WHAT WE KNOW ABOUT THE COURSE OF THE SMOLENSK CATASTROPHE.
THE SMOLENSK CONFERENCES - A PRELIMINARY SUMMARY

From the closing document of the 2nd Smolensk Conference:

"The picture that emerges from the presented papers, is quite clear. It indicates that the hypothesis saying that the Tu-154 plane near Smolensk on April 10, 2010 lost a piece of wing due to the collision with a birch and then disintegrated completely after hitting the ground (catastrophe type 1A) - - this hypothesis is entirely false. There is the irrefutable evidence that the plane disintegrated in the air and its fragments fell to the ground separately (catastrophe type 2B). The surface of the ground represents a kind of book in which the course of the catastrophe is registered. The appearance of the fragments as well as their distribution on the ground and upon the terrain obstacles are documented in thousands of pictures and videos taken by many independent operators. This huge documentation shows, both as a whole and in detail, that the laws of physics rule out the course of events presented in the reports of the MAK Commission and of the Miller Commission. It is clear to anybody, even to those without any knowledge of mechanics, that the fuselage resting on the Smolensk airport was torn, not compressed (...) "

Warsaw, October 22, 2013

The Organizing Committee and the Scientific Committee of the 2nd Smolensk Conference

1. ACADEMIC INVESTIGATION

The Smolensk Catastrophe took place on April 10, 2010 in Smolensk, Russia. It represents the greatest post-war national tragedy, in which the President of the Polish Republic and 95 accompanying persons, the country's political elite, were killed in mysterious circumstances. The official reports produced by the state institutions for explaining the catastrophe: the Russian, or MAK, report and the Polish one, the later produced by the Polish Governmental Commission headed by Jerzy Miller, both presented the same hypothesis as to the causes and course of the Smolensk Catastrophe. This hypothesis will be referred hereafter as the MAK/Miller hypothesis. Both of these reports treat the known facts quite selectively as well as overestimate other ones, and therefore, unfortunately, are devoid of scientific value.

When this fact became clear to scientific community, the later felt obligated to make an independent examination of the circumstances of the Smolensk Catastrophe, especially scientific verification of the MAK/Miller hypothesis. According to this hypothesis the Smolensk Catastrophe consisted of five consecutive phases. Each of the phases can be verified by scientific methods, as illustrated in Tab. 1.

Table 1 indicates that verification of the MAK/Miller hypothesis needs professionals from diverse scientific disciplines to be involved. However, for the sake of the investigation's integrity one should also take into account some scientific disciplines that are necessary for analysis of the neglected aspects in the MAK/Miller hypothesis and are essential to identify the causes and the course of Catastrophe (i.e. archaeology and chemistry). The study of the Smolensk Catastrophe took both multidisciplinary and interdisciplinary character.

Tab. 1. Phases of the Smolensk Catastrophe, according to the MAK and Miller official reports, as well as the possibilities of their scientific verification.

No	Phase of Catastrophe	Possible scientific verification
I	Flight along the assigned trajectory until contact with birch tree	1) analysis of flight recorders 2)analysis of the on-ground recorders
II	Contact with birch tree	1) material science 2) analysis of photographs 3) computer simulation 4) model investigation
III	Flight from the birch tree until hitting the ground	1) analysis of flight recorders 2) ground photographs'.analysis 3) computer simulation 4) aerodynamic investigation
IV	Hitting the ground and disintegration	1) material science 2) computer simulation 3) ground photographs'.analysis
V	Motion from the ground contact till the final positions	1) computer simulation 2) aerodynamic investigation

As many official scientific institutions have chosen to refrain from participation in such an analysis, this inquiry was carried out within the framework of what is known as **academic investigation**. Three Smolensk Conferences took place: in 2012, 2013 and 2014.

2. SMOLENSK CONFERENCES

The Smolensk Conferences had international character and have been organized annually thanks to the support of scientists themselves, grouped in three committees, and working in several domains of science. The Smolensk

Conferences were organized by the Organizing Committee with help of the Inspiring and Advisory Committee, that consisted of 110 professors representing various domains of technical and natural sciences. To keep the scientific standard as high as possible the Scientific Committee has been elected. Its size changed in time, but altogether 45 professors have been incorporated, with specialties covering all task related domains of science. The Scientific Committee has been divided into ten subcommittees representing the following groups of scientific disciplines:

1. Mechanics and Constructions
2. Mathematics and Informatics
3. Electrotechnics and Electronics
4. Physics and Geotechnics
5. Chemistry and Structural Sciences
6. Aviation and Aerodynamics
7. Geodesy and Archaeology
8. Medicine
9. Sociology
10. Law

Each of the subcommittees included eminent scholars from the Polish as well as from foreign universities. The 1st Smolensk Conference has been headed by professor Tadeusz Kaczorek, member of the Polish Academy of Sciences and at that time the President of the Central Scientific Evaluation Committee, while the 2nd and 3rd Conferences have been headed by professor Kazimierz Flaga, a former President of the Cracow Technical University and its *doctor honoris causa*.

The goal of the Conferences was defined as "*Creation of the scientific forum for presenting results of interdisciplinary research within technical, medical, sociological and legal aspects of the Smolensk Catastrophe"*. More than a hundred of papers have been submitted and 78 of them were accepted for presentation by the Scientific Committee.

The 1st Smolensk Conference employed a "brain storm" character, all essential hypotheses as to the course of the Smolensk Catastrophe were presented. The 2nd Conference focused on evaluation of the hypotheses and for rejection of the false ones. Here the MAK/Miller hypothesis was rejected for failing to adequately explain the position and deformation of the plane fragments. The 3rd Conference focused on determination of the most probable course of the Smolensk Catastrophe.

The closing document of the 1st Conference highlighted possible further areas of research. It also represented a call for parallel investigation and conferences in the domains of medicine, law and sociology, also related to the Catastrophe. As a consequence the 2nd Conference was supplemented by these domains, which required two conference days.

The closing document of the 2nd Conference called to all the members of the senates of the technical universities for initiating and financing independent research by these institutions. If this were not possible, the call asked for organizing scientific seminars on the results of the Smolensk Conferences. None of the senates responded to this call.

The Smolensk Conferences have been transmitted by the web and by interested TV channels. The total number of the viewers amounted to 200 000 for the 2nd Conference in 2013 and 300 000 for the 3rd one held in 2014.

The main information archive of the Conferences is the website http://konferencjasmolenska.pl. Conference videos are also available on the same website.

After each Conference the Conference Proceedings [1, 2, 3] have been published, being afterwards sent to the libraries of all of Poland's state-owned universities and technical universities as well as to all related institutes of the Polish Academy of Sciences. The Proceedings have been also posted to the Conference website (with unrestricted access).

3. THE MAK/MILLER HYPOTHESIS - SCIENTIFIC VERIFICATION

3.1. The essence of the MAK/Miller hypothesis

In the scientific sense this hypothesis is quite complex, and therefore easy to be verified in several different ways. All of five phases shown in Tab. 1 must agree with the laws of physics. As it is shown in the Table, each of the phases represents a subject of a straightforward verification. Moreover, according to the MAK/Miller hypothesis the Catastrophe represented a five-step cause-effect chain:

