NATO attack on FR Yugoslavia in 1999 was used to test the effectiveness of new weapons

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Abstract:

Introduction/purpose: During the 1999 NATO attack on Yugoslavia, three new weapons were used and tested for the first time. The first is the strategically invisible B-2 bomber, the second is the new JDAM (Joint Direct Attack Ammunition) and the third is the "soft bomb", or the blackout bomb, made of thin electrically conductive fibers. The aim of the paper is to present the new combat devices used during the aggression on the FRY and to quantitatively detect the elements of electrically conductive fibers. The paper also presents the lawsuit of the Federative Republic of Yugoslavia (FRY) to the International Criminal Tribunal for the former Yugoslavia (ICTY) in The Hague. The lawsuit was rejected.

Methods: Physical and chemical analyzes of the fibers were performed. An electron microscope, SEM JSM Jeol 6610LV, was used to analyze the physicochemical characteristics of electrically conductive fibers. It provides the information on the morphology of the sample surface, resulting in a high-resolution image.The microscope is equipped with an X-ray detector (Oxford Instrumets X-Max 20 mm2) for EDS analysis (Energy Dispersive Spectroscopy). It enables the determination of the chemical composition of the material in the analyzed sample volume, based on the interaction between the directed electron beam and the sample atom.

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Results: The characteristics of the B-2 stealth aircraft used to bomb the FRY are shown. The JDAM bomb is an improved ordinary MK bomb with electronic devices added to guide the bomb via satellites. A semi-quantitative analysis of the fibers was performed on the SEM, confirming that the metal layer of the fiber predominantly consists of aluminum, and the non-metallic layer has the highest proportion of silicon dioxide. The fiber is carcinogenic.

Conclusion: In 1999, the territory of Yugoslavia was a testing ground for new combat weapons of NATO aviation - B-2 and JDAM guided bombs. Blackout bombs were dropped on the electrical power systems of Yugoslavia leaving the whole Serbia without electricity for hours. Not only was the bombing-caused environmental pollution radiological and chemical but it was also caused by glass-aluminum electrically conductive fibers as pollutants.

Key words: lawsuit, B-2 stealth aircraft, JDAM penetrating bombs, blackout bombs, electrically conductive fibers, environmental pollution.

Introduction

The North Atlantic Treaty Organization (NATO) bombed the Federal Republic of Yugoslavia (FRY) from 24 March, 1999 to 9 June, 1999. The NATO aggression began at 7:41 p.m. on 24 March, and, by 4:00 a.m. on 25 March, 1999, the entire territory of the FRY was under attack with the focus on the Yugoslav Air Force and Air Defense forces and facilities (Gaćinović & Tomić, 2019). The coded name of the bombing campaign was Operation Alied Force or (in the USA) Operation Noble Anvil, known in Serbia as the "Angel of Mercy". This was the final phase in the land grabbing of Kosovo and Metohija, soverign territory of Serbia.

While the aggression was going on, the Yugoslav government filed a lawsuit with the International War Crimes Tribunal in The Hague for the crimes committed by the NATO alliance in Yugoslavia, primarily Serbia, during the bombing.

On 14 May, 1999, the then-prosecutor established a commission to assess the allegations and the supporting documents with the lawsuit, and appointed a prosecutor and deputy prosecutor to consider whether there was a basis for the lawsuit to continue investigating some or all allegations or other incidents tied to the NATO bombing. (International Criminal Tribunal for the former Yugoslavia, 2022)

The lawsuit of FR Yugoslavia stated the attacks on cities, factories, civilians, columns of refugees, as well as the use of prohibited ordnance, cluster munitions and depleted uranium ammunition.

A particular emphasis was placed on crimes in the attacks on civilians:

1. Attack on a passenger train in the Grdelica Gorge on 12 April, 1999,
2. Attack on a Gjakova convoy on 14 April, 1999,
3. Attack on the RTS in Belgrade on 23 April, 1999,
4. Attack on the Chinese Embassy on 7 May, 1999, and
5. Attack on the village of Koriša on 13 May 1999.

FR Yugoslavia submitted evidence of the use of depleted uranium (DU) missiles during the bombing. The court's response was that there is no specific ban on the use of depleted uranium missiles and that there is no consensus in international legal circles that the use of such missiles violates the general principles of humanitarian law applicable to the use of weapons in armed conflict, even in the case of nuclear warheads and other weapons of mass destruction - those recognized as having the most harmful effects on the environment - it is difficult to argue that banning their use in all cases is absolute. (International Court of Justice, 1996)

Based on the information reviewed, the commission considered that neither the in-depth investigation into the bombing campaign as a whole nor the investigation into specific incidents was justified. "In all cases, either the law is not clear enough or investigations are unlikely to lead to sufficient evidence to substantiate charges against high-ranking indictees or lower-ranking indictees for particularly heinous crimes."

And as a conclusion, "based on the available information, the committee recommends that the Prosecution not initiate an investigation into the NATO bombing campaign or incidents that occurred during the campaign." This is the official position and justification of the court for the crimes of the aggression of the NATO alliance and its military members, mostly pilots, in the war against FR Yugoslavia and its people.

The number of killed Serbian citizens, soldiers and police officers is shown in the book "Merciful Angel or Book of the Dead", published in 2008 by Branimir B. Stanojević, writer (Stanojević, 2008). The book lists all civilians, military personnel and police officers killed during 1998 and 1999 by name and surname, in most cases by date of birth. The Albanian victims in refugee columns were also counted. According to the book, 3,799 people were killed during the war in the FRY, including 1,040 soldiers and police officers and 2,560 civilians, including 78 children, 117 Albanian refugees killed in two refugee columns and 82 killed in Gjakova. Unfortunately, the author was not able to find out their names. The list used the data from the Government of Serbia, the Ministry of Defence, the Association of Families Kidnapped and Killed in Kosovo and Metohija, the daily press, official websites of individual municipalities, and many books and publications published in different cities. (Stanojević, 2008)

The aggression against Serbia continues today, but in a different way. "Bombed today, die later," is one of the headlines (Graham, 2004, pp.34-36). Today, 23 years after the bombing, more and more people and children are suffering from various types of diseases, children with malformations are being born, there are more and more cases of sterility, and the nature remains polluted in the places that have been intensively bombed.

In the territory of FR Yugoslavia in 1999, an experimental war was waged, initiated to allegedly protect Albanian civilians from the so-called Serbian agression, and the goal was to break up Serbia and separate Kosovo and Metohija from its homeland.

During the aggression, the territory of FR Yugoslavia, especially Serbia, served the Western Military Alliance (NATO) as a testing ground for new weapons and for testing the efficiency of American invisible (stealth) aircraft. Three types of combat means were tested: the B-2 strategic bomber, whose deadly debut was on the Yugoslav territory; demolition precision-guided JDAM bombs carried by the B-2 bomber; and blackout bombs (electrically conductive fibers).

The environmental pollution since the 1999 bombing can be divided into three major groups:

- Radiological pollution,
- Chemical pollution, and
- Pollution due to glass-aluminum electrically conductive fibers, which can also be classified as chemical pollution.

The paper will present all aspects of the pollution, with a special emphasis on electrically conductive fiber pollution, which was not given enough attention - it was considered harmless because it is not radioactive and consists of aluminum and glass. However, there is information that the people who worked on cleaning the transmission lines and substations from that "cobweb" became seriously ill and almost all died very soon after the war (Anđelković-Lukić, 2015, p.25).

