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The current state of research and development of electromagnetic weapons

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This article aims to discuss about the current situation of electromagnetic weapons, and their development, and research in the world. Electromagnetic weapons generate directed high-power electromagnetic signals that are actuating for some time on the specified device enemy, which causing distortion or total outage of electronic circuits. Electromagnetic weapons aren't still the basis of military weapons arsenal, but their use in practice is becoming more frequent.

I. Introduction

At the present time begin the armies of some developed countries to dispose of weapons whose principle is fundamentally different from conventional mechanisms with dust cartridges and solid projectiles. This type of weapons is known as electromagnetic weapons. Energy generated by weapons have harmful or destructive effect to the target without use of solid projectiles. The base is to eliminate strategic or all enemy equipment, which causing his paralysis in important situations. Presently there are a large number of electromagnetic weapons, but their deployment to military armament is still relatively slow. Despite it, the electromagnetic weapons are referred as weapons systems of the 21st century. [1]

Among the most famous electromagnetic weapons include so-called Directed Energy Weapons (DEWs), which use microwave technology with high-power (HPM). EM DEW generates an electromagnetic field, which negatively affects all electronic equipment. So originate e.g. discharging or liquidation of certain electronic components, which can cause temporary or total decommissioning the facility. Electromagnetic weapons don't have effect on the health or life, but they may have psychological consequences. An example might be an incident at April 2014, when the unarmed bomber SU-24 Russian Air Force do several times "air raid" around the US destroyer USS Donald Cook. After this incident asked the 27 crew members for release from service. Donald Cook is one of the most modern destroyers of the US Navy, which has great maneuverability and is designed for use in combating of submarines, ships and air targets or the escort and defense of convoy watercraft.

On board of the destroyer are two sixbarrel-Phalanx CIWS (Close-In Weapon System) and approximately 74 missiles RIM-66 SM-2. While SU-24 isn't the most modern

aircraft of Russian Air Force and thereto hadn't any weapons. Therefore arises the question, why did the 27 crew members decide to leave the service? About the reasons the sailors decision, as well as about the incident, we can only speculate, because there aren't any credible official statement. But speculates that the reason has name Khibiny. Mysterious Khibiny, which has name as per mountains on the Kola Peninsula, is a project radio-electronic warfare of the Russian government to paralyze the enemy. We can assume that the Russian bomber with Khibiny in overflights of the US destroyer eliminated all the equipment on the boat, which made from the crew members only observers of the situation. The situation hadn't changed crew solicitude of re-commissioning the systems, which again triggered after the departure SU-24th. [9]

The United States dedicate to the development and research of electromagnetic weapons currently. They have already tested some of them. The Counter-electronics High-powered Microwave Advanced Missile Project (CHAMP) is one of electromagnetic weapons, which US did successfully test in 2012. The company Boeing leads CHAMP program, together with Raytheon and the Air Force Research Laboratory. The first test was in the desert in western Utah. Heavy bomber B-52 launched the missile on the building, without a destruction effect. The CHAMP strucked the object with a disruptive high-frequency microwaves. A television camera mounted in the target building showed screens of desktop computers. When CHAMP activated a microwave emitter, the computers went dark and, then, so did the camera monitoring the test. This technology may disable enemy's electronic and data systems before the first troops or aircraft arrive. The CHAMP began as reaction on Israel's air strike on Syria in 2007. Israel apparently used same electromagnetic weapons to shut down Syrian air defenses. [10]

Russian-american incident is an illustrative proof that the role of electromagnetic weapons becomes crucial in combat situations. EM DEWs can assure in fight a victory and minimize the loss of human lives. Electromagnetic weapons include devices and systems that use technology generating direct electromagnetic pulses that cause invasion of the correct function or total destruction of the enemy's electronic circuit devices. This method disrupts or completely disables the operation of information, communication, control, weapons and other electronic systems. Currently are electromagnetic weapons used and states realise perspectives for their further development. [2]

II. Electromagnetic Weapons

Electromagnetic weapons are used electromagnetic field which harmful acts on all electronic devices in its surroundings. Their uniqueness stem from the fact that in addition to physical effects have even psychological effects. Nothing frighten man more than their own vulnerability. Typical representative of electromagnetic weapons are directed-energy weapons (DEWs). EM DEW includes pulsed power source, the radiation source and antenna. The pulse source creates a high-power electrical pulse that takes several nanoseconds. The resulting pulse affects the radiation source through the diode and the result is a beam of electrons. Then is the beam radiated through the antenna. [6] Electromagnetic directed-energy weapons are a term that encompasses technology producing beams of electromagnetic energy or atomic or

subatomic particles. EM DEW is a system designed as an appliabce to eliminate or complete outage of enemy equipment.