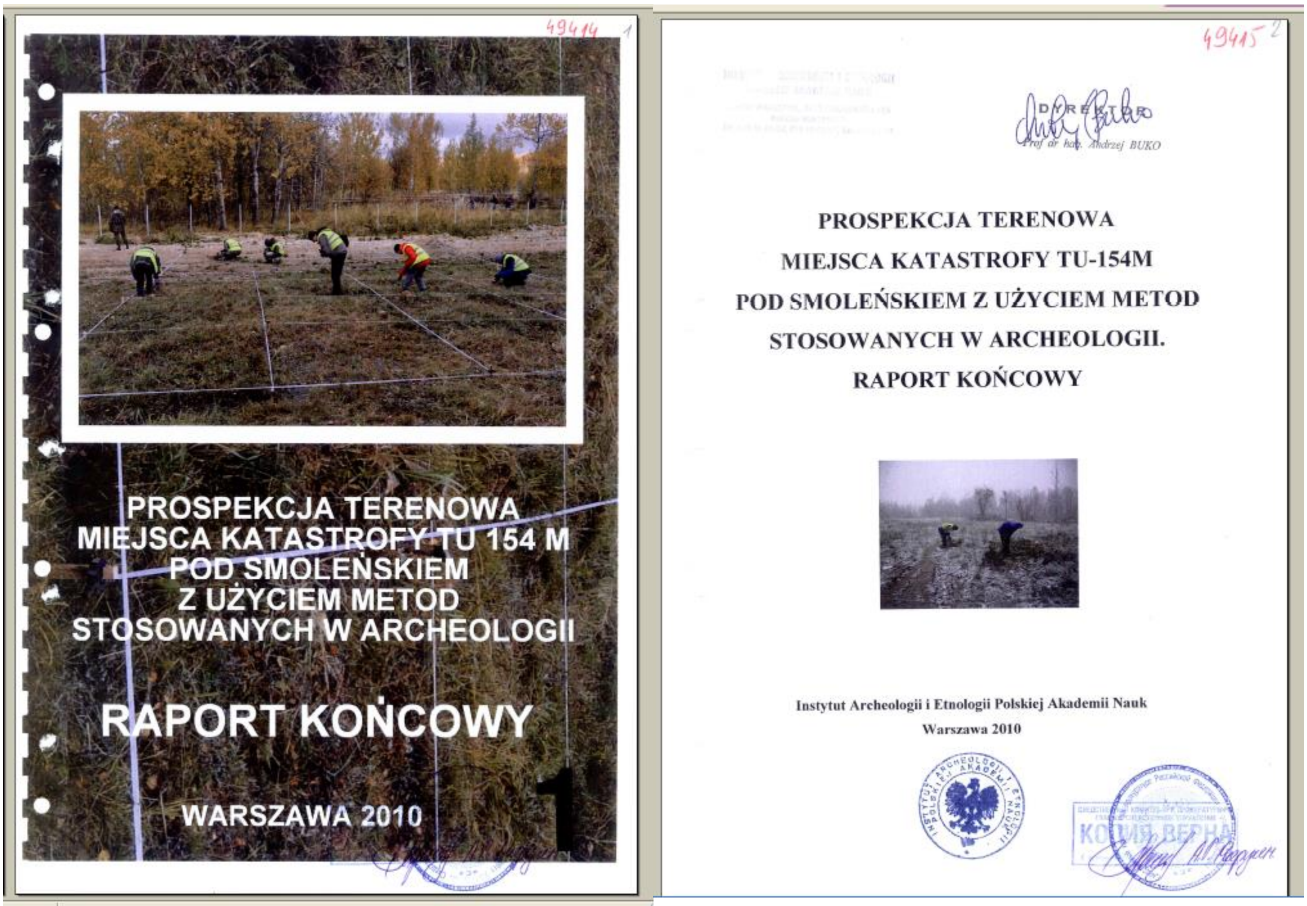
1) phase II (hitting the birch) happened, because of the flight trajectory in phase I,
2) phase III (flight after hitting the birch, i.e. rotation about the plane axis) resulted, because of hitting the birch,
3) phase IV (hitting the ground) happened, because of the trajectory in phase III,
4) phase V (distribution of the fragments) resulted from the disintegration after hitting the ground.

Thus, the MAK/Miller hypothesis represents a logical construction of such a kind., that to prove it false it is sufficient to show that even a single phase in the hypothesis is false.

3.2. Ignored evidence

In the papers presented in the three Smolensk Conferences all the selected above ten scientific disciplines have been covered. One has to underline that some papers presented and analyzed the documents that were just ignored by the authors of the MAK/Miller hypothesis. Some most important of these are listed below.

1. The report of the official team of the Polish archaeologists (Fig.1), who, after the official search already done, reinvestigated the crash site between October 13 and October 27, 2010 and have found some further 30 000 fragments. The team estimated the total number of fragments still hidden in the ground as 60 000. A part of the fragments found was situated before the location, which according to the MAK/Miller hypothesis was identified as the first contact of the plane with the ground. It should be stressed that among the fragments found in this spot, there were some human remains.


PROSPEKCJA TERENOWA
MIEJSCA KATASTROFY TU 154 M
POD SMOLEŃSKIEM
Z UŻYCIEM METOD
STOSOWANYCH W ARCHEOLOGII

RAPORT KOŃCOWY

WARSZAWA 2010

DYREKTOR
Prof. dr hab. Andrzej BUKO

PROSPEKCJA TERENOWA
MIEJSCA KATASTROFY TU-154M
POD SMOLEŃSKIEM Z UŻYCIEM METOD
STOSOWANYCH W ARCHEOLOGII.
RAPORT KOŃCOWY

Instytut Archeologii i Etnologii Polskiej Akademii Nauk
Warszawa 2010

KOPIA WERNA

Fig. 1. The report of Polish archaeologists from the Institute of Archaeology and Ethnology of the Polish Academy of Sciences.

2. The forensic documents prepared for the victims by the Moscow Forensic Institute (Fig. 2). One should stress that the Polish experts, who arrived to Moscow on April 11, 2010, were not allowed to participate in victims' autopsies: "*after arriving to Moscow on April 11, 2010 and transportation of the team to the forensic institute (arrival time not given) we were informed, that the autopsies of all the victims, that have been transported from Smolensk to Moscow till now, have been already performed by the experts of the Russian side*" [4]. Moreover, it follows from these documents, that the inspection of the victims in the Catastrophe site began about 2 p.m. on April 10, 2010 and lasted, with variable inspection time, from four to six or more hours. Despite of this on April 11, 2010 all victims not only have been transported to Moscow, but according to the Russian side the autopsies were already over.

3. Photo and video documentation of the Catastrophe site. There are a lot of photographs as well as movies (recorded by various operators), which show the deformation of the plane' fragments and their positions in the Catastrophe site. Some of the key, and ignored, evidence are the photographs, Figs.3 and 4, showing the destruction of the plane fuselage. Of key importance are some other photographs that show that the airplane disintegration began before the plane approached the Bodin birch.


ФЕДЕРАЛЬНОЕ ГОСУДАРСТВЕННОЕ УЧРЕЖДЕНИЕ
РОССИЙСКИЙ ЦЕНТР СУДЕБНО - МЕДИЦИНСКОЙ ЭКСПЕРТИЗЫ
ФЕДЕРАЛЬНОГО АГЕНТСТВА ПО ЗДРАВООХРАНЕНИЮ
И СОЦИАЛЬНОМУ РАЗВИТИЮ

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ЗАКЛЮЧЕНИЕ ЭКСПЕРТА № [redacted]/10
(судебно-медицинская экспертиза трупа)

Zał. Nr 1 Do pisma Nr Z-[redacted] Stron 17 data 01-10-2012
Zał. Nr 2 Do pisma Nr Z-[redacted] Stron 17 data 01-10-2012

«21» июля 2010 г. г. Москва

В период с 9.00 мин. 11 апреля 2010 г. по 15.00 мин. 21 июля 2010 г. на основании постановления следователя следственной группы ГСУ Следственного комитета при прокуратуре РФ по г. Москве Прокопец Ю.А. от 11 апреля 2010 года, в помещении морфологического корпуса БСМЭ ДЗ города Москвы, комиссия экспертов в составе:

- **Леонова Сергея Валерьевича** - заведующего отделом науки ФГУ «Российский центр судебно-медицинской экспертизы Федерального агентства по здравоохранению и социальному развитию», доктора медицинских наук, судебно-медицинского эксперта высшей квалификационной категории, имеющего высшее медицинское образование, специальную подготовку по судебной медицине, со стажем работы по специальности с 1992 года;

– **Фетисова Вадима Анатольевича** – заведующего отделом судебно-медицинских экспертиз ФГУ «Российский центр судебно-медицинской экспертизы Федерального агентства по здравоохранению и социальному развитию», судебно-медицинского эксперта высшей квалификационной категории, доктора медицинских наук, имеющего высшее медицинское образование, специальную подготовку по судебной медицине, со стажем работы по специальности с 1993 года;

провела судебно-медицинскую экспертизу **ТРУПА НЕИЗВЕСТНОЙ ЖЕНЩИНЫ** (обнаруженной на месте происшествия в секторе № [redacted], с условным номером [redacted], при осмотре в морге с присвоенным **номером** [redacted]).

Права и обязанности эксперта, предусмотренные статьей 57 УПК РФ, разъяснены. Об ответственности по ст. 307 УК РФ предупреждены.

Эксперты: С.В.Леонов В.А.Фетисов

При экспертизе присутствовали: лаборант Михайлова Ю.С. и санитар Мурзин С.В.

Следственный комитет России
Главное следственное
КОПИЯ ВЕРНА
Следователь

Вопросы, подлежащие разрешению, и другие разделы «Заключения» излагаются на следующих 7 листах.

Za zgodność
INSPEKTOR
WOJSKOWEJ PROKURATURY OKRĘGOWEJ
w Warszawie
[redacted]

Fig. 2. The first page of a typical Russian forensic post-autopsy protocol. In the headline: "Federal State Institution. Russian Forensic Center of the Federal Health and Social Progress Agency

Fig. 3. The central part of the fuselage: from rung 40 till rung 64 [5]. The tear along the fuselage as well as the sides and the ceiling of the aircraft, that are flanged and thrown out, witness about a huge internal explosion. This kind of destruction cannot result from any external forces.

