; • the missile contained a 9N314-model warhead carried on the 9M38-series of missiles as installed on the Buk, Buk-M1 or Buk-M1-2 surface to air missile system. • the point of detonation was on the left hand side of the aeroplane, above the cockpit and between 1.5 and 4 metres laterally from the aeroplane.	**Proposed text:** Delete this text from the report. **Argumentation:** During the second meeting, the representatives of the Russian Ministry of Defense and Almaz-Antei (BUK design bureau) presented the data and calculations with conclusions, which were different from the ones presented by DSB: it was pointed out that the detonation point was incorrectly determined and the pattern of fragment spay was incorrectly oriented too, not all damage of aircraft structure by high energy objects was considered either. This part of the report does not contain any arguments as to why the data provided by the Russian experts have not been used.	It is noted that the presentation was not intended to identify the weapon used. The report is amended accordingly and the presentation by JSC Concern Almaz-Antey contained in the Appendices to the draft Final Report is therefore withdrawn. Regarding the rest of the comment, JSC Concern Almaz-Antey provided the Dutch Safety Board with new information on the characteristics of the warhead. This information was used independently in different simulation models. The outcome of the simulations was incorporated in the Final Report. The Russian Federation has, notwithstanding their previous position during the first and second progress meeting, stated that the aircraft was shot down by a missile that could have been launched from an aircraft as well as from the surface. The third progress meeting was concluded with the common conclusion, supported by the Russian Federation that the aircraft was hit by high energy objects that originated from a missile that detonated on the left side and above the cockpit. Abovementioned information is described in the Dutch Safety Board's report 'About the investigation'.

State / Organisation	Page	Section / Paragraph	Text to be corrected (first... last word)	Argumentation / substantiation	Dutch Safety Board response
Russian Federation / FATA	156	3.13	3.13 Recording of surveillance radar data According to ICAO Annex 11 Air Traffic Services, paragraph 6.4.1 Automatic recording of surveillance data, States are required to automatically record surveillance data from primary and secondary radar equipment systems for use in accident and incident investigations, search and rescue, and air traffic control and surveillance systems evaluation and training. These recordings shall be retained for a period of at least thirty days and for accident and incident investigation for a longer period until it is evident that they will no longer be required. As the accident had occurred outside Russian Federation territory, the Federal Air Transport Agency of the Russian Federation stated that no radar data was saved nor was it required to be so by national regulations. It was confirmed that had the event occurred in Russian Federation territory, the data would have been saved according to Russian Federation regulations. The Russian Federation was requested to provide its national regulations. As to date these regulations have not been received. It is noted that the provisions in paragraph 6.4.1 of Annex 11 are not restricted to State's boundaries. The Russian Federation had not notified ICAO of a difference between their national regulations and practices and this ICAO Standard requiring the automatic recording of surveillance data. Such a notification obligation was imposed by Article 38 of the Convention on International Civil Aviation. Finding The Russian Federation had not notified ICAO of a difference between their national regulations and practices and an international ICAO Standard, in Annex 11, requiring the automatic recording of surveillance data.	**Proposed text:** Delete this text and replace it with the following: «The Russian Federation has requirements for automatic recording of surveillance data in the national legislation that are fully compliant with ICAO Annex 14. The explicit explanations and extracts from the national regulations were sent to the investigator in charge on May 6. 2015. ICAO Annex 14 does not specifically say that raw data must be saved. The Russian Federation saved the necessary surveillance data in the format of a video file thus fully complying with the requirements of ICAO Annex 14». **Argumentation:** In accordance with the item 3.6.8 of the Federal Aviation Rules 'Air Traffic Management' the radio exchange between ATS units and aircraft pilots, voice exchange between ATS unit controllers, weather briefings of pilots and ATC controllers, pre-flight inspection, weather data transmitted on radio channels as well as radar and flight data shall be recorded by special equipment. The recorded data must be kept and used for the purpose of ATS within 14 days if using analogue recording equipment and within 30 days if using digital recording equipment. The ICAO documents do not provide any definition of the term 'ATS surveillance system'. Pursuant to item 8.1.2. of the ICAO Doc 4444, the surveillance system comprises integration of all data necessary for air traffic services. In this regard, the video file with the air situation from the radar screen provided by the Russian Federation can be qualified as 'surveillance data', which retention is required by the item 6.4.1.1 Annex 11 to the Chicago Convention. The Russian Federation is in full compliance with the requirements of the item 6.4.1.1 of Annex 11 to the Chicago Convention. All data at disposal of the Russian side was properly made available to DSB and used in the course of the investigation.	ICAO was consulted on this matter. The text in ICAO Annex 11, paragraph 6.4.9 refers to 'automatic recording'. According to ICAO this includes the recording of all data, including raw data. The report's text has also been modified.
