Report on experimental research concerning the destruction with the use of explosive materials of a construction imitating a part of the fuel box in the left wing of TU154M, 2018
Doc No: PW/WB/GAJ-080717-01 Experiment: cutting the wing model with the use of a linear explosive charge, 2017

The experiments conducted by the Committee in February 2018 on a scale 1:1 show that the destruction of the wing with a cutting character, with all the spars and stringers, can be achieved with the use of a linear explosive material with a thickness of 1mm and 5mm width. This material can be placed inside the fuel box and sealed to prevent it from having contact with fuel and at the same time making it undetectable.

Source: Report on experimental research concerning the destruction with the use of explosive materials of a construction imitating a part of the fuel box in the left wing of TU-154M, 2018.

Events between the explosion of the wing and TAWS 38

The main part of the lifting force of the 76ton TU-154M comes from the lift force of the left and right wing, and from the slats and flaps. When rolling (90 degree and more) the plane loses altitude.

Very precise experiments conducted in the aerodynamic tunnel, as well as simulations with the use of fluid dynamics conducted by 4 independent institutions (WAT, Akron University, IL, Metacomp) show that the loss of the left wingtip, which decreased the wingspan by approx. 6.5m, will result in a loss of lifting force, in this particular case, by 4.8%-8.7%, depending on the angle of attack

Source: Results of experiments of the Aviation Institute 6.XI.2017 and 27.III.2018.

Experiments in the aerodynamic tunnel, conducted in IL, showed that the loss of lift force between 4.8% and 8.7%, due to the loss of the left wingtip, does not have to end in a left roll. This work shows that the pilots, even with an angle of attack up to 11.5degrees, can fully balance the rolling moment by introducing a 7degree sideslip (they have to change the configuration of the plane so that the left wing is moved forward). Further balancing is possible with the move of the right aileron. A side slip is an element of basic aviation training and instinctive for every experience pilot, which is used during side-wind. When losing 1/3 of the left wing, the decreased wind resistance on this side will result in a right-turn of the plane to the sideslip with the left wing to the front. (Fig. 25).

Source: Results of experiments of the Aviation Institute 6.XI.2017 and 27.III.2018.

A number of airplanes of similar size to TU-154M, e.g. B707, experienced a similar or even bigger loss of lift force of one of the wings during the flight and they were able to land safely.

Source: PANAM lot 843, https://www.youtube.com/watch?v=_-fNahas8Ro.

Fig. 25. Airplane model in the wind tunnel of the Institute of Aviation. Here in version with a cut left wing and without slats and the outer flap.

The loss of the left wingtip, 1/3 length, together with the loss of the left slats and flaps (which were found before the Kutuzov street) will result in a major loss of lift force (16%-20%), which can't be balanced by the activities of the pilots and has to lead to a left roll and deepening turn on the left wing connected with a sudden loss of altitude.

Source: Experiment on TU-154M model on a 1:40 sale in the T-1 tunnel of the Aviation Institute, Polish Institute of Aviation (IL), Prof. Krysiak, 06.11.2017. Polish Institute of Aviation (IL), Prof. Krysiak, 27.03.2018.

At the altitude point set by the geographical coordinates recorded in TAWS#38, approx.710m from the runway threshold, the recorded barometric altitude was 36.5 with reference to the RWY26. This altitude was confirmed by the FMS of the second pilot, who a second after TAWS#38 noted the same barometric altitude.
Source: Universal Avionics Report

The distance between the so called bb tree and TAWS38 is approx. 140m. The distance that the plane traveled between the places of supposed contact of the wing with the bb tree, as assumed in the Miller and MAK reports, and TAWS 38 was 115m.

