

NLT and their Human Effects – Organisation and Terminology

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- The opinions expressed in this paper are those of the author and should not be interpreted as an official position of any part of the North Atlantic Treaty Organization or the German Department of Defence, or Government.
- The sources used in this paper are to be found in the original presentation at RTO-TR-HFM-073: The Final Report of NATO RTO HFM-073, www.rta.nato.int.

1. The **wide spectrum of techniques** that may be used and the **variety of situations** make it very difficult to predict all possible **medical effects** of Non-Lethal Technologies. It seems fair to assume, that medical effects of NLW in general, must be mild compared to the lethal alternatives.

3. Slide Relationship between SAS 35 and HFM 73

As already was pointed out, there were different national groups and NATO RTO Panels working on Non-Lethal Technologies/Weapons:

- SAS 035 “Measures of Effectiveness of Non-Lethal Weapons”,
- HFM 073 “Human Effects of Non-Lethal Weapons” and
- SAS 40 “Non-Lethal Technologies in the Future” - Long-term scientific study

While reading the specific papers of the different groups and during combined sessions it became clear that there was an urgent need for definitions and fixed but commonly agreed terminology. Otherwise Babylonian confusion of language and understanding would have persisted.

4. Slide Definition and limits

DEFINITION, according to NATO's definition:

Non-lethal weapons are weapons which are specifically designed and developed to:

- incapacitate or repel personnel, with a low probability of fatality or permanent injury;
- disable equipment, with minimal undesired damage or impact on the environment.

and LIMITS

The NATO policy on NLW (1999), stipulates that:

- NLW do not always prevent fatalities or injuries;
- NLW complement the use of lethal weapons: They are not and should not be considered replacements.

2. **Annex G** NLT and their Human Effects (The Final Report of NATO RTO HFM-073, www.rta.nato.int) therefore describes technologies are being used or are being proposed for use for non-lethal applications. Specific weapon systems are not addressed, except for a few examples.

5. Slide NLW Technologies and their Desired and Possible Undesired Human Effects

I will guide you through this paper always having in mind the desired and undesired possible effects on the human being exposed.

6. Slide NLW Technologies showing part of the agenda

7. Slide NLW Technologies Animals

1. **Animals:** Both contemporaneously and historically, animals have been used in combat and law enforcement. Dogs, horses and dolphins are well known examples. In the future, other species may be employed for non-lethal applications. Insects (e.g., bees) have been proposed. The variable sensitivity of the human population to insect stings could be a medical issue.

8. Slide NLW Technologies Physical Devices

2. **Physical Devices:** Barriers (e.g. fences), entanglement material (e.g., nets), restraints (e.g., handcuffs) designed to deny access, restrict human movement, or prevent escape. Such devices may have a number of secondary undesired effects, such as people being trampled or crushed against a fence by an advancing crowd, or being forced into a position that is incompatible with adequate breathing (positional asphyxia).

a. **Caltrops:** A vehicular barrier device with four projecting spikes so arranged that when three of the spikes are on the ground, the fourth one points upward. Caltrops were used by the ancient Romans to thwart the advance of cavalry.

b. **Entanglements:** Net or rope containing devices intended to impede or stop vehicles or vessels by entangling the wheels or running gear. They can be deployed by a launcher or by other explosive devices.

c. **Microwire Obstacles:** Thin steel wires compacted under tension. When deployed the wires expand to assume predetermined geometric shapes formed from a tangle of the wire itself. Expansion ratios of 1:6000 are achievable. The devices could be used to prevent access by vehicles or by personnel to designated areas. Micro wires represent a means of erecting an impenetrable barrier to deny access to an area or building. Sharp edges could lead to cuts.

d. **Portable Vehicle Arresting Barrier:** A device with a pop-up net deployed across a road that can stop a heavy, rapidly travelling vehicle within a short distance. Human safety issues include the effects of rapid deceleration.

e. **Instant Barriers:** Rapidly deployed barriers, e.g., pre-emplaced nets, fences, or gates that emerge, rise, or descend when needed. Conceivably, automobile air bag technology could be extended to produce a barrier for persons or vehicles.

f. **Spiked Strip Barrier:** A flat strip that resembles a fire hose, with retractable hollow spikes that are designed to flatten the tires of a target automobile. When the strip is activated, hollow spikes extend vertically and puncture the tires as they roll over the strip.

9. Slide NLW Technologies Acoustic Devices

- 3. Acoustic Devices:** Weapons utilizing acoustic energy to induce human effects through the sense of hearing or through the direct impact of pressure waves on other parts of the human body. A large variety of acoustic devices have been proposed for non-lethal applications. Most are of uncertain effectiveness and many could damage hearing.
- a. **Audible Acoustic Weapons:** Weapons utilizing acoustic energy that can be heard by the human target and have their effect through the sense of hearing. Some intended effects of such weapons are to irritate, distract, divert, repel, disperse, and general sensory overload. Such weapons may also be used to communicate, inform, or confuse an adversary as well as to disrupt communication. Other effects that have been claimed include the induction of giddiness, nausea, fainting, and loss of equilibrium. Acoustic energy may be combined with other stimuli to enhance the effects of both. Examples include “flash bang weapons,” in which an acoustic stimulus is combined with light, and the “whistling baton” in which a wooden round is designed to produce a loud whistling sound in addition to a kinetic impact. Methods have been proposed that may allow the delivery of acoustic energy to highly specific locations. A possible undesired effect of loud acoustic weapons is damage to the sense of hearing.
 - b. **Inaudible Acoustic Weapons:** Acoustic weapons that cannot be heard, but have their impact through direct coupling of the acoustic energy pressure waves with the human body. Generally, these fall into two categories, infrasound and ultrasound.
 - c. **Infrasound:** Very low-frequency sound that can travel a long distance and easily penetrate most buildings and vehicles. There have been claims that infrasound can create such human effects as nausea, loss of bowel control, disorientation, vomiting, internal organ damage, and even death. Experimental research has not confirmed such effects at intensities that are practical for use in non-lethal applications.
 - d. **Ultrasound:** Acoustic energy at frequencies above the audible range for human hearing, nominally above 20 kilohertz. There have been proposals that two ultrasonic beams could be combined to produce audible frequencies and that other directed energy sources could be used to produce ultrasound at the surface of the body, perhaps inducing discomfort or pain.
 - e. **Infrapulse Generator (Vortex Generator):** A device under development that produces an acoustic noise, pulsing shock waves and vortices, and may be used as carriers for irritants. Current devices produce a vortex that travels at approximately 30 to 50m per second with an effective range is about 60m. It is proposed for crowd control.

