

* APPENDIX D

DIRECTED-ENERGY WEAPONS

The battlefield of the next war will include directed-energy weapons (DEWs). Several threat weapons have already been tested in combat; improved versions of these weapons may be fielded soon. For the task force commander, the DEW battlefield is here now. It exists in the form of threat weapons that he must be prepared to face today and in the form of our own DEW systems, many of which are already being tested in prototype form. Commanders, S2s, and S3s must understand the nature of the DEW threat and how to defend against it, or it may become an enemy combat multiplier of enormous impact.

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Section I. CHARACTERISTICS

DEWs include microwave-radiation emitters, particle-beam generators, and lasers. Conventional weapons rely on chemical or kinetic energy in the form of a projectile. DEWs rely on subatomic particles or electromagnetic waves that impact at or near the speed of light. Since the energy from DEWs travels this fast and is line of sight (LOS), it arrives at the target almost instantly. A DEW gunner need not lead a target, and resupply of ammunition is never a problem. DEWs can attack heavily armored targets at their most vulnerable points—their optics (eyes) and soft electronics.

D-1. MICROWAVE RADIATION EMITTERS

Long-term exposure to high-intensity microwaves may produce physical and psychological effects on humans to include warmth, pain, headaches, fatigue, weakness, and dizziness. Used against equipment, high-intensity microwaves can cause on-board electrical systems to fail; they can severely damage or destroy miniaturized electronic components, such as microchips, by overloading them with electrical energy. Microwave energy also can cause electrically fuzed munitions to become duds or to detonate. This effect depends on the power output of the weapon and the distance to the target.

- a. Protection. The only reliable protection for emitters is completely encasing susceptible equipment in a heavy gauge metal shielding or surrounding it with special metal screening. Burying or covering equipment with sandbags or other nonmetallic materials will not provide adequate protection. On combat vehicles, sensitive components should be left in their proper mounts, and their grounding strap should be checked. Smaller pieces of equipment should be placed in empty ammunition cans. Hatch covers should be kept closed unless someone is entering or exiting the vehicle. EMP follows ground contours, so terrain masking provides some protection.
- b. Countermeasures. Known or suspected locations of enemy ground-based microwave-generating weapons should be attacked by direct and indirect fires. The type of munitions used should be nonsmart rounds that do not require command guidance or triggering at the target location. Microwave radiation weapons can neutralize more advanced munitions by affecting their internal electrical components.

D-2. PARTICLE BEAM GENERATORS

A particle beam is a directed flow of atomic or subatomic particles. These high-energy particles, when concentrated into a beam that can interact with a target, can melt or fracture target material and generate X-rays around the point of impact. If effective particle beam weapons are developed for use in ground combat, the same kind of defensive measures taken against any direct-fire weapon will protect against their effects. Terrain masking is the most effective method available to counter particle beam weapons.

D-3. LASERS

These weapons are the category of DEWs most likely to be used against our forces. Laser weapons produce intense heat and light on a target. Optical devices, specifically vehicle sights and sighting systems, are the most likely targets. Lasers can burn out optical devices and flash-blind those who operate them. However, soldiers are susceptible to laser weapons even when not using optical devices. Laser energy from friendly and enemy systems can damage the

naked eye (damage may be temporary or permanent). Because the eye is more sensitive to light during darkness, laser weapons have a greater effect at night than during the day.

- a. **Direct-View Optical Devices.** A laser weapon targeted on see-through optical devices damages the eyes of the targeted operator. The beam passes through the optical device and burns the eye, causing either temporary loss of vision (flash-blinding) or permanent blindness. When the optical device has a magnifying capability (such as binoculars), the beam strength is magnified, which causes greater injury to the eye (Table D-1).

DIRECT-VIEW DEVICES	ELECTRO-OPTICAL DEVICES
Direct View	Image Intensifiers
Eyeglasses Contact Lenses Sun, Wind, and Dust Goggles Vision Blocks	AN/PVS-4 AN/PVS-5
Magnifying	Thermal Devices
Binoculars (7x) ITV Acquisitions Sight (3x) ITV Squad Leader's Periscope ITV Gunner's Sight (13x) TOW Daysight	Thermal Nightsight AN/TAS-4A Ground laser-location designator (GLLD) M2/M3 integrated sight unit M1A1 tank gunner's primary sight
Infrared Devices	
Infrared TOW Missile Tracker	

Table D-1. Direct-view and electro-optical devices.

