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FM 20-60

FIELD MANUAL

BATTLEFIELD ILLUMINATION

HEADQUARTERS, DEPARTMENT OF THE ARMY
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FIELD MANUAL
No. 20–60

HEADQUARTERS
DEPARTMENT OF THE ARMY
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BATTLEFIELD ILLUMINATION

*This manual supersedes FM 20–60, 19 October 1964, including all changes.

CHAPTER 1
GENERAL
(STANAG 2088 AND SOLOG 108)

1–1. Purpose and Scope

a. This manual is a guide for commanders and staff at all echelons employing battlefield illumination. It covers the principles of employment of battlefield illumination, characteristics and capabilities of the various illumination means, and considerations in selecting illumination means for given missions. The material presented herein is applicable without modification to nuclear and nonnuclear warfare, general war, limited war, and cold war operations to include internal defense and internal development assistance.

b. Users of this manual are encouraged to submit recommended changes or comments to improve this manual. Comments should be keyed to the specific page, paragraph, and line of text in which the change is recommended. Reasons should be provided for each comment to insure understanding and complete evaluation. Comments should be prepared using DA Form 2028 (Recommended Changes to Publications) and forwarded direct to Commanding Officer, U.S. Army Combat Development Command Field Artillery Agency, ATTN: CAGFA-DC, Fort Sill, Oklahoma 73503.

c. The procedures set forth in this field manual are in agreement with STANAG 2088, Battlefield Illumination and SOLOG 108, Battlefield Illumination. To insure complete and unmistakable understanding among all users of this manual, the STANAG is included in its entirety in appendix F to include exceptions as stated in paragraph F–3.

1–2. Definitions

a. Battlefield Illumination. The lighting of the zone of action of ground combat and combat support troops by artificial means whose effects can be observed by the naked eye (STANAG). U.S. Army interprets this definition to include combat service support troops but eliminates infrared or illumination intensification devices. In internal defense operations, battlefield illumination includes the illumination of any area as a security measure.

b. Definitions pertaining to battlefield illumination are grouped into three general categories. These categories and their associated definitions are as follows:

(1) *Area to be illuminated.*

(*a*) Close-in illumination is illumination of an area in the immediate vicinity of friendly individuals or units. In general, this area extends outward a distance equal to the effective range of direct fire weapons (about 2,000 meters).

(*b*) Intermediate area illumination is illumination of the area extending from the forward edge of the close-in area (about 2,000 meters) to a distance equal to the maximum effective range of the bulk of division artillery cannon weapons (about 15,000 to 18,000 meters).

c. Deep illumination is illumination of the area extending from the far edge of the intermediate area (about 15,000 to 18,000 meters) to a distance of about 160 kilometers.

(2) *Illumination intensity.*

(*a*) Artificial moonlight is illumination of an intensity between that of starlight and that of a full moon on a clear night.

(*b*) Artificial daylight is illumination of an intensity greater than the light of a full moon on a clear night. (The optimum illumination is the equivalent of daylight.)

(3) *Employment of illumination.*

(*a*) Direct illumination is provided by direct light from pyrotechnics, ground mounted and mobile searchlights, and/or airborne illumination systems.

(*b*) Indirect illumination is provided by diffusion or reflection of direct light.

1. Illumination by diffusion is provided in the area beneath and to the flanks of a slightly elevated searchlight beam. Diffusion of this light is caused by atmospheric particles.

2. Illumination by reflection is provided by reflection of the direct light source from low-lying clouds (150 to 900 meters), or other reflective surfaces such as smokescreens.

CHAPTER 2

PURPOSES AND PRINCIPLES OF BATTLEFIELD ILLUMINATION

2–1. Purpose of Battlefield Illumination

The general purpose of battlefield illumination is to provide additional light for friendly forces to conduct operations during periods of darkness and to restrict and/or make more hazardous the movement of enemy forces. Proper use of illumination can provide more effective execution of offensive operations, and makes possible better coordination and control of attacking elements. It also assists in the organization of defensive positions and the conduct of the defense. Illumination may, through the employment of harassing and interdictory illumination, deny the use of certain areas and routes of movement to the enemy while enhancing the ability of Air Force and Army aircraft to detect and attack enemy troops, weapons emplacements, commands posts, base camps, field repair facilities and supply installations. Illumination in rear areas permits maintenance, repair, recovery, and evacuation of vehicles and other equipment. The conduct of bridging operations, road repairs, and other construction requirements are expedited by illumination. Necessary light for the conduct of port and stevedore operations can be provided when needed. Illumination promotes troop confidence and morale when properly employed. In most cases a night attack, where preparatory nuclear or nonnuclear fires are to be used, can be effectively and favorably supported by battlefield illumination. Such employment facilitates a more rapid exploitation of the attack. Daylight tactics and techniques can be employed as the degree of intensity of illumination of the battlefield approaches that of daylight.

a. In the offense, illumination may be used to—

(1) Assist patrols or parties in night reconnaissance and in diversionary actions to conceal such operations.

(2) Facilitate the advance of troops by providing sufficient light to assist in maintaining direction, terrain orientation, and control of troops.

(3) Facilitate the effective siting of close support direct fire weapons.

(4) Facilitate the location and detection of enemy positions.

(5) Blind the defending enemy force while promoting troop confidence and morale.

(6) Facilitate the detection and removal of mine fields and the reduction of other obstacles.

(7) Permit more rapid displacement and movement of supporting arms accompanying the forward elements.

(8) Facilitate the handling and servicing of weapons and vehicles of all types.

(9) Facilitate embarking and debarking of watercraft, enhance control of bridging or river crossing operations, and expedite road repairs and other construction requirements.

(10) Facilitate the attainment of more distant objectives by increasing control of the operation, minimizing disorganization, and expediting the forward movement of reserves, combat support units, and combat service support units with their accompanying resupply and repair facilities.

(11) Provide a deceptive effort such as the illumination of a rear area or river crossing site, to deceive the enemy as to the true area of operations or the actual crossing site.

(12) Improve airstrike effectiveness and aid in the adjustment of artillery fires by illuminating the objective.

(13) Facilitate on-site repair, recovery, and evacuation of unserviceable materiel.

(14) Facilitate shore party operations during an amphibious operation when the beachhead has been secured.

(15) Assist in airmobile operations where appropriate and advantageous.

b. In the defense, illumination may be used to—

(1) Facilitate the organization of defensive positions by aiding reconnaissance; permit more effective siting of direct fire weapons and adjustment of indirect fires; and facilitate the laying of minefields, erection of wire, construction of obstacles, and the preparation of foxholes and other emplacements.

(2) Facilitate the early detection and

blinding of an attacking enemy force, and the placing of effective fires on them for psychological as well as physical effects.

(3) Promote confidence and morale of defending troops.

(4) Discourage enemy patrol action, infiltration, and night attacks.

(5) Deny the enemy freedom of movement and canalize his movements into established kill zones.

(6) Facilitate the organization and conduct of night counterattacks.

(7) Facilitate communications by providing light to aid wire crews in laying, maintaining, or recovering wire lines; to assist radio teams in erecting or dismantling antennas; and to assist mounted and dismounted messengers in locating routes to their destinations.

(8) Facilitate the tactical and administrative movement of troops, vehicles, and supplies within the battle area.

(9) Facilitate the location, treatment, and evacuation of casualties.

(10) Facilitate the displacing, handling, and servicing of weapons and vehicles.

(11) Facilitate on-site repair, recovery, and evacuation of unserviceable materiel.

(12) Facilitate search and rescue operations by providing light to locate and/or recover individuals or groups isolated or separated from their parent organization in friendly or enemy territory.

(13) Facilitate the security of critical installations in an internal defense operational environment wherein the primary threat is from infiltration and/or ground attack rather than air or artillery action.

(14) Assist in night aerial resupply and medical evacuation operations.

2–2. General Requirements for Illumination

The principal requirement for battlefield illumination is to overcome the limitations imposed on friendly forces by the absence of light. Illumination should be used in such a manner as to give maximum assistance to friendly forces while impending the enemy to the utmost or, at least, giving the enemy as little assistance as possible. The requirements for battlefield illumination may originate from an individual, a patrol, or an isolated outpost and progress in creasing magnitude to the requirements for the field army. Type illumination requirements for various organizations are listed in appendix D.

2–3. Principles of Battlefield Illumination

a. Battlefield illumination in support of friendly forces must be provided wherever and whenever needed in the intensity required and throughout the period of time required. Battlefield illumination can frequently be the critical factor that influences the course of the battle in favor of the friendly troops. Conversely, insufficient or improper use of battlefield illumination could result in the failure of friendly troops to accomplish their tactical mission. It is particularly important to consider the use of battlefield illumination as a means of counterbalancing a lack of training or experience of friendly troops in the conduct of night attacks. In planning for the conduct of night or pre-dawn attacks, consideration must always be given to the use of illumination.

b. Employment of an illumination means is the responsibility of command. The decision to employ illumination (type, means, degree, and area) must be made by the commander after he considers the effects that the illumination of one area will have on the operations of units in adjacent areas.

c. Wherever possible, a means of illumination that gives maximum advantage to the user should be employed; for example, the employment of an illumination means other than organic weapons will free those weapons for their primary mission of providing conventional supporting fires.

d. Battlefield ilumination should be provided by searchlights, airborne illumination systems, and aircraft flares wherever and whenever practicable.

e. Illumination should be provided by the highest level practicable. The purpose of this principle is to conserve the illuminants available to lower echelons so that the lower echelons will be prepared at all times to meet emergency requirements for illumination. Coordination and preplanning of illumination will materially assist in the application of this principle.

f. Each ground unit requiring illumination should have available sufficient means to initiate the illumination mission and to maintain the required illumination until the illumination mission is assumed or provided by a higher echelon. When the illumination mission cannot be accomplished by the ground unit employing organic means, illumination support must be made available by

higher headquarters before the ground unit initiates the operation. In all cases, higher echelons will assume the illumination mission as early as practicable. Continuous coordination between adjacent headquarters on illumination restrictions will decrease response time of illumination support.

g. Artillery illuminating shells must be available for delivery to artillery firing positions by vehicle, helicopter lift, or other means whenever they are needed to insure continuous illumination in the event of failure of the primary illumination means.

h. All battlefield illumination must be coordinated at the highest level practicable. Such coordination is required because illuminants frequently light areas outside the zone of the using unit and, unless fully coordinated with all elements concerned, may disclose to the enemy the operations of adjacent units. In addition, units planning to employ illumination should directly coordinate such plans with adjacent units whenever the illumination might possibly affect those units.

i. An alternate means of illumination such as artillery illuminating shells, searchlights, airborne illumination systems, and aircraft flares for intermediate area illumination must always be maintained.

j. Once illumination producing artificial daylight is commenced, it must continue without interruption until the need for illumination is satisfied. This type of illumination temporarily eliminates night vision unless precautionary measures are taken. During interruption of illumination, the supported troops may be incapable of seeing in the resulting darkness. They may be at the mercy of an enemy who has kept his eyes closed or used filtering goggles during the illumination. About 15 minutes are required for troops to regain night vision.

k. Battlefield illumination provided by artillery or naval gunfire to an engaged unit must be closely coordinated with all aircraft supporting that unit.

CHAPTER 3
GROUND SIGNALS, ILLUMINATING GRENADES, AND TRIP FLARES

Section I. GROUND SIGNALS

3–1. General

Ground signal devices are used primarily for signaling and can provide only a minimal amount of illumination. However, since these devices are normally available to the individual or small unit, they can be used to provide emergency close-in illumination (para 1–2*b*(1)(*a*)) for short periods of time. The ground signal is not suitable for producing continuous illumination and has little, if any, application in other than defensive operations. Characteristics of the signaling device (M–127A1) most commonly found in small units are listed in table 1. Characteristics of other ground signal devices—rifle-projected and hand-held—are listed in TM 9–1370–200.

Table 1. Characteristics of Ground Signal, Illuminating Grenade, and Trip Flares

	Signal, illumination, ground, white star, parachute, M127A1 (handheld)	Grenade, hand illuminating, Mark 1	Flare, surface, trip, M49 and M49A1
Candlepower	50,000	55,000	40,000.
Approximate burning time (second).	36	25	55.
Approximate rate of descent (meters per second).	3 to 4.5	Does not apply	Does not apply.
Approximate diameter of area illuminated (meters).	450	200	300.
Approximate HOB (meters)*	200	Does not apply	Does not apply.
Approximate maximum range (meters).	275**	Hand thrown 40 meters	Hand thrown 30 meters.
Fuze time	5-second delay	7-second delay	Instantaneous.
Type of projectors	Hand-held rocket type launching mechanism incorporated in signal.	Hand thrown	Hand thrown or fixed to stake or tree.

*Based on burnout of flare 30 meters above ground.
**Based on firing angle of 45 degrees.

