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BLINDING LASER WEAPONS
THE NEED TO BAN A CRUEL AND INHUMANE WEAPON

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I. SUMMARY

International efforts to ban blinding laser weapons have been growing impressively during the past year, but at the same time, some countries have been moving toward the production and export of these inhumane systems. This spring, the China North Industries Corporation, or Norinco, exhibited a weapon described as a "laser disturber" at an arms fair in the Philippines and advertised one of its major applications as injuring the eyesight of individuals.[1] On August 31, 1995, the United States approved a contract for the production of fifty prototypes of the portable, rifle-mounted Laser Countermeasure System (LCMS), which the U.S. Army states can burn out a human retina from a distance of 3,000 feet.[2] Yet, the next day, U.S. Secretary of Defense William Perry issued a statement that reversed long-standing Department of Defense policy by acknowledging that blinding as method of warfare is unacceptable.[3]

Nations have been working on tactical laser weapons[4] for at least twenty years, but it is believed that no country has entered into full scale production or fielded such weapons in significant numbers. The United States, France, Britain, China, Russia, Ukraine, Israel and Germany have been reported to have laser weapon research and development programs and it is feared others have sought to use lasers against the human eye.[5]

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[1] China North Industries Corp., ZM-87 Portable Laser Disturber Fact Sheet, (no date, obtained May 1995); See for example, "Chinese Offer Laser Eye-Damage Weapon," *International Defense Review*, May 1995.

[2] Lockheed Sanders Inc. of Nashua, NH, was awarded the $16.8 million contract, which also includes production of twenty-five low power training units. Human Rights Watch interviews with Pentagon officials, September 1995; Bradley Graham, "Pentagon Shifts, Seeks Laser Weapon Curbs," *Washington Post*, September 20, 1995. The initial decision to go forward with LCMS was made in June. See, Letter, H. Allen Holmes, Assistant Secretary of Defense (Special Operations Low-Intensity Conflict), to Representative Lane Evans, July 18, 1995; Christopher Parent, "Army Pushes Ahead with Laser Countermeasure System Production Plan," *Inside the Pentagon*, July 13, 1995.

[3] Department of Defense News Release, Reference Number 482-95, September 1, 1995. Reprinted in the appendices.

[4] Human Rights Watch has chosen to use the term "tactical" laser weapons to distinguish them from the high energy and directed energy laser weapon applications most often associated with ballistic missile defenses, which presumably do not have antipersonnel roles. Human Rights Watch believes that tactical laser weapons have the potential to blind, are in some cases intended to blind, and are distinct from non-weapon lasers such as target designators and range finders.

[5] In August 1994, the *Berliner Morgenpost* reported that, based on information from the British secret service, the United Nations was worried that Iraq planned to use blindness-inducing lasers against aircraft and helicopter crews transporting U.N.

inspection teams. During the Gulf War, at least two Americans received laser injuries in separate incidents. Dr. Thomas Mader, et al., "Ocular and Ocular Adnexal Injuries Treated by United States Military Ophthalmologists during Operations Desert Shield and Desert Storm," *Ophthalmology*, Vol. 100, October 1993, pp. 1462-1467.

U.S. intelligence reported on the danger of Serbian- and French-manufactured laser devices in the former Yugoslavia.[6] Reports from Japan indicated that the cult, Aum Supreme Truth, allegedly planned to attack the Metropolitan Police Department's main building in Kasumigaseki, Tokyo, with a vehicle equipped with some type of laser weapon before the March 20, 1995 sarin nerve gas subway attack.[7] During the Gulf War, British ground forces were issued protective goggles because they were concerned about Russian-made lasers believed to be in service with the Iraqis.[8] German pilots flying over the Iraqi no-fly zone were also issued laser protective goggles.[9] The U.S. Armed Forces Medical Intelligence Center has reported, "It is highly probable that laser eye injuries occurred in the Iran/Iraq war, based on numerous reports of such injuries and the known purchases of lasers for the implied purpose of weaponization."[10]

It is clear that the international community is at a crucial juncture in the research, development and acquisition of blinding laser weapons. If steps are not taken soon to prohibit these systems, the prospect of rapid and widespread proliferation — to governments and their agents, to guerrillas groups, and to private groups and individuals using terror for political ends — is very real.

Human Rights Watch believes that blinding as a method of warfare is illegal under the international legal and humanitarian principles regulating armed conflicts and that blinding laser weapons must be banned. The U.N.-sponsored Review Conference for the 1980 Convention on Conventional Weapons (CCW) provides the best chance for the international community to ban these weapons before their widespread acceptance and use.[11] The Review Conference, the first since the Convention was adopted, begins in Vienna, Austria, on September 25, 1995.

Developments in the U.S.

For the United States, the development of tactical laser weapons has not been easy or without controversy. According to some estimates, the United States has spent more than $400 million for research and testing, but it has not fielded fully a single system. In May 1995, Human Rights Watch detailed for the first time publicly ten tactical laser weapon programs in the United States.[12] At least five U.S. laser weapons already exist in prototype form — LCMS, Stingray, Outrider, Dazer, and Cobra — and are available for use in certain circumstances. Stingray and Dazer were sent to the Gulf War, but were not used.

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[6] "Helicopter and Ground-Based Electro-Optics and Laser Systems," U.S. Department of Defense, NGIC-1100-55F-95, January 9, 1995, pp. 29-30, released under the Freedom of Information Act. The report states that in situations "such as the Balkan conflict, where military actions are constrained by political pressures, trying to blind or flashblind (sic) with LRFs [laser rangefinders] may be a tactic born of frustration." It recommended that U.S. soldiers and other forces take "appropriate precautions against lasers." U.S. military sources have told the Arms Project that a flash blinding incident reportedly occurred in Bosnia.

[7] See for example, Kozo Mizoguchi, "Authorities Launch New Effort to Apprehend Fugitives, 1 Arrested," *Associated Press*, July 20, 1995; "Cult Eyed Laser Attack on MPD," *Yomiuri Shimbun*, June 26, 1995. Several senior cult members reportedly told investigators of their plans, but said the attack was cancelled because the laser system broke down and cult leaders decided instead to order other actions. The nature of this laser system is not clear. At least two Aum Supreme Truth followers were arrested on suspicion of stealing high-tech information from Mitsubishi Heavy Industries' Hiroshima plant, apparently to help the cult manufacture laser weaponry. "Cultists Allegedly Stole NEC Laser Info," *Mainichi Daily News*, June 4, 1995.

[8] Christopher Bellamy, "Britain is Offered U.S. Laser Weapons," *The Independent*, April 14, 1993.

[9] "German Pilots in Iraq Gain Eye Protection," *Defense News*, August 29-September 4, 1994.

[10] Armed Forces Medical Intelligence Center, AFMIC Special Weekly Wire 32-90, August 8, 1990, partially declassified and deposited on GulfLINK.

[11] The formal name of the Convention on Conventional Weapons is the *Convention on Prohibitions or Restrictions on the Use of Certain Conventional Weapons which May Be Deemed to be Excessively Injurious or to have Indiscriminate Effects*.

[12] Human Rights Watch Arms Project, "U.S. Blinding Laser Weapons," May 1995.

Since release of its report, Human Rights Watch has identified six additional laser weapon programs being worked on in U.S. military laboratories, a new Marine Corps "validated requirement" for a laser weapon, and several other laser systems whose blinding effects or potential for collateral damage is unclear, but bear further investigation.

As nations have prepared for the CCW Review Conference, the United States has stood out as one of the major opponents of a ban on blinding laser weapons. U.S. military lawyers concluded that the intentional blinding of individuals was legal under existing international law, maintaining that the antipersonnel use of a laser would not cause superfluous injury or unnecessary suffering even if it resulted in permanent blindness.[13]

[13] Memorandum of Law: The Use of Lasers as Antipersonnel Weapons, September 1988, Judge Advocate General; see also, Memorandum on the AN/PLQ-5 Laser Countermeasure System, Law of War Review, September 1994, Department of the Army, Office of the Judge Advocate General.

However, in mid-1995, the Pentagon decided to undertake a review of its laser programs and to develop for the first time a policy guidance statement. On September 1, 1995, Defense Secretary Perry announced, "The Department of Defense prohibits the use of lasers specifically designed to cause permanent blindness of unenhanced vision and supports negotiations prohibiting the use of such weapons."[14]

Senior Pentagon officials have told Human Rights Watch that this statement represents a major change in policy and that henceforth it is the position of the Department of Defense that blinding as a method of warfare is unacceptable and should be prohibited. This new policy is a very welcome step forward, but it may fail to restrict many types of laser weapons that blind. Indeed, the Pentagon's policy statement appears to have been crafted so as to permit the U.S. to go forward with all of its existing laser weapon programs.

Nearly every government that has made a public statement on laser weapons, including the United States and Britain, maintains that it does not possess nor is it developing laser systems intended or designed primarily to blind individuals permanently. Thus, the U.S. Army characterizes the LCMS as an anti-sensor or anti-optical system, not as a blinding antipersonnel system. However, when used against an individual employing optical devices, such as binoculars or gunner's sights, the LCMS would not destroy the optic; instead the optic would intensify the laser beam and focus it on the most sensitive part of the eye, causing blindness.

The fact that tactical laser weapons have the potential to blind, and that in some circumstances (notably against eyes enhanced by optical instruments) the military mission is indeed to blind, is reflected in a U.S. Marine Corps document which expressed concern about tactical laser weapons in the hands of the enemy because they "can disable optical devices and cause permanent blindness."[15]

Human Rights Watch believes that tactical laser weapons, such as the LCMS, Stingray, Outrider, Cobra and Dazer, are distinct from non-weapon laser rangefinders and target designators. Lasers used for such tasks as detection, targeting, and rangefinding should not be prohibited; indeed they have positive humanitarian implications in that they assist in pinpointing military targets. While the technical specifications for some of the non-weapon lasers may not differ much from the tactical laser weapons, a clear distinction can be made based on function, mission, and intent. Rangefinders and target designators use a laser beam to aid other weapons in their task, while tactical laser weapons use a laser beam as the primary kill mechanism.

Military Considerations

Numerous interviews with those deeply involved in tactical laser weapon programs in the United States have led Human Rights Watch to conclude that the military utility of these weapons is very limited. Two distinct tracks exist for the use of tactical laser weapons: (1) on the armor-heavy, high-intensity battlefield and (2) in the low-intensity conflict, operations other than war and special missions scenario. On the high-intensity battlefield, tactical laser weapons would make only a minor contribution to military capability. In the presence of other so-called smart weapons, particularly the increasingly long-range systems, contribution to weapons lethality and accuracy is only marginal, and the defensive function (countering enemy electro-optical use) is minor, given the limited scenarios in which such as laser weapon could work.

[14] "DOD Announces Policy on Blinding Lasers," News Release, Office of the Assistant Secretary of Defense, Public Affairs, September 1, 1995.

[15] Mission Need Statement (MNS) for the Active Laser Countermeasure System (ALCS) (No. Log 47) (no date, obtained July 1995 through Freedom of Information Act request).

It seems evident that, at least in the United States, the lack of military utility of tactical laser weapons for high intensity warfare has resulted in support for these weapons primarily for "special missions," such as counterinsurgency, counterterrorism and peacekeeping. Yet, even in low-intensity conflicts and special missions, a number of factors currently work against effective or widespread use of tactical laser weapons, including size, weight, cost and reliability. Apparently, there is also a severe technical problem to overcome in that the usefulness of lasers to perform, for example, counter-sniper operations would depend on the laser being on precisely the same axis as the sniper's scope.[16]

Moreover, the presence of enemy electro-optical devices in low intensity conflicts and special missions would be minimal. In these operations the likely targets would be what some have called "the most valuable sensor" — the human eye — and blinding would be the express intent.

Legal and Humanitarian Considerations

Military commanders and soldiers in combat do not have unlimited choices in what weapons they employ and what tactics they use. They are forbidden from causing superfluous injury or unnecessary suffering.[17] The military necessity of a weapon must be balanced against the injury and consequences to the individual and to society.[18] The military's actions ultimately are subject to the dictates of established custom, humanity and public conscience.[19]

Ever since the St. Petersburg Declaration of 1868, restrictions on how soldiers fight and what weapons they use has been summed up by the idea that the "progress of civilization should have the effect of alleviating as much as possible the calamities of war." The legal principles of St. Petersburg and subsequent international conventions on the laws of war have banned classes of weapons and methods of warfare that have been deemed likely to cause suffering and injury so excessive that their use is never justified. They even have banned classes of weapons, such as chemical

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[16] A U.S. Joint Chiefs of Staff publication notes that "lasers have a limited off-axis capability." JCS, "Joint Laser Designation Procedures," Joint Pub 3-09.1, June 1, 1991, p. I-1. This document also notes, "Natural and manmade obscurants, including smoke, dust, and chemical particles in the air, may attenuate or reflect the laser beam, and significantly degrade laser systems." (p. I-3, II-7). Also, "Repeat use of laser weapons on the battlefield would be constrained by smoke and debris from previous weapons impacts." (p. II-10).

[17] These decades-old principles were most recently codified in Article 35 (1) and (2) of the 1977 Additional Protocol I to the Geneva Conventions of 12 August 1949, and the Preamble to the 1980 U.N. Convention on Prohibitions or Restrictions on the Use of Certain Conventional Weapons which may be deemed to be Excessively Injurious or to have Indiscriminate Effects, hereinafter referred to as either the Convention or the Convention on Conventional Weapons (CCW).

[18] See for example, Adam Roberts and Richard Guelff, eds., *Documents on the Laws of War*, p. 5 n. 2; International Committee of the Red Cross, *Commentary on the Additional Protocols of 1977* (Geneva: Martinus Nijhoff, 1987), pp. 392-393.

[19] See for example, Preamble to the Hague Conventions of 1899 and 1907; Article 1 (2) of the 1977 Additional Protocol 1 to the Geneva Conventions; Preamble to the Convention on Conventional Weapons.

weapons, that could be considered militarily helpful or capable of disabling large numbers of combatants, but whose use would be widely condemned.

Human Rights Watch believes that blinding as a method of warfare, and use of laser weapons with the intention to blind, are illegitimate because: (1) the military necessity is overshadowed by the unnecessary suffering they cause and, (2) the public would find repugnant the intentional blinding of individuals.

Deciding what is superfluous injury and unnecessary suffering is subjective but also determinable as international agreements banning or restricting the use of other weapons has shown. In comparison with other battlefield injuries, including those from artillery and weapons fragments and even bullets, blinding is a particularly pernicious wound. In modern warfare, it is estimated that fifty percent of those wounded return to duty within fifty days, but blinding is permanent. In addition to blinding or severe eye damage itself, individuals likely would suffer greater rates of battlefield stress and post-traumatic stress syndrome because blinding tactical laser weapons are a silent and invisible threat and their presence is not always known. Military psychiatrists and specialists in different disabilities have focused on the exceptionally severe consequence of blindness on all aspects of life, from a person's transportation needs to their ability to exchange information through reading and writing. Sight provides 80 percent to 90 percent of an individual's sensory stimulation. Rehabilitation is not always possible or successful. Societal or cultural biases can have a great impact on blind individuals in their communities.[20]

Government officials have often defended the development of laser weapons by saying that it is better to be blind than to be dead. It is an odd argument from individuals who proclaim that blinding is not a goal of laser weapons and who say that these systems are designed primarily to disrupt electro-optical and optical instruments. Laser weapons are not being developed as a humane alternative to killing; rather laser weapons are meant to make it easier to kill. The reality is that lethal fire likely would follow the blinding of the person.