- b. **Electro-optical Devices.** A laser attacks a non-see-through optical device by burning the sensor or reticle inside of it, degrading its capabilities. Some of the electrical circuitry inside the device also may be damaged by the heat surge. However, lasers do not affect the operators of non-see-through optical devices.
- c. **Hazards.** Soldiers should be aware of the potential hazards from laser devices, which are currently available in the US Army inventory. Just as a commander plans his unit fires to avoid the hazard of fratricide, he must likewise plan his laser fires.
- (1) Devices most likely to be found near friendly troops are *laser range finders*. Laser range finders are used on the M60A3 and M1 tanks, and they are also used extensively by the artillery. Artillery FISTS all use systems based on laser emitters, either vehicle-mounted or lightweight, hand-carried units. This capability is also found in scout platoons with the GVS-5 laser range finder, and US Air Force and US Navy aircraft carry

laser target designators for aiming precision-guided munitions. Operators of laser firing devices receive extensive training in their safe employment. The devices themselves cannot be activated without deliberate action by the operator.

- (2) While the possibility of an accident is remote, it can happen. A victim might suddenly and unexpectedly move directly into the path of a laser beam and look directly at it, or a laser beam might reflect off a shiny surface and strike a victim in the eyes. To prevent such accidents, operators of laser firing devices must be kept constantly aware of friendly troop locations, and they must positively identify targets before lasing them. They should not fire lasers at reflective surfaces, and, whenever possible, they should give the oral warning, LASING, before activating the laser.
- (3) Conversely, commanders of soldiers operating in areas near friendly lasing must ensure that the commanders of laser-operating units are constantly aware of friendly troop locations. Soldiers should be alerted to the presence of friendly lasers in their areas and given the locations of the lasers if possible. They should be warned not to look in the direction of laser-emitting devices unless specifically told it is safe to do so. When possible, soldiers should wear the ballistic laser protection system (BLPS), which is available through normal supply channels.

WARNING

Using goggles to look through a magnifying optical device may not provide sufficient protection against lasers, depending on the intensity and frequency of the laser.

- d. **Tactical SOP.** The following is a tactical SOP for offensive and defensive operations with DEWs.
 - (1) **Offense.** Soldiers must be protected from the time they cross the LD/LC until combat is over, because they will not know the exact locations of laser range finders and laser designators. Therefore, leaders should—
 - (a) Mount and inspect all filters while in the *assembly area*. Leaders must inspect each soldier's laser goggles to ensure he has them and that they are serviceable. They must review the soldiers' knowledge of laser effects to ensure the soldiers will know when they have been engaged and can take appropriate counteraction. Leaders must also review soldiers' knowledge of the first-aid procedure for treating laser damage to eyes.
 - (b) While in the *attack position*, ensure that all soldiers wear their laser goggles and that gunners keep optical devices covered except during use.