3–2. Control

Ground signal devices are used by the individual, squad leader, or platoon leader in accordance with instructions issued by the appropriate commander. When used solely for signaling, prior planning and coordination within the unit and with adjacent units must be accomplished well in advance of the employment of these signals. Standardization within and between major units on the employment and meaning of certain signals, especially those to be used in emergency situations, is desirable to insure complete and instant understanding as to their meaning by all who observe them. When used to provide limited illumination, consideration must be given to their effect on adjacent units to insure that the flare is not mistaken as a true signal and acted on accordingly by other units within viewing range.

3–3. Method of Launching

The signal, illumination, ground, white star, parachute, M–127A1 is hand fired and does not

require the use of a weapon or special launcher. Certain ground signal devices require the use of a weapon, a crimped cartridge, and a grenade launcher for firing. The height of burst and range achieved by any ground signaling device is dependent upon the angle of the signal at the time it is fired. Firing the signal at a high angle (45° to 90°) secures a height of burst that will use the full burning time of the flare and will illuminate the largest possible area (fig 3–1). When firing the

Figure 3–1. Illumination of largest possible area.

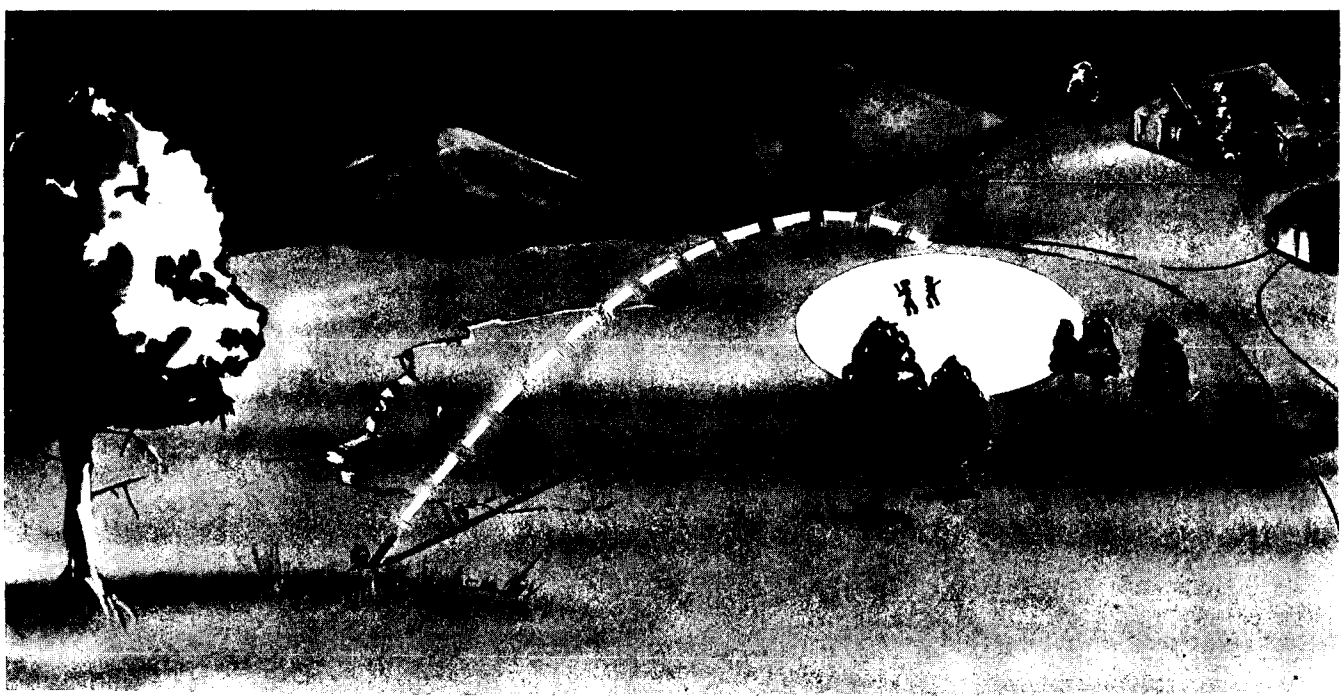

Figure 3–2. Illumination to pinpoint or silhouette troops.

Figure 3–3. Flare fired to achieve low airburst and burnout on the ground.

signal at a low angle (15° to 45°), greater range and a lower height of burst is achieved; this angle of fire permits the placing of the flare at a low altitude over or behind enemy troops to pinpoint or silhouette their location (fig 3–2). In certain instances, it is desirable to fire the signal at an elevation less than 15° in order to secure a low airburst and allow the flare to burn out on the ground (fig 3–3).

3–4. Use

Outposts, security personnel guarding critical installations, and troops on defensive perimeters employ ground signals for detection of infiltrating troops and for providing instant and responsive illumination for short periods of time. Additionally, these devices may be employed by ground troops engaged in patrol or offensive operations to assist in detecting and locating enemy troops and positions. However, care must be exercised in the use of these signals by troops engaged in ambush or patrol operations since their employment immediately discloses their location. In a static defense position, ground signals may be employed by security personnel as a harassing means to discourage infiltration into the area; their use also improves the morale of friendly troops by giving them confidence and a sense of security.

Section II. ILLUMINATING GRENADES

3–5. General

The Mark 1 illuminating grenade was designed for the specific purpose of providing battlefield illumination and is the only grenade available that is practicable for this purpose. Incendiary or white phosphorous (WP) smoke grenades are of little value for illumination and should not be used for this purpose. The Mark 1 is not suitable for producing continuous illumination and has little, if any, application in other than defensive operations. Characteristics of the Mark 1 illuminating grenade are listed in table 1.

3–6. Control

Control necessary for the employment of illuminating grenades is the same as that for ground signals (para 3–2).

3–7. Use

Illuminating grenades may be thrown by hand, employed as trip flares, or activated by remote control (fig 3–4). Outpost personnel, troops on perimeter defense, and troops in ambush positions or night patrols use the illuminating grenade to

locate and deliver accurate fire on enemy troops. When the grenade is used on soggy or swampy ground, it may sink into the ground and produce less than the expected illumination. This physical limitation of the grenade should be considered when target areas are selected. The illuminating compound in the grenade burns with a very hot and intense flame and often starts fires in dry grass, leaves, or brush. Thatched roofs are easily ignited by use of this grenade. In employing the illuminating grenade as a trip flare, care must be exercised to insure that the grenade is securely anchored and that the safety pin and safety pin pull ring are in a position to be easily pulled; these are also prime considerations when the grenade is to be activated from a remote position (fig 3–4). When the grenade is employed so as to be activated from a remote position, consideration must be given to the 7-second delay fuze. Another refinement that may be used with this grenade in a defensive position is to place a reflector behind the grenade to direct and intensify the light toward the expected area of enemy movement.

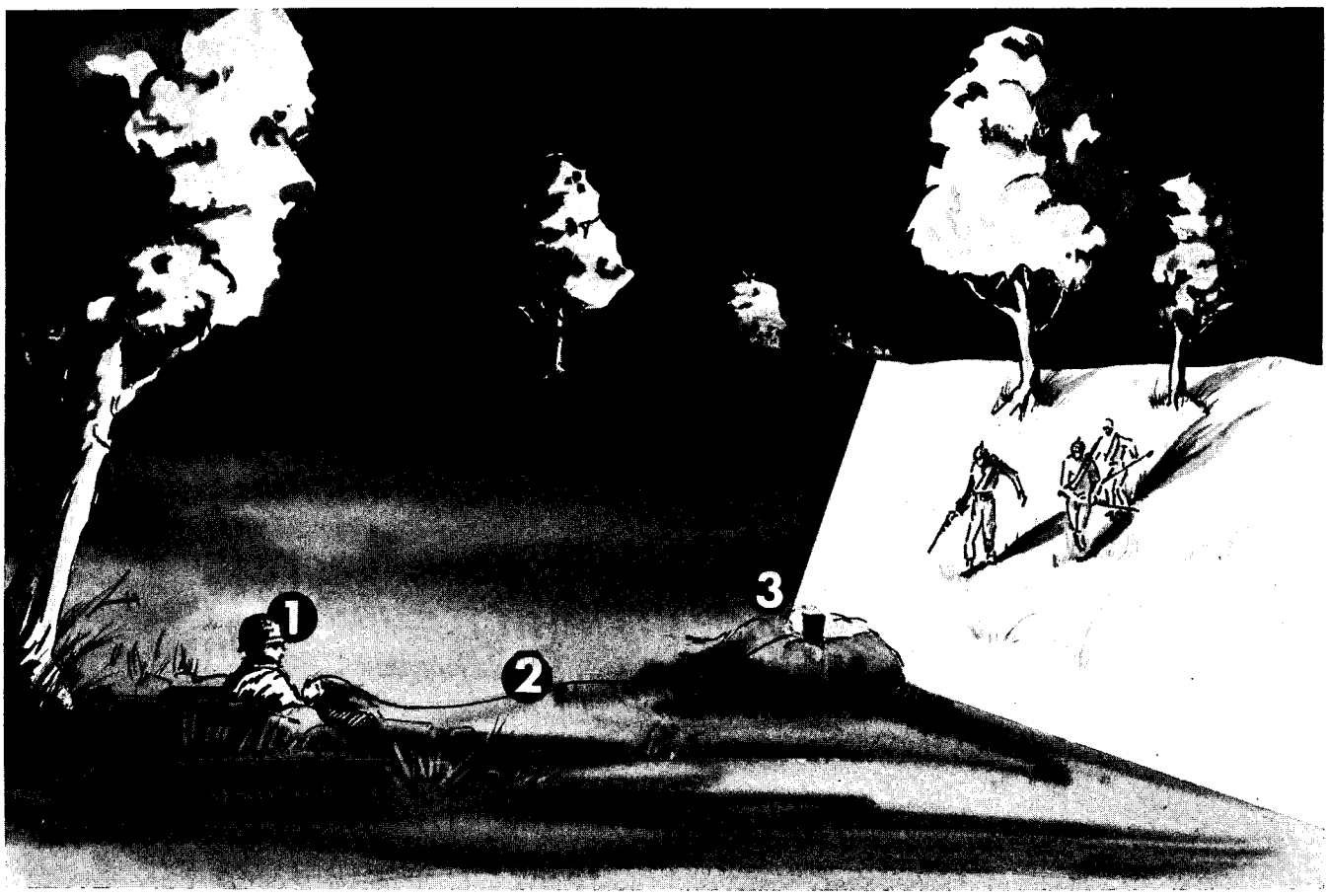

Figure 3–4. Remote activation of the Mark 1 illuminating grenade.

Section III. TRIP FLARES

3–8. General

Two types of trip flares are currently availabe for issue to individuals and small units for employment on the battlefield. These are the M–49 and the M–49A1 illuminating flares. Both flares burn with a yellowish-white light for approximately 1 minute. Each of the flares can be installed so that it can be detonated by either a pull-pin release action or by a trigger release action. When arming either of these flares, the *cautions* listed in TM 9–1370–200 for each flare must be followed.

3–9. Control

Control for the use of trip flares is the same as that for ground signals (para 3–2).

3–10. Use

Trip flares are used on the battlefield to provide early warning of attacking or infiltrating enemy troops. Normally, they are placed along and across likely avenues of approach, in barbed wire barriers with mines, and in gaps between defensive perimeters. Trip flares are not suitable for providing continuous illumination; however, they may be used under emergency conditions to provide temporary close-in illumination.

CHAPTER 4
ARTILLERY AND MORTAR ILLUMINATING SHELLS

Section I. GENERAL

4–1. General

All artillery and mortar illuminating shells (TM 9–1300–203 and TM 9–1300–206, respectively) currently in production contain a parachute-supported flare which produces sustained high candlepower illumination. Although their primary function is illumination, illuminating shells may be used for incendiary purposes, position location, target identification, and for signaling.

Caution: **Note paragraph 10–4 for hazards of the ilumination carrier impacting in non-combatant and friendly force locations.**

4–2. Artillery Illuminating Shell

Illuminating shells are currently provided for 105-mm and 155-mm howitzers. The characteristics of artillery illuminating shells are listed in table 2. Control over the use of illuminating shells in nuclear and nonnuclear war environments is exercised by the division commander, even though illumination may be furnished by other than division units. In stability operations environment, control over the use of illuminating shells may be delegated to commanders of outposts, isolated bases, villages, hamlets, and/or such area commanders as those at district and province levels who have field artillery under their control. Requests for field artillery illuminating shells are made through normal artillery channels. Clearance should be obtained from the division headquarters concerned prior to use within the division zone of action. The large area illuminated, the number of friendly units affected, and the limited availability of the shell make centralized control mandatory. This control, however, should not result in restriction of illumination for registration and surveillance for purely artillery purposes. The interested division headquarters can readily establish a line comparable to the no-fire line beyond which other elements may use illuminants as necessary.

4–3. Mortar Illuminating Shell

Illuminating shells are provided for 81-mm and 4.2-inch mortars. The characteristics of these illuminating shells are listed in table 2. Control over the use of mortar illuminating shells is exercised by the commander having overall control of the operation after coordination with adjacent units through the next higher headquarters.

