The Active Denial System
A Revolutionary, Non-lethal Weapon for Today's Battlefield

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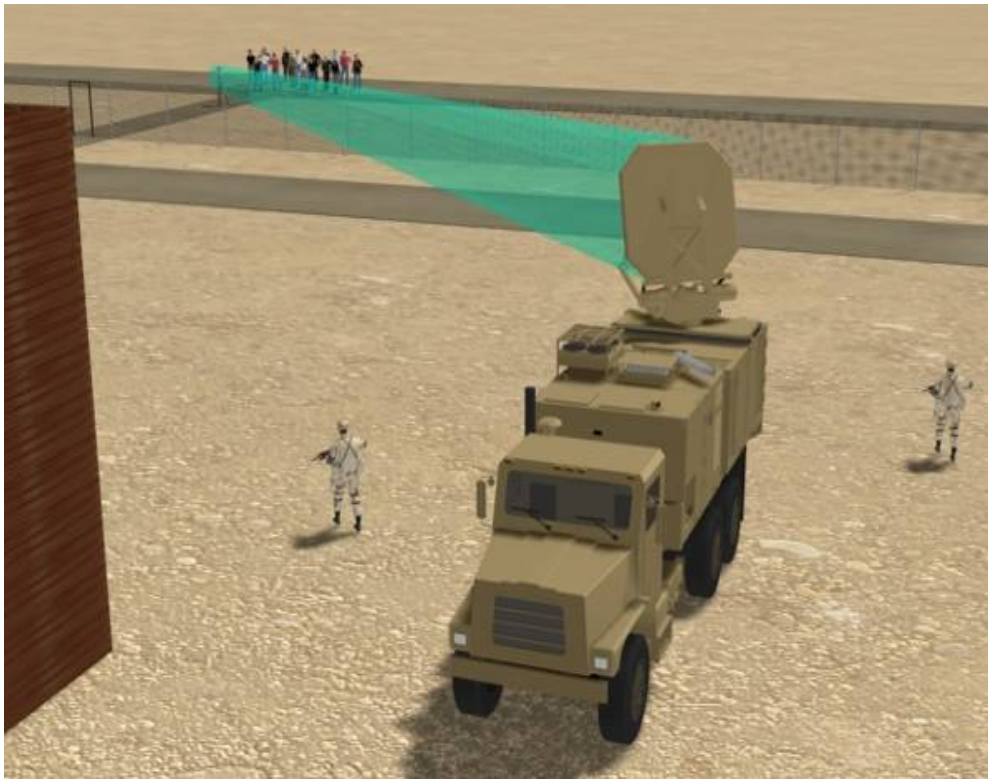
Figure 1. The Active Denial System directed energy beam can engage targets at extended ranges, giving a clear warning to potential aggressors while increasing the force protection of U.S. troops. (Image courtesy of Raytheon Company)



Introduction

Since the end of the Cold War, U.S. Armed Forces have participated in many operations that combine military operations against combatants in situations where the civilian population is at risk. Such complex operations, as they are now called, necessarily place troops in close contact with local civilians—and sometimes in confrontations that lead to violence. Use of force against civilians can create local tensions that undermine efforts to rebuild a society and, thanks to the globalization of communications, widespread condemnation that can jeopardize the entire mission.

Non-lethal weapons provide an additional set of tools for our troops engaged in complex operations. Research efforts to advance the types and efficacy of non-lethal weapons available to our warfighters is producing novel capabilities. One such capability is the Active Denial System (ADS). ADS can provide our troops a capability they currently do not have, the ability to reach out and engage potential adversaries at distances well beyond small arms range, and in a safe, effective, and non-lethal manner. The ADS can immediately compel an individual to cease threatening behavior or depart through application of a directed energy beam that provides a sensation of intense heat on the surface of the skin. The effect is overwhelming, causing an immediate repel response by the targeted individual. The vignettes below illustrate two of many possible applications.

