EYE-SAFE LASER ILLUMINATORS AS NON-LETHAL WEAPONS

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ABSTRACT

In the present domestic and world political climate, civilian and military forces are often faced with situations requiring less-than-lethal response options. Low-energy, eye-safe laser illuminators have been shown to be effective, non-lethal weapons for a variety of law enforcement and other-than-war military applications. Through the effects of illumination, glare, and psychological impact; lasers can provide unequivocal warning, threat assessment based on reaction to the warning, hesitation, distraction, and reductions in combat and functional effectiveness. This paper discusses three system concepts developed by Science and Engineering Associates, Inc.: a laser flashlight, a laser adjunct to closed-circuit television security systems (fixed or mobile), and a laser police baton. These concepts have been designed, tested, and are production ready.

INTRODUCTION

The fundamental purpose of non-lethal weapons is to offer military and law enforcement personnel response options for situations in which the use of potentially lethal options, such as firearms, are not appropriate at the time. Such situations range from apprehending hostile law breakers to rescuing hostages from terrorists. The need to delay or avoid lethal responses is particularly problematic to military forces engaged in peacekeeping or humanitarian missions in the midst of opposition. Premature response with firearms in these situations often has international ramifications and can escalate into armed conflict. In civilian law enforcement scenarios the consequences of inappropriately severe responses may not be as far-reaching, but on a local scale are nonetheless important. Injury or death of bystanders and even the criminals themselves often results in multi-million dollar lawsuits and negative impact on police department - community relations. Non-lethal weapons can prevent such escalation and thereby significantly reduce the chance of injury or death in these situations.

Non-lethal weapons themselves cover a spectrum of severity in terms of their effect on adversaries and potential for causing injury or even death. Options at the "soft" end of this spectrum include pepper sprays and fired nets, which have little probability of causing permanent harm. At the other end of the spectrum are options such as sticky foams and rubber rounds which, although capable of incapacitating a subject, can cause serious injury or death in some situations. This paper presents a new addition to the soft response options – eye-safe laser illuminators – which have been developed by Science and Engineering Associates (SEA) for both military use and law enforcement applications. These devices are covered by U.S. Patent Number 5,685,636.

THE EFFECTIVENESS OF NON-LETHAL LASER ILLUMINATORS

Low-power (100 - 500 mw) laser illuminators can be effective, non-lethal weapons for a variety of applications. Through the effects of illumination, glare, flashblinding and psychological impact, lasers can (1) provide unequivocal warning; (2) create hesitation, delay, distraction; and (3) reduce combat and firearm proficiency. Furthermore, if continuous wave (cw) lasers are used rather than pulsed

lasers, these effects can be created at exposure levels below the maximum allowed by international safety standards.

Laser Safety

The term *eye-safe*, as applied to the laser devices discussed in this paper, means that the devices are designed to illuminate subjects with beam intensities and operational modes that have a very low probably of causing eye injury. The worst-case exposure that subjects will receive is below the Maximum Permissible Exposure specified by international laser safety standards. In fact, it can be said of the SEA lasers discussed in this paper that:

NON-LETHAL LASER ILLUMINATORS ARE AS EYE-SAFE AS THE SUN!

This statement means that, like the sun, eye damage is possible if one stares into the laser illuminator for several seconds or views it through magnifying optics. However, also like the sun, one must overcome the natural reaction to blink and look away and withstand painful discomfort in order to stare at the source long enough to cause injury.

One further point should be made clear with respect to laser devices in general:

LASERS DO NOT BLIND!