Ukraine / NBAAI	157	3.14	3.14 Air Traffic Service As of the day of the crash Air Traffic Services for flight MH17 were provided by air traffic controllers of Lviv, Kyiv and Dnipropetrovsk ACCs. UKSATSE air traffic controllers were licensed, qualified and accordingly trained. The regulations and procedures of air traffic service provision complied with ICAO Standards and Recommended Practices. Finding Air Traffic Services for flight MH17 could not be the cause or any contributing factors of the crash.	Additional subsection should be added to this paragraph.	As the training an qualifications of the air traffic controllers have not been included in the investigation, the matter will be addressed in a similar manner to that of the cabin crew. There is no evidence that the controllers did not perform their duties correctly.

State / Organisation	Page	Section / Paragraph	Text to be corrected (first... last word)	Argumentation / substantiation	Dutch Safety Board response
Russian Federation / FATA	159	4	4 CONCLUSIONS	**General comment to section 4 of the report «Conclusions»:** 1. The conclusion was subjectively formulated without due regard to the requirements to the 'Format of Final Report' from Annex 13 to the Chicago Convention. This section does not indicate any action, inaction, circumstances, conditions or their combination (causes) and action, inaction, circumstances, conditions or their combination, removal, prevention or absence of which would reduce the probability of the air accident (contributing factors). 2. The conclusion does not take account of and contradicts to the conclusions contained in «Flight MH17 and flying over conflict areas» report regarding the responsibility of Ukrainian authorities for analyzing the situation in the conflict zone as well as ensuring proper coordination between military and civil authorities of Ukraine for the purpose of timely introduction of necessary restrictions aimed at provision of safety of civil aviation flights. 3. The proposed 'Conclusion' does not contain any substantiation for the need to develop actions to prevent similar air accidents in the future. Thus, the main objective of the investigation established by Standard 3.1 of Annex 13 to the Chicago Convention is not achieved.	The Final Report contains both the investigation into the damage sustained by the aeroplane and the investigation into the flight route. The outcome of the results from the investigation does not lend itself to the layout of Annex 13. The need to exclude other possible causes, for examples, has lead to an alternative layout for the conclusions.
Russian Federation / FATA	159	4.1 4.2	4.1 Cause 4.2 Supporting conclusions	**Proposed text:** Add the following conclusion to this section: «Airspace On 17 July 2014, airspace restrictions were in place for the eastern part of Ukraine and parts of the bordering airspace in the Russian Federation from ground level up to FL320. There were no restrictions for flight MH17 to fly in Dnipropetrovs'k Flight Information Region planned flight levels FL330 and FL350. Ukraine did not devote enough attention to the risks to civil aviation which arose from the spreading of the military conflict to the air. The decision-making related to Ukrainian airspace was dominated by the military authorities and the interests of military aviation. The civil aviation authority and air navigation service provider had insufficient information to be able to make an independent assessment of the safety of the airspace for civil air traffic at cruising altitude. This made it possible that Ukraine did not close its airspace, even though the fact that the conflict had spread to the air was reason to do so as a precaution». **Argumentation:** The sections «Cause» and «Supporting conclusions» contain a formal enumeration of certain factors without any conclusions as to why they became possible. This section shall be added with the conclusions contained in part «b» sub-item 1 section 8 of «Flight MH17 and flying over conflict areas» report concerning the lack of appropriate actions on part of Ukraine to ensure safety of civil aircraft flights over the armed conflict zone.	Text amended insofar as it addresses the NOTAMs that were in place. The second paragraph proposed is related to the security of the route and is addressed in Part B of the Final Report.

State / Organisation	Page	Section / Paragraph	Text to be corrected (first... last word)	Argumentation / substantiation	Dutch Safety Board response
Ukraine / NBAAI	159	4.1	Air Traffic Services for flight MH17 was provided by licensed, qualified and accordingly trained air traffic controllers of Lviv, Kyiv and Dnipropetrovsk ACCs. Air Traffic Services for flight MH17 did not have any impact on safety to be the reason of the crash.	Additional sentences should be added after the Line 11 (ref. protocol of meeting on 23.07.2014).	As the training an qualifications of the air traffic controllers have not been included in the investigation, the matter will be addressed in a similar manner to that of the cabin crew. There is no evidence that the controllers did not perform their duties correctly.
Ukraine / NBAAI	159	4.1	The 9M314-model warhead carried by a 9M38-series missile was launched from a Buk, Buk-M1 or Buk-M1-2 surface-to-air missile system in an area south of Snizhne, Ukraine, which was controlled, at that time, by the illegal armed groups.	At time of the accident, the territory was de-facto controlled by illegal armed groups, which needs to be mentioned in the report.	The Dutch Safety Board does not provide any political interpretation of the conflict and strives to use politically neutral terms as much as possible. Interpretations by other parties are those parties' responsibilities.
