A-1. INTRODUCTION
Modern battles are fought and won by a combination of air, land, and naval forces working together. As the complexity of the battlefield increases, we, as a nation, have turned to developing technology to help us meet the challenges we face. One of the most promising of the new technologies is the development of laser systems to increase our capability. (Laser stands for light amplification by stimulated emission of radiation.)

a. Laser Use on the Battlefield. The use of laser technology on the battlefield has developed in three primary areas: laser target ranging and designation systems, laser acquisition systems, and laser-guided munitions (LGMs).

(1) Laser target ranging and designation systems provide accurate directional distance and vertical angle information for use in locating enemy targets. These systems may vary from hand-held to aircraft-mounted devices, but they all perform the same basic function. Once a target has been selected and accurately located, the laser designation capability is used to identify the specific target for laser-guided munitions.

(2) Laser acquisition devices are used to acquire reflected laser energy. These devices are used in conjunction with laser designation systems to pinpoint targets or other specific items. Normally, laser acquisition devices are mounted on fixed-wing aircraft or helicopters.

(3) Laser-guided munitions home in on reflected laser energy during the terminal portion of the attack to accurately hit the specific target. Such munitions are part of the precision guided munition (PGM) family.

b. Requirements. Three basic requirements for using laser designators with laser acquisition devices or laser-guided munitions are discussed below.

(1) The PRF code of the laser designator and the laser acquisition device or LGM must be the same.

(2) An agreed-upon direction of attack is necessary. The laser acquisition device or LGM must be able to "sense" the reflected energy from the laser designation device.

(3) The laser designator must be lasing or designating the target at the correct time.

c. Value. The value of laser devices and LGMs has been recognized by all branches of the armed services. Each service has developed laser systems to meet its own particular needs. The proliferation of laser devices has already resulted in the development of service-specific procedures and international standardization agreements [STANAGs and/or QSTAGs]. To achieve our goal of fighting together efficiently, we must use procedures to which all services have agreed. These procedures are still being developed. This appendix gives information on the use of the Army’s primary laser systems and a brief description of those of other services.

A-2. GROUND/VEHICULAR LASER LOCATOR DESIGNATOR

a. Description. The G/VLLD is the Army’s long-range designator for precision guided semiactive laser weapons. It is two-man portable for short distances and can be mounted on the M981 FIST vehicle. The G/VLLD gives the observer accurate OT distance, vertical angle, and azimuth data. Accurate azimuth information depends on initial orientation of the G/VLLD. All three items of information are shown in the eyepiece display.

(1) The laser designator places coded laser energy on stationary or moving targets. Reflected coded laser energy provides guidance information for terminal homing munitions such as Hellfire and Copperhead. The code transmitted by the designator is manually set on the G/VLLD PRF code switches by the observer. This same code is also set on the laser-guided projectiles to be fired for that observer. Coded laser energy allows for multiple designators to operate in the same target area without mutual interference. The G/VLLD is equipped with an AN/TAS-4 night sight (Figure A-1). This night sight significantly increases the observer’s ability to detect and engage targets during periods of reduced visibility caused by darkness or battlefield obscuration.

(2) Detailed procedures for the technical operation of the G/VLLD are in TM 9-1260-477-12. This manual discusses those operational aspects of using the G/VLLD not covered in the TM.
NOTE: The division FSE is the overall manager of PRF codes for the division area. Blocks of codes are assigned to division artillery, to maneuver brigades or battalions, and to the division. The lowest level for management of PRF codes is the brigade FSE, which controls fire support for the brigade. The brigade FSE provides positive coordination of the codes for both the designator and the artillery FDC as a part of fire mission processing. For information on Air Force PRF codes, see [Chapter 8, Section I].

b. Boresighting the G/VLLD. The manufacturer’s tolerance on the G/VLLD laser designator/range finder (LD/R) is enough to ensure that the laser line of sight and the day optics remain in boresight under normal conditions. However, unusually rough handling of the G/VLLD may cause a boresighting problem. If the observer suspects the laser and optical alignment, he should turn in the G/VLLD to DS maintenance. The night sight of the G/VLLD also requires boresighting. The observer should be familiar with these procedures. The night-vision sight is boresighted at the time of mounting. A field boresight check is performed on the G/VLLD.

c. Initial Orientation of the G/VLLD. Since target locations are determined by the polar plot technique, target location accuracy depends on the accuracy of the observer’s location as reported to the FDC and of his initial orienting azimuth. The G/VLLD gives accurate distance, direction, and vertical angle data. However, the accuracy of the azimuth information depends on the initial orientation of the G/VLLD. Upon occupation of a position, the observer should ensure that accurate orienting information is placed on the G/VLLD and that his accurate location is encoded and sent to the FDC. As a minimum, he should do the following as soon as possible after occupying an observation post:

- Using an M2 compass, measure the grid azimuth to a reference point that is easily identifiable on the ground.
- Orient the G/VLLD on the reference point, and set the grid azimuth reading in the azimuth display of the G/VLLD eyepiece.
- With the G/VLLD thus oriented for direction, determine the azimuth, distance, and vertical angle to any point that he can observe with the G/VLLD and can identify on his map.
- Determine his location through resection and terrain analysis and report his grid coordinates to the FDC.

A-3. SELF-LOCATION

The observer should refine his location and the orientation of the G/VLLD as soon as possible. If possible, his location should be determined by survey. Lacking survey control, however, he can use the G/VLLD to locate himself through a procedure called self-location. In this procedure, the observer sends to the FDC the direction, distance, and vertical angle to two known points separated by at least 300 mils. He must also specify which known point is on his left. The FDC determines the G/VLLD location. Then the FDC determines the correct orienting azimuth to one of the known points. This information is sent through secure means to the observer. The observer then plots his location on the map and reorients his G/VLLD on the known point with the corrected azimuth. Self-location can be done by using two known points, one known point and one burst, or two bursts.

NOTE: The observer’s location can also be determined by using only one point. However, the accuracy of the observer’s location depends on the accuracy of the initial azimuth orientation of the G/VLLD.

a Self-Location by Use of Two Known Points.