10. Slide NLW Technologies Multi-Sensory Devices

- 4. Multi-Sensory Devices:** Devices that affect more than one sensory modality simultaneously, e.g., the visual and auditory senses. There is an expectation that the effects will be at least additive and, perhaps, synergistic. Sensory overload is a possibility, leading to confusion and indecisiveness.
- a. **Flash Bang Grenade:** An acoustic & optical diversionary device, usually hand thrown, which emits a loud bang and a dazzling light when activated. The device is designed to create a sensory overload, which temporarily causes confusion, distraction, and an inability to effectively respond to a tactical team’s actions.
 - b. **Multi-Sensory Distraction Device:** A device that contains a combination of payloads, including audible sounds, bright strobe lights, and malodorants.

- c. **Thermobaric Compounds:** Compounds that are characterized as having a single-event chemical explosion requiring no external atmosphere. Thermobaric compounds could potentially be tailored for a specific energetic release for a desired non-lethal effect. The energy release is expected to last longer than that from a typical flash-bang.

11. Slide NLW Technologies Kinetic Devices

- 5. **Projectile, Blunt Impact, and other Kinetic Devices:** Devices intended to impart kinetic energy and cause temporary physical pain, resulting in deterrence, distraction, incapacitation, and a reduced motivation. Also, hollow projectiles can be filled with chemicals, dyes, or other substances that are released upon impact. Depending on energy, range, ricochet, bounce, location of impact, and the sensitivity of the individual, such devices can result in undesired injuries such as severe bruising, broken bones, contusion, concussion, and eye damage and are potentially lethal.
 - a. **Batons:** Projectiles, usually cylindrical, fired at a human target from a riot gun. They vary in hardness and elasticity. They may be made of wood or rubber. The wooden version is also known as a “broomstick round.” They are usually aimed at the legs or at the ground for ricochet effect into a crowd. The “Soft Baton” is a pliable variant that changes its shape after impact to form a pancake. Direct fire at close or point blank range of any projectile can cause serious or fatal injuries.
 - b. **Bean Bag:** Fabric sacks filled with lead shot usually weighing from 40 to 150 grams, designed to be fired from shotguns and other launchers. The bags conform to the shape of the target on impact, producing less damage than a solid hard projectile.
 - c. **Ring Vortex Projectile:** A concept of creating a stable gas vortex to cause kinetic impact and/or deliver chemicals at a distance.
 - d. **Rubber Balls:** Hard rubber balls, usually 8-16 mm in diameter, fired from a shotgun. They have maximum effect when fired in confined spaces, where multiple bounces augment the number of impacts on the target with sufficient force to sting rather than hurt. The small size and velocity of the balls may create a significant ocular hazard.
 - e. **Sponge Grenade:** Projectile made out of spongy material. These can either be used as a kinetic weapon or with the inclusion of CS to produce skin/eye irritation or a dye to mark the target.
 - f. **Water Cannon:** A mobile unit that projects a bolus or stream of water at an individual or crowd for riot control purposes. Injuries from falling or hits from ground particles are possible.

12. Slide NLW Technologies Chemicals for Antipersonnel or Anti-Material Application

- 6. **Chemicals for Anti-Personnel Applications:** Pharmaceuticals, irritants, and lubricants, have been proposed for a variety of anti-personnel applications. Possibilities for undesired human effects are significant and depend on the amount of exposure (dose) of the agent, its means of entry into the body (e.g., skin for liquids, respiratory for gasses), and access to sensitive organs (e.g., the eye). While some of these compounds are used by domestic police, their use by multinational forces and in warfare is limited by law and treaties.