A soldier is manning a checkpoint, guarding an important facility. She notices a group of people approaching her position. The group appears agitated and threatening. Or is it? The soldier tries to decide as the group nears. There are women and children in the group, as well as several men yelling something in a language the soldier does not understand. Through a loudspeaker the soldier warns the group that they are approaching a restricted area. She tells them to halt. They keep coming. Are they ignoring the warning? Or did they not understand it? They are almost on her. She may have to use lethal force.

But the soldier has another option. She calls for support from the operators of the compound's ADS, who have been observing the situation through the system's onboard optics. In particular, they have been watching a man who appears to be leading the group. Upon the order of the on-scene commander, the ADS operators target the man and activate the beam (see figure 1 on facing page). The man turns and runs a few steps. The group stops, puzzled by his behavior. The man regains his composure and returns to the group, urging it on to the compound. The ADS operators reengage the man, who turns and runs off. The group quickly follows him.

A United States Navy ship is underway in international waters. The lookout on deck has been monitoring the movement of a small "go-fast" boat that has been trailing his ship. The boat's behavior is becoming increasingly suspect, approaching the ship, veering off, returning a few minutes later, coming ever closer. Does the boat hold a group of terrorists attempting a suicide attack, or just a family trying to get a closer look at a Navy ship? The officer-of-the-deck alerts the commanding officer, who decides to issue a clear warning to the occupants of the boat. As the boat approaches the ship again, operators of the shipboard ADS target the boat driver. Upon feeling the intense heat, the boat driver immediately stops piloting the boat, ducks for cover, and does not resume following the ship.

As these vignettes illustrate, ADS technology has the potential to provide our warfighters new options in sensitive situations. Along with new technologies come numerous questions. Does the military really need this technology? How does it work? Is it legal and compliant with U.S. international treaty obligations? How quickly can it be deployed? What are the policy implications for employment? Does the risk of injury rule out its use against human targets? This article addresses those topics and the in-depth research that has resulted in the development of the ADS as a potential game changer for the 21st-century warfighter.

The Complex Battlefield

Today's battlefield is characterized by urban terrain and poses a challenge in distinguishing ordinary citizens engaged in harmless activities from those who intend to cause harm. As engagements in Iraq, Afghanistan, Somalia, Bosnia, Kosovo, and Haiti demonstrate, today's battlefield environment has created an increased demand for non-lethal weapons. When a suspicious situation arises, our troops have only moments to make a decision on the use of lethal force, even when clearly allowed within the rules of engagement. When a lethal shot takes the life of an innocent victim, the consequences are passed through the victim's family and friends. The Iraqi or Afghani man or woman who may originally have supported or been indifferent to U.S. forces may switch to supporting insurgents. Because of such incidents, the campaign to win hearts and minds can be lost because of the understandable need for self-protection.

Today's non-lethal weapons, while useful in a number of situations, have limitations, particularly with respect to range and universality of effect. Blunt impact munitions, electric stun guns, flash bang grenades, and pepper spray have been used successfully in many situations, but they have limited range, on the order of 50 meters or less. The ADS provides a means to project non-lethal force well beyond that range, greatly enhancing force protection for U.S. troops.

Technology Concept

Although the use of a millimeter wave beam as a non-lethal weapon is new, the phenomenon of millimeter waves has been studied since James Maxwell's theory of electromagnetism revolutionized physics in the late 1800s. Maxwell's theory opened the door to the electromagnetic spectrum, which ranges from radio waves, microwaves, millimeter waves, infrared radiation, and visible light to x-rays.

The ADS is often mistakenly referred to as a weapon that produces microwave energy, but there is a big difference between microwaves and millimeter waves. Microwaves penetrate deeply, which is why they can cook, for example, a large roast. Microwave ovens operate at a frequency of approximately 2.5 GHz (2.5×10^9 Hz), with a corresponding wavelength of 4.7 inches. The ADS operates at 95 GHz (95×10^9 Hz), with a corresponding wavelength of approximately 1/64th inch—about the thickness of three sheets of paper. This extremely short wavelength allows the application of this technology as a non-lethal weapon, because the ADS heats only the top layer of skin.