(1) With this method, the observer uses two known points [Figure A-2]. A known point may be established through survey, firing, or measuring from a map. If measured from a map, the point must be easily identifiable on the ground; for example, a church steeple, a water tower, or a prominent road junction. The observer must be sure that he can associate the known point on the ground with the same point on the map. This method of self-location is the most accurate and, therefore, the preferred technique. When using a voice call for fire, the observer will announce trilateration in the method of fire.
EXAMPLE
A24 THIS IS A58, TRILATERATION, OVER.
KNOWN POINT CADD0, DIRECTION 1743 (encoded),
DISTANCE 1230 (encoded), VERTICAL ANGLE PLUS
10 (encoded), KNOWN POINT FLATTOP (encoded),
DIRECTION 2338 (encoded), DISTANCE 3180
(encoded), VERTICAL ANGLE MINUS 10 (encoded),
OVER.
KNOWN POINT CADD0 ON LEFT, OVER.
A58 THIS IS A24, LOCATION NK47253824 (encoded),
DIRECTION TO CADD0 1723 (encoded), OVER.

(2) If the observer has a DMD, the DMD FR LASER
message is used for this function as follows. Select
TRILAT to determine the grid coordinates of the
G/VLLD location. Tell the FDC in a FREETEXT
message which known points will be lased and which
known point is on the observer's left. The leftmost known
point must be lased first and identified as point 1. The
rightmost known point must be lased second and identified
as point 2.

b. Self-Location by Use of One Known Point and
One Burst. If only one known point is available, the
second point may be established by a planned burst of an
HE or a WP round (Figure A-3). The observer should
plan the location of the burst so that it is separated from
the known point by at least 300 mils. Graze bursts should
be used. Using the G/VLLD, the observer ranges the
known point and the burst of the round to determine the
direction, distance, and vertical angle (VA) for each of the
two points. He reports these to the FDC. The FDC
computes the G/VLLD location and corrected azimuth to
the known point and sends the information to the observer.

NOTE: The accuracy of the computed G/VLLD location
and the reference azimuth is affected by the accuracy of
the firing data used to fire the round. The FDC should
use the most accurate data available.

Figure A-2. SELF-LOCATION BY USE OF TWO KNOWN POINTS

DIRECTION 1743
DISTANCE 1230
VERTICAL ANGLE +10

CADD0

+ FADD0

DIRECTION 2338
DISTANCE 3180
VERTICAL ANGLE -10

Figure A-3. SELF-LOCATION BY USE OF ONE KNOWN POINT AND ONE BURST

CADD0

+ BURST

AT LEAST
300 MILS

OBSERVER

A-3
c. Self-Location by Use of One Known Point.

(1) This method is used by a DMD-equipped observer communicating with a BCS-equipped FDC. The FR LASER message format is used for this method as follows:

- Select RESEC in the MSN field of the format.
- Tell the FDC in a FREETEXT message that RESEC is being used and on which known point.

NOTE: If no known point has been established, one can be established by using an FR GRID message with EOM RAT in the control field. An MTO will then be sent from the FDC to notify the G/VLLD-equipped observer of the known point number assigned to that grid location.

(2) The one known point method also may be used with a burst as follows:

- Compose and transmit FR GRID with ADJ FIRE entered in the control field (active mission buffer 1).
- Compose an FR LASER message in active mission buffer 2 with RESEC entered in the MSN field of the format and DIR, DIST, VA, and KN PT # entries blank.
- After the round is fired, lase or range the burst. (Laser polar data are “dumped” into the FR LASER format.)
- Select active mission buffer 1, and compose an EOM SURV message with EOM RAT in the CONTROL field.
- From the FDC receive the MTO assigning a known point number.
- Compose and transmit a FREETEXT message telling the FDC that a RESEC follows the known point number received in the previous MTO.
- Select active mission buffer 2.
- Enter the known point number from the previous MTO, and transmit it to the FDC.

NOTE: The FDC determines and transmits a location back to the G/VLLD-equipped observer.

d. Self-Location by Use of Two Bursts. If no known points are available, the bursts of two rounds may be used as the prearranged points. The observer selects the locations at which he wants the rounds to burst, ensuring that they are separated by at least 300 mils (Figure A-4). Also, the direction to a reference point is determined. When the rounds are fired, the observer ranges the bursts to determine the direction, distance, and vertical angle of each burst point. He reports these to the FDC and records the direction to the second burst point. The FDC computes the G/VLLD location and corrected azimuth to the second burst point and sends the information to the observer. The observer determines the difference between his measured azimuth to the second burst point and the azimuth that the FDC reported to the second burst point. The angular difference, in mils, is plus if the reported azimuth from the FDC is greater than the azimuth the observer measured. It is minus if the reported azimuth from the FDC is less than the azimuth measured by the observer. The difference is applied to the initial reference point azimuth by either adding or subtracting, as the sign indicates. The observer places the resulting azimuth on the G/VLLD while sighting on his initial reference point.

![Figure A-4. SELF-LOCATION BY USE OF TWO BURSTS](image-url)
EXAMPLE
The observer occupies a position and initially orients the G/VLLD by using an M2 compass. He selects a reference point (BARN) and measures the azimuth to BARN as 5,796 mils. No known points are available, so he requests self-location using two bursting rounds.

A24 THIS IS A58, SELF-LOCATION, 2 ROUNDS, OVER.
1 ROUND, GRID NK603368, OVER.
(Round is fired and observed.)
DIRECTION 6398, DISTANCE 4110, VERTICAL ANGLE MINUS 9, 1 ROUND, GRID NK564381, OVER.
(Round is fired and observed.)
DIRECTION 5927, DISTANCE 3840, VERTICAL ANGLE MINUS 11, FIRST ROUND ON LEFT, OVER.

The FDC determines and sends to the observer his G/VLLD location and orienting azimuth to the second burst point.

A58 THIS IS A24, LOCATION NK58723423 (encoded), DIRECTION TO SECOND ROUND 5918 (encoded), OVER.

