The Active Denial System

Obstacles and Promise

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P|I|P|S *The Project on International Peace and Security*

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The Project on International Peace and Security
Institute for the Theory and Practice of International Relations
The College of William and Mary

Please direct inquiries to:

The Project on International Peace and Security (PIPS)
Institute for the Theory and Practice of International Relations
The College of William and Mary
427 Scotland Street
Williamsburg, Virginia 23185
tele. 757.221.1441
fax. 757.221.4650
pips@wm.edu

Electronic copies of this report are available at www.wm.edu/pips

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Amy Oakes, Ph.D.
Dennis A. Smith, Ph.D.
Directors

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Executive Summary

The Active Denial System (ADS) is a non-lethal weapons technology that uses millimeter wave directed energy to impede and deter potential adversaries. Developed by the Air Force Research Laboratory and Joint Non-Lethal Weapons Directorate, ADS provides U.S. troops with a highly effective means of responding to potential threats, while also preserving human life.

Despite its promise, ADS has confronted non-technological challenges in its deployment, most recently in Afghanistan. This report analyzes the political, psychological, sociological, and legal barriers to the use of non-lethal, directed energy weapons. Specifically, the report argues that two characteristics—normally viewed as strengths—create obstacles to ADS deployment: (1) the technology causes significant pain without leaving a visible mark or physically harming a target; and (2) it acts silently and invisibly. As a result, ADS raises human rights concerns about its potential for untraceable abuse, use as an instrument of torture, and employ by authoritarian governments as a tool of repression. The unseen nature of ADS's radiation also leads to unfounded fears of long-term health effects and may evoke images of "evil forces" in local folklore, complicating relations with host populations. Finally, the limited health impact of ADS potentially increases the likelihood that it will be used more frequently against civilians compared to other non-lethal technologies. This possibility raises legal concerns about avoiding the targeting of civilians under *in jus bello* and prompts worries that increased ADS use will drive a wedge between U.S. forces and host populations.

The report offers several recommendations to address these obstacles. Primarily, ADS technology should be integrated with other non-lethal technologies, such as acoustic hailers and laser dazzlers, into a single weapons package that provides operators with a non-lethal force continuum. This continuum should have rules of engagement linking a target's actions to a spectrum of non-lethal responses. Within the spectrum, U.S. forces should use ADS as a weapon of last resort with operators initially delivering sensations of mild heat, followed by intense heat if the target is not deterred. In addition, the report recommends that an augmented ADS be combined with tamper-proof audio and visual recording devices to document each use of the millimeter wave beam for review by higher command and, if necessary, the public. The report also recommends that the new system be given a name that avoids negative words, like "denial," which implies that operators are opposed to their targets. Instead, a new name should stress the system's role as a tool of threat determination and deterrence, such as the Non-Lethal Intent Determination System.

The Promise of ADS Technology

Since the end of the Cold War, American military planners have confronted a new strategic and operational landscape. Adversaries have increasingly avoided traditional force-on-force confrontations in which the U.S. military dominates. Instead, they have adopted low-cost unconventional strategies and tactics that target U.S. vulnerabilities in order to raise the human and financial costs of military operations. This deterrent, or asymmetric, approach to warfare seeks to undermine U.S. public support for military engagements. It also seeks to give U.S. leaders pause when they consider escalating or launching future operations. Part of this effort includes adversaries harnessing information technology to shape opinion in the United States, the host nation, and the international community.[1]

U.S. forces also are increasingly operating close to and with civilian populations, as part of peacekeeping, counterinsurgency, stability assistance, and disaster relief efforts. This population-centric arena requires that U.S. forces pay careful attention to host nation and international public opinion. Moreover, it requires that U.S. commanders and troops minimize civilian suffering and damage to infrastructure.[2]

The rise of asymmetric warfare and population-centric operations presents the U.S. military with a difficult challenge. Commanders can expect adversaries to adopt strategies that bait U.S. forces into overusing their conventional superiority, causing greater civilian causalities or collateral damage and thereby undermining public support for U.S. operations. Commanders also can expect adversaries to blend in with the host population to inflict losses on U.S. forces at close range. Given these two probabilities, commanders are confronted with a critical question: *How can U.S. forces minimize civilian suffering, while also giving them the ability to identify and deter aggressors?* One answer has been the rise of non-lethal weapons technology.[3]

The Active Denial System: Benefits

ADS is a revolutionary non-lethal, energy-based weapon that uses non-ionizing millimeter wave radiation to heat the moisture just below the skin's surface, creating a sensation of heat. This sensation prompts an immediate and reflexive flight response in the target.[4]

This millimeter wave technology provides several unique benefits to U.S. forces:

(1) *ADS is a single weapon that provides a spectrum of deterrent options.*

Unlike lethal weapons and a variety of non-lethal weapons—such as conductive energy devices (CEDs), rubber bullets, pepper spray, and tear gas—ADS can operate

along a wide spectrum of deterrence, because the intensity of its millimeter wave is adjustable. This flexibility allows it to produce sensations from moderate discomfort to a feeling of extreme heat. In addition, ADS can be used to deliver single or repeated warnings to a target.

These features allow personnel equipped with ADS to be responsive to changing and highly complex situations that are typical of population-centric operations. The ability to tailor a response precisely to hostile behavior also helps prevent overreactions that can exacerbate rather than contain dangerous situations.

(2) *ADS does not physically damage its targets*.

ADS allows operators to protect themselves and their assets without resorting to lethal or even harmful force. A 2008 Human Effects Advisory Panel study showed that, when operated in the 94-95 GHz frequency range, ADS repels its targets at a lower temperature than would cause first or second-degree burns, and the sensation of heat subsides as soon as a target steps out of the millimeter wave beam. The ability of ADS to leave its target uninjured, without lasting pain, and fully functional almost immediately after use is a revolutionary feature in the realm of non-lethal weapons technology. In the only incident in which ADS resulted in a severe injury, a technical malfunction caused the system to be used outside of its standard power and duration settings.[5]

The ability to cause a sensation of intense heat without physical damage is a significant strength relative to kinetic devices that rely on blunt force to deter a target, risking some degree of harm.[6]

(3) *ADS acts on single human targets, minimizing collateral damage*.

Unlike other non-lethal weapons, such as chemical crowd control systems, ADS's energy beam can precisely target individuals. This feature allows U.S. forces to deter instigators or potential perpetrators of violence selectively. This level of accuracy provides U.S. forces with more control over who is targeted than most other available non-lethal force options, minimizing harm to innocent bystanders.