Obviously, this statement cannot be true for the highest power lasers, which could burn the skin as well as the eyes. However, for the power levels employed in current and anticipated battlefield laser devices, the statement does hold true. Although pulsed lasers, particularly those with very short-pulses, can and do cause injury to the eye's retina, only a small portion of the retina is involved and the injury usually results in some degree of permanent visual deficit. Patients with diabetic retinopathy often receive dozens of shots from a pulsed laser to seal off bleeding vessels in the retina, yet still retain functional vision. In the more than two-hundred laser accidents involving the eye during the past several years, most were confined to one eye and none resulted in total blindness in that eye. Furthermore, even though the continuous wave lasers used as non-lethal weapons may cause eye injury in very limited circumstances (such as viewing through a rifle scope), this type of injury is more likely to be in the nature of a retinal sunburn with little or no permanent visual deficit

Laser Effects

The first effect that is usually employed is illumination of the subject's body with the laser beam. The laser beam is a bright red, well-defined circle generally one to two feet in diameter (depending on the range) with a distinct "laser" character due to the optical coherence of laser light. Besides the "laser" look and the red beam (which signifies **STOP!** or **DANGER!** in any language), this beam differs from a flashlight beam in one other key feature: *it can illuminate subjects at ranges exceeding 500 meters at night!* When this beam falls on an adversaries chest, he or she clearly realizes that they have been seen and may have a firearm trained on them. When laser illuminators developed by SEA were employed in Operation United Shield, the U.S. withdrawal from Somalia, simple illumination of armed adversaries was 100% effective. In all cases, the subjects dropped their weapons, surrendered, or fled.

The next level of laser effect is glare and flashblinding. These effects are experienced when one looks at the sun briefly, or catches its reflection from a car window or chrome bumper. Glare can be described as "visual jamming": the light is so bright that it obscures one's vision partially or completely while the light is shining in the eye. Flashblinding, on the other hand, remains after the light is no longer shining in the eyes. This effect causes the "spots before your eyes" after a flash photograph has been taken. Although flashblinding does cause some temporary visual impairment for several seconds after exposure, it is not generally as severe as that caused by glare. Either of these effects, however, is sufficient to reduce an adversary's ability to aim a firearm or effectively engage in other combat actions.

In addition to the above physical effects, laser illuminators can have significant psychological impact, as evidenced by the response of the Somalian adversaries mentioned above. Specific psychological responses include fear, hesitation, and delay. These responses are particularly useful in applications such as drug raids, hostage rescues, dog release against an adversary, and prison cell extractions, where a few seconds advantage is sufficient to overcome the opposition.

Non-lethal laser illuminators can be effective for many applications and scenarios. However, it is important to understand their limitations as well. These devices are more effective at longer ranges in reduced light situations. The darker it is, the better they work. A device that causes glare at 150 meters at night may only be effective at 50 meters in bright daylight. Illumination is even more limited by bright ambient light. A laser that can produce a clearly visible spot out to 500 meters in the dark may only produce a visible spot out to 50 meters during the day. However, in both situations, the laser far outperforms a conventional flashlight or spotlight.

One final limitation of laser non-lethal weapons, which is contrary to some of the fictional accounts of their use, is that these devices do not incapacitate an adversary. An adversary will experience discomfort from the bright light and be forced to look away, but they will not be "stunned" or drop to the ground. On the other hand, they will not be inclined to look or move in the direction of the laser after the first exposure.

SEA LASER DEVICES

For the past ten years, SEA has been involved in analysis, modeling, development, and testing of several eye-safe laser illuminator systems. The first of these is the grenade shell illuminator, developed jointly with the Air Force Weapons Laboratory and the Defense Nuclear Agency (DNA) from 1990 to 1993. After successful field testing this device, now called the Saber 203 system, entered the acquisition phase as an engineering manufacturing development program directed by the Air Force Electronic Systems Center. Current plans call for SEA to begin producing operational systems in early FY 2000.

Over the past year, SEA has employed the technology advancements and technical expertise derived from the early DNA research and the Saber 203 program to develop three additional laser systems for military and civilian law enforcement: (1) the laser flashlight, (2) the laser police baton, and (3) the surveillance camera/laser system. At the same time, SEA developed a business plan to manufacture and market these devices starting in mid-1998. The following sections describe each of these devices and their use.