Radiological effects of pollution

Using depleted uranium (DU) missiles (anti-tank ammunition and ammunition of large caliber of great destructive power to destroy concrete fortifications and bunkers), NATO waged a specific radiological war against the FRY, with long-term pollution of ecosystems and attempts to destroy life in this area, which will have unforeseeable consequences for the whole living world, not only in the region, but also in Europe (Fortuna & Dimitrijević, 2000).

Based on the examination of the remains of the projectiles performed by the FRY army and on the basis of the performed spectrometric measurements and identification of the present radionuclides, it can be reliably claimed that NATO forces deployed DU-core ammunition from A-10 aircraft. It is estimated that the United States alone has at least 700,000 tons of depleted uranium, or radioactive waste. Storage of such material is expensive, and a useful way has been found to reduce its amount by using it for 30 mm sub-caliber ammunition, as well as for larger calibers. Due to its large atomic mass, it is used for the core of anti-tank rounds. The US Army developed DU ammunition for 25 mm gun (85 g uranium), 30 mm air gun (278 g uranium) and 105 and 120 mm tank guns (2.2 to 4.9 kg uranium) [23].

On 21 June, 2009, Belgium became the first country in the world to ban submunitions and armors containing depleted uranium or any other industrially produced uranium.

This ammunition was banned even earlier by the Resolution of the Subcommittee on Prevention, Discrimination and Protection of Minorities of the UN Commission on Human Rights from 1996 and 1997.

During the aggression on the FRY, the Yugoslav army conducted radiological and chemical reconnaissance of the areas where A-10 were deployed. It was found out that there are four areas in Serbia outside Kosovo and Metohija where radiological contamination was recorded: (Fortuna& Dimitrijević, 2000)

"Borovac" - two locations about 6 km south-east of Bujanovac
time of impact 26.05.1999
contamination (KonZ) area 9,100 m2
DU activity (Bq / kg) in the soil samples 250-17,490

"Bratoselci" - about 10 km south-east of Presevo
time of impact 27.05.1999
KonZ area 5,400 m2
DU activity (Bq / kg) in the soil samples 1,800-23,400

"Reljan" - two locations, east of Presevo for about 10 km
time of impact 28.05.1999
KonZ area 8,700 m2
DU activity (Bq / kg) in the soil samples 70-200

"Pljačkovica" - north of Vranje for about 4 km
time of impact 29.05.1999
KonZ area 2,400 m2
DU activity (Bq / kg) in the soil samples 5,580-235,000
* KonZ- contaminated area

Pljačkovica, the hill above Vranje where a repeater is located, was hit by a large number of DU rounds. The solid, rocky base of the hill enabled firing of rounds and dispersion of radioactive aerosols over long distances. The hill dominates the city, so that a large amount of radioactive particles reached the inhabitants of Vranje, and spread farther.

The main danger to humans is the inhalation of aerosols in the immediate vicinity of the affected object. Internal radiation is much harder to avoid. The largest amount of DU is inhaled by persons who are in the immediate vicinity of the affected area at the time and immediately after the impact. It is not excluded that one hundred milligrams of DU is inhaled in such cases. Inhaled aerosols have both soluble and insoluble components. Acute consequences caused by uranium chemotoxicity are not excluded from the soluble component. Total equivalent doses can be as much as a tenth of a millisievert. (Đurović et al, 2011)

In the later phases after the impact, especially when mitigating the consequences, additional inhalation of aerosols in the vicinity of the impact site is not excluded. The reason is the resuspension of the aerosol in air caused by wind or movement of vehicles and people. Equivalent doses in these cases are significantly lower and can hardly exceed tens of millisieverts. (Đurović et al, 2011)

If the target is missed, a small percentage of DU goes into the phase of insoluble aerosols because the round penetrates the soft soil. In contact with water or moisture, uranium metal corrodes quickly. Under the influence of air and water, a very clearly visible yellow oxide layer is formed. Over time, the oxide layer becomes radioactive contamination that can be easily transferred to the wider environment. In addition to the dominant presence of uranium, the X-ray fluorescence spectrometry of the projectile core identified the presence of iron, titanium, nickel, zinc, copper, and zirconium in small concentrations.

The addition of titanium reduces the corrosion rate of the projectile (Đurović, et al, 2011). The data for central Serbia without Kosovo and Metohija and AP Vojvodina are presented.

Depending on the geological situation, pollution of even groundwater is not excluded. From 1999 to 2019, in central Serbia, there is a constant increase in mortality from various polluting agents thrown during the 1999 aggression, as shown in Figure 1. In terms of the number of cancer deaths, Serbia ranks first in Europe.

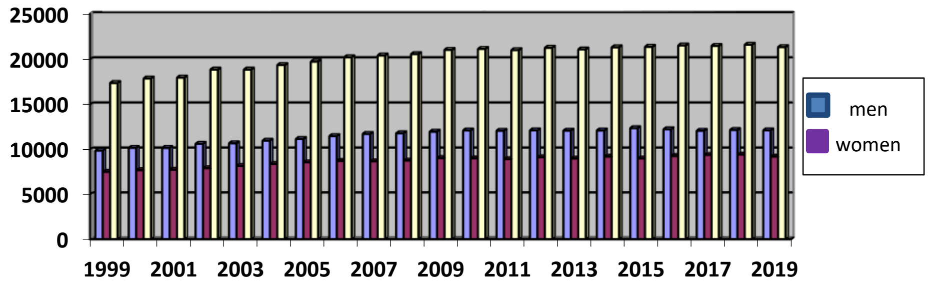

Figure 1 – Mortality in central Serbia according to the "Cancer Registry in the Republic of Serbia, 2021" (data for central Serbia, excluding Kosovo and Metohija and AP Vojvodina) (Institute of Public Health of Serbia "Dr Milan Jovanović Batut", 2021)

Projectiles dropped on the FRY territory during the 1999 aggression

Depending on their destructiveness and purpose, all projectiles dropped on the FRY during the bombing can be classified into the following groups:

• guided and unguided high-explosive projectiles of various calibers (missiles, bombs and cluster bombs),

• anti-armor and anti-concrete projectiles, filled with DU,

• new types of so-called "soft" bombs, which do not have an effect of destruction, but inflict substantial damage, and

• new piercing bombs, large in mass, used for the first time and tested on the Yugoslav battlefield, dropped on the territory of the FRY from the B-2 strategic bomber which also had its combat debut in the military operation over Yugoslavia.

During the NATO aggression on the FRY, 26,095 air raids were registered, out of which 18,168 were conducted by combat aviation. About 37,000 missiles, bombs and other projectiles were launched, out of which 1,400 were cruise missiles with about 40,000 tons of high-explosive ordnance.

At the beginning of the aggression, NATO deployed 371 aircraft a day, and at the end of the aggression, that number was increased to 1,200 aircraft a day (Anđelković-Lukić, 2015).

The NATO alliance did not directly use chemicals in the attack on FR Yugoslavia (poison gases, for example); however, by precisely targeting metal-industrial plants and warehouses of chemical raw materials, oil tanks and oil plants, as well as substations normally containing large quantities of pyralene, they produced effects which were very close to the effects of chemical warfare, that is, as if they used poison gases. (Anđelković-Lukić, 2021, pp.147-168)

The combustion products from composite gunpowder-powered missiles were dispersed in the air, heavily polluting it. The huge amount of kerosene burned in the aircraft that flew at high altitudes also contributed to chemical pollution.

