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Bradford Non-Lethal Weapons Research Project (BNLWRP)

Research Report 2

June 1998

Dr. Nick Lewer

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1. Introduction

Drawing from the Non-Lethal Weapons Database this report summarises and reviews:

- non-lethal technology research and development issues, themes and trends
- developments in non-lethal military organisation and co-ordination capacity
- recent developments in selected non-lethal technologies
- commercial opportunities and applications of non-lethal technology

- ethical and social implications of non-lethal technology
- non-lethal human bioeffect research

2. Bibliographic Database

Version 2 of the Database contains additions from a wide variety of sources including conference papers, journal articles, books, discussion documents and the media. All of these are documents available in the public domain, and are unclassified.

3. Non-Lethal Weapons in the United States

3.1 Department of Defense Joint Non-Lethal Weapons Program (JNLWP)

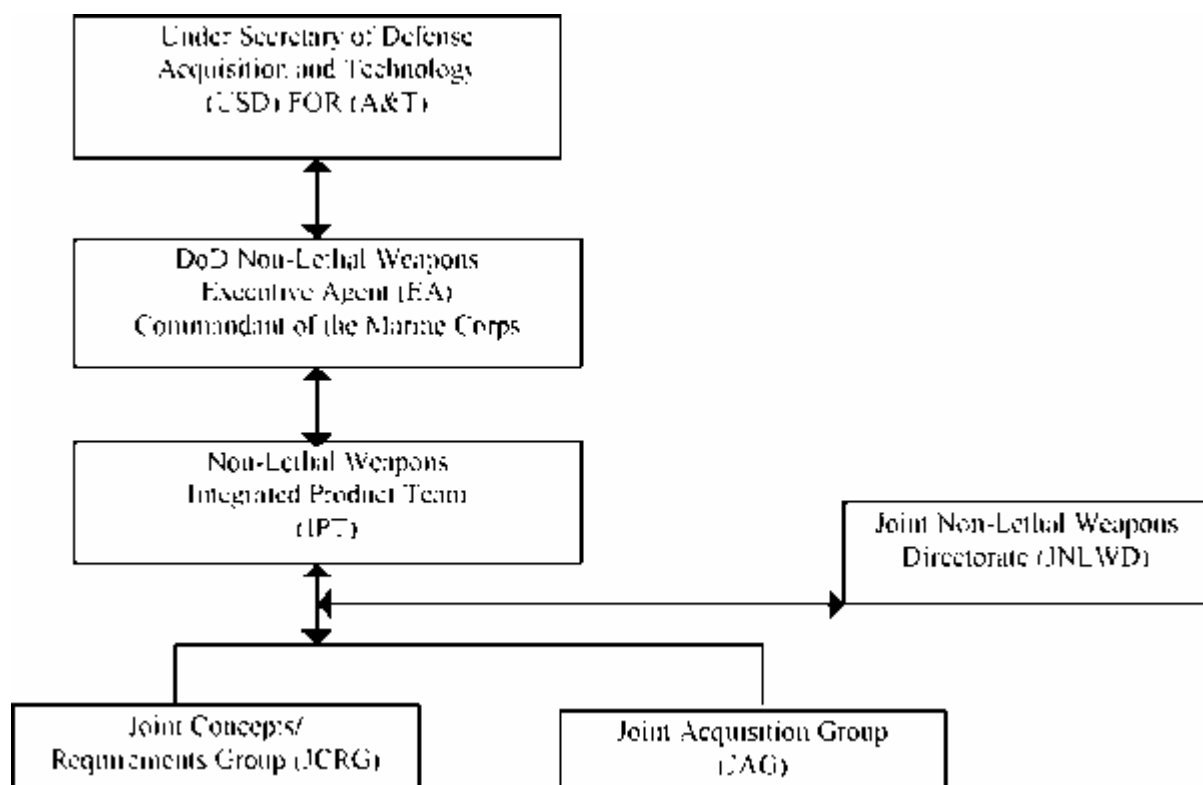
Address: Director, 3097 Range Road, Quantico, VA 22134-5100, U.S.

