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# Blinding Laser Weapons and International Humanitarian Law

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Multilateral arms regulations may restrict or prohibit the production and possession of specific weapons (the disarmament approach) or the use of specific weapons considered excessively inhumane or indiscriminate in their effects (the humanitarian law approach). This article focuses on the second approach, seen against the background of the St Petersburg Declaration of 1868, which states that whenever scientific developments lead towards improvement in armaments, the Contracting Parties will 'come to an understanding' in order to 'conciliate the necessities of war with the laws of humanity'. The article discusses the prospects for and the legal arguments against battlefield laser weapons which can cause permanent blindness on human beings. Since aggressive use of force is forbidden under the UN Charter, it follows that any use of any weapon is prohibited within the context of aggression. But where international law does not prohibit the use of armed force – as in the case of self-defence or Security Council mandated actions – the right of parties to the conflict to choose methods and means of warfare is not unlimited. The argument is made that systematic use of laser-beams against the eyesight of individuals is prohibited under the existing law of warfare. It is also argued that the use of anti-eye laser weapons is prohibited under existing law, although this conclusion will need to be confirmed in a multilateral document.

## 1. Introduction

In early 1990 it was reported that surface-to-air laser guns, designed to dazzle the pilots of attacking aircraft, had been deployed by the British Royal Navy for over seven years.<sup>1</sup> The system, known as 'Laser Dazzle Sight' (LDS), is intended to counter the threat of aircraft by directing a laser beam at the pilot and making him abandon his attack. Even if this system is designed to inflict only temporary loss of vision, it could, depending on the distances involved and the energy power used, result in serious eye damage and even permanent blindness. LDS variants were used during the Falklands/Malvinas conflict in 1982 and may apparently account for certain losses of Argentine aircraft in that conflict. Since 1987, at least the Soviet Union deployed laser devices, on the *Sovremny* class destroyers, which in certain instances appear to have been used against personnel on US aircraft.<sup>2</sup>

This basically anti-personnel weapon development supplements existing anti-tank/anti-sensor laser weapon developments and raises some disturbing questions about the compatibility of these new military applications with international humanitarian law, be it *de lege lata* or *de lege ferenda*.

This article will address the effects which the use of dedicated anti-personnel laser weapons and other laser devices may have on the human eye, and the ensuing implications for international law and international law-making.

The United States and the Soviet Union realized in the late 1980s the need for international regulation of military uses of laser technology as a measure to prevent incidents between their armed forces and to protect their military personnel. In June 1989, a bilateral agreement on the prevention of dangerous military activities was signed in Moscow.<sup>3</sup> Its second Article stipulates that each Party shall take necessary

measures directed towards the prevention of dangerous military activities, including

(6) using a laser in such a manner that its radiation could cause harm to personnel or damage to equipment of the armed forces of the other Party.

The agreement is limited, however, to activities of armed forces 'in proximity to personnel and equipment of the armed forces of the other Party' during *peacetime*. In the following pages, the focus will be on legal restraints in time of *war*. More specifically, the approach taken is that of international humanitarian law applicable in armed conflicts.

## 2. *Conventional Weapons and International Humanitarian Law*

In any armed conflict, the rights of the Parties to the conflict to choose methods or means of warfare is not unlimited.

This customary law principle, here quoted from Article 35 of the 1977 Additional Protocol I to the Geneva Conventions of 1949, is fundamental to the international humanitarian law applicable in armed conflict. In another wording, this principle was included in Article 22 of The Hague Regulations of 1907. It reflects the basic requirement of proportionality in warfare: or, more specifically, it reflects the mutually balancing principles of necessity and humanity inherent in the law governing the conduct of hostilities. Only those measures of warfare are justified which are relevant and proportional to the achievement of a definite military advantage; and those measures which are manifestly disproportionate to the human suffering involved are prohibited under international law.<sup>4</sup>

This abstract principle concerning limitations in warfare has been supplemented by a more concrete (but still vague) principle of international customary law which is incorporated in Article 23(e) of The Hague Regulations. It is given the following wording in paragraph 2 of Article 35 of the 1977 Protocol:

It is prohibited to employ weapons, projectiles and

material and methods of warfare of a nature to cause superfluous injury or unnecessary suffering.

