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Training Manual (TRAMAN)

Electronics Technician

Volume 9–Electro-Optics

0502LP4776400

Although the words "he," "him," and "his" are used sparingly in this manual to enhance communication, they are not intended to be gender driven nor to affront or discriminate against anyone reading this text.

Naval Education And Training Program Management Support Activity

ELECTRONICS TECHNICIAN

VOLUME 9
ELECTRO-OPTICS

NAVEDTRA 12419

1993 Edition Prepared by
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PREFACE

This training manual (TRAMAN), *Electronics Technician, Volume 9, Electro-Optics,* NAVEDTRA 12419, and its companion nonresident training course (NRTC), NAVEDTRA 82419, are part of a planned 9-part series of TRAMANs intended to provide Navy enlisted personnel with information pertinent to their assignments and necessary for advancement to the Electronics Technician Second Class rate. The nine volumes planned for the series areas follows: Volume 1, *Safety;* Volume 2, *Administration;* Volume 3, *Communication Systems;* Volume 4, *Radar Systems;* Volume 5, *Navigation Systems;* Volume 6, *Digital Data Systems;* Volume 7, *Antennas and Wave Propagation;* Volume *8, System Concepts;* Volume *9, Electro-Optics.*

Designed for individual study instead of formal classroom instruction, the TRAMANs provide subject matter that relates directly to the Occupational Standards for the Electronics Technician Second Class. The Navy Electricity and Electronics Training Series (NEETS) modules provide information that is basic to your understanding of the material presented in these volumes. To avoid repeating such basic information, these volumes refer you to the appropriate NEETS modules and EIMB handbook. You may also be directed to review or study additional references commonly found in ET workspaces or used by Electronics Technicians. You should study the referenced publications as thoroughly as you would if they were repeated as part of the ET2 TRAMAN. The NRTCs, printed under separate cover, consist of supporting questions designed to help you study the associated TRAMAN and referenced publications and to satisfy part of the requirements for advancement.

This training manual and the nonresident training course were prepared by the Naval Education and Training Program Management Support Activity for the Chief of Naval Education and Training.

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THE UNITED STATES NAVY

GUARDIAN OF OUR COUNTRY

The United States Navy is responsible for maintaining control of the sea and is a ready force on watch at home and overseas, capable of strong action to preserve the peace or of instant offensive action to win in war.

It is upon the maintenance of this control that our country's glorious future depends; the United States Navy exists to make it so.

WE SERVE WITH HONOR

Tradition, valor, and victory are the Navy's heritage from the past. To these may be added dedication, discipline, and vigilance as the watchwords of the present and the future.

At home or on distant stations as we serve with pride, confident in the respect of our country, our shipmates, and our families.

Our responsibilities sober us; our adversities strengthen us.

Service to God and Country is our special privilege. We serve with honor.

THE FUTURE OF THE NAVY

The Navy will always employ new weapons, new techniques, and greater power to protect and defend the United States on the sea, under the sea, and in the air.

Now and in the future, control of the sea gives the United States her greatest advantage for the maintenance of peace and for victory in war.

Mobility, surprise, dispersal, and offensive power are the keynotes of the new Navy. The roots of the Navy lie in a strong belief in the future, in continued dedication to our tasks, and in reflection on our heritage from the past.

Never have our opportunities and our responsibilities been greater.

CONTENTS

SUMMARY OF THE ELECTRONICS TECHNICIAN TRAINING SERIES

This series of training manuals was developed to replace the *Electronics Technician 3 & 2* TRAMAN. The content is directed toward personnel working toward advancement to Electronics Technician Second Class.

The nine volumes in the series are based on major topic areas with which the ET2 should be familiar. Volume 1, *Safety,* provides an introduction to general safety as it relates to the ET rating. It also provides both general and specific information on electronic tag-out procedures, man-aloft procedures, hazardous materials (i.e., solvents, batteries, and vacuum tubes), and radiation hazards. Volume 2, *Administration,* discusses COSAL updates, 3-M documentation, supply paperwork, and other associated administrative topics. Volume 3, *Communication Systems,* provides a basic introduction to shipboard and shore-based communication systems. Systems covered include man-pac radios (i.e., PRC-104, PSC-3) in the hf, vhf, uhf, SATCOM, and shf ranges. Also provided is an introduction to the Communications Link Interoperability System (CLIPS). Volume 4, *Radar Systems,* is a basic introduction to air search, surface search, ground controlled approach, and carrier controlled approach radar systems. Volume 5, *Navigation Systems,* is a basic introduction to navigation systems, such as OMEGA, SATNAV, TACAN, and man-pac systems. Volume 6, *Digital Data Systems,* is a basic introduction to digital data systems and includes discussions about SNAP II, laptop computers, and desktop computers. Volume 7, *Antennas and Wave Propagation,* is an introduction to wave propagation, as it pertains to Electronics Technicians, and shipboard and shore-based antennas. Volume 8, *System Concepts,* discusses system interfaces, troubleshooting, sub-systems, dry air, cooling, and power systems. Volume 9, *Electro-Optics,* is an introduction to night vision equipment, lasers, thermal imaging, and fiber optics.

CHAPTER 1

INTRODUCTION TO NIGHT VISION EQUIPMENT

Throughout the history of wars, the cover of darkness has provided a tactical advantage for one force or the other. In this chapter, we will begin with a brief explanation of how the human eye "sees" during daytime and nighttime. We will then introduce and explain the various devices used in today's military to enhance the night vision capabilities of military personnel.

THE HUMAN EYE

The primary components of the eye that control day vision and night vision are the *rods* and the *cones,* found in the retina. The retina translates light energy, absorbed by the rods and cones, into nerve impulses to be carried to the brain by the optic nerve. The brain then converts the nerve impulses into images.

The eyes of some animals that hunt at night and sleep in the daytime (such as the opossum) have retinas composed almost entirely of rods; other animals that sleep in the nighttime (such as most birds) have retinas composed almost entirely of cones.

The human eye has a retina composed of both rods and cones.

CONES

The primary factor in both color vision and acute daytime vision is the cones. During the day, the eye tends to rotate, to center the image nearer to the area of the retina where the cones are most concentrated.

The center three degrees of the retina is made up entirely of cones. This area is called the fovea.

RODS

The rods, being very sensitive to low illumination levels, control night vision. At night, the eye switches from cone vision to rod vision and becomes color blind. Since only rods can adjust to the low-light levels available at night, the center three degrees of solid cones becomes a blind spot in the center of the field of view.

The average field of view for the human eye is about 80 degrees vertical by 170 degrees horizontal.

OFF-CENTER VISION

To compensate for the blind spot in the center of the field of view, an observer should use off-center vision. Off-center vision involves looking off to the side of the object of interest, scanning its periphery using short three-second movements. Three seconds allows the rods adequate stimulation time. In the dark, extra stimulation time is needed for the rods to gather sufficient information to form visual images.

DARK ADAPTATION

The cones and rods are turned on and off by the secretion of photosensitive pigments called iodopsin and rhodopsin.

Cones adapt (secrete iodopsin) very quickly to high-light levels. However, the rods require several minutes to adjust (secrete rhodopsin) to low-light levels. In extremely dark situations, the normal eye may require up to 40 minutes to become fully dark-adapted.

Now that we have discussed how the human eye reacts to different light levels, let's move on to electro-optical devices.

HISTORICAL BACKGROUND

Early efforts to remove the cover of darkness included the use of torches, brush fires, flares, and rockets. During World War I, formal research work was begun in the realm of night vision, but those efforts were limited to developing and refining searchlight illumination.

Research by an electronics company in the 1930's led to development of an image tube that could be used to convert infrared images to visible displays. The military significance of this quickly became apparent. Further development led to the production of a small arms unit—the "Sniperscope."

Use of the sniperscope involved pointing the device toward some sound heard in the darkness, switching on the power supply, and scanning the forward area until the source of the sound was located or determined. Infrared rays, visible only to the operator, were projected over the sighting area. The reflected rays, picked up by the electronic telescope, were converted to a visible image and magnified according to the power of the telescope. Sighted objects appeared in varying shades of green, regardless of their daylight color. Researchers chose the color green because green light stimulates the cones without shutting down the rods. This enables the person using the night scope to look at a relatively bright picture without losing any night vision.

Night vision capabilities proved to be particularly effective in combatting enemy infiltration tactics conducted during periods of darkness. However, a major problem with the use of infrared instruments was that the user could be readily spotted by a foe who also was using infrared instruments or detection equipment. To combat this problem, researchers developed passive devices, devices that only received light from a source and amplified that light to produce a picture on a screen. In the following sections, we will discuss both active and passive devices that are in use today.

ELECTRO-OPTICAL DEVICES

All electro-optical devices use some source of power to produce an image of an object through illumination, amplification, or thermal imaging. These devices contain electronic components as well as electro-optical components such as light emitting diodes, image intensifier tubes, and lasers. Examples of such devices are night vision goggles and rifle sights, laser range finders, markers and designators, and forward looking infrared receivers.

The night vision department of the Naval Surface Warfare Center, located in Crane, Indiana, is the central point of contact for all electro-optical equipment used in the Navy.