Proponents of tactical laser weapons also frequently raise the possibility of temporarily blinding someone, as opposed to permanent blinding. There is divergent opinion on whether current or future technology will allow a weapon that will blind only temporarily, without danger of permanent blinding. Some experts, including ophthalmologists and biophysicists specialized in lasers, believe that it is impossible to design a laser that can blind only temporarily, a situation also referred to as flash blind or dazzle.[21]

Recommendations

The European Parliament has overwhelmingly approved resolutions calling for an international ban on laser weapons that can cause blindness and urging Member States to adopt national legislation banning blinding weapons.[22] The Council of Ministers of the Organization of African Unity also supported adoption of a protocol banning blinding laser weapons.[23]

Human Rights Watch calls on nations at the Review Conference to follow these examples and to adopt a strong protocol prohibiting blinding as a method of warfare and banning all blinding tactical laser weapons. The most important step is to establish a new international norm that blinding as a method of warfare is unacceptable. **A prohibition against blinding as a method of warfare establishes the principle that the common and systematic**

[20] ICRC, *Blinding Weapons: Reports of the Meetings of Experts Convened by the International Committee of the Red Cross on Battlefield Laser Weapons, 1989-1991*, (ICRC: Geneva, 1993), pp. 179-183, 187, 286-290, 336-337.

[21] ICRC, *Blinding Weapons*, p. 339. One reason is that lasers that might dazzle individuals at the far range of their beam could blind at a closer distance. Soldiers would be faced with the problems of determining the correct power level for the exact distance and compensating for smoke, dust and other battlefield conditions that could distort the laser beam.

[22] European Parliament, "Resolution on Landmines and Blinding Laser Weapons," June 29, 1995.

[23] Council of Ministers of the Organization of African Unity, "Resolution on the 1980 United Nations Convention on Certain Conventional Weapons," June 23, 1995.

use of lasers to blind is unlawful. At the same time, the "method of warfare" provision would protect personnel who use such non-weapon laser systems as laser rangefinders and target designators, which can cause blindness incidentally or accidentally while performing non-eye focused missions.

The protocol also should prohibit the use, production and transfer of all blinding tactical laser weapons. Production and trade must be proscribed in the protocol to ensure that a ban on the use of laser weapons is meaningful. The ban should encompass all blinding tactical laser weapons. Delegates should take care to avoid loopholes that excuse particular systems, notably those laser weapons that ostensibly target optical systems, but in fact have blinding as their military mission in some instances.

The protocol should apply in all circumstances of international and internal armed conflicts, and **a verification and enforcement scheme should be incorporated.**

Human Rights Watch asks the national delegations to the Review Conference to consider these issues when they debate the language of a protocol on blinding lasers in Vienna. If nations do not adopt a strong protocol, they must ask themselves whether they are ready to accept the widespread proliferation of blinding lasers, whether they are prepared to protect their soldiers and possibly civilians against such a threat, and whether they are prepared to meet the socio-economic costs of caring for blinded soldiers and civilians.

II. RECENT DEVELOPMENTS

The United States

The United States tactical laser weapon program has been plagued by technological constraints, competing priorities, disagreements over the threat, concerns over blinding, a lack of central direction, overlap with other systems and capabilities, and legal and political sensitivities. According to some estimates, the United States has spent more than $400 million for research and testing, but it has not fielded fully a single tactical laser weapon system. In the words of U.S. Brigadier General Jack Nix, Jr., "Our country has allocated resources to support testing and to write requirements that have resulted in the spending of hundreds of millions of dollars. Nevertheless, except for the two Stingray systems that were taken to Desert Storm and have since been disassembled, we have not fielded any systems."[24]

The U. S. military moved forward with the development and production of tactical laser weapons in June 1995 even as it undertook a review of its policy on these systems and engaged in preparation for international negotiations aimed at restricting or banning such systems. The U.S. Army decided at that time to purchase fifty actual and twenty-five low power training units of the LCMS, a portable, manually-operated, shoulder-fired system mounted onto an M-16A3 rifle.[25] The $16.8 million contract was awarded to Lockheed Sanders Inc. of Nashua, New Hampshire on August 31, 1995,[26] and is part of a $275 million program that calls for procurement of approximately 2,500 of the systems at a cost of between $85,000 to $100,000 each.[27] **Money for the purchases came from previously approved fiscal year 1995 funds.**

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[24] Keynote speech and briefing, Brigadier General Jack Nix Jr., Assistant Commandant, U.S. Army Infantry School, "Fifteenth Annual Lasers on the Modern Battlefield Conference," Brooks Air Force Base, Texas, February 1994, released under the Freedom of Information Act.

[25] The LCMS is battery-powered and weighs forty-two pounds. Letter, Holmes to Representative Lane Evans, July 18, 1995; Christopher Parent, "Army Pushes Ahead with Laser Countermeasure System Production Plan," *Inside the Pentagon*, July 13, 1995.

[26] Human Rights Watch interviews with Pentagon officials, September 1995; Bradley Graham, "Pentagon Shifts," *Washington Post*, Sept. 20, 1995.

[27] U.S. Army, Response to David Isenberg, *America's Defense Monitor*, August 2, 1995; Laser Countermeasure System Fact Sheet obtained under Freedom of Information Act in June 1995.

The decision allows for execution of a limited LCMS production plan and "is the first step" toward full-scale production because it provides the Department of Defense with the opportunity to carry out tests to confirm the system's reliability.[28] The fifty prototypes will go to operational units and will be available for further field testing and deployment.[29] Another pre-full-scale production review of the LCMS is scheduled between January and March 1997.[30]

[28] Parent, "Army Pushes Ahead...," *Inside the Pentagon*.

[29] T**he training systems will have a low-power laser similar to the MILES laser for force-on-force training.**

[30] Lockheed Sanders is promoting its Target Acquisition System, the sensor element of the LCMS, to detect and identify weapons using optical sights. The company has supplied six to Canadian forces operating in the former Yugoslavia, which uses them to detect snipers. "Optical detector locates weapons and snipers," *IDR Despatches*, August 1995.

The Department of Defense made one of its most open statements regarding the effect of laser weapons when it told members of Congress about the LCMS purchase decision: "Virtually all laser systems have the potential to cause vision impairment under certain conditions."[31] However, the Pentagon maintained that the LCMS is a "legitimate laser system" and not an antipersonnel weapon because it is "not intended to be used to produce permanent blindness ... (but is) designed to locate and destroy enemy optical and electro-optical systems."[32] A 1994 Army Memorandum of Law said that even if there was a ban on weapons designed or intended *solely* to cause permanent blindness, the LCMS would not be affected because it is a weapon whose "primary effect is OED disruption, but which has an ancillary antipersonnel effect."[33]

The long awaited September 1995 U.S. Department of Defense policy guidance statement "prohibits the use of lasers specifically designed to cause permanent blindness of unenhanced vision and supports negotiations prohibiting the use of such weapons."[34] This statement is the first time the DoD has gone on record in support of a protocol on laser weapons, and, senior Pentagon officials have told Human Rights Watch, is a major shift in DoD policy intended to establish that blinding as a method of warfare is unacceptable.

However, the statement appears to be crafted so as to protect the LCMS and permit the U.S. to go forward with all of its existing tactical laser weapon programs. The phrase "unenhanced vision" is particularly telling and objectionable. The statement also fails to address the concerns raised by members of Congress who told Secretary of Defense Perry that it was not enough to prohibit lasers "designed" to be used against personnel because virtually all laser systems have the potential to damage eyesight.[35]

Nearly ten years ago, the United States did not feel the need to distinguish between enhanced and unenhanced vision when then-Secretary of Defense Caspar Weinberger raised U.S. concerns about the use of blinding lasers and condemned the possible Soviet Union development of laser weapons that could blind soldiers. Weinberger said the Soviets had the technological capability to deploy low-power laser weapons "at least for antipersonnel use and against soft targets."[36] U.S. military officials at the time expressed outrage at the possible use of laser weapons against their

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[31] Letter, Holmes to Representative Lane Evans, July 18, 1995.

[32] Ibid. Similar explanations are echoed through various levels of the military. Two recent letters are instructive: "The LCMS is designed to provide a significant tactical advantage for the individual, early entry soldier. It will promote survivability for light forces against armor and enhance night fighting capabilities. LCMS is not an antipersonnel system. It is a non-lethal system and was not designed with the intent of producing permanent vision impairment in people. ... The development of specific tactics and doctrine is in the planning stages appropriately aligned with the progress of the LCMS program." Letter, Gilbert F. Decker, Assistant Secretary of the Army, Research, Development and Acquisition, July 7, 1995 to Human Right Watch.

"For the record, U.S. laser weapons and, specifically the Laser Countermeasure System, are designed to produce optical and electro-optical disruption and are neither designed nor intended to produce permanent vision impairment in people." Letter, George R. Schnieter, Director, Strategic and Tactical Systems, Office of the Under Secretary of Defense, June 9, 1995, to Human Rights Watch.

[33] Memorandum on the AN/PLQ-5 Laser Countermeasure System, Law of War Review, September 1994.

[34] "DOD Announces Policy on Blinding Lasers," News Release, Office of the Assistant Secretary of Defense, Public Affairs, September 1, 1995.

[35] Letter, Senator Patrick Leahy, Representative Lane Evans and other members of Congress, to Secretary of Defense William Perry, July 31, 1995.

[36] George C. Wilson, "Pentagon Annual Says Soviets Able to Deploy Blinding Laser Weapons," *The Washington Post*, March 25, 1987. See also, Warren Strobel, "Pentagon Accelerates Counter-Laser Studies," *The Washington Times*, October 15, 1987. The article states that the Pentagon was accelerating research into countering laser attacks because it faced a growing number of incidents in which the Soviets had turned an experimental shipborne laser on Western military personnel and equipment.

personnel, not distinguishing between its use against vision that was either unenhanced or enhanced by optical instruments. "The morale problems from battlefield lasers are horrendous," an unnamed official told reporters.[37]

[37] Wilson, "Pentagon Annual Says...," *Washington Post*.

In May 1995, the Human Rights Watch Arms Project identified and detailed ten different U.S. tactical laser weapons, five active and five dormant programs, that have the potential to blind.[38] Further research has revealed for the first time additional programs and confirmed that the U.S. continues to aggressively pursue tactical laser weapons technology.

Since the release of its report, Human Rights Watch has identified six additional laser weapon programs being worked on in U.S. military laboratories, a new Marine Corps "validated requirement"[39] for a laser weapon, and several other laser systems whose blinding effects or potential for collateral damage is unclear, but bear further investigation.

In general, current U.S. laser weapon programs may be divided into three categories: weapons that exist either in limited quantities or for prototype use; laboratory systems that do not have validated requirements and have not been handed over to the military; and systems that are not tactical laser weapons per se, but whose blinding effects or potential for collateral damage is not clear.

In the first category, U.S. laser weapons include, for the Army, the LCMS, Stingray, and Outrider[40]; and for Special Operations Command, Cobra[41] and Dazer.[42] All of these have been fielded in prototype form. In

[38] Human Rights Watch Arms Project, "U.S. Blinding Laser Weapons," May 1995. The U.S. tactical laser weapon programs identified in the report were the: Laser Countermeasure System, Stingray, Outrider, Dazer, Saber 203, Perseus Optical Munition, Cobra, Coronet Prince, Compass Hammer and Cameo Bluejay.

[39] "Validated requirement" is a term of art within the military indicating that the military authority has approved those requirements or needs and is seeking systems to fulfill those requirements.

[40] The Marine Corps is currently funding the Outrider effort through fiscal year 1996 in the amount of $250,000. Letter, John B. Bennett, Counsel U.S. Marine Corps Systems Command, to William M. Arkin (consultant to the HRW Arms Project), attached to Mission Need Statement for the ALCS, July 19, 1995, in response to Freedom of Information Act request. Overall, Outrider is funded at a level of about $1 million in fiscal year 1995 in the Army budget.

[41] Cobra is a portable, rifle-like, shoulder-fired, non-scanning tactical laser weapon that is manually operated. Cobra, which was tested in 1989, competed for the LCMS contract awarded to Lockheed Sanders. U.S. military sources have indicated that McDonnell-Douglas is still actively pursuing sponsorship to continue development and production for Cobra.

addition, Human Rights Watch has learned that the Marine Corps has a Mission Need Statement for the Active Laser Countermeasure System (ALCS),[43] a need that could be fulfilled by the LCMS, Stingray, Outrider or a new system.

[42] Dazer is similar to Cobra and also competed for the Army's portable laser weapon contract awarded to Lockheed Sanders. According to the U.S. Special Operations Command (USSOCOM), the Dazer prototype is not routinely issued for training and "will only be issued as a result of USSOCOM SOJ3 (Director of Operations) direction. The Dazer is normally reserved for operational missions." U.S. Special Operations Command (USSOCOM) Fact Sheet, "Dazer System NSN 6660-00-X01-6666 (no date, obtained May 1995).

[43] The Marine Corps identifies LCMS, Outrider and Stingray as potential systems, "which may meet this requirement" "to seek enemy directed energy systems and disrupt them." U.S. Marine Corps, Mission Need Statement (MNS) for the Active Laser Countermeasure System (ALCS) (No. Log 47), (no date, obtained 1995 under the Freedom of Information Act).

Within the second category of laboratory systems, at the Los Alamos National Laboratory work is or has been conducted on "eye-safe" argon lasers,[44] infrared CO2 lasers,[45] and previously disclosed battlefield optical munitions including Project Perseus for the Army.[46] Other laboratory systems include research at the U.S. Air Force's Phillips laboratory into chemical oxygen iodine lasers,[47] and at the Naval Weapons Center China Lake into

[44] "The [argon] laser would dazzle the occupants of the car, which would temporarily immobilize them but not harm them," Vincent Kiernan, "Lasers seen as an aid to law enforcement," *Laser Focus World*, September 1994; "... the lab is developing an argon laser beam bright enough to temporarily blind suspects in daylight but not so intense as to damage the eyes. When the beam is aimed at windows, automobile windshields, or airplane canopies, microabrasions in the glass scatter this particular wavelength of light turning the entire sheet a glaring, opaque green. This weapon could prevent a high-rise sniper from seeing a target, a driver from speeding away, or a pilot on a suicide mission from aiming a plane at the White House," Mark Fischetti, "Less-than-lethal weapons," *Technology Review*, January 1995; See also Russell Shorto, "Armageddon: Killing them softly," *GQ*, March 1995.

[45] Mark Fischetti, "Less-than-lethal weapons," *Technology Review*.

[46] The Perseus "optical flash" 40 mm rifle grenade projectile was developed by the Los Alamos National Laboratory as part of its "disabling technologies" program and was managed by the U.S. Army Armament Research, Development and Engineering Center, Picatinny Arsenal, New Jersey. Perseus works when the light from an explosion-induced shockwave is used to pump an inexpensive plastic compact laser "bullet" or "optical flash" device. The grenade's pulsed chemical laser would put out a flash of intense white and laser light brilliant enough to at least temporarily blind people and sensors. The program was cancelled in 1992.

[47] "Development of advanced technologies and demonstration of the scaling of chemical lasers to weapon-power levels for strategic and tactical applications." Fact Sheet, Phillips Laboratory Significant Projects Listing, June 1994.

advanced expendable lasers.[48] The Department of Defense and NASA also have sponsored research into advanced laser diode arrays with EOCM/IRCM functions.[49] U.S. Army special operations forces also have identified a technology requirement for an "optical laser weapon."[50]

[48] Abstract, C.D. Marrs, and others, "Advanced Expendable Laser," Secret/NOFORN paper presented at the Twelfth Lasers on the Modern Battlefield Conference, October 22-26, 1990.

