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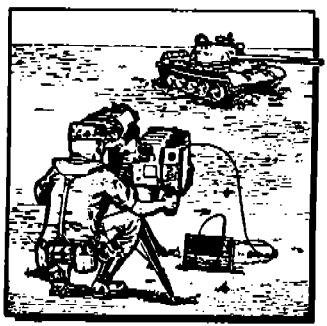
QUESTIONS AND ANSWERS ON LASER DESIGNATOR HAZARDS



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DEPARTMENT OF THE ARMY
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ABERDEEN PROVING GROUND, MARYLAND 21010-5422

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QUESTIONS AND ANSWERS ON LASER DESIGNATOR HAZARDS

1. **BACKGROUND.** This technical guide (TG) summarizes questions and answers on the hazards of ground laser designators (GLD). It was prepared following discussions with personnel within U.S. Army Training and Doctrine Command (TRADOC) who are responsible for developing the training doctrine for designator use.

2. **SCOPE.** The summary is directly applicable to three laser designators:

- AN/TVQ-2, Ground/Vehicle Laser Locator Designator (G/VLLD)
- AN/PAQ-1, Laser Target Designator (LTD)
- AN/PAQ-3, Modular Universal Laser Equipment (MULE)

3. **PURPOSE.** To ensure the use of GLD to their full potential, this TG has been prepared to put to rest unwarranted worries about laser hazards. The GLD add a new dimension to the fire control systems within the Army. They can defeat point targets with precision guided munitions and hand off guidance to airborne laser acquisition systems for added flexibility. This system will allow engagement of targets with fewer rounds of standard ammunition.

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* This TG supersedes USAEHA TG No. 083C, March 1992.

IS THE LASER REALLY SO MUCH MORE HAZARDOUS THAN CONVENTIONAL LIGHT SOURCES?

Yes. Conventional light sources, such as an electric lamp, send their light out in all directions. The light bulb looks like an extended (large) source when viewed directly, and not a brilliant point source as does the laser. Figure 1 shows how laser light can be focused by the eye into a very small spot on the retina.

Compared with viewing a tank searchlight 100 meters (m) in front of a tank, the laser would appear more than 100 million times brighter if it emitted visible light. The searchlight is only slightly less bright than the sun. The searchlight beam at 100 m is about 1/100 watt-per-square-centimeter, whereas the laser beam is about 80,000 watts per-square-centimeter.

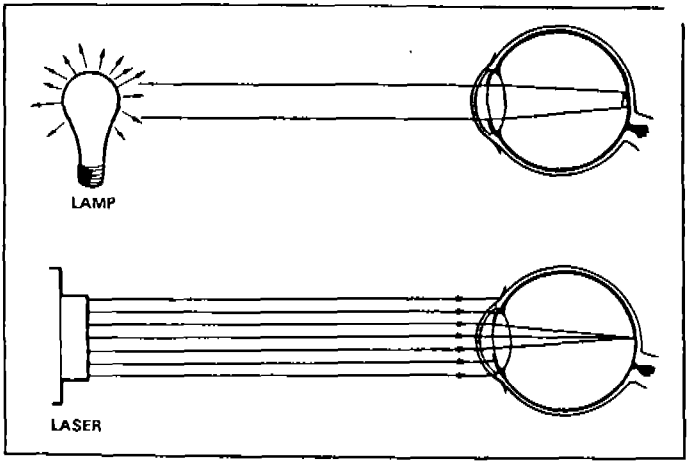

Figure 1. Comparison of Laser with Conventional Light Source

SUPPOSE I REALLY GET IN THE DESIGNATOR BEAM, WHAT CAN HAPPEN TO ME?

This depends on which designator you are exposed to and how far away you are from the laser. For the LTD, if you are unlucky enough to have your eye in the central part of the beam, and IF YOU ARE LOOKING BACK AT A DISTANCE OF 100 m OR LESS, you will incur very serious eye injury in at least one eye. You will have a severe loss of vision for the rest of your life. As your distance from the laser increases, the severity of injury decreases.

- At 1,000 m, there is probably only a 50-50 chance of winding up with a very minimal injury - a tiny black speck in your field of view.
- At still greater distances, the chance of such injury is even less.
- Finally, at 8 kilometers (km), it is permissible to view the beam directly without protection.