BATTERIES FOR NIGHT VISION EQUIPMENT

Every night vision device uses a battery to produce image intensification. The battery supplies voltage that accelerates electrons across an image intensifier tube. Various types of batteries are used in Navy and Marine Corps night vision equipment.

Alkaline batteries are inexpensive and readily available. However, their service life is the shortest of all the battery types.

Mercury batteries were used as power sources in earlier night vision equipment but, due to ecological problems, are now being removed from service.

Nickel-cadmium batteries are used primarily for training since they require down time while recharging.

Lithium batteries provide the longest service life at temperatures above 15 degrees Fahrenheit. Because of high performance, this type of battery is used when possible. These batteries must be approved by the Navy Lithium Safety Review Board before approval for service use.

Figure 1-1 shows batteries commonly used in night vision instruments.

Beginning at the upper left and going clockwise;

1. BA-1100/U Mercury Battery (6.5 volts)
2. TD-100A NiCd Battery Pack (14.0 volts)
3. BA-3058/U “AA” Alkaline Battery (1.5 volts)
4. BA-1567/U Mercury Battery (2.7 volts)
5. BA-5567/U Lithium Battery (3.0 volts)
6. BA-1312/U Mercury Battery (1.3 volts)

HAND-HELD NIGHT VISION SIGHTS

Hand-held sights are small, lightweight devices that are used for signaling or map reading.

AN/PAS-6 Metascope

The metascope, illustrated in figure 1-2, is a small hand-held device used as an aid in detecting infrared sources. The metascope has an attachable infrared light source (active) that can be used for signaling. With the light source attached, the metascope can be used for map reading.

The metascope weighs 2.5 pound. It has a range of 1 mile for signaling purposes and 12 inches for map reading. Its receiver is powered by a 4.3 vdc battery and its light source is powered by two “AA” alkaline batteries. The field of view is 26 degrees and the battery life is estimated at 40 hours at a temperature of 23 degrees Celsius. This unit is being replaced by the Nite-Eye Pocketscope.

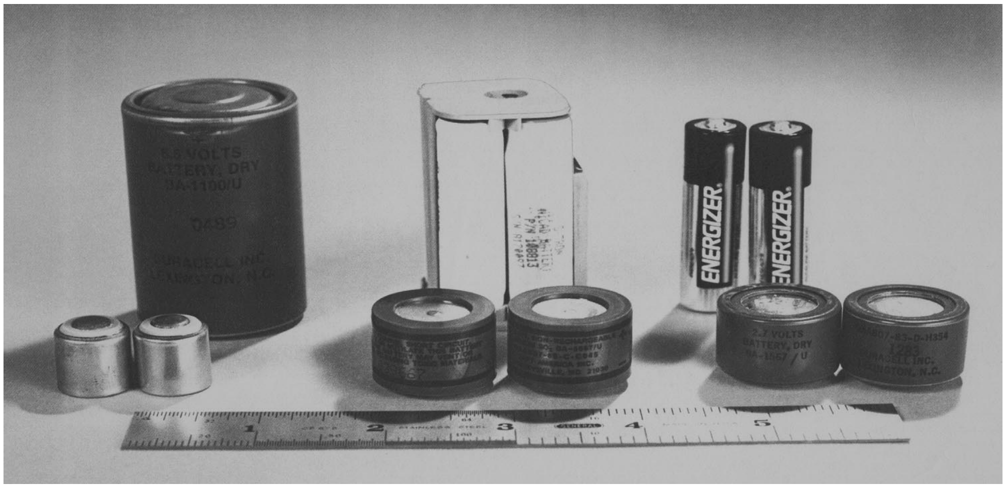

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Figure 1-1.—Batteries for night vision equipment.

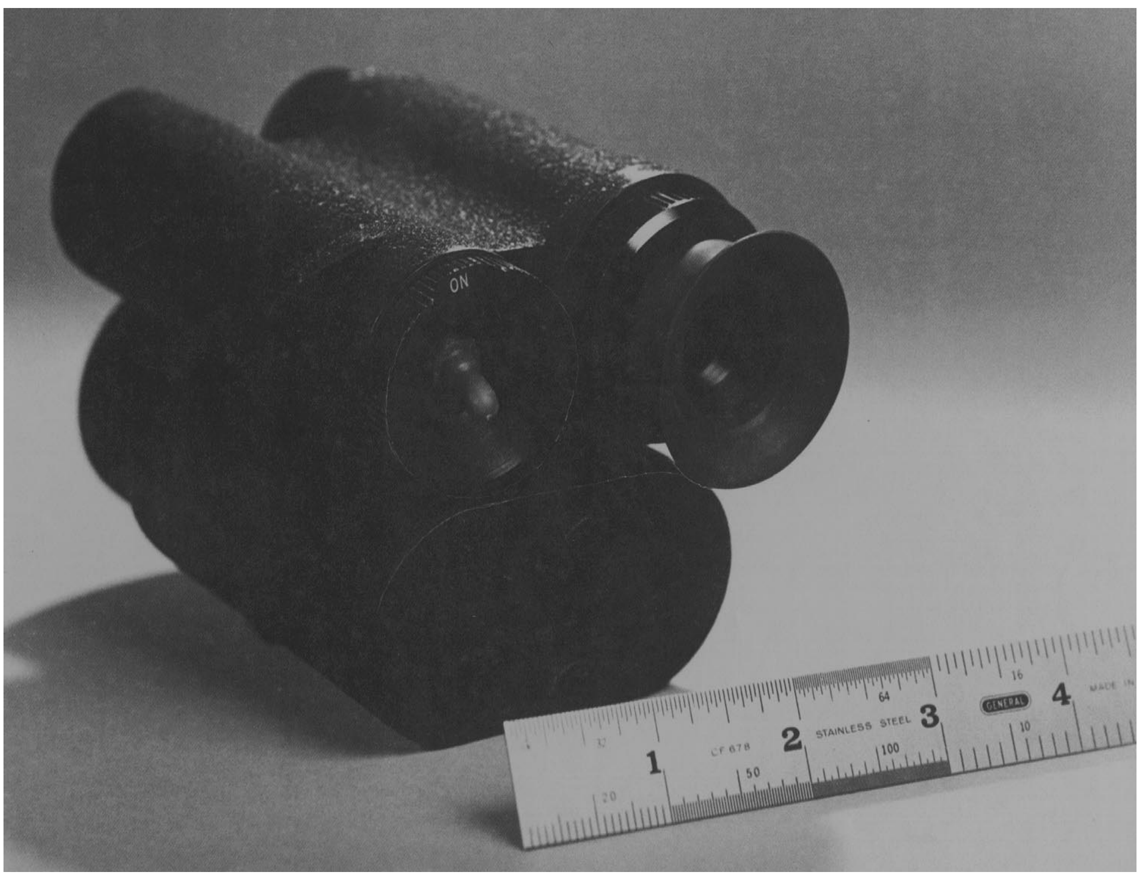

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Figure 1-2.—AN/PAS-6 metascope.

Nite-Eye Pocketscope

The pocketscope, illustrated in figure 1-3, is similar to the metascope; however, the infrared light source is built into the main body of the unit.

This pocketscope weighs 15 ounces and uses two “AA” alkaline batteries as a power source. Its range is 100 to 200 yards for man-sized targets, with a 40-degree field of view.

CREW-SERVED SIGHTS

Crew-served sights provide improved night observation and aimed fire of weapons by using available light from the night sky.

MK37 Night Vision Sight (NVS)

The MK37 NVS, illustrated in figure 1-4, is bracket mounted on the ship’s signal bridge. It is used for navigational purposes, for fire control, and to identify long-range objects.

The MK37 weighs 34 pounds and has a range of 2200 yards with a 9-degree field of view. It can be powered by either a BA 1100 6.8 vdc mercury battery or a 115 vac-to-6.8 vdc shipboard power converter. Battery life is estimated to be 72 hours. This unit will be replaced through attrition by a long-range night vision sight.

AN/TVS-5 Weapons Night Vision Sight (NVS)

The AN/TVS-5, illustrated in figure 1-5, is used mainly for aimed fire of weapons. It can be used with the M2, M60, and M85 machine guns, M40 recoilless rifle, M139 20mm cannon, and the MK19 40mm automatic grenade launcher.

The AN/TVS-5 has a range of 100 to 1200 yards for vehicle-sized targets and a 9-degree field of view. It weighs 8 pounds and is powered by two BA 5567 lithium batteries. The life of the batteries is estimated to be 12 hours at 23 degrees Celsius. The AN/TVS-5 is used by the fleet and Naval Special Warfare units.

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Figure 1-3.—Pocketscope.