Laser Flashlight

Although the production version is undergoing final design changes, the current SEA laser flashlight prototype is similar in appearance to a conventional police flashlight, as seen in Figure 1. It is powered by two lithium D-cell batteries and is switched on and off with a pushbutton. The beam spread can be adjusted between narrow angle for long-range illumination and wide angle for area coverage at shorter ranges. The advantages of the laser flashlight in the narrow beam mode over a conventional 5-cell flashlight in terms of effective range is evident from the graphs of Figure 2.

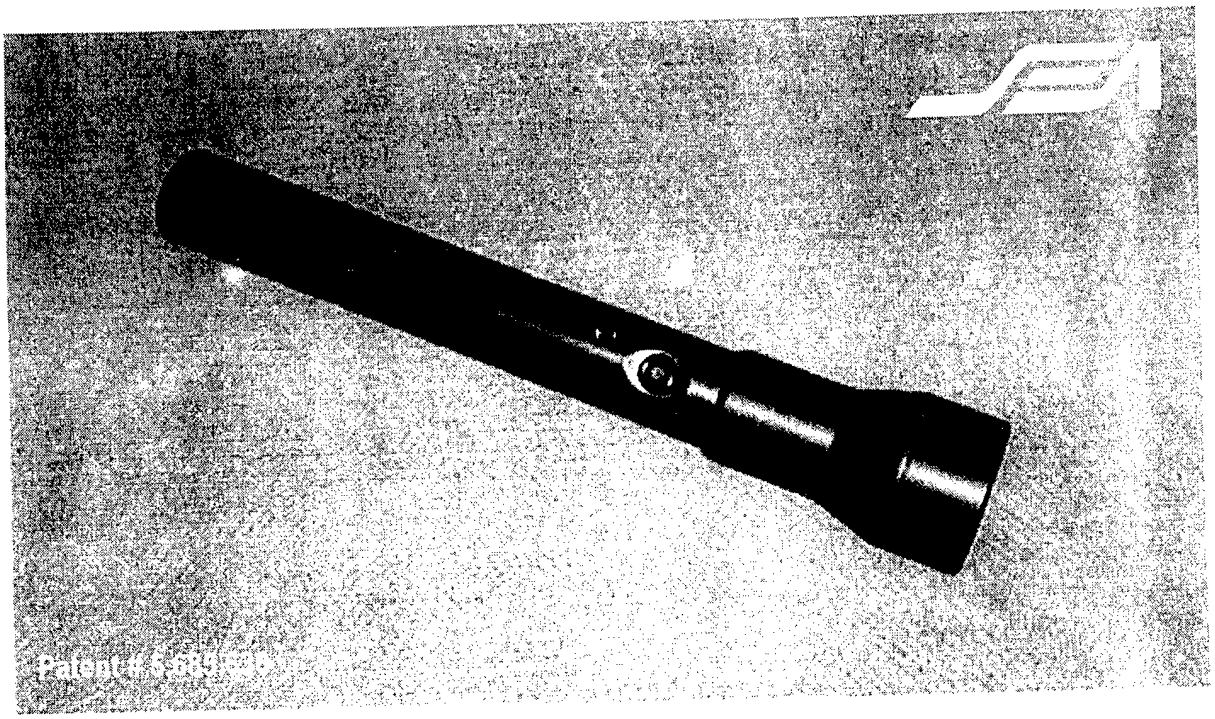

Figure 1. The prototype of SEA laser flashlight is similar to a conventional police flashlight in form and function.