Those distances are about the same for the MULE, but should be multiplied by 5 for the G/VLLD.

HOW CLOSE TO THE CENTER OF THE BEAM MUST SOMEONE BE TO GET HURT?

- As the beam leaves the G/VLLD, it is 10 centimeters (cm) (3-to-4 inches) in diameter.
- At 1,000 m, it is about 20 cm (8 inches) in cross-section.
- At 5,000 m, it is about 30 cm (12 inches) across.

Unless a person's eye is within 1 radius of the beam center, there is little chance of injury. If it is raining, it is best to be one arm's length from the beam. Since the laser is invisible, however, eye protection should be worn by individuals located near the target.

IF I AM DOWNRANGE AND THE GLD BEAM IS COMING RIGHT AT ME, CAN I TAKE EVASIVE ACTION?

No. Each laser beam pulse lasts for only 20 billionths of a second. That time is so short that when it is compared with 1 second, 1 second would correspond to about a year and a half. Light traveling at 186,000 miles per second travels only 20 feet in this duration. You simply do not have time to take evasive action from a pulsed laser beam.

HAVE THERE BEEN MANY ACCIDENTS WITH LASERS?

Yes. Although there have not been an extremely large number of laser accidents, there have been several recorded. These accidents occurred due to insufficient training and improper use of the laser equipment. Note that these accidents occurred with hand-held laser rangefinders or designators either before or after the field training commenced or curtailed, not during field training.

ARE REFLECTIONS OF THE LASER BEAM HAZARDOUS?

Only certain surfaces are shiny enough to cause hazardous reflections. These include glass, standing water, and other flat mirror-like surfaces. Follow this rule of thumb: if you can see your reflection by looking at the surface, it is likely to cause a hazardous reflection.

HOW FAR WILL A REFLECTION BE HAZARDOUS?

The reflective hazard distance varies for each piece of equipment and type of surface the beam is reflected from. Refer to operator's manual, USAEHA reports, or DA Pam 385-63, for specific reflective hazard distances for each laser device. Most range control measures require that the beam be terminated at a diffuse backstop located within the controlled range area.

- Hazard distances from specular surfaces can range from several meters for a curved surface to as much as the hazard distance for direct beam viewing, if the laser beam had a large angle of incidence to a flat specular surface (a glancing reflection).

- A mirror-like ("specular") reflection is a significant hazard only if the reflecting surface is flat. Curved surfaces (such as chrome bumpers and wraparound windshields) will spread the beam, and a hazardous condition will only exist within a few meters of these surfaces (Figure 2).

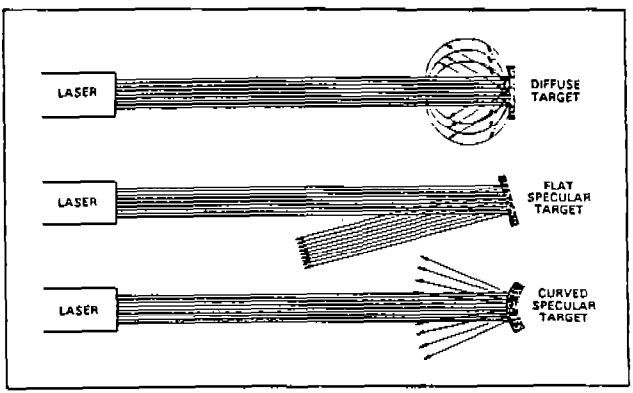

Figure 2. Only Flat, Mirror-Like Surfaces Produce Hazardous Reflections Over Significant Distances

WHAT "MIRROR-LIKE" REFLECTIVE SURFACES SHOULD I WORRY ABOUT OUT IN THE FIELD?

Generally the only surfaces of concern are flat glass surfaces such as view-blocks and windows in target vehicles. Broken glass lying on the ground and pools of standing water (Figure 3) can reflect a fraction of the beam, but always in the downrange direction. To maintain an adequate controlled area, it is good practice to pick up broken glass prior to using the range area and cover special surfaces that cannot be removed.

