

Active Denial System

A Non-Lethal Weapon for the 21st Century Warfighter



Directed Energy Weapons 2006

London, England

January 24, 2006



The U.S. Defense Department is pursuing the development of Non-Lethal Weapons in order to provide our forces additional options for conducting operations in the 21st century.





Non-Lethal Weapons enhance the capability of U.S. Forces to:

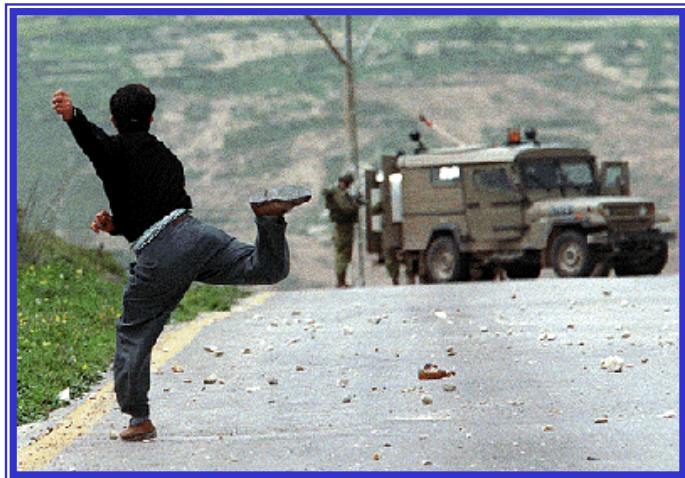
- Discourage, delay or prevent hostile actions
- Limit escalation
- Take military action in situations where use of lethal force is not the preferred option
- Better protect our forces
- Temporarily disable equipment, facilities and personnel

Simply stated, Non-Lethal Weapons provide our forces an additional option between “shouting” and “shooting”



Non-Lethal Weapon Defense Department Definition

“Weapons that are explicitly designed and primarily employed so as to *incapacitate personnel or materiel*, while *minimizing fatalities, permanent injury* to personnel, and *undesired damage* to property and the environment.”



U.S. Forces Want and Need Non-Lethal Weapons



Operating in Urban Environments



Countering Asymmetric Threats

**Representative
Operational
Challenges**



Site Security



Determining Friend from Foe

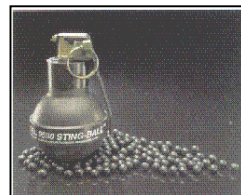
Non-Lethal Weapons Today



• Provide an initial, but limited capability



• Consist primarily of blunt impact munitions which use kinetic energy to provide a non-lethal effect



• Have relatively short range



• Have proven effective in many situations and have been credited with saving many lives



Active Denial System

- A mobile, self-contained, tactically feasible non-lethal counter-personnel directed energy weapon
- Provides numerous advantages over existing non-lethal weapons such as extended range and extremely small risk of injury



Active Denial System 1



ADS Evolution



**ADS Initial Concept
(1989)**



**ADS Concept
Demonstrator
(2000)**



**ADS System 1
(2005)**

Active Denial System 1



- **Highly Mobile Multi-Wheeled Vehicle (HMMWV) Integrated System**
 - 95 GHz mm-wave beam; speed of light
 - Millimeter wave...not microwave!
 - Precise, line-of-sight
 - Deep magazine – limited only by HMMWV fuel capacity
 - Day / Night Capability
- **Provides a repelling effect at ranges greater than that of small arms range**
- **The resulting target human effects are universal and compelling**



How Does ADS Work?



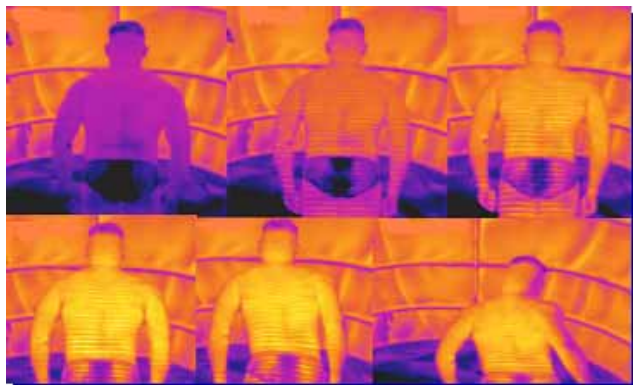
- ADS uses Millimeter Wave Energy (95GHz), which is absorbed in top 1/64th inch of skin
- Skin heats nearly instantaneously, triggering involuntary response
- Target unable to conduct/continue potential military task
- Instantaneous onset and termination of effect



Human skin cross-section

ADS effect is thoroughly tested

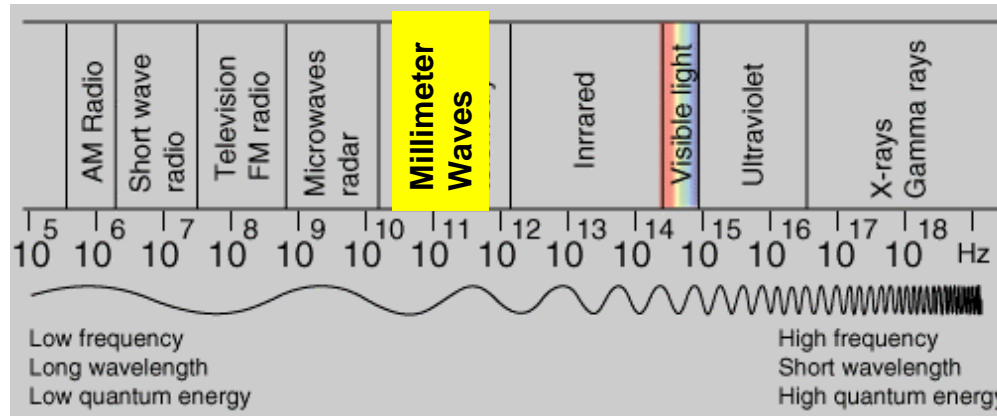
- 12 years of bio-effects research
- 100's of volunteers and over 9300 shots (laboratory and field)
- Peer-reviewed research results
- Numerous independent reviews