Fig. 4. The Tu-154M wreckage in the Smolensk airport [6]. It is evident, even after cutting off the ceiling as well as a large part of the sides, that the fuselage has been torn.

3.3. Conclusions

As stated before, all ten scientific disciplines, that were represented in the Scientific Committee, have been covered by the Conference papers. However, to verify the MAK/Miller hypothesis, the papers belonging to the first seven disciplines (sciences and technology) are most important. The MAK/Miller hypothesis was rejected by all the papers, no matter which discipline was involved, which objects were investigated or which investigation technique was applied. The papers that confronted the consecutive phases of the Catastrophe according to MAK/Miller (Tab. 1) with basic physics are of particular importance. This is because, as stated in 3.1, to falsify the MAK/Miller hypothesis, it is sufficient to prove that any single one of the Catastrophe phases is unlikely to be true. Quite a lot of the Conference papers have been devoted to such an analysis, see Tab. 2.

The Table shows that each of the phases of the MAK/Miller hypothesis turned out to be wrong. In particular

1) the airplane did not fly along the trajectory indicated in the MAK/Miller hypothesis, and therefore could not hit the famous "Bodin birch",
2) if, however, the plane hit the birch tree, the tree would not shear off the wing tip, but instead the birch would be cut,
3) if, nevertheless, the wing tip was shear off, the airplane could not turn upside down,
4) if the airplane still hit the ground after turning upside down, the degree of the observed disintegration, into tens of thousands of fragments, could not happen.

Tab. 2. The phases of the MAK/Miller hypothesis and their verification to date. The phases I, II, III and IV have been verified negatively (falsified).

No	Phase of Catastrophe	Investigation performed by
I	Flight along the assigned trajectory till hitting the birch tree	Prof. Kazimierz Nowaczyk Prof. Marek Czachor MSc Michał Jaworski MSc Eng. Marek Dąbrowski MSc. Eng. Glenn Jørgensen
II	Hitting the birch	Prof. Wiesław Binienda Dr Eng. Gregory Szuladziński
III	Flight from the birch tree till hitting the ground	Prof. Kazimierz Nowaczyk Prof. Marek Czachor MSc Michał Jaworski MSc Eng. Marek Dąbrowski MSc. Eng. Glenn Jørgensen
IV	Hitting the ground and disintegration	Prof. Wiesław Binienda Prof. Piotr Witakowski
V	Motion from the ground contact till the final positions	not investigated

The conclusions of the investigation shown in Tab. 2 agree with all papers that are related to other domains of science, like acoustics, electrotechnics, aviation, archaeology, physics, geophysics, chemistry, medicine. All the Conference papers are consistent and form a coherent picture:

The MAK/Miller hypothesis is rejected, because all of the phases described contradict both the laws of physics and material evidence. The actual course of the Smolensk Catastrophe was different.

3.4. Irrefutable evidence

The Catastrophe phases described in the MAK/Miller hypothesis have been falsified independently by many Conference papers. The arguments involved, in many cases, require expertise in the corresponding domain. There are, however, numerous evidence, which on one hand are easy to understand for anybody, even to those outside a given domain, and on the other hand

indicate a unique possibility, thus excluding any other possibilities.

Such evidence have a character of the irrefutable evidence. One may highlight here two kinds of them:

a) deformation of the fragments,
b) location of the fragments.

3.5. Deformation of the fragments

The appearance of the fragments in the Catastrophe site clearly indicates, that they resulted from tearing the structure of the aircraft, not crushing it due to a collision with the ground. The central part of the fuselage, Figs. 3 and 4, is, no doubt, torn longitudinally, the sides and the ceiling of the aircraft flanged and thrown out. This proves a huge internal explosion took place. This type of destruction cannot be a result of any external force.

Moreover, such a destructive explosion must have happened **above ground level**, at an altitude higher than the length of the sides that are overhung. Only in such a case could the opening motion of the fuselage be possible.

An airplane fuselage may be treated as a thin-walled structure. Mechanics of the thin-walled structures is a well developed domain of science and serves as a basis for designing buildings, vehicles and machines. It is present in the curricula of almost all Polish technical universities. The corresponding specialists are members of the International Association for Shell and Spatial Structures. It is worth noting that prof. Jan Obrębski, a member of the Scientific Committee of the Smolensk Conference, has been elected in 2013 a honorary member of this organization. According to mechanics of the thin-shell structures it is impossible for the shell of the fuselage to tear open longitudinally (as shown in Fig. 3 and Fig. 4) as a result of external forces acting due to a collision with external obstacles, whatever they would be and regardless of which side of the construction would hit these obstacles. This conclusion is elementary even for undergraduate students of mechanics.

This statement is confirmed by the entire history of aviation. All the catastrophes of type 1A (the fuselage hits the ground and no explosion occurs) ended up with the breaking of the fuselage across the fuselage axis, Fig. 5, Fig. 6 , Fig. 7, Fig. 8 . Among thousands of the registered aircraft crashes without explosion (type 1A), a crack along the axis of the fuselage and its opening has never happened. This indicates that such a longitudinal crack is impossible without an explosion. In other words, the observed damage is possible only as a result of an internal explosion. A particular illustration of this rule represents the catastrophe in the Tokyo Narita airport (Fig. 9), where striking the ground caused the transverse division of the fuselage, and, only later on, an explosion opened it longitudinally, in front of the eyes of many witnesses.

Fig. 5. The catastrophe of the Tu-154M airplane in Moscow on December 4, 2010. The catastrophe is of the 1A type -- the airplane hit the ground, no explosion.

Fig. 6. The catastrophe of the Tu-204 airplane in Moscow on March 22, 2010. The catastrophe is of the 1A type -- the airplane hit the ground, no explosion.

One could see the very essence of the longitudinal cracking mechanism when studying hitting the ground during the crash experiment (2012) in the Sonora desert in Mexico (Fig. 10).

Fig. 7. The catastrophe of the Boeing 737-800 airplane in Kingston, Jamaica on Dec. 22, 2009. The catastrophe is of the 1A type -- the airplane hit the ground, no explosion.

Fig. 8. The catastrophe of the Boeing 737-800 airplane in Amsterdam, The Netherlands on Feb. 25, 2009. The catastrophe is of the 1A type -- the airplane hit the ground, no explosion.

Fig. 9. The catastrophe of the MD-11 airplane in Tokyo, Japan on March 23, 2009. The airplane hit the ground, divided (perpendicularly to the airplane axis) into several segments. Then the plane exploded, the explosion occurred in the rear part, this part has been torn and opened longitudinally.

Fig. 10. The crash test with the Boeing 727-200 in desert (Mexico) on April 27, 2012. The movie shows the way the construction is crashed after hitting the ground [7].

From mechanics of the thin-wall structures it follows that a cylinder-like thin-wall structure cannot be torn longitudinally by hitting from outside. This can be understood even by a layman. The reason is that hitting a thin-wall structure from outside leads, in addition to some local dent, to its bending. The later leads, at sufficiently large forces used, to cracking, sometimes multiple ones, perpendicular to the cylinder axis. The mechanism of such a destruction, in an initial phase, is shown in Fig. 11. Anyone may convince himself just by taking a pipe, of any material and diameter, and hitting it in an arbitrary way. There is no possibility to split it longitudinally.

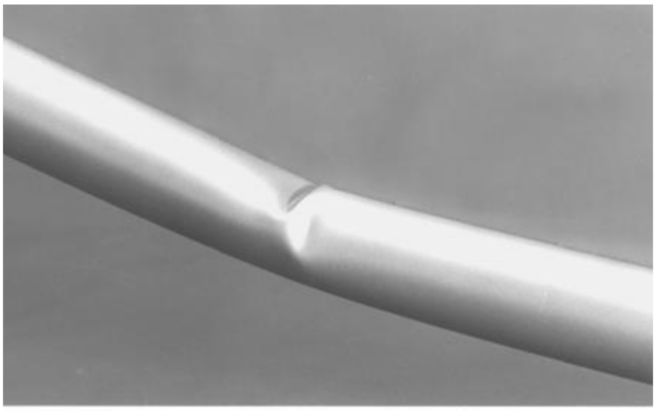

Fig. 11. Bending of a thin-wall tube [8].