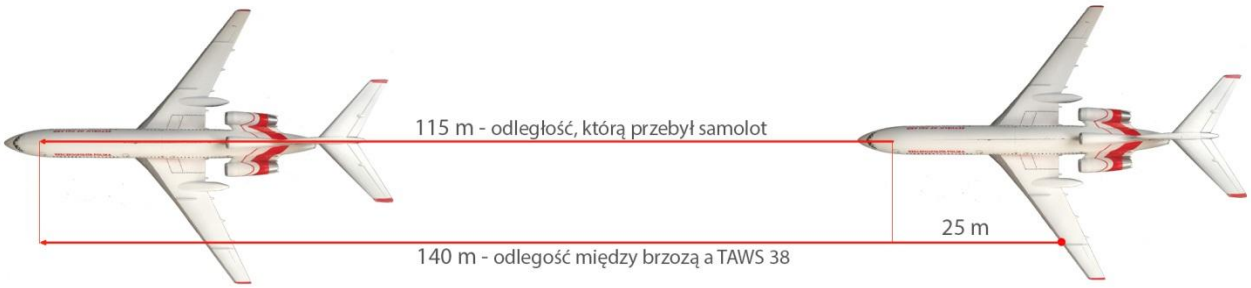

Fig. 26. The difference in distance from the tree, that is claimed to have made wing contact with TAWS38 (140m) and the distance that the plane travelled (115m). The distances are different as the GPS antennas are located 25m in front of the hypothetic zone of contact.

Source: Reconstruction of the Committee showing real distances between bb and TAWS.

According to the profile from the SRTM 1 base (made available by the US Geological Survey in 2014) the level of terrain next to bb tree, broken at a height of approx.6m, was 249m, so 5 meters below the level of the runway being 254m. According to this data and ATM WAR the damaged plane in landing configuration after contact with the birch tree within one second would have to climb over 35m to the barometric altitude recorded in TAWS38, which exceeds the possibilities of an intact TU-54M plane by four times.

During the test flight of a lighter TU-154M, PLF101 at Okęcie airport, which was lighter during this test, with 85% RPM so 9500 kg of thrust, the plane was climbing, while doing the go-around with a velocity of 7.5 m/s and 80m/s of horizontal velocity.

Source: Committee materials.

The disintegration of the plane from TAWS38 to Kutuzov Street

The data from the FDR shows that 3 engines were working with 85% RPM, so 9500 kg thrust/engine after moving the thrust lever from small RPM to full power after 5 seconds of acceleration. Such thrust sufficed for a go-around. This was achieved in the vicinity of TAWS38. Then, according to FDR data, the RPM's started to decrease on engine 2 and 3 to 80,7% and 81.6%, meaning 8300-8500 kg, and in engine 1 (left) rapidly to 39,5% of RPM so a thrust of approx. 2000kg. So after passing Kutuzov street the total thrust of three engines, according to ATM-QAR, was 18800 kg, which was 60% of maximal thrust and was not enough to continue the go-around. Approximately 650m from the beginning of the runway the KBN 1-1 recorder noted an error in the first engine.

In the last seconds of the flight TAWs and FMS recorded a series of errors:

- TAWS recorded the first fault.log at 6:40:59 UTC time, in the place of the landing event (TAWS#38 landing), and recorded no connection with the sensor on the flaps of the wing
- The last two fault.log records happened at the same time at 6:41:02 UTC time and informed about a loss of communication between FMS of the first and second pilot as well as a chassis error.
- At the same time the readout of the FMS memory of the second pilot included information about no readouts concerning the magnetic course and the last read value 267.1 degrees, the same as in TAWS#38 three seconds earlier.
- At 6:41:02 UTC time, when the plane was still in the air, the FMS memory froze, which meant there was no electricity supply.

In addition to that we can read the following information about consequent TAWS38 errors from discreet data recordings:

- Radio altimeter of the first and second pilot (parameter SPRRW5NR1/2) and the first hydraulic installation (parameter PH1VZBLIZ).
- Engine and generator no.1 of the same engine

Events between the Kutuzov Street after the explosion in the center wing

One line of elements from the left horizontal and vertical stabilizer (stemming from the area, where it was connected to the horizontal stabilizer) behind the Kutuzov street shows that the roll of the plane was large and the dispersion of parts falling off the plane and destroyed branches points to a sudden destruction of the plane in the air (Fig. 27).

Fig. 27. Placing the left side of the horizontal stabilizer and the vertical stabilizer behind Kutuzov highway. Flight direction is from right to left. Red dots show debris from the Tu-154M and green dots show debris from the associated tree damage.