This formula outlaws certain weapons designed exclusively for anti-personnel purposes, but it also applies to weapons designed and produced to fulfil a variety of purposes. Many modern weapons are basically anti-materiel in character, designed primarily to destroy or neutralize military equipment. However, most of them may also be used to restrict military movements, by disabling enemy soldiers. The test of whether the human suffering is needless, superfluous, or disproportionate to the military advantage expected from the use of the weapon is a difficult and partly subjective exercise. Inevitably, the assessment of suffering versus military effectiveness is difficult to quantify.

The situation is somewhat simpler if the assessment is focused on a weapon (or a method of warfare) designed exclusively for use against individuals. The St Petersburg Declaration of 1868, today expressing customary law, primarily refers to this situation. The Preamble to that Declaration states:

That the only legitimate object which States should endeavour 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 men; That this object would be exceeded by the employment of arms which uselessly aggravate the sufferings of disabled men, or render their death inevitable; That the employment of such arms would, therefore, be contrary to the laws of humanity.

In the concluding part of the Declaration the Parties

... reserve to themselves to come hereafter to an understanding whenever a precise proposition shall be drawn up in view of future improvements which science may effect in the armaments of troops, in order to maintain the principles which they have established, and to conciliate the necessities of war with the laws of humanity.

This first step in the work 'to conciliate the necessities of war with the laws of humanity' meant in 1868 a prohibition against the use of high-explosive bullets weighing less than 400 grams. The next step was taken in 1899 when the first Hague Peace Conference out-

lawed the use of the so-called dum-dum bullets. The first Hague Peace Conference, as well as the second one of 1907, also codified a prohibition on poison and poisoned weapons.<sup>5</sup>

The next treaty to prohibit the use of specific weapons was the Geneva Protocol of 1925 relating to bacteriological (biological) and chemical means of warfare. Since 1925 there has been no comprehensive prohibition of use of any existing weapon category. The 1981 United Nations Convention on Prohibitions or Restrictions of Use of Certain Conventional weapons which may be Deemed to Be Excessively Injurious or to Have Indiscriminate Effects includes only one total prohibition on use, and this with regard to a weapon category which so far has not been militarily useful enough to develop ('fragments which in the human body escape detection by x-rays'). The remaining two regulations of 1981 merely lay down restrictions on the use of certain weapons (landmines/booby-traps and incendiary weapons). This modest result of the Conventional Weapons Conference points to the need for a follow-up, covering additional weapon categories. The general formula of 'superfluous injury or unnecessary suffering' is not sufficient to draw definite conclusions with regard to the legality or illegality of new weapons. It is generally considered that a specific weapon is not prohibited by the general formula unless there already exists an explicit regulation on the issue: there has to be an agreement between states, with regard to the weapon in question, where humanitarian imperatives are given precedence over military considerations.

International humanitarian law prohibits, *inter alia*, reliance on weapon effects which are indiscriminate in nature – that is attacks which are not or cannot be directed at a specific military objective, and which consequently are of a nature to strike military objectives and civilians/civilian objects without distinction.<sup>6</sup> The effects of laser beams are not indiscriminate, rather the opposite: they can always be directed against specific targets. Any legal case against the use of anti-personnel laser weapons thus cannot

rely on the prohibition against indiscriminate effects, but only on the prohibition against superfluous injury or unnecessary suffering. In the following, this latter line of argumentation will be pursued. We submit that the use of laser technology, when specifically designed and employed for certain anti-personnel (anti-eye) purposes, is in contravention of that part of international humanitarian law which prohibits superfluous injury or unnecessary suffering.

Since the concept of unnecessary suffering is inevitably very vague, it is not surprising that any debate on whether a new weapon is unlawful or not tends to produce divergent views. With regard to lasers, it has been asserted that even if such weapons were to have blinding effects, they should not be considered 'unnecessarily cruel' since it is better to be blind than dead (the latter effect is presumed to be the alternative if a different kind of weapon were to be used).<sup>7</sup> We submit, however, that when evaluating the suffering involved, comparisons should be limited to the weapon effects relevant to soldiers not immediately killed on the battlefield.