The precision of ADS contrasts with the use of tear gas or other chemical agents and acoustic devices for crowd control. Gas can spread unpredictably due to prevailing weather conditions, often affecting neutral or even friendly personnel. Gas and other chemical agents also can linger in an area and have adverse effects long after the initial confrontation.[7] And human rights groups like Amnesty International have

argued that acoustic devices like LRAD can cause "long-term hearing damage" if used as a weapon.[8]

Table 1: Characteristics of Non-Lethal Weapons						
	ADS	Chemical	Kinetic	Acoustic	CED	Dazzler
Scalability	✓			✓		✓
Discrimination	✓		✓	✓	✓	✓
Safety	✓	✓		✓	✓	✓
Range	✓			✓		✓
Countermeasures	✓	○		○	○	○

Scalability – Can the non-lethal weapon be used along a wide spectrum of deterrence?
Discrimination – Does the device allow operators to precisely target individuals?
Safety – Does the non-lethal weapon have a low potential to cause serious permanent injury when used within recommended specifications?
Range – Can the device be used beyond the effective range of small arms?
Countermeasures – Is the non-lethal weapon able to withstand basic countermeasures? A circle represents the ability to withstand some, but not all rudimentary countermeasures.

(4) *ADS acts at a range and efficacy unprecedented in the realm of non-lethal technology.*

ADS exceeds the range of traditional non-lethal weapons. This feature is important because it allows operators to use ADS as a non-lethal tool, while being out of the effective range of many traditional forms of lethal retaliation, such as small arms.[9] It is also a quality that most other forms of non-lethal engagement lack, as their operators must be within range of lethal force in order to be used.

ADS also produces an uncontrollable flight response in its targets. In approximately 10,000 test exposures, most subjects reached their threshold for pain within 3 seconds, with no subjects lasting more than 5 seconds. The deterrent effect of ADS is unmatched by other non-lethal technologies.[10]

(5) *ADS can resist most traditional countermeasures.*

Most traditional forms of protection against non-lethal weapons will not counter ADS's millimeter wave, which can penetrate clothing and glass, but not wood or metal. In testing, metal shields proved ineffective because the system works on any area of exposed skin, however small. Even hiding behind concrete traffic barriers proved ineffective because the beam came through the space between the road and the barrier.[11] While countermeasures are possible, ADS is far more difficult to neutralize than other traditional non-lethal weapons.

While some existing non-lethal weapons have a few of these features, ADS is the only system that combines all five characteristics. The unique features of ADS are summarized in Table 1.

The Active Denial System: Development and Deployment

Because of the positive characteristics of non-lethal millimeter wave technology, the Department of Defense designated ADS as an Advance Concept Technology Demonstration program between 2002 and 2007. Two ADS systems were produced under this program:

System 1 is mounted on a specifically modified High Mobility Multi-Purpose Wheeled Vehicle (HMMWV); and

System 2 is a self-contained, box-shaped model transportable via tactical vehicles larger than the HMMWV.

Figure 1: ADS Systems

System 1

System 2

Both systems use a millimeter wave generator that operates in the 94-95 GHz range. In 2008, System 2 underwent a Capabilities and Liabilities review and was deemed ready for deployment.[12] In 2010, ADS was introduced into two theaters—U.S. COIN operations in Afghanistan—and then quickly withdrawn.[13] While the reason for the withdrawal from Afghanistan is unknown, it is rumored that ADS was removed because of concerns about how its use against Afghans might be perceived by the local population and international community.[14]

ADS attracted wide media coverage during and after its initial deployment.[15] While most early coverage was neutral and focused on the technical development of ADS, later reporting emphasized both the positive and negative aspects of the technology. Positive media coverage centered on the ability of ADS to limit civilian deaths, its utility in dispersing mass demonstrations, and aspects of its novel technology, such as its range, economic value, and potential to limit collateral damage.[16] Meanwhile, negative media reports focused on the "science fiction" nature of the technology (i.e., its ability to cause pain from a distance), the potential for a backlash among target populations in theaters of use, and possible unanticipated adverse health effects.[17] In sum, coverage was initially neutral and turned more negative over time.

Barriers to ADS Deployment

Two characteristics of millimeter wave technology, normally viewed as strengths, are obstacles to ADS deployment:

(1) *ADS has the potential to cause severe pain without leaving a visible mark or physically harming a target*.

(2) *ADS acts silently and invisibly*.

These two features prompt concerns about the possibility of human rights abuses, trigger psychological and sociological biases, and raise potential legal objections.

Human Rights Concerns about ADS

ADS can cause severe pain, while leaving no physical evidence of its use. Consequently, there are concerns that ADS technology provides unethical operators with a highly effective and deniable tool of repression and torture. In addition, because ADS is a new and radiation-based technology, some in the human rights community fear that exposure could lead to long-term negative health effects.

While few human rights organizations have explicitly commented on ADS, many have raised concerns about the use of non-lethal weapons. An analysis of these concerns can help shed light on future opposition to ADS deployment and use.

Amnesty International has been the most outspoken critic of non-lethal weapons, particularly of conducted energy devices (CEDs), such as the Taser.[18] It has recommended the recall of all non-lethal weapons on the grounds that their abuse is easy to conceal and they are potentially deadly if used on targets with some medical conditions.[19]

Human Rights Watch does not oppose the use of non-lethal technology in principle; indeed, it has supported their use as an alternative to lethal force in places like New York City, Kazakhstan, Tibet, Yemen, and Uganda.[20] However, in a 2007 interview, Marc Garlasco, a former senior military expert for the organization, argued that, although ADS is preferred to lethal force, it has the potential to be used excessively because of its non-lethal nature. Law enforcement literature supports Garlasco's fear that the availability of

non-lethal force can prompt an "increase in the total incidence of force."[21] Garlasco also expressed misgivings about ADS's long-term health effects.[22]

The United Nations has called for measures to prevent the misuse of non-lethal weapons. In 2004, UN Special Rapporteur on Torture Theo van Boven released a report on the development and sale of technology specifically designed to inflict pain.[23] In Article 30 of the report, Van Boven concluded that non-lethal weapons could be used for "torture and ill-treatment" and recommended extensive testing, "stringent training [for their use], and restrictions on their transfer."[24]

All of these organizations speculate that states and non-state actors could easily abuse non-lethal weapons with impunity, to the extent that these weapons leave no physical trace. In a 1997 report, Amnesty International alleged that twelve states, including the United States, had abused CEDs.[25] Additionally, Human Rights Watch and UN officials worry that there has been insufficient research into the long-term medical effects of non-lethal weapon use, especially testing that examines how non-lethal weapon exposure will interact with pre-existing conditions.

We can extrapolate potential concerns about ADS use in population-centric warfare from the critiques these organizations level at non-lethal weapons in general. The possible objections are outlined below.