Initial System Configurations

The first ADS configuration consisted of a conex shipping container housing the necessary components, with the antenna mounted on the roof. This system, known simply as System 0, allowed for proof of concept testing that led to the ADS Advanced Concept Technology Demonstration (ACTD). For demonstration and warfighter assessment purposes, the ADS ACTD first integrated the millimeter wave beam into a hybrid-electric version of the Highly Mobile Multi-Wheeled Vehicle (HMMWV), popularly known as a "Humvee." This technology demonstrator, referred to as System 1, is shown in figure 2**.**

The ADS ACTD and System 1 configuration were conceived prior to the terrorist attacks of September 11, 2001. Recognizing the potential applications of this technology in complex operations, the Office of the Secretary of Defense provided additional funding to the ADS ACTD to build System 2, which is armored, environmentally sealed, and designed to operate between 0 and 125 degrees Fahrenheit. System 2 is a containerized design composed of two boxes that can be transported by, or operated from, a variety of tactical trucks. One box contains the components necessary to produce the directed energy beam. The second box is a self-contained power generator unit and operator station.

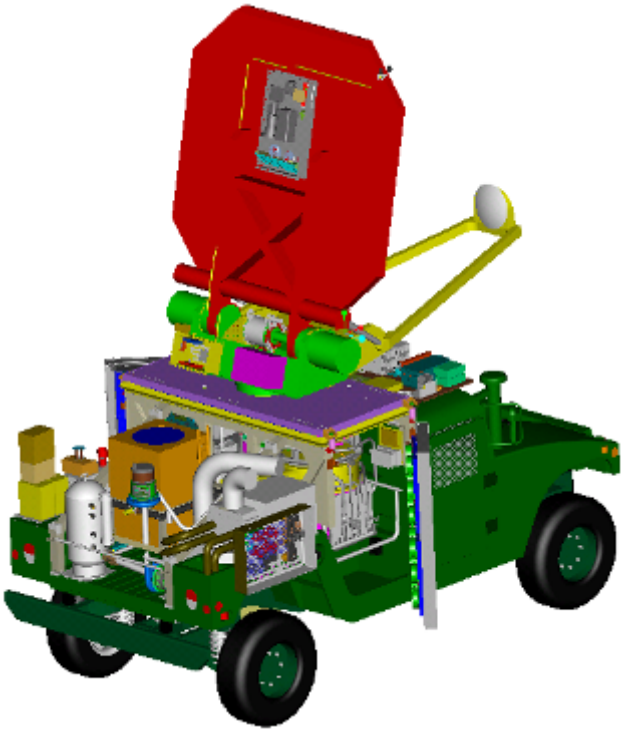
The Air Force Research Laboratory (AFRL) at Kirtland Air Force Base in Albuquerque, NM, has been the principal developer of active denial technology. Known worldwide as a leader in directed energy technology development, the AFRL Directed Energy Division conceived the design to weaponize millimeter waves as a non-lethal directed energy weapon into a configuration that would be militarily useful. For System 1, the substantial technical challenge was integrating all the technology components needed to mount a self-contained, millimeter wave system onto the Humvee platform. System 0 had a total volume of 1,280 cubic feet and a weight of 16,500 lbs. To integrate the technology on the Humvee, system components had to be scaled down to a volume of 190 cubic feet and a maximum weight of roughly 6,000 lbs. Major technical challenges included development of self-contained power generation and a system to reduce the considerable heat generated by system components.

Power Generation. The production of millimeter waves requires the conversion of electrical energy to millimeter wave energy. To generate millimeter wave energy that reaches tactically significant ranges (on the order of hundreds of meters), a substantial amount of electrical energy is needed by the millimeter wave source. A Humvee with a hybrid electric power plant, using a combination of lithium ion batteries and a diesel generator, was chosen as the optimum method for generating and storing the required electric energy in the constrained space of the Humvee.