Each detonation of high-explosive ordnance releases a large amount of poisonous and suffocating gases from the explosion process itself, the product of detonation in the places affected. For example, only one penetrating missile, AGM 130, loaded with the most commonly used explosive tritonal (370kg, TNT 80 / Al 20,) releases 5173 m3 of a mixture of toxic gases and 146 kg of carbon during detonation, all in the form of the most dangerous nanoparticles. (Anđelković-Lukić, 2021, p.153)

JDAM penetrating bombs first combat deployed on the territory of FR Yugoslavia

In 1999, in addition to classic unguided MK bombs for carpet bombing, FR Yugoslavia was targeted with new penetrating, laser-guided missiles powered by large masses of explosives. It is highly likely that projectiles had depleted uranium charges because they were used to penetrate fortified underground tanks, underground aircraft hangars and underground ammunition depots (Di Pietro & Accame, 2006). These are JDAM bombs (Figure 2) and AGM cruise missiles, with the GBU 31 warhead, the characteristics of which are shown in Table 1. These bombs were active in Serbia in 1999.

The Ponikve military air base, located 12 kilometers northwest of Užice, was hit by more than 700 missiles and cruise missiles in 37 attacks during the NATO bombing, out of which about 40 remained unexploded in the ground. One of the unexploded projectiles unearthed by a demining team in 2012 was the GBU31, JDAM with the MK warhead (Table 2), which proved that they had used new, modified penetration bombs experimentally. The most frequent targets of the NATO bombing were the military airports Ponikve near Užice and Dubinje near Sjenica (bombed almost 30 times with over 300 projectiles). (Tošić, 2021)

During the aggression in 1999, the Command Center on the Straževica hill near Rakovica was bombed daily, but due to its natural protection (the center was buried in the hill) it could not be destroyed.

Table 1 shows some of the characteristics of large penetrating bombs dropped by stealth aircraft on FR Yugoslavia in 1999.

Table 1 – Characteristics of laser-guided penetrating bombs which were tested in real conditions on the territory of the FRY in 1999

The name of the bomb	Winged bomb **AGM*-130, BLU**-109**	**GBU***-27 system JDAM**** BLU-109**	**GBU-31 system JDAM BLU-109**
Total weight (kg)	1323	1065	2130
Type of explosive	Tritonal (TNT 80/Al 20)	Tritonal (TNT 80/Al 20)	Tritonal (TNT 80/Al 20)
Explosive mass (kg)	430	240	306
Length (m)	3.9	4.24	5.27
Range (km)	48	20	10
Aircraft carriers	B1-B,B-2, B-52	F117-A	B1-B,B-2

*__AGM__ Air-launched, surface-attack, guided missile,
**__BLU__ Bomb Live Unit
***__GBU__ Guided Bomb Units
****__JDAM__Joint Direct Attack Munition

Military fortifications are made of reinforced concrete with strong metal reinforcement, rebar, and therefore it is necessary that the warhead, in addition to high explosive, have a penetrator, which upon impact releases high temperature necessary for the penetration of metal reinforcement.

One of the aerial lethal weapons used for the first time during the NATO aggression on the FRY were satellite-guided general-purpose air bombs of the JDAM system.

One of the systems of guided air bombs is shown in Figure 2.

a)

b)

Figure 2 – JDAM guided air bomb (Valka, 2022)

The JDAM bomb is a modernized variant of the unguided MK general purpose bomb, improved by adding GPS guidance, and from these cheap unguided bombs a successful variant of the JDAM guided bomb was obtained. They are applied during air strikes on well-defended objects from medium and higher heights. The carrier aircraft ejects JDAM in all meteorological conditions on the principle of "launch and forget" from a great distance and altitude and out of the reach of the Yugoslav air defense. According to the Pentagon report, the bombs carried by the B-2 stealth aircraft were marked GBU-31, with a BLU-109 warhead, powered by tritonal explosives, as shown in Table 1. (Navedtra 14014A, nd)

At the Dubai International Fair in 1999, immediately after the war in Kosovo and Metohija, an arms dealer presented the BLU-109 warhead and described its capabilities in penetrating super-armored underground targets, explaining that this model had been tested in the recent war in Kosovo (Parsons, 2002). During the aggression, more than 500 JDAM bombs were dropped on the FRY from the B-2 strategic bomber alone, which carries 16 pieces each. After the bombing of the FRY, sales of this guided bomb increased, so it ended up in the armament of many NATO members and some Arab countries.

B-2 strategic aviation aircraft carrying JDAM penetrating bombs

B-2 stealth bombers were used against the integrated air defense system of Serbia, command and control points, runways and airports, communication facilities, factories, bridges and other elements of infrastructure. The first American aircraft used in the allied forces were B-2s which took off from the Whitman Continental Base in Missouri. One such plane bombed the Chinese embassy in New Belgrade in 1999, on 5 June. Six B-2 aircraft constantly took part in the bombing of FR Yugoslavia. The report of the 509th Air Brigade states that all B-2 planes proved to be extremely efficient. Only one plane "had mechanical problems in flight" and had to stop the mission (until the breakdown was repaired). (Tirpak, 1999)

The B-2 aircraft operated exclusively at night, sometimes on a mission with two more planes, but mostly alone. They did not fly in a group with other NATO aircraft because they had a large radius of movement. They took off from the Whitman Continental Base in Missouri and returned without landing. The flight lasted for 30 hours. They were supplied with kerosene in the air. When approaching a specific target area, the B-2 had a radar image almost photographically accurate in detail and quality. This was checked on the basis of intelligence photographs, and the target was identified. At the appropriate moment, the door of the bomb bay opens, JDAM is dropped from the plane, and directed towards the target.

Table 2 – Physical characteristics of conventional explosives

Explosive	Point of melting (°C)	Heat of explosion Qe (kJ/kg)	Explosion temperature Te(°C)	Detonation velocity D (m/s)
TNT trinitrotoluen $C_7H_5N_3O_6$	181-182	4561	3169	6900 (for density 1.60 g/cm^3)
RDX Ciklo-trimetilen trinitramin $C_3H_6N_6O_6$	205	6322	4249	8750 (for density 1.76 g/cm^3)
HMX Ciklo-tetrametilen tetranitramin $C_4H_8N_8O_8$	275	6192	4249	9100 (for density 1,90 g/cm^3)

Table 2 shows that the heat of explosion Qe and the explosion temperature Te of the explosives used are very high (Hristovski, 1994), so that the detonation products are in a gaseous state with very fine combustion particles, of the order of nanometers. These particles are easily inhaled and remain in the lungs for a long time. The high temperature of the explosion enables the formation of nanoparticles in the products of detonation. The size of particles depends on the temperature - the higher the temperature, the smaller the dimensions of formed particles (Gatti& Montanari, 2004). In combination with various additives to explosives due to increased energy performance, and in synergy with released radicals (chlorine or fluorine) or oxides (mainly metals, aluminum, magnesium) in detonation products, these particles become very toxic. (Agency for Toxic Substances and Disease Registry, 2004, 2014)

Toxic gaseous products of detonation and combustion of gunpowder in high concentrations are found in craters immediately after the explosion. Later, they are dissolved in the air and dispersed in the immediate vicinity of the bombed site. They have an extended duration of action on human health.

Various heterogeneous gunpowders are used as a combustion charge in long-range projectiles, mainly missiles. These are homogeneous, physical mixtures of oxygen-rich compounds (mostly inorganic crystalline salts) and fuels (usually of organic origin) which under certain conditions in the combustion process (oxidoreduction) react with each other, producing heat and high pressure gases. Of such gunpowders, the most famous are composite rocket gunpowders, i.e., propellants.