Having recorded the G/VLLD-measured azimuth to the second burst point, the observer records the FDC-reported information and makes the following computations:

- G/VLLD-measured azimuth: 5927
- FDC-reported azimuth: 5918
- Angular difference: -9

Observer azimuth to reference point (M2 compass): 5769
Angular difference: -9
Corrected azimuth to reference point (BARN): 5760

The observer places this resulting azimuth on the G/VLLD while sighting on reference point BARN.

A-4. SECOND G/VLLD-EQUIPPED OBSERVER ASSISTANCE

A G/VLLD-equipped observer who has been accurately located and oriented through survey or through self-location can help other G/VLLD-equipped observers locate themselves. The second observer can establish known points for another G/VLLD-equipped observer to use in self-location, or he can perform a simultaneous observation with the other observer on two illuminating rounds. The FDCs can refer G/VLLD-equipped observers requiring self-location to G/VLLD-equipped observers accurately located to coordinate assistance.

a. Establishment of Known Points for Other Observers.
An observer emplacing a G/VLLD may have no preestablished known points and no readily identifiable terrain feature that can be measured from a map. A second observer with an accurately located and oriented G/VLLD can use his G/VLLD to establish known points for the other observer. To do this, both observers must be able to see a common area well enough to clearly identify and locate two objects to serve as known points for self-locations; for example, a prominent lone tree and an abandoned tank. These points should be separated by at least 300 mils as observed from the G/VLLD position being located. This requires very careful and thorough coordination between the two observers. Once mutually agreeable points have been identified they can be established as known points as outlined in the example below.

EXAMPLE
A G/VLLD-equipped observer, A23, has no known points in his area. The FDC, A16, instructs him to contact A47, a nearby observer with a G/VLLD that is accurately located and oriented, for assistance in establishing known points in his area. Mutually agreeable points have been identified.

A16 THIS IS A47, KNOWN POINTS FOR A23, OVER.

KNOWN POINT TREE, DIRECTION 0832 (encoded), DISTANCE 5740 (encoded), VERTICAL ANGLE MINUS 9 (encoded), KNOWN POINT TANK BODY, DIRECTION 0947 (encoded), DISTANCE 6570 (encoded), VERTICAL ANGLE MINUS 11 (encoded), OVER.

With two known points established, the observer operating the G/VLLD being located can now locate himself through self-location by using two known points.

A16 THIS IS A23, SELF-LOCATION, OVER.

KNOWN POINT TREE, DIRECTION 5823 (encoded), DISTANCE 6240 (encoded), VERTICAL ANGLE MINUS 10 (encoded), KNOWN POINT TANK BODY, DIRECTION 6207 (encoded), DISTANCE 5970, VERTICAL ANGLE MINUS 14 (encoded), KNOWN POINT TREE ON LEFT, OVER.

A23 THIS IS A16, LOCATION NK38374512 (encoded), DIRECTION TO TREE 5815 (encoded), OVER.
b. Location by Simultaneous Observation. An observer with an accurately located and oriented G/VLLD can help determine the location of another G/VLLD. He does this by performing a simultaneous observation on two illuminating (illum) rounds with the other G/VLLD observer (Figure A-5). This technique is especially useful during periods of limited visibility. Both observers must be able to see and lase the illuminating rounds. Also, these illuminating rounds must be separated by at least 300 mils as observed from the G/VLLD position being located. Thorough prior coordination between the two observers must take place for this technique to be effective. The observer with the G/VLLD being located records the direction to a reference point and prepares to observe. The observer with the accurately located G/VLLD acts as the controlling station and initiates the illumination call for fire as outlined in the example on the next page.

**NOTE:** Ranging an illuminating canister may be difficult for some observers. A variation of this technique is to adjust the illumination so that it burns on the ground. Both observers then range the flare.

**WARNING**
Lasing or ranging above the skyline requires specific authorization from range control during peacetime training.

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**Figure A-5. LOCATING SECOND OBSERVATION POST BY SIMULTANEOUS OBSERVATION**

![Diagram of simultaneous observation](image)
EXAMPLE

A47 is the observer with the accurately located G/VLLD. A23 is the observer with the G/VLLD being located. A16 is the battery FDC. Coordination between A47 and A23 has already taken place.

A16 THIS IS A47, SIMULTANEOUS OBSERVATION WITH A23, OVER.
1 ROUND, GRID NK374522, 1 ROUND, GRID NK391516, OVER. ILLUMINATION, BY ROUND AT MY COMMAND, OVER.
A47 THIS IS A23, READY TO OBSERVE, OVER.
A47 THIS IS A16, READY, OVER.
(A47 commands the first round to be fired.)

As the illuminating round descends, the observer with the accurately located G/VLLD coordinates simultaneous lasing on the flare. He begins tracking the descending flare and has his RATELO transmit TRACKING, TRACKING, TRACKING, ... LASE.

Once the command LASE is given, both observers lase or range the flare simultaneously.

The observers must use their judgment to determine if they have received an accurate return from the flare. If one of the observers believes that he has an inaccurate return, the tracking phase should be repeated before any data are sent to the FDC. Once the observation data have been completed for both rounds, the FDC determines the location and orienting azimuth correction.

A23 THIS IS A16, LOCATION NK49163842 (encoded), DIRECTION TO SECOND ROUND 0317 (encoded), OVER.

A-5. OBSERVER ACTIONS AFTER BEING LOCATED

a. As soon as the observer knows his accurate location, he should determine polar plot data to several prominent points around his position. The FDC can determine the grids of these points for the observer, making them known points (Figure A-6). Then the observer can refer to these known points when he moves. He can use them in self-location by using the two known points technique to locate his new position.

![Diagram: Using a Laser to Determine Known Points and New Location]

Figure A-6. USING A LASER TO DETERMINE KNOWN POINTS AND NEW LOCATION
b. When the G/VLLD location has been accurately determined and is known by the FDC, the observer uses the G/VLLD to measure distance, direction, and vertical angle to targets from his location (Figure A-7).

![Figure A-7. TARGET LOCATION BY POLAR PLOT](image)

polar plot data (encoded) taken from the G/VLLD can be sent directly to the FDC (preferred), or it can be converted to a grid location and then sent to the FDC.