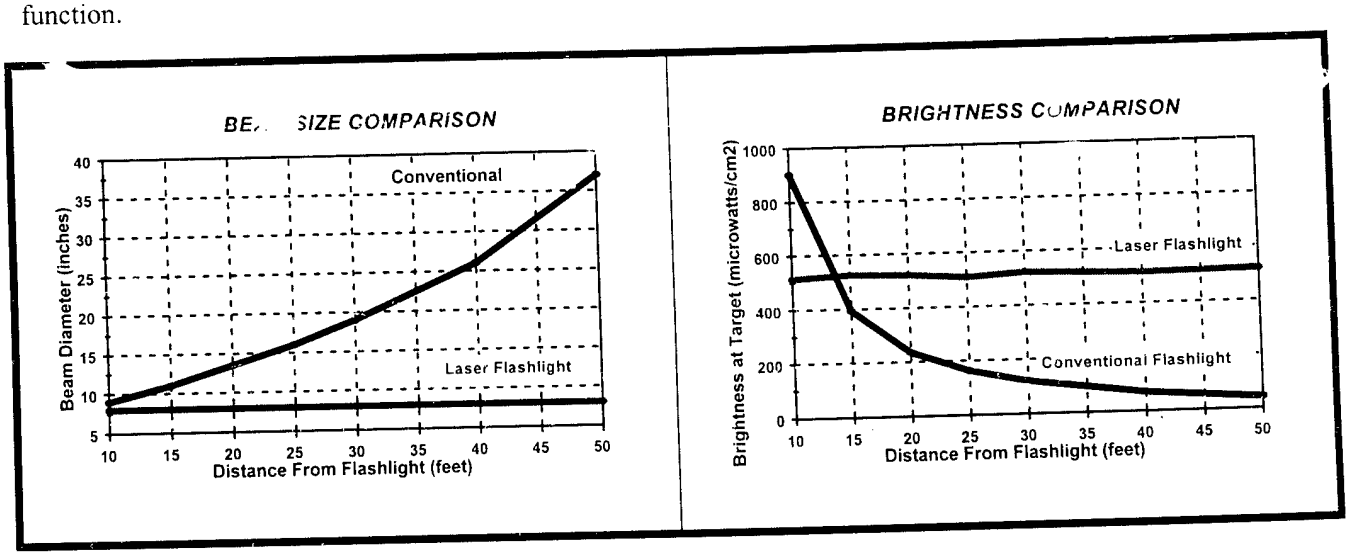

Figure 2. Comparison of conventional police-type flashlight with the SEA laser flashlight.

consuming. This gives security forces time to respond and apprehend the intruder before he can complete his mission and escape. Figure 4 illustrates this new improved system.

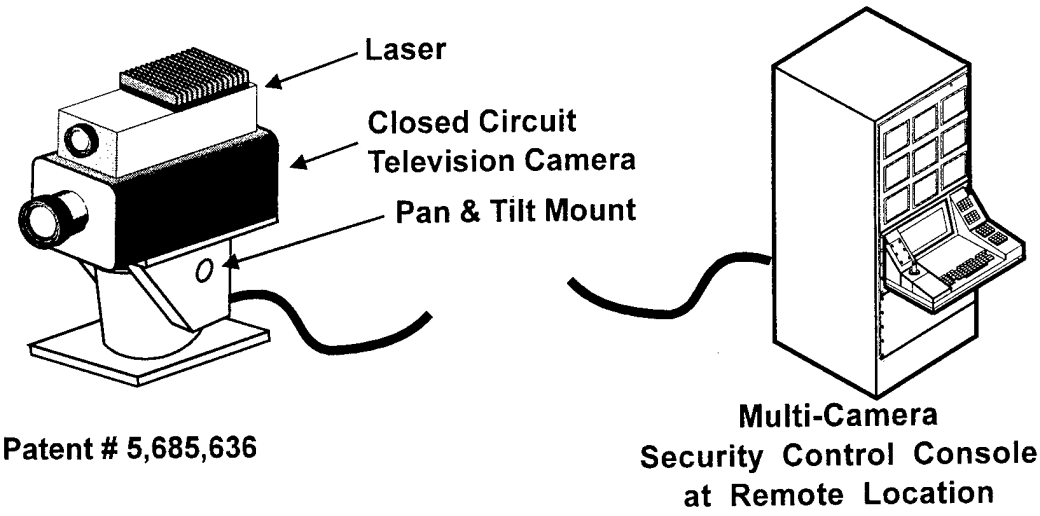

Figure 4. The present SEA design for the surveillance camera/laser system is based on the latest technology available.