To many people this kind of humanitarian law argumentation may seem bizarre, since war itself brings unnecessary suffering, not only certain weapon effects on the battlefield. But even though war ought to be ruled out in the practice of states as a consequence of the UN Charter (where Article 2:4 prohibits aggressive resort to force), armed conflicts continue to occur. Since this is the case, international law has to reduce the suffering involved. While international law has managed to achieve this in a very limited sense, war is always 'a dirty business', and humanitarian law will never be able to change this. Thus it cannot be argued that humanitarian efforts will make war less reprehensible and therefore more probable.

### *3. New Weapons Technologies and International Law*

The somewhat abstract rule prohibiting means and methods of warfare of a nature to cause superfluous injury or unnecessary suffering is quite old (St Petersburg 1868,

Hague 1899 and Hague 1907). Still, it was not until 1977 that a concrete corresponding duty to evaluate new weapon developments and tactics was established in international humanitarian law. Article 36 of Additional Protocol I contains, *inter alia*, the following statement:

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 . . . [any] rule of international law . . .

This envisaged national procedure, assessing whether the use of new weapons or tactics under consideration is compatible with international legal standards, appears to be an obvious and indispensable corollary to the general formula of unnecessary suffering. Although new to the formal corpus of international humanitarian law, such a procedure is required by the internal regulations of some countries.<sup>8</sup>

The relevant Committee Report of the Diplomatic Conference on International Humanitarian Law (1974–77) makes it clear that Article 36 of Additional Protocol I is not intended to make the outcome of national assessments internationally binding. There is, however, an expectation that the obligation to make an assessment will ensure that dubious means or methods of warfare will be introduced only after a finding of legality.<sup>9</sup>

In this context, it should be noted that the UN Conference on Certain Conventional Weapons (1978–80) during its 1979 session adopted a resolution relating the dum-dum bullet prohibition to the need for caution in modern weapon developments. The resolution, dated 28 September 1979, includes the following wording:

Recalling the agreement embodied in The Hague Declaration of 29 July 1899, to abstain, in international armed conflict, from the use of bullets which expand or flatten easily in the human body . . .

Convinced that it is desirable to establish accurately the wounding effects of current and new generations of small-calibre weapon systems including the various parameters that affect the energy transfer and the wounding mechanism of such systems . . .

6. Appeals to all Governments to exercise the

utmost care in the development of small-calibre weapon systems, so as to avoid an unnecessary escalation of the injurious effects of such systems.<sup>10</sup>

This resolution takes a significant step towards implementation of the principle of national assessment expressed in Article 36 of Protocol I with regard to one category of weapon. As a minimum, similar steps of caution should be taken with regard to the development of military laser systems, so as to – in the spirit of the 1979 resolution – avoid an escalation of those injurious effects of such systems which are in contravention of international humanitarian standards.

4. *Laser Beams and their Effects on the Eye* In 1958, Theodore Maiman from Hughes Aircraft (USA) demonstrated the possibility of laser light amplification by stimulated emission of radiation action in a ruby crystal with an extremely intense short flash of red light. Since then, the whole field has had a startling rapid development. In the military field, lasers are found with an ever-increasing number of applications.

Laser radiation consists of an intense stream of electromagnetic waves which are said to be ‘coherent’, as they have the same frequency, phase and direction of motion. The laser beam is characterized by its collimation, coherence, monochromaticity, intensity and, of course, its speed – which is that of light, approximately 300 million metres per second. A laser beam is a light ray and it is perfectly straight. All of these qualities aid in allowing the beam to be more intense and capable of carrying a far greater amount of energy than any other source of light (Department of the Army, 1985).

Although most lasers are operated at a few well-defined wavelengths, tuneable lasers exist which allow a choice of wavelengths within a specific band (*ibid.*).