- (c) Ensure that soldiers continue to wear their laser goggles, especially when using direct-view sights during the attack and consolidation.
- (2) **Defense.** A laser is the LOS device most likely to be used first by the enemy during a defensive operation to locate friendly positions. An enemy tank may use a laser on a suspected target before firing its main gun, or an enemy artillery observer may use the laser designator or range finder to control indirect-fire missions. These actions can hurt friendly equipment or soldiers. Therefore, leaders should—
 - (a) Ensure that when a vehicle or soldier moves from a hide position or from a covered and concealed position, all filters, electro-optical devices, and laser goggles are used.
 - (b) Ensure that soldiers open optical protective doors *only* during required observation or engagement of targets. Ensure soldiers use the naked eye to scan the battlefield until target cues such as movement or dust are observed, then use precision optics to identify and engage targets.
 - (c) Ensure that scouts and soldiers in observation posts wear laser goggles full-time, when the commander determines that the risk warrants doing so.
- e. **Soldier Preparation.** The main difference between being wounded by a laser weapon and being wounded by any other type of direct-fire weapon is the absence of noise and detectable signature from a laser weapon. Soldiers should be trained and educated accordingly. They must train using the laser protective equipment and techniques previously discussed. All soldiers should know how lasers affect them. (This information is contained in the laser survivability manual.) First-aid classes should be conducted to prepare soldiers to help DEW casualties. The battlefield is an unnatural and stressful environment where panic is always possible. This can be avoided through proper training, protective measures, and education.
 - (1) Soldiers most at risk from laser energy are those looking through devices with direct-view magnifying optics such as the TOW daysight or military binoculars. The laser energy that enters a direct-view optical device (DVOD) is increased by the square of the magnifying optic; the energy is further multiplied by the light transmission ability of the optic. Table D-1 lists examples of DVODs and electro-optical devices.
 - (2) Several methods can be used to protect against the possible effects of lasers directed against friendly soldiers. One way is to use nondirect-view optical devices such as thermal imagers or NVDs. The laser energy deposited on the screens of the imaging devices can burn out the devices themselves, but the eyes behind them are protected.
 - (3) Other protective measures are like those used against any LOS weapon. Cover and concealment should be used to avoid detection and possible lasing. Also, units should ensure that a minimum of optical surfaces are

presented to the enemy—for example, binoculars not in use should be pointed toward the ground or, if they are laid aside during combat, their lenses should be capped. Antitank and armor direct-view optical and electro-optical sighting devices should be covered when not in use.

- (4) Known and suspected locations of laser devices can be suppressed with artillery, mortars, or direct-fire weapons. Smoke can degrade the effectiveness of many types of lasers. When firing from a defensive position, soldiers should use alternate and supplementary positions to reduce the chance of being detected, suppressed, or destroyed by aimed fire.
- (5) Soldiers operating in an area where the enemy is known or suspected of using lasers should wear sun/wind/dust goggles with the laser filter attached. Commanders should realize that the BLPS filter does reduce contrast and available light for users. They can add a subparagraph to the “Coordinating Instructions” portion of OPORDs similar to that in the “Air Defense Warning Status” to provide soldiers with the best information available about enemy laser capabilities.
- (6) Soldiers should know of the potential hazard from laser devices. Laser range finders are the ones most likely to be used near friendly soldiers. US Air Force and US Navy aircraft may also carry laser target designators, used for aiming precision-guided munitions. To avoid injury to other friendly soldiers, operators of laser-firing devices must positively identify their targets before lasing. Also, lasers should never be fired at reflective surfaces.
- (7) Commanders must ensure that their subordinate units know the locations of any nearby friendly laser-operating units, and vice versa. Soldiers should be warned not to look in the direction of laser-emitting devices unless specifically told that doing so is safe. Each soldier should wear laser safety goggles matched to the wavelength of the friendly lasers.

Section II. TACTICAL IMPLICATIONS

The battalion task force must take precautions to protect itself in a DEW environment. It can do this by planning actions under a possible DEW attack and assuming an appropriate level of laser MOPP should such an attack occur.

D-4. PLANNING CONSIDERATIONS

The battalion task force conducts operations in a DEW environment by including the following in its planning

- a. The S2 identifies possible DEW threats during the IPB process and focuses reconnaissance assets to accurately identify and target those threats.
- b. The S3 incorporates the DEW threat into his operational plan—
 - (1) By integrating DEW countermeasures into the TF operation:
 - (a) Planning indirect suppressive fires on likely or suspected locations.
 - (b) Avoiding open terrain.
 - (c) Operating during conditions of poor visibility (fog, rain).
 - (d) Using obscurants.
 - (2) By advising the commander on the DEW protection level:
 - (a) Minimizing the number of personnel viewing through direct-view devices.
 - (b) Modifying vision blocks and other direct-view devices with tape or canvas to reduce personnel exposure (Figure D-1).
 - (c) Using eye protection equipment.