Table 2. Characteristics of Artillery and Mortar Illuminating Shells

	Approximate candlepower	Approximate burning time (seconds)	Approximate rate of descent (feet per second)	Approximate diameter of area illuminated (meters)	Approximate HOB (meters)	Approximate maximum range (meters) (air burst)	Continuous illumination (rounds per minute)
*Mortars**							
81-mm, M301A3	500,000	75	12	1,100	400	3,300	2
4.2-Inch M335A2	850,000	90	12	1,500	400	5,500	2
*Artillery**							
105-mm Howitzer M314 series	600,000	60	35	1,000	750	8,500	2
155-mm Howitzer M118 series	500,000	60	35	1,000	750	11,600	2
155-mm Howitzer M485 series	1,000,000	150	15	2,000	600	14,000	1

*Reference TM 9-1300-203.

Section II. EMPLOYMENT

4–4. General

Illuminating shells can be placed at a point in the air with the accuracy and flexibility inherent in the weapons from which they are fired. After the parachute opens, its horizontal movement is controlled by the force and direction of the wind. By considering wind, visibility, terrain relief, and target reflectivity, personnel can quickly determine, by adjustment, the proper point of burst for illumination of any desired target, except under the most adverse wind conditions. For maximum effective illumination for the ground observer, the flare should be positioned to one flank of the target and at approximately the same range. However, because of the rapid rate of descent of the parachute flare and the fact that illumination of objects on the ground depends on the candlepower and the height of the flare above the ground, it is impossible to place the flare at an altitude where the flare will provide the most effective light and still utilize its full burning time. With current shells, if the flare is ignited at an altitude to insure burnout before reaching the ground, the first one-third or one-half of the burning time is less than optimum. If the shell is fired at an altitude for providing the optimum light, the flare burns out on the ground, wasting the latter part of its burning time. The height of burst should be adjusted to allow the flare time to burn out just before it reaches the ground, so that the flare will not start fires which may cause smoke and haze to obscure the target area. In some cases it may be desirable to obtain a low burst with artillery illumination, e.g., to avoid illuminating a nearby

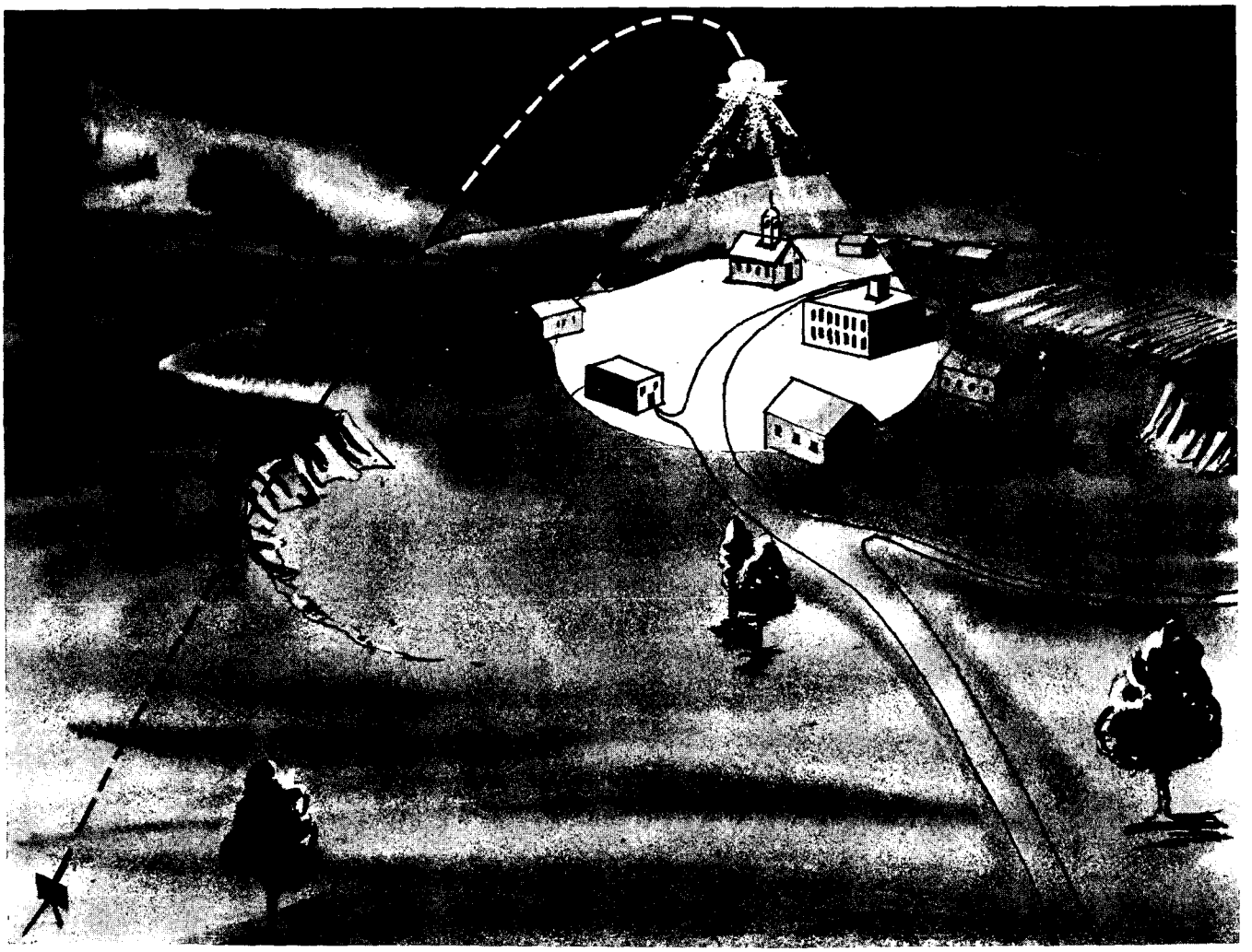

Figure 4–1. One-gun illumination.

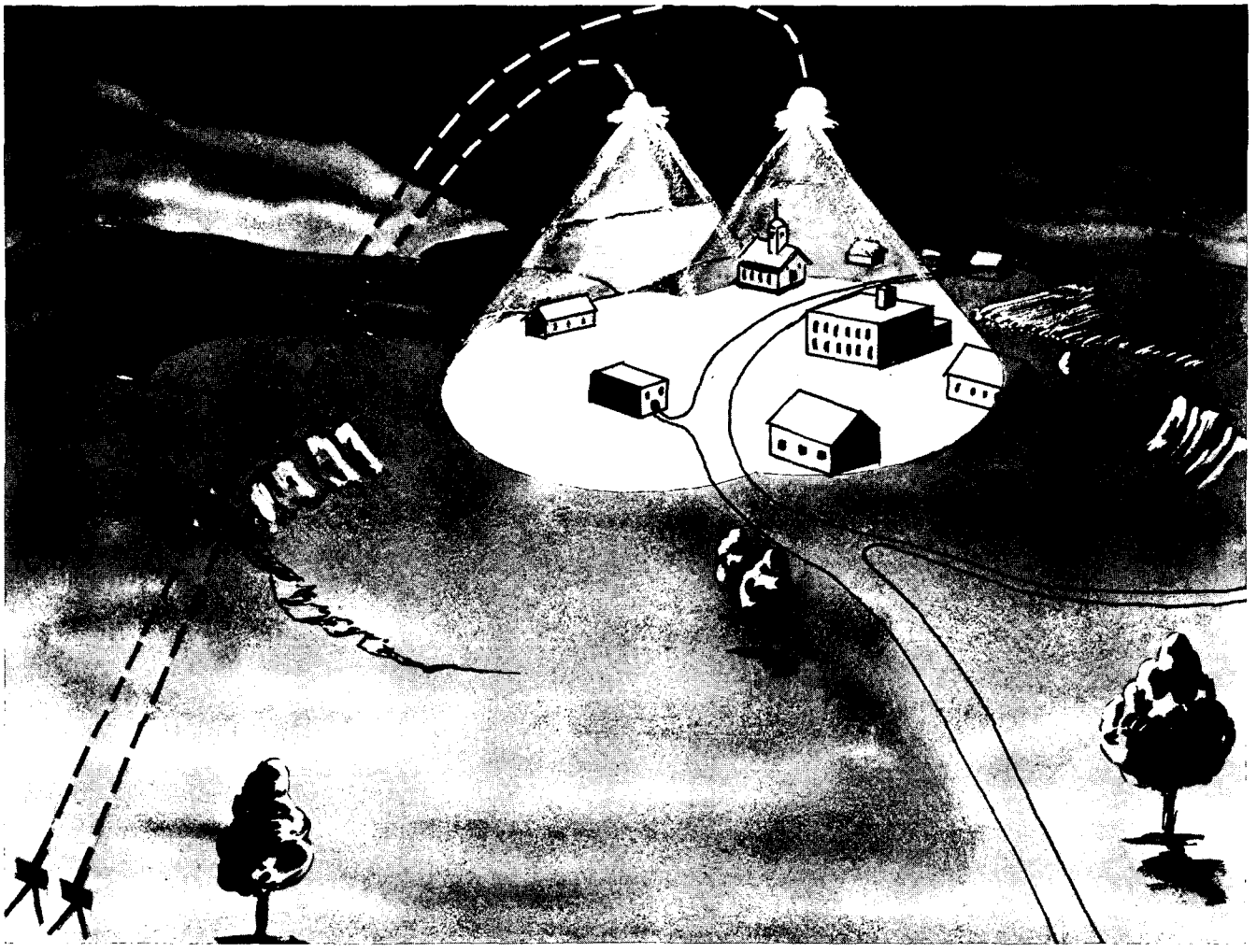

Figure 4–2. Two-gun illumination.

friendly position, to mark targets for aircraft, to start fires, or to hang flares in high trees. In such cases, the fuze should be set for burst at or near ground level.

4–5. Use

Illuminating shells afford a rapid, accurate, and flexible means of providing artificial illumination for forces in the offense or the defense. By using illuminating shells as a means of securing close-in and intermediate area illumination, the supported unit can deliver effective fire during the hours of darkness.

4–6. Types of Adjustment

The size and shape of the area to be illuminated, observer-target distance, conditions of visibility, and candlepower of the shell influence the selection of the type of adjustment. The following are the types of adjustment that may be used:

a. One-gun Illumination. One-gun illumination of an area (fig 4–1) is normally provided by one piece which has been adjusted for the mission; however, successive rounds may be delivered by any selected piece in the adjusting battery.

b. Two-Gun Illumination. Two-gun illumination of an area provides increased illumination during periods of poor visibility and increases the observing range. Two rounds are fired simultaneously with the same time setting and at the same deflection and range (fig 4–2).

c. Two-Gun Lateral Spread. Illumination may be provided by firing one round from each of two guns bursting simultaneously at the same range but separated laterally. Areas of variable widths can be illuminated in this manner (fig 4–3). However, the normal spread is 800 meters between flares. This type of illumination is the normal method used to assist in ground offensive and de-

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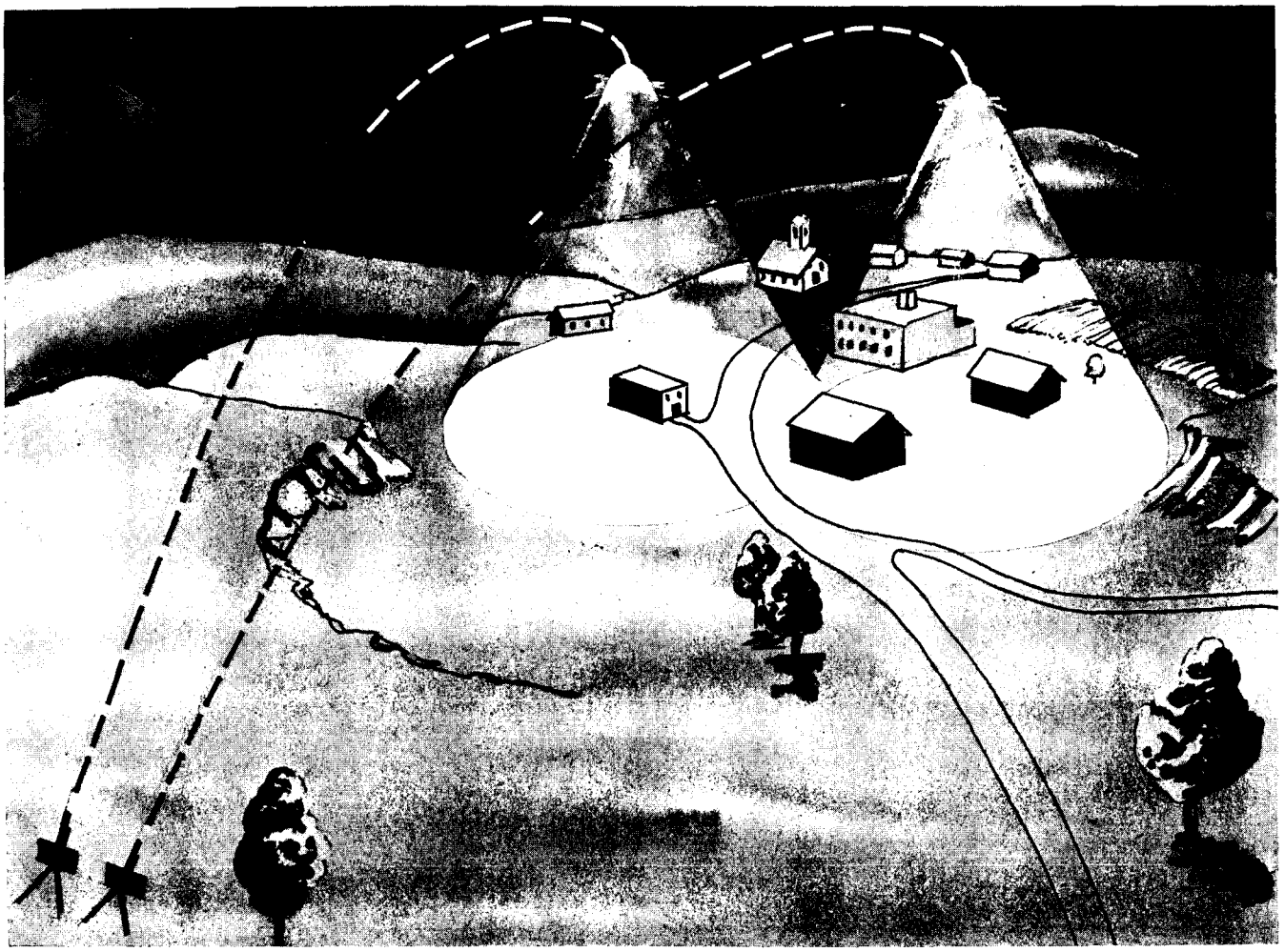