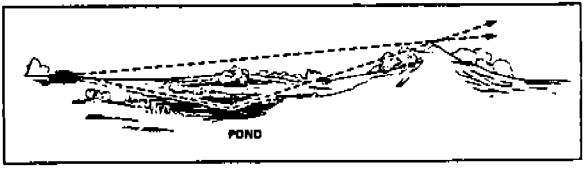

Figure 3. Specular Reflections From Standing Water

ARE REFLECTIONS FROM RAIN, SNOW, SLEET, OR WET LEAVES HAZARDOUS?

We have measured reflections from all of these and found that beyond an arm's length from the beam path these reflections are not hazardous to view.

ARE REFLECTIONS FROM DULL, DIFFUSE, OR LUSTERLESS SURFACES EVER HAZARDOUS?

Not under normal operation conditions, however, some maintenance procedures may call for focusing the beam to a small spot on a diffuse target which will greatly increase the potential hazards.

CAN THE LASER BEAM BE A HAZARD TO THE SKIN?

Not under normal operation conditions, however, some maintenance procedures may call for focusing the beam to a small spot on a diffuse target which will greatly increase the potential hazards.

CAN THE GLD BEAM START A FIRE?

Not under normal operation conditions, however, some maintenance procedures may call for focusing the beam to a small spot on a diffuse target which will greatly increase the potential hazards.

WHO NEEDS LASER SAFETY GOGGLES?

Usually only personnel downrange who could be in the laser beam or buffer zone need laser eye protection. If the range is cleared of exposed flat glass, no hazardous reflections could come back to the vehicle crew or to anyone at the firing line; hence, these personnel do not require eye protection.

WHERE CAN WE GET LASER SAFETY GOGGLES?

At the present time standardized anti-laser goggles are being developed for general use. Until the time these goggles become available, eye protection should be procured commercially. Assistance in this procedure can be obtained by contacting USAEHA.

In general, laser safety goggles are not considered necessary for routine training and testing of laser designators. Protection for personnel involved in special two-sided tactical exercises and for downrange personnel operating moving targets requires the use of standard laser eye protection which offers a high optical density.

DO OPTICAL SIGHTS INCREASE THE LASER HAZARD; AND WHY DO SOME SIGHTS HAVE LASER SAFETY FILTERS?

Yes, the hazard of looking into a direct beam (called "intrabeam viewing") is greatly increased when you are using a pair of binoculars, a battery commander's (BC) scope, or a telescopic sight in an armored vehicle. In effect, the viewer is placed closer to the laser by a factor of the magnifying power of the sight. As an example, if you are at 1,000 m from the laser, the hazard to your eye when looking through an 8X scope is equivalent to the unaided eye located only 1/8 that distance, 125 m, from the source.

Since hard-point targets, such as armored vehicles or fixed bunkers, are the targets of fire-control lasers, the personnel using the optical instruments at these targets have a high probability of hazardous exposure. They need protection and, fortunately, modern technology permits the use of lighter color filters in sights than in personnel safety goggles. Therefore, the filters that can be built into the sights do not significantly reduce your visual ability to see targets. Operator's manuals or USAEHA reports for a device will state whether your optics has filters.

DO GREEN LASER SAFETY GOGGLES IMPAIR YOUR VISION?

Yes, to some extent. The primary difficulty in developing a standard laser-protective goggle has been the determination of how much reduced red color vision could be acceptable in a combat environment. We have learned, however, that after you have worn the green laser-protective goggles for several minutes, your eyes adjust to permit more normal vision. The red-sensitive visual cells in your retina become more sensitive, thus partially compensating for the reduction of red light by the filters.

CAN WE USE SUNGLASSES FOR LASER PROTECTION?

ABSOLUTELY NOT. Sunglasses reduce the laser light entering your eye only by 50-75 percent. Goggles suitable for protection from a GLD should have an optical density of 4 which is a 0.01-percent transmission at the laser wavelength. On the other hand, the laser eye protection may transmit more total light of other colors than sunglasses. Polarizing glasses are also of little or no value as laser eye protection.

CAN WE USE GLD IN TWO-SIDED TACTICAL EXERCISES?