- **Potential Human Rights Concern #1: ADS has the ability to cause severe injury to targets.**

  Like many non-lethal weapons, ADS may cause grave harm if misused by operators. During testing, accidental overexposure to the ADS beam caused second-degree burns in a test subject requiring medical intervention.[26]

  The International Convention on Conventional Weapons (CCW) bars the use of certain types of weapons to protect military troops from inhuman injuries and prevent civilians from unintentionally being wounded or killed. Protocol III prohibits the use incendiary weapons that are intended to burn or set fire to a target.[27] While ADS is not an incendiary weapon, its ability to cause burns or create the sensation of burning is a potential cause for concern among human rights groups and may result in calls for ADS technology to be included in the CCW.

  ***Implication**: If unethical governments use ADS outside its safety range to cause severe injury, human rights organizations will likely cite the principles of CCW and call for a complete ban of the technology on the grounds that it is inhumane.*

- **Potential Human Rights Concern #2: The device could be used as an instrument of torture.**

  Because ADS can cause severe pain in a target without causing a target's death or leave no visible mark if exposure occurs at sufficient intervals, it could serve as a device of torture.

  Human rights groups have paid particular attention to the abuse of CEDs, such as the Taser, by members of law enforcement. Examples of abuse have been highlighted in conflicts in Northern Ireland and the Palestinian territories.[28] Amnesty International has paid particular attention to the use of CEDs in the United Kingdom on detained prisoners.[29] There also have been reports documenting abuse of CEDs in China and Saudi Arabia.[30]

  ***Implication**: Human rights organizations will likely view ADS technology as having a high potential for abuse and will pay particular attention to the safeguards operators adopt to protect against this possibility.*

- **Potential Human Rights Concern #3: Operators, even well-meaning ones, are likely to use ADS more frequently than lethal weapons.**

  There is a wealth of evidence that suggests ADS operators may be prone to using the technology more frequently than they would use lethal weapons. For example, law enforcement literature shows that pepper spray and CED use skyrocketed shortly after their respective introductions into U.S. police departments, often surpassing the prior frequency of officer weapons use.[31] Similarly, a Department of Justice study found that police officers were likely to turn to CED use earlier in a confrontation instead of using conflict resolution techniques.[32] Although the mandate of ADS is to mitigate the need for troops to use lethal force, a likely proclivity to use non-lethal weapons could spur an increase in its use against civilians in theater.

  ***Implication**: Human rights organizations will likely be concerned that ADS will result in more frequent uses of force against civilians and will distract from non-violent approaches to managing populations.*

- **Potential Human Rights Concern #4: ADS may have a long-term impact on health or aggravate a target's pre-existing health conditions.**

There is currently no evidence that the ADS beam has any negative long-term health effects. However, there is the possibility that insufficient time has passed to identify any such harmful effects.[33] Additionally, although human effects panels have found that ADS does not worsen pre-existing health conditions, several human rights organizations worry that ADS, like CEDs, may do so.

***Implication**: Human rights groups will be suspicious of government studies indicating that ADS has no long-term health effects and will call for more independent, third-party research to be conducted before they fully sanction use of the technology.*

- **Potential Human Rights Concern #5: ADS may produce unanticipated reactions by targets that result in civilian casualties and collateral damage, especially in urban situations with large crowds and moving vehicles.**

  According to press reports, much of the testing of ADS involved members of the military who were aware of the nature of the technology—in particular, that the sensation of heat would end if they moved out of the beam. Uninformed civilians, however, may not have the same reaction to ADS or may not be able to escape the beam without causing injury. For example, a civilian irradiated by ADS, not knowing the cause of the heat sensation, may drop to the ground in pain, increasing the likelihood of overexposure. The potential for unexpected outcomes is of particular concern in an urban setting. ADS use may cause a crowd to stampede, resulting in injuries. And the use of ADS against occupants of a vehicle may cause that vehicle to hit pedestrians or other cars. In such scenarios, human rights organizations and locals will likely blame U.S. forces for any resulting injuries or damage to property.

  ***Implication**: Human rights groups will likely worry about the unintended negative consequences of ADS use in complex and dense social settings, such as areas in which there is heavy vehicle and pedestrian traffic. ADS testing to date may be seen as unrealistic.*

Psychological and Sociological Biases against ADS

ADS is a radiation-based technology that likely will trigger significant psychological biases against its use. Such biases against radiation, whether ionizing or non-ionizing, are well documented. For example, in a 2000 study, Lennart Sjoberg reported that radiation was one of the four most frightening phenomena according to approximately 700 participants who were

surveyed about a variety of terrifying situations. Additionally, when asked about a Chernobyl-like nuclear disaster, participants indicated that they were more afraid of the mere presence of radiation than the actual catastrophic nature of the accident. The participants also said that they felt radiation technology was "tampering with nature."[34]

A number of psychological studies have further shown that radiation is one of the top "modern health worries" resulting from the emergence of new technologies.[35] Individuals for whom radiation is a primary worry also reported experiencing increased physical sensitivity to the effects of radiation-based technologies.[36] Indeed, victims of nuclear accidents, such as those in Chernobyl in 1986 and Fukushima in 2011, suffer from more persistent psychological trauma than victims of natural disasters, where the physical damage incurred was of a comparable degree.[37]

Two characteristics of radiation-based technology most distress the public and may cause them to view ADS as a particularly frightening weapon:

(1) *Radiation has the potential to cause permanent damage.*

Unlike conventional weapons, radiation not only causes immediate contamination but also long-term, irreversible damage.[38] The potential for permanent injury underlies the fear of and hostility towards radiation technologies.[39] Despite medical testing that indicates the technology is safe, ADS's use of radiation may spark fears that it is carcinogenic.[40]

(2) *Radiation invisibly penetrates the human body*.

Traditional weapons, like bullets, cause pain and physical damage as they visibly penetrate a target's body. But like other radiation-based technologies, the effect of ADS is invisible. Its millimeter wave imperceptibly and inaudibly causes a sensation of burning under the surface of the skin and cornea, while leaving the surface intact.

These characteristics interact to create the potential for significant biases against the use of ADS.

- **Potential Psychological and Sociological Bias #1: As a radiation-based technology, ADS invisibly affects the human body, generating fear about the weapon's health effects.**

ADS uses non-ionizing radiation that lacks the energy to damage DNA and is not associated with cancer, unlike ionizing radiation, which is a carcinogen. The general

public, however, is unlikely to make such a distinction. They may view ADS as a radiation emitting technology that causes pain and fear that it is damaging the human body in unknown ways.[41] Such a reaction is similar to continued popular concerns about possible links between cell phone and power line emissions and cancer, in spite of a wealth of scientific evidence indicating that their non-ionizing radiation is safe.[42] There has been a similar disconnect between scientific evidence indicating that depleted uranium ammunition is safe and continued public fear (see highlight).