Figure 4–3. Two-gun lateral spread.

fensive operations. (All spreads are made with respect to the gun-target line).

d. Two-Gun Range Spread. Illumination may be provided by firing one round from each of two guns bursting simultaneously but at different ranges along the gun-target line. An area can be illuminated in depth by employing the range spread (fig 4–4). Again, the normal spread is 800 meters between flares.

e. Four-Gun Illumination. Illumination may be provided by firing one round from each of four guns bursting simultaneously in a diamond pattern (a combination of the methods described in *c* and *d* above). It is most effective for searching an area of suspected enemy activity. The four-round illumination pattern is centered over the area indicated by the observer (fig 4–5).

f. Illumination for HE Adjustment. If the adjustment of an illuminating shell discloses a suitable artillery target, the observer should request CONTINUOUS ILLUMINATION while he adjusts HE fire on the target (fig 4–6) as explained in FM 6–40. If the HE adjustment is made on an immobile target or there is a requirement to conserve illumination, the observer should request COORDINATED ILLUMINATION instead of CONTINUOUS ILLUMINATION and request control to be BY SHELL, AT MY COMMAND. Subsequent requests are handled in a similar manner (FM 6–40).

g. Self-Illumination for Close Defense. Artillery firing batteries of 105-mm and 155-mm caliber have the capability to illuminate their own positions in defense against night attacks. Self-illumination must be preplanned to include computation and test firing of data. Normally, the self-illuminating mission is assigned to one howitzer in the firing battery firing shell illumination at preselected data. Since immediate reaction is important in close defense, it is desirable to have a number

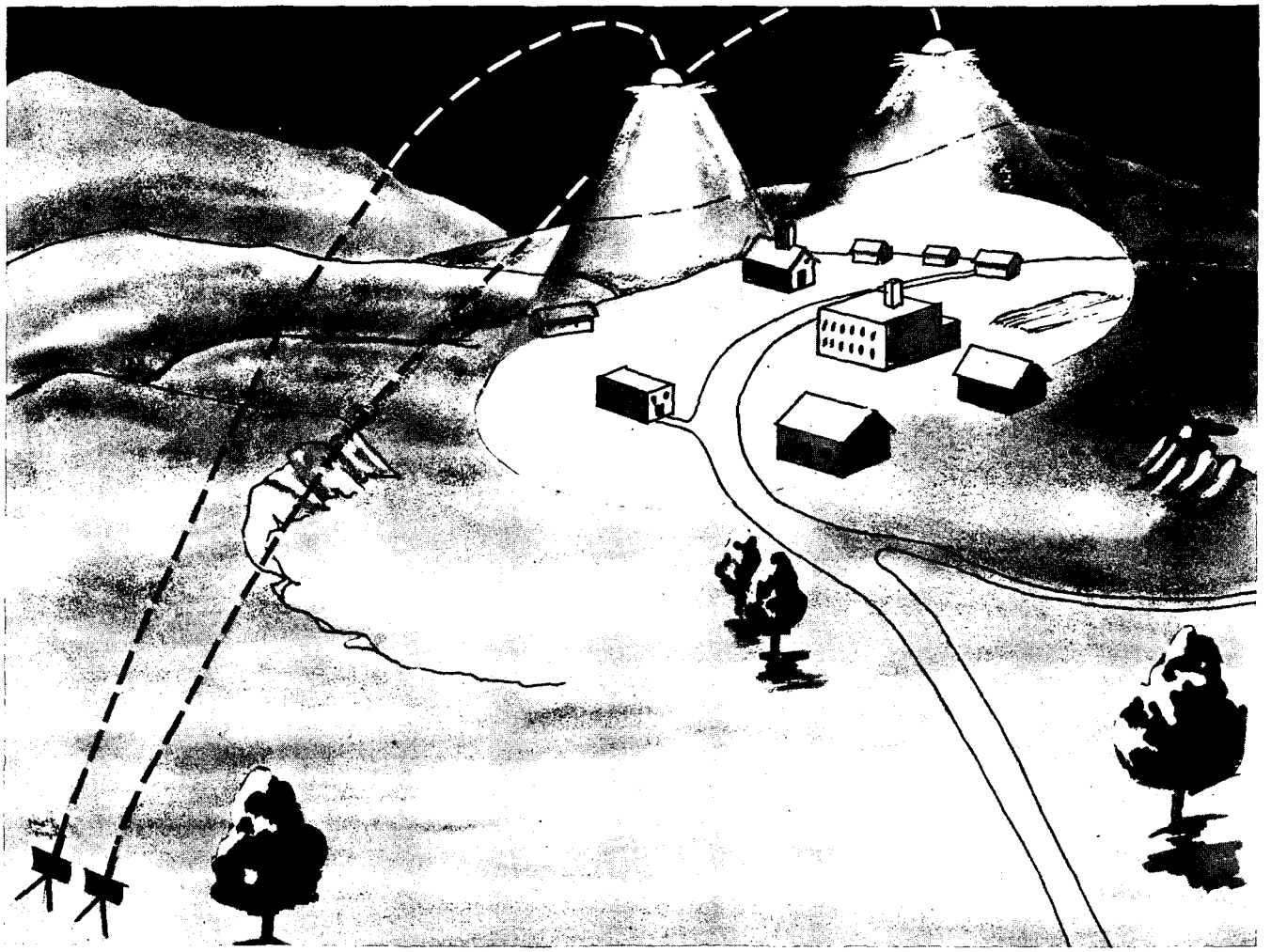


Figure 4–4. Two-gun range spread.

of rounds available at each piece with charges and fuzes cut to the appropriate data. Terrain, weather, and friendly situation will dictate the exact method of employment, but two general approaches are—

(1) High angle fire with any charge and a fuze setting of 5 seconds or less.

(2) Low angle fire at quadrant 100, low charge and fuze settings of 1.0 to 4.0 seconds.

With method (1), precaution must be taken to avoid carrier impact in friendly areas and drift of the flare into the battery area. Method (2) is appropriate when firing into trees and over a friendly perimeter. Whenever possible, and particularly on windy days, check rounds should be fired early in the evening and adjustments made to the prepared data. If accurate data is available and illuminating shells are prepared in advance, a firing battery should be able to provide itself with excellent self-illumination within two minutes after the initiation of an attack.

h. Starlight Illumination. Illumination may be fired to facilitate the use of passive night vision devices. 105-mm and 155-mm illumination rounds fired for burst 6,000 meters beyond and 1,000 meters above a target will provide sufficient light for these devices and will not compromise the observer's position.

4–7. Adjustment Procedures

The procedures used in adjusting 105-mm and 155-mm howitzer illuminating shells by observers or spotters are explained in FM 6–40.

4–8. Factors Affecting Employment

Consideration must be given to the following factors in using each technique in the employment of illuminating shells:

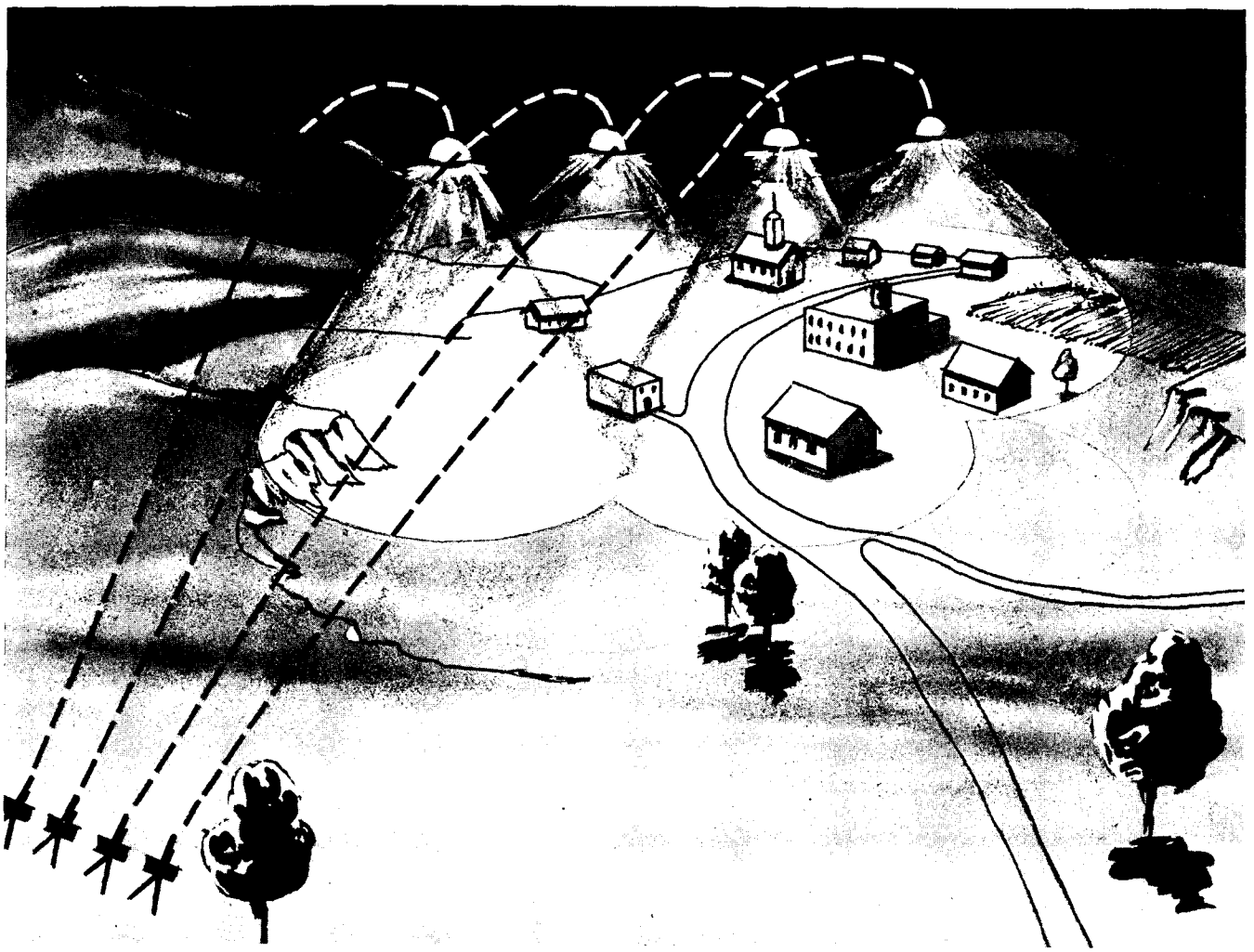


Figure 4–5. Four-gun illumination diamond.

a. The correct height of burst normally is that which will allow the flare to burn out shortly before reaching the ground.

b. A strong wind will necessitate an increase in the rate of fire for continuous illumination.

c. Fog, haze, smoke, and dust will decrease the illumination materially.

d. Refinement of adjustment closer to the target than 200 meters is not justified.

e. Correction in height of burst should be made in multiples of 50 meters. Variation in time of burning renders closer adjustment in height of burst useless.

f. The point of burst for illuminating shells must not be to the rear of or over friendly troops.

g. Care must be exercised by the firing unit to insure that the canister impact point of the illuminating round is clear of friendly positions and populated areas.

h. Continuous illumination for periods longer than a few minutes must be planned in advance, and sufficient weapons and ammunition must be available to maintain illumination.