POTENTIAL LAW ENFORCEMENT APPLICATIONS FOR NON-LETHAL LASERS

Low-energy lasers used as non-lethal weapons can contribute to success in several law enforcement and corrections applications for a variety of local, state, and federal agencies. Figure 5 illustrates this point with a Laser Concept/User/Applications Matrix. In the center of the matrix are listed five potential using agencies: (1) routine law enforcement at municipal and state levels; (2) special law enforcement operations such as SWAT teams and riot-control forces; (3) U.S. Drug Enforcement Agency and Alcohol Tobacco and Firearms agents; (4) the U.S. Border Patrol and Coast Guard; and (5) corrections institutions at the local, state, and federal levels. In the left wing of the matrix, the four SEA non-lethal laser illuminator devices are shown with check marks to indicate which agencies would be likely to use each c :ept. In the right wing of the matrix, five application areas are listed, again with check marks indicating the appropriate using agency. These six application areas are described below.

Illuminate/Designate

In almost any situation involving potential conflict, the ability to illuminate and designate at ranges out to 500 meters or more can be a valuable asset. All four of the laser concepts can be very useful as an illuminator or designator. The laser flashlight and surveillance camera/laser (designated CCTV in the figure) are especially good for this application area because, with an adjustable focus capability, they can produce a nearly collimated (parallel) beam of light with a spot diameter of less than a foot at 100 yards range. Besides use directly against subjects, the lasers can be used to illuminate shadowed areas day or night, or designate the location of a hiding suspect. They can also be used to designate buildings, objects, boats, and automobiles, or point out approach routes to the target for maneuvering officers.

Warn

Any of these laser concepts will provide an unequivocal, language-independent warning to an adversary. A subject's reaction to a laser warning can also provide threat assessment. The intent and motivation of the subject can be assessed based on whether the subject surrenders, retreats, continues to advance, or raises a weapon in response to the warning. The anticipated outcomes in most cases are those observed in Somalia: surrender, find cover, or flee. In any of these cases, the likelihood of physical or armed conflict will be reduced.