Therefore, if external strikes, even multiple ones, are unable to split the fuselage longitudinally, the question appears as to what kind of forces were able to do that in Smolensk. From the thin-wall mechanics only a unique answer follows: such a deformation could appear exclusively, because of a fast increase of the internal pressure in the fuselage, i.e. as a result of the internal explosion. The reason is physics: the resulting tension trying to open the fuselage longitudinally is approximately twice as large as that trying to break the airplane perpendicularly (to its longitudinal axis) [9]. If, inside a cylinder, the internal pressure exceeds a critical material-dependent value, the shell will be torn in the longitudinal direction of the cylinder, Fig. 12

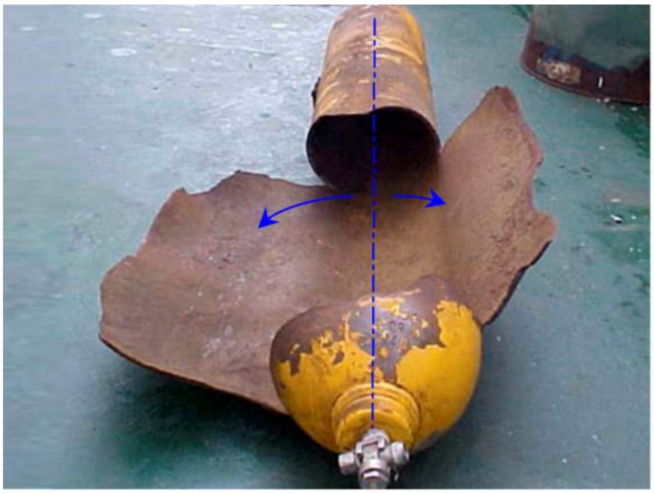

Fig. 12. A gas container, being essentially a thin-walled cylindrical pressure vessel, was torn apart along the longitudinal axis, when the gas pressure exceeded a critical value [8].

The above reasoning, that follows from the general laws of physics, is independent of dimension of the pressure vessel. It is equally valid for large cylindrical structures like airplane fuselages, as well as for the industrial pipes and also for such thin pipes as the blood vessels in the human body or capillary vessels in trees. From this law it follows, that:

1) the airplane fuselage, shown in Figs. 3 and 4, could not be deformed as a result of hitting the ground,
2) the airplane fuselage, shown in Figs. 3 and 4, has been torn off by an internal explosion.

It should be stressed that examination of other fragments' deformation proves that, besides the explosion that has torn the airplane fuselage, a sequence of other explosions happened inside the wings and in the steering system.

3.6. Distribution of the fragments

3.6.1. Horizontal distribution

Distribution of the fragments on the ground represents the principal evidence as concerns the course of events during any airplane catastrophe. The surface of the ground may serve a kind of archive, the location of the fragments indicates the sequence of events during the catastrophe. The distribution of the fragments is shown in the satellite image of April 11, 2010 (Fig. 14) as well as in thousands of the on-ground photos and videos.

According to the archaeological report the Tu-154M aircraft has been disintegrated into about 60 000 fragments (educated estimation). The distribution of the main fragments can be divided into eight zones, shown in Fig.14. The distance between the first fragment found (several dozens of meters before the Bodin birch) and the last one spans the trajectory section of about 500 m long. These zones may be described as follows.

Zone B1

A large number of the fragments of various size are located within the terrain about the Bodin property. The fragments are located before the Bodin birch (the first fragments found 40 m before the birch [10]), around the birch and behind the birch. These are the fragments of the rear and of the central parts of the left wing, which excludes the thesis that they have been created by hitting the terrain obstacles, Fig. 13

Fig. 13. The drive of the left wing outer flap with a part of the flap found at the foot of the Bodin birch [11].

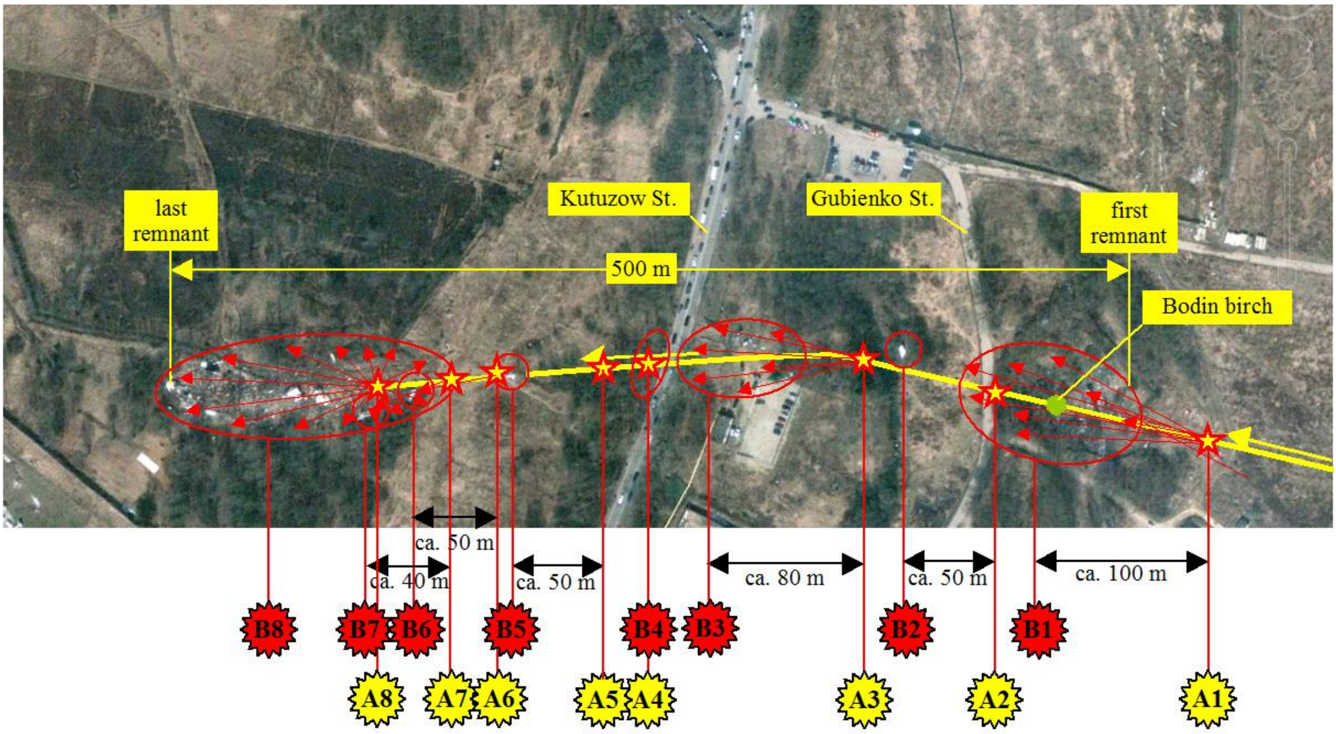

Fig. 14. The trajectory of the Tu-154M plane and the horizontal distribution of the main fragments. Letter B stands for showing the centers of the successive zones of the residual debris (remnants). Letter A indicates an approximate location of the corresponding point of detachment of the fragments from the aircraft structure, the later moving at a speed of about 270 km/h.

Zone B2

The tip of the left wing has been found in this zone. Also, within the radius of about 10 m from the wing, there are several metallic fragments of the plane, of various size [12]. This photograph (Fig. 15), taken short after the Catastrophe, **excludes the possibility of shearing off the tip due to a terrain obstacle**, instead it suggests damage from a detonation strap.

Fig. 15. The breakthrough of the tip of the left wing. Photo taken within the first hour after the Catastrophe. It comes from the movie "Anatomy of a downfall" [13]. One can see the non-dented wing slot, i.e. its front part, and particularly even cutting of the wing surface.

Zone B3

Many airplane fragments have been found in this zone, some of them of three meter size (cf. Fig. 16 and Fig. 17). A tentative analysis of these fragments indicates that all of them belong to the left wing.

Fig. 16. Zone 3. A CNN jounalist Nic Robertson demonstrates a large fragment of the plane's shell [14].

Fig. 17. A large size fragment of the airplane shell found on the Kutuzow Street roadside [15].

Zone B4.

This zone is characterized by the fact that it is located inside the forest band on the west side of the Kutuzov Street. The fragments within the forest are surrounded on all sides by trees. This demonstrates that they have fallen vertically in the middle of the trees from an altitude that was larger than that corresponding to the treetops. Since the aircraft moved at a velocity of about 270 km/h, at the moment of separation from the airplane these fragments must have experienced a momentum opposite to the plane velocity. Only in such a case their velocity could be reduced to such an extent that the fragments could fall perpendicularly in the middle of the trees. This zone is the only one for which the separation point and the final position of fragments, after they have fallen, coincide on the plane's trajectory. One has to stress that the following parts of the plane are close to each other in this zone

- the highest located part of the plane - a fragment of the left elevator (Fig. 18).
- one of the lowest-lying bottom parts of the plane - a part of the chassis (Fig. 19)
- the rear-most part of the right wing - the interceptor (Fig. 20).

The location of these parts in the aircraft structure eliminates a possibility of detachment due to collisions with the terrain obstacles. Moreover, the fact, that these very different detached parts have been found close to each other, witnesses about separate detachment causes.