[49] Companies involved in current laser diode array work include Fibertek, Lockheed-Martin Sanders, McDonnell Douglas, Hughes, TRW, Advanced Optoelectronics, Spectra Diode Laboratories, Litton, Spire Corporation, Northeast Semiconductor, Opto Power Corporation, and Laser Diode Arrays, Inc. Army/Navy Briefing, "Laser Diode Productibility, Status and Potential for Dual Use," National Infrared Information Symposium, May 25, 1993, obtained under the Freedom of Information Act.

[50] The United States Army 1995 Modernization Plan, Department of the Army (no date, obtained September 1995), p. T16.

The third broader category includes high-energy lasers with tactical applications and so-called eye-safe non-lethal systems whose blinding effects or collateral damage is unclear. Examples of such systems are the U.S. Army's Advanced Threat Infrared Countermeasures System (ATIRCM),[51] the U.S. Air Force's Saber 203 Grenade Shell Laser Intruder Countermeasure System/Visible Laser Illuminator, LX-5 IR Laser Illuminator,[52] F-15E optics-blinding laser,[53] and the Navy's Hughes/Signaal naval close-in weapons system (CIWS) laser replacement.[54] The Air Force's Airborne Laser (ABL) classified mission to attack aircraft also might be within this category.[55]

In a summary of its involvement in exploring new concepts for battlefield laser use, the Phillips Laboratory singles out its involvement in the withdrawal of U.N. forces from Somalia through the use of several developmental models of laser systems described as providing "a force continuum between doing nothing and firing lethal rounds."[56] More than fifty U.S. Navy Seals and Marine snipers qualified to operate the deployed lasers. More than twelve hours before the main landing force came ashore, an advance team landed with over $100,000 worth of state-of-the-art laser equipment deployed over two miles in the combat zone. The systems were the Phillips Laboratory-developed LX-5 IR Laser Illuminator and the Saber Visible Laser Illuminator.[57] Phillips claims, "Both the LX-5 and SABER allowed U.N. forces to distinguished (sic) looters and children from armed threats at safe distances. The visible SABER successfully deterred threats by the psychological impact of implied lethal force."[58]

China

China North Industries Corporation, or Norinco, marketed at an arms exhibition in southeast Asia a portable, tripod-mounted laser device developed "to injure or dizzy" eyes and to damage **photo-electric optical sensors.[59] The system is known as the ZM-87 Portable Laser Disturber.[60]**

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[51] The ATIRCM is used to defeat heat-seeking air-to-air and surface-to-air missiles and is mounted on helicopters or fixed-wing aircraft. Pat Cooper, "U.S. Army Turns to Lasers to Stop Missiles," *Defense News*, September 19-25, 1994.

[52] "Air Force Support of Operation United Shield with Laser Diode Technology," appended to letter, Phillips Laboratory to William M. Arkin, August 15, 1995, in response to FOIA request.

[53] The F-15E optics-blinding laser is similar to the ATIRCM and is the follow-on to the Coronet Prince concept. David A. Fulghum, "Wild Weasels May Get Optics-Blinding Laser," *Aviation Week & Space Technology*, March 8, 1993.

[54] "Hughes, Signaal Join to Develop Laser CIWS," *Jane's Defence Weekly*, April 22, 1995; see also Vincent P. Grimes, "Lasers as Naval Weapons," *Wings of Gold,* Summer 1993.

[55] David A. Fulghum, "USAF Aims Laser at Antimissile Role," *Aviation Week & Space Technology*, August 14, 1995.

[56] "Air Force Support of Operation United Shield with Laser Diode Technology," appended to letter, Phillips Laboratory to William M. Arkin, August 15, 1995, in response to FOIA request.

[57] Ibid. The LX-5 IR Laser Illuminator uses a near-infrared diode array while the Saber operates in the red portion of the visible spectrum. Saber is similar to the Los Alamos National Laboratory/Army battlefield optical munition, Project Perseus.

[58] Ibid.

[59] U.S. Army intelligence sources report that Norinco displayed the ZM-87 first in November 1994. Military magazines report that Norinco displayed a "laser interference device" in March 1995 at a defense exhibition in Manila, the Philippines, and also marketed the system at IDEX in Abu Dhabi in the same month. The devices match the description of the system designated ZM-87. Peter Felstead, "China Markets Blinding Laser," *Jane's Intelligence Review, Pointer newsletter*, June 1995. A Norinco fact sheet on the ZM-87 states that one of the weapon's major applications is to: " injure or dizzy the eyes of an enemy combatant, and especially anybody who is sighting and firing at us with an optical instrument, so as to cause him to lose combat ability or to result in suppression of his observation and sighting operations. Besides, the high-power laser beam can damage or invalidate any enemy photo-electric sensor in a highly converging optical system, such as the photo-electric detector of a laser rangefinder, the head of a video-camera and the head assembly of a laser guidance system." ZM-87 Portable Laser Disturber Fact Sheet, China North Industries Corp. (no date, obtained 1995).

[60] ZM-87 Portable Laser Disturber Fact Sheet, China North Industries Corp.; "Chinese Offer Laser Eye-Damage

Norinco's specifications sheet for the ZM-87 states that the effective distance of direct human eye injury is two to three kilometers, and the effective distance of human eye injury by adding a magnifying sighting telescope seven times normal strength is less than five kilometers. Norinco states that the effective distance for so-called flaring blindness, or flash blinding, is ten kilometers. The ZM-87 can simultaneously transmit fifteen megawatt laser pulses at two different wavelengths. More than 10,000 pulses can be generated from each battery and it can fire continuously for five minutes at ordinary temperatures. The weight of the ZM-87 is nearly seventy-three pounds, including its tripod.[61]

Weapon," *International Defense Review*, May 1995.

[61] Ibid.

Officials in the Pentagon's Directorate for Combating Terrorism believe that the ZM-87 is aimed for buyers from Third World "rogue states."[62] It is not clear why these officials believe a distinction needs to be made between Third World rogue states or any other country throughout the world or independent non-state entities. It also is not clear how this system is any different in its effect from the LCMS.

III. MILITARY CONSIDERATIONS

Non-lethal Weapons?

Politicians and military officials have tried to categorize blinding tactical laser weapons as so-called non-lethal weapons. Interest in developing non-lethal weapons arose in the context of trying to make military operations more palatable to the public and to find alternatives to the use of lethal force, especially with the increase in peacekeeping operations and humanitarian interventions.[63] However it is questionable whether tactical laser weapons fall within the category of non-lethal weapons.

The U.S. Department of Defense draft policy directive on non-lethal weapons defines them as weapons that "are explicitly designed and employed so as to incapacitate personnel or materiel, while minimizing fatalities and undesired damage to property and the environment."[64] They have three distinct characteristics: 1) they use means other than gross physical destruction to prevent the target from functioning; 2) they have relatively reversible effects; and 3) they discriminate between targets and non-targets.[65] The draft directive states that non-lethal weapons will "provide an effective but also reversible and more humanitarian means of denying an enemy the use of some of his human and material assets."[66] The non-lethal weapons are also intended to limit the post-conflict costs of rebuilding infrastructure.

Tactical laser weapons would not fulfill this definition of non-lethal weapons. The damage to the human retina from laser weapons in many instances would involve gross physical destruction and irreversible effects. Tactical laser

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[62] Nick Cook, "Chinese Laser 'Blinder' Weapon for Export," *Jane's Defence Weekly*, May 27, 1995.

[63] See for example, "Less-Than-Lethal Weapons," *Technology Review*, January 1995. Military laser technology is also being considered for adaptation by law enforcement agencies through a U.S. Department of Justice initiative and efforts by U.S. laboratories.

[64] U.S. Department of Defense Draft Non-Lethal Weapons Policy, July 21, 1994; Christopher Parent, "Draft Policy Directive Spells Out DOD's Rules for Non-Lethal Weapons," *Inside the Pentagon*, July 13, 1995. By comparison, the United Kingdom states that it has made "no policy statement or expressed any interest in acquiring non-lethal weapons." Spokesperson for the Ministry of Defense, July 20, 1995.

[65] Parent, "Draft Policy Directive...," *Inside the Pentagon*.

[66] U.S. Department of Defense Draft Non-Lethal Weapons Policy.

weapons do not have a low probability of inflicting "permanent disablement," and blinding is not a "relatively reversible effect." In addition, the use of tactical laser weapons would entail prohibitive political costs.

Another problem with designating tactical laser weapons as non-lethal is that some military commanders may view non-lethal weapons as pre-lethal weapons to incapacitate combatants. Enemy soldiers would become "sitting ducks to be destroyed by conventional means."[67] By one estimation, a disabling weapon "works only if it leaves an opponent vulnerable to full scale, deadly force."[68] Colonel Sam Gardiner, a consultant to the U.S. Department of Defense, said in 1993 that the theory behind the use of non-lethal technologies in the Gulf War would have been to stop the enemy from using such measures and then "go in with conventional weapons and destroy them."[69]

Blinding lasers may more accurately fall into a category described by one commentator as "worse than lethal weapons."[70] "[T]he temptations to burden an enemy with wounded ... need to be weighed against their moral and political hazards."[71]

Military Utility

Numerous interviews with those deeply involved in tactical laser weapon programs in the United States have led Human Rights Watch to conclude that the military utility of these weapons is very limited.[72] The lack of utility and need for laser weapons has been reflected in the confused, uncoordinated, contradictory nature of the U.S. laser programs. As late as July 1995, after decades of research and development into tactical laser weapons, the U.S. Army acknowledged that military requirements documents were incomplete and that specific tactics and doctrine had not been developed for the use of laser weapons.[73]

A recent *Washington Post* article noted that Secretary of Defense Perry "found little support among senior military officers for either the utility or appropriateness of blinding as a method of warfare," and that he "found no Pentagon program with the professed mission of inducing permanent blindness." In the same article, Deputy Undersecretary of Defense for Policy Jan Lodal stated, "So, whether legal or not, it seemed something that many people were uncomfortable with and for which there were no ascertainable military requirements."[74]

In theory, a tactical laser weapon may be an effective alternative to conventional weapons for disabling electro-optical and optical sensors or instruments used in night fighting, surveillance, target seeking and fire control systems, such as thermal sights, other infrared sensors, image intensifiers and low-light television systems.[75] At least in part, the

[67] Lewer, "Non-Lethal Weapons."

[68] Ibid., quoting E. Cohen, "The Mystique of U.S. Air Power," *Foreign Affairs*, January-February 1994, 109-124.

[69] Ibid., quoting Media Transcription Service, transcription of report by David Shukman for BBC 2 Television, *Newsnight*, April 22, 1993.

[70] Harvey M. Sapolsky, "Non-Lethal Warfare Technologies: Opportunities and Problems," report based on a conference held June 2-3, 1993, in Lexington, Massachusetts.

[71] Ibid.

[72] It is also worth noting that a striking feature of experts' meetings organized between 1989 and 1991 by the International Committee of the Red Cross on lasers is that none of the participants argued that tactical laser weapons are militarily essential, though they outlined several possible anti-personnel uses of laser weapons. ICRC, *Blinding Weapons*, p. 332.

[73] "The development of specific tactics and doctrine is in the planning stages... " Letter Decker to Human Rights Watch, July 7, 1995.

[74] Bradley Graham, "Pentagon Shifts, Seeks Laser Weapons Curbs," *Washington Post*, September 20, 1995.

[75] Major General Bengt Anderberg and Dr. Myron Wolbarsht, *Laser Weapons: The Dawn of a New Military Age,* (Plenum Press: New York, 1992), pp. 92-93.

question of military importance hinges on the ease and ability of a laser under combat conditions to disable electro-optical systems. There are still many doubters within the U.S. military on this point.

Moreover, the most important sensor on the battlefield remains the eye, and likely targets for laser weapons would be dismounted infantry, soldiers in defensive positions such as forward artillery controller teams, air controller teams, anti-tank missile teams, surveillance teams, commanders and "generally any soldier looking through binoculars, magnifying sights or using naked eyes in the direction of the enemy."[76] Laser weapons clearly function as blinding antipersonnel weapons in these situations, not as anti-sensor weapons.

High Intensity vs. Low Intensity Conflicts

Two distinct and separate tracks exist for the use of tactical laser weapons with different humanitarian implications: (1) on the armor-heavy, high-intensity battlefield and, (2) in the low-intensity conflict, operations other than war and special operations scenario. While numerous missions are advanced for the possible use of tactical laser weapons, the most likely use today is in special operations where the blinding attribute is most useful and attractive.

[76] ICRC, *Blinding Weapons*, p. 332.

Tactical laser weapons were originally conceived as force multipliers for high-intensity warfare. Many now believe, however, that on the high intensity battlefield laser weapons would make only a minor contribution to military capability, particularly in light of the presence of many increasingly long-range "smart" weapons.[77] Given the demonstrated superiority of U.S. fire control systems and guns in the Gulf War and the variety of ground- and air-delivered anti-tank weapons, such as the Sensor Fused Weapon (SFW), Brilliant Anti-Tank Munition (BAT) or the Joint Standoff Weapon/Joint Direct Attack Munition (JSOW/JDAM), the need for laser weapons is very questionable. Moreover, operators of an assortment of barreled weapons or missiles, including rifles and machine guns, are able in most cases to determine immediately whether the target has been hit by directly viewing the target or by using an optical instrument. Operators of tactical laser weapons will not be able to register direct hits or easily judge what effect the laser beam had on the target.[78] "In case of a miss, the gunner even has difficulty determining by how much and in what direction the beam was misdirected."[79]

Military services are becoming more involved in operations other than war or in low-intensity conflicts, as humanitarian interventions in Somalia and peacekeeping operations in Bosnia show. It is the promise or hope of a less-than-lethal impact that is the current main attraction of laser weapons. Brigadier General Jack Nix, Jr., assistant commandant of the U.S. Army Infantry School, concludes that many of the U.S. lasers "would be ideal for these missions." Nix has stated, "Many situations where detection and surveillance are critical and minimum force is required, laser capabilities would be very valuable. The psychological impact, in itself, would be a significant deterrent."[80]

At least in the U.S., laser weapons have clearly moved into the realm of low intensity conflict and special operations. One frequently discussed mission for laser weapons is sniper-type operations.[81] Yet, in low-intensity conflicts, special missions, and sniper operations, the presence of electro-optical devices would be minimal. Therefore, the laser's mission would be to detect and attack direct optics, as in gunner's sights or eyes. Blinding would be the deliberate intent in these operations.

There is reason to doubt the effectiveness of lasers in this role, as well. Technical problems would arise in carrying out such missions because the usefulness of lasers to perform, for example, counter-sniper operations would

[77] Tactical laser weapons can only be claimed to operate beyond the range of U.S. weapons in the narrow context of Army weapons organic to specific units as opposed to the more likely joint warfare scenarios.

[78] Anderberg and Wolbarsht, p. 100.

[79] Ibid.

[80] Brigadier General Jack Nix, Jr., keynote speech at the Fifteenth Annual Lasers on the Modern Battlefield Conference, February 1994.

[81] See for example, Abstract, John V. Meier, Los Alamos National Laboratory, Lynn Childers, U.S. Army Infantry School, "Sniper Applications of the Man Portable Laser Assault Weapons (MANPLAWS)," presentation before the Twelfth Annual Lasers on the Modern Battlefield Conference, October 22-26, 1990.

apparently depend on the laser being on the precise same axis as the sniper's scope. In addition, in urban settings, there would be the danger of civilian collateral damage, as from the deflection of laser beams from windows.