ADS would not be the first weapon to be subject to a bias because of a technology's real or perceived ability to damage the human body from the inside out. Chemical and nuclear weapons are two examples.

> *Chemical weapons.* Chemical weapons have not been openly used against combatants since World War I, representing an even more robust taboo than that against nuclear weapons. Richard Price speculates that chemical warfare—like the use of poison before it—has become delegitimized, because the body is damaged internally by chemical agents rather than defeated by superior physical strength. Additionally, delegates at the Hague peace conferences of 1899 and 1907, which set the precedent for all subsequent international discussion on chemical weapons, overwhelmingly agreed that chemical weapons were more likely to affect civilians than conventional weapons.[43]
>
> *Nuclear weapons.* The stigma against nuclear weapons, Nina Tannenwald argues, is rooted in the taboo against chemical weaponry and emerged in the wake of World War II. After the 1945 nuclear bombing of Japan, the U.S. government sought to counter the American public's association of radiation with chemical weapons poisoning. There was also an attempt to "conventionalize" the use of nuclear weapons with the argument that, except in destructive power, nuclear weapons were no different than chemical-based explosives. These efforts eventually failed because of the Soviet Union's acquisition of nuclear weapons and the rise of the international anti-nuclear movement. Fear of the effect of radioactive fallout on the body, reinforced by press coverage of visits by victims of the Hiroshima bombings to the United States for treatment, spurred domestic and international calls for a ban on nuclear testing. This international pressure and a growing fear of nuclear proliferation led to the 1963 Partial Nuclear Test Ban Treaty.[44]

***Implication**: Populations in areas where ADS is deployed will be fearful of the technology, believing that its non-ionizing radiation produces long-term negative health effects. Indeed, even when local populations do not experience the sensation of*

heat that accompanies ADS, they may believe that they are being exposed to radiation because ADS is deployed in their vicinity.

Highlight: Depleted Uranium, Public Fear, and Scientific Research

Scientific findings do not always convince the public that a technology is safe. Extensive research on depleted uranium (DU), for example, has done little to quell societal fears.

The United States and United Kingdom use DU, a weakly radioactive material in armor-piercing ammunition and deep penetration bombs, because of its high density and low cost. Most notably coalition forces used DU ammunition in the 1991 Gulf War, reportedly firing 944,000 DU rounds, and in NATO bombing campaigns in Bosnia and Kosovo.

Research by the UN Environmental Program, RAND, World Health Organization, and IAEA consistently demonstrates that the health risks of DU exposure are insignificant.[45] For example, there is no evidence of the so-called "Balkans Syndrome"—a set of adverse health effects attributed to DU exposure, such as leukemia, birth defects, and neurological disorders. However, these findings have done little to appease those who deem the use of DU weapons in Iraq and the Balkans to be a "war crime."[46]

Saul Halfon, an expert in science and technology policy, posits that scientific study cannot eliminate public fears about the long-term effects of radiation technologies for two main reasons:

- Individuals worry that future advances in our ability to measure radiation eventually will reveal the dangers of a particular technology.

- Individuals worry that future advances in our understanding of radiation's effect on the human body will reveal that current guidelines about the level of safe exposure and contamination are inaccurate.

Halfon concludes that these fears explain the case of DU: "Most of the experts who have done research on DU know quite convincingly that DU is essentially safe as used—that is, it has theoretical toxicity and radioactivity, but these are low enough to be effectively safe. On the other hand…citizens know quite convincingly that, of course, DU is dangerous—it is, after all, both radioactive and the stuff that bombs are made of."[47]

These concerns are reinforced by the public's tendency to favor anecdotal evidence over scientific analyses. That is, reports from individuals who claimed to suffer from the Balkans Syndrome after the NATO air campaign were judged to be more credible than systematic studies of the ill effects of DU exposure. Thus, the debate about the use of DU in weapons will continue to be shaped by the public's beliefs, however misguided.

- **Potential Psychological and Sociological Bias #2: Because of the invisibility of the ADS beam and its actual and feared effect on the human body, ADS may be perceived as a supernatural instrument of evil in cultures where belief in the supernatural is prevalent.**

  Superstitions and belief in the supernatural exist in many societies (see Table 2). In the past, insurgents and counterinsurgents have manipulated local superstitions for strategic gain in conflicts, such as those in the Philippines, the Congo, and India.

  Philippines, 1953: During the communist insurrection against the Philippine government, U.S. Air Force Colonel Edward Lansdale successfully frightened Huk guerrillas away from their strongholds by killing select insurgents near Huk territory as if *asuang*, or a local vampire, had murdered them.[48]

  Congo, 1960's: Insurgents against the European-educated Congolese political leadership mobilized tribal populations against the government on the premise that the regime's attempts to ban witchcraft were themselves evil acts of sorcery.[49]

Table 2: Belief in Other Supernatural Phenomena

	Median % in each region who say they ….	
	Believe in Jinn	*Believe in Witchcraft*
South Asia	77	35
Sub-Saharan Africa	—	35
Middle East-North Africa	69	26
Southeast Asia	53	49
Southern-Eastern Europe	30	31
Central Asia	19	21

Source: *The World Muslims: Unity and Identity*. Washington, DC: The Pew Forum on Religion and Public Life, August 9, 2012.[50]

Maharashtra, India, 1980's to present: The belief in *Angadev*, or a protective deity that can be summoned with money, is strong in rural central India. Locals summon *Angadev* to discover the causes of adversity, such as witchcraft and sorcery. Indian law enforcement discourages the practice as it sometimes leads to innocent villagers being severely punished by their neighbors. Law enforcement efforts to halt the practice have been unpopular. Capitalizing on local beliefs, Maoist insurgents have convinced many villagers in the region that the police ban on superstitious practices is to blame for misfortunes.[51]

Given the prevalence of superstition in many societies and the potential for these beliefs to be exploited for political gain, it is likely that ADS will encounter strong cultural obstacles if it is deployed. For example:

Middle East and Africa. A sizeable number of those living in Islamic communities in the Middle East and Africa believe in *jinn*, invisible supernatural entities or forces that cause misfortune or illness.[52] And throughout southern Africa, there is widespread belief in a spirit called the "thokolosi." Invisible to adults, the thokolosi harasses individuals who are not considered to be its owner, potentially causing injury.[53]

Asia. In parts of Asia, belief in supernatural entities or forces that negatively affect humans plays a role in political discourse and competition. Thai politicians, for example, have used superstition and belief in paranormal forces to attack opponents and influence constituents.[54]

***Implication**: Given the sociological obstacles to ADS, deployment of the technology must be accompanied by aggressive efforts to gain the support of local political and religious authorities. Any information campaign addressing the fears of ADS within a population must take into account local beliefs in the supernatural. But even if the public does not anthropomorphize ADS's invisible millimeter wave, U.S. operators may have difficulty proving that ADS is not the root cause of later misfortunes among local populations.*[55]

- **Potential Psychological and Sociological Bias #3: Similar to drone technology, ADS may evoke memories of Western imperialism, especially among populations where there is a significant anti-western bias and low information.**

The use of armed drones has inflamed pre-existing anti-western bias in parts of the developing world and evokes memories of colonialism in which European powers

used their technological superiority to overcome the numbers and physical strength of host populations.[56] In the Middle East, for example, the public views armed drones as a cowardly and unfair tool that denies their targets any means of defense or retribution.[57] Moreover, anecdotal evidence and local media reporting have linked drone strikes with civilian casualties.