Composite rocket propellants (Orbović, 2020, p.329) consist of oxidants, mainly ammonium perchlorate 60 - 80%, binders which ensure the cohesion and homogeneity of oxidants, and fuels, and are formed from prepolymers such as polybutadiene, curing agents (toluene diisocyanates), adhesives (triethanolamine), plasticizers (diisocotyl sebacate), cure catalysts (ferriacetone acetonate, lead chromate), aluminum, about 25% of combustion accelerators, antioxidants based on phenol and amine) and combustion stabilizers (acetylene carbon black and aluminum powder). These are mostly general components of composite rocket propellants, but they can also be enriched by very fine-grained explosives and energy fluorine compounds, such as formals, also explosives, fluoronitroformals, in order to increase energy characteristics. Combustion products contain metal oxides (aluminum, iron, lead, and chromium).

During combustion of different types of gunpowders (rocket propellants), among combustion products there are carbon monoxide, carbon dioxide, nitrogen oxides, hydrogen cyanide, soot, etc. Metal oxides of lead, copper, magnesium, aluminum, but also some aggressive radicals caused by incomplete combustion are also found in combustion products. Some of composite gunpowders also contain transformer oil, chlorinated biphenyls, which when burned release a whole range of toxic genotoxins, polychlorinated dibenzofurans, chlorinated benzoparadioxins, chlorinated phenols, hydrogen chloride, and soot. Solid combustion products are distributed in the gaseous phase in the form of fine particles, measuring about 5 micrometers and less, forming aerosols of smoke. Salts of heavy metals present in these combustion products, especially lead, are toxic. These products can cause skin reactions. All these combustion products are toxic and carcinogenic, they fell to the ground polluting the environment and have a delayed effect on the health of the population.

There are no lethal devices such as bombs, mines or projectiles that do not contain a pyrotechnic element. A complete system of rockets, from the smallest to the largest, contains pyrotechnic parts. Pyrotechnics have enough energy in a small volume to achieve desired effects. The only external energy required for proper functioning is the initial pulse, usually electrical, which can be controlled with great precision to avoid unwanted initiation and to deliver just as much energy to the system as needed to properly and reliably start a reaction (detonation). Pyrotechnic mixtures contain oxidants, fuels (inorganic and organic) and additives. Inorganic salts of sodium, potassium, barium, lithium, strontium, lead and iron are used as oxidants. Inorganic fuels are mainly calcium, beryllium, boron, lithium, silicon, aluminum, magnesium, and of organic fuels, the most commonly used are polyethylene, polyester, asphalt, naphthalene, carbon, polyesters, polyamides, and nitrocellulose (Orbović, 2020, p.329). Pyrotechnic mixtures are very important in the initial chain - they are in fuses and if there is a break in the chain, there is no activation of ordnance. Due to that mistake, inactivated bombs fell on the territory of Serbia, representing a great danger to deminers during UXO removal and destruction.

Blackout bombs

The third weapon used for the first time during the bombing of FR Yugoslavia were blackout bombs, as the Pentagon called them. It was an extremely guarded military secret of the Pentagon, revealed on the battlefield of FR Yugoslavia. There were great expectations of this bomb which was supposed to cut off electricity in Serbia for a long time and thus disable the functioning of the bloodstream of civilian life, the civilian infrastructure.

Electricity supply is a very important factor for the functioning of all activities in one society. Therefore, it is considered that the attack on the power grids, nuclear power plants and computer systems of one country is a terrorist act and that all security measures must be taken to prevent that from happening. Given that the power grid of FR Yugoslavia in 1999 was attacked by blackout bombs, and the whole electrical power system of Serbia was brought to a standstill for 70 hours in one period, according to the definition of American terrorism experts, it was one of the terrorist actions of the NATO alliance. In addition to being aggressors, NATO acted as a terrorist in the Republic of Serbia. (Nye, 2019)

The CBU-102 (B) 2 / B "soft bomb", a cluster bomb, was used to attack the Serbian electricity grid, with BLU-114 / B cassettes filled with small coils of electrically conductive fibers that scatter into a cloud of micron-thin threads and cause short circuits on the power grid. Similar weapons were successfully used in the Operation Desert Storm against Iraq in 1991, but these bombs contained graphite fibers.

The new CBU-102 (B) 2 / B bomb, with satellite guidance to the selected target, was carried by a B-2 stealth bomber. The bomb tracks signals from global positioning satellites to reach its target - a substation or a transmission line. Its cost is unknown, but some analysts estimate it is probably below $ 100,000. Figure 3 shows the appearance of a cassette containing fiber coils.

Figure 3 – Appearance of the cassette with threaded conductors

In each BLU-114 / B cassette there are a total of 147 coils with electrically conductive fibers. The thickness of individual threads is 6 to 7 μm. There are about 30 fibers twisted in one thread. When falling on high-voltage lines of power systems, the coils fall out of the cassettes, unwind and form giant, superconducting "cobwebs" which cover power lines and cause short circuits with huge, lightning-like electric discharges. Unwound threads have a length of about 150 m, and when falling, the basic thread is unwound into a larger number of thinner ones, creating a net that covers large areas and has a greater strength than individual threads (Dnuo Zhend Technology New material, 2022). The network of conductive fibers is dispersed on the elements of a plant or on the transmission line and brings them into a state of permanently short-circuited elements, so that they are disabled until all conductive fibers are removed, even the smallest elementary threads. It turns out that the technical problem is solved by removing the fibers to the level of elementary threads with procedures that do not require much time, and guarantee the safety of the engaged workforce. The most efficient ways to remove fibers are mechanical, with the use of convenient tools and vacuum cleaners. All conductive material has been carefully collected and disposed of so that it cannot come into contact with electrical lines again. Residues of conductive material that could not be collected from the ground were chemically treated with 5% sodium hydroxide solution so that the aluminum lost its conductivity. The most effective way of sticking the fibers to the soil was by sprinkling water glass or dilluted starch. (Filipović, 1999)

The "soft bomb" for blackout was produced in 1994, and was included in the weapons of the United States in the late 1990s as a closely guarded secret.

It was tested for the first time in real conditions on the territory of Yugoslavia on May 2, 1999 (Anđelković-Lukić & Stojanović, 2020). When it falls from the plane, the bomb rotates vertically, and then discards the outer shell and begins to rotate. When it rotates, it releases two hundred submunitions (cassettes) the size of a beer can, each of which contains thousands of thin fibers. A small explosive charge inside each box detonates, scattering fibers like electrically conductive cobwebs and forming a "net" that slowly descends. (Ricks, 2002)

The appearance of unwound electrically conductive fibers under an optical microscope is shown in Figure 4. When this conductive network falls on a target — an electric transformer, a transmission line, or a substation — it causes thousands of explosive short circuits, i.e., fires, thus disabling the target.

For a long time, no attention was paid to the information that the workers who were removing the conductive "cobweb" from the electrical grid elements (transmission lines and substations) died of leukemia very soon after (a year or a year and a half). The information about the death of these workers after cleaning the power lines from the "cobweb" was obtained from the employees of Elektrodistribucija in 1999 who were union presidents and leaders of relevant sectors. (Anđelković-Lukić , 2015, p.25). This knowledge, which has been downplayed for a long time, shows that the bombing of the FRY in 1999 had three important aspects that affected human health: radiological, chemical and conductive fibers. On the basis of both this information and the same information obtained from the ED Nis, we started detailed research on the physico-chemical characteristics of these electrically conductive fibers.