III. Classification of electromagnetic weapons

In this section are classified and described most of the electromagnetic directed-energy weapons.

A. Directed Energy Weapons Lasers (DEWL)

DEWL is a one of most famous energy weapon in present. The basis is compelled emission of light, which is amplified by integrated components and then concentrate into a narrow beam. Laser is quantum energy generator, which is operating in the visible and infrared range of the electromagnetic spectrum. Radiation is monochromatic and coherent with exiguous traces of own signal noise. The beam is easy to focus on large distances with high-speed (cca. the speed of light), and also is used for information transmission. The first attempts to create laser weapons in the military domain were enregistered in the late 60s. It belongs to the most important scientific-research programs of the armed forces since then. Energiser transmits energy to the active medium, which excites electrons in higher levels. This manner excites majority of electrons in the higher level which causes uneven manning of energy levels by the particles (population inversion).

The emissions of energy in the form of photons are generated by the reversing transfer of electrons from higher energy levels to lower. This causes the interaction between photons and electrons of inverted population, giving rise to the stimulated emission of photons, which have the same phase and frequency. The active medium is placed in a resonator which is formed by mirrors, which causes reflections of photons and their passage through the medium. It supports the stimulated emission, causing amplification of photon flux. Finally the beam comes through the semipermeable mirror. Individual types of lasers used different active medium. There are for example solid-phase lasers, gas lasers, with optical fiber, with free-electron, etc. [5] Classification of lasers by using:

- a, Lasers with power up to kW: This lasers are called “dazzlers” and they are designed for temporary outage of humans or damage to optical devices. They can be used to destroy of explosives. For example: blinding gun PHASR (Personnel Halting and Stimulation Response) developed by the US Air Force. Israeli laser weapon Rafael Thor or American ZEUS are working with the same performance.
- b, Lasers with power from tens to hundreds of kW: This lasers are designed for destruction of airborne targets (missiles and low-flying aircraft). For example: THEL (Tactical High Energy Laser) and its modifications MTHEL (ie. Mobile THEL) and HELRAM (High Energy Laser for Rockets, Artillery and Mortars). ATL (Advanced Tactical Laser) – US military project, which is installed in the aircraft class C-130 Hercules. SSHEL (Solid State High Energy Laser) – US Army program. Installed in gunship class F-35, for ensuring the defense.
- c, Lasers with power in MW: These powerful lasers have the same use as in the previous case. Weapons systems of this type are from the US, respectively Russian military programs. For example: MIRACL (Mid-Infrared Advanced Chemical Laser Red) – is one

of the most powerful chemical laser in the world. Chemical element is deuterium fluoride, which the energy divides on 10 beam with a width of cca. 3.6 to 4.2 microns. ABL (Airborne Laser) – weapon system installed in the aircraft. Chemical laser-based oxygen-iodine.

B. Particle Beam Weapons (PBW)

The second category of EM DEWs are the particle beam weapons. This type of EM DEW has a different form of energy emanation. The principle is a accelerating a certain numbers of atoms or other subatomic energy particles (electrons, protons and hydrogen atoms). The speed should get of the speed of light and then regulate to the beam with a very high energy. The total energy is dependent on the size of kinetic energy, which is specified by the speed and quantities of moving particles in the beam. The proton, which is the basis of the hydrogen atom, is approximately 2000 times greater than the weight of an orbiting electron. We can say, that the particle beam weapons are equivalent of the lightning. The electric field in lightning is about 500 000 V / m, which is less than is required for PBW. However the number of electrons in lightning is higher, but the destructive effects are similar. The beam energy is stored in target's material, after the beam of particles is shot from PBW. Energy of particle beam passes to the particles in the target material and it causes a rapid increase in temperature. This effect causes the destruction of the target. [4] In the PWB group are also plasma weapons, which are best known representatives PWB currently. In this group include for example:

- electrolasers – similarity to the classic taser. Electrolaser creates through the weak laser beam a plasma channel. A strong electric current passes by this plasma channel and it can numbed an enemy or detonate explosive system.
- PASS (Plasma Acoustic Shield System) – rays creates a bubble that after the "rupture" gives an acoustic effect, respectively pressure wave.