Internet Site: <http://www.hqmc.usmc.mil/nlw/nlw.nsf>

The JNLWP was formed in January 1997 when the joint service Memorandum of Agreement was signed. The purpose of the MOA is to implement procedures in Public Law 104-106, Section 219 - Non-Lethal Weapons Study which states "...the Secretary of Defense shall assign responsibility for development (and any other functional responsibility the Secretary considers appropriate) of non-lethal weapons technology to an existing office within the Office of the Secretary Defense or to a military service as the executive agent". Additionally, the Agreement implements the Under Secretary of Defense (Acquisition and Technology) direction to the Commandant of the Marine Corps to serve as the NLW Program Executive Agent. The Executive Agent is responsible for program recommendations and for stimulating and coordinating NLW requirements. There are six functional areas established by the Joint Concept for NLW within the categories of counterpersonnel and countermaterial.

<i>Counterpersonnel</i>	<i>Countermaterial</i>
Crowd Control	Area Denial to Vehicles
Incapacitation of Personnel	Disabling Vehicles, Vessels, and Facilities
Area Denial to Personnel	
Clearing Facilities of Personnel	

3.1.1 JNLWP Organisation (1)



3.1.2 Responsibilities of Elements in the JNLWP

- **Executive Agent (EA)**: co-ordinates NLW requirements for CINCs, has oversight and ensures co-ordination between acquisition and requirements communities, and expands operational NLW demonstrations within appropriate ACTDs. It also organises the IPT so as to co-ordinate the services' acquisition and requirements efforts, recommends appropriate funding levels based on requirements for DoD NLW

programmes, and approves the consolidated DoD NLW Research, Development, Testing and Evaluation (RDT&E) budget submission.

- **Integrated Product Team (IPT):** Recommends approval of the consolidated DoD NLW RDT&E POM and provides oversight to and reviews recommendations of the JRCG and the JAG. It reviews/resolves security, environmental, health and safety, and policy issues that may arise in the development of NLW programmes and is the final arbiter for service concerns. Membership of IPT includes Chairs of both JRCG and JAG, service operations and acquisitions representatives, and representatives from OSD, the Joint Staff, and CINCs. The departments of Energy, transportation, and Justice are also invited to send observers to the IPT.
- **Joint Concepts and Requirements Group (JRCG):** Evaluates service NLW mission need statements (MNSs) and operational requirements documents (ORDs) and recommends multi-service or joint programmes as appropriate. It develops and prioritizes the DoD requirements list in support of POM development. JRCG provides input to the NLW Master Plan, co-ordinates and integrates joint material requirements, reviews NLW training initiatives, and participates in doctrine development. JRCG co-ordinates and integrates the development of joint NLW models, simulations and war games and incorporates initiatives into joint service efforts.
- **Joint Acquisition Group (JAG):** Co-ordinates and integrates the NLW programme concepts and requirements into a management system to achieve standardisation and interoperability and optimise resources. JAG reviews service NLW programmes, recommends approval of new starts or termination of unsuccessful programme efforts, and co-ordinates with the JRCG to assist in determining a responsible service. Principal role of JAG is to harmonise the design, development, test, evaluation, and introduction into service of non-lethal systems.

- **Joint NLW Directorate (JNLWD):** Serves the IPT, JRCCG, and JAG and functions as the EA's action office for the day-to-day activities of the NLW programme. Co-ordinates the various working groups of JAG, JRCCG, and IPT.

3.1.3 JNLWP 1997 Report - A Year in Review: This is a useful account of the JNLWP first year of operation and gives some details of the concept, structure, funded programmes and other NLW activities. Funded programmes include:

- Modular Crowd Control Munition (MCCM)Ground (Electric) Vehicle Stopper
- Portable Vehicle Immobilisation System (PVIS)NL Bounding Munition (Mine)
- 40mm NL Crowd Dispersal MunitionUAV NL Payload/Delivery System
- Under Barrel Tactical Delivery System (UBTDS)Foams Applications
- Maritime Vessel StopperAcoustic Programme
- Vortex Ring Gun

3.1.4 JNLWP Database: Available only for authorised personnel. Contains information on NLW concepts, scenarios, policies, MNSs, ORDs, proposals, programmes, and systems. Each proposal, programme, and system is related to a NLW technology, which is organised in a hierarchy.

