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Counter-Material Non-lethal Weapons Technologies

Homeland Security Research Corp.

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1.1 Overview

The following table presents major non-lethal counter-materiel technologies.

Table 1 - NLW Counter-Material Technologies

Technology	Description
Special EM Interference	Family of devices to provide electronic interference effects.
Non-nuclear EMP	Device that duplicates the effects of nuclear electromagnetic pulse, disrupting electronics.
High-Voltage Shock	High-voltage generator to disrupt electronic systems.
Conductive Particles	Family of particles that short-circuits electronics when inserted.
Conductive Ribbons	Family of ribbons that short-circuits electronics when deployed over wires.
Radio Frequency	System that radiates a microwave burst, disabling electronics.
Optical Coatings	Family of materials that can be deposited on optical sensors or viewing ports to obscure vision.
Optical Munitions	Explosive/electric flash device to stun, dazzle, or temporarily blind optical sensors.
Engine Killers	Family of agents that disables or destroys engines.
Fuel Additives and Viscosifiers	Family of agents that cause fuel to solidify.
Bio-deterioration	Family of organic substances that corrode structural materials or fuels.
Super-corrosives& super-caustics	Family of substances that corrode structural materials such as metal.
Filter Cloggers	Family of airborne agents that clog air filters when ingested in engines.
Material Embrittlement	Family of substances that cause materials to quickly disintegrate or break down molecular bonding.
Adhesives and Abrasives	Substances that adhere to the surfaces of moving parts of machinery to damage them/prevent normal function.
Anti-Traction	Family of substances that cause lack of traction.
Entanglers	Family of nets, meshes, and the like to ensnare vehicles.
Soil Destabilization	Family of substances that cause soil to become soft or unstable, thus unusable by vehicles.
Tire Attack	Family of methods to destroy the tire/wheels of vehicles.
Combustible Dispersants	Family of substances that ignite when subject to pressure from vehicles passing over.
Obscurants	Family of smoke-like agents to obscure visual or electronic observation.

1.2 Electromagnetic Technologies

1.2.1 Radio Frequency (RF) NLW Devices

a) Principles and System Description

The threat from electromagnetic pulses (EMP) generated in connection with nuclear explosions has been well-known since the first tests of nuclear weapons in the atmosphere. Radio frequency (RF) weapons based on frequencies in the 10 MHz to 100 GHz range can cause similar effects using high-power generators connected to a suited antenna. They produce a burst of energy which damages the components of electronic systems or disrupts their operation.

Radio frequencies can be envisaged to produce the electromagnetic equivalent of spike strips and to disrupt electronic equipment.

These systems may be recurrent in operation (the effect can be repeated) or single-shot. The energy required to operate these systems may be stored in electrical form (in batteries or produced in generators), in chemical form (as explosives) or in piezoelectric devices. The systems may be fixed or portable (ground, sea, air) and delivered by (un)manned means.

The emitted wave can have various characteristics:

Pulsed or continuous.

Narrowband or broadband.

• Mean and peak power.

• Wave form.

• Pulse repetition rate (there may only be one pulse).

• Pulse duration and frequency.

Typical purposes of RF devices are the neutralization of enemy weapon systems, military equipment, infrastructure and facilities by destroying their electronic components without the use of lethal munitions.

The future RF weapon systems could be divided into different system sizes. Smaller systems may be delivered by projectiles, the effects being initiated by a separate power source like batteries, explosives or piezo elements. More effective systems can be installed inside bigger platforms like ground vehicles, glide bombs, UAV and other airborne systems. They can act repetitively, and cover a wide area eventually over a long time.

High priority will be given to man portable RF systems for easy, covert and fast use to act against control, communication, surveillance, alarm and radio controlled systems off the shelves. This technology allows to act against crowd

leaders by taking away their ability to spread information into the crowd (e.g. by radio or cell phone).

RF Sources can be used in urban terrain to increase protection against radio controlled bombs or to stop vehicles breaking through simple road barriers. The RF Sources can be vehicle mounted or be integrated in easy and fast set up street barriers. Energy supplies can be simple generators or rechargeable battery systems.

The target range for RF devices will be the range of the used carrier platform. This goes from several hundred meters for ballistic projectiles up to several hundred kilometers for UAVs / cruise missiles.

The effective range of the RF effect is limited by the available volume and payload inside the platform (projectile, mortar munitions, portable device, vehicle, artillery rocket, UAV, etc.). The expectation in 2020 is for a man portable device against unprotected COTS equipment of about 50 m to 500 m. For a vehicle mounted long range RF weapon against remote controlled flying objects, an effective range of 5 km to 25 km is expected. The affected area can vary from a few m^2 up to several thousand m^2 depending on the beam-pattern and the related range to the target of the RF device.

The delivery accuracy for the carrier platforms should be within the effective range of the RF payload.

In order to protect facilities and high value equipment, ground based long range RF sources will be capable of acting against flying threats in the range of small radio controlled planes up to intelligent missile systems.