Risks and Effects

While wanting to preserve the ability to procure laser weapons that can blind, the military often focuses on the risks lasers pose to their personnel. Indeed, it may be that outdated and exaggerated notions of the threat posed by enemy lasers continue to drive technological developments to secure so-called countermeasures. In turn, these technological developments may be creating a nexus of advantageous laser size, weight, power, cost and reliability that could lead to the development of the very weapons that the military fears would be used against their personnel.[82]

The U.S. Marine Corps believes that its Marine Air-Ground Task Forces "must be prepared to face directed energy threats" and its long-range plan assessment for 2000-2020 "acknowledges a significant and rapidly emerging threat from directed energy weapons."[83] Comments from top U.S. Army personnel follow a similar line.[84] The U.S. Marine Corps considers that tactical laser weapons are a rapidly emerging threat to individuals because they "can disable optical devices and cause permanent blindness."[85] The Marines conclude that their forces "risk permanent blindness" when using binoculars, laser rangefinders and laser target designators against the opposing side in a conflict.[86] They are especially worried by technological developments that enable existing lasers to easily adjust their frequencies to levels at which protective devices are no longer effective against them.

> Such modifications are relatively simple, low cost, and make any laser a potential weapon. The eyesight of individual Marines and optical devices are especially vulnerable. ... Enemies employing frequency agile lasers can deny us use of our optical devices and the ability to look directly toward the enemy.[87]

To counter this concern, the U.S. Marines propose to procure a laser weapon of their own: the Active Laser Countermeasure System (ALCS). The ALCS ranked fourteenth out of the top twenty-nine types of equipment the Marine Corps believed it needed for close combat. Officials are seeking full operating capacity of such a system during fiscal year 2002.[88]

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[82] Laser diodes for example, have reduced weight by one-third and have led to a total cost reduction in output by fifteen times from 1989 to 1993. Army/Navy Briefing, "Laser Diode Producibility, Status and Potential for Dual Use," National Infrared Information Symposium, May 25, 1993, released under the Freedom of Information Act.

[83] Mission Need Statement (MNS) for the Active Laser Countermeasure System (ALCS) (No. Log 47) (no date, obtained in 1995 through Freedom of Information Act request). Directed energy refers to laser, particle beam, radio frequency and other focused electromagnetic energy or particles used to defeat military targets.

[84] "We have weaknesses that the threat can attack with directed energy weapons and devices and we must protect our soldiers and equipment." Briefing, Jan Gray, U.S. Army Training and Doctrine Command, "Historical Perspectives on Military Lasers," Twelfth Lasers on the Modern Battlefield Conference, October 22-26, 1990; "The threat of directed energy warfare will not go away. ... We must continue to develop lead-ahead technologies, such as lasers and radio frequency, to ensure these systems are properly integrated into our force structure." Brigadier General Jack Nix Jr., briefing at the Fifteenth Annual Lasers on the Modern Battlefield Conference, February 1994, Slide 5.

[85] Mission Need Statement.

[86] Ibid.

[87] Ibid.

[88] Ibid. Joint interest for developing this laser weapon comes from the U.S. Army, Air Force and USCINCSOCOM. The Marine Corps states that the U.S. Army's program managers for Night Vision/Electro-optics and Electronic Warfare - Reconnaissance, Surveillance and Target Acquisition are developing three ALCS units, likely referring to LCMS, Stingray and Outrider.

Characteristics of Lasers

Power

Environmental health agencies designate lasers within at least four classes, all of which have actual or potential applications in battlefield weapons.[89] The lowest power lasers are designated as Class I, which are intrinsically safe. These lasers include such items as bar-code readers in supermarket checkout counters and in compact disc players.

Class II lasers are used as lecture pointers and for laboratory demonstrations and their upper limit is approximately one milliwatt. They are dangerous only to someone who stares directly at them for longer than one-quarter second, and experts say that an aversion reflex forces individuals to blink or turn their eyes away in enough time to prevent damage.

Class III lasers can damage the eye in less time than it takes to blink, however it may be safe to view diffuse reflections of such lasers off of a wall, for example. Class III lasers can be used to align building foundations.

[89] Malcolm W. Browne, "Lasers for the Battlefield Raise Concern for Eyesight," *New York Times*, April 26, 1988.

Class IV lasers comprise surgical lasers and lasers with potential military applications. They can damage eyes and burn skin, cloth and other materials, and it may not be safe even to view their diffuse reflections. The U.S. LCMS and Dazer use Class IV lasers. The Chinese ZM-87 system is advertised as having a peak output of fifteen megawatts, and experts believe it also uses a Class IV laser. In addition, if a laser rangefinder output is, for example, 10 mJ in 14 nanoseconds it would yield a peak power of approximately one megawatt. Laser designators could be expected to exceed this figure.[90]

In-band and Out-of-band Wavelengths

Lasers operating at "in-band" wavelengths are the most dangerous because they can produce the most severe eye damage and blindness. The eye transmits the laser beam to the retina if the wavelength is "in-band," the visible and near-infrared range, which is between approximately 400 to 1,400 nanometers. This bandpass is sometimes called the "retinal hazard region."[91] The energy in the visible and near-infrared range easily penetrates the cornea and the lens and is absorbed at the retina.[92] U.S. laser weapon systems are all believed to operate at the in-band wavelength. "It is sufficient to use a low-energy laser operating in the visible or near-infrared part of the spectrum to damage a person's eyes and, in effect, cause blindness."[93]

Lasers operating at "out-of-band" wavelengths, which affect the cornea more often than the retina, also can cause damage. Injuries from lasers operating at these wavelengths are extremely painful and would result in the injured person's immediate incapacitation. Immediate medical care would be required for damage done to the eye by "out-of-band" wavelengths.[94]

Tunability

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[90] ICRC, *Blinding Weapons*, pp. 102-104.

[91] The eye does not transmit far-infrared or short ultra-violet radiation. Near ultra-violet radiation will penetrate only as far as the lens. See generally, ICRC, *Blinding Weapons*, p. 35-37, and Maj. Gen. Bengt Anderberg and Ova Bring, "Battlefield Laser Weapons and International Law," *Nordic Journal of International Law*, 1988, p. 461.

[92] ICRC, *Blinding Weapons*, p. 30. **With far-ultraviolet and far infrared radiation, energy is absorbed or reflected at the surface and may damage the cornea. With near ultraviolet radiation, energy penetrates to the lens and may even penetrate to the retina.**

[93] Anderberg and Wolbarsht, *Laser Weapons: The Dawn of a New Military Age*, p. 2.

[94] Anderberg, "The Low Energy Laser Aimed at the Eye as Potential Anti-Personnel Weapon," *RUSI Journal*, 1988, pp. 35-40, 36-37; Anderberg and Bring, "Battlefield Laser Weapons and International Law."

Most lasers can emit light over a range of wavelengths, and it is possible to design a laser to emit laser energy at several wavelengths at the same time. A laser may be tunable continuously within a particular band, which would make it more difficult to effectively counter laser weapon systems. Protective gear or other countermeasures depend upon the laser wavelength being known beforehand with a high degree of accuracy.[95] Laser weapons systems also may have automatic, semi-automatic and manual control settings, the final setting putting more power within the hands of individual combatants.[96]

Effects on the Eye

[95] Anderberg and Wolbarsht, *Laser Weapons: The Dawn of a New Military Age*, pp. 22-23.

[96] **Manual operation is a characteristic of at least the LCMS and Dazer.**

The eye is the organ most vulnerable to laser radiation. The severity of the damage is due primarily to the exact wavelength used and the energy.[97] **Most infrared wavelengths produce permanent damage.[98] The eye sees the light as coming from a point source and focuses the laser beam of certain wavelengths onto a small point on the retina. This focusing action of the eye amplifies the laser's intensity by a factor of approximately 100,000 or more.[99] When soldiers are using direct-view optics, such as binoculars, the potential for damage and blindness is even greater because those optics collect more light together and so magnify its intensity. Damage to the retina caused by a concentrated laser beam includes thermal burns that "immediately kill" that portion of the retina, and the rupture of blood vessels, usually caused by the shockwave from an extremely short duration laser pulse. The rupture puts blood underneath the retina or into the vitreous cavity in front of the retina producing distinct damage. Even a retinal burn in the periphery, where a laser injury ordinarily does not interfere with vision, "could induce bleeding that spreads to the center of the eye and blocks vision enough to result in functional blindness."[100]**

In describing what occurs to the eye, experts explain that an antipersonnel laser weapon would produce large vitreous hemorrhages, or bleeding. At the limits of the weapon's range or in thick smoke, the laser beam would produce less devastating effects such as subretinal hemorrhages. Once the retina is hit by the laser beam, even if only the outer segments of the photoreceptors are compromised, a slow decline begins that cannot be stopped. There is no medical treatment that can reverse, halt or slow down this process.[101]

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[97] Anderberg and Bring, "Battlefield Laser Weapons and International Law."

[98] ICRC, *Blinding Weapons*, p. 99. Another important consideration is that laser weapons would be affected by smoke, dust, water droplets and bad weather. At least two experts believe it is possible to design lasers operating within the retinal hazard region with an energy output sufficient to cope with such atmospheric conditions within 2,000 to 3,000 meters. Anderberg and Bring, "Battlefield Laser Weapons and International Law," p. 464.

[99] Maj. Gen. Bengt Anderberg and Ove Bring, "Battlefield Laser Weapons and International Law," *Nordic Journal of International Law*, 1988, pp. 457-469, 461.

[100] Maj. Gen. Bengt Anderberg et al., "Blinding Laser Weapons and International Humanitarian Law," *Journal of Peace Research*, Vol. 29, No. 3, 1992, p. 291.

[101] **ICRC, *Blinding Weapons*, p. 134. One ophthalmologist said during the expert meetings that "in the cases he has**

Military Laser Injuries

At least two Americans received laser injuries in separate incidents during the Gulf War against Iraq.[102] One American soldier was using a monocular laser rangefinder with his left eye to determine the distance to an Iraqi bunker. As he was looking down-range, he noticed a red flash from the bunker area and immediately lost vision in his left eye. Doctors noted he had macular findings consistent with laser burns. A second American soldier suffered reduced vision in his right eye after participating in field exercises among friendly forces before the ground war began. He was in an area where lasers were in use, but he did not recall seeing a laser flash. Doctors found two apparent laser burns to the right macula with subretinal hemorrhage and a smaller burn in the left macula. Military doctors commenting on these two documented cases concluded that "[i]ncreasing dependence on laser devices for target acquisition and range finding may result in larger numbers of laser-related eye injuries in future conflicts."[103]

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seen of people hit by lasers on the battlefield, they have always suffered bilateral hemorrhages," while another participant said experiments had shown that even a range-finder, which is weaker than a purpose-built anti-sensor/anti-personnel laser, had destroyed the eyes of animals up to 850 meters away. Ibid., p. 350.

[102] Dr. Thomas Mader, et al., "Ocular and Ocular Adnexal Injuries Treated by United States Military Ophthalmologists during Operations Desert Shield and Desert Storm," *Ophthalmology*, Vol. 100, October 1993, pp. 1462-1467.

[103] Ibid., p. 1467.

It is not clear whether other allied forces' soldiers sustained such laser injuries, but attempts were made to protect against the possible use of laser weapons. The British issued special goggles developed by the Defence Research Agency's Malvern branch to armored vehicle crews because they were concerned about Russian-made lasers believed to be in service with the Iraqis.[104]

At least one civilian has also suffered a military-related laser injury.[105] The incident occurred near the edge of a town at dusk while a 19-year-old German civilian was watching an American tank on maneuvers approximately twenty-five meters away.[106] The civilian suddenly saw a bright red flash coming from the tank and, and "immediately he realized a decrease of vision in both eyes."[107] He suffered severe blurred vision and bleeding within the retina, leading to a hole in his visual field. There was a greater decrease in vision in the left eye than in the right eye. Doctors found it surprising that both eyes were injured from a single pulse because the calculated diameter of the laser beam was only 2.5 cm at a distance of twenty-five meters. The most likely explanation given by them is that laser energy in the extreme "wings of the laser beam profile" entered the less injured right eye.[108] Doctors concluded from this case and their investigation of other laser accident injuries that, "no medical therapy is effective."[109]

According to one study, 180 laser accident eye injuries occurred in the United States between 1964 and 1994 to individuals ranging from technicians, scientists, and plant workers to patients, spectators and pilots.[110] More than 90 percent of the eye injury cases recorded some function loss, of which 77 percent were permanent. Five laser types ─ Nd:YAG, Argon, Dye, Ruby and HeNe ─ were involved in 90 percent of the severe eye injuries.

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[104] Christopher Bellamy, "Britain is Offered U.S. Laser Weapons," *The Independent*, April 14, 1993.

[105] V.P. Gabel, et al., "Clinical Observations of Six Cases of Laser Injury to the Eye," *Health Physics*, Vol. 56, No. 5, pp. 705-710; interview with Dr. Ulrich Schoenherr, July 5, 1995; transcript of "File on 4," British Broadcasting Corporation, transmission June 13, 1995.

[106] Since the incident occurred at dusk, doctors were led to believe that the civilian's pupils were dilated at the time. Doctors concluded the injury was caused by a Q-switched laser between the 532 and 780 nanometer range.

[107] Gabel, "Clinical Observations of Six Cases of Laser Injury to the Eye."

[108] Ibid.

[109] Ibid.

[110] R. James Rockwell, Jr., "Laser Accidents: Reviewing Thirty Years of Incidents: What Are the Concerns - Old and New?," *Journal of Laser Applications*, 6 (1994), pp. 203-211, 205.

Protection Against Lasers?

Key questions put forward at the Fifteenth Annual Lasers on the Modern Battlefield Conference in February 1994 included whether the U.S. Army was prepared to prevent massive eye injuries and whether the military could determine the psychological impact on soldiers caused by the use of laser weapons on the battlefield. The answer seemed to be negative. The laser beam in a weapon is spoken of as a zero-time-of-flight weapon and evasive action by the target of a laser beam such as the human eye is impossible. For a protective shutter filter to be effective it must close within "pico-seconds," or ten to the negative twelve seconds.

At present, no 100 percent effective protective measures against laser weapons systems have been developed. There are goggles that protect against a laser emitting a single wavelength, but it is possible to design a laser system that can fire a variety of wavelengths.[111] Recommendations made by the U.S. Air Force in 1988 are not particularly helpful, offering such suggestions as "Go 'heads-down' in the cockpit. Take cover if on the ground... Avoid looking directly at light sources... Use your hands to shield your eyes... Close one eye."[112] The silent and invisible threat of a laser weapon makes such recommendations useless. For infantry use, optical countermeasures are "possible but hardly feasible" primarily because of the variety of wavelengths a laser system could be designed to use.[113] Short of effective protective measures, the military also has considered studies that could provide adequate warning of attack by antipersonnel lasers and cue countermeasures.

In 1990, medical experts estimated that with the state of unclassified knowledge at that time, 25 percent to 50 percent of soldiers involved in battles who had no eye protection would experience laser-induced damage that would lead to "a reduction in visual performance." "This situation translates into numbers in the hundreds of visually impaired troops who would quite overwhelm any medical field station conceived today or likely in terms of resources that could be deployed."[114]

The type of effect on soldiers could range from deterring them from accomplishing particular missions to injuring them with such severe wounds that they could require immediate surgery from highly trained specialists in specially equipped operating theaters.[115] The effect on military morale would be "devastating and immediate."[116]

Proliferation

The specter of numerous nations in conflict, governments and their agents, guerrillas forces, and private groups and individuals using terror for political ends all having blinding laser weapons available, including portable, rifle-like systems, is one of the strongest factors demanding a prohibition on blinding as a method of warfare and on laser weapons now. A not insignificant number of nations are thought to have laser weapon programs--including the U.S., Russia, China, France, Britain, Israel, Germany, Ukraine, and perhaps other former Soviet republics. German pilots flying over the Iraqi no-fly zone were issued laser protective goggles to guard against Iraqi blinding use of rangefinders.[117] U.S. military personnel in Bosnia have been warned of the blinding potential of French and Serbian

[111] See for example, John Marshall, "A Horrifying New Laser Weapon That the World Should Ban Now," *International Herald Tribune*, April 12, 1995.