A primary challenge for System 1 developers was producing a millimeter wave source that was efficient and generated sufficient power to be effective at the required distances. A vacuum tube device called a gyrotron, which is commonly used in high-power radio frequency applications, was selected. The source developed for ADS achieved record-

Figure 2. ADS Technology Demonstrator

Figure 3. ADS Technology Demonstrator Components



breaking levels of power conversion efficiency for this type of device—in excess of 50 percent—and output power levels of approximately 100 kilowatts. To help achieve this efficiency, it was necessary to produce very high magnetic fields around the gyrotron, which was done with a superconducting magnet operating at approximately 4 degrees Kelvin. This was achieved with a liquid helium cryocompressor instead of surrounding the magnet in liquid cryogens, which would have made the system nearly impractical for field applications. Even with the gyrotron's high efficiency, nearly half of its input power had to be dissipated. This was accomplished in the Humvee with extensive use of liquid cooling loops, radiators and fans.

System Operation. Figure 3 depicts the main components of the ADS. The system works as follows. The Humvee's hybrid-electric power plant is the prime power source for the entire system, including the gyrotron. The gyrotron's millimeter wave output is sent through a beam conditioner system that focuses the waves into a beam and carefully steers it to a small subreflector plate in front of the main antenna. The subreflector then broadens the beam to evenly illuminate the main antenna reflector array, which then sends the millimeter wave beam down range. The antenna is made up of 25 separate subreflectors, each of which affects the beam differently; together they produce a nearly constant beam diameter down to the maximum effective range. A video camera for day operations and an infrared camera for night operations allow the system operator in the Humvee to aim and fire the system using a joystick, while seeing exactly where the millimeter waves are directed and the reactions of the human targets on the display panel. Concerns that a human target could accidentally be overexposed are mitigated by the fact that the beam is turned off immediately by releasing the trigger or at the expiration of a preset time. Through the use of a laser range finder, the output power level can be adjusted for different ranges to ensure safety parameters are not exceeded. Integrating these components into the Humvee was a significant technological achievement.

Human Effects Research

ADS human effects testing has been extensive. Over the last 12 years, significant resources have been invested in understanding the interaction and effects of millimeter wave energy on a human subject. Since 1993, the Directed Energy Bioffects Division of the ARL Human Effectiveness Directorate at Brooks City-Base, San Antonio, TX, has comprehensively examined the interaction of millimeter waves with the human body. The objective was to study the effectiveness and understand the risk and safety margins associated with the use of this technology as a non-lethal, counter-personnel weapon.

The ADS research program emphasized four major areas: 1) understanding the basic science and physiology of millimeter wave interactions with the human body, 2) evaluating specific effects on skin, 3) evaluating specific effects on the eyes, and 4) determining the risk of cancer. Other areas of interest, such as risk to reproductive organs, were also studied.

Basic Science. At 95GHz, the ADS energy is non-ionizing, meaning that the millimeter waves do not have enough photonic energy to affect cellular structure. The energy reaches a skin depth of 1/64th inch, raising the skin's temperature in a manner similar to the infrared energy from the sun. The ADS heating sensation is intense, but it does not

produce a burn; the sensation ends when exposure to the beam ends. The increase in skin temperature triggers nociceptors, which are nerve endings in the skin that are thermal sensitive. This sudden exposure to the nerve endings evokes the temporary, intolerable heating sensation and instinctive human escape response.

With blunt impact, non-lethal weapons, such as bean bag rounds, the gender, weight, condition, and overall physical health of the targeted individual can be factors in determining both the non-lethal weapon's effectiveness and the likelihood of injury. With the millimeter wave beam, the instinctive repel response is universal; all individuals, no matter their physical characteristics, react to move away from the beam in roughly the same response time. Furthermore, as will be discussed more fully below, experience and test results so far have shown the risk of injury to be extremely remote independent of an individual's physical characteristics.