- a. **Calmatives:** Sedatives or sleep-inducing agents intended to incapacitate personnel or render them less aggressive.
 - b. **Markers:** Materials, dyes, and paints, usually in a dust or liquid form, used to mark the clothes or skin of individuals or groups. A marking substance may be clearly visible, or may be relatively or totally invisible until detected using special tools or equipment. One concept envisions a fluorescent powder sprayed into crowds from pressurized containers; particles adhering to clothing would only be visible under ultraviolet light. Another concept envisions sponge grenades or projectiles impregnated with infrared dye. Potential medical issues include adverse reactions on the skin and eyes, the delivery device of such markers, and the energy used to detect invisible agents.
 - c. **Malodorants:** Foul smelling gases or sprays, such as scatole or mercaptans, that cause temporary distraction and potential repulsion of individuals by revolting olfactory saturation.
 - d. **Obscurants:** Chemical agents used to obscure vision. Concepts include chemicals that create smoke screens and liquids that harden and obscure vision ports or optics.
 - e. **Riot Control Agents:** A chemical that can produce physical discomfort, incapacitation, or area denial. They generally work by irritation of eyes or respiratory tract. Effects reverse within a short time following termination of exposure. Some potentially useful agents are prohibited by the Chemical Weapons Convention.
 - i. **Dibenz (b,f) – 1:4-oxa zepine (CR):** An effective riot control agent with immediate effects similar to CS, but more potent and less toxic than CS. It causes immediate eye pain, blepharospasm and lacrimation, which persist for 15 to 30 minutes. It causes almost no effects in the lower airways and lungs and has no persistent eye and skin effects. It does not degrade in water, but resists weathering and is also very persistent in the environment.
 - ii. **1-Chloro aceto phenone (CN):** A riot control agent no longer in common use because it is more toxic than CS, OC, or CR. It was sold under the trade name “Mace.”
 - iii. **Oleoresin Capsicum (OC):** A food product obtained from chili peppers that are dried and ground into a fine powder. When mixed with an emulsifier such as mineral, vegetable, soy oil or water, it may be sprayed from a variety of dispensers and used as an irritant for safely controlling violent persons or vicious animals. OC is the primary active component of “pepper spray.” PAVA (Pelargonic Acid VanillylAmide) is a pure, pharmaceutical capsaicinoid, less caustic and developing only minor secondary effects.
 - iv. **Ortho-chloro benzal malono nitrile (CS):** An effective riot control agent that usually incapacitates within 5 to 10 minutes. Effects linger for about an hour. Decontamination and cross-contamination is a considerable problem in urban environments. Can cause erythema and delayed blistering after contact with the skin.
- 7. Chemicals for Anti-Materiel Applications:** Chemicals intended primarily to disable or degrade materiel. They may have an impact on humans who are incidentally exposed to them during handling or use.

- a. **Anti-Traction Agents:** Polymers and other chemical compounds that can reduce the coefficient of friction of surfaces thereby creating a slippery surface that is impassable to personnel or vehicles. Humans attempting to traverse such surfaces generally fall down and are unable to stand back up. These agents are also known as low-friction polymers, slick'ems, "Instant Banana Peel", and super-lubricants. Although intended for anti-material applications, contact with these agents could cause skin and eye irritation.
- b. **Depolymerisers:** Chemical compounds that induce the breakdown of chemical bonds in polymers, which could cause the breakdown in rubber-based materials such as tires and other plastics.
- c. **Embrittlers:** Compounds that operate by altering the molecular structure of base metals or alloys, causing metal structures to become brittle and irreversibly lose their structural strength.
- d. **Emulsifiers:** Chemicals contained in a mixture of mutually insoluble liquids that when dispersed over the ground can create a quicksand-like surface that can inhibit foot or vehicle travel. Also known as soil destabilizers.
- e. **Foams:** Chemical compounds mixed with air to form foams with various properties, e.g., rigid foams are made from epoxies and other organic chemical compounds to immobilize material components thereby rendering them inoperative. Foams tend to be made of volatile chemical that can be harmful when breathed or can irritate the skin.
- f. **Fuel Contaminants:** Chemical additives to fuel intended to degrade standard engine performance by altering combustion properties or increasing viscosity.
- g. **Lubricant Contaminants:** Chemicals intended to destroy the lubricating property of lubricants.
- h. **Supercorrosives:** Highly corrosive acid compounds that can dissolve most noble metals, such as gold and platinum, and organic compounds. They could be used to attack structures, vehicles, tires, roads, rooftops, and optical systems. They could be hazardous to humans as well.

13. Slide NLW Technologies Electrical Stimulation Devices

8. **Electrical Stimulation Devices:** Devices that produce and deliver a non-lethal electrical shock to a target, resulting in pain, involuntary muscle contraction, and incapacitation, depending on the device and its application. The shock can be produced by pulsed or direct electric current, affecting the target muscle signal paths and disturbing the body's nervous system. Conceivable undesired effects could include effects on the heart and interference with medical implants that utilize electricity, such as cardiac pacemakers. Electrical burns at the area of contact are possible.
 - a. **Electrical Fence:** A fence that delivers a non-lethal electrical shock. It can be employed as a barrier against intruders.
 - b. **Electrical Water Stream:** A proposed mobile unit that projects a water stream charged with high voltage, low amperage.
 - c. **Net mines:** Emerging technologies which would use a target-activated mine to deploy a net that would deliver an electrical stimulation.
 - d. **Stun Gun:** A generic term often applied for electrical stimulating devices. The term "cattle prod" is also used.

- e. **TASER:** A commercial electrical stimulation device with increasing use for law enforcement, security, and anti-terrorism. Such devices usually deliver electrical energy through pointed barbs that enter the skin. Depending on the location of entry, such barbs could cause undesired minor to severe injury. TASER is a registered trademark of a specific company, however the term TASER is often used generically to mean any hand held, gun-like electrical stimulating device.
- f. **Wireless “TASER”:** Postulated devices for delivering electrical energy to a target at a distance without a wire. There are many ideas but little success. One concept would deliver a shocking projectile includes a source of stored electricity (e.g., a capacitor) and barbs that catch onto the target and discharge upon impact. Another proposal is to use an aerosol charge to produce a gas-dispersed conducting channel, down which an electrical shock could be delivered to the target.