[112] ICRC, *Blinding Weapons*, p. 141.

[113] Maj. Gen. Bengt Anderberg and Dr. Myron Wolbarsht, "Hand-Held Laser Weapons are Waiting in the Wings," *Armed Forces Journal International*, May 1992.

[114] ICRC, *Blinding Weapons*, p. 137.

[115] Anderberg et al., "Blinding Laser Weapons and International Humanitarian Law," p. 291; See also ICRC, *Blinding Weapons*, pp. 134-139.

[116] Ibid.

[117] "German Pilots in Iraq Gain Eye Protection," *Defense News*, August 29-September 4, 1994.

laser rangefinders.[118] Reports from Japan indicated that the cult Aum Supreme Truth allegedly planned to attack a police building with a vehicle equipped with some type of laser device.

Yet it is not believed that any nation has entered into full-scale production of laser weapons, or that laser weapons are fully deployed operationally with military units in any country.

[118] National Ground Intelligence Center, "Helicopter and Ground-Based Electro-Optics and Laser Systems (less ATGMs)," NGIC-1100-55F-95, January 6, 1995, partially declassified and obtained under the Freedom of Information Act.

At present, cost and weight are two factors that remain significant in the development and spread of tactical laser weapons. The U.S. LCMS costs at least $85,000 each, and initial field testing was unsuccessful because of excessive weight.[119] The Chinese ZM-87 weighs seventy-two pounds with its tripod.[120] It is not clear how long this situation will last as research continues into producing lighter and more portable systems with greater power outputs and rates of repetition. Diode lasers already are more flexible.[121] When it comes to protective devices, lasers could be developed to have more power to overwhelm protective devices, and frequency tunable, or agile lasers, could be used to sidestep filter protections. Even though lasers remain expensive for the time being, improvised or early generation lasers, such as ruby lasers, remain a danger and the most significant in terms of humanitarian concerns.

Dazzling Lasers and Temporary Blinding

Proponents of tactical laser weapons maintain that at certain ranges some lasers will only temporarily blind through dazzling (flash blinding) or will produce limited eye injury that will not result in blindness. The United Kingdom fielded a laser dazzle device that reportedly caused temporary visual disturbance to pilots of aircraft attacking a ship during the Falklands War.[122] The device, identified as the Laser Dazzle Sight, has been described by the

[119] U.S. Army Infantry Center, Fact Sheet, Laser Countermeasure System (LCMS), as of May 8, 1995, obtained under the Freedom of Information Act.

[120] China North Industries Corp., ZM-87 Portable Laser Disturber Fact Sheet.

[121] See "Air Force Support of Operation United Shield with Laser Diode Technology." The Laser Applications Group at Phillips Laboratory develops "portable low-cost devices by taking advantage of the diode laser's unique small size and ability to run off battery power.... Since many wavelengths and power levels are available in diode lasers, the operational possibilities are endless." Ibid. The LCMS uses a laser diode and image intensifier system. Memorandum on the AN/PLQ-5 Laser Countermeasure System; Law of War Review, September 1994, Department of the Army, Office of the Judge Advocate General.

[122] ICRC, *Blinding Weapons*, p. 339; See also e.g. Simon O'Dwyer-Russell, "Navy's top secret laser was tried out in Falklands," *The Sunday Telegraph*, January 7, 1990; Anderberg et al., "Blinding Laser Weapons and International Humanitarian Law," *Journal of Peace Research*, Vol. 29, No. 3, 1992.

government since then as a rudimentary laser dazzle system designed to temporarily dazzle attacking aircraft pilots to force them to abort their attacks. According to the Earl Howe, Parliamentary Under-Secretary of Defence, "This practice has now been discontinued and I can confirm that the equipment no longer exists."[123] The United Kingdom armed forces "do not possess and currently have no plans to develop or procure any laser weapon designed permanently to blind enemy troops or to disrupt their eyesight temporarily."[124]

Some experts, including biophysicists specialized in lasers, are skeptical about the ability to design a tactical laser weapon that could only dazzle. The same laser that dazzles could also blind, depending on such factors as distance, energy and atmospheric conditions**. It would be very difficult during conflict to establish that the correct conditions prevailed. It is also possible that during conflicts combatants seeking to ensure an effective hit on a target might use a weapon's stronger power.**

Some experts believe it may be theoretically possible to flash blind an individual at night and possibly at dusk, but not during the day.[125] According to Major General Bengt Anderberg and Dr. Myron L. Wolbarsht:

[123] Letter, the Earl Howe, Parliamentary Under-Secretary of State for Defence, to Harry Cohen, member of Parliament, August 17, 1995. In responding to questions from the House of Commons, Roger Freeman, Minister of State for Defence Procurement, said the "feasibility of making use of temporary dazzle effects was investigated in 1983 and tests on one system were conducted which were subsequently discontinued." *Official Report of the House of Commons*, January 19, 1995, Col. 690.

[124] *Official Report of the House of Commons*, January 19, 1995, Col. 690. Freeman went on to say that the United Kingdom is researching the technology associated with laser weapons "in order to develop effective defences against such weapons should they be deployed against our armed forces."

[125] Major General Bengt Anderberg and Dr. Myron Wolbarsht, "Hand-Held Laser Weapons are Waiting in the Wings," *Armed Forces Journal International*, May 1992; interview with M.F. Heiniger, consultant with the Swiss Defense Technology and Procurement Agency, August 8, 1995.

dazzle is almost impossible by a laser beam in daylight without also causing permanent visual damage, and at night, although dazzling is possible, it is not an extremely long-lasting type of incapacitation from an infantry standpoint. Even at night, there is still a great risk of permanent damage, so that a laser dazzle weapon is as serious a hazard as those weapons whose primary purpose is permanent visual incapacitation from retinal burn or hemorrhage.[126]

Laser Weapons vs. Non-Weapon Lasers — Rangefinders and Designators

Human Rights Watch believes that tactical laser weapons are distinct from non-weapon lasers such as rangefinders and target designators, even though the technical characteristics in some cases may not differ much. Human Rights Watch does not believe that these non-weapon lasers should be banned; indeed they may have a positive humanitarian impact by increasing accuracy and limiting collateral damage.

Non-weapon lasers use a laser beam to aid other weapons in their tasks. For example, laser rangefinders and target designators are specifically used to determine distances and assist in pinpointing targets. Laser weapons use the laser beam as a weapon, not as an aid to another weapon The distinction between tactical laser weapons, and laser rangefinders and target designators is in the function, mission or intent. Tactical laser weapons should be defined as *weapons that use a laser beam as the primary kill mechanism.*

It does not appear possible at the present time to make a technical distinction between lasers used as weapons and those used as rangefinders and target designators. But, the U.S. military itself implicitly makes this distinction. For example, the U.S. Army has prepared legal reviews of the LCMS and other laser weapons, but not of target designators or rangefinders.[127] And, in literature distributed to U.S. armed forces, the U.S. military classifies rangefinders and laser designators as distinct from laser weapon systems.[128]

While laser rangefinders and target designators may in some cases reduce the humanitarian toll, experts agree that they can cause significant injury and blindness.[129] Therefore, combatants and their commanders remain under a

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[126] Anderberg and Wolbarsht, "Hand-Held Laser Weapons...," *Armed Forces Journal International*.

[127] DoD Instruction 5000.2 requires legal reviews of weapons.

[128] Report on Directed Energy Warfare Awareness Training, by the U.S. Army Combined Arms Training Activity, Fort Leavenworth, Kansas, November 25, 1987. Freedom of Information Act request.

[129] For example, during the 1989 meeting of government experts on blinding weapons, Dr. G. Schaefer posed the question of whether "a military commander who wished to use laser weapons for anti-personnel purposes [could] do so with lasers designed for other purposes." Dr. Schaefer stated that the answer was that lasers used for target designation have enough energy to harm the eye if it happens to be in the target area or if the laser is intentionally aimed at the eye. ICRC, *Blinding Weapons*, p. 24.

A U.S. Joint Chiefs of Staff publication states, "The laser beam's highly directional invisible IR radiation can be refracted by the cornea and eye's lens and transmitted through the vitreous humor onto the retina, causing damage ranging from unnoticeable

legal obligation to weigh the human consequences even of these instruments and work to diminish the potential for the deliberate use of such instruments to blind.

Wavelengths and output power levels overlap between laser weapons and non-weapon lasers, and laser rangefinders and target designators fall within the visible and infrared range that is dangerous to the retina. The first laser rangefinder used a single-pulsed ruby laser operating at a wavelength of 694.3 nanometers. The most common rangefinder currently used employs an Nd:YAG or Nd:glass laser with an output wavelength of 1,064 nanometers within the infrared spectrum.[130] In comparison, the Dazer system reportedly is tunable from 700 to 815 nanometers, well within the near infrared range.

tiny spots to complete blindness." JCS, "Joint Laser Designation Procedures," Joint Pub. 3-09.1, June 1, 1991, p. V-1.

[130] Ibid.

Both the ruby and the Nd:YAG rangefinders are hazardous to the human eye, and many laser rangefinders are not considered "eye-safe." Research and development into cost-efficient eye-safe laser rangefinders continues,[131] and lasers in the upper end of the in-band spectrum and out-of-band spectrum are becoming more prevalent.[132] Target designators employ more powerful laser outputs than rangefinders and therefore are likely to be more hazardous.[133]

The Armed Forces Medical Intelligence Center has concluded that during the Iraq/Iran war, "laser eye injuries probably occurred as a result of the use of tank-mounted laser rangefinders or other laser systems. These systems possibly were used in an offensive, antipersonnel mode, with the explicit purpose of blinding troops... Sources have reported that Iraq fielded these lasers as antisensor or antipersonnel weapons."[134] The AFMIC also noted, "Hand-held

[131] For example, Computing Devices Canada received an order in October 1994 for fifty Computerized LASer Sights or CLASS systems, which consist of an eye-safe laser rangefinder capable of measuring ranges up to 4,000 meters.

[132] The technology allows for the wavelength on eye-safe lasers to be just outside the infrared A wavelength or the retinal hazard zone, which is between 400 to 1,400 nanometers. The experts gathered by the ICRC spoke in 1990 discussed use of these slightly longer wavelengths such as 1540 nanometers from a Raman-shifted Nd:YAG to improve eye safety. ICRC, *Blinding Weapons*, pp. 103-104.

[133] ICRC, *Blinding Weapons*, p. 103.

[134] Armed Forces Medical Intelligence Center, AFMIC Special Weekly Wire 32-90, August 8, 1990, partially declassified and deposited on GulfLINK. The AFMIC noted that the injuries were described as retinal burns and hemorrhages, and could have been inflicted by a visible or near-infrared laser, most likely a tank-mounted Ruby or Neodymium/Glass laser rangefinder.

laser rangefinders and designators associated with armor or artillery could be used in an attempt to dazzle, disorient, or blind personnel in low-flying aircraft (fixed and rotor-wing)."[135]

IV. LEGAL AND HUMANITARIAN CONSIDERATIONS

International humanitarian law has long held that parties to a conflict do not have unlimited discretion in their choice of means or methods of warfare. Military needs must yield to humanitarian considerations when weapons or methods of waging war cause unnecessary suffering or superfluous injury.[136] These principles were codified most recently in Article 35 (1) and (2) of the 1977 Additional Protocol I to the Geneva Conventions of 1949.[137]

[135] Ibid.

[136] These rules were expressly stated, for example, in the St. Petersburg Declaration of 1868 (The Declaration Renouncing the Use, in Time of War, of Explosive Projectiles under 400 grams weight); the Second and Third Hague Declarations (respectively, the Declaration concerning asphyxiating gases and the Declaration concerning expanding bullets, July 29, 1899); the Hague Regulations respecting the laws and customs of war on land, Oct. 18, 1907; and U.N. General Assembly Resolution 2444, "Respect for Human Rights in Armed Conflicts," January 13, 1969.

[137] Article 35 - Basic rules

1. In any armed conflict, the right of the Parties to the conflict to choose methods or means of warfare is not unlimited.
2. It is prohibited to employ weapons, projectiles and material and methods of warfare of a nature to cause superfluous injury or unnecessary suffering.

Article 36 - New weapons

In the study, development, acquisition or adoption of a new weapon, means or method of warfare, a High Contracting Party is under an obligation to determine whether its employment would, in some or all circumstances, be prohibited by this Protocol or by any other rule of international law applicable to the High Contracting Party.

The principles are regarded as customary international law[138] and are typically applied in the form of a balancing test: the military necessity for a particular weapon or method of warfare balanced against the expected humanitarian toll caused by that weapon or method of warfare. [139] The application of this balancing test is known as the proportionality rule and is one of the oldest and most fundamental precepts of humanitarian law.

While the term "military necessity" defines the view that "an army be allowed to do its job, but no more," the expected humanitarian toll takes into account the individual victims of the conflict. Another important element in assessing the legality of tactical laser weapons is their long-term societal effects and whether their use would make the return to peace especially difficult.

The principles of international humanitarian law most clearly governing the use of tactical laser weapons are (1) the prohibition against unnecessary suffering and superfluous injury; and (2) the dictates of established custom, humanity, and public conscience, known as the Martens clause.

Prohibition Against Unnecessary Suffering and Superfluous Injury

Proportionality

The proportionality rule recognizes that although war is intended to inflict harm, "all acts of hostility which injure the enemy without necessity or which do not intend to procure victory . . . are unjustifiable, and as such, condemned by . . . law."[140] Although now also incorporated into laws protecting civilians, the proportionality rule initially was geared to safeguard combatants from excessive and unnecessary harm. It still serves this purpose.[141] Considerations of proportionality are "in delimiting the acceptable means of warfare."[142]

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[138] ICRC, *Commentary on the Additional Protocols of 1977,* pp. 390-391; Judith Gail Gardam, "Proportionality and Force in International Law," 875 A.J.I.L. 375, 391 (1993).

[139] See for example Adam Roberts and Richard Guelff, eds., *Documents on the Laws of War*, p. 5 n.2; ICRC Commentary, pp. 392-393; Gardam, "Proportionality and Force in International Law," p. 391.

[140] Emmerich de Vattel, *The Law of Nations*, ch. 1, section 172.

[141] See generally Judith Gail Gardam, "Proportionality and the Use of Force." Also see Louise Doswald-Beck and Gerald C. Couderay, "The Development of New Anti-Personnel Weapons," *International Review of the Red Cross*, November-December 1990.

[142] Gardam, "Proportionality and the Use of Force," pp. 399, 402.

Restraints on the means and methods of warfare follow from the notion that the least harmful alternative must be chosen from among several available means to achieve a legitimate military aim.[143] Under the proportionality rule, "a weapon may either inherently cause unnecessary suffering, and thus all use is prohibited, or it may cause such suffering in certain cases only and therefore these uses are proscribed."[144]

At least one interpretation of the proportionality rule includes the consideration of long-term effects, stating that "...we are to weigh the mischief done, which presumably means not only the immediate harm to individuals but also any injury to the permanent interests of mankind, against the contribution that the mischief makes to the end of victory."[145]

Military Necessity

[143] Hans Blix, "Means and Methods of Combat," in UNESCO, *International Dimension of Humanitarian Law* (1990), p.137-138.