The treetop of one of the trees on the eastern side of the Kutuzov street, on the flight path of the TU-154M, was cut with a straight line with an angle of cut 120degrees from the line of horizon. (Fig. 28).

Fig. 28. A damaged tree on the East side of Kutuzov Street.

The height of the plane with a left wing roll angle of 120 degrees determined by the tree damage on both sides of the Kutuzov street was about 28m just before the street.
Source: Committee Analysis.

Based on the damage on both sides of the Kutuzov street the balance point of the plane was set the moment the plane passed the trees on the western side (closest to the crash), which is 26m above the place of event.

A 6-7 meter high tree marked with the letter “Z” on fig 29 to fig. 31b and directly above the trajectory of flight was not damaged by the plane which means that the altitude to the balance point in that moment, when the tail passed the “Z” tree, was at least 10m.

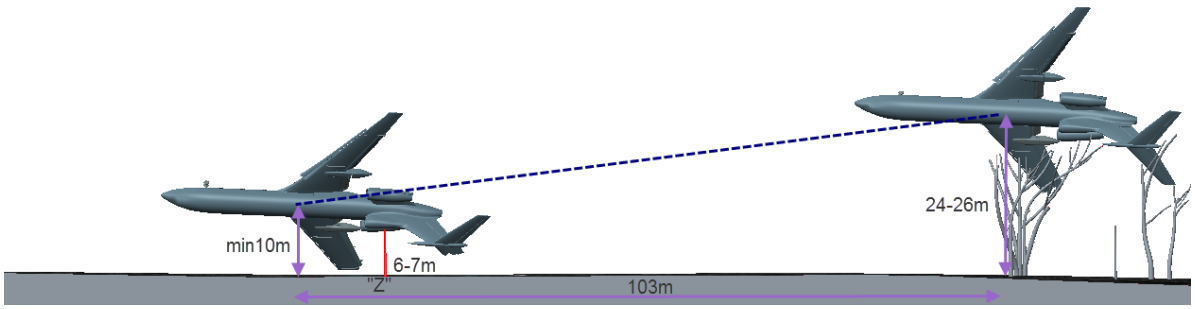

Fig. 29. A view to the north at the moment the plane flew from Kutuzov street (right) to the crash site (left). The 6-7m tall tree is here marked with the letter "Z".

Fig. 30. The tree marked "Z" growing in the direct vicinity of the flight path, when the plane was flying from Kutuzov Street (in the background) to the place of crash. On the right side, starting at the blue marker on a stick there is a visible ground trace when the ground was hit with the left stabilizer.

Fig. 31a. The tree marked "Z" growing in the direct vicinity of the flight path, when the plane was flying from Kutuzov Street (red circle) to the place of the crash. The ground trace from the tail is visible and marked here as "Southern Ground Trace".

Fig. 31a. The tree marked "Z" growing in the direct vicinity of the flight path, when the plane was flying from Kutuzov Street (right side) to the place of the crash (left side). The ground trace from the tail is visible and marked here with a red ellipse. The white part inside the ellipse shows the new position of the left horizontal stabilizer after Russians had moved it 35m closer to the crash site.

Burnt pieces of the Tu-154M found 100m before the crash site

During a terrain analysis, done by Polish archeologists in Smolensk in October 2010 in sector 13 behind Kutuzov Street and before the main crash site, numerous pieces of the plane were found (fig 32). Those pieces, varying in size, from a couple to tens of square centimeters, had traces of thermal and mechanical effects (fig 33).