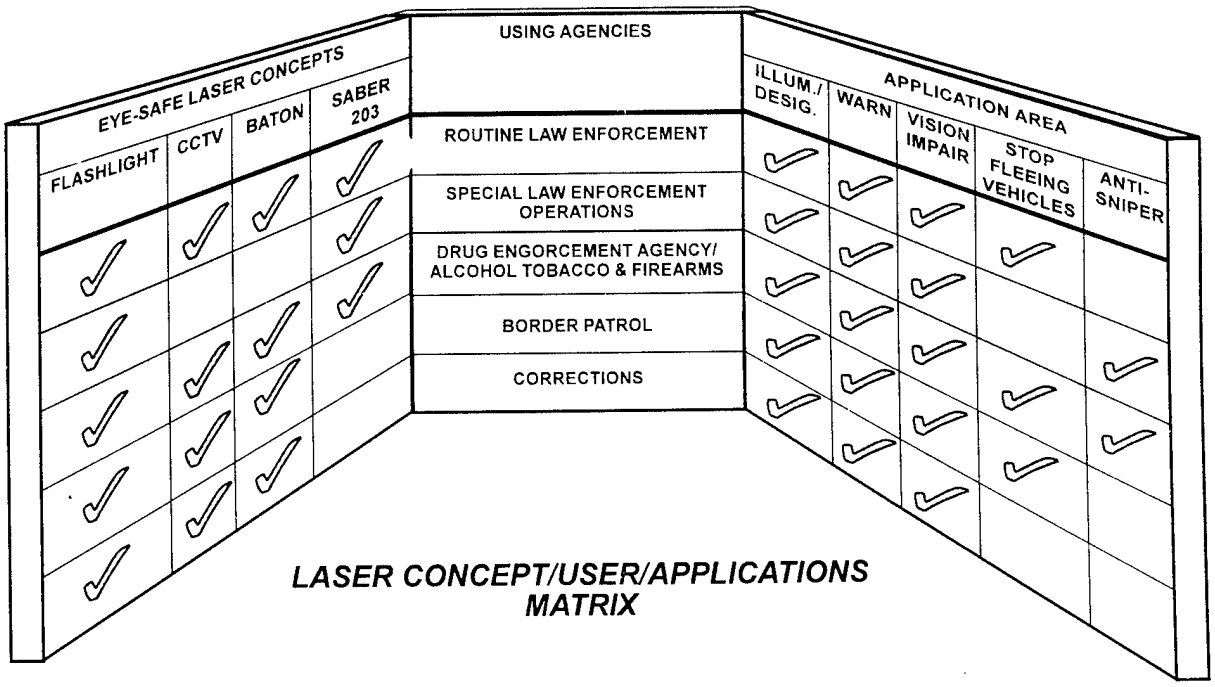

Figure 5. This matrix shows which laser concepts and application areas are likely to be of greatest interest to four types of using agencies.

Impair Vision

If these laser devices are shined in an adversary's eyes, their ability to see is temporarily impaired. If a police officer is holding the flashlight or baton laser, a subject cannot see if the officer is behind cover, armed, or is accompanied by other officers. At night, illuminating a subject's face or chest causes the eye pupils to constrict and makes it very difficult for him or her to run or accurately aim a firearm. Corrections applications in this area include highlighting prisoners in the yard, installing surveillance camera/lasers in critical corridors and gates for riot control, and impairing a prisoner's vision during a cell extraction. The U.S. Border Patrol could use the laser flashlight to impair the vision and slow down fleeing illegal aliens. They currently do this with conventional flashlights, but the range is very limited compared to a laser flashlight. DEA, ATF, U.S Coast Guard, and SWAT forces could use the laser flashlight to impair adversaries vision at long ranges as well as to create distraction and psychological impact.

Stop Fleeing Vehicles

During operational scenario tests of military laser systems by SEA, it was demonstrated that lasers can very effectively obscure a driver's vision when shined on the windshield. There is no need for the laser beam to be directly in the driver's eyes because the scattered light from dirt and pits on the windshield will constrict the pupils sufficiently to prevent the driver from seeing beyond several meters at night, even with the vehicle headlights on high beam. For routine law enforcement use, a helicopter would be the best platform to gain frontal access to the windshield of a fleeing vehicle. The laser could be turned on when the vehicle has slowed down for a turn or is in a situation where the chance for collateral damage is minimal. The Border Patrol could place a CCTV laser a short distance inside border crossings and illuminate the windshield of "gate crashers" before they picked up sufficient speed to be a hazard.

Anti-Sniper

Lasers provide three benefits in the anti-sniper application area. First, they can be used for identifying possible locations of snipers because rifle scopes, as well as other magnifying optics, produce a bright glint return when illuminated by a laser. Secondly, lasers can warn a suspected sniper that he has been spotted and distract him from his mission. If the suspect is not really a sniper, there is no harm done. Finally, if the laser is located within the field of view of the rifle scope when the sniper is looking through it, his vision will be significantly impaired for several seconds due to flashblinding. Furthermore, he will be very hesitant to look through the scope again. Based on recent incidents, these capabilities would be very useful to DEA and ATF agents, as well as SWAT teams at all law enforcement levels.

CONCLUSION

Laser illuminator devices can be used very effectively as non-lethal weapons in a wide variety of military and law enforcement applications. Although these devices are at the soft end of the non-lethal spectrum, they have a very low probability of causing injury to adversaries or innocent bystanders. The variety of laser designs available from SEA allows different users to select the system that best matches their operational needs.