5.4 Identification of weapon

As a result of the investigation of the combat damage on the Boeing 777 fragments, it was established that the aircraft was hit by a remote-controlled high-explosive warhead loaded with ready-to-use high-explosive fragments. The warhead exploded no more than 1.6-2.0 metres from the window of the cockpit on the left side.

The number of damage of all types from prefabricated and hulled destructioners is:

on fragments of the outer skin of the nose section of a Boeing 777 installed in a 3D reconstruction of about 350;[146]

there are about 60 holes in the airframe elements, the position of which can be established with a high degree of accuracy;

more than 120 fragmentation injuries on the cockpit floor, interior and transverse structural elements of the cockpit floor;

The "inside-out" portside exit holes (punctures and non-pitch damage) are concentrated below the second portside window and distributed further along the portside;[147]

The left wing and left engine have combined fragmentation damage, which includes through holes from prefabricated projectiles up to 14 mm in size.

Most of the high-energy objects that struck the aircraft moved predominantly along the longitudinal axis of the aircraft or at slight angles to it. The highest density of damage to the outer skin and the structure was recorded in the area of the windshield and the vent on the left side of the cockpit, and further along the port side and the upper left part of the aircraft roof. This is confirmed by the mutual location of fragments of the outer skin, the structure and the cockpit floor with maximum damage densities on the 3 D-reconstruction. Damage to the cockpit floor is concentrated along the port side, while damage to the power structure (bends) - on the left side of the roof and on the port side - is spread further than the outer skin damage.

In accordance with the missile manufacturer's technical documents (DNPP), it was established that both numbered fragments: the engine part marked "9D1318869032" and the nozzle part marked "9D131.05.000 No. 8.30.113" were installed in the 9M38 missile (without the "M1" index, i.e. an older modification) with the factory technical number "8868720".

[146] There are no "inside-out" exit punctures on the starboard side of the Boeing 777.

[147] About 70 more holes have been accounted for by Almaz-Antey specialists in the fragments that were not represented in the final 3D rendering.

The analysis showed that **the 9M38 missile** of the BUK system **could only be the cause of the** destruction of the aircraft in mid-air if it **encountered the aicraft** "**on a collision course**".

This is confirmed by the actual boundaries of the fragmentation area, the direction of damage, the shape, number and density distribution of the holes to the outer skin, structure, floor and internal equipment of the cockpit, as well as the characteristics of the 9H314M warhead impact field confirmed experimentally.

When considering the conditions of the aircraft missile encounter "on an opposite course", the 9M38 missile could not be the cause of the crash of the Boeing 777. In this case, the nature of the damage to the starboard side and the structure does not correspond to the most important characteristics of the impact field - the density of the fragmentation field and the penetration effect of the flow of preformed projectiles produced by the detonation of the BUK warhead, and the location of the detonation point area contradicts the non-contact fuse algorithm.

In the "opposite direction" version, the aircraft was hit by another unidentified weapon with a high-explosive fragmentation warhead loaded with preformed fragments of one or two fractions.

6. Analysis of the results obtained

As a result of the research including calculations and modelling confirmed by a series of full-scale experiments and tests, specialists of Almaz-Antey Corporation have confirmed their conclusions, which were first announced in May 2015 during a meeting at Gilze-Rijen Air Base.

The essence of these conclusions is as follows:

1. If the crash of the Boeing 777 was caused by a BUK missile, it could only have happened "on a collision course" and it could only have been an older version of the missile, the 9M38.

2. Based on the results of the analysis of the full-scale experiment carried out under the conditions in the findings of the Dutch experts, the results of special studies of the penetration capability of projectiles, assessment of the damage to the outer skin, internal equipment and the structure of the Boeing 777, and the full-scale experiments involving the Utes-T ARRC, it was established that the DSB findings that the aircraft was hit by a 9M38M1 missile flying "in an opposite direction" were not confirmed.

3. If the Boeing 777 had been hit by a BUK missile with a 9H314M warhead "on an opposite direction", the damage pattern would have been radically different – the number and density of holes in the outer skin would have been 2-3 times greater than what is actually observed. The structure of the aircraft would have been penetrated through from the starboard side, and the outer skin of the cockpit would have many holes with a "butterfly" shape which is characteristic of "bowtie shaped" projectiles.[148]

4. Calculations and experiments[149] proved that taking into account the detonation point area corresponding to the actual damage to the Boeing 777 and considering all the basic characteristics of the 9H314M warhead damage area, the version about the impact of BUK missiles can only be considered under the missile aircraft encounter conditions where the missile crosses the aircraft course in the horizontal plane with angles 72^{+2}_{-10} degrees.

5. The methodologies used by the Almaz-Antey Corporation specialists to calculate the missile launch areas are largely the same as those used by independent specialists. When the same source data are used, the calculation results for the main parameters are the same.

By making necessary adjustments to the source data for the aircraft damage model (fragments with a high density of damage) taking into account the fragmentation field boundary and the actual position of the aircraft in space (taking into account local magnetic declination), the possible launch area calculated according to the methodology of independent specialists will shift to the west, which

[148] Experiment in a combined target layout conducted on 07.10.2015.

[149] Shielded target experiment conducted on 31.07.2015.

is closer to the results of Almaz-Antey specialists' calculations.

Thus, the studies using adjusted source data in the models do not support the version of a missile launch from the area of Snezhnoye and Pervomaysky settlements.

6. BUK missiles launched from any of the three areas[150, 151, 152] determined by calculations of specialists from the "Netherlands Air and Space Centre" (NLR) cannot approach an aircraft under actual encounter conditions that can explain the damage to the outer skin and airframe which is objectively observed in the airliner's fragments. This is confirmed by calculations made by the 9M38 and 9M38M1 missile (including the non-contact fuse) control system software and in-flight control data recorded by Utes-T ARRC.

7. The lack of complete objective data from metallurgical examinations and the and the mismatch between the weight and dimension characteristics of the fragments specified in the materials of the Dutch experts and the reference samples obtained during the tests do not allow for unequivocal identification of the type of warhead and weapon. This does not exclude the possibility that the aircraft was also hit by another, unspecified, weapon.

[150] **250** km^2. Draft Final Report. 3.8 Launch area. Figure 47. Area of missile launch (Source NLR), p.132.
[151] **320** km^2. Final Report. Visualisation of NLR fly out simulation result. Figure 62, p.144.
[152] **75** km^2. A new area, images of which have been published in the public domain.