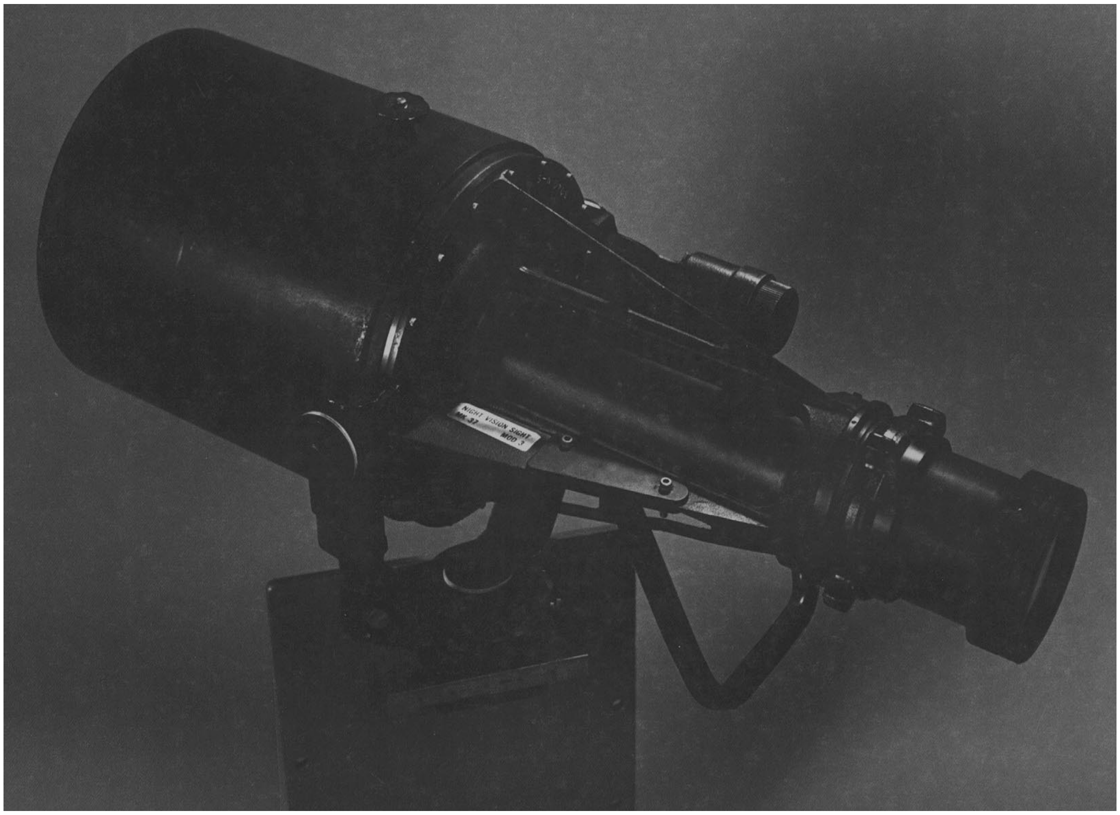

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Figure 1-4.—MK37 night vision sight

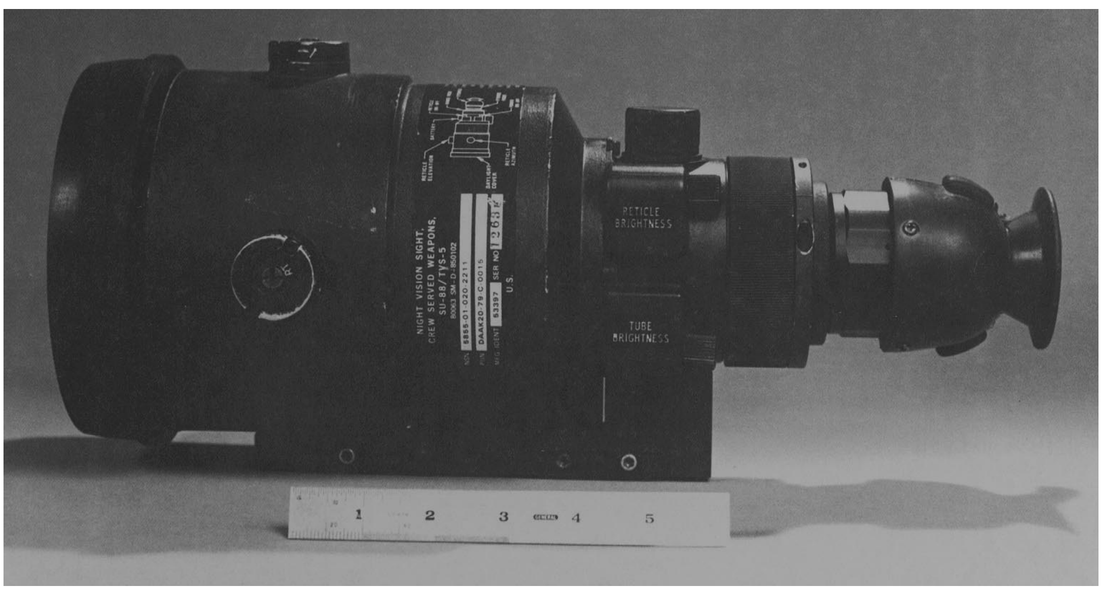

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Figure 1-5.—AN/TVS-5 weapons night vision sight.

INDIVIDUAL-SERVED SIGHTS

Individual-served sights also provide improved night observation and aimed fire of weapons by using available light from the night sky. The primary difference between these sights and crew-served sights is that these sights are mainly mounted on hand-held weapons.

AN/PVS-4 Weapons Night Vision Sight (NVS)

The AN/PVS-4, illustrated in figure 1-6, can be used with the M14 and M16 rifles, M60 machine gun, M79 grenade launcher, and M16 with the M203 grenade launcher.

This sight is powered by two BA 5567 lithium batteries with an estimated life of 12 hours at 23 degrees Celsius. Its range is 400 to 600 yards for man-sized targets, with a 14.5-degree field of view. The AN/PVS-4 is used by both fleet and Naval Special Warfare units.

M921 Submersible Night Vision Sight (NVS)

The M921, illustrated in figure 1-7, is a submersible-sight for use on the 5.56mm and the 7.62mm weapons and for general observation. This system provides a high resolution, intensified image for effective viewing and aiming. The submersible design provides watertight protection to a depth of 50 meters and salt water corrosion resistance for missions requiring underwater transport.

The M921 has a range of 300 to 500 yards for man-sized targets and a 13-degree field of view. It weighs 4.6 pounds and is powered by either a BA 1567 mercury battery or a BA 5567 lithium battery.

Aquila Night Vision Sight (NVS)

The Aquila sight, illustrated in figure 1-8, is used with most 5.56mm and 7.62mm weapons. This system was procured by Naval Special Warfare as a replacement for the AN/PVS-4. The Aquila sight offers better performance, lighter weight, and improved accuracy.

The Aquila weighs 2.7 pounds and has a range of 400 to 800 yards, with an 8.3-degree field of view. It is powered by two BA 3058 “AA” alkaline batteries with an estimated life of 40 hours at 23 degrees Celsius.

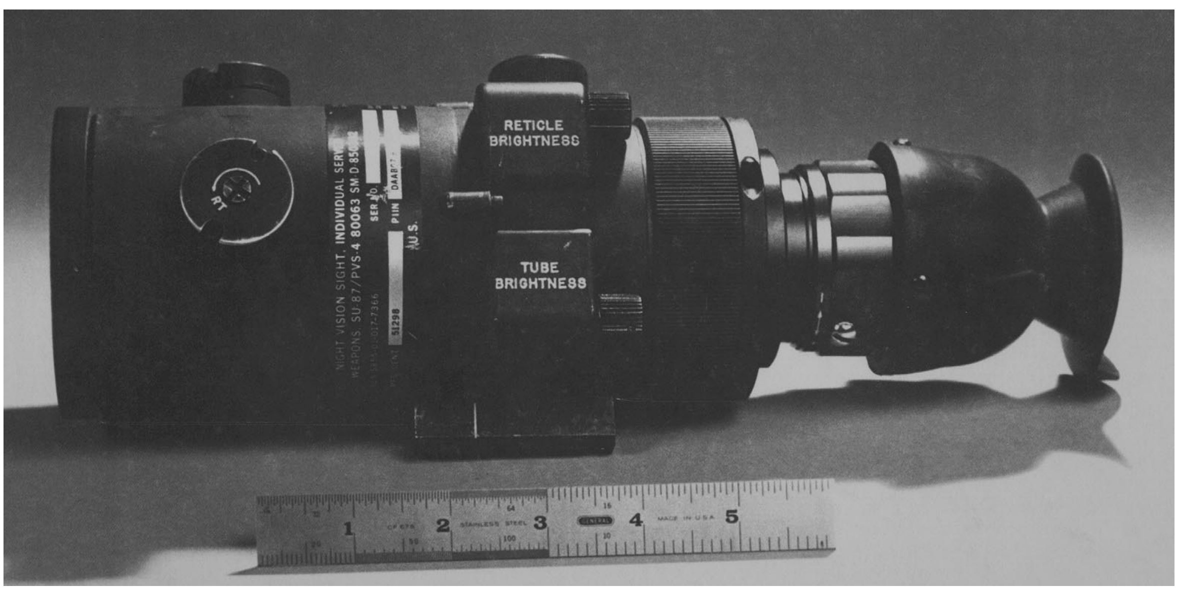

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Figure 1-6.—An/PVS-4 weapons night vision sight.