Fig. 18. A fragment of the left horizontal stabilizer lying in the woods about 5 meters from the Kutuzov Street. In the background, behind the trees, one can see the entire dart of the plane. Photo by Jan Gruszyński. Deformation of the detached parts excludes that detachment was due to a collision with a terrain obstacle.

Fig. 19. A fragment of the main landing gear shock-absorber lying among the trees in zone 4 [16].

Fig. 20. The interceptor (deflector) of the left wing lying in the woods about 10 meters from the Kutuzov Street. On top a fragment of the slot is visible. Photo by Jan Gruszyński.

Zone B5

In this zone the rear part of the left horizontal stabilizer lies alone, the elevator being visible (Fig. 21). **The very fact that this is the back, not the front, part, excludes a collision with a terrain obstacle as a possible cause.** On April 11, 2010 this horizontal stabilizer has been transported by Russian soldiers by a distance of several dozen meters to the west, behind the first groove in the ground - the alleged first contact with the ground. This was to make an impression that the detachment of the stabilizer resulted from the ground contact.

Fig. 21. Zone B5. The rear part of the left horizontal stabilizer (with the left elevator) [17].

Zone B6

In this zone the right horizontal stabilizer with the elevator has been found (Fig. 22). Note breaking of its bottom and the detachment of its fragment in the direction of the flight, that is, opposite to the force that would be expected at a collision with an obstacle.

Zone B7

In this zone the rest of the vertical stabilizer has been found, with the fragments of the horizontal stabilizers visible (Fig. 23). It is peculiar that the place of its fall is just right behind the trees. This is why the visible damage cannot result from repeatedly striking the ground, the missing parts are absent in the local area.

Zone B8

The main mass of fragments is located in this zone. Over this zone the fuselage has been torn (Fig. 3, Fig. 4). The explosion was so powerful that not only it ripped the fuselage, but also caused a "blow-out" of its entire contents. As evidenced by Fig. 24 not only the passengers, but also all the seats, despite their solid attachment to the floor, have been blown out.

Fig. 22. The bottom surface of the terminal part of the right-hand-side horizontal stabilizer with the elevator. The leading edge is to the right. The lower part of the stabilizer lacks a fragment, that was detached in the direction of the flight [18].

Fig. 23. The rest of the tail fin (vertical stabilizer) and the adjacent portions of the horizontal stabilizers [6]. The missing part of the horizontal stabilizers dropped off earlier.

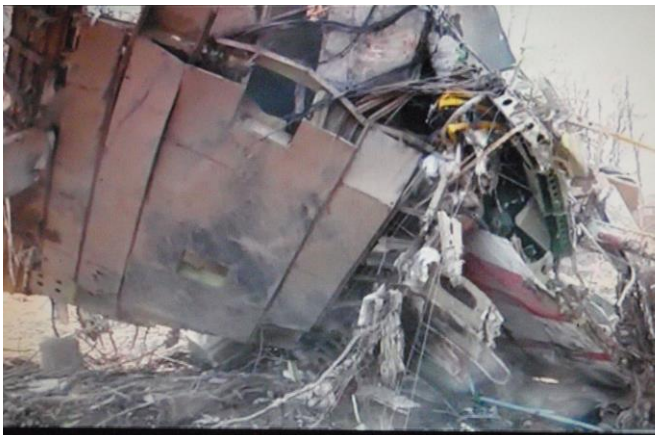

Fig. 24. The floor of the Tu-154M plane when lifting the fuselage [13]. Throwing out the sides and the ceiling of the torn fuselage (the later already turned upside down), led the fuselage to fall down in such a way that the floor was adjacent to the surface of the ground. However, during lifting the fuselage (shown in the photograph), one does not see neither the passengers' bodies nor even the seats. Only the floor rails for fasting the seats are visible.

As a result of the explosion the sides and the ceiling of the fuselage have been thrown out. The fuselage, being earlier rotated upside-down during the flight, fell down with its internal face of the floor being adjacent to the ground. However, during lifting the fuselage, shown in the photograph, it turned out that under the floor one finds neither crushed passengers' bodies nor even airplane's seats. This means the contents of the fuselage had to disappear earlier, before the aircraft's floor fell to the ground.

A separate issue represent the distant positions of both sides of the shells of the structures an aircraft is built of. For example, the left wing: both wing shells lie separately. This demonstrates the disruption of the structure that happened from its inside.

Fig. 25. The terminal part of the left wing (bottom shell) with the flap track fairings (6). In the background the right -hand-side horizontal stabilizer (3) [17]. The upper shell has been crushed and its pieces are in remote locations.

Conclusion

The on-ground position of the main fragments demonstrates that the MAK/Miller hypothesis is false. The essence of the Smolensk Catastrophe was not shearing off the tip of the plane's left wing and striking the ground, but instead a successive fragmentation of the aircraft structure over a distance of about 500 m. The laws of physics rule out the possibility that detachment of the subsequent fragments was due to collisions with obstacles e.g. trees. The reason is, that, as demonstrated above, in all cases the first parts to fall off were those located in the rear of the structure, thus those being protected from a front collision by front parts. This way of destruction happened to the left wing as well as to the plane's tail. Distant final positions of both sides of a single shell structure prove operation of the forces splitting those sides, i.e. a pressure inside the closed sections of the aircraft appeared. The later could be caused only by some internal explosions.

Blowing-out of all the contents of the fuselage: the passengers, the seats and the equipment, and the fact that this contents' position is a way off the torn structure, represents an independent evidence that the damage of the fuselage resulted from an internal explosion. This supports the previous conclusion taken on the basis of the kind of fuselage deformation, cf. Fig. 3 and Fig. 4.

3.6.2. Vertical distribution

All air catastrophes can be divided into two basic types:

1) type 1 - plane as a whole (or at least its fuselage) strikes the ground and breaks up into pieces as a result of the impact,
2) type 2 - plane breaks up in the air and the fragments fall to the ground separately.

In the type-1 catastrophe the fragmentation takes place at the impact site, and therefore on the surface of the ground. The motion of individual fragments is determined by the velocity at which the aircraft hit the ground, begins at the point of impact and the trajectory of each of the fragments is horizontal. The motion takes place either on the surface (turning or sliding) or a bit above the surface. If these fragments meet some obstacles, they collide with them horizontally, Fig. 26 .

The motion of the fragments in catastrophes of type 2, when the destruction of the aircraft occurs at a certain altitude above the ground, looks very different. The trajectory of each of these fragments is a result of the velocity of the aircraft at the moment of destruction and the energy of the disintegration. It is thus a superposition of the motion of the plane before the disintegration and the ballistic curve, the later corresponding to the free motion of each of the fragments in the gravitational field after the operation of the force causing the separation (e.g. an explosion). During the descent of each of the fragments, the initial motion of advancing in the direction of flight gradually disappears as a result of air resistance, while the vertical component of the velocity prevails more and more due to the gravitational force. Individual fragments fall on the ground, the higher the fragmentation of the structure occurred the lower horizontal velocity, Fig. 27 .

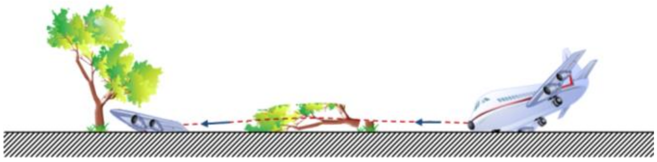

Fig. 26. Catastrophe of type 1. The fragmentation occurs due to the collision with the ground. The trajectories of the fragments are horizontal.

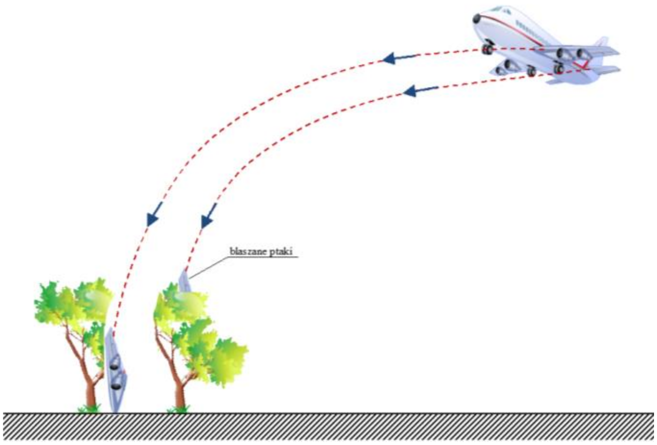

Fig. 27. Catastrophe of type 2. The fragmentation occurs in the air. The trajectories of the fragments are close to the ballistic curve.