Reflexive Reaction. Because the ADS beam does not affect cellular structure, the sensation of heat ends when exposure to the beam ends. The reason the sensation is more intense is that most of the energy of the beam is deposited on the surface of the skin, where it excites nociceptors. Cutaneous nociceptors have two interesting properties: they are highly sensitive to a threatening stimulus (though not to normal stimuli), and they trigger a reflex. Thus, heating of the skin by an ADS beam creates an intolerable sensation and reflexive movement to end the discomfort—ducking and running, for example.

Skin Effects. Thorough studies to understand and quantify the effects on human skin were conducted. A major goal of the skin effect studies was to determine if the rapid increase in skin temperature could cause injury, and also to quantify the human reaction rate for the perception of the temperature increase. The baseline for conducting the initial human effects studies was research conducted in the 1940s on skin temperature increases and the effects of intense heating on the skin.[1] ADS human effects testing, like all DOD scientific research using human volunteers, was conducted under strict human use experimentation protocols that are reviewed by an Institutional Review Board and approved by the lead Service Surgeon General. The initial human effects studies were conducted in a laboratory and consisted of exposing the backs of volunteer subjects to a small spot of millimeter wave energy. The subjects sat on a stool and moved when the heating sensation became intolerable. Their reaction time was measured, and any resulting skin irritation examined. The research showed that a considerable safety margin exists between the time it takes for a person to feel the heating sensation and move away from the beam and the time it takes for the beam to produce an injury. Research results were published in peer-reviewed scientific and medical journals in 1997[2] and 2000.[3] Testing later moved to the field, where data on full spot size exposures was recorded.

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[1] Morit, A.R. and Henriques, F.C. Jr, (1947). Studies of thermal injury. II. The relative importance of time and surface temperature in the causation of cutaneous burns. *Am J Pathol*, 23, 697-720

[2] Blick, DW, Adair, ER, Hurt, WD, Sherry, CJ, Walters, TJ and Merritt, JH (1997) Thresholds of Microwave-Evoked Warmth Sensations in Human Skin, *Bioelectromagnetics* 18: 403-409.

[3] 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.

As of the time of writing, there have been over 11,000 exposures on over 700 humans in the laboratory and field studies. Of those 700 humans, 172 volunteers were exposed in the laboratory small spot size evaluations; the other volunteers were exposed in outdoor field assessments using the full spot size from the full-scale millimeter wave source and antenna configuration.

With respect to concerns about skin damage, in most instances there is no after-effect. On occasion, some skin reddening and irritation has been observed. The 11,000 exposures produced only eight second-degree burns, six of which consisted of pea-size blisters that healed without medical attention. The other two required medical care; both individuals recovered fully without complications.

Effects on the Eyes. A thorough research program was conducted to assess effects on the eyes, with and without eyewear (glasses, contact lenses, night vision goggles, etc.). Researchers learned that the human eye reflexively blinks within a quarter of a second of detecting millimeter waves, quickly protecting the eyes. In addition to the blink response, the human reflex is to raise the hands or turn the head to avoid the effect. The research also showed that the use of eyewear does not impact the human target. Similar to the skin effect studies, the eye effect research began with small spot size exposures in the laboratory, followed by full spot size exposures in outdoor field experiments. Research results of the eye tests were published in the scientific medical journal *Health Physics* in 2002[4] and 2003.[5]

Cancer Studies. Scientists believed from the outset that millimeter waves are non-ionizing and, therefore, do not initiate, promote, or co-promote skin cancer. To confirm this hypothesis, a research program was conducted to determine whether the ADS beam might promote or co-promote carcinogenesis in the skin. Using established practices in skin cancer research, the ADS human effects research team investigated the possibility that single or repeated exposures would promote or co-promote skin cancer. These tests included exposing mice to millimeter waves for up to 12 weeks. The results of these tests clearly showed no evidence of cancer promotion or co-promotion. The test results were conclusive that the ADS millimeter wave energy is not a cancer risk. The findings of these studies were published in the peer-reviewed medical journal *Carcinogenesis* in 2001.[6]

Other Considerations. Effects on reproductive organs were also considered in the research program. Due to the shallow penetration depth of millimeter waves, there is no damage to reproductive organs. As part of the verification testing, a sperm motility/morphology study was conducted and verified no effects. Likewise, pacemakers, metal implants, artificial hips, etc. are unaffected by millimeter waves.