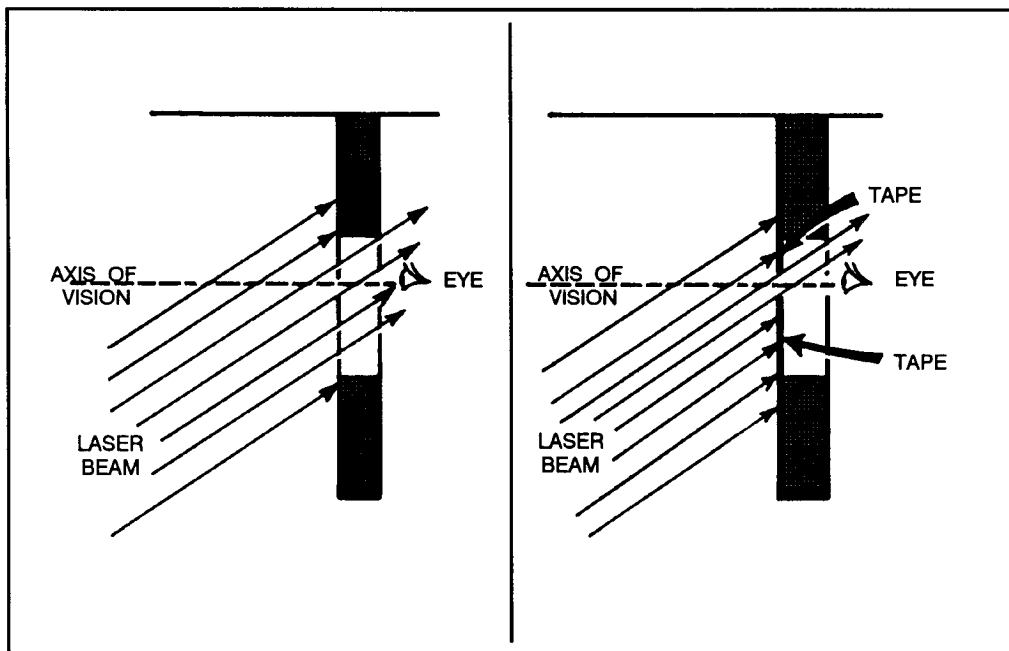


Figure D-1. Tape-on vision blocks.

- (3) By advising attached and OPCON elements of the threat.
- (4) By advising supporting Army aviation and Air Force personnel of the danger.

- c. To reduce the panic that may result from a DEW attack, leaders must ensure that their soldiers know—
 - (1) Laser weapons can cause damage to the human eye ranging from temporary flash-blindness to permanent eye damage.
 - (2) Direct-view devices, optics, and especially magnifying devices, if attacked, pose the greatest danger to personnel (eye injury).
 - (3) Unless both eyes are being used in conjunction with an optical device, only one eye will be susceptible.
 - (4) Individuals might not immediately know the extent of damage, because the time that a person is flash-blinded by the brightness will vary among soldiers.
 - (5) Leaders and key system operators (gunners) are the most susceptible to DEW attack, because they are most likely to be looking out over the battlefield either with or without the aid of optics.

D-5. ACTIONS UNDER DIRECTED-ENERGY WEAPON ATTACK

When a unit comes under attack from DEW, it should—

- Advise higher headquarters of the attack.
- Increase the DEW protection level.
- Suppress the enemy systems.
- Employ obscurants.

D-6. TREATMENT OF LASER INJURIES

Laser eye injuries do not cause death. However, a laser injury can worsen with time, so soldiers with suspected laser injuries must be evaluated immediately and again at regular intervals. Most laser injuries can be treated in the unit or will heal by themselves.

- a. **Symptoms.** After receiving laser eye injuries, soldiers may experience sharp pain, a sudden loss of vision, streaky or spotty vision, or disorientation.
- b. **Corneal Burns.** Laser burns to the cornea (exterior surface of the eye) require eye ointment and an eye patch.
- c. **Retinal Burns.** Laser burns to the retina (interior surface of the eye) do not require an eye patch; in fact, an eye patch reduces the soldier's remaining vision. When internal hemorrhage is suspected, the injured soldier should be positioned with his head up to allow the blood to settle out of his center of vision.