[144] ICRC, *Blinding Weapons*, p. 331.

[145] Michael Walzer, *Just and Unjust Wars*, 2d. ed. (1992), p. 129.

The concept of military necessity in international law refers to "the necessity for measures which are essential to attain the goals of war, and which are lawful in accordance with the laws and customs of war."[146] In the conduct of hostilities, it is forbidden to do "any mischief which does not tend materially to the end [of victory]."[147]

Military need can never "justify a degree of violence which exceeds the level strictly necessary to ensure the success of a particular operation in a particular case."[148] Defined more narrowly, military necessity is:

> an urgent need, admitting of no delay, for the taking by a commander, of measures which are indispensable for forcing as quickly as possible the complete surrender of the enemy by means of regulated violence, and which are not forbidden by the laws and customs of war.[149]

The two prongs of military necessity therefore refer to (1) whether the military action is essential or indispensable to accomplish the military goal, and (2) whether the military action is within the limits of the laws and customs of war.

The Lieber Code

The Lieber Code, enacted in 1863, is considered a cornerstone of humanitarian law. It states that military necessity "does not admit of cruelty — that is, the infliction of suffering for the sake of suffering." Lieber went further to say that military necessity "does not include any act of hostility which makes the return to peace unnecessarily difficult."[150]

Lieber's concern over the long-term consequences of acts during armed conflict is echoed by contemporary military scholars. In "Teaching the Law of War in the Military," Walter D. Reed wrote that a vital function of a military commander "is to assist in identifying conduct or means and methods of warfare which on the basis of objective studies

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[146] ICRC Commentary, p. 393, citing F. Lieber, Instructions for the Government of Armies of the United States in the Field, known as the Lieber Code, 1863, Article 14; See also W. Downey, "The Law of War and Military Necessity," 47 A.J.I.L. 251 (1953).

[147] Walzer, *Just and Unjust Wars*, p. 129, citing H. Sidgwick, *The Elements of Politics* (1891,) p. 254.

[148] ICRC Commentary, p. 396.

[149] Downey, "The Law of War and Military Necessity," p. 254; ICRC Commentary, p. 396.

[150] Lieber Code, Article 16.

has been determined to be of marginal military advantage, particularly when there are indications such conduct may interfere with the successful conclusion of peaceful relations."[151]

Thus, the legal definition of military necessity is restrictive. In terms of the necessity of a particular weapon, a decisive military advantage must be identified, and the degree of injury and suffering to people, including combatants, must be considered. The Lieber Code establishes that military necessity does not include means and methods of warfare that are cruel and that military necessity does take into account the long-term consequences of the use of a particular weapon.

Determining Unnecessary Suffering and Superfluous Injury

The terms "injury" and "suffering" include the degree of physical pain, the severity of wounds, the incidence of permanent damage and disfigurement, and to many experts, psychological damage. In short, the totality of a victim's injury must be considered.[152]

[151] Walter D. Reed, "Teaching the Law of War in the Military," 16 Air Force L. Rev. 70, 74, No. 2 (1974).

[152] See generally ICRC, "Report on the Conference of Government Experts on the Use of Certain Weapons: Lucerne 1974," (Geneva: ICRC 1975), pp. 8-9; Blix, "Means and Methods of Combat," p. 138; ICRC, *Blinding Weapons*, p. 75; Human Rights Watch, *Landmines: A Deadly Legacy* (1993), p. 268 (including access to adequate treatment as a criterion).

In addition, the aggregate suffering or injury caused to society is a critical factor when deciding whether to prohibit an entire weapon system or method of warfare.[153] While there is debate whether the social consequences of an injury fall specifically within the concept of injury in existing law, at the very least social consequences are a relevant political factor in deciding whether to ban certain categories of weapons.[154]

During a roundtable of experts convened by the ICRC in April 1991, several participants, including psychiatrists and other medical personnel, took into account the impact blindness-causing weapons could have on society, especially given that sight is an essential irreplaceable central sense, that no prosthesis exists and that rehabilitation measures, especially in countries with inadequate resources, are limited.[155]

While there is general agreement in defining suffering and injury, consensus often breaks down when trying to determine what comprises unnecessary suffering and superfluous injury. The primary question is when is the suffering or injury caused by weapons or methods of warfare so excessive compared to military advantages that the weapon or practice is illegal. Most p**articipants at the ICRC experts' meetings agreed that the suffering and injury caused by laser weapons is extensive and serious for the victim, the victim's family and community.[156] Several statistics are important. Individuals are considered blind by the World Health Organization if they have less than 5 percent of their vision left. Low vision is less than 30 percent of normal vision remaining.[157] Sight provides 80 percent to 90 percent of sensory stimulation. A number of experts at the ICRC meetings stressed that "sight is the most precious sense that persons have and that the loss of it is a very severe handicap."[158] One participant believed that the typically large compensation awards for blindness given by insurance companies confirmed the particularly serious nature of the injury.[159] Another participant, a psychiatrist, concluded that blindness is unlike other injuries because:**

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[153] ICRC, *Blinding Weapons*, p. 344.

[154] Ibid., p. 76.

[155] Ibid., p. 344.

[156] The only participants who expressed doubts about the egregiousness of blinding weapons compared with other conventional weapons were officials from the United States and the United Kingdom.

[157] World Health Organization, *International Statistical Classification of Diseases and Related Health Problems*, Tenth Revision, Vol. 1, 1992, pp. 456-457.

[158] ICRC, *Blinding Weapons*, p. 336.

[159] Ibid.

the eye is an extension of the central nervous system and an organizing sensory modality. It is therefore too simplistic to see the weapon as touching one of the five senses as sight is central, organizes the others and protects the person by enabling him to orient himself.[160]

[160] Ibid.

Several experts examined the attitudes of society and soldiers toward permanent blindness, especially because it is difficult to objectively assess what constitutes unnecessary suffering. Among soldiers, one military psychiatrist said, "eye injury is the most dreaded injury in the battlefield."[161] Experts also believed that blinding is much more debilitating than most battlefield injuries, even if soldiers are not hit by lasers, because laser weapons operate by stealth. They are soundless, odorless and invisible. There is no evolutionary history to deal with a technological threat that has these attributes. The silent and invisible threat created by the presence or suspected presence of blinding lasers in an opponent's arsenal would increase the occurrence among soldiers of combat stress disorder and, later, of post-traumatic stress disorder.[162]

In studying the effects of blindness compared with other battlefield injuries, military psychiatrists and specialists in different disabilities describe the exceptionally severe consequence of blindness on all aspects of daily life, including mobility.[163] Statistics on disabilities and death rates during armed conflict compiled during the ICRC's second working group on lasers demonstrated that the majority of war casualties recover with no long-term disability.[164]

Despite these conclusions, the U.S. Department of the Army in 1994 determined "that antipersonnel use of a laser does not cause *superfluous injury* or *unnecessary suffering*, even if it results in permanent blindness and that antipersonnel laser use was consistent with the law of war obligations of the United States."[165] At the same time, the Department of the Army said that the laser is unique because of its so-called non-lethality and because it "can only cause harm to a combatant by injury (temporary or permanent) to his or her sight." Lasers would never be used at ranges where the opponent was not also subject to "permanent loss of vision or considerably greater injury, including death, from lawful weapons other than lasers."[166]

Despite the legal analysis that it is legitimate to blind, the Department of Defense has disavowed blinding in other statements.[167] The September 1995 policy guidance statement by Secretary of Defense William Perry implies that the U.S. now considers intentional blinding to be illegal: "The Department of Defense prohibits the use of lasers specifically designed to cause permanent blindness of unenhanced vision and supports negotiations prohibiting the use of such weapons.... The Department of Defense recognizes that accidental or incidental eye injuries may occur on the battlefield as the result of the use of legitimate laser systems. Therefore, we continue to strive, through training and doctrine, to minimize these injuries."[168]

Societal Consequences

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[161] Ibid., p. 337.

[162] Ibid., p. 337; ICRC, "Blinding Laser Weapons: Questions and Answers," November 16, 1994.

[163] ICRC, *Blinding Weapons*, p. 187.

[164] Ibid., pp. 182-183.

[165] **Department of the Army, Office of the Judge Advocate General, Memorandum, Subject: AN/PLQ-5 Laser Countermeasure System, Law of War Review, September 16, 1994, obtained under the Freedom of Information Act. (emphasis in the original).**

[166] Ibid. (parentheses in original).

[167] The U.S. Department of Defense "does not possess, nor is it developing, laser weapons designed or intended primarily to permanently blind enemy combatants. However, one presently unfunded program investigated the potential for use of lasers to temporarily impair vision." Letter Holmes to Representative Evans, March 27, 1995. In another statement, the U.S. Army said that U.S. systems are "not designed to cause ocular injury to opposing soldiers." U.S. Army, Response to press query by Chris Hanson, Washington correspondent, Hearst News Service, Subject: Stingray System, March 21, 1995.

[168] DoD News Release, Reference Number 482-95, "DoD Announces Policy on Blinding Lasers," September 1, 1995.

Widespread use of blinding weapons would create a new population of veterans with serious long-term disabilities. Some psychiatrists have determined that a soldier's reaction to blinding weapons would be far worse than other conventional weapons, and that blinding weapons would lead to increased mental illness among soldiers during and after battle. In addition, societal attitudes in general toward blindness also must be taken into account given the difficulty in objectively assessing what constitutes unnecessary suffering.[169]

The introduction of lasers as weapons designed to blind, or blinding as a legitimate method of warfare would have devastating long-term consequences for whole societies because the blind population would increase dramatically. Ophthalmology experts described the situation as follows:

[169] ICRC, *Blinding Weapons*, pp. 286-290; military psychiatrists and other participants said it was impossible to ignore individuals' fear of blindness, cultural perceptions and the idea that blindness is less easily accepted because it is not considered part of the normal life cycle. One participant recalled the particular horror felt in relation to chemical weapons that affect eyes. Ibid., p. 337.

Ophthalmology in most developed countries is a small specialty . . . In the third world, it is practically non-existent . . . The introduction of battlefield anti-eye laser weapons . . . is a situation similar to that conjectured for the detonation of a Hiroshima-sized atomic bomb in London, where the whole of the burn beds in the UK would be overwhelmed with serious casualties.[170]

Lasers Used in Conjunction with Other Weapons

Tactical laser weapons would also cause unnecessary suffering and superfluous injury because they are designed to be used in conjunction with other weapons. In other words, they would be used mainly to disable an individual before lethal fire, rather than as a replacement for lethal fire.[171] In addition, a soldier who has just been blinded is much more prone to serious injury or death. He is incapable of defending himself and is exposed to becoming an easier kill as well as being more helpless to avoid danger. In these ways, laser weapons might have the effect of increasing mortality rates.

It also is unlikely that an attacker would be able to assess at a distance whether an opponent has been rendered out of action by blinding.[172] Therefore he also would be inclined to use other weapons. The result may be just as many deaths and many more blindings, thus increasing the suffering that results from battle.[173]

***Hors de combat* for the Duration of the Conflict**

Humanitarian law permits only that a soldier be put *hors de combat* for the duration of the conflict, and not for life-long incapacitation short of death.[174] The concept is an especially important one regarding the

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[170] Ibid., pp. 138-139.

[171] See Lewer, quoting BBC transcript of interview with Colonel Sam Gardiner; ICRC Legal Advisor Louise Doswald-Beck presented one scenario where although a laser may be more accurate than a bullet, a laser fired at the back of retreating combatants would be ineffective and an operator of a laser weapon would find it difficult to hit a small portion of a running enemy. "Lasers would therefore have to be used in combination with rifles." ICRC, *Blinding Weapons*, p.333; see also p. 346.

[172] Anderberg and Wolbarsht, *Laser Weapons: The Dawn of a New Military Age*, p. 100; See also Section III regarding military considerations of laser weapons.

[173] See ICRC, "Blinding Laser Weapons: Questions and Answers."

antipersonnel use of lasers against infantry. The ICRC has concluded that laser weapons have the potential to result in a far higher rate of lifetime incapacitation than other conventional weapons.[175]

[174] Some commentators claim that it is necessary to disable combatants for longer than a particular battle, and perhaps for a longer period of time, given the nature of modern warfare. ICRC, *Blinding Weapons*, p. 75. Assuming this is the case, unnecessary suffering and superfluous injury still is proscribed, because military necessity always is subject to the constraints of law. The short-term and the long-term societal effects of laser weapons and blinding as a method of warfare are so extreme that whatever incremental military utility may be gained by their use, is overshadowed by the devastating human costs. See also Ibid., pp. 338-339.

[175] **In comparing laser weapons to other weapons banned in the past, there is a "certain similarity between a weapon that primarily kills and one that primarily blinds in that both render the soldier *hors de combat* for life."** Ibid., p. 335.

There are other ways of rendering a soldier *hors de combat* that are not likely to cause permanent blindness or other permanent disability.[176] Lasers for anti-material or antipersonnel use stand aparta because they can blind permanently, while the "average damage inflicted by conventional weapons" is less likely to be permanent. For example, studies of particular wars have shown that, with conventional weapons, one in ten casualties is permanently incapacitated, and 60 percent recover completely.[177]

Undertaking an evaluation of injury and suffering includes a consideration of the degree of physical and psychological effects, and the incidence of permanent damage. Although humanitarian law recognizes that the object of war is to put the greatest number of combatants *hors de combat*, it also recognizes that this purpose is exceeded when a means or method of warfare is likely in most cases to cause useless injury and suffering. The question becomes whether a weapon or practice causes injury and suffering greater than that required to simply force soldiers out of combat.[178]

Historical Perspective

The rationale for banning explosive projectiles under 400 grams, under the St. Petersburg Declaration, and dum-dum bullets, under the Hague Declaration of 1899, applies to lasers as well. It is unlawful to use a weapon that causes more suffering or injury than another that offers the same or similar military advantages. This is particularly true given that the military has conceded that it has not determined what advantage laser weapons would offer, and that experts on blinding weapons have viewed lasers as being of limited military importance.[179]

The basis for the St. Petersburg Declaration of 1868 was a consensus that exploding bullets, which were already in use by governments, represented "the technical limits at which the necessities of war ought to yield to the requirements of humanity," and "[t]hat the progress of civilization should have the effect of alleviating as much as possible the calamities of war."[180] The treaty provided that

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[176] Ibid., p. 334.

[177] Ibid., p. 335.

[178] See Downey, "The Laws of War and Military Necessity," p. 261. Downey describes the use by Confederate forces during the American Civil War of a 30-caliber explosive bullet. He notes that:

> an ordinary 30-caliber bullet fired from a rifle has for its military purpose the killing or wounding of the enemy soldier at which it is aimed. The suffering caused by that bullet is not disproportionate for such a military purpose. However, a 30-caliber explosive bullet, having the same purpose and the same lethal effect, which explodes upon penetration of the body and causes an agonizing and perhaps incurable wound, aggravates the suffering of the recipient without furthering the military force of the projectile.

Downey quotes the memoirs of Gen. Ulysses S. Grant that:

> When [the bullet] hit and the ball exploded, the wound was terrible. In these cases a solid ball would have hit as well. Their use is barbarous, because they produced increased suffering without any corresponding advantage to those using them.

A similar logic applies to the use of laser weapons.

[179] See Section III regarding the military considerations of laser weapons, especially the issue of high-intensity versus low-intensity conflicts and the intent to blind.