ADS technology is likely to evoke similar images of "technology-enabled" western aggression by nationalists and those with anti-western leanings in the developing world. As with drones, ADS is a science fiction-like technology that operates at a distance and invisibly affects its target. ADS also is likely to be used against civilians. Thus, ADS could produce a backlash among local populations akin to the opposition to conventional munitions fired from drones. Confronted with ADS, host populations will rely on local memory and history, possibly viewing the use of ADS by U.S. forces through the lens of colonialism.

Deployment of ADS may be further complicated by significant anti-American sentiment in regions where the United States is engaged in population-centric missions. In Pakistan, for example, 80 percent of respondents in a 2012 Pew Survey reported an unfavorable view of the United States.[58] Consequently, even though its purpose is to avoid civilian casualties, hostility towards the United States may lead to profound skepticism of ADS.

***Implication**: Rather than being seen as an attempt to limit civilian casualties by the United States, ADS may evoke memories of western imperialism, where technology was used to subjugate and repress a host population.*

Legal Objections to ADS

The increased use of non-lethal weapons in combat has raised concerns regarding their compliance with the two principles of *in jus bello,* or the legal concept of "justice in war."[59] They are:

(1) Discrimination: *In jus bello* dictates that force must not be used against noncombatants. While the application of this concept within the framework of lethal force is straightforward, its application to the use of non-lethal weapons is contested. Non-lethal weapons are often used with the express knowledge that they may target civilians.[60]

(2) Proportionality: *In jus bello* dictates that "enemy combatants should not be subjected to unnecessary suffering and superfluous injury."[61]

These legal principles could lead to the following objections to the deployment of ADS:

- **Potential Legal Objection #1: ADS may be disproportionately used against civilians.**

  The main potential legal obstacle to the use of non-lethal weapons is that they "reduce lethality by making force itself less lethal while also *increasing* the likelihood of civilian exposure to that force."[62] For ADS in particular, discrimination is a bigger concern than proportionality. The utility of ADS to the U.S. Armed Forces lies in its ability to determine the intent of approaching individuals; therefore, the mandate of ADS is, in part, to be used against non-combatants. As Human Rights Watch's Marc Garlasco contends, the use of ADS is ethically and legally problematic because it is likely to be employed more frequently against non-combatants than lethal weapons.

  While ADS does not violate any explicit international statutes on weapon use in military operations, the 1997 Additional Protocol to the Geneva Conventions provides concrete legal guidelines that should shape future ADS deployments. Article 35.2 of the Additional Protocol reads: "it is prohibited to employ weapons, projectiles, and methods of warfare of a nature to cause superfluous injury or unnecessary suffering." Therefore, when ADS is used, the group responsible for deployment must demonstrate that it does not cause superfluous injury or unnecessary suffering.[63]

  ***Implication**: The domestic and international legal community will likely want operators to adopt safeguards mitigating the possibility that civilians will disproportionally be targeted by ADS.*

Recommendations for Developing and Fielding ADS

ADS is a revolutionary non-lethal weapons technology that gives operators a valuable tool in population-centric operations. But to deploy ADS successfully, the potential obstacles discussed above must be overcome. To that end, we recommend that ADS be integrated with other non-lethal technologies into a single weapons package that provides operators with a non-lethal force continuum. This force continuum should have rules of engagement linking a target's actions to a spectrum of non-lethal responses. Within this spectrum, U.S. forces should use ADS as a weapon of last resort, with operators initially creating a sensation of mild heat, followed by intense heat if the target is not deterred.

Addressing Human Rights and Legal Concerns

Human rights organizations and the international legal community will likely have five primary concerns regarding ADS use:

(1) *ADS has the ability to cause severe injury to a target.*

(2) *ADS could be used as an instrument of torture*.

(3) *Operators, even well-meaning ones, are likely to use ADS more frequently than lethal weapons*.

(4) *ADS may have a long-term impact on health or exacerbate a target's pre-existing health conditions*.

(5) *ADS may produce unanticipated reactions by targets that result in civilian casualties and collateral damage, especially in urban situations with large crowds and moving vehicles.*

(6) *ADS may be disproportionately used against civilians.*

To combat these concerns, we recommend the following:

- **Recommendation #1: Limit ADS ownership to U.S. forces or close allies with strong human rights records.**

  While the United States can enforce standard operating procedures for ADS among its operators, the government cannot control how ADS will be used by other states. In light of the potential to misuse ADS, we recommend that the weapon and any civilian-made equivalents (e.g., Raytheon's "Silent Guardian") should only be sold through Foreign Military Sales (FMS) or Direct Commercial Sale (DCS) to close allies with a robust record of protecting human rights.

  At present, ADS is not a DOD "program of record" and, therefore, does not qualify for transfer under the FMS program.[64] However, this status does not preclude the sale of civilian-produced equivalents, such as the "Silent Guardian," through the process of DCS.[65]

  Preventing unwanted foreign acquisition of ADS is particularly important as there has not yet been a large-scale deployment of the technology by U.S. forces. If abused by foreign governments, ADS will lose much of its strategic utility for U.S. operators. In addition to eliminating an existing technological superiority, improper foreign use will undermine U.S. efforts to encourage a positive public perception of ADS and cultivate norms for its appropriate operation. Misuse of ADS by foreign governments likely will result in the weapon being perceived by the international community as a tool of oppression.

  Possible Objection: After ADS is used by the United States in combat or peacekeeping operations, isn't it inevitable that hostile governments will develop their own versions?