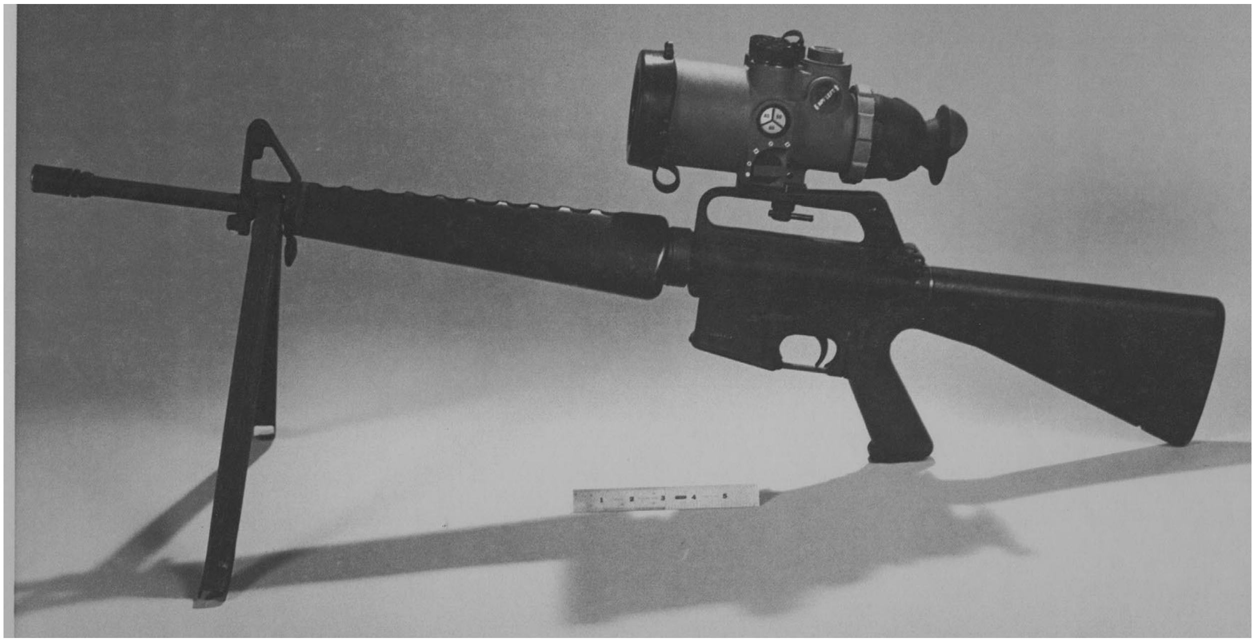

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Figure 1-7.—M921 submersible night vision sight.

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Figure 1-8.—Aquila night vision sight.

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Figure 1-9.—KN200 night vision sight.

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Figure 1-10.—AN/PVS-5C night vision goggle.

KN200 Night Vision Sight (NVS)

The KN200 NVS, illustrated in figure 1-9, is a lightweight sight adapted by Naval Special Warfare forces for use with a 10X day scope. It may also be used with currently fielded laser range finders.

The KN200 has a 10-degree field of view and a range of 400 to 800 yards. It can be powered by either two BA 3058 “AA” alkaline batteries or two “C” alkaline batteries.

NIGHT VISION GOGGLE (NVG)

The night vision goggle (NVG) allows the user to perform tasks such as reading, patrolling, walking, short-range observation, and mobile equipment operation. It can also be used with laser aiming devices for off-hand shooting.

AN/PVS-5C NVG

The AN/PVS-5C, illustrated in figure 1-10, is the latest in the PVS-5 series. It is fairly lightweight and is held to the user’s face by rubber straps. Instructions for donning the NVG are permanently mounted on the side of the unit.

The AN/PVS-5C has a range of 200 to 300 yards for man-sized targets, a 40-degree field of view, and is powered by a BA 5567 lithium battery or two BA 3058 “AA” alkaline batteries.
The AN/PVS-5C NVG is scheduled to be replaced by a new configuration, the AN/PVS-5D.

AN/AVS-6 NVG

The AN/AVS-6, illustrated in figure 1-11, is an Aviator’s Night Vision System (ANVIS) providing the user with improved night vision. This unit enables the user to pilot rotary wing aircraft or to drive high-speed ground vehicles.

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Figure 1-11.—AN/AVS-6 NVG, ANVIS

The AVS-6 has a 40-degree field of view. However, since its range is only approximately 200 feet, pilots use the sight only for low-level observation, up to 200 feet AGL. It can be powered by either two BA 5567 lithium batteries or adapted aircraft power.

Catseye NVG

Figure 1-12 illustrates the Catseye NVG. This sight is used in fixed wing military aircraft as a pilot aid during nighttime operations. The image intensifier assemblies are mounted above the pilot's line of sight so they do not interfere with forward vision. In this sight, the intensified image is superimposed on the "real world" image. This allows the pilot to see both the intensified image of the scene outside the cockpit and the cockpit displays simultaneously.

The Catseye weighs only 1.7 pounds. It has a 30-degree field of view and, like the AVS-6, is limited to a range of 200 feet. It is powered by two "AA" lithium batteries.

AN/PVS-7A NVG

The AN/PVS-7A, shown in figure 1-13, is used in the fleet for short-range observation and chart reading. It has a monocular design, which results in lower system weight.

The PVS-7A has a range of 200 to 350 yards and a 40-degree field of view. It can be powered by either

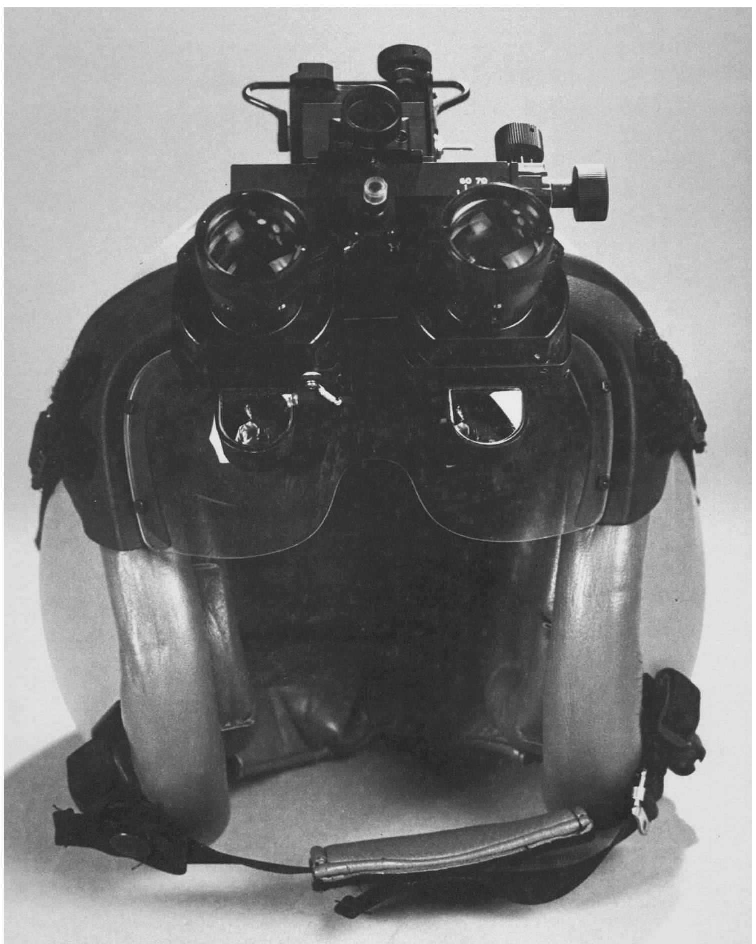

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Figure 1-12.—Catseye NVG.

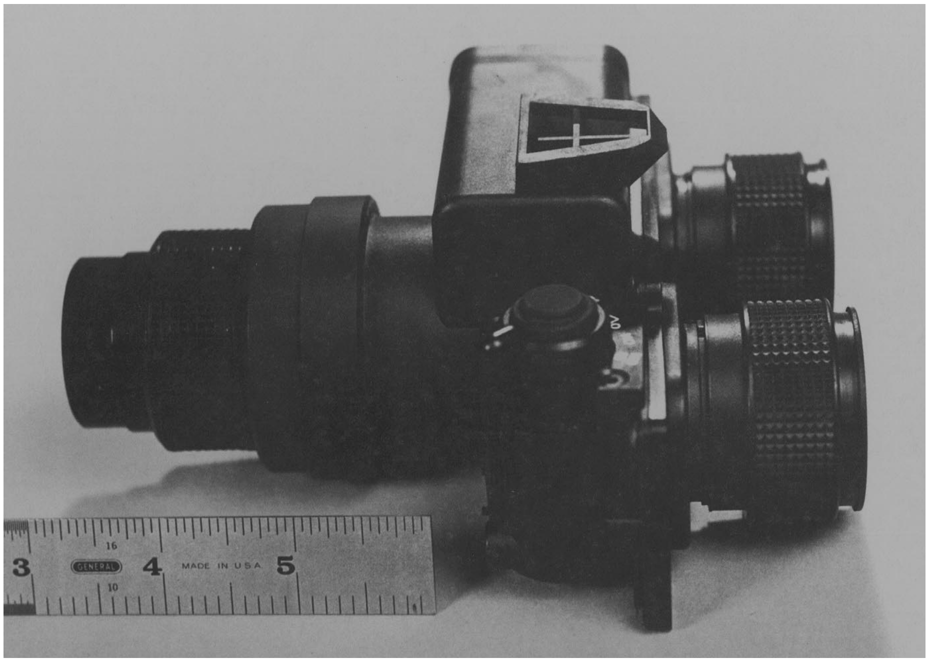

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Figure 1-13.—AN/PVS-7A NVG.

a BA 5567 lithium battery or two BA 3058 “AA” alkaline batteries.