This paragraph implements STANAG 2934, Chapter 6, Annex A and QSTAG 505.

A-6. ADJUSTMENT OF FIRE

a. If the G/VLLD is accurately located and is properly oriented, resulting target locations will be accurate enough for first-round FFE missions. However, many times, some of the requirements for accurate first-round FFE are lacking at the firing battery. If the observer is not sure he can achieve first-round FFE on the target, he should request an adjust-fire mission. The G/VLLD then gives him a superior capability to adjust fire for conventional munitions. Once the first adjustment round impacts, the observer determines whether the round impacted right or left of the target. Then he determines angular deviation by finding the difference between the measured direction to the target and the measured direction to the burst of the adjusting round.

b. If the angle of deviation exceeds 100 mils, the mil relation and observer adjustment techniques are not accurate enough. In this case, the observer sends the laser polar plot data of the burst to the FDC to compute the shift. In a unit equipped with BCS or BUCS, the observer always sends the laser plot to the FDC. The computer determines the shift to place accurate fires on the target.

EXAMPLE

**BURST DIRECTION 5872, DISTANCE 4350**
**VERTICAL ANGLE MINUS 11, FIRE FOR EFFECT, OVER.**

![EXAMPLE](image)

25 x 3 = 75, or L80 meters.

The call for fire formats outlined in Chapter 4 are used. Target locations are usually laser polar plots.
EXAMPLE
Vertical angle to target +2 mils
Vertical angle to burst (-) 1 mil
Vertical shift +3 x 3 = 9 meters = 10 meters, Less than 30 meters; no correction is needed.
(Vertical angle) x (OB factor) = vertical shift (meters)
Correction sent to FDC: LEFT 80, ADD 200, FIRE FOR EFFECT, OVER.

A-7. AUXILIARY ADJUSTING POINT
a. To achieve surprise on the target, an adjusting point may be selected that is well away from the target. To ensure that the adjusting point is far enough away, the angle of deviation between the target and the adjusting point should be at least 100 mils. In any case, the FDC computes the shift.

b. If the observer has a DMD, he uses the following procedures to adjust on an auxiliary adjusting point:
   - Select OK TGT to identify a new target location.
   - Select OK BT if the adjusting round was observed and the burst location has been ranged. The BCS will compute the shift required. Normally, fire for effect can be specified after one adjusting round has been observed and ranged.
   - Select DNO TGT or LOST TGT if the adjusting round was not observed or was lost and the target location has been ranged. This procedure can be used to identify the original or a new target location.
   - Select LOST BT if the adjusting round is lost and the estimated burst location has been ranged. Because the actual burst location is uncertain, another adjusting round is requested.

EXAMPLE
An observer’s position is map-spotted, and the G/VLLD is oriented for direction by using the M2 compass. Registration corrections are not available. The observer ranges the target and obtains the following data (Figure [A-9]):
- Direction 0220 mils
- Distance 3,680 meters
- Vertical angle +2 mils
Select IGN RD if the adjusting round was erratic and another one must be fired.

EXAMPLE (Continued)
The observer then selects an adjusting point at grid coordinates NK633374, well removed from the vicinity of the target, and sends a call for fire for adjustment to that point.

H24 THIS IS H58, ADJUST FIRE, SHIFT AUXILIARY ADJUSTING POINT, OVER.
ADJUSTING POINT GRID NK633374, OVER,
TARGET DIRECTION 0220, DISTANCE 3680,
VERTICAL ANGLE PLUS 2, OVER.
BATTALION ASSEMBLY AREA, ICM IN EFFECT, OVER.

NOTE: When the adjusting round bursts, the observer ranges the burst and sends the data to

BURST DIRECTION 0803, DISTANCE 5010,
VERTICAL ANGLE PLUS 1, FIRE FOR EFFECT,
OVER.
The FDC computes the shift and fires for effect on the original target.

NOTE: To facilitate accurate fires on the target, the observer should select an auxiliary adjusting point whose range from the guns is close to the GT range and is within 400 mils left or right of the GT line.

c. To digitally accomplish an adjust fire mission by using an auxiliary adjusting point, the following procedure must be used (see also Appendix B):

- Compose and transmit an FR LASER message with data to the auxiliary adjusting point.
- Receive the MTO with target number assigned.
- Compose and transmit an SA LASER message with data to the target and OK TGT entered in the OBSN field of the message.
  - Receive SHOT (round impact).
  - Compose and transmit an SA LASER message with data to the burst. Enter OK BT in the OBSN field and FFE in the CONTROL field.

NOTE: The following example shows the message formats as they would appear on the DMD display.

Figure A-9. SHIFT FROM AN AUXILIARY ADJUSTING POINT

A-10
A-8. OBSERVER CLOUD HEIGHT

a. In addition to reporting his location to the battery FDC, the observer must report observer cloud height (height of clouds above the observer). The cloud height over the target (target cloud height) significantly affects the performance of the Copperhead round. Cloud ceilings that are too low will not allow the Copperhead round enough time to lock on and maneuver to the designated target. The FDC uses the reported observer cloud height to compute target cloud heights.

b. The observer must use his judgment in evaluating the potential effects of clouds over the target area on Copperhead performance. On cloudy and partly cloudy days, observer cloud height must be determined. The observer should not hesitate to report separate observer cloud heights for target areas having significantly different cloud coverage. The procedures below are used to determine observer cloud heights.

(1) The observer elevates the G/VLLD to a vertical angle of +350 mils toward his area of responsibility, selects RNG 1 mode, and measures the slant range to the cloud base. Slant range is then expressed to the nearest 100 meters.

(2) If the slant range is greater than 6,300 meters, the observer reports OBSERVER CLOUD HEIGHT GREATER THAN 2,120 METERS.