4–9. Distribution

The number of points at which illuminating shells of a given caliber must be fired to illuminate a frontage by lateral spread (para 4–6*a*) can be determined by the following rule:

Frontage in meters divided by the lateral spread in meters per shell equals the number of points (any fraction becomes another point).

Example:

Frontage is 2,000 meters (155-mm howitzer M118 projectile). Lateral spread is 800 meters (FM 6–40). 2,000 ÷ 800 = 2.5, or 3 points required.

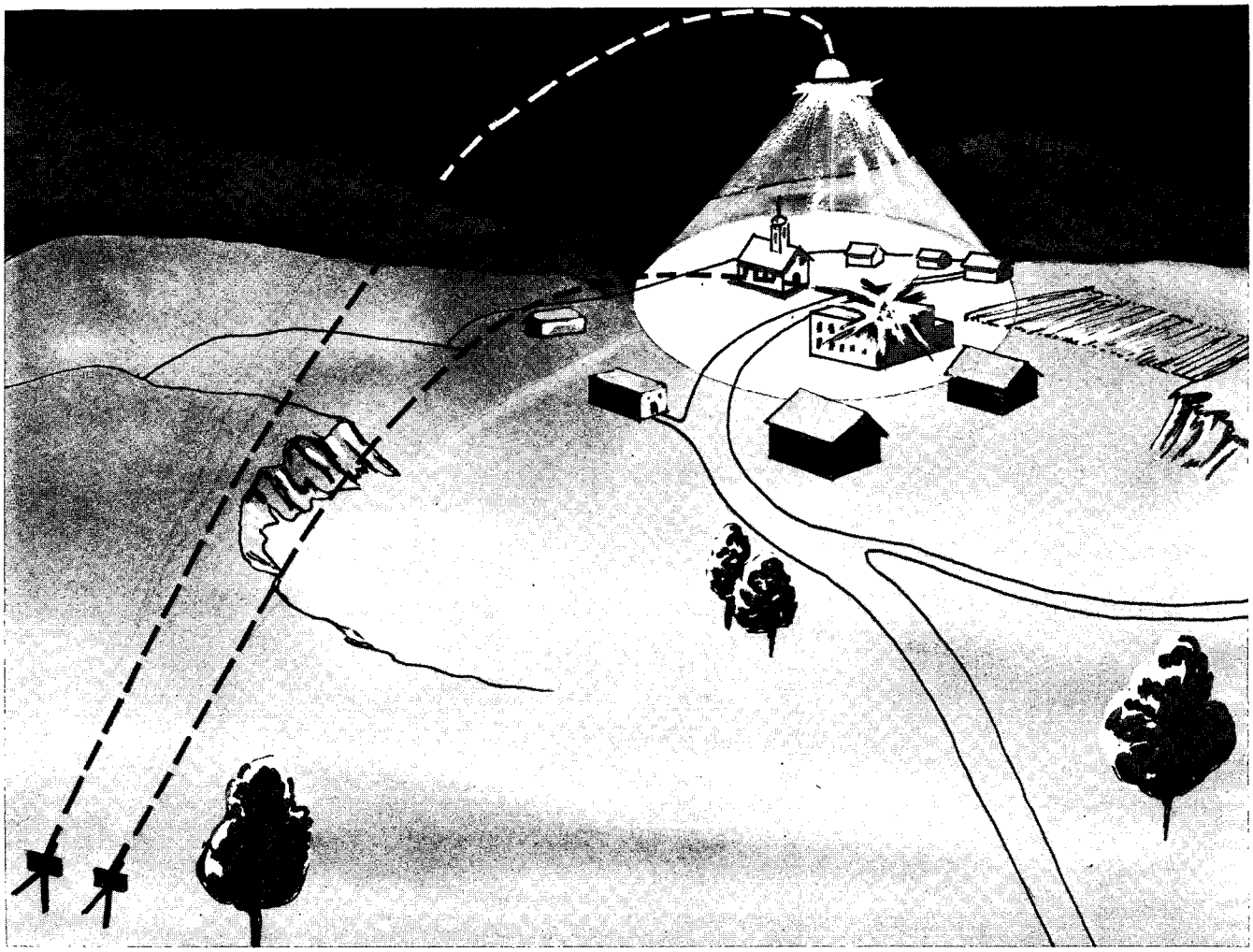


Figure 4–6. Illumination for HE adjustment.

4–10. Planning

Illuminating shells of all calibers are employed in a similar manner. The selection of the weapon to provide illumination depends on the tactical situation and is also controlled by the range to, and size of, the area to be illuminated; the duration of the illumination desired; the ammunition available; other requirements for supporting weapons; and the time available for planning and preparation. In the attack, prolonged illumination of the objective or routes of advance should be provided by searchlights, airborne illumination, or aircraft flares supplemented by general support or reinforcing weapons made available by higher headquarters, thus leaving organic mortar and artillery weapons free to fire conventional support missions. In defensive action, initial illumination should by provided by organic mortar or artillery weapons; but illumination for periods of long duration, or for covering large frontages should be prearranged and made available on call from general support artillery, available searchlights, and supporting aircraft. A checklist to use in planning continuous illumination in support of infantry and armor operations is provided in appendix B.

CHAPTER 5
SEARCHLIGHTS

Section I. GENERAL

5–1. General

a. Searchlights are employed in a combat role on the battlefield by combat units to assist in the accomplishment of their missions during periods of darkness. Searchlights provide the most reliable, efficient, and economical means available to the field commander for providing continuous illumination over an extended period of time. These lights may be employed, singly, in pairs, by platoons, or by battery/company as the tactical situation requires. When employed in pairs the usable illumination generated by the two lights is approximately 25 to 45 percent brighter than the combined output of the two lights when they are individually considered. This is also the case when searchlights are used as platoon-, company-, or battery-size elements. Lights are more difficult for the enemy to locate when pairs (or greater numbers) are employed.

b. Searchlights are often used in their secondary role of providing illumination around the perimeter of fixed and semi-fixed installations. They may also be used for illumination of bridging sites; emergency illumination of airfield landing areas; illumination of dock loading and unloading operations and facilities; and the illu-

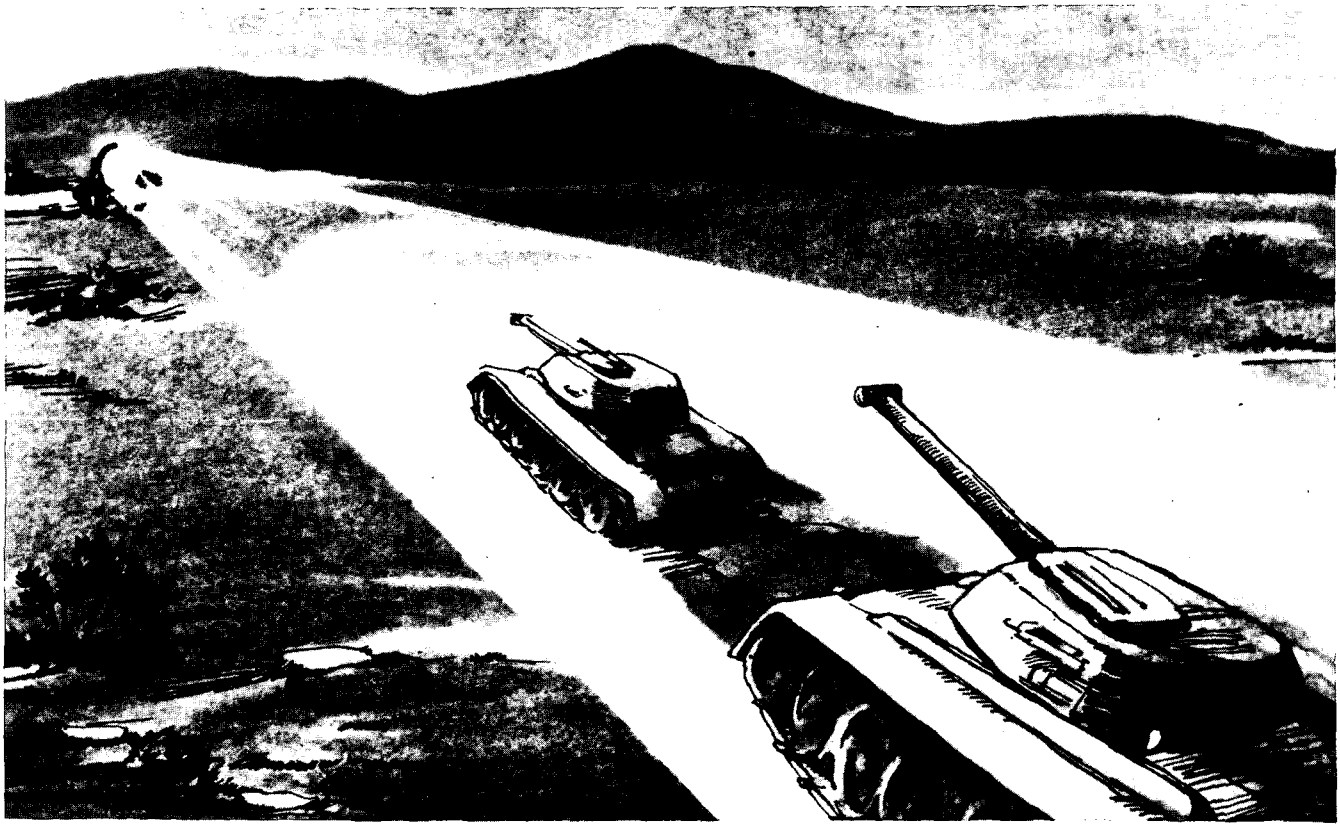


Figure 5–1. Direct illumination.

mination of logistical depots. Employment of searchlights in this secondary role must not interfere with or detract from their employment in the support of combat operations.

c. A minimum of one field artillery searchlight battery (TOE 6–558) is normally assigned to a corps artillery. It has the mission of furnishing direct and indirect illumination in support of tactical night operations within division and corps areas.

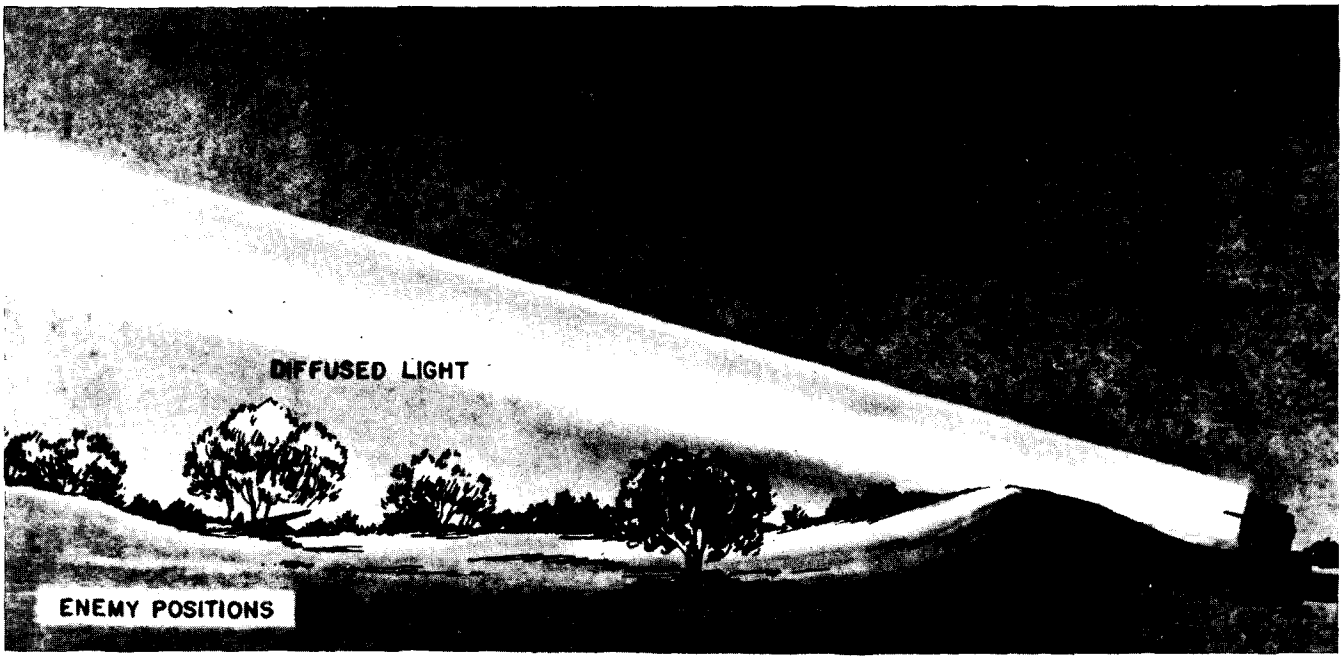


Figure 5–2. Diffused illumination.