Human Testing – IR view



Millimeter Waves vs. Microwaves



Microwave Oven

Microwaves

Frequency: 2.5GHz

Wavelength: 4.7 inches



Active Denial System

Millimeter Waves

Frequency: 95 GHz

Wavelength: 0.12 inches (vacuum)

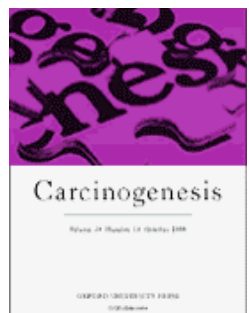
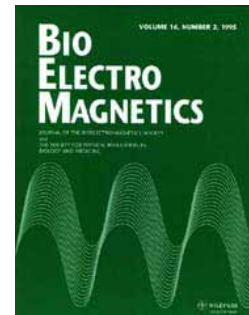
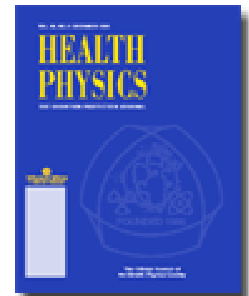
0.015 inches (skin)

- Microwaves are much longer in length, allowing them to go deeper, thus being useful for cooking food
- Millimeter waves are much, much shorter in length, allowing for only the surface heating effect



Representative Peer Reviewed Research

- Walters, TJ, Blick, DW, Johnson, LR, Adair, ER, and Foster, KR (2000) *Heating and Pain Sensation Produced in Human Skin by Millimeter Waves: Comparison to a Simple Thermal Model.* Health Physics 78(3): 259-267.
- Pakhomov, A.G. Akyel, Y. Pakhomova, O.N., Stuck, B.E., and Murphy, M.R. *Current State and Implications of Research on Biological Effects of Millimeter Waves,* Bioelectromagnetics 19:393-413, 1998.
- Mason, PA, Walters, TJ, DiGiovanni, J, Beason, CW, Jauchem, JR, Dick, EJ, Jr., Mahajan, K, Dusch, SJ, Shields, BA, Merritt, JH, Murphy, MR, and Ryan, KL (2001). *Lack of Effect of 94.0 GHz Radio Frequency Radiation Exposure in an Animal Model of Skin Carcinogenesis.* Carcinogenesis, 22:1701-1708, 2001.



Comprehensive Human Effects Program



- Over 12 years of bio-effects research that has been independently reviewed has confirmed:
 - ADS provides consistent and reliable effects regardless of age, gender, size and body type
 - Significant safety margin exists to prevent eye injury
 - Significant safety margin exists regardless of environment, use of alcohol, eyewear, jewelry
 - ADS does not cause or co-promote skin cancer
 - ADS exposure causes no reproduction concerns

The ADS effect is safe and effective with minimal risk of injury



Independent Reviews

- Within the Department of Defense:
 - 3 independent panels reviewed the work of the ADS development team
 - The *Non-Lethal Weapons Human Effects Review Board*, which consists of representatives from all the Service Surgeon Generals and the Medical Officer of the Marine Corps.
 - The *Armed Forces Epidemiological Board* which examines occupational safety issues for DoD personnel
 - The *Tri-Service Electromagnetic Radiation Panel* which examines health and safety issues associated with non-ionizing radiation in the 0 – 300 GHz portion of the electromagnetic spectrum
 - All panels concluded that the ADS effect is thoroughly researched and provides a safe and effective non-lethal capability with minimal risk of injury
- Outside of the Department of Defense:
 - The Human Effects Advisory Panel at Penn State University reviewed ADS in 2002 and 2004
 - The panel included subject matter experts from such prestigious institutions as Yale University, the University of Virginia Medical Center, Hershey Medical Center and Temple University School of Medicine
 - The panel concluded that ADS was a model non-lethal weapon development program with a resulting human effect that has minimal risk of injury.

ADS is the most studied and reviewed non-lethal weapon in DoD history.



Legal and Treaty Compliance

- Per Defense Department Policy, non-lethal weapons undergo the same stringent legal and treaty compliance review process as lethal weapons
- **Legal Review Results:**
 - *The development, acquisition, use and possession of the Active Denial System 1 is allowed under U.S. Domestic Law*
 - *Law of Armed Conflict*
 - *Active Denial System 1 does not cause unnecessary suffering that is disproportionate to the military advantage of using the weapon*
 - *Active Denial System 1 is discriminate and capable of being controlled and directed against a lawful target*
 - *There is no specific rule of law prohibiting the use of Active Denial System 1*
- **Treaty Compliance Review Results:**
 - *ADS ACTD System 1 is compliant with relevant arms control obligations*

Field Testing Is Demonstrating Military Utility





Active Denial System Current Status

- ADS System 1 is now undergoing military user assessments
- The Army, Marine Corps, Air Force, Navy and Coast Guard are participating in these assessments
- Based on the results of these assessments and other military needs, the Services will determine their future requirements for this new capability





Summary

- Non-Lethal Weapons are of increasing importance to U.S. Forces
- The Active Denial System provides a new non-lethal capability helping to fill the gap between the ‘shout’ or ‘shoot’ alternatives faced by our troops
- The Active Denial System has the potential to provide a tremendous new capability for U.S. Forces in support of today’s complex missions