14. Slide NLW Technologies Electromagnetic – Radio Frequency

- 9. **Electromagnetic - Radio Frequency (RF):** Electromagnetic energy typically in the frequency range of 3 kHz to 300 GHz is an emerging technology for NLW applications.
 - a. **Anti-Electronic Electromagnetic Weapons:** Anti-materiel weapons utilizing high power microwave pulses or non-nuclear EMP to disable electronic equipment by jamming or burning out sensitive components. Such weapons could be employed, for example, to disrupt the electrical system of engines, disable communication or radar systems, or damage computing equipment. Both the operators of such weapons and humans near the targeted equipment could be incidentally exposed to RF energy, but at the levels anticipated, such exposure would be expected to have no deleterious direct effect on humans. Indirect effects, such as the disruption of medical equipment, could have severe human consequences.
 - b. **Microwave Energy:** Radio Frequency electromagnetic energy typically in the frequency range from 100 MHz to 30 GHz. High Power Microwave (HPM) and ultrawideband (UWB) radiation usually refer to high peak power, low average power pulses used as anti-electronic weapons. The primary accepted effect of human exposure to high average power microwave energy is the heating of tissue. Depending on the frequency of the microwaves and other factors, the energy may be deposited deep into the body or primarily localized near the body surface.
 - c. **Microwave Hearing:** A phenomenon in which microwave pulses of certain characteristics are heard as clicks or buzzes. The mechanism of this phenomenon is believed to be a thermoelastic transduction of the rapid temperature rise caused by the RF pulse into a mechanical wave in the head that is heard by the normal hearing apparatus. It is not believed to be harmful, but some consider that it might be annoying.
 - d. **Millimetre Wave Energy:** Radio Frequency electromagnetic energy typically in the frequency range of 30 GHz to 300 GHz. Millimetre Wave Energy is an emerging technology for non-lethal weapon applications, in particular, the Active Denial System, which beams ~95 GHz millimetre waves at a distance to heat human skin to an intolerably painful but non-damaging level. As this frequency of energy is deposited on the surface of the body, the first medical signs of excessive exposure would be skin burns or damage to the cornea.

- e. **RF Human Exposure Standards:** NATO and other international bodies have established health and safety recommendations for permissible exposure limits for human exposure to RF radiation (RFR) energy. Such recommendations would doubtless apply to occupational exposures during development, training, and use of RF technologies for non-lethal applications. For NATO, the applicable standard is STANAG 2345 “Evaluation and Control of Personnel Exposure to Radio Frequency Fields - 3 kHz to 300 GHz.”

15. Slide NLW Technologies Electromagnetic – Light and Lasers

- 10. **Electromagnetic - Visible and Invisible Light and Lasers:** Most NLT-concepts utilizing light are intended to temporarily disrupt vision. For these, the principal human effect of concern is damage to the eye. In particular, the ability of the eye to focus certain frequencies on the retina creates an increased risk of damage from these frequencies. Secondary effects due to visual impairment are also of concern. Reflections from high energy lasers used for anti-material applications might produce enough energy to damage the skin or eyes.
 - a. **Flashes and Flares:** Devices used to generate light in the visible spectrum, directionally or omni-directionally.
 - b. **Infrared Energy:** Electromagnetic radiation in the 1 to 100 micron wavelength range, with a majority of the devices using such energy operating between 1 and 10 microns.
 - c. **Isotropic Radiators:** Special munitions that illuminate or bloom with high intensity. The energy is generated by an explosive burst, which superheats gaseous plasma surrounding it, causing a bright flash.
 - d. **Laser Illuminators:** Devices that use low energy lasers operating in the visible spectrum in a variety of colours, intending to illuminate, intimidate, distract, and identify the target. Such devices are intended to be “eye-safe,” however a major human effects issue with visible lasers has been concern over the possibility of retinal damage.
 - e. **Laser Ionisers:** Postulated technology that would use laser energy to ionize the air molecules along a path, thereby enabling transmission of electromagnetic or electrical energy at long distances without conventional antennas or wires. Also see Electrical Stimulating Devices.
 - f. **Laser Light Bullets:** An emerging technology that purportedly produces a long bright pulse of focused laser light in a variety of colours. It is produced by rounds containing a tuned resonator chamber surrounding a lasing medium that is energized by the explosive charge.
 - g. **Laser Scattering Obscuration:** Visual obscuration or glare caused by aiming lasers at windows, vision ports, automobile windshields, or airplane canopies. Micro-abrasions in the glass scatter the light in such a way that visibility is greatly impaired.
 - h. **Ultraviolet Energy:** Electromagnetic energy typically of wavelengths ranging from about 1nm to 400 nm.
 - i. **Visible Light:** Electromagnetic energy typically in the 400-700 nm wavelength range, which is detectable by the human eye. Such light is focused onto the retina by the lens of the eye, generally making it more potentially hazardous to vision than light at higher or lower wavelengths.

- j. **Visible Light Strobes:** Visible lights that flash at a frequency near that of the human brain electrical waves (7-9 Hz). Such stimulation could possibly cause vertigo, disorientation, seizures, and vomiting in sensitive individuals. However, such effects are poorly documented and their potential utility for non-lethal applications has not been evaluated.