MAINTENANCE

Most maintenance on night vision equipment is preventive maintenance only (i.e., clean and inspect) and can be completed with little to no problems. Corrective maintenance is primarily limited to the depot level. Therefore, if you experience a minor problem with night vision equipment, you must sent it to the Naval Surface Warfare Center, Crane, Indiana, for repair.

Throughout this chapter, we have introduced night vision devices that are in use in the Navy today. This area of technology is continually expanding. As it does, your knowledge of this area should also grow.

The next chapter will introduce you to laser systems and the safety precaution needed for their use.

CHAPTER 2

INTRODUCTION TO LASERS

The word *laser* is an acronym for Light Amplification by Stimulated Emission of Radiation. The first lasers were used for surveying applications, as they gave an accurate measurement of distance. As the technology increased, laser systems were adapted for military applications. The initial application was for gunfire control. Today, lasers are used in the military for range finding, target designation, communications, target detection, and landing systems, and training aids. In the civilian community, lasers are used in the medical field and for welding, cutting, surveying, and communications.

CHARACTERISTICS OF A LASER

A simplified illustration of a typical solid-state laser is shown in figure 2-1. The elements of the laser are:

- Lasing material (crystal, gas, etc.)
- Pump source (flash lamp, electron collision, etc.)
- Optical cavity
- Laser radiation

Lasers operate on the principle of stimulated emission. Electrons in the atoms of the lasing material reside in a steady-state. When energy is added to an atom, an unstable condition occurs when its electrons are excited to a higher energy level. The electrons will stay in this state for a short time and then decay back to their original energy state. This decay occurs in two ways:

1. Spontaneous decay—the electrons simply fall to their ground state while emitting randomly directed photons; and
2. Stimulated decay—the photons from spontaneous decaying electrons strike other excited electrons, which causes them to fall to their ground state.

This transition through stimulated decay will release energy in the form of photons of light that travel in phase and in the same direction as the incident photon. If the direction is parallel to the optical axis, the emitted photons will travel back and forth in the optical cavity, through the lasing material, between the 100-percent reflecting mirror and the 99-percent reflecting mirror. The light energy is amplified each time the beam passes through the lasing material. When sufficient energy is built up in the beam, a burst of light will be transmitted through the 99-percent reflecting mirror. This action is called lasing.

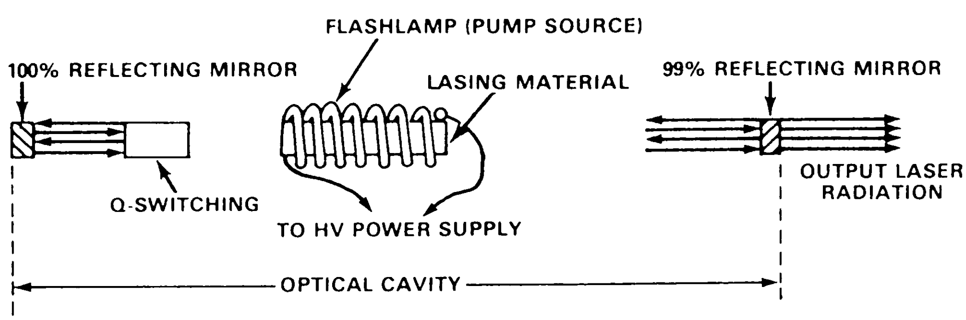

Figure 2-1.—Typical solid-state laser configuration.

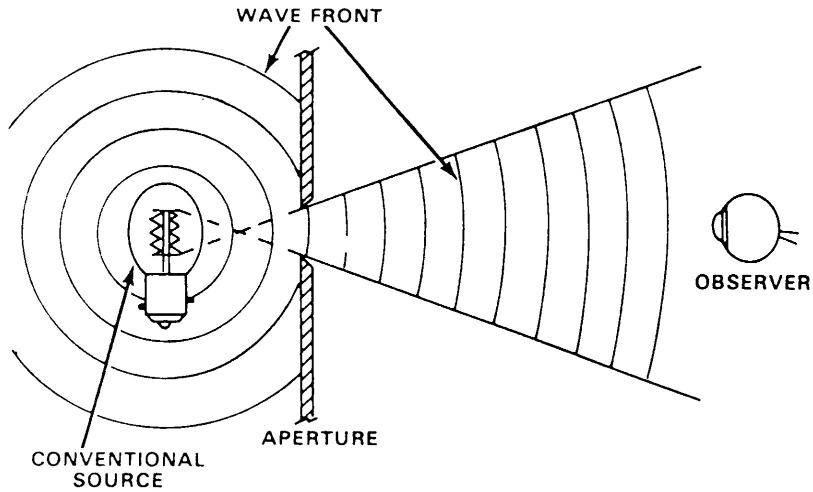

Figure 2-2.-Divergence of a conventional light source.

Light from a conventional light source spreads rapidly, as illustrated in figure 2-2. The intensity may be large at the source, but it decreases rapidly as the distance from the source increases. In contrast, the output of the laser, shown in figure 2-3, has a very small divergence and the beam intensity at reasonable distances is almost the same as the intensity at the source. Therefore, relatively low-power lasers project more energy at a single wavelength within a narrow beam than do much more powerful conventional light sources.

CHARACTERISTICS OF REFLECTIVE MATERIALS

Material will either reflect, absorb, or transmit light rays. Reflection of light is best illustrated by a mirror. When light rays strike a mirror, almost all of the energy will be reflected. Figure 2-4 shows how a ray of light is redirected as it strikes a plastic or glass surface. The sum of the energy transmitted, absorbed, and reflected will equal the amount of energy that strikes the surface.

A surface is considered to be *specular* if the size of the surface imperfections and variations are much smaller than the wavelength of the striking optical radiation. When the imperfections are randomly oriented and are much larger than the wavelength, the surface is considered to be *diffuse.*

Specular Reflection

A flat specular surface will not change the divergence of the striking beam of light significantly.

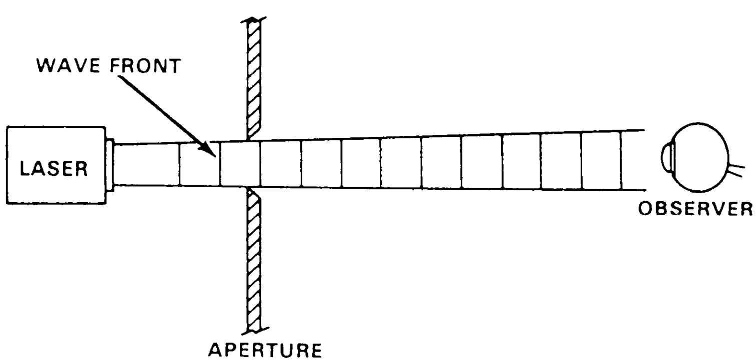

Figure 2-3.—Divergence of a laser source.

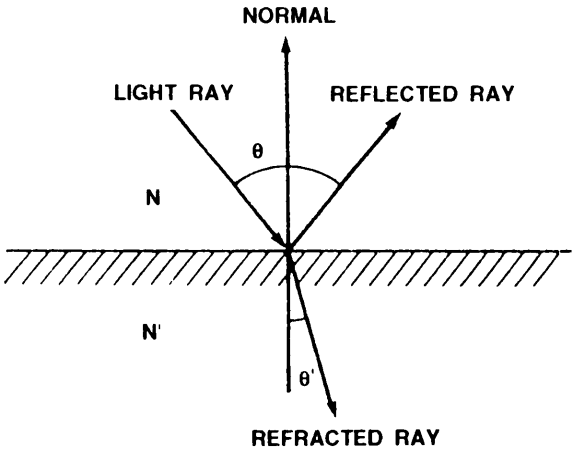

Figure 2-4.—Light ray striking a glass surface.

However, curved specular surfaces may change the divergence. The amount that the divergence is changed depends on the curvature of the surface and the size of the beam striking the surface. Figure 2-5 illustrates these two surfaces and how they will reflect a laser beam striking them. (Note: The divergence and curvature of the reflector have been exaggerated to better illustrate the effect.)

Diffuse Reflection

A diffuse surface will reflect the striking laser beam in all directions. The beam path is not maintained when a laser beam strikes a diffuse reflector.

Whether a surface acts as a diffuse or specular reflector depends on the wavelength of the striking laser beam. A surface that would be a diffuse reflector for a visible laser beam might be a specular reflector for an infrared laser beam.

As opposed to specular reflectors, various curvatures of diffuse reflectors have little effect on the reflected beam (figure 2-6).