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[4] Chalfin S, D'Andrea JA, Comeau PD, Belt ME and Hatcher DJ (2002). Millimeter wave absorption in the nonhuman primate eye at 35GHz and 94GHz. *Health Physics*, 83, 83-90.

[5] Foster KR, D'Andrea JA, Chalfin, S, and Hatcher, DJ (2003). Thermal Modeling of Millimeter Wave Damage to the primate cornea at 35GHz and 94 GHz. *Health Physics*, 84(6): 764-769.

[6] 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.

Independent Human Effects Research Review

The human effects research and independent reviews of the ADS make it the most studied and reviewed non-lethal weapon in DOD history. The research results have been scrutinized by several independent review groups, both government and non-government, to provide an additional assessment on the thoroughness of the research, as well as to assist in the overall understanding and public education required for this revolutionary non-lethal capability. Within DOD, the research was reviewed by the NLW Human Effects Review Board (HERB), which consists of representatives from all the Service Surgeon Generals and the Medical Officer of the Marine Corps. The HERB was established in 1999 to review non-lethal weapon development programs in DOD. The HERB reviewed the ADS research program in 2004 and assessed the research as thorough and comprehensive, recognizing it as a role model for other non-lethal weapons development efforts. The Tri-Service Electromagnetic Radiation Panel, which is chartered with providing technical advice on non-ionizing radiation issues in the 0–300 Ghz portion of the electromagnetic spectrum as they relate to the health and safety of DOD personnel in their missions, also examined the ADS research program in 2004. The Armed Forces Epidemiological Board examined occupational safety issues for DOD personnel who might be exposed to the millimeter wave beam as part of testing, training, exercises, and operational use.

In addition to multiple reviews within DOD, the independent, non-government Human Effects Advisory Panel (HEAP) has also reviewed the program. The HEAP was established in 1998 to provide an independent human effects review of DOD non-lethal weapon efforts. Under the guidance of Penn State University, HEAP panels are formed with non-government personnel, particularly drawing from the academic community, with credentials in the specific technology areas under review. The HEAP that reviewed the ADS research program included recognized experts in multiple disciplines from Yale University, the University of Virginia Medical Center, Hershey Medical Center, and Temple University School of Medicine. The HEAP has reviewed the ADS research program three times—in 2002, 2004, and 2007[7]—and has consistently concluded that ADS is a model non-lethal weapon development program with a resulting human effect that has minimal risk of injury.

In July 2005, the Under Secretary of Defense for Acquisition, Technology and Logistics approved a policy allowing the exposure of DOD personnel for purposes of demonstrating, training, and assessing the ADS ACTD systems outside the strictly controlled research environment and without the use of human-use protocols. This was a significant achievement for this new capability and a critical step in moving it from the laboratory to the field.

Field Demonstrations

Demonstrating the ability of the ADS to have military utility was a critical part of the development effort. The Air Force Operational Test and Evaluation Center (AFOTEC)

[7] "A Narrative Summary and Independent Assessment of the Active Denial System," Dr. John Kenny, et al, Human Effects Advisory Panel, February 11, 2008

conducted three joint military utility assessments (JMUAs) of ADS ACTD System 1. The three JMUAs were held over the course of 8 months, using Air Force, Army, Marine Corps, Coast Guard, and Border Patrol personnel to operate System 1 in a variety of scenarios and in a wide range of realistic environments. Not surprisingly, the Humvee platform, which is at its maximum weight with the millimeter wave weapon system and is unarmored and not ruggedized, was deemed an operational issue for deployment in a desert environment. However, the military utility assessment results demonstrated the warfighters' assessment that the ADS is a highly effective, non-lethal, counter-personnel capability.