3.2 Armament Research Development and Engineering Centre (ARDEC) and Army Research Laboratory (ARL): Technology Programmes

An indication of current technology focus can be seen from programmes being funded by the DoD at ARDEC and the ARL in the US. **(2)**

Technology	Resources
Acoustics	33%
Active Denial	19.8%
Foams	11.4%

Maritime Vessel Stoppers	9.7%
Vortex Ring Gun	7.7%
Ground vehicle Stoppers	6.4%
Advanced Kinetics	6.2%
APLs	3.7%
UAV Hovering	1.9%

At the US Army ARDEC the FY 98/99 Service Program List reflected these priorities **(3)**:

1. Non-Lethal Crowd Dispersal (M203). Blunt impact trauma.
40mm round for M203 grenade launcher
2. Acoustic Bio-Effects: Vehicle mounted or portable mechanical pressure wave generation capable of range of non-lethal to lethal effects
3. Mines (Claymore): Pre-emplaced claymore mine, kinetic weapon (rubber balls) and flash bang. Sting and flash effects at 5-15 metres.
4. Stoppers
 - a. Ground: disable electronic components of vehicle by microwave transmitter
 - b. Maritime: under development by US Navy

5. Speed Bump and Net: Pre-emplaced net being designed to stop a 5,100lb vehicle travelling at 40-60 mph within 200ft, without serious injury to occupants.
6. Area Denial technology
7. 66mm Vehicle Launched Payload: Kinetics, Pyrotechnics (whistles, flash/bang) to be launched at standoff from vehicle to deter riotous crowds.
8. Unmanned Aerial Vehicle (UAV) NL Payloads: could include stingballs, chemicals, malodorants, electronic disablers, lasers.
9. Bounding NL Munition: Bounding mines could deliver entanglement nets (sticky and electric). Useful for perimeter defence.
10. Canister Launched Area Denial System (CLADS):Dispensing of various NL payloads from vehicle mounted canister launcher rack.
11. Foam Applications: to seal hatches, doors and windows. Incapacitate personnel and small arms.
12. Acoustic Generators
13. Vortex Ring Gun: Vortex ring gas impulses with flash, concussion, non-lethal chemical agents and/or markers.
14. Underbarrel Tactical Payload Delivery System: An underbarrel NL kinetic weapon.

And at Army Research Laboratory the Directed Energy and Power Generation Division includes the following areas of research relating to non-lethal weaponry **(4)**:

- Directed Energy Weapons (DEWs): devices which destroy/negate targets using radiated waves or beams of microscopic particles. Current DEWs include only sources that are electromagnetic in origin - laser, particle beam and radio frequency/high power microwave (HPM). Future DEWs may include other sources such as acoustic waves or other fluid/particle structures.

- Power Generation
Kinetic Energy Weapons: ballistically delivered kinetic systems such as 40mm sponge grenade munition; variable velocity rifle system (VVRS) - a selectable shot-to-shot projectile velocity/lethality; combined air/water-jet anti-personnel gun. **(5)**
- Vehicle stoppers (including trains):
 - (a) Mechanical - spike strips, caltrops, barriers (nylon net arresters, entanglers)
 - (b) Chemical - combustion modifiers, engine cloggers, antitraction materials
 - (c) Electrical - direct injection (Jaycor), microwave, NNEMP
- Vortex-Ring Gun: integrates concussion, flash, chemical, impact and possibly infrasonic methods of crowd control into a single vortex ring delivery. Target range of approx. 50 metres.
- Area displacement spheres for delay/exhaustion of individuals

3.3 Institute for Non-Lethal Defense Technologies

Penn State University, Pennsylvania, U.S.