C. Directed Energy Weapons – Radio Frequency (DEWRF), Microwave (DEWM)

DEWRF and DEWM are weapons operating in the radio waves and microwaves. Both types of weapons are similar, they differ only part of the electromagnetic spectrum in which they work. The generator sends out radio waves that are targeted through the antenna on a particular object. Electromagnetic energy is in band radio wave; therefore it isn't visible to the human eye, as in previous cases. DEWRF and DEWM operate in the frequency band from Hz to GHz, which can be used against humans or technology. Effect of high-frequency weapons on the human body is still studied, but doctors believe they are harmless. Scientists have mainly studied thermal effects of high frequency weapons. High-frequency electromagnetic wave radiation can distort the brain and nervous system, according to setting the carrier frequency and power, which numbed human. The individual effects of high frequency weapons on humans are different. These may be:

- perception of disorder,
- tiredness,
- doziness,
- disconcertedness and stress

- hunger or dipsesis,
- changes in temperature,
- pains, etc.

The scientists discover that humans perceive the effects of DEWM (DEWRF) as unbearably painful feelings of intense noise and whistling, which accompany the anxiety and nausea depending on the specific conditions and parameters of the signal. Compared to optical frequency weapons, but don't require direct visibility. Radio waves passing by some natural obstacles. [5] Another reason for the development of high frequency weapons is their effect on technical devices. DEWRF and DEWM generate very intense electromagnetic field (usually a pulse), which has the ability to temporarily or permanently inactivate object to which or in which it operates. This phenomenon is called electromagnetic pulse (EMP). The size of the electromagnetic field depends on the power produced. DEWM and DEWRF use, according to the bandwidth of the signal generated two classes of generators:

- High Power Microwave (HPM) – it create a harmonic signal mostly pulse-amplitude modulation.
- Ultra Wide Band (UWB) – it create a high-power pulse. DEWRF have the pulse duration is greater than 1 ns and DEWM have the pulse duration smaller than 1 ns. [3]

HPM sending the pulses of high power for individual frequencies. HPM is used in cases when we know the frequency of target. UWB sends pulses of low energy density in the wide frequency band. This method is used in cases when we do not know the frequency of targets. [6] Electromagnetic fields penetrate into the target objects in several ways, for example: filters, parasitic input channels or unscreened parts. The size of the power density is set to values, which there do not cause destruction of electronic components, but only their temporary outage. The semiconductor components (diodes, transistors, integrated circuits, etc.) are the most sensitive to electromagnetic pulse. DEWM or DEWRF created in recent years:

- ADS (Active Denial System) – a device is working with frequencies around 95 GHz, which act to people the pain. Higher frequencies have deadly effects. ADS has the purview only 0.7 km from the source. It used to disperse a demonstration.
- Ranets-E and Rosa-E – Russian systems for elimination of enemy devices. The difference between Ranets-E and Rosa-E is in position. The first one is installed in vehicles, the second is in aircrafts.
- Vigilant Eagle – American version of the previous systems.

IV. Research and development of the EM DEWs

The electromagnetic weapons are public for a few years, but information about their research and development is still a secret. The reason is clear, better weapons are assure better strategic position in the world. I want to describe the current situation of EM DEWs in the following lines. The greatest progress in research and development of electromagnetic weapons has in recent years mainly states such as Russia, USA and China. The development and research is in Europe still a secret. Other states are primarily concerned in the area of protection against the effects of HPM (High Power Microwave). The national defense ministries are the main factors in

this domain. The role has also private organizations, whose products are sold to individual states. The prices of the EM DEWs are less than the prices of other weapon systems with comparable parameters. The missiles costs hundreds of thousands of dollars, but a shot from EM DEW costs around hundreds of dollars. Electromagnetic weapons use projectiles without explosive charge, because they acts to the target only own kinetic energy. The consequence is to reduce of the problems associated with the storage and manipulation with the cartridges. The EM DEW can be installed almost anywhere and among other benefits include:

- fast effect,
- noninterference by the weather,
- minimal information about the characteristics of targets,
- affect hardly accessible targets,
- shorten the time tracking and navigation the forces, etc. [6]

V. Europe

European Defence Agency (EDA) dedicates the area of the EM DEWs in Europe, which was established by Council Joint Action 2004/551/CFSP in 12 July 2004. The main objective of the EDA is to promoting cooperation in research and development of the defense technology. EDA is the Managing Authority that works with Ministries of Defense, the Directors of militarization, research and development and the political directors. The mission of the European Defence Agency is to support the European Council and Member States in their efforts to improve the defense capabilities of the European Union (EU) in the area of crisis management and to support the Common Security and Defence Policy (CSDP). In the agency are all Member States except Denmark. EDA operates under the supervision of the European Council, which manages the work program and financial framework of the Agency. EDA develops mainly the DEWL, for example:

- AD-HELW (Air Defense High Energy Laser Weapon) – project created by eleven institutions of the Member States from Germany, France, Portugal and Poland. AD-HELW is intended to disposal of military targets (missile, ect.).
- NLOAS (Non-Lethal Optical and Acoustic Systems) – the concept focuses on optical and acoustic non-lethal weapons for land and marine environments. The concept defines of restraints in the use of acoustic and optical devices and it evaluates their tactical use. EDA created NLOAS at the end of last year. [13]

A. BAE Systems

The company is from Great Britain and currently is one of the biggest companies in the military domain in the world. The company arose from the 1999 and today is concerned a lot of military projects, including a railgun for the US Navy. BAE Systems thinks it is time to deploy the electromagnetic weapons in means of transport. Therefore BAE cooperated on the modification of armored personnel carrier M2 / M3 Bradley, which the US military ended in last years. BAE Systems continued finally on the project even after the end and presented idea of a technological demonstrator GCV on exhibition AUSA at last year. GCV is equipped by remote-controlled towers with DEWL.

B. The Federal Office of Bundeswehr Equipment, Information Technology and In-Service Support (BAAINBw)

The company develops technologies, mainly in domain of military protection. BAAINBw has two institutes, which study the electromagnetic weapon. The first institute is The Bundeswehr Research Institute for Protective Technologies and NBC Protection (WIS), and one of which things that analyze is the way of equipment protection against the electromagnetic interference. The second institute is the Bundeswehr Technical Center for Protective and Special Technologies (WTD 52), which study the weapons effect and protection against attacks (for example DEWs).

C. Rheinmetall Defense

The company is from Germany and it operates in international defence and security industry. European supplier of military technology which developed a powerful laser weapon. The weapon is an advanced air defense system, which has two versions. One of DEWL has two 5-kW laser modules and second weapon has 1-kW laser weapon module. The DEWL can be used against:

- terrorist threats,
- rockets, artillery and mortar rounds,
- an aircraft target, etc. [14]

D. Defence Science and Technology Laboratory

Defence Science and Technology Laboratory (DSTL) is Technological Institute of Britain's Defence Ministry. DSTL operates in the domain of science and technology for the defence and security of the UK. The Institute in cooperation with an unnamed company began by developing the project of DEWL in last year.

E. Military Technical Institute, s.e.

State enterprise realizes a projects and services for the Ministry of Defence of the Czech Republic, Police of the Czech Republic, Fire Rescue Service of the Czech Republic and other security agencies. Military Technical Institute operates in the domain of defense and security research and development (weapons, ammunition, ground vehicles, airborne aircraft equipment, etc.). Three sectors of Military Technical Institute are:

- Military Technical Institute of Air Force and Ground Based Air Defence (AFADMTI),
- Military Technical Institute of Armament and Ammunition (MTIAA),
- Military Technical Institute of Ground Forces (MTIGF).

Military Technical Institute worked on the project AUTONOM.