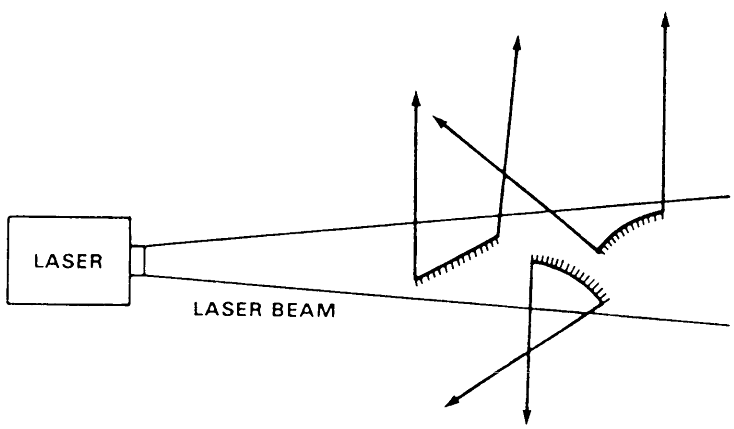

Figure 2-5.—Specular reflection.

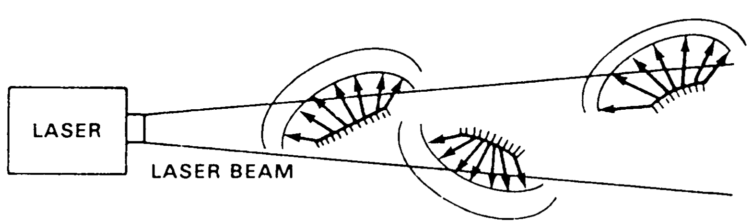

Figure 2-6.—Diffuse reflections.

LASER CLASSIFICATION

As lasers became more numerous and more widely used, the need to warn users of laser hazards became apparent. To meet this need, laser classifications were established. Current classification levels vary from optically safe, requiring no controls (Class 1) to very hazardous, requiring strict controls (Class 4).

CLASS 1

A Class 1 laser or laser system emits levels of optical energy that are eye-safe and consequently require no controls. An example of this class of laser system is the checkout scanning device found in most grocery stores.

CLASS 2 AND CLASS 3A

Class 2 and Class 3A lasers emit visible, continuous-wave (CW) optical radiation levels slightly above the maximum permissible exposure (MPE) level. Although these lasers can cause eye damage, their brightness usually causes observers to look away or blink before eye damage occurs. These lasers have strict administrative controls requiring placement of signs warning personnel not to stare directly into the beam (figure 2-7).

WARNING

Class 3A lasers must not be viewed with optically-aided devices.

CLASS 3B

Class 3B lasers, and Class 3A lasers with outputs of 2.5mW, are hazardous to personnel who are within the beam path and look at the beam source directly or by specular reflection. These lasers cannot produce hazardous diffuse reflections.

Personnel working with these lasers should wear appropriate protective eyewear during any operation of the laser. Class 3B lasers have both administrative and physical controls to protect personnel. Physical controls include limited access work areas. Administrative controls include special warning signs posted outside the entrances to the laser work spaces and lights outside the entrances that warn personnel when the lasers are in use. Figure 2-8 illustrates a laser maintenance area warning sign.

CLASS 4

Class 4 lasers are high-power lasers that will cause damage to unprotected eyes and skin through intra-beam viewing and specular or diffuse reflections. Consequently, no personnel should be in a room where a Class 4 laser is operating without

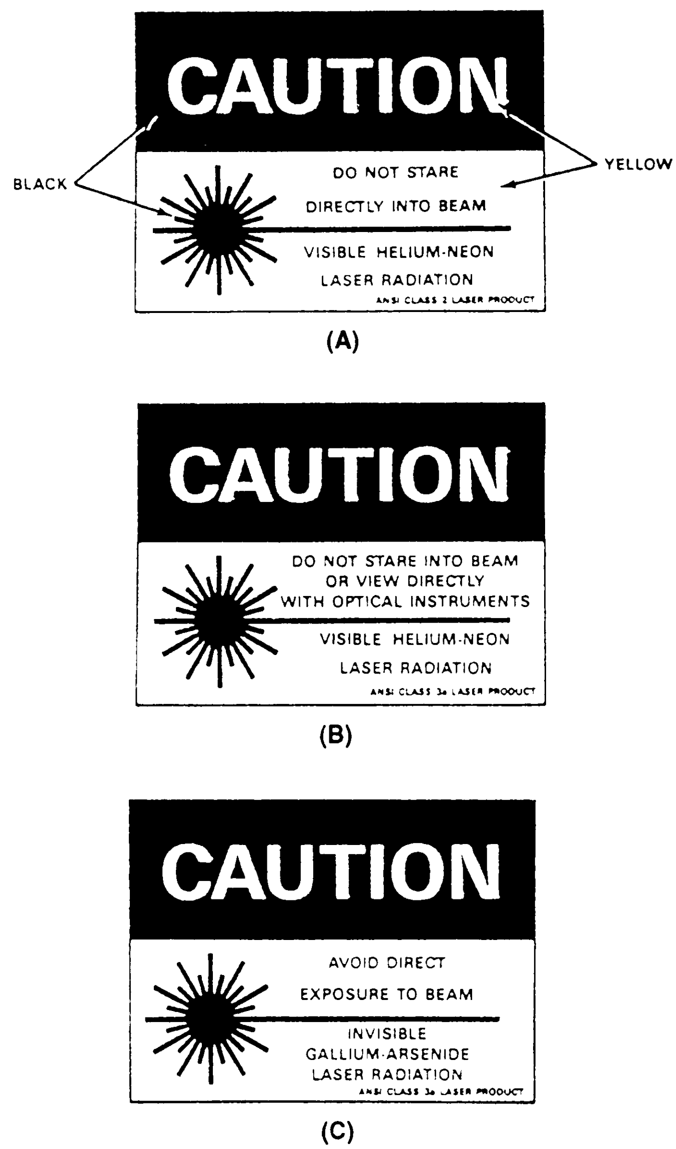

Figure 2-7.—Examples of laser warning labels: A. Class 2; B. Class 3A visible and near infrared; C. Class 3A infrared and ultraviolet.

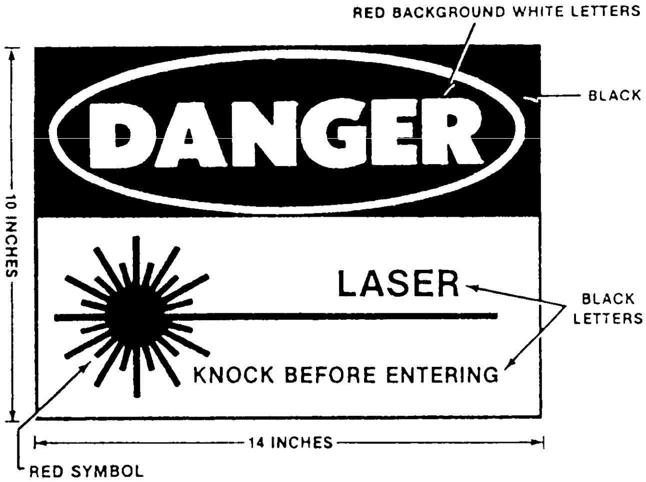

Figure 2-8.—Laser maintenance area warning sign.

appropriate laser-protective eyewear and appropriate clothing. Other controls include the use of warning lights, signs stating the danger involved, and the control measures provided for Class 3B lasers.

Figure 2-9 illustrates warning labels for Class 3B and Class 4 lasers.

LASER EQUIPMENT

In the following paragraphs we will discuss a few of the types of laser equipment found in the Navy today. There are three categories of laser equipment: markers/designators, pointers/aiming devices, and rangefinders. This equipment is used for target designation, aimed firing, and target ranging, thereby enhancing our tactical ability.

MARKERS/DESIGNATORS

Markers are used to mark objects as targets for laser-guided weapons. Designators are used to designate an object in a cluster of objects as a target for laser-guided weapons.

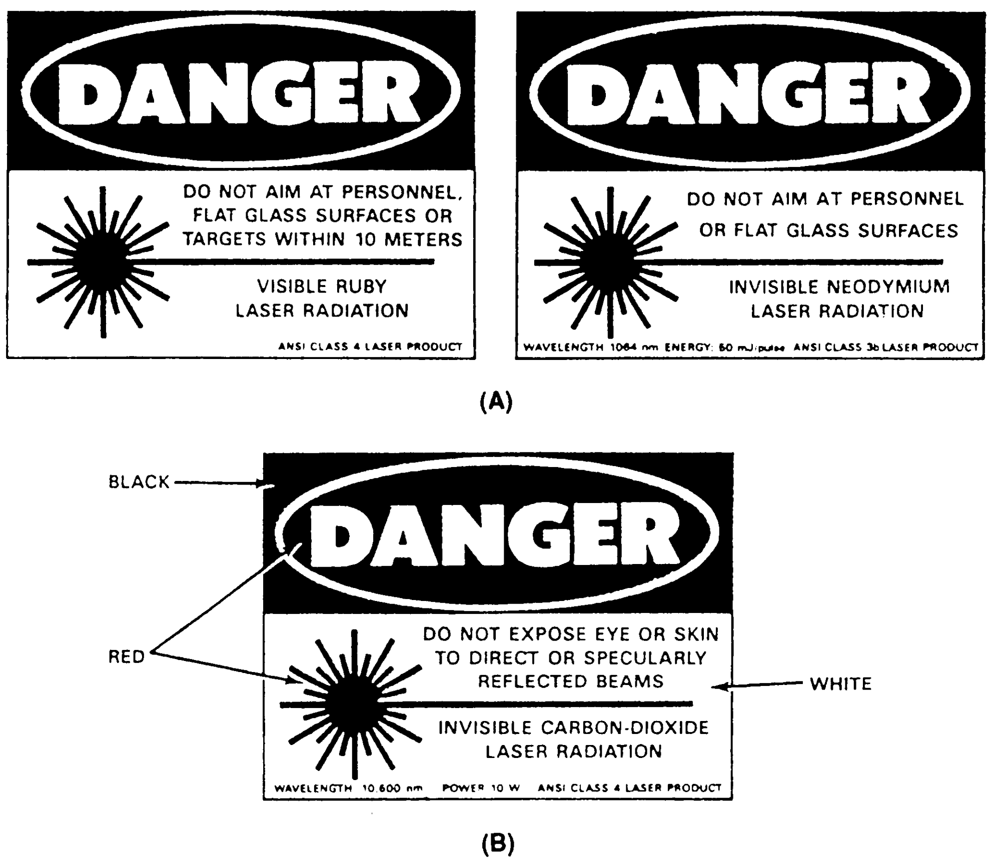

Figure 2-9.—Examples of laser warning labels: A. Class 3B and Class 4 visible and near infrared; and B. Class 3B and Class 4 infrared and ultraviolet.