Internet site: <http://www.arl.psu.edu/core/nonlethal/mission.html>

Contact: Ron Madrid. E-mail: rrm1@psu.edu

The Institute is 'dedicated to the development of the multidisciplinary knowledge and technology options in both military and civilian applications'. It is administered by Penn State's Applied Research Laboratory (ARL), under the direction and support of The University's Office of the Vice-President for Research. The ARL has been sponsored by the US navy for a long time especially in the field of weapons engineering and acoustics research. The JNLWD has contracted the ARL to establish a Human Effects Advisory Panel (HEAP). HEAP will not do any testing but review test results, existing policy, legal reviews and other documentation to address the issue of "acceptability" for individual non-lethal technologies. **(6)**

3.4 The U.S.-U.K. Master Information Exchange MOU (MIEM) covering the exchange of R&D information on non-lethal technologies was signed on 2 February 1998 in Washington. A first

technical exchange meeting was scheduled for 13-14 May in Farnborough. which was to focus on NLW organisational structure and kinetic and acoustic bio-effects data.

3.5 Office of Law Enforcement Technology Commercialization (OLETC)

Wheeling Jesuit University, 316 Washington Avenue, Wheeling, WV 26003, U.S.

<http://www.iridium.nttc.edu/law/brochure.html>

OLETC is a programme of the National Institute of Justice (NIJ), located in the National Technology Transfer Centre (NTCC) at Wheeling Jesuit University. Its mandate is to develop and refine new strategies to accelerate the commercialisation of innovative law enforcement and corrections products. OLETC is part of a network of centres and offices developed by the NIJ Office of Science and Technology. which includes: National and Regional offices of the National Law Enforcement and Corrections Technology Centres (NLECTC), Border Research and Technology Centre, Office of Law Enforcement Standards. OLETC non-lethal projects include developing a Retractable Spike Barrier to stop vehicles. This is being researched with the Idaho National Engineering Laboratory and the PMG Manufacturing Group.

4. Selected Technology Developments

4.1 Acoustic - PRIMEX Physics International Company **(7)** is developing a vehicle mounted Acoustic Blaster which can be used for (a) area denial, and (b) against selected groups in crowds, intruders, mobs and rioters in a hostile situation. It can be operated by one person. A prototype blaster consisting of an array of four combustion detonation driven devices are capable of being fired simultaneously or independently. An acoustic pressure of up to 165dB at 50ft has been achieved. An output pressure waveform "appears to contain very desirable risetime and pulsewidth characteristics that are essential for optimal acoustic-physiological coupling to targets for antipersonnel applications". The US Army Research Laboratory (ARL) is developing and testing a variety of acoustic sources for possible application in scenarios such as crowd control and area denial. "These sources include devices which generate energy by repetitive combustion or detonation of a fuel-oxidizer mixture....The acoustic signals produced by these devices are typically repetitive impulse waveforms similar to generated by explosives and are characterised by an initial short-risetime, high positive sound pressure level that falls roughly exponentially to a lower-level negative-pressure undershoot". **(8)** The ARL is also working on a Sequential Arc Discharge Acoustic Generator (SADAG) which produces high-intensity impulsive sound waves by purely electrical means. An excellent paper by William Arkin

(9) summarises the stage of development of various acoustic technologies (accessible to the public domain) and points out the lack of information as to the bioeffects of these weapons.

4.2 Riot Control and Law Enforcement Chemical Agents

4.2.1 CS Gas - Following Home Office approval for the use of CS spray (10), concerns are still being voiced over the use of the spray by UK police forces. (11) Particular worry has been expressed at the 5% CS concentration as authorized by the Police Scientific Development Branch (PDSB) and endorsed by the Association of Chief Police Officers (ACPO). Earlier work done at the Chemical Defence Establishment in the 1970s had shown that a solution containing as little as 0.005% produced immediate and effective results. It appears that guidelines laid down for the correct use of the 5% spray have been regularly breached by police officers, and as a result 'sensitive relations between police and local communities have been jeopardised not only by indiscriminate use of CS, but also the treat of use against juveniles and the elderly'. The New York City Police Department came under criticism last year for unilaterally introducing a more powerful pepper (OC) spray. The new spray was also contained in a larger dispenser can with a longer range, and was mixed with citrus fibres giving it a foamy quality to help it stick to its target, thus causing a stronger reaction. (12)

4.2.2 In the U.S. the Chemical Weapons Convention (CWC) was ratified by the Senate under a series of conditions, one of which (Condition 26) allowed U.S. use of riot control agents (RCAs) in a number of circumstances including use against combatants. (13)