The headaches are many, but it is possible if all exposed personnel are equipped with laser eye protection and the maneuver site is not within line-of-sight of any uncontrolled area that can be occupied.

IS THERE REALLY ANY HAZARD TO PEOPLE IN A TOWN MORE THAN A DISTANCE EQUAL TO THE HAZARD RANGE AWAY FROM THE LASER FIRING POSITION?

No. However, at one time consideration was given to the premise, if the laser is aimed in the general direction of the built-up area, one must always be concerned about the outside chance of someone in the town looking out toward the range with binoculars. Since binoculars extend the hazardous range, the thought was that there is no such thing as an absolutely safe distance from the laser. This is why laser range areas are selected for the presence of backstops. Recently this type of thinking has been replaced with the idea that the probability of someone viewing the range with magnifying optics is so remote that there is no reason for concern.

MUST WE HAVE A MOUNTAIN OR HILL AS A BACKSTOP?

Anything opaque to light can serve as a backstop. A line of dense trees is suitable if you cannot see through them.

IS SKYLINE LASER OPERATION PERMITTED?

Yes, the laser can be aimed at a target on the skyline (no vertical buffer zone) if the nautical airspace downrange is restricted over the range area to a distance of 17 km for the G/VLLD, and about 12 km for the MULE and LTD.

IS IT POSSIBLE FOR TRAINING PURPOSES TO FILTER OR OTHERWISE REDUCE THE OUTPUT ENERGY OF THE GLD FOR THE PURPOSE OF SHORTENING THE HAZARDOUS DISTANCE?

Yes, the use of filters will decrease the hazard distance. Ranging can still be accomplished for short distances, however, using the device as a designator cannot. A relatively long hazard distance will still exist for someone using an optical device along the beam path, therefore, adequate backstops are still necessary.

I HAVE TO SET UP A LASER RANGE SAFETY FAN FOR THE G/VLLD, BUT CANNOT FIND THE APPROPRIATE BUFFER ZONE IN ANY MANUALS. WHAT DO I USE?

The tripod mounted G/VLLD is considered a stable platform due to its tripod arrangement, consequently 2 mil is an adequate buffer. A good rule of thumb is: if it can be easily dislodged, use a 5 mil buffer zone. If it is stable (i.e., cannot be easily dislodged from pointing downrange, and has a small pointing error), then 2 mil can be used. A hand-held laser designator, due to its inherent instability, requires a 10 mil buffer area. If there is any doubt, use a 10 mil buffer zone until you can get confirmation of the smaller buffer zone being adequate.

WHO NEEDS A LASER EYE EXAMINATION?

An individual whose occupation or assignment may result in a significant risk of exposure to potentially hazardous levels of optical radiation shall have a preplacement medical examination, a termination of employment medical examination, and be included in an occupational vision program. These personnel would include individuals routinely using lasers in research, development, test and evaluation, and maintenance facilities.

However, personnel who are known or suspected to have been accidentally exposed to levels in excess of applicable laser protection standards shall be examined as soon as possible following such exposure. GLD operators normally would not require a laser eye exam.

WHAT ARE THE SOURCE DOCUMENTS ON LASER HAZARDS; AND WHERE CAN WE GET FURTHER INFORMATION?

The source documents are:

- TB MED 524, Control of Hazards to Health from Laser Radiation, 20 June 1985.
- AR 40-46, Control of Health Hazards from Lasers and Other High Intensity Optical Sources, 6 February 1974.
- AR 40-5, Preventive Medicine, 15 October 1990.
- DA Pam 385-63, Policies and Procedures for Firing Ammunition for Training, Target Practice, and Combat.

Additional information can be obtained by contacting Laser Microwave Division, USAEHA, Aberdeen Proving Ground, MD 21010.

- DSN 584-3932/2331
- Commercial (410) 671-3932/2331

ARE LASER TRAINING DEVICES HAZARDOUS?

It depends upon which laser training devices you are referring to. For example:

- The MILES equipment is safe for field use.
- The M-55 training device is not hazardous for incidental exposures in the pulsed mode and can only be considered marginally hazardous in the alignment mode for brief exposures where the laser transmits continuously. The precautions are to avoid exposure, and do not look into the alignment beam.

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