The energy in the laser beam interacts with biological tissue, in particular the eye, in several distinctive ways. It can add enough heat to the tissue to cook it or vaporize the water into steam, tearing the tissue apart; some actions gentle, others violent and at times even explosive. The

energy can foster chemical reactions, or the high concentration of energy can generate more plasma to explode the tissue. In the following, only harmful effects with respect to the eye will be considered, since the eye is that part of the body to which also a low energy laser beam may be exceedingly harmful.

The sensitivity of the eye to laser damage is best understood with reference to the main structures of the eye. Only the wavelength range between approximately 400 and 1,400 nanometres (nm) can enter the eye and is termed the retinal hazard range (Department of the Army, 1985). The laser beam is sharply focused by the eye onto the retina. In the central portion of the retina is the fovea, a small spot occupying less than one degree of visual space, but needed for the most demanding visual tasks. Destruction of this region makes a person incapable of sighting a rifle accurately or even driving an automobile.

The focusing action of the eye on the laser beam amplifies the laser intensity by a factor of a hundred thousand or more. The particular types of damage to the retina caused by this concentrated laser beam include thermal burns which immediately kill that portion of the retina. Another type of damage is rupture of a blood vessel, usually caused by the shockwave from an extremely short duration laser pulse. This rupture puts blood underneath the retina or into the vitreous cavity in front of the retina. Blood in either place produces its own special set of ocular damage. In each case, large portions of the retina are made non-functional, which may be far from the original laser exposure area due to the diffusion of the blood. For example, even a retinal burn in the periphery, where a laser injury ordinarily does not interfere with vision, could induce bleeding which spreads to the centre of the eye and blocks vision enough to result in functional blindness.

The distances at which a laser beam can cause retinal injury vary with laser power in relation to wavelength and exposure duration (Kinney, 1983, fig. 2, pp. 26–30). Binoculars and optical aids increase the danger to the eye by further concentrating

the laser beam. Even ordinary military binoculars, 6 × 30 with 50% transmission and with a 3 mm pupil, can be about 50 times more hazardous than the naked eye.

The laser effect on the retina of the eye in the retinal hazard region may vary between a temporary reaction without any residual pathological effects up to permanent loss of function.

The type of retinal damage is mainly dependent on the energy, the pulse length and the exact wavelength used. A higher level of exposure causes gas bubble formation near the centre of the lesion, which may disrupt the retina and in some cases alter the physical structure of the eye (Mellerio et al., 1991, pp. 52–53). As the irradiance or energy density is increased, a simple whitening of the retina occurs which progresses in severity to charring, haemorrhage and additional tissue reaction around the lesion. The spreading of the blood from a haemorrhage in the inner cavity of the eye, over or underneath the retina, is a serious injury requiring immediate medical attention and possibly intraocular surgery, and any damage to vision may be permanent.

Although there are many safety regulations in use,<sup>11</sup> all based on energy levels that just barely cause damage, not much is known on the effect of higher powered lasers. The effect of the laser on a soldier can range from merely deterring the expeditious accomplishment of a particular mission, up to making a soldier a casualty who needs immediate surgery from highly trained personnel in a specially equipped operating room in a modern medical care facility. Such surgical intervention must be followed by lengthy and expensive visual rehabilitation, which would be a longstanding burden on society. Also, a devastating and immediate effect on military morale can be expected.

##### *5. Current Devices and Future Options*

Lasers have many purposes for the military. Range-finding was the earliest, and today laser range-finders are often combined with sighting systems, TV cameras or infrared cameras. This means that most armoured

fighting vehicles, armed helicopters, ships and many aircraft will have fire-control systems including a laser range-finder. In addition, there are hand-held laser range-finders, reminiscent of ordinary binoculars in appearance and size.

A laser beam is used in some weapon systems as a target designator to guide a missile, smart bomb or rocket to the target. A coded laser beam is directed at the target where the laser reflection is located by the missile's laser target seeker, and the missile homes in on it.

Lasers and missiles also function together as beam-riders. The operator aims the laser at the target, and the missile then follows the beam to the target.

Lasers are also used for training purposes in simulated weapon systems, for communication systems and in laser gyros, proximity fuses and radar systems.