The differences in the trajectory of individual fragments for the two types of catastrophes make the distributions of the fragments on the ground and on the terrain obstacles clearly distinguishable. Only during the catastrophe of type 2 the flying fragments may fall on buildings and on tree branches in their motion downwards. Therefore, the metal parts of the plane that are hanging on the branches, known as "tin birds", clearly show that the disintegration of the aircraft took place above the trees, and thus testify to the fact that we are dealing with the catastrophe of type 2.

The second basic element that makes a difference in the air catastrophes is a possible explosion accompanying the crash. In the type-1 catastrophe it is usually caused by explosion of fuel and happens after hitting the ground. Fuel explosion is always accompanied by fire, and fire created earlier can initiate a fuel explosion.

In the type-2 catastrophe the explosion usually means the beginning of the catastrophe. Such an explosion may be accompanied by appearing of fire and the burning wreckage may fall on the ground. This, however, is not always the case. Breaking the plane at high altitude may result, even after some fragments caught fire, for the flames to be extinguished during the descent and in such a case the fragments will not burn on the ground.

Generally, in the catastrophe of type 1, any explosion represents a result of the catastrophe and completes it, while in catastrophe of type 2 the explosion represents the cause of the catastrophe and initiates it..

Explosion or lack thereof at the time of catastrophe allows to divide any type of catastrophe into two subtypes. This divides all plane catastrophes into four distinct categories, Fig. 28

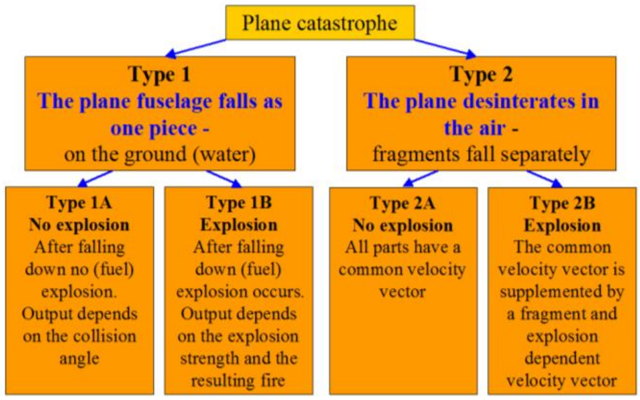

Fig. 28. All airplane catastrophes can be divided into four categories.

Vertical distribution of fragments in the Smolensk Catastrophe excludes the possibility that it was a catastrophe of type 1. This is supported by numerous evidence. All of them can be divided into two types::

1) location of the fragments lying on the ground in the middle of the terrain obstacles, e.g. trees - this means they can be there only after falling down from an altitude exceeding that of the obstacles,
2) location of the fragments on the obstacles, e.g. on the trees, in the form of what is known as "tin birds".

Falling down in the middle of obstacles

Many fragments lie in the middle of the trees, which proves that they can only be found there by a fall from an altitude larger than that of the treetops. The first such example is the terminal part of the left wing lying in zone B2 (Fig. 29). This fragment has been found in a spot surrounded by the trees higher than 10 m, with the crowns that are not damaged. Its location and the fact that it is stuffed into a thin tree proves that the fragment fell down vertically from an altitude higher than 10 m. This eliminates the possibility of its arriving there as a result of a mowing-like flight from the location of the "Bodin's birch."

Another example are the fragment lying in zone B4 (see, Fig. 18, Fig. 19, Fig. 20). They lie in the forest band along the Kutuzov Street and are surrounded by trees on all sides. Therefore, they have had to fall on the ground vertically down to the trees, which proves that the point of their detachment from the airplane structure was located higher than the trees.

"Tin birds"

The "tin birds", Figs .30 , 31 , 32 , not only prove they broke off the aircraft above the location they were found hanging, but also witness they broke away from the aircraft at a distance of at least several tens of meters in front of the tree. Indeed, please note the plane was moving at a velocity exceeding a quarter of the speed of sound. At such a speed, the metal fragments behave like missiles and cut the branches. "Tin birds" show, therefore, that their separation from the aircraft occurred so far away, that a metallic object lost its speed almost completely due to air resistance and was able to settle on a tree branch. Since the motion follows the ballistic curve, it also proves that the separation occurred at an altitude far above the altitude at which a "tin bird" hangs (cf. Fig. 27).

Fig. 29. The tip of the left wing lying in the location that is surrounded on all sides by the trees of height larger than 10 m [19].

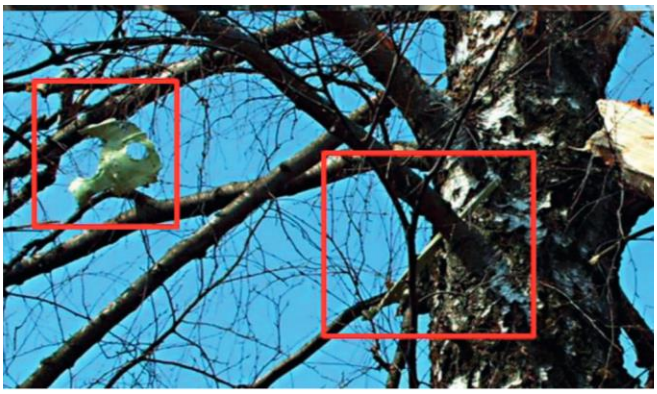

Fig. 30. Fragments of the left wing on the Bodin birch at the altitude of the breakthrough [10]. "Tin birds" have been detached from the aircraft, not less than several dozen meters earlier and much higher than the points they have been settled on.

The above arguments exclude the possibility that the Smolensk Catastrophe course corresponded to the MAK/Miller hypothesis. They prove the detachment of the plane fragments occurred above the terrain obstacles, while damages of the branches of some trees resulted from collisions with the detached and separately flying airplane fragments.

Fig. 31. "The tin birds" at Gubienko Street.

Fig. 32. A "tin bird" at Kutuzov Street [13].

4. Errors and relinquishments at creating the MAK/Miller hypothesis

Although incredible, the representatives of the Polish Republic did not prepare any document at the Smolensk crash site. There is no inspection protocol of the crash site, no report, no recorded interview with any witness, despite the presence at the crash site of numerous representatives of the country, in particular the presence of the representatives of the Military Prosecutor's Office. Moreover, no samples were secured, nor any material evidence collected.

The first Polish document, which was created on the site of the Smolensk Catastrophe, was the report prepared by a team of Polish archaeologists staying in Smolensk in October 2010, i.e. six months after the Catastrophe (see 3.2). These results of archaeological research have been completely ignored, both in writing the MAK report and the Polish (Miller committee) report.

The first task during a plane catastrophe is, in accordance with the guidelines of ICAO, to determine whether the catastrophe was of type 1 (disintegration as a result of colliding with the ground) or type 2 (decay above the ground level). Both Russian and Polish authors of the MAK /Miller hypothesis just completely ignored this task by assuming arbitrarily that the catastrophe was a result of collision with the ground, thus fully neglecting the material evidence and the statements of witnesses.

The main evidence in a study of any air catastrophe are the fragments of the plane and the bodies of the victims. Both Russian and Polish authors of the MAK/ Miller hypothesis again completely ignored the study of these basic evidence. The Smolensk Catastrophe represents the first one in the whole history of international aviation, whose cause has been stated, in the form of the MAK/ Miller hypothesis, without examination of the basic evidence.

The only evidence to support the MAK/Miller hypothesis is presented by the Russian side including the records from some selected on-board recorders and from the QAR recorder of Polish company ATM. The later is the only recorder that the Polish side had access to. Unfortunately, due to the small number of parameters recorded and low frequency of registration, it did not register all the events, especially during the final period of time. In a version of the original record, that has been provided by the Russian investigators, the last part was replaced by an inserted portion of unknown origin, furnished by the Russian side.

Among the analyzed recorders not included are in particular:

- the TCAS and K3-63 recorders (mounted on the TU-154),
- the TCAS recorders on other aircrafts in the Smolensk area,
- the recorders and the on-board equipment mounted on the Polish JAK aircraft, that had landed in Smolensk just before the Catastrophe of the Tu-154M,
- the on-ground recorders of the Smolensk airport,
- the recorders from other ground stations.

5. THE ACTUAL COURSE OF THE CATASTROPHE

The irrefutable evidence given above (see 3.4, 3.5 and 3.6) are by no means the only ones proving the MAK/ Miller hypothesis is false. As it was stressed above (cf. Tab. 2), all results obtained so far by various domains of science are mutually consistent and show the falsity of this hypothesis. Moreover, all the papers presented at the Conferences provided a coherent picture, and allow for the following conclusion:

The Smolensk Catastrophe represented what in the international scientific literature is termed as a controlled demolition.

It was apparently a series of events that resulted in the airplane structure catastrophically falling during the last few hundred meters of the flight, and finally a violent increase of the internal pressure causing the fuselage to be destroyed.