The dangers to the CWC are well illustrated by the evolving disclosures about U.S. use of chemical agents in Vietnam. In September of last year it was disclosed that special forces had been supplied with incapacitants such as BZ. (14) Now it appears that these special forces were also using the lethal nerve gas sarin. (15) As is shown elsewhere in this report the U.S. is still interested in a wide range of applications of non-lethal chemicals. These appear to include the possible continued development of new non-lethal chemicals which may erode the distinction between lethal and non-lethal uses in the future. One Washington insider has noted that (16):

As research and development work progresses in the United States on non-lethal alternatives to RCAs, options may become available that remove the potential requirement to chose between RCAs or deadly force.

Thus, although not openly known it must be presumed that research on new chemical agents continues.

4.3 Electro-Magnetic - work in this area continues. The JNLWP is funding a programme "which uses an intense non-nuclear electromagnetic pulse which can disable vehicle electronics and computer control systems. The disabling mechanism is eddy currents generated in electrical components of the vehicle ignition and control system" **(17)**.

4.4 Entanglements - refinements of the nets which can be launched from portable or vehicle mounted dispensers proceeds, with R&D looking at methods of enhancing the effectiveness by incorporating electrical stunning and/or sticky chemicals into the net.

4.4 Kinetic - US Army Military Police (USAMP) are evaluating the operational impacts of the Modular Crowd Control Munition (MCCM). The MCCM is similar in appearance and operation to a claymore mine, but is designed to deliver a non-lethal kinetic payload such as small rubber balls. It could also dispense chemical weapons such as CS, CR and OC.

4.5 Laser

4.5.1 Laser Dazzler (18) - US Defence Advanced Research Projects Agency (DARPA) and the National Institute of Justice (NIJ) have delivered a prototype Laser Dazzler to the USAF and NIJ for evaluation. The advanced diode-pumped laser technology is being incorporated into a 250 milliwatt 532nm green-laser hand-held flashlight. The device includes a miniature laser and power supply and has output optics that temporarily expand the eye-safe laser into a blinding light. It can also penetrate smoke and fog at more than twice the distance of white light. The dual-use technology is likely to be marketed separately to military and commercial markets.

4.5.2 Laser Pointers - during October and November 1997 a spate of incidences involving children distracting drivers of, for example, school buses was reported in the press. **(19)** Footballers, firefighters and women were amongst other groups who had been specifically targeted. Whilst most devices on the UK market had an output of less than 5 milliwatts, and according to manufacturers were not dangerous (being more suitable for dazzling or distraction), there were reports of much more powerful 'mini-lasers' becoming available. As a result Consumer Affairs Minister Nigel Griffiths banned laser pointers which came into the Class 3 category on 28/10/98.

4.6 Vortex-Ring Generator - this continues to be developed. **(20)** Lucey and Jasper describes the work of a team from ARL and ARDEC to demonstrate a kit for retrofitting to weapons already stockpiled which enables a weapon to apply flash, concussion, vortex ring impacts, marker dyes and malodorous impulses onto a target at frequencies approaching the resonance of human body parts.

5. 'Exotic' Weapons Systems

Two recent papers have examined various aspects of what may be termed as the 'exotic' end of NLWs. **(21)** Victorian, a long-term researcher in such topics, describes in some detail American and Russian research in the fields of electronic, microwave and mind control technology and claims that because the West's scientific community refused to take the topic seriously, it gave the Soviets at least 30 years head start in the field of psychotronic weaponry. Victorian also describes work being done in the UK at Queen Elizabeth College, London on microwave weaponry, and suggests that women who were involved in the 'Greenham Common Women's Peace Camp' were at some stages affected by similar weapons. Several other consciousness-altering devices are described. Thomas quotes an article written by a Russian Army Major I. Chernishev who describes work being done in Russia on 'psychotronic war' and 'psy' weapons. These included methods for disrupting the psyche of an individual including: ESP research, clairvoyance, telepathy, telekinesis and psychokinesis. A recent Channel Four TV programme **(22)** interviewed participants and researchers in the US Intelligence Community funded programme working in this area - particularly using a technique known as 'remote viewing'.