16. Slide NLW Technologies Summary

The next part of my lecture would be - as announced in the Program -

17. Slide NLW Technologies Glossary

GLOSSARY OF TERMS IMPORTANT TO THE HUMAN EFFECTS OF NON-LETHAL TECHNOLOGIES

(Appendix H: The Final Report of NATO RTO HFM-073, www.rta.nato.int)

but a good lecture - as you all know - should be like a bikini. It should cover the important aspects, and show off as much as necessary to enforce further interest ... So I will try to rush through the Glossary, just to give you an impression how it looks like and what is in it:

There are an enormous number of terms relating to human effects from different perspectives, e.g., medical, biological, physiological, psychological, sociological, psychiatric, legal, pathological, and so forth. This Glossary attempts to define some of the terms that are most relevant to the human effects of non-lethal weapons so that NATO HFM and RTO will have a common reference. There is a special focus on terms that are used in the body of the HFM-073 Final Report.

Criteria for including words were:

1. Terms unique to the human effects of NLTs,
2. Common terms that are used in an unusual way in the context of NLT human effects, and
3. Common terms that are used with their usual meaning, but are very important to the human effects of NLTs.

The terms are put down according to the alphabet, so it's easy to find one or knowing it is not in the table.

I just will go through it pagewise.

3-Rib Chest Structure: A mechanical model used to measure chest compression and thoracic response (chest wall velocity) from ballistic impacts.

Accreditation: The official certification that a model or simulation or process is acceptable for use for a specific purpose. Also see Validation and Verification.

Acceptability: The complex determination of whether the contemplated use of a non-lethal technology is (1) worth the cost in manpower, material, and time involved; (2) is consistent with the law of war; and (3) is militarily and politically supportable.

Acute Effects: An immediate physiological, behavioural, or psychological effect occurring as a result of the stimulus from an NLT. Examples of acute desired effects include pain from a kinetic impact, distraction from a flash-bang, and irritation of the eyes and lungs from Oleoresin Capsicum.

After-Action Review (AAR): A professional discussion of an event that enable soldiers to discover for themselves what happened, why it happened, and how to sustain strengths and improve on weaknesses. It is a tool that leaders, trainers, and units use to get maximum benefit from every mission or task. It could be used to assess the operational performance of NLT.

Asphyxia: Decreased oxygenation of the blood, often due to the inability to breathe due to airway obstruction or irritation.

Asphyxia, Positional: Asphyxia caused by restricting a human in a position in which breathing is inhibited.

Basis Responses: A set of abilities defined by SAS-035 as the smallest set of descriptors that form the basis from which all the desired target responses necessary to accomplish anti-personnel and anti-materiel assigned mission tasks can be generated. These Basis Responses describe the Required Responses and Measures of Response in a simple and common manner such that they can be mathematically compared in order to compute the Measures of Effectiveness. They are a means of reducing complex information to a minimum ordered set of actions to allow the Measures of System Effectiveness to be mathematically calculated. The following seven Basis Responses were listed:

- Physical Function
- Mobility
- Communication
- Sense and Interpret
- Group Cohesion
- Identification

Battle Stress: A temporary disorder of psychological function and performance experienced by some individuals during combat. Battle Stress cases are considered as Battle Casualties, but the majority of these casualties do not become patients and most can be handled outside of the medical support system.

Behavioral Effect: An effect on the behavior or performance of a person.

Blunt Trauma: Change of body structure caused by imparted kinetic energy.

Bystander: A person located near the target of a NLW who is not an adversary and is not the intended target of the NLW. Similar to the term “non-combatant.” The safety of bystanders will be an important issue for the use of NLTs.

Chronic and Long-Term Effects: Effects of a NLT that could affect health over a long period of time, even years. The potential effects most often cited are the induction or promotion of cancer, the reduction of fertility and/or the increase of birth defects, and facilitation of a variety of physiological disorders and diseases. Concern applies both to the user, who may experience repeated low-level exposure and to the targets, who may experience multiple acute high-level exposures. Such effects may take many years to appear.

Commotio Cerebri: Shock to the brain causing unconsciousness. This condition is especially relevant to kinetic NLT.

Commotio Cordis: A ventricular fibrillation induced by impacts to the front chest, particularly near the front left ventricle, during repolarization.

Communication: Capability of exchanging information with other persons via verbal or non-verbal means. The goal of some NLTs is to disrupt this capability.

Compliance: The act of submitting to the will, control, or orders of another person.

Confuse: To disrupt thinking with clarity or acting with intelligence and understanding.

Concussion: An injury to the brain produced by a violent blow and followed by temporary or prolonged loss of function and consciousness.

Constraints to NLTs: Limiting factors that influence development, testing, training, and deployment of NLTs. For example, certain conventions, laws, & treaties restrict the use of chemicals in combat; standards that set limits on human exposure to electromagnetic fields, lasers, or acoustics may limit testing and training on some NLTs. The claim or perception that some NLT effects are tantamount to torture could limit their use.

Control Force: Police or military personnel attempting to restore civil order. Also see “crowd control” and “riot control.”

Contusion: An injury to an organ or tissue that is caused without breaking the skin, e.g., a bruise.

Countermeasure: A means via actions or equipment by targets to defeat the goals of a NLT.

Crowd Control: The goal to effect the gathering, unified action, or dispersal of a crowd in a desired manner.

Cultural Background: Characterization of human groups by such factors as ethnicity, religious beliefs, and education. It is believed that cultural background will affect human response to some NLT, especially those relating to psychological effects.

Dazzle: Temporary loss of vision or temporary reduction in visual acuity. Also see “Glare.”

Damage Assessment: The evaluation of the effect of NLTs on targets.

Deception: Measures designed to mislead the enemy by manipulation, distortion, or falsification of information in order to influence his course of action.

Delayed Effect: Physiological (e.g., health), behavioural, or psychological effect of a NLT that appears some time after the original stimulus, e.g. a delayed toxic effect.