  Response: There is always the potential that another state will produce its own version of ADS. Technology diffusion cannot be delayed forever.[66] In the case of ADS, some reports indicate that scientists in other states, including China, Israel, and perhaps Iran, are developing prototypes inspired by the U.S. design. The Russian government has confirmed tests of its own version of ADS.[67]

  While the spread of military technology cannot be stopped indefinitely, what can be affected is the rate of diffusion and the norms surrounding the technology's use.[68] Unrestricted sale of ADS technology would increase the speed of its diffusion and, if the weapon is abused, it would associate the United States with such abuse. Strict controls on the sale of ADS would signal to the international community that the United States is aware of the technology's potential as a tool of torture and

oppression. Moreover, limited sales would increase the likelihood that any misuse of the technology would be linked to other states selling such a system.

- **Recommendation #2: Equip ADS units with audio and video recording systems and establish a credible chain of command for recordings of ADS use.**

  ADS technology should be integrated with a tamper-proof audio and video recording mechanism that tracks the user, date, time, duration, and intensity of each instance when the millimeter wave is fired and sends the data to a central database. ADS System 1 and 2 already have a video recording capability, upgrading this capability should be a relatively easy and low-cost modification. Similar recording mechanisms are found in the TASER's AXON device, which exports video recordings of police TASER use to an external database via a camera attached to the officer's head. This capability would allow officers to show the precise situations they faced when using the TASER. A digital fingerprint on each file ensures that the recordings in the central database cannot be altered.[69] Recordings of ADS use should regularly be made available to the international media, human rights organizations, and senior commanders to demonstrate the appropriate use of the device.

  This modification will serve two important purposes. First, keeping permanent records of ADS use will protect U.S. troops from wrongful prosecution should hostile target populations make false allegations of abuse. Mitigating the potential for such accusations will not only assuage fears U.S. troops may have about using the technology, but it will also protect the reputation of the U.S. Armed Forces internationally and among populations where ADS is deployed. Second, installing a tamper-proof data recording and transmission capability will help the United States identify any ADS abuse by its forces. Commanders can then punish operators who violate established standard operating procedures.

  Possible Objection: How do we guarantee that video and audio recordings will not be used against U.S. forces or interests?

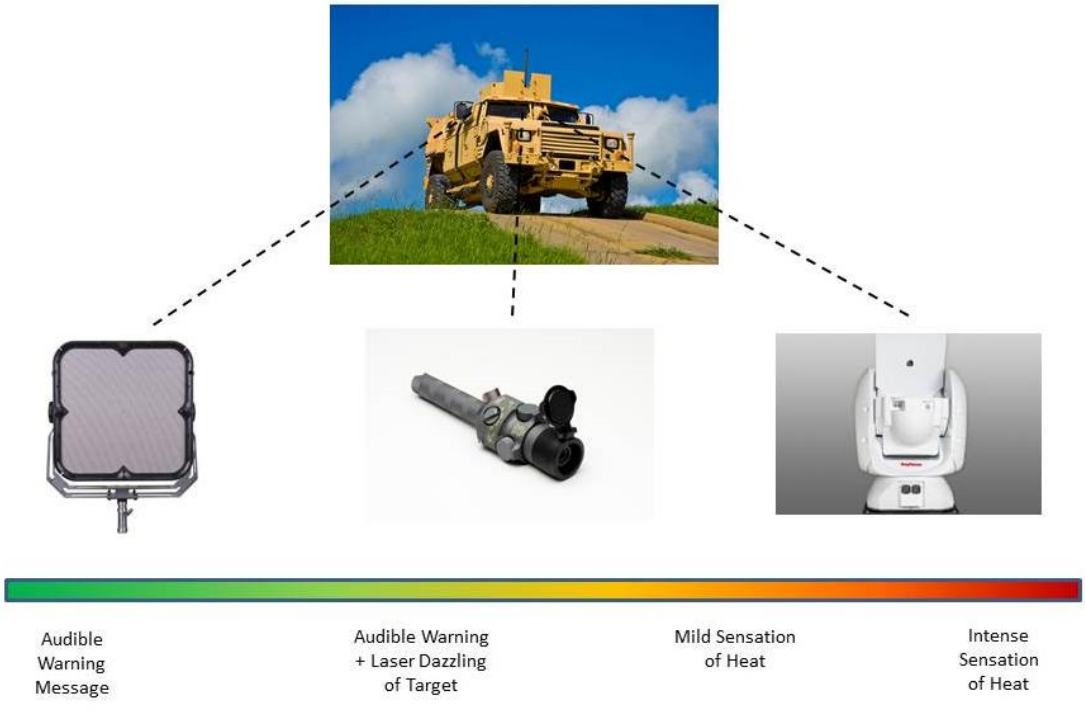
  Response: Making video and audio recordings publicly available would combat misinformation about how ADS is used by U.S. forces. While a full recording of a confrontation could be misconstrued, it is significantly better than a bystander's cell phone video of part of an engagement or hearsay from onlookers.

- **Recommendation #3: Integrate ADS technology with other non-lethal technologies and establish a non-lethal use of force continuum, with use of ADS constituting the high end of the force spectrum.**

  Integrating ADS with other non-lethal technologies, such as a laser dazzler and acoustic hailer, would allow operators to provide targets with early warning of possible ADS use and allow for a greater spectrum of deterrence (see Figure 2).[70]

  To take advantage of this deterrent spectrum, a non-lethal use of force continuum and protocols should be established for an "augmented" ADS system.[71] Such a continuum would associate specific target behavior with the use of a particular non-lethal technology. In this spectrum, ADS would be a weapon of last resort and only used at its most intense setting when other means of deterrence have failed or if a target threatens the lives of U.S. forces. For example, operators at a check point could first use an acoustic hailer to transmit a warning message. If this warning fails to change the target's behavior, then a laser dazzler could signal that use of ADS is imminent by illuminating the target. Should the dazzler fail to deter the target then a quick pulse of the ADS beam at a low setting could occur, followed by a longer and more intense pulse if necessary.

Figure 2: Non-lethal Force Continuum Through an Augmented ADS



Photos: Lockheed Martin JLTV, LRAD 500X, B.E. Meyers GLARE MOUT, Raytheon Silent Guardian[72]

This force continuum has several advantages. First, it reduces the likelihood that ADS will be used extensively against civilians, mitigating concerns that the weapon violates the discrimination principle of *in jus bello*. Once a population is aware of the beam's effect and associates the warning signals with an imminent sensation of heat, it is likely that use of the acoustic hailer and dazzler will be sufficient to alter a target's behavior. Second, the continuum signals to the local and international community that U.S. forces seek to limit discomfort to a host population, in addition to preventing civilian deaths. Third, reducing the use of ADS due to this continuum will lessen fears that extensive ADS use will have long-term negative health effects.