6. Technology of Political Control

Ballantyne in a recent article **(23)** writes of the danger that some of the new non-lethal technology is being misused as 'repression technology', echoing a warning voiced by the British Society for Social Responsibility of Scientists (BSSRS) some twenty years ago. Enough concern was felt within the EU, that the Scientific and Technological Options Assessment (STOA) Committee of the European Parliament commissioned a study on behalf of the European Union's Civil Liberties and Internal Affairs Committee entitled: An Appraisal of the Technology of Political Control. **(24)** The report, written by the Omega Foundation, is critical of 'harmless' NLWs and documents cases of where people have been killed or seriously injured, and where police forces have used the weapons for torture or in a cruel and inhumane manner. It particularly focuses in what is identified as increasingly intrusive and malign surveillance techniques which threaten fundamental civil and human rights. The report calls for effective international codes of conduct and mechanisms to prevent these technologies from being used to violate human rights.

7. Commercial

7.1 Commerce Business Daily Online - Non-Lethal Weapons.

On 8 May 1998 the US Commerce Department published a Broad Agency Announcement (BAA) for new non-lethal technology ideas on their 'Commerce Business Daily' Internet website (at <http://cbdnet.access.gpo.gov/>) asking for submissions to the Joint Non-Lethal Weapons Directorate. The procurement requirement was for one to two year concept demonstration projects that will be funded up to the \$700,000 level. Emphasis was placed on developing systems that provide a 'leap ahead' capability from what is currently available with blunt trauma type munitions such as rubber bullets. Consideration would be given to proposals which addressed one or more of the following core capability requirements:

- To provide a non-lethal dispenser/tool that can be selected/adjusted - a "rheostat" or "tunable" quality - whose effects are tunable across the entire force spectrum (from no effect up to lethal).
- To effectively employ non-lethal technology beyond effective small arms engagement (greater than 100 metres). In addition to tactical applications, there is interest to include the use of NLWs in the battle space of major conflicts
- Capabilities to both deploy and employ non-lethal technologies without sacrificing other critical offensive and defensive capabilities and options. The following prioritized list of desired operational capabilities was given:
 - incapacitate personnel
 - clear facilities of personnel
 - denial of area to personnel
 - seize personnel
 - denial area to vehicles
 - disable/neutralise vehicles
- Capabilities that allow for replacement of lethal anti-personnel landmines (APLs) with non-lethal alternatives that produce the same desired effects as of APLs such as delaying, hindering and even incapacitating individuals without producing lethal or irreversible damage.

Desired qualities for any non-lethal system proposed to address the above capabilities were stated as being:

- enhance operations - provide more flexibility

- augment lethal force - allow soldier to use lethal force if necessary
- expeditionary - rugged, easy maintenance and transportable
- reversible effects - no permanent damage

7.2 Private Companies

(Inclusion of selected companies listed in this report does not imply endorsement or support of any kind. They are only given to illustrate the range of 'non-lethal', products now available on the market. The weapons mentioned are only part of what each company has to offer).

7.2.1 AERKO INTERNATIONAL: PO Box 23884, Ft Lauderdale, FL 33307, USA.

<http://www.shadow.net/~aerko1/>

- - 'FREEZE+P'. A mixture of CS (1%) and OC (1%) spray with an ultra-violet dye delivered via a hydrocarbon propellant. The strong respiratory effects of OC combine with the severe pain induced by CS, and magnify each other.

7.2.2 ALS TECHNOLOGIES: PO Box 525 (1301 Central Blvd.), Bull Shoals, AR 72619, U.S.

<http://www.ozarkmnts.com/less-lethal/index.htm>.

- - 'Power Punch' Bean Bag. Fired from a shotgun, this is a 12-gauge round which launches a 40-gram ballistic nylon shot-filled bag.
- - 'The Bolo'. 12-gauge round which launches (at 400 feet/sec) three .72 calibre high energy release rubber balls connected together with 12 feet of cord. Range 20-40 yards.