Therefore, this was a catastrophe of type 2B, not 1A (cf. 3.6.2). The order in which various parts of the plane fell off, rules out this was due to a collision with any terrain obstacles, e.g. trees. This is because the initial parts to fall off were not exposed to such an impact. The sequence of this consecutive detachments is illustrated schematically in Fig.14.

First, a rear portion of the central part of the left wing detached, and the large dispersion of the fragments indicates that the cause was not firing of a single explosive charge, but rather a series of small explosions inside the wing. The fragments spread over a large area labeled as zone B1. Their distribution testifies to the fact that the disintegration of the wing began at about 100 m before the Bodin birch.

The second stage of the disintegration is shearing off a 6 m long tip of the left wing. The location of this fragment as well as the shape of the cut, seen in many photographs and videos (Fig. 15), clearly indicate the cut by a detonation strap. The strap detonation technique is commonly used e.g. in demolition, construction, forestry and many companies offer the corresponding material. Examples of such an advertising show Fig. 33 and Fig. 34, but the corresponding market is much larger.

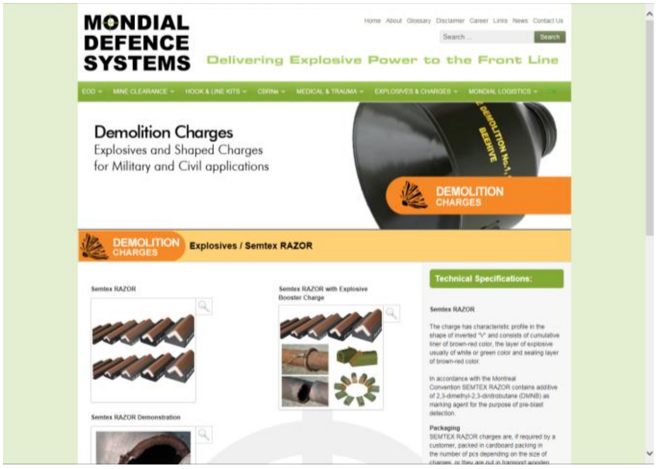

Fig. 33. Web advertisement of the detonation straps used as the tools for cutting metallic objects, here the pipes [20].

The third step was to destroy the rest of the left wing up to the centerwing. Portions of this wing were found in the large area B3 (see Fig. 14), but were also found in zone B4 and B8, like e.g. a wing fragment of the lower shell with the Polish Air Force emblem. The distribution of the fragments indicates that the destruction of the wing resulted from a series of explosions of small charges. The charges were located within the wing structure and fired in a definite sequence, in a way similar to that used for demolition of buildings. One can easily choose the size of such charges in order their acoustic effect were drowned out by the aircraft engines.

In the fourth stage the fragments detached off were tail and undercarriage. These fragments have been found in the forest lane just behind the Kutuzov Street. The first fragment detached was an outer portion of the left horizontal stabilizer (Fig. 18). It fell in the middle of the trees, next a large part of the horizontal stabilizer separated, together with the adjacent elevator - the aileron (Fig. 21).

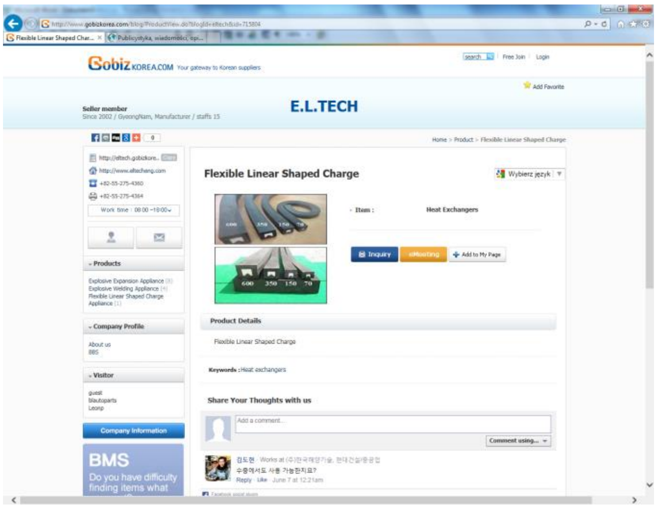

Fig. 34. Flexible Linear Shaped Charge -- elastic detonation straps are oferred for a wide range of detonation strength, for many thicknesses and length of the material to be cut, and with possibility of bending to adjust for the material's particular shape [21].

Another explosion tore a large part of the right horizontal stabilizer with the aileron (Fig. 22). This part has been found about 30 meters (zone B6 in Fig. 14) before two longitudinal grooves in the ground. The grooves have been indicated in the MAK/Miller hypothesis as the first traces of the plane hitting the ground. To enlarge the credibility of the MAK report, Russian soldiers moved that portion westward with respect to the groove. This new position, registered later in aerial photograph, was already consistent with the MAK hypothesis. We have to emphasize that those grooves have no relation with the Smolensk Catastrophe of April 10, 2010, and have appeared in the terrain before the previous vegetation season, as is witnessed by their bottom covered by dry grass [22].

Another explosion tore the vertical stabilizer with the rest of the tail, Fig. 23.

At the end a massive explosion ripped the fuselage. As a result of this explosion the fuselage was torn along the ceiling, while the cockpit and tail parts have been detached. The force of the explosion was so huge that the entire contents of the fuselage - not only passengers but also their seats and even the thermoinsulation have been shredded and blown out. The earlier destruction of the left wing caused a rotation of the plane about its axis, thus at the instant of the explosion the plane was already in the upside down position. Through the fuselage torn open, along the ceiling and the back (after falling off the tail), the remains of passengers and objects flew also back covering the entire area up to the previously separated tail parts in zones B7 and B6 – Fig. 35.

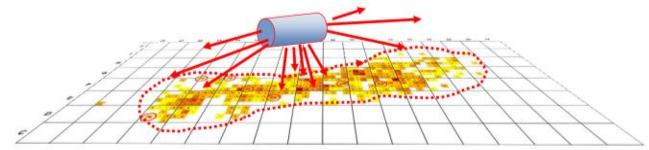

Fig. 35. The distribution of the fuselage thermoinsulation debris (from the archaeological research). The content of the fuselage has been „blown out" in two opposite directions, thus producing a characteristic shoe-like form – with its two ends most diffused. A longitudinal burst results in the largest debris concentration located in the center of the distribution. The distribution of the debris reflects the force field experienced earlier by the debris [13].

6. CONCLUSION

The scientific results of the three Smolensk Conferences 2012, 2013,2014 are related to all disciplines represented in the Scientific Committee. A particular emphasis was on sciences and technology, but non-technical domains such as medicine, sociology and law were represented as well. The Conferences allowed for examination of all available evidence and information concerning the Smolensk Catastrophe. Usually a catastrophe investigation team needs additional assistance of external experts representing those domains of science, that are not represented among air-safety investigators. The Smolensk Conferences had no problem with this, because the Committees of the Conference, in particular the Scientific Committee and the Advisory and Inspiring Committee incorporated specialists from all branches necessary in such investigation. This scientific versatility, offered by the Committees as well as that represented in 78 presentations delivered from all the related domains, enabled the complex investigation of the available evidence and information.

The conclusions of the Smolensk Conferences that can be drawn from the various domains of science are consistent and mutually confirm each other. These domains include: geodetic survey, geotechnics, archaeology, medicine, physics, chemistry, mechanics, aerodynamics, electric technology, acoustics. All the corresponding papers presented at the Conferences produce a coherent picture and allow to draw the following conclusions.

1. The MAK/Miller hypothesis is not supported by the evidence, since each of its five phases contradicts the laws of physics and irrefutable evidence.
2. The Smolensk Catastrophe represented, what in the scientific literature is known as a controlled demolition, and has been carried out by a series of explosions, which took place in closed plane profiles, not available for pyrotechnic inspection. Some basic information concerning controlled demolition are provided in the Appendix..
3. The Russian team that controlled the Catastrophe site disturbed evidence to favor the MAK/Miller hypothesis. Transfer of some fragments to predefined locations and concealing of the evidence that would deny the hypothesis, it served this aim.
4. The general **course** of the Smolensk Catastrophe is known. Although it can be determined based even on the scarce evidence available to independent research, it is clear, that investigation concerning **causes** of Catastrophe cannot be completed without examining crucial evidence, such as the wreckage and the victims' bodies. Without conducting such studies it is impossible to determine some very important details.