(3) If the slant range is less than or equal to 6,300 meters, the observer enters the cloud height table (Table A-1) and determines the cloud height. Entry values for the table are row and column headings which total the slant range measured.

| Table A-1. OBSERVER CLOUD HEIGHT |
|----------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| RANGE                           | 0               | 100             | 200             | 300             | 400             |
| 1500                            | 510             | 540             | 570             | 610             | 640             |
| 2000                            | 670             | 710             | 740             | 780             | 810             |
| 2500                            | 840             | 880             | 910             | 940             | 980             |
| 3000                            | 1010            | 1040            | 1080            | 1110            | 1140            |
| 3500                            | 1180            | 1210            | 1250            | 1280            | 1310            |
| 4000                            | 1350            | 1380            | 1420            | 1450            | 1480            |
| 4500                            | 1520            | 1550            | 1580            | 1620            | 1650            |
| 5000                            | 1680            | 1720            | 1750            | 1790            | 1820            |
| 5500                            | 1850            | 1890            | 1920            | 1950            | 1990            |
| 6000                            | 2020            | 2060            | 2090            | 2120            |                |

NOTES:
1. Angle of measurement is +350 mils.
2. Enter with slant range to the nearest 100 meters.

EXAMPLE
Slant range at vertical angle of +350 mils = 2,570 meters (expressed to 2,600 meters). Enter with 2500 (left side) and 100 (top) (2500 + 100 = 2600). Read an observer cloud height of 880 meters and report OBSERVER CLOUD HEIGHT 880 METERS.

NOTES:
1. A table similar to Table A-1 is on the cover card of the Copperhead footprint template set. The observer should report observer cloud height as soon as possible after occupying a position. He then reports changes only when the change in observer cloud height exceeds 100 meters.
2. An increase or decrease of 300 meters in measured slant range corresponds to an approximate 100-meter increase or decrease in observer cloud height.
A-9. REGISTRATION

The G/VLLD also may be used to determine data for computation of an HB, an MPI, or a precision registration. If the accuracy of the observer’s location meets the standards for an HB or MPI registration, the HB or MPI is the preferred method of conducting a registration with the G/VLLD. If the location for the G/VLLD is doubtful, the G/VLLD may be used to help conduct a precision registration.

a. High-Burst or Mean-Point-of-Impact Registration. Orienting data are provided the observer through a message to observer from the FDC as currently outlined in TC 6-40 under HB and MPI registrations. The observer uses the G/VLLD to determine laser polar plot data for the burst of each round fired during the registration and sends the data to the FDC.

b. Precision Registration. In a precision registration, the observer uses the G/VLLD to determine corrections as described in the procedures for using the G/VLLD in the adjustment of fire. When a 50-meter bracket has been established (100 meters when the PE is 25 meters or more), the procedures in Chapter 5, Section III are used.

c. Abbreviated Registration. In an abbreviated registration, the impact portion is conducted with two rounds. The observer lases the burst of the first adjusting round and determines corrections as outlined for the adjustment of fire with the G/VLLD. The FDC computes new firing data and fires a second adjusting round. The observer lases the burst of the second adjusting round and determines corrections. If a time portion has also been requested, two airbursts are fired to establish the mean height of burst. The observer sends corrections to adjust the mean height of burst to 20 meters.

A-10. TARGET RANGING AND DESIGNATING WITH THE NIGHT SIGHT

a. The night-vision sight can be used in both day and night operations. It has an effective range of 3,000 meters. An observer can effectively detect and ultimately bring fires on targets that would otherwise be obscured because of smoke, dust, haze, fog, or darkness. The night-vision sight, however, lets an observer see a target through smoke and other battlefield obscurants that would attenuate and weaken laser energy. To verify that the laser energy will penetrate these obscurants for successful designation, he should range the target several times in the RNG 2 mode. If he is sure he is receiving consistent and accurate ranging data, he can expect the target to be successfully engaged with Copperhead. Any field-expedient technique that can be used to verify that the range readings in the G/VLLD are accurate is acceptable.

b. If the target is near a known point, the observer should compare the range read to the target with the distance to the known point. If they are about equal, it is a good indication that the laser energy penetrated the obscurant.

c. Another technique is to range the target several (four to six) times. Determine if the variation of the range readings is consistent with the target motions. If so, locate and range to a terrain feature at a much greater distance from (greater than 500 meters, if possible) but along or very close to the line of sight to the intended target. If the return remains essentially the same as was observed in ranging the intended target, the laser energy is probably not penetrating the obscurant. If a reasonable range is observed, this is a good indication that laser energy is penetrating the obscurant.
A-11. NIGHT-SIGHT TRAINING

All observers must be thoroughly proficient in the use of the AN/TAS-4 night sight with the AN/TVQ-2 G/VLLD. Procedures for training with the night sight for target detection, identification, and tracking are as follows:

- Set the field of view control to wide field of view (WFOV).
- Sight through the night-sight eyepiece, and scan a sector of your area of responsibility until you detect a target.
- Place the night-sight reticle on the center of the identified target, and set the field of view to narrow field of view (NFOV). Turn the RANGE FOCUS knob to focus the target image. Adjust the BRT and CTRS controls to give the best target image detail.
- Determine whether the target image is a wheeled or tracked vehicle. Then identify it as friendly or enemy.

**NOTE:** To track and designate for precision guided weapons, such as Copperhead, using the night sight, it is recommended that engagements be restricted to targets within the optimum operating range of the night sight (0 to 3,000 meters).

- Analyze the image seen in the night sight, and place the cross hairs at the best aiming point. Maintain smooth tracking, and follow the target image.

A-12. AN/GVS-5 LASER RANGE FINDER

a. The AN/GVS-5 (Figure A-10) is a lightweight, hand-held, laser range finder that can accurately determine the range to a target within 1 second after the FIRE button has been pressed. The device emits a laser burst and detects its return when the burst is reflected from a distant object. The time lapse between emission of the beam and its return is converted to meters and displayed in the eyepiece on the range-to-target display. The entire AN/GVS-5 package, including battery, weighs 5 pounds. The AN/GVS-5 provides a range to the target that is accurate to within ±10 meters.

b. To use the AN/GVS-5, an observer simply aims the device by superimposing the circle at the center of the reticle pattern over the target and presses the FIRE button. The range is displayed in the range-to-target window and remains there as long as the FIRE button is pressed. The observer should not automatically consider the displayed range to be the correct range to the target.