Russian Federation / FATA	161	4.2	*6. Damage pattern* The location, shape and boundaries of the damage to the wreckage of flight MH17 and the number and density of hits on the wreckage was consistent with fragmentation spray pattern damage of pre-formed fragments from different shapes and sizes in a 9N314-model warhead carried on the 9M38-series of missiles and installed on the Buk, Buk-M1 or Buk-M1-2 surface to air missile system.	**Proposed text:** Delete this text from the report. **Argumentation:** 1. The report lacks any substantiation that the damage has been inflicted by BUK type anti-aircraft weapons system («9M38 type» rocket with «9H314 type» warhead). 2. The report does not unambiguously identify the type of the warhead. The warhead fragments (high energy objects) are not unambiguously identified either (by steel grade, weight, sizes). 3. The report does not consider that 9N314 and 9N314M warheads have significantly different characteristics such as types and quantity of fragments, spay patterns of fragments under static and dynamic conditions.	This comment repeats comments made above. It is handled as per those comments. Studying the detailed chemical composition of the steel is not relevant to the investigation as the high-energy objects are usually made from low-grade metal (unalloyed steel) originating from different batches, different sources, different manufacturing locations and over different periods of time. Matching the fragments found with reference material from an intact warhead would not be possible because of these differences. Considering changes due to deformation, abrasion, chipping and shattering on explosion and impact, the bow-tie fragments found in the wreckage originally had the shape, size and mass of the fragments used in the 9N314M warhead. These fragments are very distinct and they are found in this type of warhead.
Russian Federation / FATA	161	4.2	The objects found are consistent with the pre-formed fragments in the 9N314-model warhead carried on the 9M38-series of missiles as installed in the Buk, Buk-M1 of Buk-M1-2 ground to air missile system.	**Proposed text:** Delete this text from the report. **Argumentation:** The conclusion about «9N314 series» warhead is not correct as 9N314 does not use «butterfly or bow-tie» type fragments.	Text has been rewritten. The warhead identified as the only one having bow-tie shape fragments is the 9N314M (in Cyrillic text, the 9H314M). This warhead is intended to be carried by the 9M38M1 missile but it is known to be also installed on the 9M38M. Therefore, the report refers to the 9N314M warhead and the 9M38M or 9M38M1 missile as launched by the Buk surface-to-air missile system.
Russian Federation / FATA	163	4.3	*9. Other weapons* a. Air to air gunfire The high-energy object damage was not caused by air to air gunfire because the number, the size and type of high-energy objects impact damage is not consistent with gunfire impact damage and the trajectories of the high-energy objects that struck the aeroplane are not parallel but converge to a single location close to, and above, the aeroplane. b. Air to air missile The high-energy object damage was not caused by an air to air missile because there was no military aircraft in the area of flight MH17 to launch such a missile. Air to air missile warheads do not have butterfly or bow-tie shaped fragments, and an infra-red guided missile would have caused damage to the aeroplane nearer the engines.	**General comment on this conclusion:** It is necessary to accurately identify the type of the rocket hitting the aircraft before drawing such conclusions. The comments to the previous sections of the report clearly indicate that the conclusions on the use of BUK type anti-aircraft weapon system again Boeing 777-200 (MH17) are not substantiated and do not take account of the actual tactical & technical performace of this type of the weapon system.	The report has been modified to include more details on weapon systems. The last sentence in the text is deleted. However, for a weapon system to be considered as being a potential source of the damage, its warhead must include the distinctive 'bow-tie' shaped pre-formed fragments that were recovered.

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Russian Federation / FATA	164	4.4	*2. Retention of ATC data* The Russian Federation had not notified ICAO of a difference between their national regulations and practices and an international ICAO Standard, requiring the automatic recording of surveillance data.	**Proposed text:** It is necessary to exclude this section from the report as not meeting the objective of 'Conclusion' section of the draft final report. **Argumentation:** The Russian Federation is in full compliance with the requirements of the item 6.4.1.1 of Annex 11 to the Chicago Convention. All data at disposal of the Russian side was properly made available to DSB and used in the course of the investigation. The necessary Argumentation is given in comments to sections 2.9.5.3 and 3.13.	ICAO was consulted on this matter. The text in ICAO Annex 11, paragraph 6.4.9 refers to 'automatic recording'. According to ICAO this includes the recording of all data, including raw data. The report's text has also been modified.
Russian Federation / FATA	165	5	RECOMMENDATIONS	**General comment on section 5 of the report «Recommendation»:** The presented draft final report does not contain any recommendations on flight safety.	The proposed recommendations were not included in the draft Final Report. These were, however, presented during the third progress meeting. The recommendations are included in the Final Report.
Ukraine / NBAAI	169	Appx. A	the illegal armed group	The armed groups operating in certain areas of Donetsk and Luhansk Regions of Ukraine that are not controlled by the government do not have any legal status	The Dutch Safety Board does not provide any political interpretation of the conflict and strives to use politically neutral terms as much as possible. Interpretations by other parties are those parties' responsibilities.
Ukraine / NBAAI	219	Appx. K	the illegal armed group	The armed groups operating in certain areas of Donetsk and Luhansk Regions of Ukraine that are not controlled by the government do not have any legal status	The Dutch Safety Board does not provide any political interpretation of the conflict and strives to use politically neutral terms as much as possible. Interpretations by other parties are those parties' responsibilities.