LTM86 Compact Laser Designator (CLD)

The LTM86 CLD, illustrated in figure 2-10, is a man-portable unit used to obtain a close estimate of range to a target or to designate a target for laser guided munitions.

The CLD is a Class 4 laser with a 7-degree field of view and a range of 5 kilometers when used as a designator, and 50 meters to 10 kilometers when used as a rangefinder. It can be powered by either a lead acid mission battery or a nickel-cadmium training battery. Safety eyewear must have an optical density (OD) with a rating of 4.5 at a wavelength of 1064 nano-meters.

Special Operations Forces Laser Marker (SOFLAM)

The SOFLAM, illustrated in figure 2-11, is a compact, lightweight, man-portable unit that is used to obtain a close estimate of range to a target or to designate a target for laser-guided munitions. This unit has provisions for tripod mounting and remote operation and can directly accept a night vision sight for 24-hour observation.

The SOFLAM is a Class 4 laser that has a 5.6-degree field of view and a range of 5 kilometers as a designator and 200 meters to 10 kilometers as a rangefinder. It weighs 9.1 pounds and is powered by a either BA 5590 lithium battery, a BB 590 rechargeable battery, or 28-volt vehicular power. The safety eyewear must have an OD of 4 at a wavelength of 1064 nano-meters.

POINTERS/AIMING DEVICES

These devices are used for aimed firing of hand-carried weapons. They will produce a splash of light at the point of impact for the weapon's projectile.

TD-100A Laser Target Designator (Aiming Device)

The TD-100A, illustrated in figure 2-12, is a self-contained battery-powered optical sighting/laser aiming device designed for mounting on the M12A1 rifle or the MP5 9MM submachine gun. A red spot

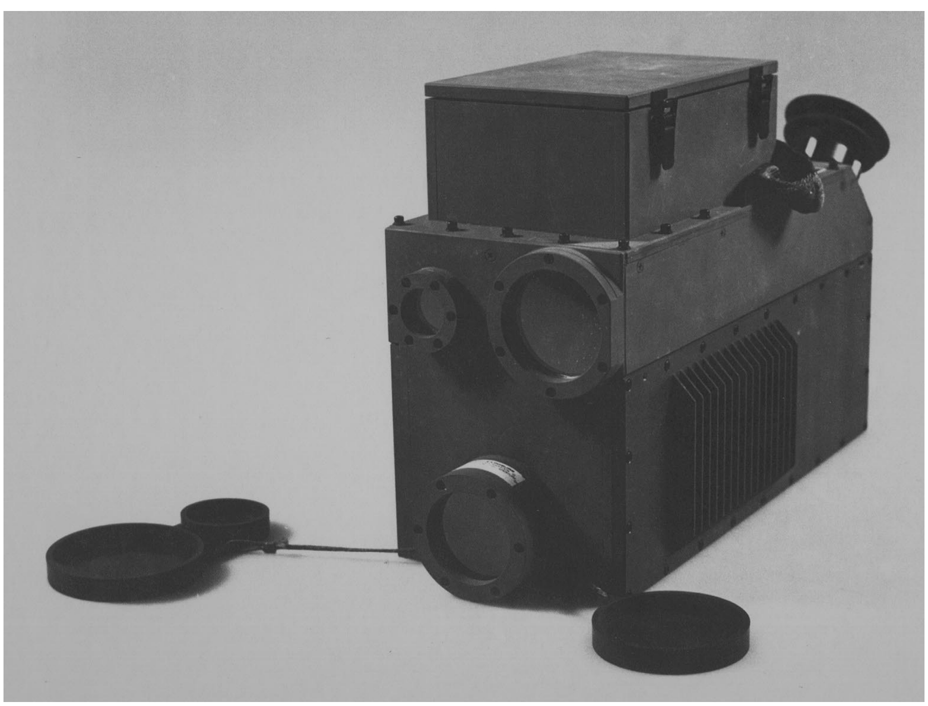

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Figure 2-10.—LTM86 CLD.

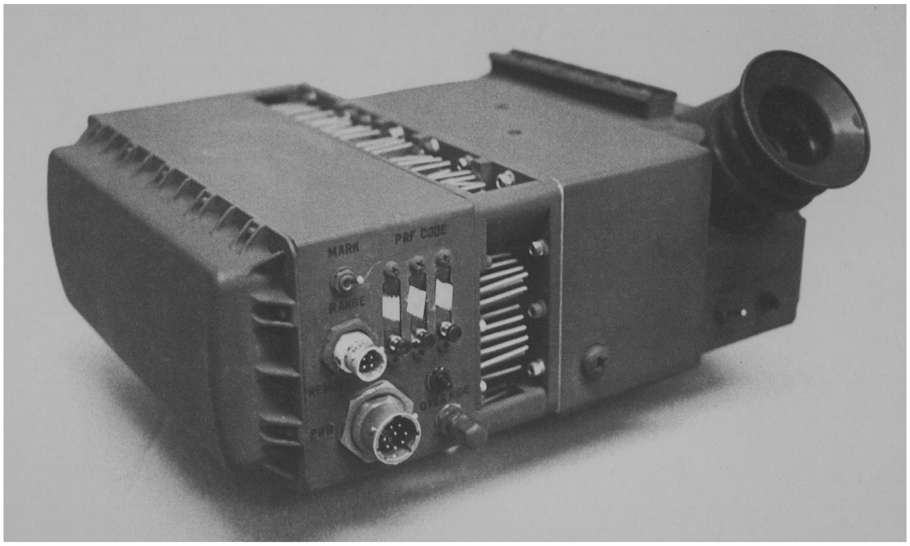

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Figure 2-11.—SOFLAM.

(visible mode) or an infrared pulsed spot (IR mode) indicates the impact point of a round fired from a TD-100A-equipped weapon.

The TD-100A is a Class 3B laser device with a range of 50 yards in the visible mode and 300 yards in the infrared mode. It is powered by a nickel-cadmium battery pack or an alkaline battery pack, and weighs 1.55 pounds. Safety eyewear must have an OD of 1 at a wavelength or 670 nano-meters for the visible mode and an OD of 1 at a wavelength or 850 nano-meters for the infrared mode.

NOTE

Night vision equipment is required for infrared use of this device.

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Figure 2-12.—TD-100A mounted on an MP5 9MM submachine gun.

AIM-1DLR Laser Aiming Device

The AIM-1DLR, illustrated in figure 2-13, is a weapon-mountable aiming device with an adjustable-intensity beam used as a long range pointer. This unit can operate with any type of night vision system.

This unit is a Class 3B laser with a range of 3000 meters and weighs only 9 ounces. It is powered by two BA 3058 “AA” alkaline batteries. Safety eyewear for this unit must have an OD of 1.67 at a wavelength of 840 nano-meters. The note preceding this section also applies to the AIM-1DLR.

RANGEFINDERS

Rangefinders are devices that are used to find a close estimate of the distance to a target quickly.

AN/PVS-X Miniature Laser Range Finder (MLRF)

The AN/PVS-X, illustrated in figure 2-14, is a small, man-portable, lightweight, hand-held unit used to obtain a close estimate of the range to a target.

The AN/PVS-X MLRF is a Class 3B laser that weighs 2.5 pounds and has a range of 50 meters to 10 kilometers, with a 7-degree field of view. It can be powered by either four BA 5567 lithium or four BA 1567 Mercury or a battery pack containing eight BA 3058 “AA” alkaline batteries. Safety eyewear for this unit must have an OD of 3.7 at a wavelength of 1064 nano-meters.

M931 Ranging Night Scope (RNS)

The M931 RNS, illustrated in figure 2-15, is a man-portable, lightweight, hand-held or tripod-mounted laser device. It is used to obtain a close estimate of range to a target under starlit or moonlit conditions. The M931 is a Class 3B laser with a 13.6-degree field of view and a range of 1 kilometer. It weighs 2.9 pounds and is powered by four “AA” 3.5-volt lithium batteries. Safety eyewear for the M931 must have an OD of 1 at a wavelength of 830 nano-meters.