[180] 1868 St. Petersburg Declaration renouncing the use, in time of war, of explosive projectiles under 400 grams weight, December 11, 1868.

the only legitimate object which states should endeavor to accomplish during war is to weaken the military forces of the enemy; that for this purpose it is sufficient to disable the greatest possible number of combatants; that this object would be exceeded by the employment of arms which uselessly aggravate the sufferings of disabled men, or render their death inevitable.[181]

Therefore using such weapons would be contrary to the laws of humanity. The St. Petersburg Declaration banned the use of certain exploding projectiles because they exacerbated injuries that would have in any case rendered a soldier *hors de combat.* Consequently such projectiles were deemed to cause unnecessary suffering.

[181] Ibid.

Provisions of the Hague Agreements of 1899 and 1907 also are rooted in the customary prohibition against means of warfare that cause unnecessary suffering. The provisions proscribe the use of projectiles whose only purpose is to diffuse asphyxiating gases.[182] They also outlawed the use of so-called dum-dum, or expanding bullets, and banned the use of poison and poison arms, and all arms, projectiles, or material of a nature to cause superfluous injury.[183]

With regard to the Hague Declaration concerning expanding bullets, which expand or flatten easily in the human body, the ICRC has pointed out that the treaty appears to confirm that the rule of proportionality is violated *inter alia* "if excessive suffering is caused *in the majority of cases*" (emphasis added).[184]

The laws of St. Petersburg and The Hague categorically ban classes of weapons and methods of warfare that, although militarily helpful and certainly capable of disabling large numbers of combatants, were deemed likely to cause suffering and injury so excessive that their use was *never* justified. The same is true of subsequent laws prohibiting the use of gas and biological and chemical means of warfare.

The laws of Geneva, in particular article 35 (1) and (2) of 1977 Additional Protocol I, further codify the rule against unnecessary suffering and superfluous injury with respect to means *and* methods of warfare. Mirroring language included in the St. Petersburg Declaration and the Hague Agreements, article 35 (1) states that "[i]n any armed conflict, the right of the Parties to the conflict to choose methods or means of warfare is not unlimited." Article 35(2) expresses the corollary rule: "It is prohibited to employ weapons, projectiles, and material and methods of warfare of a nature to cause superfluous injury or unnecessary suffering."

In sum, the St. Petersburg and Hague agreements as well as provisions in the more recent laws of Geneva characterize unnecessary suffering and superfluous injury in terms of whether a means or method of warfare exceeds that which is militarily necessary. Militarily necessary practices of war have been defined narrowly by the ICRC, courts, and experts, as those which are essential, urgent, or indispensable for rendering combatants unable to fight,[185] which do not pose a significant negative effect on prospects for peace,[186] and for which there is no less injurious alternative means or method for disabling combatants.[187]

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[182] The Declaration concerning asphyxiating gases, The Hague, July 29, 1899.

[183] The Declaration concerning expanding bullets, The Hague, July 29, 1899; Regulations respecting the laws and customs of war on land annexed to the Convention respecting the laws and customs of war on land, The Hague, October 18, 1907.

[184] ICRC, *Blinding Weapons*, p. 331.

[185] See ICRC Commentary, p. 396; Downey, "The Law of War and Military Necessity," p. 254.

[186] See Schmidt, "The Protection of Victims of International Armed Conflicts;" ICRC Commentary, p. 399; Lieber Code, Article 16.

[187] Blix, "Means and Methods of Combat," p. 137.

Weighing Military Necessity Against Humanitarian Considerations

Combatants are expected to sustain some degree of injury. Yet balancing the military necessity against individual harm and humanitarian considerations is important as a legal principle and a normative goal. In analyzing whether the use of a particular weapon or practice of war violates the proportionality rule, it is crucial to weigh military necessity and human consequences both in the individual instance of use and in the aggregate.

The weighing of aggregate consequences is inherent in the notion of banning a whole weapons system; it means that nations have decided that, on the whole, the overall military utility of the weapon is not worth the human toll caused by its use. Given the profound long-term effects on a country of permanently blinding large numbers of soldiers, the intentional blinding by lasers or any other weapon cannot justify whatever minimal military utility might be gained in the short run. Tactical laser weapons, including weapons that are often referred to as anti-material or anti-sensor such as the LCMS, have the capacity for directly causing blindness and in some cases are intended to cause blindness. This characteristic renders them essentially antipersonnel and requires that they be banned.

Criteria

The discussion of military necessity during the First Round Table of Experts convened by the ICRC is helpful in thinking about why laser weapons and blinding are illegal under the proportionality rule.[188] The experts viewed the concept of military necessity as encompassing humanitarian concerns, consistent with customary and conventional law holding that military need is limited by humanitarian considerations.

The list is not exhaustive but provides a useful framework for analysis. Several points considered in arriving at the appropriate balance are:

- **(a) the ability to provide "significant military advantage which cannot be provided by another weapon";**
- **(b) cost-effectiveness;**
- **(c) extent of incapacitation produced;**
- **(d) inevitability or probability of effects, such as death or long-term consequences; and**
- **(e) accuracy.**

Tactical laser weapons are described as protective systems and as intended for defensive measures. They are said to counter electro-optical and optical devices. But the electro-optical devices are not physically destroyed. With electro-optical devices the sensor is overloaded by the laser beam and is temporarily jammed, forcing its operator to either repair the device or rely on non-electronic instruments for observation. Optical devices would magnify the laser beam from the tactical laser weapon, causing the laser beam to instantaneously hit the operator's eye and damage it.

While mass production may be relatively inexpensive in the long term, the cost of development is steep. The tremendous costs of treating and caring for the injuries that laser weapons cause does not make laser weapons cost-effective. The extent of incapacitation caused by laser weapons is extreme and permanent blinding is virtually inevitable. The only element that might support the use of laser weapons is their potential for accuracy. This element is insufficient to outweigh the negative factors, especially given that the accuracy of laser weapons depends among other things on battle and weather conditions.

The Martens Clause

The Martens clause, named after the Russian diplomat who proposed it, was included by unanimous decision in the preamble to the Hague Conventions of 1899 and 1907 respecting the laws and customs of war on land, in Article 1(2) of 1977 Additional Protocol I, and in the preamble to the Convention on Conventional

[188] ICRC, *Blinding Weapons*, p. 83-84.

Weapons itself. It provides that in cases not expressly governed by international agreement, both civilians and combatants remain under the protection and authority of the principles of international law derived from established custom, from the principles of humanity and from the dictates of public conscience. The laws of war with regard to subjects not explicitly regulated must be shaped not only by reference to existing law "but more compelling considerations of humanity, of the survival of civilization, and of the sanctity of the individual human being."[189]

[189] Sir Hersch Lauterpacht, "The Problem of the Revision of the Law of War," 29 B.Y.I.L 379 (1952).

The purpose of the Martens clause is two-fold. First, it is aimed at covering situations not specifically provided for in existing treaty law. The Martens clause prevents the assumption that anything not explicitly prohibited by relevant treaties is therefore permitted.[190] The Martens clause also applies to treaty provisions whose interpretations may not be entirely clear. Second, the Martens clause establishes that despite continuing developments in technology and methods of warfare, the principles of custom, humanity, and public conscience always hold. The Martens clause applies independently of the treaties that contain it, and applies in all armed conflicts.[191]

The Martens clause is generally considered customary law.[192] It reflects "the ideas of the positive jurists and of the essential nexus between military requirements, the dictates of humanity, and the standards of civilization."[193] For example, the use of poison gas in World War I led to the conclusion of the 1925 Gas Protocol, which draws on the Martens clause. Furthermore, the discussions regarding bans on the use of gas and chemical weapons "centered on [their] horrific and barbarous nature...rather than a careful appreciation of their legality under the existing rules."[194]

Most legal experts at the ICRC meetings on blinding weapons agreed that the Martens clause is a source of customary and conventional international law, and that laser weapons need to be assessed in light of its standards. Other participants viewed the Martens clause as a predecessor to *jus cogens*, or as part of *jus cogens*.[195] The Martens clause addresses the problem of suffering so that the public conscience refers to what is considered inhumane or socially unacceptable.

Even if the use of laser weapons or other means or methods of warfare to blind were somehow construed to be legal under the unnecessary suffering prohibition, their use should still be banned under the Martens clause. The drafters of the Martens clause perhaps thought that "lawyers do not necessarily make the best policy decisions, so the values of humanity and the public conscience also have to be taken into account."[196]

Application of the Martens Clause to Blinding

With laser weapons the world has the opportunity to ban a particularly cruel weapon before it is marketed and used extensively. It is especially appropriate to apply the Martens clause to a prohibition on blinding lasers since such a ban does not require armies to give up weapons upon which they have come to rely.

Experts who participated in the ICRC meetings were largely in agreement that laser weapons and methods of warfare that cause blindness would run counter to the requirements of established custom, humanity, and public conscience. Some experts expressed either personal repugnance for lasers or the belief

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[190] ICRC Commentary, p. 39.

[191] Ibid.

[192] G.I.A.D. Draper, "The Development of International Humanitarian Law," in UNESCO, *International Dimensions of Humanitarian Law* (1988), pp. 72-73.

[193] Ibid., p. 73.

[194] ICRC, *Blinding Weapons*, p. 342.

[195] Jus cogens means peremptory norms of general international law, which are defined in Art. 53 of the Vienna Convention on the Law of Treaties: "a peremptory norm of general international law is a norm accepted and recognized by the international community of States as a whole as a norm from which no derogation is permitted and which can be modified only by a subsequent norm of general international law having the same character." ICRC, Commentary on the Additional Protocols of 1977, pp. 27, 1111.

[196] Ibid., p.341.

that their countries' civilian population would find the use of blinding as a method of warfare horrific.[197] Some doubted their ability to field such weapons, notwithstanding possible military utility, because of public opinion.[198]

[197] Ibid., pp. 344-346.

[198] Ibid., p. 345.

Public opinion might be more negatively affected by large numbers of blind than large numbers of dead, because the blind "would remain in view and be distressful for society."[199] Furthermore, the use of weapons designed to produce extreme handicaps or excessive damage have always produced unnecessary strain on peace negotiations, later peaceful relations between nations no longer at war, and societal infrastructure. Consequences to society are an important political factor in deciding whether to ban a particular weapon.[200]

The Example of Phosgene Gas

During World War I phosgene gas was used against soldiers to cause blindness. It operated silently and demoralized combatants, not only those who were directly affected, but also those who witnessed those effects on their colleagues. Soldiers, the public and the political leadership at the time abhorred its use. It also was feared that the use of phosgene gas would spread from the battlefield to civilian population centers.

All of these factors are relevant to lasers. Lasers are silent. They destroy the sight of combatants. Because they are silent, it will frequently be too late to prevent eyesight damage once the use of a laser is detected because by then the damage will have occurred. Laser weapons would have a demoralizing effect on soldiers and cause serious psychological consequences even for those not directly affected.

Another view on why the use of gas was banned was that it was not so much public outcry as the fear of retaliation. If so, this view only serves to prove an important point. If one finds a weapon system to be so heinous that it must not be used against one's own soldiers, then it cannot be considered legally to be less heinous if used against the enemy.

Proliferation

Another critical reason for banning laser weapons under the Martens clause is their potential for proliferation. Because tactical laser weapons may be made relatively light weight, portable, and battery-operated, there would be a greater propensity for laser weapons to proliferate dramatically. Potential purchasers or users could be any countries, guerrilla groups or private criminal entities. The special characteristics of laser weapons and the likelihood of dramatic proliferation would inevitably increase indiscriminate use and direct attacks on civilians.

Illegitimate Use of Targeting Devices

The Martens clause emphasizes that good faith is required by individuals who enjoy a degree of freedom of action in the field.[201] The issue is to diminish the potential for the deliberate use of targeting instruments and other laser devices to blind. Furthermore, rangefinders and target designators are subject to humanitarian law because they are means of warfare. Commanders still must evaluate the particular uses of lasers to determine whether the military necessity is proportionate to the expected human toll.

Laser target designators and rangefinders are of great military utility and may reduce the number of casualties or ensure more precise attacks on military targets. Still, experts believe that because they can cause significant injury and permanent blindness, combatants remain under a legal obligation to weigh the human consequences even of these instruments. Perhaps the most important consideration is to ensure that laser rangefinders and target designators are not abused and used intentionally against the eyesight of individuals

[199] Ibid.

[200] Ibid., p. 76.

[201] ICRC Commentary, p. 395.

and outside their missions. Government officials have expressed the fear that personnel using such lasers might be charged with war crimes if an individual is blinded. However, soldiers and their commanders always are required to know the legitimate and illegitimate, unacceptable uses of weapons.

V. ANALYSIS OF POSSIBLE PROTOCOL LANGUAGE

Delegates at the Review Conference will work from the draft protocol, originally proposed by Sweden, that emerged from negotiations in the Group of Governmental Experts preparing amendments to the Convention on Conventional Weapons. The draft could become the Convention's fourth protocol. It states (with alternative wording put forward by delegates in brackets):

> **Article 1**
> **It is prohibited to employ laser beams of a nature to cause permanent blindness [serious damage] against the eyesight of persons as a method of warfare.**
> **Article 2**
> **It is prohibited to [produce and] employ laser weapons primarily designed to blind [permanently].**
> **Article 3**
> **Blinding as an incidental or collateral effect of the legitimate employment of laser beams on the battlefield is not covered by this prohibition.**

Currently, the Convention and its three protocols only apply to international armed conflicts and "armed conflicts in which peoples are fighting against colonial domination and alien occupation and against racist regimes in the exercise of their right of self-determination."[202] Efforts are underway to amend the Convention to extend the prohibitions and restrictions of the Convention to internal armed conflicts. A protocol on blinding laser weapons should apply in all circumstances of armed conflict regardless of whether the Convention is amended. As detailed above, laser weapons are most likely to be used in low intensity conflicts, special missions, and operations other than war.

In addition to extension of scope, a verification and enforcement scheme should be incorporated into the protocol on blinding tactical laser weapons. The failure in implementation of Protocol 2, the Landmines Protocol, to the CCW has demonstrated the necessity of compliance measures.

Comments on Article 1

First and foremost, a protocol should incorporate the principle prohibiting blinding as a method of warfare. The most direct way to do this would be to have an article state, "Blinding as a method of warfare is prohibited," and Human Rights Watch recommends that this be done. Article 1 as currently drafted is intended to establish this principle, and is the most important aspect of the current draft protocol. Such a prohibition would establish the international norm that common and systematic use of lasers to blind is unacceptable and unlawful. A prohibition on blinding as a method of warfare would ban the use of all practices that deliberately cause blindness, but, by designating the "method of warfare" provision, it would protect personnel who use such non-weapon laser systems as laser rangefinders and target designators that can cause blindness incidentally or accidentally.

Comments on Article 2

A protocol should prohibit the use, production and transfer of all tactical laser weapons. Production and trade must be proscribed to ensure that a ban on the use of laser weapons is meaningful. Such a

[202] Common Article 2 to the Geneva Conventions of 12 August 1949 for the Protection of War Victims; Article 1 of the 1977 Additional Protocol 1 to the Geneva Conventions; See Article 1 of the 1980 Convention on Conventional Weapons.

proscription would be consistent with the preamble to the Convention, which emphasizes the importance of ending the production and proliferation of weapons whose use is restricted or prohibited.[203]

One of the main points of debate during negotiations likely will be whether a ban on use encompasses laser weapons "primarily designed" to blind, that "can cause" blindness, "are intended" to blind individuals, or have blinding as a "primary effect." Laser weapons that "can cause" blindness is the term used by the European Parliament in its resolution supporting a new protocol to the Convention. This phrase may be difficult for nations to accept because of the fear that it might encompass laser rangefinders and target designators because these systems operate within wavelength ranges capable of blinding individuals if the systems are not used for their intended missions of measuring ranges and aiding in the targeting of military objectives.