Most laser range-finders and designators operate at wavelengths within the retinal hazard region. High-energy laser weapons may be used to destroy incoming aircraft, helicopters and missiles. Both high- and low-energy laser weapons will be a battlefield option against various types of sensors. When the sensor target is the human eye, low-energy lasers working at the retinal hazard wavelengths will be the weapon.

One of the greatest advantages of the laser beam as a weapon is the speed at which it delivers its energy. If a laser pulse is fired at an aircraft travelling at the speed of sound (331 metres/second), and from a distance of one kilometre, the aircraft will move little more than one millimetre during the time it takes for the laser beam to travel to its target. For tactical engagements on the battlefield, this is essentially a zero time-of-flight weapon. Evasive actions by the target are not possible. The speed of the target will be a problem only if it is necessary to keep the beam on the same spot on a fast moving target for a relatively long period of time.

Another advantage is the straight line of sight along which the energy is delivered. No calculations of a ballistic trajectory are needed, as is the case with normal munitions. Thus, complex fire-control systems are not required to solve the problems of

trajectory and lead. Also, laser radiation would normally be silent and even could be invisible. Only very high-energy lasers will make any significant noise.

Another major factor that favours battlefield laser weapons, and especially low-energy lasers, is that the huge and expensive ammunition logistics system associated with all conventional weapons systems is reduced to a single battery that is disposable or rechargeable.

#### 6. *Anti-personnel Laser Weapons*

The safety problems with the outdoor use of current military lasers indicate the possibility of deliberately using these lasers against the eyes of the enemy soldier. However, current lasers are not designed for this purpose and consequently in this mode of application they have various drawbacks. It will therefore be tempting to design laser weapons with a specific anti-eye configuration (Anderberg & Wolbarsht, 1990, pp. 58–62).

The main anti-eye laser weapon applications are possibly to flashblind or dazzle the adversary for some time, or to damage the eye permanently.

Flashblinding a pilot for 15 to 30 seconds during the final phase of an attack will make him eject from the aircraft, or crash. A flashblinding laser could also be used in a tank-versus-tank engagement at the same time as the conventional tank gun is used. The laser would blind the sensors of one enemy tank, while the gun would destroy another.

A flashblinding laser weapon system is most effective at night when the eye is adapted to receive as much light as possible. However, flashblinding in broad daylight would most likely also cause permanent injury to the eye.

The possibility of deliberately damaging the eyes of the enemy to some extent already exists with many range-finders and target designators operating within the visible range. Most of these lasers deliver beams sufficiently strong to damage the most crucial part of the eye – the fovea. An anti-eye laser weapon can be designed pow-

erful enough to cause serious vision loss even when the beam hits the eye from an oblique position. The most likely mass casualties by functional loss of vision will be from peripheral sites of bleeding inside the eye where the blood effectively obscures the optical pathway (Anderberg & Wolbarsht, 1990, pp. 58–62).

These weapons could be used in close combat between infantry units. Although this may also become the weapon of choice against tank crews, missile operators, toward air and artillery controllers, and anyone else using magnifying optics, the lowly infantrymen would seem to be the primary target.

An anti-eye laser weapon could blind a soldier at a distance of more than 1,000 metres, from any point within a sector of 120 degrees from the soldier. Such a device would certainly be a highly effective weapon on the battlefield.

The psychological impact on the infantry will be significant once it is realized that viewing the battlefield with binoculars or even with the naked eye could entail a significant risk of blindness.

*Protection* against laser radiation is problematical. All persons wearing sunglasses are using filter technology to protect the eyes from the light. The aim of the sunglasses is to block all light to a certain degree; the aim of the laser filter is to allow as much light as possible to pass through, except from the hostile laser. Usually, this means that the specific wavelengths used by the enemy laser have to be known beforehand to be used in any protective filter design. If these cannot be identified, all possible wavelengths will have to be blocked. This is also the case if the enemy uses a tuneable laser that covers a broad part of the spectrum.

The transmittance of light in laser eye protection is of great importance, as low transmittance leads to obscured vision and eye fatigue, which degrade combat effectiveness. Seeing as clearly as possible in a life-threatening situation is of course vital to the soldier, whose vision may already be limited in daytime by smoke and haze and by overall low light levels at dawn, dusk and

night. Given these difficulties, adding protective filters is not an easy task. It seems impossible to develop any eye protection suitable for the individual infantry soldier, without unacceptably limiting vision.