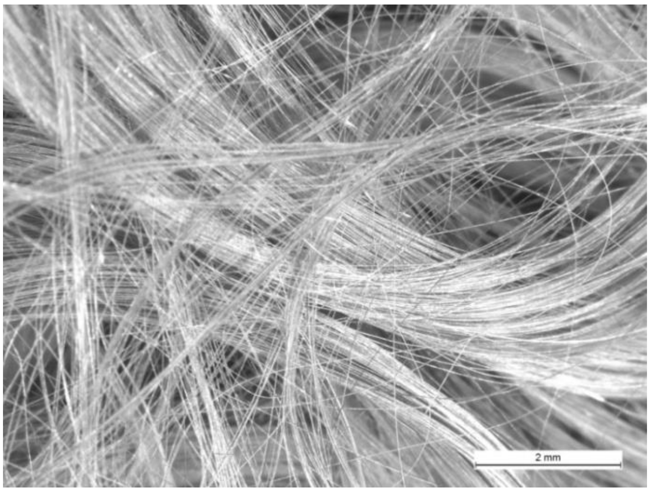

Figure 4 – Appearance of fibers under a stereo-optical microscope

The images from the electron microscope showed that the fiber consists of two bonded layers: glass (SiO_2) and metal (aluminum), as seen in Figure 5 (EDS analysis is given later in the text).

Glass fibers are a new inorganic non-metallic material. They are made from natural minerals such as kaolin, pyrophyllite, quartz sand, limestone, etc., in accordance with a certain formula, by high-temperature melting, extraction, winding and other processes. The diameter of a monofilament is between a few micrometers and more than 20 micrometers, which is equivalent to 1 / 20-1 / 5 hairs. (Dnuo Zhend Technology New material, 2022)

Synthetic glass fibers are inorganic fibrous materials, produced mainly from glass or stone. Commercially important synthetic glass fibers are primarily based on silicon dioxide, but contain various contents of other oxides (e.g. aluminum, boron, calcium, or iron oxide). Synthetic glass fibers have amorphous molecular structures, while natural mineral fibers, such as asbestos, have crystalline structures. Continuous glass filaments refer to glass fibers produced by extrusion. More than 98% of the continuous glass produced are E filaments for electrical applications. E glass fibers, which are mostly used in electronics and electrical engineering, with an adhered layer of aluminum, were used in blackout bombs. (Filipović, 1999)

Figure 5 shows a photomicrograph of a fiber, where the darker part is a layer of aluminum (Al) and the lighter part is glass (SiO_2). Microphotographs obtained from a scanning electron microscope (SEM), (Reimer, 1998), have shown that this is a modern technology, by which two very thin components of these fibers are adhered.

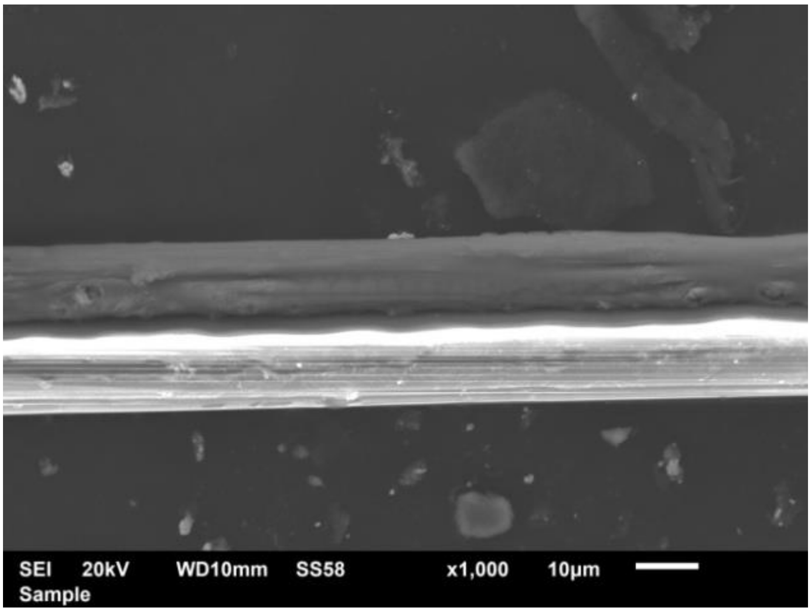

Figure 5 – Microphotograph of a SiO2 / Al composite fiber (SEM)

The thickness of the layers varies along the sample, without interrupting the continuity of the layers, and at the interface it is visible that adhesive bonding is uneven, with penetrations into one or the other component. Figure 6 shows a segment of a composite fiber at 2,000x magnification.

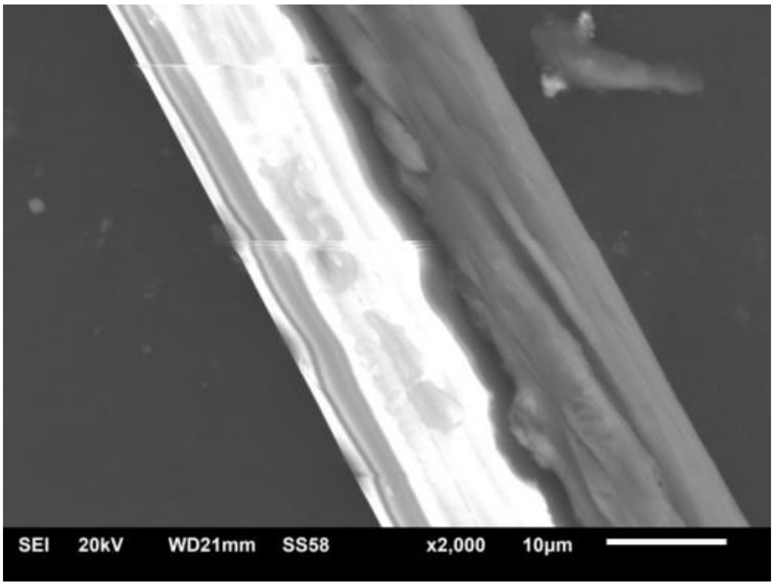

Figure 6 – Uneven adhesive bonding of fiber components (SEM)

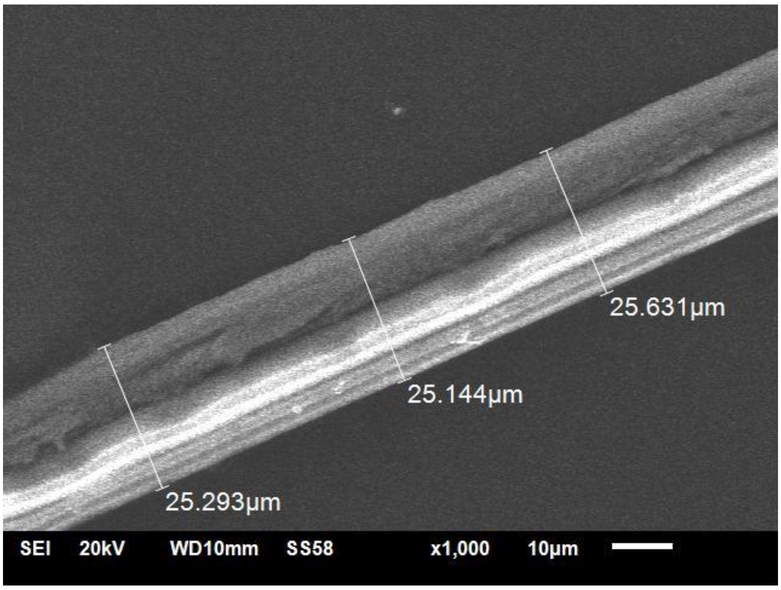

Figure 7 – Diameter of a fiber composed of two components: glass (darker) and aluminum (lighter) (SEM)

Figure 8, which was taken at a magnification of 1000x, shows the dimensions of the individual layers of glass (SiO_2) and aluminum (Al). The thicknesses of the individual glass and aluminum composites are not the same in all sections.