- AUTONOM – The objective was to analyze passive intelligent sensor, which informed about the situation on the battlefield. The sensor gave information on the dangers of using non-lethal weapons working with high-power EM fields. It determined the characteristics of the weapons and location the area of their use. Scientists did verification of the practical feasibility. The project ended in 2013. [5]

VI. The NATO Science and Technology Organization (STO)

The organization was created from the Research and Technology Organization (RTO) and the NATO Undersea Research Centre (NURC). The STO is a NATO organization, which includes a Science and Technology Board (STB), the Centre for Maritime Research and Experimentation (CMRE), the Office of the Chief Scientist (OCS), the Collaboration Support Office (CSO) and Scientific and Technical Committees. The mission of the STO is to help in science and technology in domain of the security and defence. Development and research are for the STO the investments in the future. In the projects of the STO are for example: [12]

1) Project SCI-119 (Tactical Implications of High Power Microwaves)

The project arose as a reaction to the development of high power microwave (HPM). HPM may disrupt the electronic systems over long distances. The scientists investigated the tactical implications of HPM, including theoretical, systems and operational aspects. The objective was getting knowledge for the NATO.

Topic of the project:

- sources and antennas HPM,
- a back-door of electronic components,
- EMP; lightning; modeling and simulation,
- protection measures,
- susceptibility testing,
- systems analysis,
- the threat of DEWM. [12]

2) SCI-177 (High Power Microwaves, Threat to Infrastructure and Military Equipment)

The project focused on the implications of HPM on the military and civilian infrastructure. SCI-177 concentrated on the creation of the aggregate, which compared the results of theoretical and experimental measurements. The result was a summary of protective measures to ensure the key components of NATO. It has defined the potential threats to critical infrastructure. The project ended 12 January 2007.

Topic of the project:

- threat to military and civilian infrastructure,
- susceptibility of military equipment,
- protection,
- propagation and penetration,
- test and valuation,
- implications for military operations. [12]

3) Project SCI-250 (Radio Frequency Directed Energy Weapons in Tactical Scenarios)

The project was studying the potential threat of HPM and their implications on military and civilian infrastructure and electronic equipment. The organization STO completed the project SCI-250 on 12 January 2014. The Member States provided suitable test facilities, technologies, etc.

Topic of the project:

- effects of DEWRF on tactical C4I (Command, Control, Communications, Computers, and Intelligence) systems and other critical military infrastructure,
- definition of use and constraints of DEWRF,
- RFW attack detection techniques,
- Tactical demonstration of DEWRF,
- DEWRF as non-lethal weapons,
- modeling and simulation,
- subsystem testing. [12]

4) SCI-272 (Flight Test Technical Team – FT3)

The base of the project builds on the work of his predecessors (SCI-055, 122, and 172). Program specifies developments in the domain of military and civilian aircraft and their techniques. SCI-272 tests the flight characteristics and aircraft systems.

Topic of the project:

- support of the development of concepts and systems critical to NATO’s technological and operational superiority,
- support of the educational opportunities,
- enable advancements in flight technologies,
- the vitality and continuity of the network of flight test experts within the NATO community,
- cooperation with operational parts of NATO. [12]

5) SCI-264 (High Energy Laser Weapons: Tactical Employment in the Shared Battlespace)

An aggregate of analytical tools, knowledge and techniques from the domain of DEWL, which is used for assessing the situation in the battle space in light of defense or attack. It based on project SCI-227 which expands as needed. SCI-264 was created last year and a completion is planned in 2017.

Topic of the project:

- tactical scenarios,
- identification and evaluation of risks,
- characterization of environment,
- susceptibility of the targets,
- characterization of DEWL,
- modeling and simulation. [12]

VII. United States of America

A. Joint Non-Lethal Weapons Directorate

1) U.S. Army

- ADT (Active Denial Technology) – EM DEW, which is designed to elimination of humans. The enemy has a sensation of increased temperature, after hitting, the effect is immediate. ADT is used eg. to disperse demonstrations.
- MFRFVS (Multi-Frequency Radio-Frequency Vehicle Stopper) – technology designed to stop the vehicle. MFRFVS system distort by high-power of microwaves an electronic components in vehicles. It causes the vehicle stop. The system must be self-contained and portable.
- RFVS (Radio-Frequency Vessel Stopper) – the principle is similar to the previous case. But RFVS is designed to liquidation of the electronic components vessels. [8]
- HEL MD (High Energy Laser Mobile Demonstrator) – another high-energy laser weapon, which was developed in collaboration with the company Boeing. HEL MD includes a mirrors, high-speed processors and optical sensors. [7]

2) U.S. Marine Corps

- OIS (Ocular Interruption System) – Green Beam Laser Systems, which can be mounted or can be as handheld equipment. Laser system allows interdiction of potential hostile actions in the area. It is also used to provide information to civilians about the ongoing military operations, light effects at a distance of 500m.
- DPT (Disable Point Target) – non-lethal weapons generate EMI, which cause on the human body. Human cannot control muscle movement. DPT will have an effect in range of 10 – 50 meters.