7.2.3 EASTERN COMPANY: Republic of Korea (<http://www.spraygasguns.com/products>)

- - 'Black Guardian'. Semi-automatic 5 shot revolver firing 18% CS powder gas (ortho chloro benzyl malonomitrile), with a range of 30-45 feet. Effective within 2 secs. Eastern Company also make imitation .45 mm pistols which spray liquid CS.

7.2.4 FREEMAN MARKETING: <http://www.freeman-mkt.com/homepage.htm>

- - 'The Big Kahuna'. 300,000 volt Stun Gun. Powered by two 9 volt batteries (\$59.95).
- - Air Taser. Range 15 feet. 50,000 volts. (\$189.95)

7.3.5 LIFEGUARD: 292, Leigh Road, Trading Estate, Slough, Berkshire, SL1 4BD, UK

- - Excalibur 38mm Multi Shot Riot Gun (CS grenades/cartridges and baton rounds)

7.2.6 JAYCOR: 9775 Towne Centre Drive, San Diego, CA 92121, U.S.

<http://www.jaycor.com/>

- - Auto-Arrestor. Short pulse of electrical current to disrupt vehicle electronic ignition systems. Three main versions: portable electronic roadblock, in- car chase system, stationary and permanent roadblock.
- - Electrified water cannon. Under development. Vehicle mounted, high pressure saline solution, range about 20 feet.
- - Sticky Shocker - wire-less electrified projectile. Short barbs attached to baton type round. Can deliver about 50,000 volts. Range about 10 metres.

7.2.7 MK BALLISTICS: P.O. Box 1097, Hollister, CA 95023, U.S.

<http://www.pneu.net/mk/>

- - Shotgun Rubber Buckshot. Cartridges loaded with twelve 3/8inch rubber balls.
- - Rifle Lead Balls. Brass cartridges loaded with five .22 calibre lead balls fired at low velocity. Range 10-25 yds. Can be used in M16, AR-15, Mini-14 weapons.

7.2.8 TALLEY: 2702 N. 44th Street, 100A Phoenix, AZ 85008, U.S.

<http://www.talleyind.com>

- - 'DD' Grenade. Flash-bang device.

7.2.9 UNIVERSAL PROPULSION COMPANY: 25401 North Central Avenue, Phoenix, AZ 85027-7899, U.S. <http://www.upco-inc.com/>

- - Model 1750 Distraction Device. Grenade like device combining light and acoustics. Gives 174dB @ 5ft. and > 2,000,000 candle power.
- - Model 1744 Scorpion Rubber Ball Launcher. Fires a .6 5mm rubber ball with an accuracy of 6 inches at 10 metres. Can also fire CS projectiles. Standalone or attached to an M16.

7.2.10 VERNEY-CARRON: 54, Bvd. Thiers.BP, 42002 Saint-Etienne, France.

<http://www.protee.fr/verney-carron/verney.htm>

- - 'Flash-Ball'. Two 44mm barrels fire soft rubber balls, CS gas balls, dye balls. Range 10-25 metres. Looks like a double barreled shotgun. Has 'stopping power of a 38 special'.

8. Bio-Effects of Non-Lethal Weapons

Two papers concerning biological and physiological effects of NLWs were given at the 1998 NLD III Conference by Murphy **(25)** and Widder et al **(26)**. Murphy describes the characteristics (biological variability, safety margins and testing) of NLW bioeffects, and then discusses the importance and implications of these bioeffect findings to the technical design and operational utility of non-lethal technology deployment. Animals were used by Murphy and his team to test the bioeffects of an acoustic weapon. He concludes that unless more attention is paid to this subject "...expensive hardware could be developed that would be operationally useless, prohibited by policy, or both." Weapons could be developed that would produce unreliable or extremely variable effects. Widder et al examine the blunt trauma potential of a 'free flying projectile' using data obtained from experiments with goats and other surrogate animals, and human cadavers. It was ascertained that the physiological effects of blunt trauma are due mainly to two simultaneous injury mechanisms

- crush and shear - crushes organs and shears arteries, veins, bone and connective tissue
- viscous damage - rapid compression of tissue means it cannot deform rapidly enough to relieve the sudden increase in hydrostatic pressure, so organs tissue can explode.