However, this in no way interferes with their function, the conductivity of electric current, because the layers are continuous, without interruption.

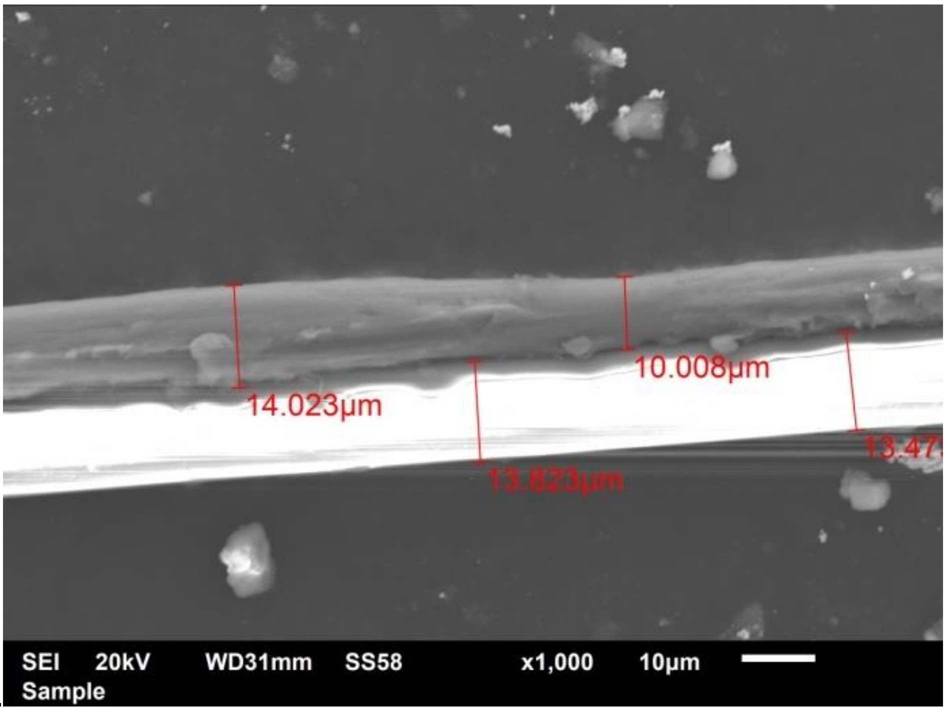

Figure 8 – Dimensions of individual components SiO2 and Al (SEM)

A semiquantitative analysis on fiber segments was performed by the EDS method (Energy Dispersive x-ray Spectroscopy - EDS) on a scanning electron microscope.

With this method, the composition of the material was obtained by analyzing the obtained spectra.

Since the analysis includes a small volume of material, the EDS method is qualitative, but semi-quantitative. (Reimer, 1998)

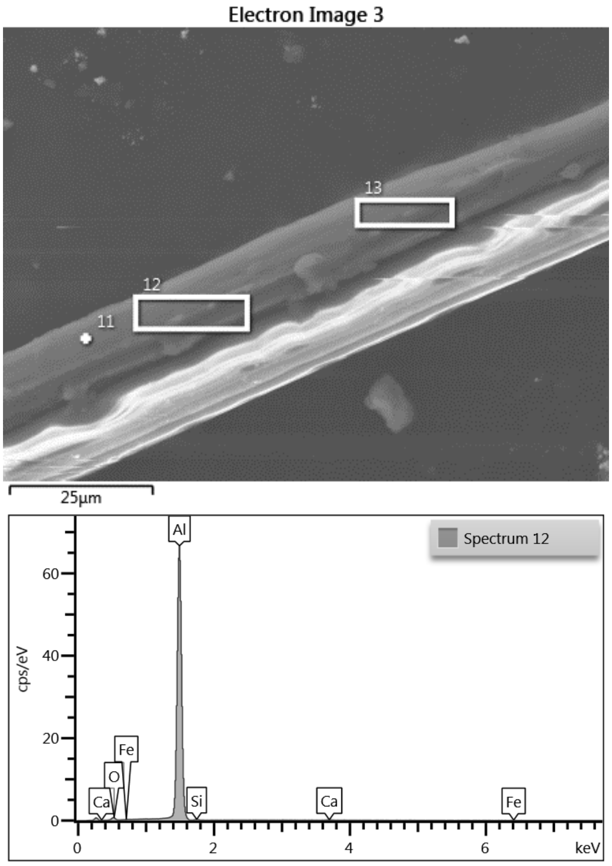

Figure 9 – Semiquantitative analysis of the composition of the aluminum part of the fiber and the typical spectrum (SEM/EDS - Scanning electron microscope/Energy dispersive x-ray spectroscopy)

Table 3 – Semiquantitative analysis of the composition of the aluminum part of the fiber from Figure 9

Element	**mas.%**			**mas.%**
	Spectrum11	Spectrum12	Spectrum13	Middle value
O	8.29	4.26	3.90	5.48
Mg	0.08	-	-	
Al	**91.43**	**94.64**	**95.76**	**93.94**
Si	0.09	0.69	0.16	0.31
Ca	0.04	0.25	-	
Fe	0.09	0.17	0.18	
total	100	100	100.00	100

The results indicate the predominant presence of aluminum and a small proportion of oxygen, while other elements are found in negligible amounts.

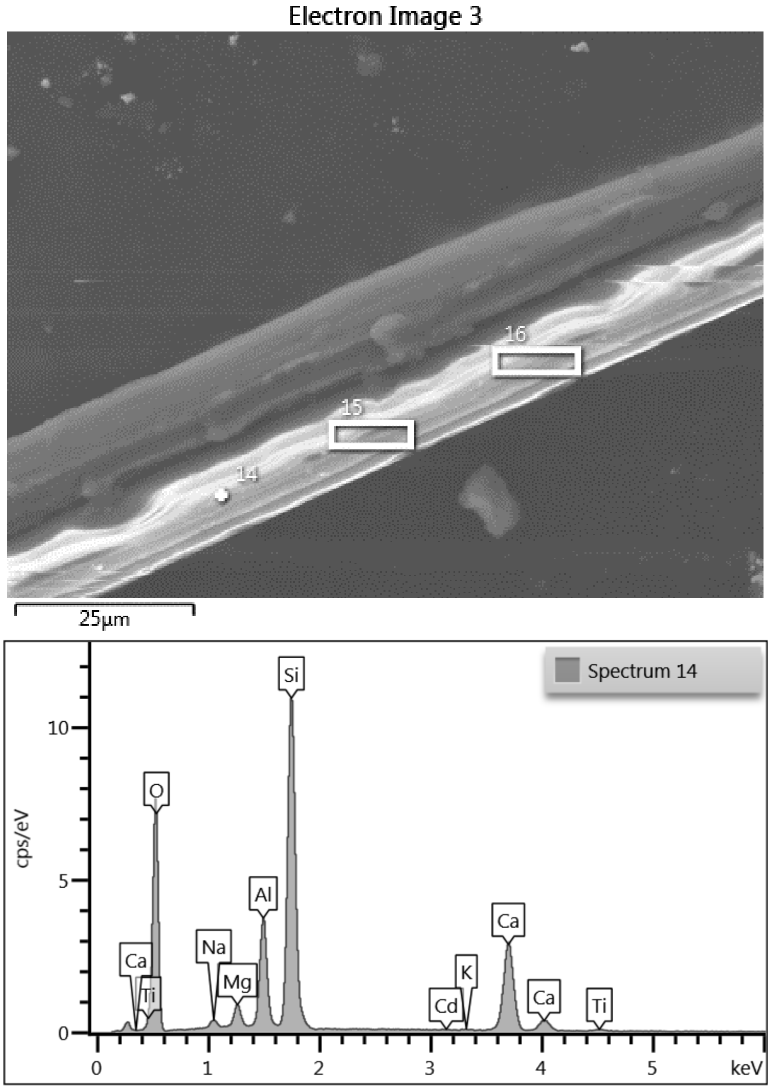

Figure 10 – Semiquantitative analysis of the glass fiber composition and a typical spectrum (SEM/EDS)

Table 4 shows the results of the EDS analysis of the glass part of the fiber from Figure 10.