3) U.S. Navy

- Electromagnetic railguns – prototypes, which the U.S. Navy wants officially test in 2016. The railguns are still in development stage, but according to Admiral Matthew Klunder (project manager), everything goes according to plan. The U.S. Navy works with companies BAE Systems and General Atomics, each company develops different prototype. The railguns will have a 155 mm caliber and striking distance 200 km, it are unbeatable parameters of weapons. Railguns will shoot specially modified projectiles, which will be fired through the electromagnetic field. The projectile will fly out of the barrel Mach 7 (8400 km/h). The project has problems with the production and transmission of energy and life of railguns (just a few shots). Reason is a high speed projectile, because contact with atoms of air causes a “plucking” of electrons from atomic shell. This causes the creation of hot plasma, which deforms the material of the barrel. The railguns will be tested on aboard the transport ship USS Millinocket. [8]
- EMALS (Electromagnetic Aircraft Launch System) – electromagnetic aircraft catapult that will facilitate the start of heavy aircraft. This system will be installed on aircraft carrier. Company General Atomics developed EMALS for U.S. Navy as modern version of aircraft catapult in last years.
- ADAM (Area Defense Anti-Munitions) – another weapon system that is designed to destroy missiles, drones, small boats, etc. ADAM can an enemy objects detect within a distance of 5 km, but distance to their elimination must be less than 2 km. It can be applied as the stable guardian of objects. The American company Lockheed Martin

developed the system in last years.
- Company Northrop Grumman has been working on a similar system called LAWS for US Navy.

4) U.S. Air Force

- HELLADS (High Energy Liquid Laser Area Defense System) – is a high-energy laser weapon system, developed to eliminate the threats to-air (rockets, artillery). The American company General Atomics developed HELLADS to fight against multiple threats. The system will be first tested on static ground installations and later in the aircraft of the US Air Force.
- YAL – 1 (Airborne Laser Testbed) – a project known mainly under the former name ABL (Airborne Laser). It is a megawatt chemical oxygen-iodine laser (COIL). It is used in aircraft to destroy of tactical ballistic missiles and other hazardous moving targets. The company Boeing developed this project. [7]
- Grade High Power Fiber Laser – laser weapon, which is characterized by excellent beam quality of light. The reason is the combination of multiple fibers into one unique laser. The beam uses about the half of energy comparison to the others alternative lasers. Beams of different wavelengths travels to a combiner, which combine beams into a single beam. The project was successfully presented last year. The system is for all military platforms (aircraft, helicopters, ships and trucks). Company Lockheed Martin developed the laser.

B. U.S. Air Force Research Laboratory

- Virtual Prototyping of Directed Energy Weapons – directed-energy weapon can generation of electromagnetic radiation in three parts of the electromagnetic spectrum: microwave (attack on electronic components), millimeter (for active denial), sub-millimeter (for explosives, ect.). Scientists studied mainly HPM generation and transmission of energy to the target object. High Performance Computing (HPC) realized simulation of Radio-Frequency system on software of Air Force Office of Scientific Research (AFOSR). HPC is synonym for a supercomputer; it joins together the performance of multiple computers.

1) The Air Force Research Laboratory’s Directed Energy Directorate

Directed Energy Directorate develops DEWL, DEWM and other directed energy technologies for the U.S. Air Force. Projects of Directed Energy Directorate are for example:

- Vehicle Stopper Program – program developed for the United States Department of Defense. High power microwave has harmful effects on electronic components of vehicles. According to the selected frequency of microwave can create a serious disturbance in the vehicle.

2) Radiofrequency Radiation Branch (RHDR)

RHDR is department of Directed Energy Bioeffects Division, which belong to U.S. Air Force Research Laboratory. The objective of RHDR is minimizing negative impact of high-power microwave and ultrawide band of EM DEWs on health and safety. The

results of the development are included in the health and safety standards (STANAG 2345, etc.). [15]

C. Commission to Assess the Threat from High Altitude Electromagnetic Pulse

- STARFISH – it was a high-altitude nuclear test, which specified the effects of the blast and radiation in the environment. The project began in 1962.
- The U.S. Stockpile Stewardship Program – project, which studies the nuclear weapons without the use of underground nuclear tests.