The *cost-effectiveness* of a well dispersed anti-eye laser weapon will be extremely high. The cost of simple changeable-frequency laser weapons fastened on rifles or machine-guns will be low enough – a few hundred dollars with negligible battery, replacement and maintenance charges – to make it possible to arm every infantry soldier in this way. At the same time, casualties could be numerous and costly to the enemy, as most laser eye injuries require complicated and expensive medical treatment. The necessary medical resources to cope with mass eye injuries cannot be organized on the battlefield; indeed, they are also extremely rare even in peacetime in the most developed countries. Soldiers injured by anti-eye laser weapons will be unlikely to return to their combat units quickly, and many will be lost forever as soldiers. Some will be permanently blinded. Most of the others will not get the proper medical treatment and will most certainly end up severely disabled. As anti-eye laser weapons will immediately put enemy soldiers out of action and injure them in a way that places a heavy medical burden on the enemy combat units, the military value of this kind of weapon is as clear as are the humanitarian drawbacks. The psychological effects on the soldier and the heavy postwar effects on society from mass blindness should also be added to the balance sheet.

### 7. *Conclusions on International Humanitarian Law and Laser Weapons*

The starting-point for an assessment of laser weapons in an international law context is the biological/medical effect of these weapons compared with the military interest involved. It is perfectly possible to design a laser weapon for use especially against the human eye by using a suitable combination of wavelength, energy, pulse width and pulse repetition frequency. Such an anti-eye laser working in the wavelengths between

400 and 1,400 nm (nanometres) can generally be expected to cause blindness. The traditional law of warfare has, as we have seen, established a principle according to which no means and methods of warfare shall be used which cause unnecessary suffering or superfluous injury. We have already noted that the 1868 Declaration of St Petersburg states that the only legitimate object of warfare is 'to weaken the military forces of the enemy'. The Declaration goes on to state that 'for this purpose, it is sufficient to disable the greatest possible number of men', i.e. to put the soldiers out of action for the duration of the conflict – not to harm them for the rest of their lives. Even if the St Petersburg formula is not sufficiently illuminating with regard to the issue of laser weapons, the aim of the 1868 Declaration – in its own words 'to conciliate the necessities of war with the laws of humanity' – gets to the root of the matter. The Hague Regulations of 1899 and 1907 reaffirmed the principle that humanitarian concerns should be balanced against military interests in the employment of weapons. Additional Protocol I of 1977 has strengthened this principle by requiring states to institute screening procedures with regard to new weapons, weapon systems and methods of warfare.

The principle of unnecessary suffering does not prohibit all weapons which are particularly inhumane, but only those which cause (or are inherently likely to cause) *unnecessary* suffering or *superfluous* injury. The test of whether this is the case with regard to a particular weapon requires a balance to be struck between the military advantages which the weapon is expected to achieve and the degree of injury and suffering which it is likely to cause. As to the case of lasers designed to disable a tank or aircraft by blinding its crew, one must ask whether the military advantage of a 'soft kill' (directed at the human beings in the tank or aircraft) is so superior to the traditional 'hard kill' approach (directed at the military equipment as such), as to justify permanent blindness or a high percentage risk of permanent blindness. In this context it has to be remembered that 'flashblinding' can never be relied upon to produce only a

temporary loss of vision, since the energy used will in itself always be enough to blind people for life in some circumstances (depending on distance, beam angle, etc.).