Table 4 – Semiquantitative analysis of the composition of the glass part of the fiber from Figure 10

Element	mas.%			mas.%
	Spectrum14	Spectrum15	Spectrum16	Middle value
O	**52.01**	**51.25**	**51.32**	**51.53**
Na	0.83	0.88	0.85	0.85
Mg	1.76	1.83	1.78	1.79
Al	**7.80**	**8.08**	**8.17**	**8.02**
Si	**24.98**	**25.40**	**25.13**	**25.17**
K	0.11	12.30	0.11	4.17
Ca	**12.08**	**0.27**	**12.19**	**8.18**
Ti	0.30	51.25	0.28	17.28
Fe	-	-	0.17	
Cd	0.13	-	-	
total	100	100	100.00	100.00

In the glass part of the fiber, there is a large mass content of oxygen, silicon and calcium, which are the components coming from raw materials in glass processing. The oxygen content indicates the presence of oxides. The aluminum in the analysis originates most likely from the fiber glass part in the bond. In addition to aluminum, silicon and calcium, a smaller amount of sodium, magnesium and potassium was detected, as well as traces of iron and cadmium.

The health of the people who cleaned these fibers was endangered due to the inhalation of small parts of this conductive composite. This is where the causes of illness and death of people who cleaned the electro-conductive cobweb should be looked for. Doctors should examine the ffects of these fibers on health.

Types of processed glass include glass fibers and glass wool. Recently, the World Health Organization (WHO) and the IARC classified synthetic glass fibers into two categories: filaments (fibers) and wool. Direct exposure to these types of glass causes irritation of the skin, eyes and upper respiratory tract, which poses a health hazard. Glass fibers used for blackout bombs belong to the category of E fibers.

Inhalation of synthetic glass fibers suspended in the air as well as other particles causes their deposition in the lungs. Concentrations of synthetic glass fibers in air samples are usually represented as the number of fibers per cubic centimeter of the air (number of fibers / cm3 of the air). Inhalable fiber is usually defined as a fiber <3 µm in diameter. In general, small diameter fibers are easier to suspend and remain suspended in the air for longer than larger diameter fibers.

The results of animal studies indicate that inhalation of any synthetic glass fiber can cause pneumonia. Synthetic glass fibers have been shown to cause pulmonary fibrosis, lung cancer, or mesothelioma (Agency for Toxic Substances and Disease Registry, 2004, 2014).

In the "List of Candidate Substances of Concern", out of 211 substances that are carcinogenic and toxic, silicon and aluminum fibers are listed as carcinogens at position 28. (Službeni glasnik RS, 58/2016)

Conclusion

During the 78 days of bombing of FR Yugoslavia, the NATO alliance used the opportunity to test new combat and lethal weapons developed in the late 1990s.

For the first time over the FRY, new, so-called invisible "stealth" B-2 aircraft flew in bombing operations from the Whitman land base in Missouri to bomb the Chinese embassy in Belgrade in one of their deadly flights. They carried JDAM penetrating bombs. The flight of these aircraft from the base to a certain location in the FRY and back lasted 30 hours without interruption. Their designers were very satisfied with their "successful" bombing actions destroying the infrastructure of one country and killing its population. Six B-2 aircraft took part in the aggression against the FRY.

The territory of the FRY was also used to test the effects of new bombs in urban areas, weighing from 1,100 to 2,500 kg. These were adapted JDAM penetrating bombs, produced to destroy underground warehouses, bunkers and underground air bases.

The third weapon, which was kept as a top military secret, were blackout bombs. These so-called "soft bombs" (because they do not have immediate lethal effects) also appeared on the FRY battlefield for the first time in 1999. It was a high-tech product, composed of cassettes containing coils of electrically conductive fibers formed by adhesing layers of aluminum and glass into one thin thread. These fibers were thrown from US made container bombs and when they fell, they unwound and formed huge electrical cobwebs. These cobwebs fell on Serbian electrical systems and caused power outages in a large part of Serbia due to short circuits. As a result of their actions, Serbia was without electric power for 70 hours in one period. However, Serbian engineers and electrical experts solved the cobweb problem very quickly, so that it was no longer a threat to Serbia's energy system.

From the presented work, it can be concluded that the NATO deployed an illegal act of agression by bombing a sovereign country making its population suffer due to, among other things, depleted uranium bombs, fires set to chemical plants and oil tanks, polluted air and soil with chemical agents, etc. Thus, the health of a large number of inhabitants, children included, was and has been endangered in FR Yugoslavia. From year to year, mortality from various types of cancers is increasing. In terms of cancer mortality, Serbia ranks first in Europe.

In addition to these two health aspects, radiological and chemical, there is the third one, caused by the effects of glass-aluminum fibers during their removal. Micro pieces of fibers, smaller than 1μm in size, could be inhaled thus harming the health of people who were removing cobwebs and restoring the power grid. A large number of young people who used hand tools, brooms and various sticks to clean transmission lines and substations from conductive cobwebs died of leukemia very soon after the aggression stopped.

The consequences of that act of agression without international legal approval are still being felt today - many people have suffered from various diseases related to the bombing, and the number of cancers and sterile marriages has increased, as well as the cases of sterility in men and children born with anomalies.

Despite the fact that it was formally established in 2018, a Serbian commission with the task to examine the impact of pollution on the health of the population has not come to life until today. There is no official list of cancer-diagnosed individuals who were engaged in Kosovo and Metohija in 1999. The number of people killed and wounded during the bombing was not listed at the state level. This was done by personal effort of writer Branimir Stanojević, who listed the names of all the victims killed by NATO in FR Yugoslavia.

This 1999 savage bombing of FR Yugoslavia by NATO and its members and associated countries must never be forgotten not only because of heavy human sacrifices and destruction suffered by the Serbian people but also because of future lives to be lost due to the consequences of radiation and chemical pollution.