- **Recommendation #4: Add a light to the ADS beam to make it visible in order to enable uninformed targets to step outside affected areas and to make the technology less magical.**

  An augmented ADS should use its laser dazzler to visibly mark the perimeter of the ADS beam. Outlining the shape of the beam serves three functions. First, by providing a visual cue for where the beam is being employed, ADS's invisible millimeter wave will be less mysterious. Second, targets who are unfamiliar with the technology can see the beam and move outside its area of effect. Third, bystanders will know whether they have been targeted, beyond whether they feel a sensation of heat.

  Possible objection: Doesn't the warning dazzler in recommendation #3 serve the same purpose as outlining the beam?

  Response: Not necessarily. The warning dazzler informs a target that ADS use is imminent. The dazzler does not necessarily outline the beam's perimeter, though dazzlers could serve both functions.

- **Recommendation #5: When possible, publicize the punishment of U.S. operators who may abuse ADS.**

  While it is assumed that U.S. forces will use ADS appropriately, it is important to demonstrate to both the U.S. public and international community that there will be strong oversight of ADS use. Oversight is particularly important when deploying a system in delicate operational environments, such as those in COIN or peacekeeping missions. Therefore, when military guidelines permit, any punishments following incidents of abuse should be publicized to demonstrate that the U.S. Armed Forces are committed to maintaining a positive relationship with populations among whom ADS is deployed and to rigorous operational standards for the appropriate use of the weapon.

  Possible Objection: Won't publicizing abuse reinforce negative public opinion about ADS?

Response: Ideally, ADS would be used appropriately in every case. However, if ADS is misused, quickly responding to the infraction and highlighting how the action violated ADS protocol will be essential to fostering positive perceptions of ADS technology—as well as encouraging international norms regarding its proper use. Publicizing officer infractions has been an important element of the strategy used by police departments in the United States and abroad to reassure a skeptical public about the overall safety and effectiveness of CEDs.

- **Recommendation #6: Fund further independent medical and social research on ADS.**

The U.S. government should fund additional independent third-party research on ADS, even if such research is repetitive. Multiple studies indicating that ADS technology is safe will help convince the public and assuage critics.

Future studies should focus on medical conditions that may amplify the severity of ADS's effects and investigate the potential for long-term damage from exposure to the technology. These findings will increase public confidence in the results of the 2008 Human Effects Advisory Panel study of ADS, which concluded that the technology was safe if used within operational guidelines.

Law enforcement agencies faced similar concerns about the long-term medical effects of using CEDs. In response, studies were conducted to determine the effect of CED use on targets that had different levels of intoxication or pre-existing heart conditions. The findings of these studies reinforced the conclusion that CEDs did not cause permanent harmful health effects, even in the presence of pre-existing conditions.[73]

Research also should be conducted on the use of ADS in a dense urban environment. These studies will help dampen any concerns that ADS testing is unrealistic regarding how civilians will physically react to the beam and the likelihood of collateral damage.

Possible Objection: If we know that medical research doesn't change biases against radiation technology, why is it useful to conduct additional studies?

Response: Medical research alone is not enough to overcome entrenched biases, but it is a necessary condition for winning general public acceptance of ADS over time. Here we can learn from the case of depleted uranium (DU) ammunition discussed above. Three main issues were responsible for the failure of the scientific community to alleviate concerns about the safety DU, and each of these can be addressed.

(1) *Future scientific discoveries*: There was an underlying fear that, while existing scientific research found DU to be safe, a new wave of scholarship could overturn these findings. While this fear is unlikely to be completely eliminated, accumulating medical findings that reinforce the same

conclusion—ADS technology is not dangerous—will diminish the public's anxiety over time.

(2) *Persuasiveness of anecdotal evidence*: Recent scholarship has explored the relative persuasiveness of statistical and anecdotal evidence, seeking to understand why quantitative analyses are often less convincing than individual experience.[74] In the Balkans, stories about the "Balkan syndrome" caused widespread doubt about the safety of DU, despite the conclusions of medical research. Thus, the deployment of ADS must be accompanied by both systematic scientific research and anecdotal evidence.

(3) *Methodological problems*: Because the subjects studied in the Balkans medical surveys were not taken from a representative sample of the population, but instead from DU weapons operators, the validity of the findings was called into question. A rigorous research design is thus essential for establishing the credibility of a study's results and should be given careful consideration in the testing of ADS. Multiple independent studies that reinforce the conclusion that ADS is safe will help address any existing concerns about the methodologies used in research on ADS.

Addressing Psychological and Sociological Biases

The use of millimeter wave radiation by ADS confronts several psychological and sociological biases:

(1) *As a radiation-based technology, ADS invisibly affects the human body, generating fear about the weapon's health effects.*

(2) *Because of the invisibility of the ADS beam and its actual and feared effect on the human body, ADS may be perceived as a supernatural instrument of evil in cultures where belief in the supernatural is prevalent*.

(3) *Similar to drone technology, ADS may evoke memories of Western colonialism, especially among populations where there is a significant anti-western bias and low information*.

To combat these concerns, we recommend the following:

- **Recommendation #7: Associate ADS with commonplace radiation technologies in public relations campaigns.**

  When confronted with a novel technology, the public often turns to a well-known technology as an analogy. Since its introduction, ADS has often been associated with

the microwave oven, due to the similarity in wavelength and heating properties of the two devices.[75] This association has encouraged a negative perception of ADS among the general public by producing a fear of being "cooked" when exposed to its beam.

Associating ADS with alternative, more benign devices—preferably ones that use similar millimeter wave radiation in their operation and are familiar—will encourage a more positive (or at least neutral) view of the technology. A potential example is the airport body scanner, which uses non-ionizing millimeter waves and is well known to the general public. Because the body scanner is now integrated into American society, the association has the potential to quell fears that ADS could cause lasting harmful health effects.

Possible Objection: Aren't there also strong negative associations with the body scanner?

Response: The millimeter wave body scanner has elicited some negative responses, mainly centered on the use of full-body imaging that is often portrayed as overly invasive.[76] However, most reporting on the millimeter wave body scanner emphasizes that it is a safe technology.[77]

The privacy concerns associated with the body scanner prevent it from being an ideal comparison. Importantly, however, it is a device that many Americans know, have been exposed to, and have accepted as part of their lives. It is certainly preferable to have ADS associated with this device than the microwave.

At this point, the body scanner is the only millimeter wave technology with a high level of recognition within the general public. Millimeter waves have a large number of other commercial and security applications and, as other devices become well known, an even more suitable candidate for association with ADS may emerge.[78]

- **Recommendation #8: Rename ADS.**

Operators should select a name for ADS technology that is free of negative language like "active denial." Instead, ADS should be given a name that emphasizes its use as a tool of non-lethal engagement and cooperation with target populations. "Active denial" implies that operators of the system are opposed to their targets, even if those targets are innocent or are approaching U.S.-manned posts to seek council or express legitimate grievances. This impression runs counter to the goals of population-centric U.S. missions.