While the use of laser weapons directly against equipment is not in contravention of the existing law, any planned use of lasers against personnel has to be screened through the legality test.<sup>12</sup> All individual combatants have the right to protection from weapon effects which are classified as unnecessarily cruel in relation to the military advantage. At the same time, in the balance to be struck between military necessity and humanitarian considerations, some weapons applications may be recognized as more necessary than others – implying that the same injury could be classified differently under the legality test due to different military situations. At least in combat against infantrymen, the following factors suggest a finding of illegality:

1. Eyesight is the most important sense for a human being. It is irreplaceable and is the part of the body which an individual will instinctively and intuitively try to protect in a crisis situation.
2. Psychological damage as well as bodily harm must be taken into account when assessing the degree of injury or suffering. As David Warren has shown, human suffering caused by blindness is intense, in particular as a consequence of the psychological damage (despair, bitterness, identity changes) (Reports 1989/1990).
3. During wartime, medical resources would not be sufficient to cope with large numbers of laser eye injuries; thus individuals who might otherwise be curable will become irreversibly blinded.
4. The amount of damages paid by insurance companies and awarded by courts as compensation for permanent blindness is extremely high in industrialized countries. This confirms blindness as one of the most serious injuries.<sup>13</sup>
5. While the death penalty is still socially acceptable in many national societies and

legal systems, blinding as a punishment is no longer used.

6. The military advantages connected to the use of laser weapons are substantial, but not dramatically so compared with other weapons available on the battlefield or at sea. Anti-eye lasers would represent an 'add-on' weapons system, in particular when intended to supplement existing anti-materiel options.

The conclusion that presents itself is that in the balance between military interests and humanitarian considerations, an irreversible disablement such as blindness caused by a laser beam can reasonably be described as 'unnecessary suffering' according to the formulas from St Petersburg, The Hague and Geneva.<sup>14</sup> But again, this is a general conclusion which could be rebutted if the military advantage of a certain weapon application (e.g. anti-pilot) should prove fundamentally superior to existing anti-materiel options. It could also be argued that any finding of illegality would have to be limited to cases where the use of laser is *exclusively* anti-personnel. If the laser beams are intended to neutralize the personnel of an attacking aircraft or tank, the anti-personnel effects would be of a secondary nature, as the major consideration is the destruction of the vehicle. On balance, then, any prohibition in this field would probably have to be limited to anti-personnel use in cases where the value of anti-materiel destruction is minor, and the major purpose is individual harm.

If the general finding is one of illegality, two further conclusions can be drawn from this. The first relates to methods of warfare, i.e. tactics or other deliberate and systematic action to harm or neutralize the enemy. Existing law already prohibits the use of directed energy (through weapons or other equipment) against unprotected individuals on the battlefield as a method of warfare, if such anti-personnel use is intended or may be expected to cause irreversible injury to the human eye.

The second conclusion relates to means of warfare – the use of weapons. In general, a specific weapon is not considered prohibited

under international law unless there is a treaty to that effect. Thus, an explicit prohibition against the use of directed-energy weapons (DEW) designed exclusively for an anti-personnel purpose to cause irreversible injury to the human eye should be considered for inclusion in an international document.

The many military areas of laser use make a total ban on all use of laser weapons unrealistic. However, there are strong reasons for seeking to establish a formal prohibition in the area of anti-personnel use. This could be achieved through focusing on prohibited methods of warfare ('the software approach'), i.e. an explicit ban on deliberate and systematic anti-personnel use of directed energy of a nature to cause superfluous injury or unnecessary suffering; or through focusing on the means of warfare ('the hardware approach'), i.e. a new ban on the use of specific anti-personnel directed energy weapons which produce the effects described above.

These two approaches could also be combined in the same document. Such a document would then (1) confirm the customary law prohibition on certain methods of warfare as related to laser technology, and (2) introduce a prohibition on the use of certain anti-personnel laser weapons. Such a double ban (on tactics and weapons) would of course be the ideal solution from a humanitarian point of view. It has to be recognized, however, that the only verification possible would be a post facto one on the battlefield. A disarmament approach verifying non-production of certain lasers does not seem possible.<sup>15</sup> Even so, taking into account the potential role of mass media and public opinion, a post facto control of use in an armed conflict would be far from meaningless. Any systematic anti-personnel use of laser would soon be revealed and – at least in armed conflicts of a limited nature – the political costs involved would be substantial.

We should not underestimate the normative value of a regulation in this field of international law. A document protecting human beings on the battlefield from being deliberately blinded for the rest of their lives would be an important new element in the

tradition of international humanitarian law applicable in armed conflict.