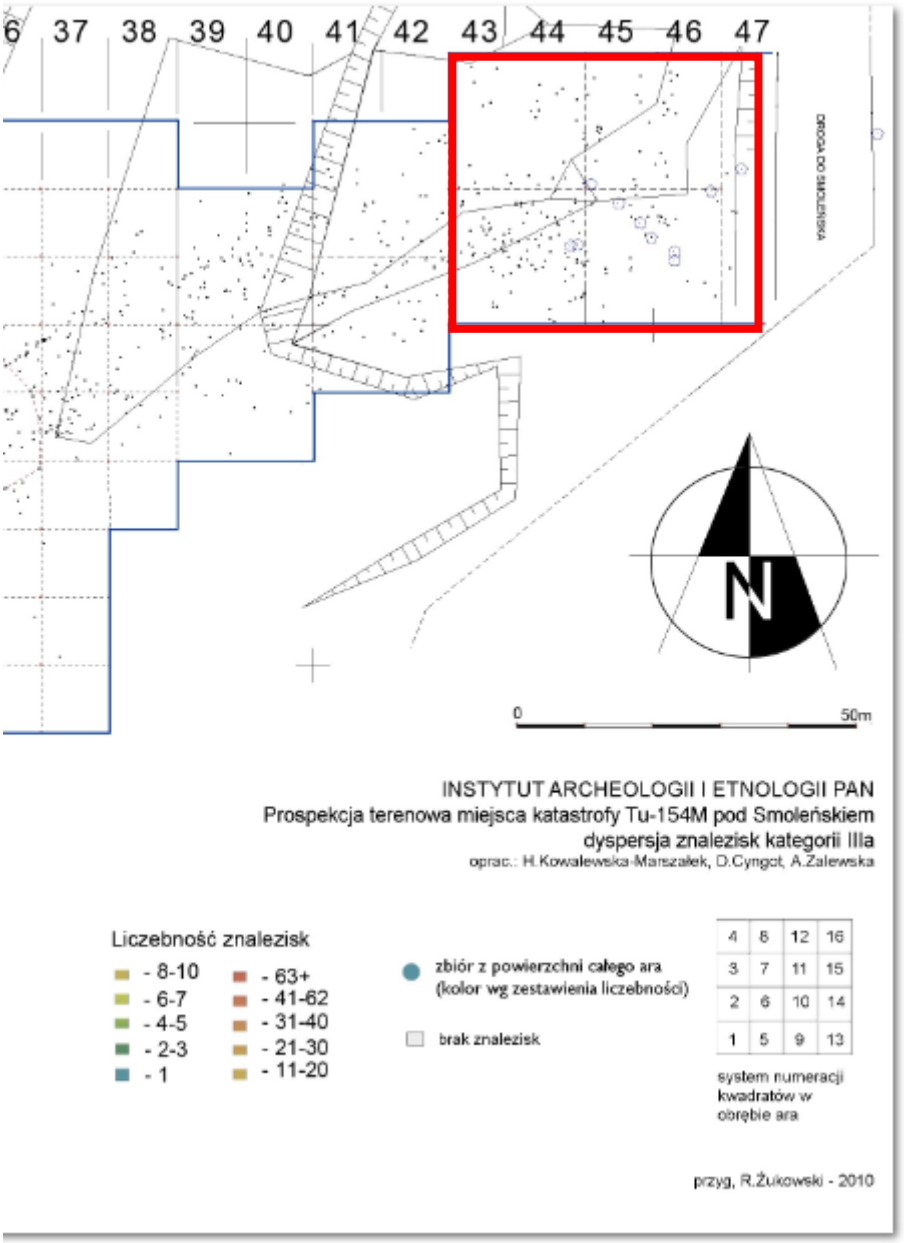

Fig. 32. Map from the archeologists report showing where pieces were found behind Kutuzov street (marked "Droga do Smolensk" at the right).

Fig. 33. Pieces collected of the Tu-154M, taken from the ground 100m before the main crash site showing thermal traces.

Part of the pieces had characteristic traces (micro craters) on its surface. This corresponded in shape and size with the traces left by pieces which were created after the pyrotechnical experiment performed by the Committee. (Fig. 34).

This feature is characteristic for an explosive destruction.

Fig. 34. Comparison of micro craters on the surface of the pieces found by archeologists and pieces created after pyrotechnical experiments.

Explosion in the TU-154M fuselage

General view of the crash site compared to the shape of TU-154M in a 1:1 proportion show that the pieces of the plane fell down as a result of an explosion in the air and not the disintegration in time when sliding on the ground (no visible crater). (Fig. 35).