A prohibition on lasers that "are intended" to blind personnel would ban tactical laser weapons while providing legal protection to combatants who use laser rangefinders and target designators that are not intended to blind personnel but can cause blindness as an incidental or accidental effect. Human Rights Watch believes that a ban on lasers "intended" to blind, and a ban on lasers that have blinding as a "primary effect" would apply to laser weapons such as the U.S. LCMS, Stingray and Dazer and the Chinese ZM-87. When aimed at an optical device, the intention and primary effect of these weapons is to blind.

A ban on lasers that "have blinding as a primary effect" would be preferable to a ban on laser weapons "primarily designed to blind" or whose "primary purpose is to blind." The two latter phrases might justify use of tactical laser weapons on the grounds that they are not primarily designed to blind or do not have the primary purpose to blind, but that they are designed primarily and have the primary purpose to disrupt electro-optical and optical instruments. The U.S. policy prohibiting the use of lasers "specifically designed to cause permanent blindness of unenhanced vision" defines a fairly narrow category and also would be held by the U.S. to exempt the LCMS and similar laser weapon systems.

Comments on Article 3

Blinding as an incidental or collateral effect of the use of lasers in the family of laser rangefinders and target designators would not violate a protocol on blinding tactical laser weapons. This clause should not apply to lasers used against optical instruments because the human eye would in fact be the target. Some have proposed a formulation explicitly exempting rangefinders and target designators; such a formulation could encourage abuse of laser rangefinders and target designators and invite individuals to use such lasers deliberately to blind.

A prohibition against blindness as a method of warfare would guard against this problem, but additional language also might want to be considered. Language such as "it is prohibited to use lasers whose original purpose is either targeting or rangefinding as laser weapons deliberately against the eyesight of persons" might better protect against the deliberate misuse of rangefinders and target designators that may not reach the level of a common systematic practice. The fear that combatants will be unable to distinguish between legitimate and unacceptable use of laser target designators and rangefinders and so put themselves at risk of criminal liability ignores the fact that soldiers always are obligated to make such distinctions.

Definitions

It is unclear whether a definition of laser weapons would be necessary given the specific language of the protocol's articles. If deemed necessary, a laser weapon should be defined as a "weapon that uses a laser beam as the primary mechanism of injury to the eyesight" or as a "weapon that uses a laser beam as the primary kill mechanism." Such definitions would clarify that tactical laser weapons such as the LCMS or the ZM-87 are prohibited because they use laser beams as the primary destructive mechanism. If there is an attempt to define what is not a laser weapon, the definition of systems that are not laser weapons might state that these are

[203] Preamble to the 1980 Convention on Conventional Weapons.

"systems that use laser beams to aid the use or targeting of another weapon" or "systems that use a laser beam to aid other weapons in their tasks."

Human Rights Watch believes that the World Health Organization's definition of blinding, including the status of "low vision," is useful for the purposes of the protocol. Individuals are considered blind by the World Health Organization if they have less than 5 percent of their vision left, and low vision is less than 30 percent of normal vision remaining.[204]

[204] **WHO, *International Statistical Classification of Diseases and Related Health Problems*, Tenth Revision, vol. 1, 1995, pp. 456-457.**

APPENDICES

Terminology

Blindness: Individuals are considered blind by the World Health Organization if they have less than 5 percent of their vision left. Low vision is less than 30 percent of normal vision remaining. WHO, *International Statistical Classification of Diseases and Related Health Problems*, Tenth Revision, vol. 1, 1995, pp. 456-457.

Dazzle: A state where "an intense beam of light enters the eye and degrades vision by overloading retinal circuits at the site of the retinal image and by flooding the retina with scattered light, thus severely decreasing contrast sensitivity and visual acuity." Visual function is severely depressed for a period of time. "Dazzle can be produced only by visible laser radiation." ICRC, *Blinding Weapons*, p. 121; John Mellerio et al., "Battlefield laser weapons: an assessment of systems, hazards, injuries and ophthalmic resources required for treatment," *Laser and Light in Ophthalmology*, Vol. 4, No. 1 1991, p. 53.

Flash blinding: The basis of flash blinding "is to expose photoreceptors to a bright flash of light and bleach the photopigments." Photopigments are in the outer segments of the rods and cones and their job is to absorb light and amplify the photons' energy into neural signs that are the first stages of vision. "The exposed area of retina will be functionally blind until the pigments regenerate and neuronal recovery takes place.""The 'blindness' may last for many minutes but no damage is done to the retinal structures and recovery is complete." In daylight, more light is needed to produce flash blindness because the pupil is constricted. One example of a mild form of flash blindness is the after-images that occur after staring at an incandescent light bulb or a photographer's electronic flash. Flash blindness is produced only by visible laser radiation because "the wavelength range of the eye depends on the absorption wavelength range of the visual pigments." ICRC, *Blinding Weapons*, p. 122.

Hors de combat: A person is hors de combat if: he is in the power of an adverse Party; he clearly expresses an intention to surrender; or he has been rendered unconscious or is otherwise incapacitated by wounds or sickness, and therefore is incapable of defending himself; provided that in any of these cases he abstains from any hostile act and does not attempt to escape. Additional Protocol I, Article 41.

Laser Weapon: A laser weapon is a weapon that uses a laser beam as the primary kill mechanism, that is, the primary mechanism of injury to the eyesight. Laser weapons are distinct in their purpose from non-eaon lasers such as rangefinders and target designators. Non-weapon lasers are systems that use laser beams to aid other weapons in their tasks.

Martens clause: The Martens clause provides for the protection of civilians and combatants in cases not expressly governed by international agreement. It is incorporated into several international documents including the preamble to the Convention on Conventional Weapons where it states that "the civilian population and the combatants shall at all times remain under the protection and authority of the principles of international law derived from established custom, from the principles of humanity and from the dictates of public conscience."

Methods of warfare: Tactics or other deliberate and systematic action to harm or neutralize the enemy. Anderberg and Bring, p. 467.

Military necessity: The legal definition of military necessity is restrictive. In terms of the necessity of a particular weapon, a decisive military advantage must be identified, and the degree of injury and suffering to people, including combatants, must be considered. The Lieber Code establishes that military necessity does not include means and methods of warfare that are cruel and does take into account the long-term consequences of the use of a particular weapon.

Nominal Ocular Hazard Distance (NOHD): The distance beyond which an unprotected person may stand in the beam with naked eye and be exposed repeatedly without injury. For example, the NOHD for a common ruby

rangefinder (US AN/VVS-1 ruby rangefinder) is 10,000 meters and for a Nd:YAG rangefinder (US AN/VVG-3 Nd:YAG rangefinder) is 2,000 to 8,000 meters. If an individual is using unfiltered magnifying optical devices, such as binoculars, and is standing in the beam, the NOHD is increased. For example, regulations state that a 10,000 meter NOHD for a certain laser should be increased to 80,000 meters for someone looking at the laser from within the beam with 13-power optics. Anderberg and Bring quoting U.S. Army, *Technical Bulletin*, Med 524, Control of Hazards to health from laser radiation, June 20, 1985.

Non-lethal weapons: As defined by the U.S. Department of Defense in a June 26, 1995, draft policy directive, non-lethal weapons are those "that are explicitly designed and employed so as to incapacitate personnel or material, while minimizing fatalities and undesired damage to property and environment." One Pentagon official said non-lethal weapons contain at least three characteristics: they use means other than gross physical destruction to prevent the target from functioning; they have relatively reversible effects; and, they discriminate between targets and non-targets.

Operations other than war: Operations other than war have been defined to include peacekeeping, disaster relief, counter-drug operations, treaty verification, nation assistance, law enforcement, security and advisory assistance, arms control and anti-terrorism. Fifteenth Annual Lasers on the Modern Battlefield Conference, U.S. Army Infantry School, Brooks Air Force Base, Texas, February 28, 1994.

Retina: the layer of membrane at the back of the eyeball, sensitive to light. **Macula:** the most sensitive parts of the eye; **Fovea:** the fovea is in the central portion of the retina and is a small spot occupying less than one degree of visual space, it is needed for the most demanding visual tasks, and destruction of this region makes a person incapable of sighting a rifle accurately or driving a car.

Wavelengths: The wavelength determines the penetration depth and the site of tissue damage

Radiation	**UVC**	**UVB**	**UVA**	**Visible**	**Infrared**
Wavelength	**200-280 nm**	**280-315**	**315-400**	**400-780**	**780-1400**
Target	**Cornea**	**Cornea**	**Lens**	**Retina**	**Retina**

Radiation	**IRB**	**IRC**
Wavelength	**1400-3000**	**3000-10000**
Target	**Lens/Cornea**	**Cornea**

Statements in Support of a Ban on Blinding Laser Weapons

A. Excerpts from the European Parliament Resolution, June 29, 1995
B. Excerpts from the European Parliament Explanatory Statement, May 24, 1995
C. Excerpts from the Organization of African Unity Resolution, June 23, 1995
D. Resolution by the Blinded Veterans Association, August 26, 1995
E. Letter to Human Rights Watch from Helen Keller International, July 11, 1995
F. Letter to Sec. Christopher from Sen. Leahy and Rep. Evans, September 14, 1995
G. Letter to Sec. Perry from forty-eight U.S. Members of Congress, July 31, 1995

A. Excerpts from the European Parliament resolution on landmines and blinding laser weapons, adopted June 29, 1995, 247-3 with 8 abstentions.

The European Parliament,
- having regard to the report of the Committee on Foreign Affairs, Security and Defence Policy (A4-0119/95),

I. Whereas this Convention [on Conventional Weapons] will be the subject of a Review Conference in September/October 1995, giving a vital opportunity to improve it,

O. Whereas there is an urgent need to take action to ban blinding laser weapons,

P. Welcoming the agreement by the Group of governmental experts preparing the Review Conference on a new draft protocol prohibiting blinding laser weapons,

6. Calls on the Council, therefore, to amend and extend the scope of its joint action (or to adopt supplementary joint actions) as follows, making more specific the provisions on APMs, strengthening the rules on anti-vehicle mines (AVMs), strengthening the Convention as a whole and tackling the problem of blinding laser weapons:

a) as far as the Convention itself is concerned:
   i) extension to apply in all circumstances,
   ii) introduction of provisions for effective implementation and compliance,
   iii) addition of a protocol banning all laser weapons which can cause blindness,
   iv) introduction of a provision for annual reports as well as automatic review conferences every five years covering the operation of the Convention and its provisions,

B. Excerpts from the explanatory statement within the report on landmines and blinding laser weapons, the Committee on Foreign Affairs, Security and Defence Policy, the European Parliament. Rapporteur: Mr Jan-Willem Bertens. Report tabled on May 24, 1995.

...

II. THE PROBLEM OF BLINDING LASER WEAPONS

Reports over the last few years have indicated the development and field-testing of "low-energy" laser weapons that can be used against electro-optical sensors and also against eyesight. There are both vehicle-mounted systems and portable systems and they could be either dedicated for anti-personnel use or dual-use. Portable lasers are capable of blinding persons permanently up to a distance of at least one kilometre and at that distance the beam will have diverged to a diameter of at least 50 cms. The beam would use pulsed energy and therefore be both silent and invisible and such lasers can use a variety of wavelengths (by using several lasers in one weapon), thus rendering protection impossible. The beam destroys the retina by burning and by creating haemorrhages, so that in virtually all cases no recovery of sight will be possible. Specialists have indicated that if widely manufactured, such portable systems would not cost more than a normal rifle.

At 80-90% of a person's information is acquired through sight, blindness is one of the most severe disabilities rendering very difficult or impossible most tasks and causing severe psychological depression through loss of self-esteem and independence.

It is essential to ban the use of lasers for blinding as quickly as possible as such weapons are now ready for deployment and large-scale manufacture. A draft Protocol to this effect will be considered by the Review Conference of the 1980 Convention on Certain Conventional Weapons. In practice this will be the only and last opportunity to take action before such systems are manufactured and widely proliferate, as they will inevitably do, rendering any attempted later regulation probably impossible.

On 22 May 1995 the Human Rights Watch Arms Project published a report entitled "United States : U.S. Blinding Laser Weapons". It urged the US Government not to go ahead with the Laser Counter-measure System, a rifle-mounted system that can burn out human retinas at a range of 1 000 metres, and to cancel nine other blinding laser weapon programmes. Apparently, a decision due in June on the Laser Counter-measure System could bring a laser weapon into full-scale production for the first time. In the light of this, the Committee would like the European Parliament resolution to be sent also to the Government of the USA.

In addition, the report specifically mentions Britain, France, Germany, Israel, Russia and China as being known to have, or alleged to have, tactical laser weapons programmes. It is vital that any programmes for production, or for research and development, should be abandoned. Member States must do their utmost to ensure that the proposed protocol banning such weapons is duly inserted into the CCW at the Review Conference.

IV. REVISING THE CCW
There seems to be extensive agreement within the Group of governmental experts preparing the Review Conference to support:
- extension of the scope, of Protocol II at least, to internal armed conflicts;
- inclusion of a protocol prohibiting the use of blinding laser weapons.
This is to be welcomed, and it is vital for all EU states taking part to fully support these extensions.

C. Excerpts from the resolution on the 1980 United Nations Convention on Certain Conventional Weapons and Problems Posed by the Proliferation of Antipersonnel Mines in Africa, adopted by the Council of Ministers of the Organization of African Unity, June 23, 1995.

The Council of Ministers of the Organization of African Unity meeting in its Sixty-second Ordinary Session in Addis Ababa, Ethiopia, from 21 to 23 June 1995,

Having considered the recommendations made by the Seminar organized jointly by the OAU and the ICRC in Addis Ababa from 11 to 12 April 1995 on the International Humanitarian Law and the 1980 United Nations Convention on the Prohibitions or Restrictions of Use of Certain Conventional Weapons which may be deemed to be excessively injurious, Doc. CM/1884 (LXII) Annex 1,

Considering Resolution CM/RES. 1526 (LX) on Respect for International Humanitarian Law and Support for Humanitarian Action in Armed Conflicts adopted by the Council of Ministers at its Sixtieth Ordinary Session held in Tunis in June 1994...,

Supports the adoption by the Review Conference of a Protocol banning laser blinding weapons; ...

ACKNOWLEDGMENTS

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Human Rights Watch Arms Project

Human Rights Watch is a nongovernmental organization established in 1978 to monitor and promote the observance of internationally recognized human rights in Africa, the Americas, Asia, the Middle East and among the signatories of the Helsinki accords. It is supported by contributions from private individuals and foundations worldwide. It accepts no government funds, directly or indirectly. The staff includes Kenneth Roth, executive director; Cynthia Brown, program director; Holly J. Burkhalter, advocacy director; Robert Kimzey, publications director; Jeri Laber, special advisor; Gara LaMarche, associate director; Juan E. Mendez, general counsel; Susan Osnos, communications director; Lotte Leicht, Brussels Office Director; Jemera Rone, counsel; Joanna Weschler, United Nations representative; and Derrick Wong, finance and administration director. Robert L. Bernstein is the chair of the board and Adrian W. DeWind is the vice chair. Its Arms Project was established in 1992 to monitor and prevent arms transfers to governments or organizations grossly violating internationally recognized human rights and the laws of war, and to promote freedom of information regarding arms transfers worldwide. Joost R. Hiltermann is the director; Stephen D. Goose is the program director; Ann Peters is the research associate; Kathleen Bleakley and Ernst Jan Hogendoorn are the research assistants; Selam Demeke is the associate; and William M. Arkin, Kathi Austin and Frank Smyth are consultants.