Denial Measure: An action to hinder or deny the enemy the use of space, personnel, or facilities. Threats, barriers, and the induction of pain are examples of denial measures.

Desired Effects: The objective for using the NLT, e.g., distraction, incapacitation, repel. Also see “undesired effects.”

Deter: To prevent or discourage from acting by imposing fear or doubt regarding the consequences of the action or by creating a physical obstacle.

Disable: To deprive targets of capability and effectiveness, often by impairing their physical abilities.

Disorient: To impair targets sense of spatial or temporal relationship with their surroundings or goals.

Disperse: To decrease the density of a group of people, e.g., breaking up a crowd.

Distract: To cause to turn away from the original focus of attention or interest.

Dose-Response: The relationship between the intensity of a stimulus (dose) and its effects. For any specified effect, a dose-response curve can be created. The separation between the dose-response curves for desired and undesired effects of a non-lethal technology defines its margin of safety and its operating envelope.

Duration of Effect: The time course of recovery from an effect produced by NLT. The duration of the effect of a NLT is important in assessing its effectiveness and in planning its use. It is also important for planning the interrogation of a captured target and in assessing medical management of an injured target. Also see “Time of Effect”

Effect: Change produced by an action or stimulus.

Effectiveness: A measure of the success of a NLT in meeting its objectives. From an operational perspective, it is a measure of the ability of a specific NLW when employed in a given scenario to allow achievement of mission objectives by an employing force.

Energy Coupling: The efficiency of transfer of energy from one medium to another. For the human effects of NLT, the issue is usually how well energy couples with the human body. For example, infrasound delivered in air couples poorly with the human body, whereas infrasound delivered in water couples well with the human body. Energy that strikes a human that is not coupled well, is usually either reflected by the body or passes through the body.

Environmental Effects: Effects of NLTs on fauna or flora. The goal to preventing undesirable environmental effects is codified in the definition of non-lethal weapons. The issue of environmental effects is especially important for chemically based NLT, the residue of which could remain for a considerable time.

Exposure Standards: Health and Safety standards developed to protect the general public and operators from exposure to potentially harmful physical or chemical stimuli. These standards are generally very conservative, employing a large safety factor. They do not apply to the use of such stimuli in NLTs against a target and are generally relaxed during warfare. However, they apply during the development and testing of NLTs and in training and exercise scenarios. In military operations, they usually apply to weapon’s operators and other personnel. In NATO, such standards are codified as Standardization Agreements (STANAGS), e.g., STANAG 2345 for exposure to radio frequency radiation.

Extrapolation: Using specific, limited observations and data (e.g., from an animal, physical, or computer model, from a small subset of the human population, or using sub-optimal levels of an NLT) to predict the effects of NLTs on humans in an operational situation. Also called generalization.

Flash-Blindness: The temporary loss of vision following exposure to a bright light.

Glare: Loss of visual performance (veiling glare) or annoyance or discomfort (discomfort glare) produced by light greater in intensity than that to which the eyes are adapted. Diminished vision can also be produced from light reflecting or scattering from surfaces, such as windshields, water surfaces, or VDTs (reflection glare).

Group Cohesion: The level of organization, cooperation, and density of a group or crowd of individuals.

Head Injury Criterion (HIC): A measure developed by the U. S. National Highway Traffic Safety Administration to indicate the probability and severity of skull fracture.

Human Effects: Effects on a human being, including psychological, physiological, and physical effects. Knowledge about human effects can be obtained by observation, experimentation, and modelling. Data can be collected from animal models and directly from humans in both laboratory and field conditions. Knowledge about the human effects of non-lethal weapons is essential to assure operational utility, technological feasibility, and policy acceptability.

Immobilize: To stop, restrict, or hinder movement.

Imparted Energy: The total energy transferred from a kinetic device to the human body. Also see “energy coupling.”

Incapacitate: To deprive the target of strength or ability, temporarily inducing a state where no effective action can be performed.

Indecisiveness: Reduced ability to plan or make a decision and act effectively.

Injury Criteria: The critical levels of various damaging effects, such as blast pressure and thermal radiation, required to achieve specified levels of damage. Also see “dose-response.”

Interim Total Body Model (ITBM): A compilation of various thoracic, abdominal, and head injury models, most often based on a biomechanical lumped parameter representation of anatomical behavior. The ITBM is being used to model the effects of blunt impact NLT.

Lobdell's Model: A lumped parameter biomechanical model of how the thorax will respond to high mass, low velocity impacts. Developed to support injury assessment for the automotive industry, now used to model the effects of blunt impact NLT.

Margin of Safety: A term borrowed from pharmacology that indicates the separation between an effective dose and a toxic dose of a drug for a specified population of users. For non-lethal technologies, the margin of safety defines the operating environment between operational effectiveness of a NLT and the occurrence of undesirable effects. The margin of safety is often expressed as a ratio of the threshold value for damage divided by the threshold for effectiveness. It can be readily visualized by plotting dose response curves for desired and undesired effects on the same graph. The margin of safety can be highly affected by the variability of the relevant population of targets. A technology with a large margin of safety is preferred.

Measures of Effectiveness (MOE): Defined by NATO RTO SAS-035 as a quantitative or qualitative measure that indicates the degree to which a military objective can be achieved by using one or more systems (lethal/non-lethal) in an operational context, e.g., probability of damage, etc.

Measures of Operational Effectiveness (MoOEs): Defined by NATO RTO SAS-035 as a quantitative or qualitative measure of the impact of the use of NLTs to the overall success of an operation.