The Scientific Committee of the Smolensk Conferences

Warsaw, September 2015

APPENDIX

CONTROLLED DEMOLITION

The technology, known as *controlled demolition* relies on using explosives in order to divide large structures into small fragments in a way that assures predefined division sequence, size of the resulting fragments as well as their positions. Controlled demolition is usually associated with demolition of large buildings. This pertains especially to large and tall structures such as towers and chimneys, which are located inside the urban areas. Removing these structures is carried out more and more frequently by demolition by means of a system consisting of many relatively small explosive charges. The charges are fired in a predetermined sequence so that the resulting debris satisfy two conditions:

1) are located in a pre-planned site,
2) the size of the resulting debris is adapted to the available transport means.

Companies that specialize in such works assure the final location of the remains to the accuracy of several meters. They can also meet other conditions, e.g. that the collapse shock does not exceed a certain threshold value. This is achieved by preparing multiple charges in strictly designed places and calculating their firing sequence (Fig. 36).

Fig. 36. Controlled demolition of a large container (left) and a tall building (right). The individual charges are fired in a carefully designed time sequence [24].

There is a lot of companies offering such services worldwide. The best known is the US company Controlled Demolition, Inc., founded in 1947. Phoenix [24], which advertises itself as having demolished more buildings than all the other companies together. Undoubtedly, this company holds the world records, as for example the controlled destruction of the largest object - a sports stadium in Seattle. For the demolition of this concrete structure weighing 125 thousand tons a system of 5905 charges has been combined in detonation cords 21.6 miles long [25].

Controlled demolition technology is used not only to such objects as buildings, but also to remove industrial installations, terrain obstacles, in mining, forestry, just to cite only several branches of industry. It is worth noting that as soon as in 1989 a Polish patent application concerning the controlled demolition of ships had been introduced („*A technique and elongated cumulative charge for cutting objects, in particular vessels”* [26].

The key for designing a controlled demolition is to choose the size of each explosive device (this is no problem since the invention of gunpowder) and the use of a strictly designed temporal sequence of explosions. This is achieved by detonating cords, which are the modern equivalent of the fuse and serve for connecting charges and detonators.

Detonating cords were invented in France in 1907 [27], now they are manufactured by hundreds of companies all around the world. The slogan "detonating cord manufacturers" returns 98 thousand pages in the web. A detonating cord looks like a thin colored string or electrical wire, Fig. 37 . In reality, it is a thin tube filled with pentaerytritol tetranitrate. After initiating the explosion the detonating cord carries a shock wave along its length at a speed of about 7000 m/s. Installations of such cables can be used for almost simultaneous firing even thousands of charges arranged in different positions. A delay of explosions is achieved by including the delay sections, the time fuses. This produces a precision of the individual explosions to be of the order of 1 millisecond.

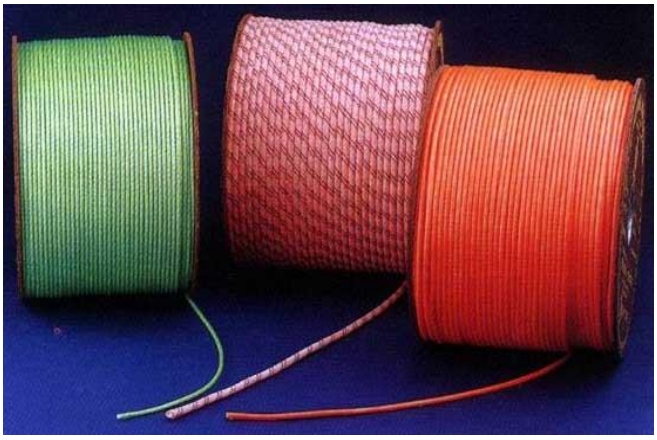

Fig. 37. Detonation cords of the Pyromark company [28].

Detonation cords are used to build explosive installations. Initiation requires a detonator. Currently, there exists a large commercial offer of detonators (Fig. 38) and the initiation may be caused mechanically, electrically, and even chemically. In recent years, however, the initiation is dominated by using electronic chips, which have many advantages: reliability, small size, low cost and the possibility of remote initiation, (e.g by using a mobile phone).

Detonation wires can be used directly for precision cutting - removal of cables, pipes and other equipment. In this case, the application is based on a single or multiple wire wrapping the element to be cut. Detonation cords can be in this way used for cutting or removal of trees, but for this purpose it is more economical to use bulk explosives. Detonation wires are manufactured in a variety of weights (e.g. 5, 10, 12, 15, 20, 40, 70 g / m [29]) and may also be directly used in the same manner as detonation straps. They are used in ports by divers to remove old poles or other underwater obstacles as well as for building demolition to cut thin concrete slabs. One arranges them in channels drilled parallel to the surface. For thicker sections it is necessary to use explosives.

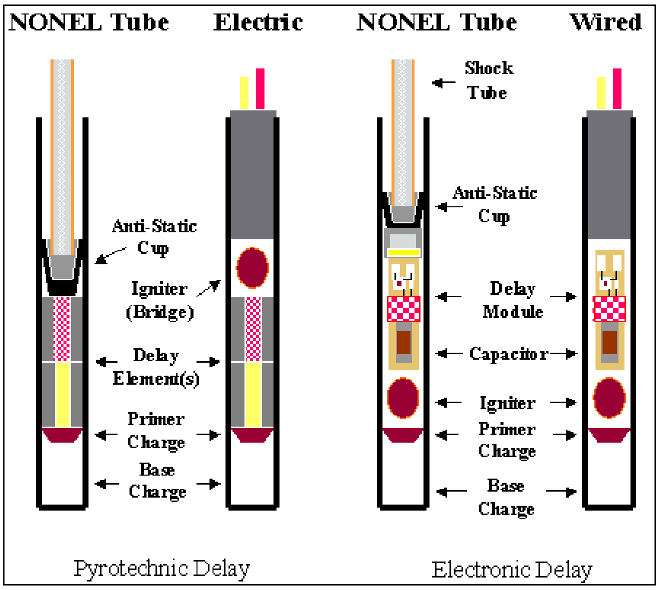

Fig. 38. Detonators -- non-electric action (NONEL) and electric action (Electric) [27].

The charges placed in the explosive installation may be made of variety of materials. One uses charges of nitroglycerin, TNT, pentrite and other materials. The charges can be also shaped as used during WWII, with the consistency of plasticine. Nitroglycerin can be easily shaped by mixing with clay, which protects against an unwanted explosion and allows for creating any shape needed [28]. The charges most often take the form of small cylinders, which should be installed in the prepared holes of customized size. In cutting, however, the linear charges in the form of detonation straps (Fig. 33, Fig. 34, Fig. 39), and for disintegration of the entire selected area the detonation sheets can be used, Fig. 40.

Fig. 39. Cutting an opening in the wall by means of the detonation straps [30].

The explosive installations are commonly used not only for demolition of large buildings, but also for cutting trees, mining, tunneling, quarries and of course for military purposes. Such installations may be prepared many days ahead of their use. They tollerate shocks, under condition the detonator remains inactive.

Individual manufacturers usually specialize in selected products, but there are also those who produce all the components for the explosive installations.

Fig. 40. Detonation sheets. Manufacturers can provide the sheets of varying strength and explosive in the form of PETN or RDX [28].

Among the later manufacturers the Novosibirsk Mechanical Plant ISKRA [31] is a prominent one. It has been established back in 1942 and specializes in production of both components and detonation systems. The quality of the products offered is in no way inferior to the most modern production in the West. The plant cooperates with the Russian Academy of Sciences and meets the needs of 80% of the Russian Federation. Its detonation systems are widely used in mining, geology, metallurgy and other fields. ISKRA specializes in production of advanced detonation products for cutting, and one of its latest products is an electronic detonator (Fig. 41). The plant produces more than two million of the non-electrical ignition systems monthly, and about a million of the detonation wires a day.

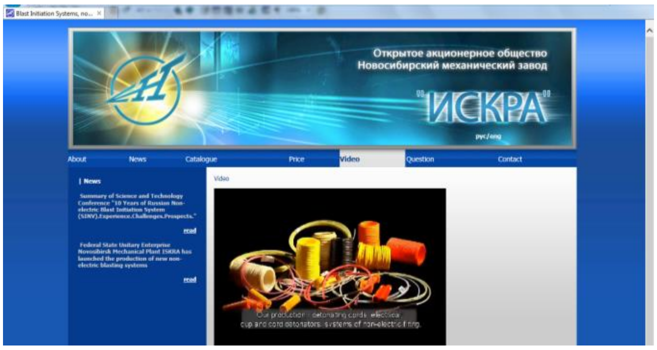

Fig. 41. The home website of ISKRA [31]. The caption for the photograph: our production -- detonation cords, capsule and wire detonators, non-electric ignition systems

On April 12, 2012 the president of the Russian Federation Medvedev delivered a document saying [31]:

"For the great contribution in the domain of development and production of high-tech products, as well as strengthening the defense capability of the country, we declare gratitude to the staff of the Novosibirsk Mechanical Plant ISKRA company."

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