On the contrary, clutter in front of or behind the target may, at times, produce false ranges. The observer must continually associate the displayed range with a terrain-map analysis and his own range estimate to decide whether the reading is accurate. If, in the observer’s opinion, all of these figures do not correlate, he should consider the information below.

(1) Multiple Firings. To ensure that the observer is aiming at the correct target, he should take a series of readings on the same target. Three consistent readings generally indicate that the observer has aimed in the same place each time.

(2) Minimum Range Set. Although the emitted laser beam is relatively narrow, it is wide enough to reflect from more than one target or object. The AN/GVS-5 has a multiple target warning light inside the eyepiece that lights when more than one return signal is received. When multiple target readings are indicated, the range displayed is the range to the first object from which the beam is reflected. To prevent obtaining a false reading from an intermediate object between the observer and the target, the AN/GVS-5 is equipped with a minimum range set (MIN RG SET). Ranges to the nearest 10 meters and up to 5,000 meters may be set on the MIN RG SET by using the variable control. The MIN RANGE SET indicates the minimum range at which the AN/GVS-5 will register a return, thereby eliminating false readings from intermediate objects. The observer can continue a trial-and-error process of eliminating false ranges by adjusting the MIN RG SET until the range read in the display correlates with the observer’s own range estimate.
based on map and terrain analysis. The observer can save time in this process by establishing on the MIN RG SET the range beyond which he is certain the target lies before he begins ranging a target. Upon completion of a mission, the MIN RG SET should always be set back to zero.

(3) Self-Location. The AN/GVS-5 can help the observer locate himself by giving him accurate distances to two known points. The observer can report these distances to his FDC, which will in turn, using graphical or computer means, give him his location. Self-location also may be obtained by giving the FDC distances to, two burst locations of rounds that have been fired after the unit has completed registration. A combination of one round and one known point may also be used for self-location. The two points or bursts should be separated by at least 300 mils.

(4) Adjustment of Fire. Lateral and vertical shifts in the adjustment of fire are computed by using the mil relation in the same way as adjustment of fire by using binoculars. Range adjustments are made by taking the difference in range between the target and the burst and making the correction in the appropriate direction.

(5) Target Location. The distance provided by the AN/GVS-5 should always be used with the most accurate direction to the target available and a quick, but thorough, map analysis. The observer should remember that the AN/GVS-5 is designed to help him refine distance. The distances determined by the device should always be correlated with known information before a target location is produced.

A-13. HELLFIRE MISSILE

Hellfire is a third-generation air-launched antiarmor weapon. It homes in on a laser spot that can be projected from a number of sources, including ground observers, other aircraft, and the launch aircraft itself. The ground observer uses lasing procedures for Hellfire which are similar to those for Copperhead. Hellfire weighs 99 pounds, and its range is classified.

### a. Designating Modes.

(1) Remote Designation. A designator other than the one on the launch platform is used for missile guidance.

(2) Autonomous Designation. The platform carrying Hellfire provides its own laser designation.

### b. Firing Methods.

(1) Direct. Direct fire can be achieved by using autonomous or remote designation.

(2) Indirect. Vulnerability of the launch platform can be minimized by using the missile in the indirect method. The missile is launched while the launch platform is positioned behind masking terrain. A pilot-selected switch action programs the missile autopilot to fly a preprogrammed, elevated trajectory over the mask. The seeker then locates and locks on the designated target.

### c. Firing Techniques.

(1) Single. One missile is fired.

(2) Rapid. Two or more missiles are fired on the same code. Once the first missile impacts, the designator slews the laser spot to the next target in succession. An interval between missile launches allows time for the missiles to maneuver to their individual targets.

(3) Ripple. Two or more missiles are launched on different laser codes by use of multiple designators. With this option, the missiles are fired virtually one after the other.

### d. Seeker Lock-On Options.

(1) Lock on after launch (LOAL) can be used in the direct or indirect method. The missile is launched before the target being designated, and the seeker lock-on occurs during flight.

(2) Lock on before launch (LOBL) requires direct line of sight to the target and requires the missile to be locked on before launch.

A-14. AH-64 TARGET ACQUISITION AND DESIGNATION SIGHT

### a. The target acquisition and designation sight (TADS) gives the US Army AH-64 a day, night, and adverse weather target acquisition and designing capability.

### b. Target acquisition is provided by means of the multiple fields of view TADS sensors, the direct view (DV) optics, day television (DTV), and forward-looking infrared (FLIR).
c. The TADS laser can designate targets for its own or remotely fired LGMs; it gives the AH-64 precision laser ranging.

d. The TADS laser spot tracker (LST) facilitates target handoffs from other laser designators. Once acquired, the targets can be manually or automatically tracked.

e. The AH-64 is a day, night, adverse weather aircraft that has a maximum laser-guided munition load of 16 Hellfire missiles. The crew can launch the missiles either singly or in multiples by using a LOBL or a LOAL mode against stationary or moving targets. Three launch methods are used: autonomous, using the TADS designator; indirectly, in coordination with a ground designator or in cooperation with another airborne designation system. In the indirect and cooperative modes, the crew may use the Hellfire as a fire-and-forget missile.

f. The AH-64 can also carry conventional munitions of up to 1,203 rounds of 30-mm ammunition and/or up to 762.75-inch rockets. The aircraft is equipped with secure very high frequency (VHF), ultra high frequency (UHF), and/or FM radios.

A-15. OH-58D MAST-MOUNTED SIGHT

a. The US Army OH-58D provides battlefield reconnaissance, aerial observation target acquisition, and designation during day, night, and adverse weather operations.

b. The laser locator/designator of the OH-58D is combined with the attitude and heading reference system (AHRS) enclosed in the mast-mounted sight (MMS). Like the G/VLLD, the OH-58D laser can designate for Copperhead and Hellfire missiles and Air Force and Navy smart munitions.

c. The communications system provides simultaneous communications capability for UHF, VHF, FM, and HP SSB radios. Automatic target handoff is provided by a digital data link through the radios. Security is provided for each radio to prevent the compromise of voice or data transmissions.