VIII. Other States

A. Russia

1) Ministry of Defence of the Russian Federation

- Jammers – Russian project of electromagnetic pulse weapons. Ministry of Defence of the Russian Federation deployed the jammers to all military vehicles, but they are still in progress of modification currently. Detonation at a height of 200-300 meters can turn off all electronic devices at a distance of 3.5 km from the epicenter of the detonation. [11]
- Khibiny – secret Russian project about which is not much information. Khibiny is a Russian equipment of the radio-electronic warfare, which is designed for combat aircraft. On the basis of the aforementioned incident in April last year, it is possible to speculate that the project is finished and has been successfully tested. Khibiny is mounted under the wing of the combat aircrafts. The equipment disables all electronic components in area after activation (speculation: distances up to 3 km). [9]
- Gimalai – part of a new Russian fighter aircraft called Sukhoi T-50. Gimalai is product of the project of the radio-electronic warfare. The equipment is not intended to attack, but to defend. Gimalai includes a several active and passive optical and radar locators, which have a function so-called a “smart skin”. What does it mean? Gimalai ensures a smooth function of aircraft in the domain of electromagnetic interference (EMI). It detects and blocks any attempts to outage by the enemy or elimination correct functions of aircraft systems. [11]

2) Companies

Company KRET is a subsidiary company of Rostec. KRET developed the products and development of military and civilian radioelectronic devices. It is the leading Russian developer of fighter aircraft. KRET cooperated on the creation of equipment called Gimalai.

- Krasuha-4 – mobile system of radio-electronic warfare, which is used to suppression (interference) spy satellites, radars, etc. The equipment detects objects from 150 to 300 km and it can cause damages on electronic and communication systems of enemy. Krasuha generates strong interference at the fundamental frequency. [11]

B. China

1) Ministry of National Defense of the People’s Republic of China

- WB-1 – microwave weapon developed by the Chinese government to the elimination of live targets. The weapon has a large range, according to the Chinese company called Poly, it can hit a target at a distance of up to half a mile. Person has the feeling of intense pain after the intervention by the beam. The Chinese government plans to use WB-1 on Chinese battleships and military ground vehicles. [11]
- Shengang-IV – it is a high-power energy laser weapon, which develops the China's People's Liberation Army (PLA).

IX. Conclusion

I see an advantages of the paper in clarifying of the current situation of electromagnetic weapons, and and their future perspectives. Currently, electromagnetic weapons are still the weapons of the future. Electromagnetic Directed-energy weapons (EM DEWs) are used only in some situations, but their potential is undeniable. The all governments realize it because they invest funds in their development or research. Private companies help with innovation and development of new weapons in the domain of EM DEWs. The paper presents several countries and organizations that show the results. But most of the information about EM DEWs are still secret to the public. The greatest progress has mainly USA and Russia, which their products successful tested in recent years. Other states cooperate on the EM DEWs, or their weapons are secret. The most often developed types of EM DEWs are laser, radio-frequency and microwave weapons. States develops EM DEWs for:

- eliminate of the threats,
- destruction of enemy targets,
- tactical advantage.

European Union examines mainly increase the electromagnetic susceptibility of the electronic and electrical devices. Private companies engaged in the development EM DEWs for:

- increasing resistance of the techniques,
- non-war situation (demonstrations, etc.),
- the government sector.

Companies often work for the government sector, and they create electromagnetic weapons for military operations. In my opinion the radiofrequency or microwave weapons are more interesting. These weapons use sufficiently powerful generator, which ensure the passage of electromagnetic radiation through solid obstacles. This is not possible with laser weapons that are limited by the visibility of their targets. DEWL are designated primarily for the airborne vehicles. DEWRF or DEWM can be installed even in the ground vehicles, which can inconspicuously move in the field (not in all cases). EM DEWs are more preferable than the current military arsenal, because their ammo is cheaper.

The potential of EM DEWs is huge and their use could lead to disastrous consequences for the society, therefore we have to ask questions how terrorists can misuse EM DEWs weapons. A terrorist attack may produce secondary effects

(demonstrations, looting, etc.) and it may divert the attention of the armed forces. Therefore ensuring of adequate protection of the critical elements (critical infrastructure, navigation systems, etc.) is important. Navigation is important in aiming of targets, therefore the covering of their security is important. The best experts take care of the safety of navigation systems, even against EM DEWs.