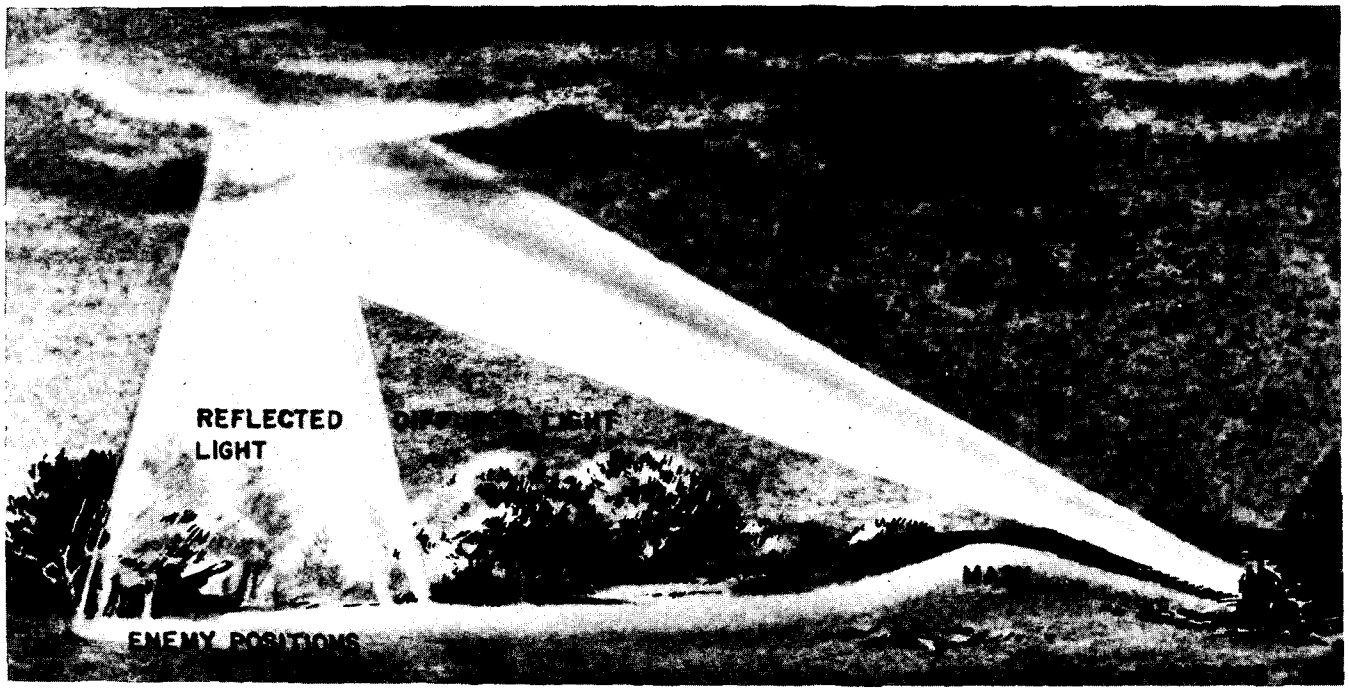


Figure 5–3. Reflected illumination.

5–2. Employment

a. The use of searchlights as a battlefield illuminant provide the commander with a responsive and reliable light source capable of delivering continuous light for long periods of time with minor supervision and adjustment. This light may be provided by either the direct or indirect method of employment.

b. Direct illumination is provided by placing the searchlight beam directly on the target (fig 5–1). Maximum illumination of the target is obtained when the searchlight is employed in this manner. A detailed discussion of the employment of searchlights in the direct mode is contained in FM 6–115.

c. Indirect illumination is provided by either diffusion or reflection of the searchlight beam. Diffused illumination is obtained by positioning the searchlight to the rear of a ground mask and elevating the beam until approximately 98 percent of the light beam passes the crest of the ground mask (fig 5–2). Reflected illumination is obtained by directing the light beam on an overhead cloud or other reflective surface and reflecting the light to the target area (fig 5–3). The altitude and percentage of cloud cover are crtical to the effective employment of searchlights in the indirect mode of illumination. Smokescreens can be employed at night to enhance reflectivity of searchlights. A detailed discussion of the indirect method of employment of searchlights is contained in FM 6–115.

Section II. TYPES OF SEARCHLIGHTS

5–3. Types of Searchlights

a. General. The current army family of searchlights is composed of three Xenon lights of varying size; these are the 15-, 23-, and 30-inch searchlights. Physical and operational characteristics of each of these searchlights are shown in table 3.

Table 3. Data Xenon Family of Searchlights

	15-inch	23-inch	30-inch
1. Nomenclature	AN/VSS–3( )	AN/VSS–1 (Tank Mtd) AN/GSS–14 (Truck Mtd)	AN/TVS–3.
2. Physical Characteristics:			
a. Size	15″ x 15″ x 18″	20.5″ x 30.75″ x 31.5″	78″ x 66″ x 54″.
b. Weight	75 lbs	245 lbs	1200 lbs.
c. Peak beam candlepower	75 million minimum	75 million minimum	400, 650, 800 or 1,000 million minimum.
d. Field of view:			
(1) Compact	1°	0.5°	1.7°.
(2) Spread	7°	7°	10°.
3. Operational Characteristics:			
a. Range (meters):[1]			
(1) IR	3500+	5000	7500+.
(2) Visible:			
(*a*) Spread	3000+	4000+	10,000+[2].
(*b*) Focused	4000+	5000+	15,000+[2].
b. Power source	Vehicle, 24–28VDC, 50 amp system.	Vehicle, 24–28VDC, 180 amp system.	Generator 10, 15, 20 or 25 KW, 120/208V, 3 phase, 400 cycle 4 wire.
c. Personnel requirements:			
(1) Installation	1 man	2 men	4 men.
(2) Operation	1 man	1 man	2 men.
d. Operator training requirements	5 hours	5 hours	5 hours.
e. Transportation requirements	Vehicle mounted	Vehicle mounted	Vehicles pull trailer mounted searchlight and generator.
f. Operational limitations and shortcomings.	Limited penetration of smoke or heavy fog.	Limited penetration of smoke or heavy fog.	Weight, noise, mobility, limited penetration of smoke or heavy fog.

[1] Testing of Xenon searchlights has not been completed. Data above is based on limited testing and will be revised as more definitive information becomes available. Ranges listed are for planning purposes and are valid to ranges shown under conditions noted below.

a. Ranges beyond 7500 meters were not tested and may be exceeded under certain conditions.

b. Ranges indicated above are from the searchlight with the observers in some cases at shorter observer-target ranges. Generally, tests demonstrated that observers at ranges greater than 4000 meters from the target are unable to distinguish vehicle types under direct illumination conditions. Most effective observation is obtained when the observer is within 1500 meters of the target. Night vision devices further enhance the observers capabilities to detect targets at this range. Lights can be positioned further back from a given target area and still provide usable illumination to personnel well forward of the searchlights under both direct and IR illumination.

c. Range varies depending on generator used with the 30-inch searchlight and newer production models have improved reflectors.

d. Data provided isf or employment of a single searchlight. Using two searchlights increases effectiveness by 50 percent.

e. Use of "Pink" light range filters have increased IR range capabilities.

[2] Ranges listed are estimated and may be exceeded under proper conditions.

b. The 15-inch Xenon Searchlight. This searchlight was designed for issue to armored cavalry units. It is normally vehicular mounted for employment in the infrared (IR or "Pink") mode in conjunction with other combat vehicle night vision system components. "Pink" mode operation consists of a filter which passes some visible light which cannot be detected with the unaided eye (para G–12). The light is also capable of operation in the visible light mode; in this mode it may be used to advantage by mounting it in perimeter watchtowers, in a vehicular mounting, or in a helicopter mounting (fig 5–4).

c. The 23-Inch Xenon Searchlight. This searchlight was designed primarily for use on the M–60 tank. However, pending development of the 30-

Fgure 5–4. 15-inch Xenon Searchlight AN/VSS–8.

inch Xenon searchlight, the 23-inch light was mounted on a ¼-ton truck and issued to field artillery searchlight batteries in lieu of the larger 30-inch carbon arc searchlight. The basis of issue was two 23-inch searchlights for each 30-inch searchlight authorized. The 23-inch Xenon searchlight may be effectively used in either the visible or infrared mode to provide night observation. This searchlight may also be used to advantage in perimeter defense and in vehicular or ground mountings (fig 5–5).

d. The 30-Inch Xenon Searchlight. The 30-inch searchlight is the standard item of equipment designed for use by artillery searchlight units. Its modes of operation include a visible and infrared mode in either a normal or spread beam configuration. For direct illumination, the beam is adversely affected by fog, smoke, or dust; for indirect illumination, the same factors reduce the effective range of the beam; however, they may increase the intensity of illumination due to greater reflection and diffusion (fig 5–6). Xenon lamps are characterized by the emission of radio-frequency (RF) energy in the frequency range of 1.5 – 2.5 mHz and may cause interference of AM (HF) type radios in proximity to the searchlights. Initial testing indicates that FM radios are not subject to this interference, but further testing is being conducted.

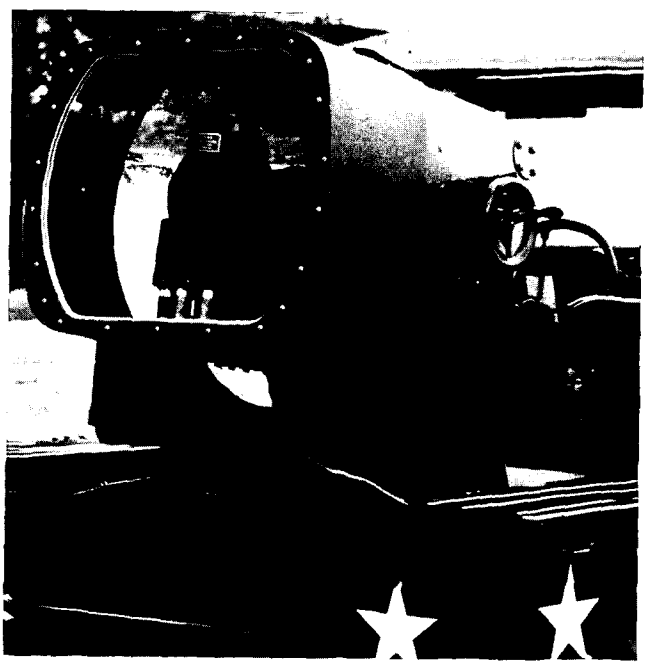


Figure 5–5. 23-Inch Xenon Searchlight AN/GSS–14, Truck Mounted, (Tank mounted, AN/VSS–1 with Pink Filter, AN/VSS–2).

Figure 5–6. 30-Inch Xenon Searchlight AN/TVS–3.

5–4. Infrared Employment of Xenon Searchlights

a. General. Although the definition of battlefield illumination excludes infrared (IR) operations, Xenon searchlights have an infrared light capability. While infrared is useful in many situations, an enemy equipped with infrared viewing devices may be able to use infrared emissions to locate friendly elements. Improper use by operators may also disclose friendly positions. Commanders must be aware of the advantages and disadvantages of this mode of searchlight operation. A pencil beam has proven to be the best for IR operations.

b. Advantages. Infrared light can be used to—

(1) Illuminate a target area, and normally cannot be detected by the unaided eye beyond 10 meters from the light source.

(2) Increase night firepower effectiveness of crew served weapons.

(3) Provide a means for early detection of enemy patrols or larger size forces.

(4) Reduce the danger of enemy night attacks.

(5) Assist the adjustment of night defensive fires.

(6) Assist in orienting friendly patrols who are equipped with infrared viewers.

(7) Increase the range of organic ground unit infrared viewers.

(8) Overload enemy infrared viewers and temporarily blind operators.

c. Disadvantages. Infrared emitters—

(1) May disclose friendly positions to an enemy equipped with infrared viewers. The vulnerability of searchlights operating in the infrared mode has not been tested, but an enemy would have to have at least two infrared detectors at surveyed locations to accurately locate a distant searchlight. Approximate positions could be estimated by an enemy familiar with the terrain.

(2) May not be used when white light illuminators are used.

(3) May be subject to enemy countermeasures by physical means.

(4) Are limited to line of sight.

(5) Are less effective in bright moonlight.

d. Coordinated Operations. The use of searchlights in the infrared mode can greatly increase the effectiveness of crew-served weapons. Detection of a target by AN/TPS-25 or other ground surveillance radars can alert the searchlight crew to orient and search an area for targets in the infrared mode. The collocation of ADA weapons such as the M55 (Quad .50 Cal MG), M42 (40mm Cannon) "duster," or M741 (20mm) "Vulcan" with a searchlight greatly enhances the weapons' night effectiveness. Both systems are oriented in aximuth and elevation. When the target is acquired by the searchlight in the infrared mode, the weapon is oriented in aximuth and elevation to the target. The exact range to the target can be computed on an M–18 computer and furnished to the gun crew. Upon command, the light is switched from infrared to visible light and the weapon commences firing, thus giving improved visibility of the target and enhancing surprise. The ground surveillance radar, by periodic monitoring, can determine if personnel are crawling or moving in the target area after the firing has ceased and the visible light has been turned off.

e. Viewing Equipment. Considering the following items of IR viewing equipment, the night vision sight for crew-served weapons was found to be best for field artllery purposes:

(1) Night Vision Sight, Crew and Individual Served Weapon.