A-16. LASER TARGET DESIGNATOR

The laser target designator (LTD) (Figure A-11) is a battery-operated, lightweight, hand-held laser designator. It transmits a coded laser beam that is used to designate point or area targets. The designated targets or areas can be detected by aircraft, by munitions equipped with laser trackers, and by laser-guided weapons (such as Copperhead) set to the same code as that of the LTD. The LTD is issued to ranger and airborne units. Procedures for use of the LTD are the same as those for use of the G/VLLD as a designator. However, its maximum effective range is 1,500 meters, and it cannot interface with a DMD.

A-17. MODULAR UNIVERSAL LASER EQUIPMENT

a. The MULE is the laser designator/range finder used by the US Marine Corps (Figure A-12). This system is similar to the G/VLLD with a few notable differences.
The MULE has a built-in, north-seeking capability which allows for self-orientation for direction, easier self-location, and readout for both grid and true azimuths.

The MULE can detect multitarget reflections and establish a minimum range for range finding.

The data determined by the system during range finding are displayed to three different locations: direction on the north-finding module, distance in the eyepiece, and VA on the tripod module.

The MULE has a digital interface capability when used with a digital communications terminal (DCT).

b. Otherwise, procedures for use of the MULE are the same as those for use of the G/VLLD.

A-18. UNITED STATES AIR FORCE LASER SYSTEMS

a. Pave Spike. Pave Spike is an electro-optical target acquisition, laser designator, and weapon delivery system. It provides precision laser designation, ranging, and tracking of ground targets for attack with conventional ordnance or laser-guided weapons. It uses a cockpit-selectable four-digit code and is PRF or PIM (pulse interval module) capable.

b. Pave Penny. Pave Penny is a passive laser tracker which uses reflected laser energy to give the pilot precise target location. It uses a cockpit-selectable four-digit code and can use either a ground or airborne designator. Pave Penny is currently used by A-10 and A-7 aircraft.

c. Pave Tack. The Pave Tack system gives high-speed tactical aircraft the ability to acquire, recognize, and attack tactical targets during day, night, and adverse weather conditions. The Pave Tack pod was developed for common usage on the F-4E, RF-4C, and F-111F aircraft. It is fully integrated into the host aircraft digital computer avionics system. The pod uses an imaging infrared sensor and laser designator/ranger for navigational updates, target acquisition and recognition, and weapon delivery. The laser designator gives guidance for laser-guided weapons and has four-digit cockpit-selectable PRF or PIM coding.

d. Laser-Guided Bombs. Paveway II and III are the Air Force designations for 500- and 2,000-pound-class laser-guided bombs (LGBs). A guidance control unit is attached to the front of the bomb, and a wing assembly is attached on the rear. Both generations are compatible with current Army, Navy (Marine), and Air Force designators. Paveway II and III have preflight selectable coding. Paveway III is the third-generation LGB, commonly called the low-level laser-guided bomb (LLLGB). It is designed to be used under relatively low ceilings, from low altitude, and at long standoff ranges.

e. Low-Altitude Navigation and Targeting Infrared System. The low-altitude navigation and targeting infrared (LANTIRN) system is designed to be used for night attack. It has two avionics pods: a navigation pod and a targeting pod. A laser designator and ranger are in the targeting pod. The designator is a four-digit PRF-coded laser that can designate for its own weapons or for other acquisition devices or munitions. The LANTIRN system is used by F-15E and F-16 aircraft.

f. AC-130 Spectre. This special operations aircraft can use its infrared target acquisition system and low-light-level TV equipment to acquire targets. It is equipped with a laser target designator which can provide guidance for laser-guided weapons, laser acquisition systems, or laser trackers.

A-19. MARINE CORPS SYSTEM

The OV-10D night observation system (NOS) is the Marine Corps version of the OV-10 Bronco aircraft. It has upgraded engines, FUR, and an LD/R. The pulse code generator is a cockpit-selectable four-digit coder which allows airborne coding of the laser pulse. The LD/R is used to determine precise target range and can be used to designate the target for other acquisition systems or laser-guided munitions.

A-20. LASER SAFETY DURING TRAINING

Lasers have been used at a number of Army installations in training demonstrations and tests without injury to personnel. However, use of the G/VLLD and other lasers requires strict safety controls. Installation range officers and training planners should follow the safety procedures in AR 385-63 when planning the training with laser systems. The safety officers and noncommissioned officers (NCOs) should be familiar with the use of the laser systems, know the local range regulations, and know the information in AR 385-63. All personnel involved in training with laser systems should also comply with the following guidelines:

- Treat the G/VLLD as a direct fire weapon, such as a rifle. Unless you have a backstop, it can be hazardous as far as 80 kilometers.
- Never look into a laser; assume it is always dangerous.
- Do not aim the laser at unprotected people or animals or at flat, reflective surfaces.
- Warn personnel before firing the laser or operating the G/VLLD set.
- Operate only on approved laser ranges which have been cleared of reflective objects.
  - Laser beams should terminate within the impact area of large-caliber ranges.
  - Laser targets should be emplaced below the horizon. If this is not possible, backstops should be built to stop the beam.
- Do not rely solely on the front window cover of the G/VLLD to stop the laser beam.
- Allow only trained personnel to operate the G/VLLD, unless untrained personnel are properly supervised.
- Always follow the laser range safety procedures of AR 385-63 and TB MED 524.

**NOTE:** Special laser surface danger zone parameters apply to designators used with the Hellfire missile. These zones protect laser operators from possible missile failure and missile tracking laser backscatter.

- Approved laser goggles are required only for people who may be exposed to the direct laser beam or its reflection from a flat, shiny surface. Goggles should have a density of 4.0 at 1,064 meters (5.0 density for people using optical devices like binoculars).
- Report to your commander if you think you may have been hit by the laser beam. You may need an eye examination.
- Use the laser attenuator filter on the G/VLLD to reduce emission hazards. Even when using the attenuator filter, a potential eye hazard still exists. See AR 385-63 for operating limitations.