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El ataque de la OTAN a la República Federativa de Yugoslavia en 1999 fue usado para probar la efectividad de nuevas

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CAMPO: tecnología química
TIPO DE ARTÍCULO: artículo científico original

Resumen:

Introducción/objetivo: Durante el ataque de la OTAN a Yugoslavia en 1999, se utilizaron y probaron por primera vez tres nuevas armas. La primera es el estratégicamente invisible bombardero B-2, la segunda son las nuevas Municiones de Ataque Directo Conjunto-JDAM (Joint Direct Attack Ammunition)- y la tercera es la "bomba blanda", o bomba opaca, hecha de finas fibras conductoras de electricidad. El objetivo del artículo es presentar los nuevos dispositivos de combate utilizados durante la agresión a la República Federativa de Yugoslavia y detectar cuantitativamente los elementos de las fibras conductoras de electricidad. El artículo también *presenta la demanda de la República Federativa de Yugoslavia (RFY) ante el Tribunal Penal Internacional para la ex Yugoslavia (TPIY) en la Haya. La demanda fue rechazada.*

Métodos: Se realizaron análisis físicos y químicos de las fibras. Se utilizó un microscopio electrónico, SEM JSM Jeol 6610LV, para analizar las características fisicoquímicas de fibras eléctricamente conductoras. Proporciona información sobre la morfología de la superficie de la muestra, lo que da como resultado una imagen de alta resolución. El microscopio está equipado con un detector de rayos X (Oxford Instruments X-Max 20 mm2) para análisis EDS (Espectroscopia de Dispersión de Energía). Permite determinar la composición química del material en el volumen de muestra analizado, basándose en la interacción entre el haz de electrones dirigido y el átomo de la muestra.

Resultados: Se muestran las características del avión furtivo B-2 utilizado para bombardear la República Federativa de Yugoslavia. La bomba JDAM es una bomba MK ordinaria mejorada con dispositivos electrónicos agregados para guiar la bomba a través de satélites. Se realizó un análisis semicuantitativo de las fibras en el SEM, confirmando que la capa metálica de la fibra se compone predominantemente de aluminio, y la capa no metálica tiene la mayor proporción de dióxido de silicio. La fibra es cancerígena.

Conclusión: En 1999, el territorio de Yugoslavia era un campo de pruebas para nuevas armas de combate de la aviación de la OTAN: bombas guiadas B-2 y JDAM. Se lanzaron bombas para apagones sobre los sistemas eléctricos de Yugoslavia, dejando a toda Serbia sin electricidad durante horas. La contaminación ambiental causada por los bombardeos no sólo fue radiológica y química, sino que también fue causada por fibras conductoras de electricidad de vidrio y aluminio como contaminantes.

Palabras claves: *demanda judicial, aviones furtivos B-2, bombas penetrantes JDAM, bombas para apagones, fibras eléctricamente conductoras, contaminación ambiental.*

Агрессия НАТО в 1999 году против Югославии была использована для проверки эффективности новой боевой техники

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РУБРИКА ГРНТИ: 78.25.12 Химическое, биологическое и зажигательное оружие. Вооружения и средства радиационной, химической и биологической защиты,
61.01.94 Охрана окружающей среды
ВИД СТАТЬИ: оригинальная научная статья

Резюме:

Введение/цель: Во время бомбардировок были использованы три новых боевых средств, которые были впервые испытаны в 1999 году. Во-первых, стратегический бомбардировщик-невидимка B-2, во-вторых, новые разрушительные авиабомбы JDAM (Joint Direct Attack Munition), в-третьих, «мягкие бомбы» или «бомбы затемнения», изготовленные из тончайших электропроводящих волокон. Целью данной статьи заключалось в описании новых боевых средств, применявшихся во время агрессии против СРЮ, и выявлении количества элементов электропроводящих волокон. В данной статье также описан иск Союзной Республики Югославия в Международный трибунал по военным преступлениям в Гааге. Иск был отклонен.

Методы: В ходе исследования были проведены физические и химические исследования волокон. Сканирующий электронный микроскоп JSM Jeol 6610LV использовался для исследования физико-химических характеристик электропроводящих волокон. Он позволил получить информацию о морфологии поверхности образцов, в результате чего было получено изображение высокого разрешения. Микроскоп оснащен детектором рентгеновского излучения (Oxford Instruments X-Max 20 мм2) для проведения энергодисперсионной рентгеновской спектроскопии. Он определяет химический состав материала в анализируемом объеме образца на основании взаимодействия электронного пучка с атомами образца.

Результаты: В статье представлены характеристики самолета-невидимки B-2, бомбившего СРЮ. Бомба JDAM представляет собой усовершенствованную обычную бомбу МК. Она оснащена электронным устройством спутниковой наводки. Полуколичественный анализ волокна был выполнен с помощью СЭМ и подтвердил, что металлический слой волокна преимущественно состоял из алюминия, а большая часть состава неметаллического слоя состояла из диоксида кремния. Соответственно волокна обладали высокой канцерогенной активностью.

Выводы: В 1999 году территория Союзной Республики Югославия являлась полигоном для испытаний новых боевых средств авиации НАТО − B-2 и управляемой бомбы JDAM с наводкой. Бомбы затемнения были сброшены на электростанции и системы

электроснабжения Союзной Республики Югославии, в результате чего вся Сербия оставалась без света по нескольку часов. В результате бомбардировок окружающая среда была подвергнута радиоактивному, химическому загрязнению, а также загрязнению от электропроводящих волокон стекла и алюминия.

Ключевые слова: иск, самолет-невидимка Б-2, проникающие бомбы JDAM, бомбы затемнения, электропроводящие волокна, загрязнение окружающей среды.

Агресија НАТО-а на СРЈ 1999. године: провера ефикасности нових борбених средстава

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ОБЛАСТ: хемијске технологије
КАТЕГОРИЈА (ТИП) ЧЛАНКА: оригинални научни рад

Сажетак:

Увод/циљ: У време бомбардовања Републике Србије 1999. године, НАТО је користио три нова борбена средства, која су тада први пут испитана. Прво средство је стратешки невидљиви бомбардер Б-2, друго су нове разорне бомбе JDAM (Joint Direct Attack Munition) и, треће, „меке бомбе", или бомбе за замрачивање, од електропроводљивих танких влакана. Циљ рада јесте да се прикажу ова борбена средства и да се квантитативно детектују елементи електропроводљивих влакана. У раду је представљена и тужба Савезне Републике Југославије (СРЈ) Међународном кривичном суду за бившу Југославију (МКСЈ) у Хагу. Тужба је одбијена.

Методе: Извршене су физичке и хемијске анализе влакана. За анализу физичко-хемијских карактеристика електропровидљивих влакана коришћен је електронски микроскоп SEM JSM Jeol 6610LV. Он омогућава добијање информације о морфологији површине узорака, при чему се добија слика високе резолуције. Микроскоп је опремљен детектором X-зрака (Oxford Instrumets X-Max 20 mm^2) за EDS анализу (Energy Dispersive Spectroscopy). Такође, омогућава да се одреди хемијски састав материјала у анализираној запремини узорка, на основу интеракције усмереног електронског снопа и атома узорка.

Резултати: Приказане су карактеристике стелт авиона Б-2 који је бомбардовао СРЈ. Бомба ЈДАМ је усавршена обична бомба МК којој *су додати електронски уређаји који је воде преко сателита. Семи-квантитативна анлиза влакана урађена је на SEM и потврдила да се метални слој влакна доминантно састоји од алуминијума, а да неметални слој има највећи удео силицијум-диоксида. Влакна су канцерогена.*

Закључак: Територија СР Југославије је 1999. године била полигон за испитивање нових борбених средстава НАТО авиона Б-2 и вођене бомбе ЈДАМ. Бомбе за замрачивање бацане су на електро-системе СР Југославије и остављале целу Србију више часова у мраку. Животна средина контаминирана је радиолошки, хемијски и стакло-алуминијумским електропроводљивим влакнима.

Кључне речи: тужба, стелт авион Б-2, пробојне бомбе ЈДАМ, бомбе за замрачивање, електропроводљива влакна, загађење животне средине.

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