THERMAL IMAGING

Thermal imaging is a process by which heat emissions (infrared energy) are converted to visible light. Thermal imaging devices detect and display changes in the heat emissions of objects.

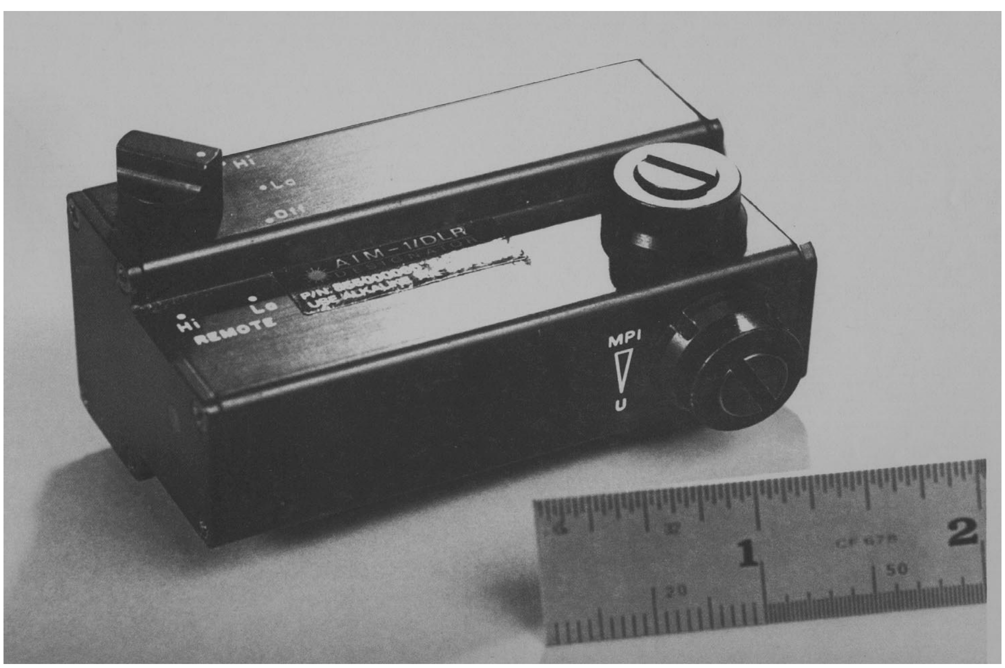

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Figure 2-13.—AIM-1DLR laser aiming device.

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Figure 2-14.—AN/PVS-X MLRF.

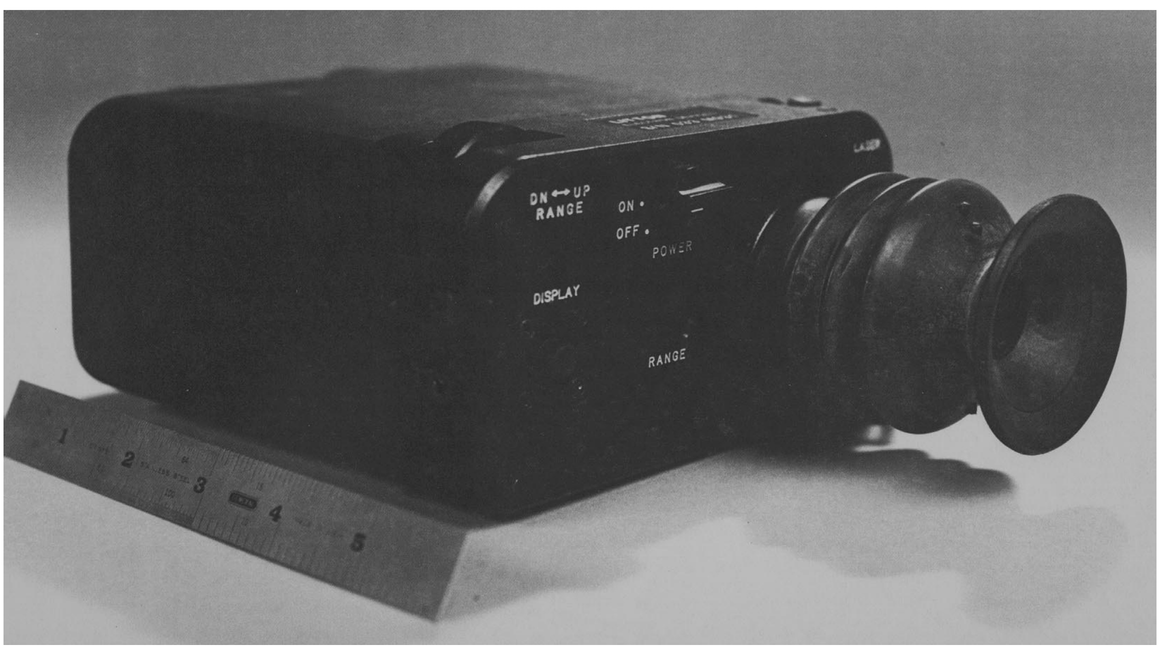

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Figure 2-15.—M931 RNS.

AN/KAS-1 CHEMICAL WARFARE DIRECTIONAL DETECTOR (CWDD)

The AN/KAS-1 CWDD illustrated in figure 2-16 is a passive device, two fields of view, forward-looking infrared system used by the Navy for standoff detection of nerve agents. The unit can be bracket-mounted on a ship's signal bridge or tripod mounted. It is used: (1) as a chemical warfare advance warning system and (2) for surveillance and navigation and search and rescue operations during hours of darkness, periods of limited light visibility, and during daylight operations.

The AN/KAS-1 weighs approximately 27 pounds and has a range of 3200 yards. It is powered by 115 volts ac, 60 hertz at 36 watts. Its field of view is 3.4 X 6.8-degrees wide and 1.1 X 2.2-degrees narrow.

MAINTENANCE

Most maintenance on laser equipment is preventive maintenance only (i.e., clean and inspect) and can be completed with little-to-no problems. Correc-tive maintenance is primarily limited to the depot level. Therefore, if you experience a major problem with laser equipment, you must send it to the Naval Surface Warfare Center, Crane, Indiana, for repair.

Throughout this chapter, we have introduced laser devices that are in use in the Navy today. This area of technology is continually expanding. As it does, your knowledge of this area should also grow.

This volume has introduced you to a small amount of the night vision equipment and laser devices that are used in today's Navy. Remember to follow all safety precautions when using these equipments. Your eyes cannot be replaced.

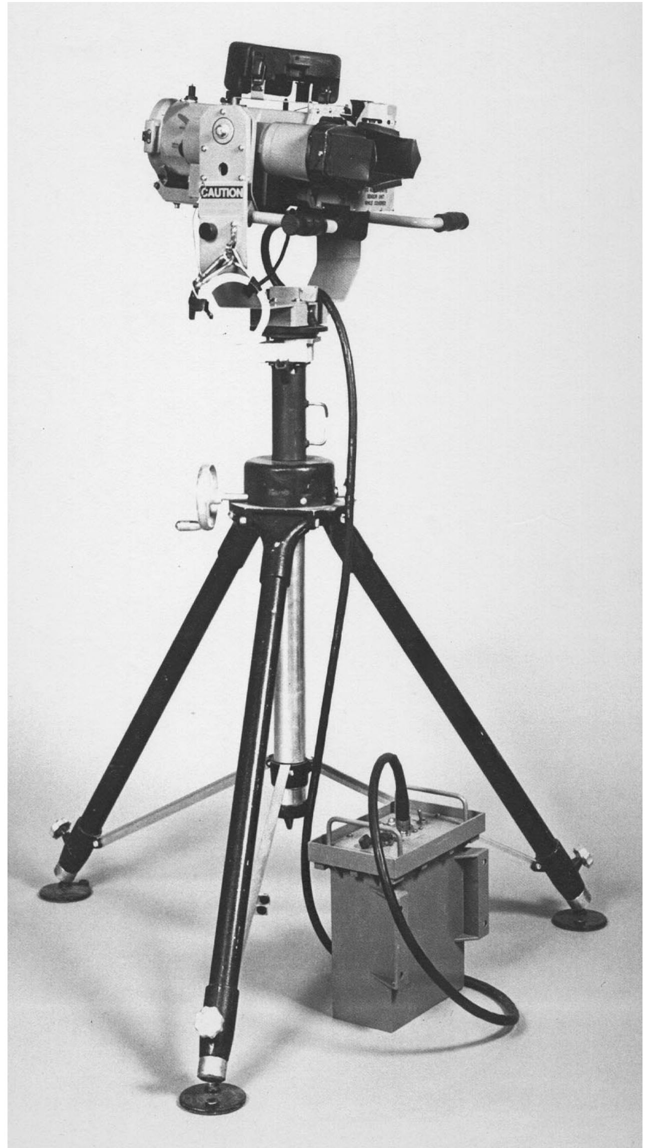

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Figure 2-16.—AN/KAS-1 CWDD tripod-mounted.

APPENDIX I

REFERENCES USED TO DEVELOP THE TRAMAN

General Information, Naval Surface Warfare Center, Code 805, Crane, Ind., 1993.

Technical Manual, LASER Safety, E0410-BA-GYD-010\7034 LASER, Space and Naval Warfare Systems Command, Washington, D.C., August 1988.

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