(2) Metascope Assembly.

(3) Binoculars, M–18

Note. Air observers found the M–18 Binocular the best for field artillery purposes. Newer equipment should be considered as it is developed. Appendix G contains additional informaton on IR and passive viewing devices.

CHAPTER 6
AIRCRAFT FLARES

6-1. Introduction

a. General. Aircraft flares may be employed to provide illumination for the conduct of all types of night operations. Although most aircraft flares were designed for use with high performance aircraft, some are suitable for drop by a variety of Army aircraft. Characteristics of available flares are listed in table 4. Each of the flares listed has a very high illumination intensity, a slow rate of descent, and a relatively long burning time. The Mark 24 is the flare most commonly employed by Army aircraft, and the Mark 45 will replace the Mark 24. The use of air-delivered flares frees ground weapons to fire conventional supporting fires rather than illumination missions. The use of aircraft for illuminating missions reduces the logistical problem of ammunition resupply associated with ground support weapons since these aircraft can operate directly from the supply point to the target area.

Table 4. Characteristics of Aircraft Illuminating Flare

Item	Method of actuation	Time lapse from actuation to full function	Burning time (sec)	Candlepower (in thousands)	Rate of descent [1] (fps)	Max lg (in.)	Max dia (in.)	Weight (lb)	Max speed of aircraft at time of release (knots)	Approximate area illuminated (radius/meters), one lumin per sq meter	Flare required to provide continuous illumination for 1 hour for one point
Mk 45	Released from aircraft.	Variable 6 to 61 sec.	180 to 210	1,650 to 2,000	7.5	36	4.87	28	550	750	20
M8A1[2] (w/o suspension bands) (emergency night landing). M8A1 [2] (training) (w/o suspension bands).	Released from aircraft.	3.0 to 5.0.	165 to 195	350	8.0	25.42	4.25	17.6	200	700	27
Mk 24 Mods 1, 2, and 2A. Mk 24 Mod 3.	Released from aircraft.	Variable 5 to 30 sec.	150 to 180	2,000	7.5	36	4.87	24 to 27	550	750	40

[1] In still air.
[2] Two Band Suspension, Parachute Flare M8A1 required for use with Flare Aircraft, Parachute M8A1.

b. Considerations for Use.

(1) Wind, which causes flares to drift for considerable distances, must be considered in determining the drop point of the flare.

(2) The best altitude for burst must be determined to use the full burning time of the flare and still provide for maximum illumination on the ground.

(3) An effective navigation system such as radar, intersecting searchlights, marking rounds, or a ground controller may be needed to guide the aircraft to the release point.

(4) Considerations must be given to such factors as weather, employment of smoke, and enemy air countermeasures.

c. Requests. Requests for aircraft flare illuminating missions are submitted in the same manner as requests for other air support missions. An immediate mission may be assigned to Army aircraft or it may be forwarded through air support request channels to the Direct Air Support Center (DASC). Preplanned requests are forwarded through Army channels to the Tactical Air Support Element (TASE) at the FATOC. The unit

requesting the illumination will be advised of approval or disapproval of the mission. Requests for illumination must be coordinated in the same manner as requests for other fire support. Coordination should include, but not be limited to, control, communications, liaison with adjacent units, and air defense unit notification. The request should include the following information:

(1) The date illumination is required.

(2) The purpose (manner in which ground forces intend to employ the illumination).

(3) The duration of illumination requested (specific times, such as three minutes at 2150, 2240, 2310 hours; 90 minutes continuous after 0145 hours; or on call).

(4) The grid reference of the points or areas to be illuminated or a clearly marked map.

(5) The proposed control means.

(6) Communication to be used for control, with frequency and call sign of controlling element.

6–2. Control

Control of aircraft flares employed for battlefield illumination is exercised by the commander being supported. Surveillance, control, and adjustment of battlefield illumination by Army aviation is coordinated by the Army aviation special staff officer. Direct communication between the ground controller (FO, Forward Air Contoller (FAC), Bn S3, etc) and the aviator providing the illumination is necessary to provide for timely responsiveness. Since aircraft flares may be carried off target by the wind, particular care must be exercised in determining the initial drop point for each type flare. Data for determining the drop altitude for all type flares is contained in TM 9–1370–200. In all instances, initial flares should be dropped well beyond friendly elements until the direction, rate of drift, and altitude of burst have been established.

6–3. Determination of Release Altitude and Fuze Settings for the MK24 Aircraft Flare

a. The MK24 aircraft flare is the flare most commonly employed by Army aircraft, and as such merits special discussion on determination of release altitude and fuze settings. In order to obtain maximum usable illumination, fuzes should be set so as to insure burnout before the flare strikes the surface. The flares are also likely to ignite combustible materials unless they are entirely burned out and cool when they land. Safe launch heights are dependent upon the burning time, fuze settings, rate of descent, and drift of the flare. In setting fuzes, the following facts must be considered: After launch and before parachute opening, the flare falls approximately 300 feet during the first 5 seconds, 700 feet during the next 5 seconds, and approximately 1,000 feet for each 5 seconds thereafter. After the parachute opens, the average rate of descent is 7.5 fps. Mods 1, 2, and 2A will burn for approximately 1,125 feet of fall before burnout. Charts 1 and 2 can be used to determine flare launch altitude and flare fuze settings. The minimal flight altitudes are based on burnout at approximately 350 feet above ground level. It should be noted that these charts do not take drift into consideration. Drift corrections must be determined for each launching site based on local wind conditions.

Chart 1. Launch Altitudes to Provide Burnout at Approximately 350 Feet Above Ground Level

Ejection Fuze Settings	5	10	15	20	25	30
Launch Altitude (Mods 1, 2, and 2A)	1800	2500	3500	4500	5500	6500
Launch Altitude (Mods 3 and 4)	2050	2750	3750	4750	5750	6750

Note No. 1. Each 5-second interval on ignition adds 75 feet to altitude of burnout.

Note No. 2. There is no 5-second ignition setting on Mods 2A, 3 or 4.

Chart 2. Distance of Fall for Fuze Settings Prior to Flare Ignition (in feet)

		Ignition Fuze Settings (seconds)					
		5	10	15	20	25	30
Ejection Fuze Settings (seconds)	5	350	425	500	575	650	725
	10	1075	1150	1225	1300	1375	1450
	15	1975	2050	2125	2200	2275	2350
	20	2975	3050	3125	3200	3275	3350
	25	3975	4050	4125	4200	4275	4350
	30	4975	5050	5125	5200	5275	5350

Note. The height values were calculated using the mean delay time of the fuze settings.

Following are three examples which illustrate how chart 2 is used:

Example No. 1—To determine what fuze settings to use when the height of desired flare igni-

tion and the altitude the aircraft will fly is known, use the following method:

(1) Subtract the height of desired flare ignition from the altitude the aircraft will fly.

(2) Using this number, read the ejection fuze setting and the ignition fuze setting.

Example No. 2—When the fuzes on the flare have been preset and the altitude of desired flare ignition is known, determine the launch altitude using the following method:

(1) Find the ejection fuze setting and the ignition fuze setting on the chart and read the distance of fall at the intersection of the fuze setting columns.

(2) Add the distance of fall to the desired ignition altitude to determine the launch altitude.

Example No. 3—When the fuzes on the flare have been preset and the aircraft's altitude is known, determine the altitude of flare ignition, using the following method:

(1) Obtain the distance of fall as in (1), Example 2 above.

(2) Subtract the distance of fall from the launch altitude to obtain the ignition altitude.

b. Procedures for determining release altitude and fuze settings for other type aircraft flares are contained in TM 9–1370–200.

6–4. Training

Ground personnel must be trained in the care, handling, storage, and proper installation of flares on Army aircraft. Aviators must be trained in the technique of releasing the flares at correct altitudes, speeds, and fuze settings in accordance with the data listed in the appropriate manuals. Safety precautions concerning the installation, arming, releasing, and jettisoning of carriers or flares which malfunction should be included in the training of Army aviators and crew members. Frequent training exercises, including radar vectoring missions, should be scheduled and coordinated with supported units to familiarize all participants with planning and teamwork. Ground units should request illumination missions in order that both air and ground personnel can become familiar with the teamwork necessary to provide timely and usable battlefield illumination.

CHAPTER 7
NAVAL ILLUMINATING SHELL

7–1. General

Naval illuminating shells are available for 5-inch and 6-inch naval guns only. Battleships, heavy cruisers, light cruisers, and destroyers mount the 5-inch or 6-inch gun either as the primary or secondary battery. When the tactical situation is such that naval fire support is to be furnished to ground forces, naval illumination may be requested through fire support channels. The request should include information similar to that required for aircraft flare illumination (para 6–1*c*). See paragraph 10–4 for hazards associated with employment.

7–2. Capabilities and Limitations

a. Naval guns firing the illuminating shell (normally referred to in the Navy as *star shell*) can provide battlefield illumination similar to *on-call* artillery or mortar illumination. The recommended assignment of fire support ships to troop units is listed in table 5.

*Table 5. Recommended Assignment of Ships**

Combat ship	Troop unit	Support
Destroyer or light cruiser	Battalion	Direct
Heavy cruiser or light cruiser	Brigade	General
Heavy cruiser	Division	General

*Final assignment of mission will depend on the availability of fire support ships and the tactical situation. Destroyers and light cruisers are normally assigned DS missions in the amphibious operation, and heavy cruisers and battleships are assigned general support missions.

b. The maximum range for the 5-inch/38 naval gun is 16,400 meters and the 5-inch/54 is 23,600 meters. The maximum range for the 6-inch naval gun is 21,100 meters. The actual inland range of naval illuminating fire depends on the distance the ship must stay from the shore. The supply of illuminating shell on a ship is limited, and expenditures must be based on the importance of mission. Troop support by naval illuminating shell requires detailed coordination. An artillery forward observer or a ground commander can adjust fire through the naval gunfire spotter or naval gunfire liaison officer, both of whom normally have communication with the supporting ships. The interested ground commander can exercise full control over the illumination through the naval liaison furnished.

CHAPTER 8
IMPROVISED MEANS OF ILLUMINATION

8–1. General

a. Field expedient illumination devices, to include flare illuminators, may be used in any operational environment to produce improvised means of limited battlefield illumination. They are particularly useful in stability operations in enhancing the defensive posture of isolated outposts, village/hamlets, night defensive positions, and temporary combat and fire support bases.

b. The variety and design of field expedient devices available for use on the battlefield are limted only by the imagination and initiative of the individual/organization employing them. Material required for their construction is usually readily available and accessible within the battle area and should not present an acquisition problem.

8–2. Field Expedient Devices

Some field expedient devices have limited application; however, most may be used to advantage in any situation. In determining the type device to construct and employ, no possible device should be overlooked. Devices discussed in the following paragraphs are a few of the many illumination devices that have been successfully employed on the battlefield. For a detailed account of the use of field expedient illumination devices, refer to FM 20–33.

a. Thatched Roofs, Grass, Brush, or Woods Fires can be started by white phosphorous shells, illuminating shells, flares, tracer ammunition, or other means. In addition to harassing the enemy, these fires often provide sufficient illumination to silhouette the enemy forces and allow effective fire to be placed on them.

b. High-Danger Flare. The high-danger flare is improvised by using a number 10 can partially filled with sand that is saturated with a mixture of lubricating oil and gasoline. The flare is placed in a likely route of approach to a defensive position and ignited. The flare will burn for several hours and produce sufficient illumination to silhouette enemy personnel between the observer and the flare for distances up to 50 meters.

c. Flame Illuminator.

(1) *Description.* The flame illuminator (fig 8–1) is a valuable field expedient that is effective for limited illumination of selected areas of the battlefield. It consists of a container (5 to 55 gallon) filled with thickened fuel, a white phosphorous (WP) grenade to ignite the fuel, an explosive charge, and a firing system. Burning time is affected by many factors. These factors include the viscosity of the thickened fuel, size and shape of the container, and the size of the opening. In constructing a flame illuminator, it should be considered that a thick fuel will burn longer than a thin fuel and that a long narrow container will cause the fuel to burn longer than the same fuel would burn in a wide container. For example, the burning time of a flame illuminator made from an 8-inch howitzer propelling charge container filled with 6 percent thickened fuel can vary from 2 to 4 hours depending on the size of the opening used in the device.

(2) *Assembly.* To assemble a flame illuminator—

(*a*) Fill the container with thickened fuel and replace bung(s).

(*b*) Secure three turns of the detonating cord along the inside of the top rim of the container, leaving 3 to 5 feet of detonating cord (the main line).

(*c*) Attach a nonelectric firing system near the end of the main line of the detonating cord by taping the nonelectric blasting cap to the detonating cord, with the base of the cap pointing in the direction the detonation wave is to ravel.

(*d*) Prepare a detonating cord and white phosphorus hand grenade assembly and attach it to the top of the container or in a small hole nearby in such a manner that the functioning of the explosive charge and the grenade assembly will be simultaneous, thereby igniting the fuel.