The onset time for RF devices is typically below 1 second. The required radiation time depends on the desired effect on the target. For causing disruption without any long term destruction at the target, it may be necessary to radiate as long as the target has to be disrupted. For long lasting destruction of electronic components of the target, a short radiation time (less than 1 second) with high energy is sufficient. In the latter case, usually the target system has to be repaired by replacement of damaged electronic components.

b) Advantages and Disadvantages

RF weapons can be used for covert operations independent of weather conditions. In comparison with laser weapons, (see following paragraph) the effectiveness of RF weapons is relatively independent of weather conditions and can propagate into buildings and shelters without being within line of sight.

When employed against targets, the weapon will be more effective when used with the more modern technology of the target. Nevertheless, although these weapons are suitable for use against ground and naval vehicles, their effect may be lethal against air targets.

Their “dispersion” may also cause undesirable disruption to other equipments which are not the target (communication networks, television systems etc). The actual impact in a given situation may be uncertain unless the basic vulnerabilities of the target are known.

The long-term physiological effect of the waves received by an individual near or inside targets (such as vehicles) or by those operating the weapon (effect of side-lobes) are still under study and could be an obstacle to the use of radio frequencies for non-lethal weapons. However, the field levels required to destroy/disrupt electronic equipments are usually already below the actual legal limit for human exposure to pulsed RF radiation. Additionally, this is only a single short-time irradiation.

The countermeasure for RF Sources is to shield the targets against electromagnetic influences, while it is quite difficult to shield systems with communication capabilities. It requires long vulnerability investigations and complex shielding technologies. This will lead to very high development costs and hence Commercial Off The Shelf (COTS) will most probably not be shielded in the future.

1.2.2 Laser

a) Principles and System Description

Lasers are sources of coherent monochromatic light. They can be used to “blind”, damage or destroy certain systems including optical systems at which they are aimed (fire control systems, sighting systems, night vision goggles etc). The most powerful lasers such as the American airborne advanced tactical laser (ATL) destroy their targets by heating.

The future high-power infrared laser weapon system can destroy different structures. The main purpose is the destruction of weapons (missiles), military equipment (UAV, ground robots, electrical distribution equipment). A destruction effect means localized fusion and/or vaporization of the exposed part of the target. This laser weapon can be mounted on a vehicle (ground, air, sea). The time of onset of action is short (below 1 second by assuming that the beam is pre-pointed in the right direction). The duration of the effect can be controlled.

The target range can reach 5 km.

Another kind of laser can be used for more limited actions on materials : the femtosecond laser can puncture for instance inflatable boats. In the future, it should be man-portable and require less energy than the previous one.

Anti-material dazzling laser is another application in order to jam different optronic devices. This kind of laser requires lesser energy than high-power laser and femtosecond laser.

b) Advantages and Disadvantages

The advantages of using lasers for destruction or puncture is that the effect is very accurate with no collateral damage. Moreover, the temperature induced by the high-power infrared laser is very important and it can result in the annihilation of a chemical or biological substance.

Compared to a classical gun, the advantage of the femtosecond laser and the dazzling laser is the possibility to graduate the energy and to be more discrete (no detonation).

These laser performances are dependent on weather or dust conditions. There are possible countermeasures depending on future materials. Adjusting the emissions correctly is very important as excessive powers may cause serious damage, above all to the crew of the target platform.

1.3 Chemical Technologies

1.3.1 Chemical Agents

a) Principles and System Description

Chemical agents may be used to immobilize vehicles. They act on the tires, the optics and sensors (windscreen, video lenses, mirrors etc), the engine and the fuel. For example, the following means of action may be mentioned:

- The tires: glue, solvents, oxidants etc.
- The petrol: gelling agents, non-combustion additives.
- The optics: pacifiers.
- The engine: gelling agent for the lubricants and gases prevent combustion of fuel in the engines.

Chemical agents may also destroy equipment and deny access to areas and buildings. Supercaustic substances/liquid metal embrittlement (LME) chemicals have the ability to dissolve metals, plastics, rubber, glass, etc.

The use of all chemical agents must be properly controlled to limit their effects on the environment, toxic action on people and indirect consequences of their use against vehicles moving at high speed for instance. Before the use of those technologies, it's necessary to make sure that all the chemical constituents used in every agent are authorized by the international conventions.

Chemicals can be delivered by pressured containers, encapsulated droplets, or by direct contact (pouring, painting).

b) Advantages and Disadvantages

Must involve direct contact. They can have serious effects on personnel, transport or storage materials and the environment. Precaution must be exercised as chemicals may be lethal to personnel. Countermeasures are unlikely even in the 2020 timeframe.

1.3.2 Slippery Foams

a) Principles and System Description

Their purpose is to prevent vehicles from moving by limiting contact with surface terrain. Agents decrease functional to near zero.

b) Advantages and Disadvantages

Preserve equipment and infrastructure. Their effectiveness depends on weather conditions.