Joint Military Utility Assessment One was conducted at Creech Air Force Base, NV, in August 2005. The purpose of this assessment was to evaluate the ability of ADS to enhance military operations in urban terrain (MOUT) and entry control point (ECP) operations. Three airmen from the 99th Security Forces Group, at Creech Air Force Base and Nellis Air Force Base, and four soldiers from the Air Defense Artillery School and 1st Air Defense Artillery Battalion, Fort Bliss, were trained as weapon crew for this assessment. Live, force-on-force exercises were conducted, including two MOUT scenarios and two ECP scenarios. ECP scenarios entailed extended overwatch for a total of 6½ hours. The ADS crews fired 657 shots and achieved 914 hits on human targets. This operational assessment was accomplished in conjunction with USAF Expeditionary Personnel Training. Friendly forces and opposing forces (OPFOR) were volunteers from the training squadron cadre and trainees. As part of the assessment, participants answered questionnaires on statements regarding ADS effectiveness. There was strong consensus among the warfighter participants that ADS has military utility and is effective at impacting the actions of individuals and crowds.

Joint Military Utility Assessment Two was conducted at Fort Benning, GA, in September 2005, at the McKenna MOUT Site. Four previously trained soldiers from Fort Bliss and one airman from Creech participated as weapon crew and over-the-shoulder mentors to the newly trained crew, which included three soldiers from the 29th Infantry Regiment at Fort Benning, and three Marines from the II Marine Expeditionary Force at Camp Lejeune. Scenarios accomplished included obstacle reduction, three iterations; entry control point, 3 hours overwatch; snatch and grab (prisoner recovery), two iterations, including tactical repositioning of ADS; search and rescue, four iterations; and perimeter security, six iterations. ADS crews fired 979 shots and achieved 1463 hits on human targets. Friendly forces and OPFOR were volunteers from local Fort Benning units and military retirees. Warfighters participating in this JMUA indicated strong agreement that ADS can easily complement existing crowd control techniques

Joint Military Utility Assessment Three was conducted at Santa Rosa Island, Eglin AFB, FL, in April 2006. The primary objective was to assess the capability of ADS to enhance the force protection mission in port and harbor environments. The following personnel were trained as weapon crew: three USCG personnel from the USCG Special Mission Training Center (SMTC), Camp Lejeune and two airmen from the AF Security Forces Center and 37th Security Forces Squadron, Lackland AFB. These trained personnel participated in boat-on-water scenarios and pierside security demonstrations. Three pierside demonstrations and three boat-on-water iterations were accomplished, with five target boats per iteration. For this first-time, live-fire demonstration over water, safety

considerations required the vessels to be stationary while their crew members conducted hostile activities. ADS crews fired 305 shots and achieved 474 hits on human targets. OPFOR were volunteers from USCG SMTC.

Legal and Treaty Compliance Reviews

As with lethal weapons, all DOD non-lethal weapons undergo a comprehensive legal and treaty compliance review to ensure that the system under development is consistent with domestic and international law, including the Law of Armed Conflict (LOAC), as well as any applicable treaties to which the United States is a signatory. Since the Air Force was the lead service developer, the Air Force Judge Advocate General (JAG) had the lead in assessing the legality of the system. The findings of the Air Force JAG were reviewed and coordinated with the JAGs of the other Services, the Joint Staff, and the Office of the Secretary of Defense (OSD) General Counsel. With respect to domestic law, the legal review concluded that there is no law that prohibits the development, acquisition, use, or possession of weapons such as the Active Denial System. With respect to international law, the legal review examined the three specific criteria that must be satisfactorily addressed to determine the legality of a weapon under the LOAC. These include 1) whether the weapon causes unnecessary suffering that is disproportionate to the military advantages of using the weapon, 2) whether the weapon is discriminate and capable of being controlled so it can be directed against a lawful target, and 3) whether there is a specific rule of law prohibiting its use under LOAC. The legal review concluded that ADS, when used as intended, does not cause unnecessary suffering due to the brevity of the effect and the target's ability to leave the area. ADS is also discriminate since it can be directed at a specific target. Additionally, there are no specific laws prohibiting use of a system such as ADS under the Law of Armed Conflict.