The paradox is the fact, that the latest electronic equipment of the army is more susceptible to interference than the older electronic equipment. The strong focus is lay on increasing of the resilience of these electrical or electronic devices. Czech Republic contributes its activities in this domain. The solution may be a return to the older electronic equipment, but it is currently unthinkable. The EM DEWs are non-lethal weapons, which are developed for a "humane" war. But the war can never be humane, and EM DEWs are just faster and easier way to win the war.

References

1. VISINGR, Lukáš. Energy weapons. In: http://lvisingr.czweb.org/ [online]. 2010 [cit. 2015-01-27]. (in Czech) Available at: lvisingr.czweb.org/stazeni/atm/energeticke_zbrane.rtf
2. VALOUCH, Jan. Electromagnetic Compatibility – military implication and legislation. Defence and Strategy, 2004, Issue No 1, p.109-113. ISSN 1214-6463. (in Czech).
3. DRAŽAN, Libor. Electromagnetic weapons, the threat of industrial society. In: Trilobit [online]. 1.12.2013: University of Defence, Department of Radar Technology, 2013. Issue No 3/2013, ISSN 1804-1795. (in Czech). Available at: http://trilobit.fai.utb.cz/Data/Articles/PDF/1f7137a8-af34-4739-ad94-086ef73781b8.pdf
4. ROBERDS, Richard. Introducing the Particle-Beam Weapon. The Air and Space Power Journal [online]. 1984 [cit. 2015-01-30]. Available at: http://www.airpower.maxwell.af.mil/airchronicles/aureview/1984/jul-aug/roberds.html
5. URBANČÍK, Václav. Directed Energy Weapons as a potentional Threat to Electronic Systems. Zlín, 2013. Master's thesis. Tomas Bata University in Zlín, The Faculty of Applied Informatics. (in Czech).
6. VALOUCH, Jan. Electromagnetic Directed Energy Weapons as Means to Elimination Electronic Systems. Defence and Strategy, 2003, Issue No 1, p.109-113. ISSN 1214-6463. (in Czech).
7. High-Energy Lasers: New Advances in Defense Applications. Optics & Photonics News [online]. 2014 [cit. 2015-02-07]. Available at: http://www.osa-opn.org/home/articles/volume_25/october_2014/features/high-energy_lasers_new_advances_in_defense_applica
8. United States Department of Defense [online]. 2014 [cit. 2015-02-07]. Available at: http://www.defense.gov
9. [9] Actual news [online]. 2014 [cit. 2015-02-07]. (in Czech). Available at: www.aktualnizpravy.cz
10. New Air Force Missile Turns Out Lights With Raytheon Microwave Tech. Breaking Defense [online]. 2012 [cit. 2015-02-09]. Available at: http://breakingdefense.com/2012/10/new-air-force-missile-turns-out-lights-with-raytheon-microwave-t/
11. Militarybox [online]. 2009 [cit. 2015-02-09]. (in Czech). Available at: http://www.militarybox.cz/
12. STO – NATO Science & Technology Organization [online]. © 2015 [cit. 2015-02-10].

Available at:
http://www.cso.nato.int/
13. European Defence Agency [online]. © 2005-2014 [cit. 2015-02-10]. Available at: http://www.eda.europa.eu/
14. Military Advantage [online]. © 2015 [cit. 2015-02-11]. Available at: http://www.military.com
15. Directed Energy Bioeffects Division (RHD). In: Wright-Patterson Air Force Base [online]. 2004 [cit. 2015-02-12]. Available at: http://www.wpafb.af.mil/shared/media/document/AFD-070418-032.pdf
16. Report of the Commission to Assess the Treat to the United States from Electromagnetic Pulse (EMP) Attack – Critical National Infrastructures [online]. 2008 [cit. 2015-02-14]. ISBN 978-0-16-080927-9. Available at: http://www.empcommission.org/docs/A2473-EMP_Commission-7MB.pdf
17. Bundesamt für Ausrüstung, Informationstechnik und Nutzung der Bundeswehr [online]. 2014 [cit. 2015-02-14]. Available at: http://www.baainbw.de/portal/a/baain

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