Measures of Performance (MOP): Defined by NATO RTO SAS-035 as a measure of the intrinsic quality of the system under consideration (taking into account environmental conditions). Examples are speed, payload, range, time on station, frequency, or other distinctly quantifiable performance features.

Measures of Response (MOR): Defined by SAS-035 as a measure of how a target reacts (desired/undesired) to a system that is applied (i.e., taking into account countermeasures).

Measures of System Effectiveness (MoSEs): Defined by SAS-035 as an overall measure of the effectiveness of a system employing NLTs. It is a combination of the Measures of Response, the Target Response Characteristics, and the Required Responses.

Medical Response: Agents and procedures to treat the acute and delayed effects of NLTs to facilitate the reversal of acute effects and the prevention of delayed effects, based on medical need. Particularly for novel NLT, preparation for medical treatment will help reduce casualties and undesired effects. Medical responders should be prepared to treat operators, targets, and bystanders who may intentionally or accidentally be exposed to NLT.

Mobility: The capability of individuals or groups of people to move from one location to another, characterized by speed and direction.

Model: A physical or mathematical representation the real world, simplified by ignoring certain details. Models allow complex systems and situations to be understood and their outcomes predicted within the scope of the model, but may give incorrect descriptions and predictions for situations outside the realm of their intended use. Also see “extrapolation” and “dose-response.”

Motivate: To provide with an incentive; to move to action; impel.

Motivation: From the perspective of NLT’s, the strength of the targets’ desire to achieve their goal, or conversely, the strength of the targets’ ability to resist the application of an NLT. Although this is an easily understood term, there are few objective metrics for assessing motivation with respect to a given NLT. In many cases, motivation is directly proportional to the effective dose of an NLT.

Non-Lethal Effect (NLE): An effect that incapacitates or repels personnel, with a low probability of fatality or permanent injury, or disables equipment, with minimal undesired damage or impact on the environment.

Non-Lethal Technologies (NLTs): Technologies being considered or utilized for non-lethal weapons.

Non-Lethal Weapons (NLWs): Weapons that are explicitly designed to incapacitate and repel personnel, with a low probability of fatality and permanent injury, or to disable equipment, with minimal undesired damage or impact on the environment. (NATO NLWs Policy)

Operating Envelope: The range of applications (dose, level) of a NLT in which desired effects are maximized and undesired effects are minimized. Also see “dose response” and “margin of safety.”

Operator: With respect to NLWs, the person responsible for firing, launching, or otherwise delivering a NLT to a target. For many NLT, operators may experience repeated low-level exposure and run the risk of accidental high-level exposures. Also see “Safety Standards.”

Pain: An unpleasant sensation occurring in varying degrees of severity as a consequence of injury or exposure to intense stimuli likely to cause injury, disease, or emotional disorder. The most basic form of pain is assumed to help prevent injury. Humans usually seek to reduce or avoid pain. The induction of pain to compel adversary compliance is common to many existing and proposed NLW.

Pain Compliance: The use of pain to exert control over a target. Also see “compliance.”

Performance: The efficiency and quality of a purposeful action. One goal of NLTs is to disrupt the performance of targets. Means of assessing changes in performance caused by NLTs could be an important issue for the NATO RTO Human Factors and Medicine Panel.

Personal Protection: Protective clothing or other means used by an operator or user to prevent potentially hazardous exposure to an NLT. Also see “countermeasure.”

Physical Restraint: The control of the capacity or mobility of targeted individuals or groups by physical means (e.g., handcuffs).

Physiological Effect: An effect on the anatomy or functioning of the human body.

Pre-empt: To act to gain time and space in order to forestall the activities of an adversary in order to maintain freedom of action.

Probability of Damage: Defined by NATO RTO SAS-035 as the probability that damage will occur to a target expressed as a percentage or as a decimal.

Probability of Detection: Defined by NATO RTO SAS-035 as the probability that a person, object or phenomenon will be detected, expressed as a percentage or as a decimal.

Probability of Unintended Effects Given a Hit (P_{HU}): Defined by NATO RTO SAS-035 as conditional probability of injury or lethality given a hit. This probability is specified as a function of dose and may vary according to population and individual variables such as age, gender, sensitivity, clothing, and motivation level.

Probability of Intended Effect Given a Hit (P_{HE}): Defined by NATO RTO SAS-035 as the conditional probability of achieving the task objective. This probability is specified as a function of dose and may vary according to population and individual variables such as age, gender, sensitivity, clothing state, and motivation level.

Probability of Hit (P_H): Defined by NATO RTO SAS-035 as a term used by the modelling community to describe the probability that a target will be hit by a given release of a munition, expressed as a percentage or as a decimal.

Probability of Kill (PK): Defined by NATO RTO SAS-035 as a term used by the modelling community to describe the probability of stopping specific functions of a target if that target is hit.

Psychological Effect: An effect on the mind (e.g., thinking, attitude, motivation, etc.) of a person. It is often considered as an intermediate to a behavioural effect. Undesired psychological effects of non-lethal technologies on the target, bystanders, and operators could also be an issue and should be evaluated in any complete risk analysis.

Psychological Operations: Military operations designed to have an effect on the mind (e.g., thinking, motivation, attitude, etc.) of a person.

Reostatic Weapons: With respect to NLW, the ability of a single weapon or technology to produce a spectrum of desired effects merely by adjusting the level of exposure or some other parameter. For example, the same weapon might be adjusted to produce annoying effects at lower levels, incapacitation at higher levels, and lethality at even higher levels. Also called tunable or scalable weapons.