**NOTE:** The US Army Training and Doctrine Command Safety Office should review and approve the installation laser range safety SOP.

### A-21. LASER SAFETY GOGGLES

**a.** Only personnel downrange in the laser safety fan need laser eye protection. If the range is cleared of exposed flat, reflective surfaces, no hazardous reflections could come back to the observer or to anyone behind the laser site. Hence, these personnel do not need laser eye protection.

**b.** At this time, no standard laser protective goggles are available for general distribution through the supply system. However, one pair of laser safety goggles, NSN 4240-00-258-2054, will be supplied in each G/VLLD test set at the direct support or higher level laser designator maintenance facility. In general, laser safety goggles are not necessary for routine training involving laser designators. However, personnel involved in two-sided tactical exercises and personnel downrange from the laser source must be protected.

**c.** The hazard of looking directly into a laser beam (intrabeam viewing) is increased by using binoculars, an aiming circle, or any telescopic sight. In effect, the viewer is placed closer to the laser source by a factor of the multiplying power of the sight. Laser light filters, if available, can be installed in optical systems to make them eye-safe for laser viewing, much like the laser goggles. Operator's manuals state whether the instrument has laser filters. The operator of the G/VLLD is protected from the G/VLLD her by a built-in filter. However, he is not protected from external laser radiation (other laser devices).

**DANGER**

**Do not use sunglasses for eye protection. Sunglasses of any type, including polarized, do not provide adequate protection from the laser beam.**

**d.** Normally, observers operating the G/VLLD do not need a laser eye examination. However, a person who may be exposed to hazardous levels of optical radiation will be included in an occupational vision program. The local medical authorities will determine who should be included in such a program.

### A-22. G/VLLD EVALUATOR

The G/VLLD trainer set transmits no laser energy; therefore, no laser hazard is present.

### A-23. ADDITIONAL LASER HAZARD INFORMATION

Other sources of laser hazard information include the following:

- The post environmental health officer.
- TB MED 524.
- AR 40-46 with Change 1.
- AM 385-63, Chapter 19.
A-24. G/VLLD SAFETY FAN AND LASER RANGE SAFETY CARD

A laser range safety card similar to a range safety card will be issued by the local range control authority for use by each laser OP. The laser range safety officer must understand the terms buffer zone and backstop to correctly construct a laser range danger fan (LRDF).

a. Buffer Zone. The laser buffer zone is the distance left or right or up or down that may be exposed to direct laser beams. The size of this target area buffer zone is measured in mils. The size changes according to the type of laser and the stability of the laser mount. The horizontal and vertical buffer zone for the G/VLLD, both on the tripod and on the stationary FISTV, is 2 mils. This 2-mil buffer zone must be built into the range safety card.

b. Backstop. A backstop is an opaque structure or terrain in the controlled area — such as a dense tree line, a windowless building, or a hill — which completely obstructs any view beyond it and therefore completely terminates a laser beam that might miss the target (Figure A-13). Unless the nominal ocular hazard distance (NOHD) (see AR 385-63) has been exceeded, the hazard distance of the laser device is the distance to the backstop. This hazard distance must be controlled. The terrain profile from the laser device field of view is very important, since the laser presents only a line-of-sight hazard. The optimal use of natural backstops is the obvious key to minimizing laser range control problems.

NOTE: Figure A-14 shows the laser safety fan with a natural backstop.

c. Maximum and Minimum Safe Vertical Angles. The safety card should specify the left and right azimuth limits of the laser range. Maximum and minimum vertical angles for lasing should also be listed. If no maximum or minimum vertical angles are given and maximum and minimum ranges are listed, the maximum and minimum safe vertical angles for laser firing are computed as follows:

**CAUTION**

Despite the computed minimum safe vertical angle, it must be clear that the total zone between the laser and the minimum range line is an active laser area. Access must be controlled and restricted.

- Determine the altitude of the laser OP.

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**Figure A-13. LASER BACKSTOP, TERRAIN DRAWING**

[Diagram showing laser safety fan with natural backstop]

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- Determine the altitude of the highest point on the minimum range line between authorized azimuth limits.
- Determine the vertical interval (VI), in meters, by subtracting minimum range altitude from the OP altitude.
- Divide the VI by the minimum range (in thousands) \((2500 = 2.5)\) on the safety card to get the minimum VA.
- Add 2 mils to the VA to get the minimum safe G/VLLD VA. (Pay attention to signs of VA; for example, \(VA -8 + 2\) mils = -6; \(VA + 8 + 2\) mils = +10.)
- Determine the altitude of the lowest point on the maximum range.
- Determine the VI by subtracting the maximum range altitude from the OP altitude.
- Divide the VI by the maximum range in thousands \((8400 = 8.4)\) to get the maximum VA.
- Subtract 2 mils from the maximum VA to get the maximum safe G/VLLD VA, for example, \(VA +10 - 2\) mils = +8; \(VA - 10 - 2\) mils = -12.

**NOTE:** The maximum safe G/VLLD VA applies only if there is no backstop for the laser within the laser impact area that is higher than the maximum VA. When there is such a backstop, the observer may lase to within 2 mils of the top of the backstop.

**WARNING**
Lasing above the skyline is forbidden except when specifically authorized by the range safety card.

d. Cleared Area. For OP personnel safety, a 30-meter area must be cleared in the direction the G/VLLD is used (Figures A-14 and A-15). This area must be cleared of trees, bushes, or anything that could be hit accidentally by the laser beam. The reflection of the laser beam from any surface at this range could be hazardous. All personnel in the OP area must stay behind this area. To warn them of laser activation, the observer must call out loudly **LASING**.

e. Warning Signs. AR 385-63 and AR 385-30 give detailed instructions on construction of laser-safe ranges and the duties of the laser range safety officer.
Figure A-15. G/VLLD SAFETY DIAGRAM WITHOUT BACKSTOP

- Maximum Vertical Angle
- Target Area
- Left Azimuth
- Right Azimuth
- Minimum Vertical Angle
- 30-Meter Cleared Area
- G/VLLD

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