To emphasize the defensive aspects of the system and its role in determining target intent, one of the following names could be adopted: Non-Lethal Intent Determination System (NLIDS), Area Defense System (ADS), or Millimeter Wave Deterrence System (MWDS).

Possible Objection: Will renaming the system actually be an effective way to change public perception?

Response: There is extensive literature in a wide variety of disciplines on the impact of naming on attitudes towards otherwise identical objects, proposals, or individuals.[79] The general conclusion is that naming can have a significant effect on perception, particularly if it evokes a strong emotional or psychological response.
A particularly salient case is that of the LRAD. Although the LRAD did not undergo a complete name change, there was an effort to have it labeled as an "acoustic hailing device" rather than a weapon and to emphasize its use as a tool of engagement with local populations. This effort came in response to reports that used emotionally charged words, such as "gun" and "sound cannon," to describe the device.[80] By focusing on the loudspeaker aspect of the device, the goal was to reinforce the idea that the LRAD is primarily a defensive system employed to warn and communicate with civilians.[81]

- **Recommendation #9: Hold domestic public demonstrations of ADS during its deployment.**

When ADS is introduced in a theater, it should be frequently and publicly demonstrated to preempt misperceptions or rumors. The "media days" held to demonstrate ADS between 2007 and 2012 are examples of such outreach campaigns. CEDs also have a long history of being publicly demonstrated on local police officers to educate the public about the devices and their use.[82]

Any future deployment of ADS should include further demonstrations, not only in the United States, but also for target populations. Local elites should be invited, as respected leaders will play a critical role in encouraging positive dialogue about the technology. In addition, the timing of these outreach efforts is crucial; it is during the months before deployment that ADS is subjected to the greatest scrutiny both at home and abroad.

Possible Objection: Won't attendees with pre-existing negative views of ADS use the demonstrations as an opportunity to malign ADS?

Response: In the vast majority of cases, past ADS demonstrations encouraged a positive, thoughtful dialogue about the technology. Not every report to come out of the media days was positive, but they were more likely to be grounded in fact and focus on the real operational benefits of ADS than misinformation.

There will always be reporters who exploit the more prominent platform that demonstrations offer to publish sensationalized stories. One example is the story written by the *Daily Mail* after Raytheon publicly demonstrated the Silent Guardian.[83] However, the overall effect of media days has been positive.

- **Recommendation #10: Publicize the challenges necessitating the deployment of ADS.**

  Another important step to overcoming potential opposition to ADS deployment is to convince the American public that ADS is needed to protect our soldiers and minimize civilian casualties. Before deployment, the value of ADS should be explained. This outreach effort could include short films chronicling life for U.S. soldiers and airmen manning checkpoints or tasked with base defense. These films should be distributed through traditional media and online media distribution sources, including YouTube.

  Efforts to publicize the need for ADS by highlighting the challenges facing individual soldiers is especially important in light of the limitations of statistical and medical research in overcoming entrenched biases against novel or frightening technologies. By focusing on individual soldiers, these videos will provide a face and a story to accompany factual information about the safety and functionality of ADS.

  Possible Objection: Can social media efforts reach a large enough audience to be effective?

  Response: Current ADS demonstration videos have already reached a wide audience, displaying the potential of online media for shaping public attitudes towards ADS. The most watched video on ADS is a *60 Minutes* clip, which has over 4 million views on YouTube. Several other clips showing the weapon in action have over 100,000 views, demonstrating that an audience clearly exists for more information about the topic.

  Videos explaining how and why ADS is more likely to aid our troops and save lives than other force options will likely have an even greater impact on public perception of ADS.

- **Recommendation #11: To combat perceptions in the developing world of ADS as a tool of imperialist oppression, initial deployment should occur under conditions that highlight the technology's use as a non-lethal means of protecting civilians.**

  For many in the developing world, memories of western colonialism and the role that superior technology played in colonial conquest and administration remain strong. Initial deployment of ADS will have to take this history into account. Simply put, managing perceptions of ADS technology is critically important. Initial deployment of ADS will have a significant impact on the assessment of the technology by host populations and the international community. ADS is a valuable non-lethal tool for protecting U.S. forces and minimizing civilian casualties. Its first deployment, however, should highlight how the technology can be used to protect civilians from harm, rather than protect U.S. forces. For example, ADS could be used to defend

refugee camps, safe-havens, or food distribution points. The message such uses send is that ADS is a tool that protects a population, while minimizing the probability that civilians will be inadvertently harmed during the mission.

Possible Objection: By using ADS to protect civilians, aren't we denying our forces the ability to protect themselves, for example, in checkpoint or base defense?

Response: Protecting civilians and protecting U.S. forces are not mutually exclusive. In the past, soldiers, marines, and airmen have defended refugee camps and safe-havens. Using and highlighting ADS in such missions will encourage a positive image of the technology internationally and locally, eventually enabling more widespread use of ADS by U.S. forces.

Notes

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[72] For the photo of Lockheed Martin JLTV, see http://www.flickr.com/photos/lockheedmartin/5862926097/sizes/z/in/photostream/. For the LRAD 500X, see http://www.lradx.com. For the B.E. Meyer GLARE MOUT 532-MP, see http://www.bemeyers.com/index.php?option=com_product&catid=36&id=12. For the Raytheon Silent Guardian, see http://www.raytheon.com.

[73] Jared Strote and H. Range Hutson, "Taser Use in Restraint-Related Deaths," *Prehospital Emergency Care* 10, no. 4 (2006).

[74] For a case study that references this tendency, see Michael J. Graetz and Ian Shapiro, *Death by a Thousand Cuts: The Fight over Taxing Inherited Wealth* (Princeton, NJ: Princeton University Press, 2005).

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December 17, 2011, http://www.nashuatelegraph.com/news/943576-196/manchester-airport-officials-hope-new-full-body-scanners.html.

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[78] For an example of an alternative application of millimeter waves, see Freescale, "Automotive Radar Millimeter-Wave Technology," http://www.freescale.com/webapp/sps/site/overview.jsp?code=AUTRMWT.

[79] For an example of this phenomenon, see Paula M. Brochu and Victoria M. Esses, "What's in a Name? The Effects of the Labels 'Fat' Versus 'Overweight' on Weight Bias," *Journal of Applied Social Psychology* 41, no. 8 (2011). For a political example, see Karen Rowlingson, "Is the Death of Inheritance Tax Inevitable? Lessons from America," *Political Quarterly* 79, no. 2 (2008).

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Institute for the Theory and Practice of International Relations
The College of William and Mary
427 Scotland Street
Williamsburg, Virginia 23185