## NOTES

1. *Jane's Defence Weekly*, 13 January 1990, p. 48.
2. See the 1987 edition of *Soviet Military Power*, p. 113. This publication also includes the following statement: 'The tactical laser program has progressed to where battlefield laser weapons could soon be deployed with Soviet forces. The Soviets already have the technological capability to deploy low-power laser weapons – at least for anti-personnel use and against soft targets such as sensors, canopies, and light materiel. Even low-power lasers, as in range-finders, can have weapon applications. Recent Soviet irradiation of Free World manned surveillance aircraft and ships could have caused serious eye damage to observers' (p. 112).
3. Agreement on the Prevention of Dangerous Military Activities, Done at Moscow, 12 June 1989. *International Legal Materials*, vol. 28, 1989, p. 877. The agreement entered into force on 1 January 1990.
4. For a commentary to Article 35 of Additional Protocol I see Bothe et al., 1982, pp. 192–194.
5. Article 23(a) of the Hague Regulations of 1907. For the legal texts referred to, see Roberts & Guelff, 1982, pp. 43–59 and 387–446.
6. Cf. Article 51, Additional Protocol I of 1977 to the Geneva Conventions of 1949.
7. This point has been made by Campbell & Borch, 1985, pp. 30–37: 'The accuracy of a laser weapon makes it an inherently discriminate weapon, thus not illegal under any test of indiscriminate attack' (p. 37). However, it is possible to envisage indiscriminate laser applications, e.g. automatic scanning systems. The usefulness of such systems as *weapons* is doubtful, however, since the military advantages of non-detectable 'firing position' and surprise will be lost.
8. Bothe et al., 1982, p. 199, mention the Federal Republic of Germany and the United States.
9. Bothe et al., 1982, p. 200. However, a State may, for security reasons, equip itself with weapons whose use is normally prohibited in order to demonstrate a second-use capacity. Reprisals in the field of prohibited weapons are not prohibited under international law. Even so, Article 36 'in itself constitutes progress as it fills a gap at an international level. It implies the obligation to establish internal procedures for the purpose of elucidating the issue of legality, and the other contracting parties can ask to be informed on this point' (Sandoz et al., *ICRC Commentary*, 1987, p. 424).
10. The 1979 Resolution on Small-Calibre Weapon Systems is rendered in the second edition of the UN publication *Status of Multilateral Arms Regulation and Disarmament Agreements*, 1983, pp. 164–165.
11. For a general overview, see Sliney & Wolbarsht, 1980.

12. It could be argued that the screening requirement of Additional Protocol I with regard to new weapon technologies is part of generally binding customary law.
13. However, in the United Kingdom the largest awards of damages have been made to those rendered quadriplegic. See statement by Greenwood in *Report*, 1989, p. 96.
14. Article 35, paragraph 2, of the First Additional Protocol to the Geneva Conventions lays down a prohibition relating to the results produced (e.g. permanent blindness), but this is not directly a prohibition on the weapon in question. That is why an explicit prohibition is needed. It has to be admitted, however – as in the words of the International Committee of the Red Cross (ICRC) – that the 'concept of superfluous injury or unnecessary suffering, its objective effect on the victim (severity of injury, intensity of suffering), and its relation to military necessity' is not interpreted in a consistent and generally accepted manner. Still, the concept continues to be the basis on which judgement on new weapons is formed. See the *ICRC Commentary*, 1987, pp. 409–410.
15. A disarmament approach to the matter would imply a rule prohibiting the production of weapons specifically designed to destroy the eyesight of individuals. Under ideal circumstances, such a rule should be related to special technical characteristics indicating a design apt to cause serious eye injury and blindness. It seems impossible, however, to single out technical parameters exclusively indicating an intended anti-personnel area of use. Hence, the imaginable impossibility of verifying a rule on non-production. Cf. Mastroianni, 1990, p. 8, where the author suggests 'laser-free zones', namely agreement on portions of the electromagnetic spectrum in which laser emissions would be prohibited. The verification task would then be simple (to detect any laser use outside the agreed-upon wavelength), but the realism of prohibiting also potential legitimate uses is doubtful.

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