1.3.3 Sticky Foams

a) Principles and System Description

Condensed polymer foams are intended to hinder the movement of vehicles or to immobilize them.

b) Advantages and Disadvantages

Preserve equipment and infrastructure.
Inhalation of or contact with these foams can have serious health consequences.
Cleaning may be difficult and lengthy, and the non-toxicity of the solvents is not proven at present.

1.3.4 Super-Adhesive Substances

a) Principles and System Description

Like foams, these substances are intended to hinder the movement of vehicles or to immobilize them completely.

b) Advantages and Disadvantages

Preserve equipment and infrastructure.

Inhalation of or (eye-) contact with these chemical agents can have serious health consequences.

Cleaning may be difficult and lengthy and the non-toxicity of the solvents is not proven at present.

1.3.5 Super-Caustic Substances/Liquid Metal Embrittlement

a) Principles and System Description

These chemical agents have the ability to dissolve metals, plastics, rubber, glass etc. Embrittlement is a loss of ductility of a material, making it brittle.

b) Advantages and Disadvantages

They can have serious effects on people and the environment.

1.3.6 Graphite Powders

a) Principles and System Description

Carbon or graphite powders can be used to put electrical systems/installations out of action by creating short circuits.

b) Advantages and Disadvantages

Inhaling these powders can have serious consequences in people.

1.4 Biological Technologies

a) Principles and System Description

Microbial agents (enzymes, bacteria) may be used to immobilize vehicles, inactivate equipment with rubber or plastic parts, or destroying storages. The specific targets could be rubber, plastic and other petroleum products. The function of the targets would be compromised or destroyed.

The material is easily portable in small amounts and delivers a large effect over time. Covert action of effect on target is possible.

There are environmental restrictions on portability. Potential difficulties exist in limiting specificity to the enemy target. Biological and environmental hazard of mutation to alternate forms is possible.

It is difficult to identify the existence of bacteria as the NL-technology. Once identified, stopping the process is possible.

1.5 Mechanical Technologies

1.5.1 Rapid Barriers

a) Principles and System Description

A passive means of traffic management could be achieved by the deployment of appropriate rapid barrier technology.

Control may be achieved via fast rising portable, telescopic cylinders between which nets or similar constructions, airbags or plastic films could be suspended. The system could be fixed to protect permanent assets.

b) Advantages and Disadvantages

The barrier system is seen as an excellent means of deterring the passage of light or soft skinned vehicles and would be an appropriate means of rapidly erecting a manned barricade. The effectiveness against a determined force equipped with tracked or heavy vehicles is considered to be limited. The system is transported in a light truck and could be deployed within minutes of arrival at the required site.

1.5.2 Nets & Entanglement Techniques

a) Principles and System Description

The arresting of moving cars and trucks vehicles may be achieved by entanglement of the running gear.

This may be achieved via the deployment of wires or fibers and there are several available systems in existence which work in this way.

Micro wires are thin steel wires compacted under tension. When deployed, the wires expand to assume pre-determined geometric shapes formed from a tangle of the wire itself. Expansion ratios of 1:6000 are achievable. When deployed, the devices could be used to prevent access by vehicles to designated areas.

The X-net system works by using wires across the path of an oncoming vehicle to entangle the wheels and axles. The system is seen as an alternative to the use of Caltrops or the spike strip.

The Portable Vehicle Arresting Barrier (PVAB) device is designed to arrest a light truck or similar vehicle travelling at a speed of around 70 kmph and bring it to a halt in about 30 to 40 meters. The net wraps around the vehicles holding the doors closed. Once in place, normal traffic flow is permitted until it is activated. The device can be activated in less than 2 seconds. When the device is

activated, two masts are pneumatically raised stretching an elastic barrier between them.

b) Advantages and Disadvantages

The PVAB system is cumbersome to deploy (about 2 hours from arrival). The X-net represents a much more rapid and more easily deployed system. Entanglement systems also represent a significant advantage in that the driver can maintain some form of control over the vehicle. This is not possible after rapid deflation of the tires when using Caltrops or similar devices.

Micro wires represent a means of erecting an impenetrable barrier to deny access to an area or building.

The technology could be extended to provide propeller entanglement to stop small boats and patrol crafts if the system could be deployed just below the surface. A further extension of the technology could be to ensnare the rotor blades and tail rotors of helicopters on the ground.

1.5.3 Tire Puncturing Techniques

a) Principles and System Description

The use of the hollow tube spike strip or "stinger" device is well known and is readily available for use for today's forces. Caltrop devices are also well known and represent proven technology for stopping vehicles.

Caltrops are pyramidal spikes that are scattered onto the road in order to deflate the tires of oncoming vehicles. The spike strip is an extension of this technology where the tires are deflated by hollow tubes which puncture the tires and allow steady deflation.

b) Advantages and Disadvantages

Neither the Caltrops nor spike strips are effective against tracked vehicles. The control aspect has been discussed in an earlier paragraph.

(**Source**: NATO)

More information can be found at:

Non-Lethal Weapons (NLW): Industry, Technologies & Global Market – 2014-2020