In addition to the legal review, a treaty compliance assessment was conducted by the OSD Treaty Compliance office. This review examined all applicable treaties to which the United States is a signatory to determine whether the use of ADS would violate any treaties. The compliance review found ADS compliant with all relevant arms control agreements.

Education and Awareness

An important part of the ADS program has been a proactive education and awareness effort that has provided information on this new, non-lethal weapon capability through a series of public displays and media engagements. In November 2006, the ADS made its public debut on display at the grand opening of the National Museum of the Marine Corps in Quantico, VA. In January 2007, the first ADS media day was held at Moody AFB, GA, in which members of the media were able to interview developers of the technology, witness live-fire scenarios, and volunteer to experience the ADS beam first hand. That media day led to factual stories in a number of print and broadcast media outlets. In April 2007, the Discovery Channel's "Future Weapons" program aired a segment on the ADS. During October 2007, at Marine Corps Base Quantico, both System 1 and System 2 were on display, and government officials, news media, and even a representative from Human Rights Watch had the opportunity to ask questions of ADS

subject matter experts, witness demonstrations, and volunteer to experience the effects of the beam. The CBS News program "60 Minutes" aired a segment on ADS in March 2008 ADS also was featured that month on the History Channel's "Modern Marvels" show. Additionally, the Joint Non-Lethal Weapons Program maintains an active and information-rich website on ADS at https://www.jnlwp.com/ads.asp.

These public education and awareness efforts are part of a proactive strategy to provide factual information on the ADS to demystify the technology and demonstrate the benefits it can provide in today's complex operational environment. These efforts underscore a recommendation from the December 2007 report of the Defense Science Board Task Force on Directed Energy Weapons. The task force recommended that DOD undertake a "concerted education effort to replace the 'death ray' myth of directed [energy] weapons" and that "the military departments should accelerate efforts to credibly assess effects on human targets, and widely publicize the facts."[8]

Policy Implications

First-time deployment of this new technology will attract the close attention of the leadership of DOD, Congress, the American public, and the international community. As stated in the Defense Science Board task force report, policy determination on the use of directed energy weapons such as the ADS "needs to be informed by a thorough and credible understanding of the risk and benefits of employing such weapons."[9] Additionally, the task force noted that much of the concern over legal and policy issues "is the product of inadequate communications rather than any unusual legal or policy constraints."[10]

All of the program efforts to date have been focused on providing a solid foundation for those in positions of leadership and policy development to make an informed and educated decision on the future use of this technology. In June 2006, Mr. Ryan Henry, the Principal Deputy Under Secretary of Defense for Policy, signed a memorandum expressing continued support for the development of the ADS. The memorandum notes that the ADS "offers the possibility for wide-ranging applications in multiple scenarios" and is a "technology that the Department should pursue."

Future Plans

While much has been accomplished in developing and demonstrating the technology, much more remains to be done, particularly in reducing the size, weight, and cost of key ADS components. The Joint Non-Lethal Weapons Program continues to invest science and technology research dollars in advanced ADS technologies. A key goal is to enable the development of next-generation, millimeter wave sources, moving beyond the current tube-based technologies to solid-state devices.

[8] Defense Science Board Task Force on Directed Energy Weapons, Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics, December 2007.
[9] Ibid, xiii.
[10] Ibid, xii.

To facilitate transition from ACTD to a formal program of record, the Joint Non-Lethal Weapons Program is sponsoring a transition or "bridge" program led by the Air Armament Center at Eglin Air Force base.

Summary

Active denial technology can fill a critical gap in the escalation of force continuum, the gap between a mission of presence and the use of lethal force. Directed energy weapons such as ADS may prove to have a profound impact on warfighter capabilities in support of complex operations. In one way, ADS today is at the stage of the biplane in 1914; Warfighters want the capability, and, while the system is not yet as sleek and efficient as a user might want, the technology will evolve. The early configuration is worthy of deployment and a true operational assessment on today's complex battlefield.