Repel: To ward off or keep away; drive back

Riot Control: The management of a large group of people engaged in unrestrained civil disobedience. Also see “Crowd Control.”

Risk Characterization: The formal process by which desired (i.e., intended) and undesired (i.e., unintended) effects of NLTs are identified, examined, and evaluated to determine the technology's effectiveness and safety.

Rules of Engagement (ROE): Directives issued by competent military authority that delineate the circumstances and limitations under which forces may initiate and/or continue combat engagement with other forces encountered. Standing ROE refer to those generally intended for all situations, but tailored ROEs for specific situations may augment those standing rules. Knowledge of the human effects of NLTs will be extremely important for specifying appropriate ROE for NLWs.

Secondary Injures: Injuries that are not due to the primary intent or effect of the non-lethal weapons, but occur as an unanticipated or unavoidable sequelae. For example, an anti-electronic weapon could disrupt life-sustaining medical equipment leading to death. Any NLW that induces momentary loss of equilibrium could inadvertently lead to injuries from falling.

Sense of Anonymity: The feeling of being anonymous and therefore being unlikely to be held accountable. Individuals in a crowd or mob often have a sense of anonymity that releases them from their behavioural norms.

Simulation: An attempt to predict aspects of the behavior of some system by creating an approximate (mathematical) model of it. This can be done by physical modeling or by writing a special-purpose computer program. The use of simulations allows many iterations of proposed scenarios with different assumptions.

Spasm: An involuntary and unnatural contraction of one or more muscles or muscular fibers. Spasms are usually either clonic or tonic. In clonic spasms, the muscles or muscular fibers contract and relax alternately in very quick succession. In tonic spasm, the contraction is steady and uniform, and continues for a comparatively long time. Also see “tetanus.”

Spoof: Mislead, often through the use of faked or altered communications.

Startle: A reaction to a sudden noise, impact, or flash that causes an involuntary response such as stiffening of the body, flexion of the arms, a verbal response, or fall to the ground. Flash-Bang devices often produce a startle response.

Stun: Condition of complete inability to act purposely. When applied to an individual, it implies inability to attack or defend or even move.

Target: Person at whom a NLT is directed. Also see “bystander.”

Tetanus: A state of continuous muscular contraction, especially when induced artificially by rapidly repeated stimuli. Electrical stimulation can result in tetanus.

Threshold Effect: An effect for which a threshold dose must be exceeded before the effect is observed. Because of the variability of human response, thresholds are often expressed probabilistically as the dose that elicits the subject response in 50% of the population; this metric is called the Effective Dose 50 (ED50). Also known as the “minimal effective dose.”

Time to Effect: The time between exposure to a NLT and the desired effect. This time may be immediate (e.g., kinetic weapons), take a few seconds to occur (e.g., millimetre wave heating), or take many seconds (e.g., calmatives). Also see “Duration of Effect”

Trauma: Any injury, either physical or psychological.

Undesired Effects: Effects of a NLT that do not support the goals of its use. Lethality and permanent injury clearly are undesired effects of NLT. These are sometimes referred to as “side effects” or “unintended effects.”

User: The operator of an NLT. Acute and long-term safety of the user will be important to the policy acceptability of NLT.

Validation and Verification (V&V): A process whereby a device, procedure, simulation, model or other product is tested for meeting its design requirements and specifications. Validation assesses the relevance of the product to its stated purpose. Verification assesses the degree of accuracy and reliability of the product.

Vertigo: A feeling of dizziness or loss of equilibrium that may lead to falling down.

Viscous Criterion: An empirically derived injury criterion developed for the automobile industry for low velocity, high mass impacts to the chest. Equivalent to the maximum product of chest wall velocity and compression (VC_{max}).

Visual Obscuration: Temporary impairment of vision, e.g., with a bright light or certain lasers. May also be called “temporary blindness.”

Vulnerability: Susceptibility to an effect (e.g., incapacitation, injury). The variability of the vulnerability of different individuals in a target population is a major challenge for the evaluation and use of NLWs.

End of Appendix H

Thank you for your attention

RESUME

The goal of NLT is to incapacitate people or equipment while minimizing unintended fatalities and damage. Every non-lethal technology has to be thought over for medical aspects during conception, development, training and application. Even if the technology might be facing material or technical installations human or humanitarian aspects might become involved during application.

So Jean Pascal Zanders from Stockholm International Peace Research Institute pointed out: "The Chemical Warfare Convention doesn't ban chemicals, it bans purposes under which those chemicals are applied."¹

The situation today has totally changed from World Wars, Cold War and even 1993, when the CWC was agreed on,

to

Crowd Control, Law Enforcement, Embassy Protection, Rescue Missions, Peace Keeping Missions and Counter Terrorism. We are depending on old law. There is an urgent need for rethinking and rewriting the existing law for implementation of NLT. Lawyers have to think over today's terminologies and the safe and reliable use of specific NLTs, if they are thought to be a useful means of action. We probably need new definitions for the use of NLT in certain situations, may be by resolution of the UN Security Council. This could be limited to Operations Other Than War (OOTW) or on discrimination between rioters, combatants and civilians or personnel used as shielding crowd. The nations by multinational exercise have to find out scenarios for the application of specified NLT, so they can be concluded on and be accepted keeping in mind alternatives for counteraction of unexpected, even unthinkable situations.

¹ (Government Executive Magazine 11/4/02: Defence Department Studying Nonlethal Chemicals. <http://207.27.3.29/dailyfed/1102/110402gsn1.htm>)