- d. **Psychological Impact.** Because soldiers may not know the extent of their injuries, they are likely to experience shock. The psychological impact of a laser eye injury can be reduced by reassuring the injured soldier that the injury is not life threatening and that treatment is available, and evacuating him rapidly for further evaluation.
- e. **Evacuation.** Except when accompanied by shock or other injuries, laser eye injuries should be treated as routine for evacuation purposes. Sending the eye protection devices worn at the time of injury along with the injured soldier helps medical personnel identify the type of laser used and provides intelligence about threat capabilities (see FM 8-50 and FM 8-55).
 - (1) **Evacuate.** A high-energy laser pulse may severely burn or perforate the cornea. When this occurs, the eye should be protected from further injury—it should not be patched—and the injured soldier should be evacuated to a medical facility. Soldiers seeing large dark spots at or near the center of their vision or large floating objects, experiencing noticeable to severe vision impairment or an accumulation of blood in the eye *must be evacuated* for medical treatment.
 - (2) **Restrict duties, but do not evacuate.** Soldiers who experience little or no visual impairment but who are seeing dark spots in their fields of vision should be restricted to tasks they can perform effectively until they can again perform their normal duties.
 - (3) **Return to duty.** In the absence of other injuries, soldiers who are merely flash-blinded will recover in seconds.

D-7. LASER MISSION-ORIENTED PROTECTIVE POSTURE

The L-MOPP levels shown in Table D-2, page D-10, are based on threat activity and known use of lasers in the area of operations.

- a. The purpose of establishing MOPP levels for a laser threat is not to restrict a commander's actions but to standardize reporting language and an appropriate response. A commander who feels there is a potential laser threat to his soldiers, be it enemy or friendly, would obviously increase his level of responsiveness (understanding that there is the potential for accidental lasing of friendly soldiers from friendly weapons). The L-MOPP levels were intentionally not tied into the current NBC MOPP system. This was done to avoid confusion with an existing system of procedures and since the ballistic laser eye protection system may not be required with NBC protection. Reference to ballistic laser eye protection refers to the mounting of outserts on the mask when wearing NBC overgarments and masks.

MOPP LEVEL	LASER USE	ACTIVITY
L0	No known laser technology. No known use in area of operations. Use of laser technology highly unlikely.	Laser-protective eyewear in close proximity. Laser-protective eyewear properly prepared.
L1	Threat possesses laser technology. Laser-capable delivery systems spotted in area of operations. Use of laser capability possible.	Laser-protective eyewear carried on person and ready for use.
L2	Use of threat/friendly lasers reported in the area of operations. NBC-L reporting system in effect. Use of laser capability probable or highly likely.	Laser protection worn on face at all times.

Table D-2. L-MOPP levels.

- b. The following reflects the addition of a laser-use reporting column to GTA 3-6-3 and inclusion of laser-use reporting. Alphabetical line codes at the left reflect line items for providing required information to higher headquarters and adjacent units.

(1) NBC 1 (observer's report).

LINE	LASER	REMARKS
B	Position of observer.	
C	Direction of attack from observer.	
D	Date-time group for detonation/attack.	
F	Location of area attacked.	
G	Means of delivery system.	State what weapon delivered the laser and what color the laser was, if known.
ZC	Area/point lasing.	State which was used, if known.

(2) NBC 3 Report (immediate warning of expected contamination-laser usage).

LINE	LASER	REMARKS
A	Strike serial number.	
D	Date-time group for start of attack.	
F	Location of probable area of attack.	

(3) NBC 6 Report (information on chemical, biological, or laser attacks).

LINE	LASER	REMARKS
A	Strike serial number.	
D	Date-time group for start of attack.	
F	Location of area attacked.	
G	Means of delivery system.	State what weapon delivered the laser and what color the laser was, if known.
I	Number of persons lased.	
M	Enemy action before and after attack; effect on troops.	
Y	Probable direction that attack is headed.	