Widder et al propose that future testing should avoid animals and rely more on computer modeling.

9. Conclusion

The arguments for and against the operational deployment of NLWs remain the same. After the initial flush of enthusiasm and some rather wild claims made with respect to the utility and effectiveness of NLWs, military and law enforcement agencies are now putting in place better designed and conceived research and evaluation programmes. These are being helped by modelling and simulation of actual and potential scenarios, and opportunities for field testing under operational conditions some of the newer weapons. This report has indicated the key non-lethal technologies being pursued, and some of the agencies and research institutes focusing on particular technologies. The importance of dual-use technologies remains, and there is a concerted effort being made to look at potential marketing and commercial openings. The technology and proven operational capacity of UAV platforms is being enhanced **(27)**, and this type of NLW delivery platform will attract increasing resources for development. NLWs are now becoming firmly established in U.S. military doctrine and operational perspectives, and will have increasing implications for weapons conventions (especially with respect to how riot control and toxic chemicals are defined) and human rights. **(28)**

There are calls within Europe for an integrated approach to NLWs, although in this respect there seems to be a hesitancy on the part of some NATO partners, and some MoD defence analysts in the UK seem somewhat sceptical about the separate concept of non-lethality and the value of a joint NATO policy.

If a NATO policy for NLWs were indeed created, this would have repercussions for national Defence planning. We must realise in this respect that, just like most of our partners, we are faced with a budget under pressure. The introduction of NLWs would further increase the pressure on the budget, leading to a situation in which choices would have to be made, with the introduction of NLWs taking place at the cost of 'regular' assets. The introduction of NLW concepts also has repercussions for the way in which military operations are conducted: they will become more complex in terms of execution and preparation. Organisational adaptations might also prove necessary, as well as different training requirements. **(29)**

Much of the interest, especially from countries such as the Netherlands and Denmark, comes from their experience in peacekeeping operations and OOTW in urban environments, and this echoes the thoughts of some UK soldiers who have been involved in such situations. Increasing resources are also being allocated by Sweden and Finland. **(30)**

The bioeffects (both short and long term) of NLWs are being questioned more. The U.S. JNLWP has funded the Human Effects Advisory Panel (HEAP) at PennState University to record the experimentation and testing being done in relation to this, and the report mentioned two examples of this work.

Notes

1. Taken from Department of Defense Joint Non-Lethal Weapons Programme Internet Website at:
<http://www.hqmc.usmc.mil/nlw/nlw.net>
2. Mazarra, A. The US Joint Non-Lethal Program Office. Paper given at Conference on 'The Future of Non-Lethal Weapons', Jane's Defence Group, London, 20/21 November 1997. Col Andy Mazarra is an officer in the USMC which is the US DoD's executive agent for the Joint Non-Lethal Weapons Program.
3. Libby, H. US Technical Programme Overview. Paper given at Conference on 'The Future of Non-Lethal Weapons', Jane's Defence Group, London, 20/21 November 1997.
4. These notes are taken from: Scannell, E. The Future of Non-Lethal Weapons. Paper given at Conference on 'The Future of Non-Lethal Weapons', Jane's Defence Group, London, 20/21 November 1997.
5. Water jets by themselves require large water supply at high pressure driven to achieve adequate range. Combining air and water synergistically produces an increase in density of jet, maintains a high velocity over a longer range, and enables more accurate targetting. This has been tested by ARL at Proving Ground 52, Reiteralpe, Germany.
6. Joint Non-Lethal Weapons Directorate News, Vol.1, No.3, December 1997; Dennis Herbert, 'Non-Lethal Weapons Pose Variety of Military Challenges', Defense News, 1/6/98.
7. From a paper written by Sze, H et al for PRIMEX Physics International. Contact e-mail: hmsze@san.prmx.com or tel: 00 1 510 577 7239.
8. Boesch, H & Benwell, B & Ellis, V. A High Power Electrically Driven Impulsive Acoustic Source for Target Experiments and Area-Denial Applications. Army Research Laboratory, 2800

Powder Mill Road, Adelphi, MD 20873, U.S. Available on Internet <http://www.dtic.mil/stinet/ndia/NLD3/boe.pdf>

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