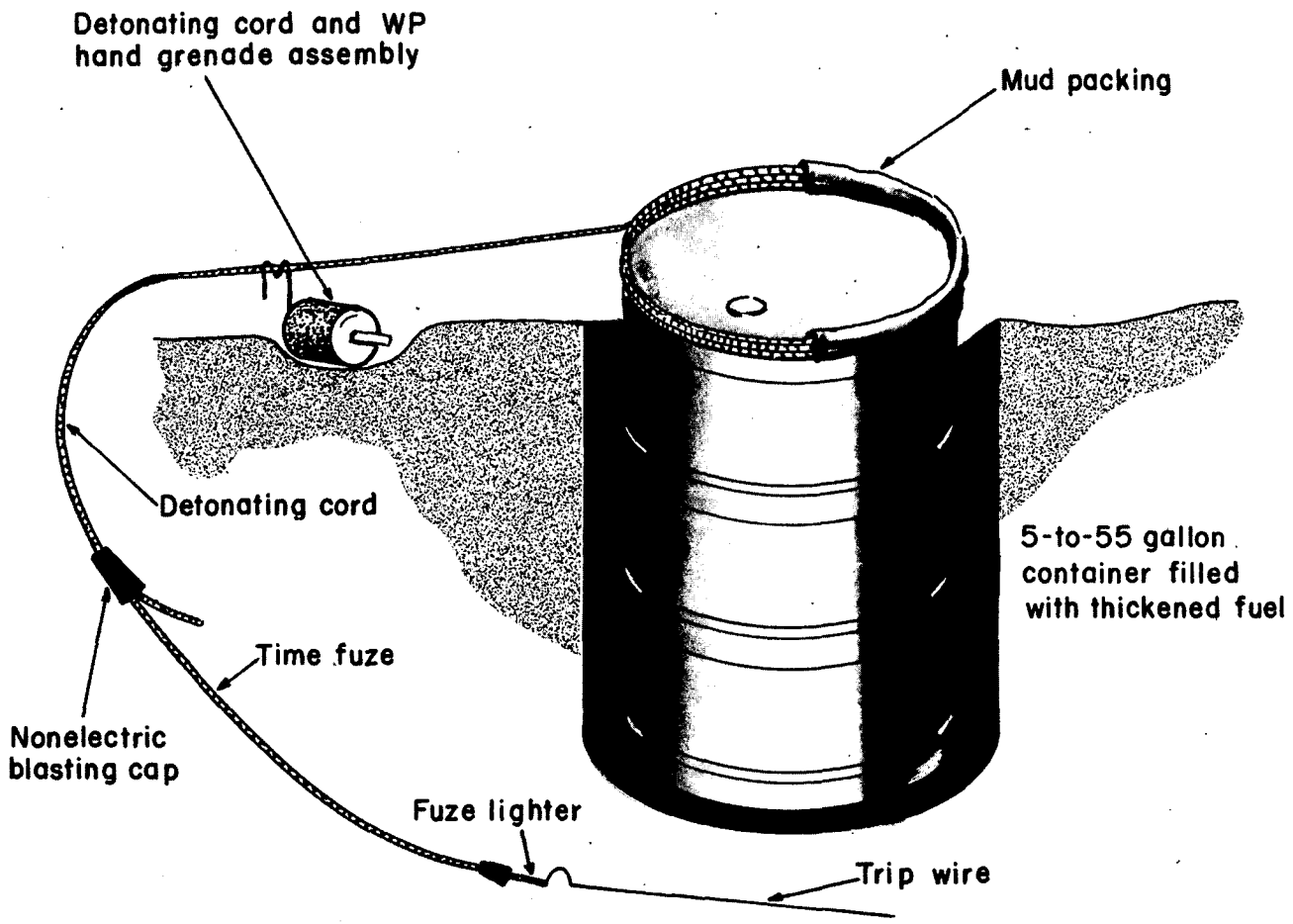


Figure 8–1. Type flame illuminator with nonelectric firing system.

Note. The assembly is prepared by wrapping five to seven turns of detonatng cord around the grenade body and securing the cord to the grenade. One end of the cord is left loose (the branch line) to be tied to a main line of detonating cord.

(*e*) Connect the branch line of detonating cord from the detonating cord WP grenade assembly to the main line of detonating cord by using a girth hitch to form an angle of not less than 90 degrees, or by using the standard M1 detonating cord clips,

(*f*) For electrical firing, replace the nonelectric firing system attached to the main line detonating cord with an electric blasting cap. Connect the lead wires from the electric blasting cap to firing wires runing to a source of power.

Caution: **Before attempting to attach the electric blasting cap lead wires to the firing wire, definitely ascertain that the firing wire is not connected to power source, i.e., a blasting machine or battery.**

Note. FM 5–25 contains detailed information concerning electric and nonelectric detonating cord firing systems. TM 3–366 contains information on the preparation, handling, and storage of flame fuels.

d. Husch Flare.

(1) *Description.* The Husch flare is a special type of flare illuminator that permits thickened fuel (TM 3–366) to be vaporized and expelled as a burning jet through a small hole. It consists of one or more metal cylindrical tubes, such as propellent or shell containers, filled with thickened fuel and inserted into a larger metal container also containing varying amounts of thickened fuel. Figure 8–2 shows an example of a Husch flare consisting of a smoke pot shipping container, two 81-mm mortar shell metal containers, thickened fuel, and a WP illumination grenade. The assembly details in (2) below relate to the Husch flare illustrated in figure 8–2; however, other Husch-type flares can be constructed by using similar components.

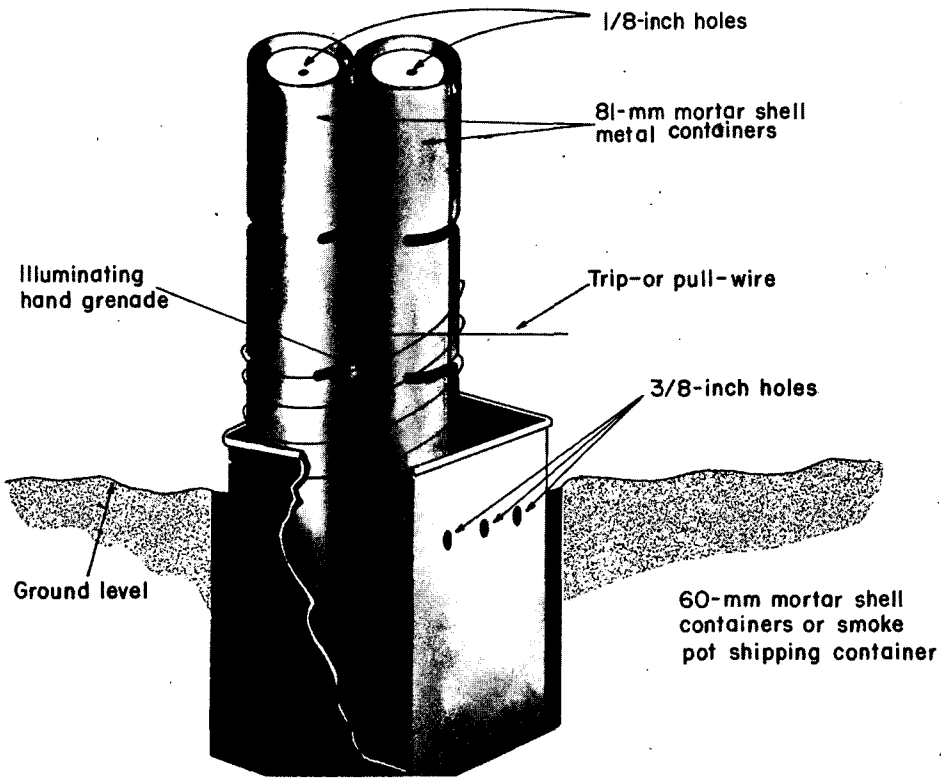


Figure 8–2. Husch flare.

(2) *Assembly.* To assemble the Husch flare—

(*a*) Remove the metal crossbars from inside the smoke pot shipping container. Punch three ⅜-inch holes in each side approximately halfway between the top and bottom of the container. Fill the container one-third full with thickened fuel.

(*b*) Punch a hole no larger than one-eighth inch in the bottom of both 81-mm mortar shell metal containers.

(*c*) Temporarily plug the holes and fill the containers approximately three-fourths full with thickened fuel. Apply heavy grease to the mortar container caps, and fasten the caps on tightly to make the mortar shell containers leakproof.

(*d*) Place the 81-mm mortar containers in the smoke pot container with the caps down. Within the smoke pot containers, pack large stones around the 81-mm mortar containers to wedge them firmly in an upright position. Remove the temporary plugs from the holes in the 81-mm mortar shell containers.

(*e*) Tie a WP or incendiary grenade between the 81-mm mortar shell containers just above the top level of the smoke pot shipping container.

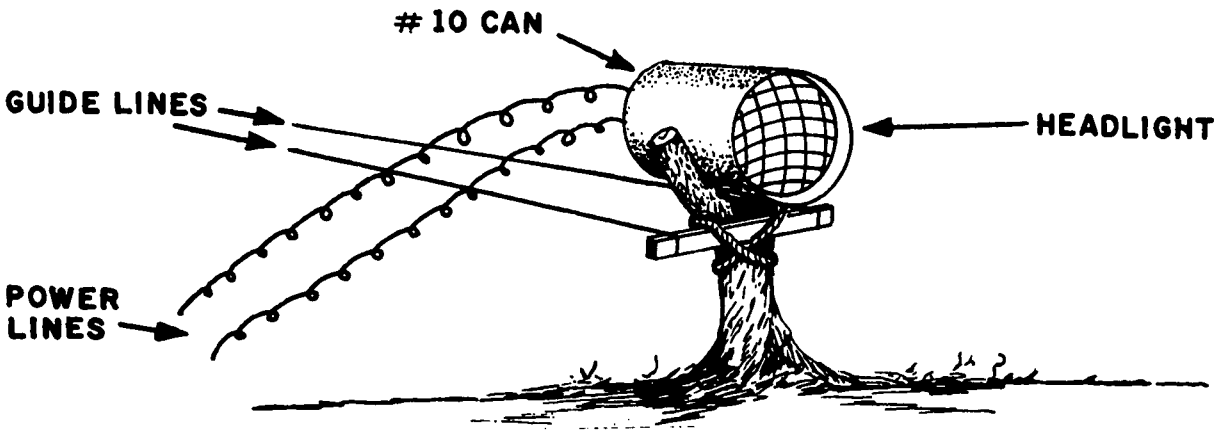
(*f*) Attach a suitable length of pull or trip wire to the pull ring of the grenade. Extend the pull or trip wire to the point selected for activation (at least 25 meters from the device).

(*g*) Press the tips of the grenade cotter pin together so that the cotter pin can be removed easily.

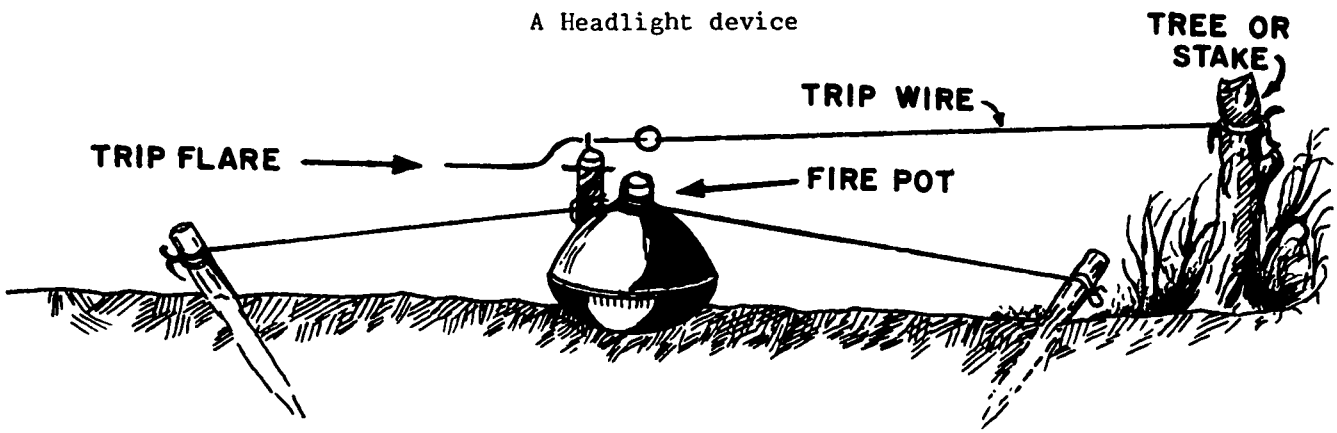
(3) *Effects.* When ignited, this particular Husch flare burns for about 1 hour, illuminating an area about 90 meters in diameter.

(4) *Employment.* Husch flares can be effectively used in the open where a need for emergency illuminating devices exists. To provide some protection from shell fragments and small-arms fire and to prevent tipping, bury one-half to three-fourths of the smoke pot shipping container in the ground or sandbag the installation.

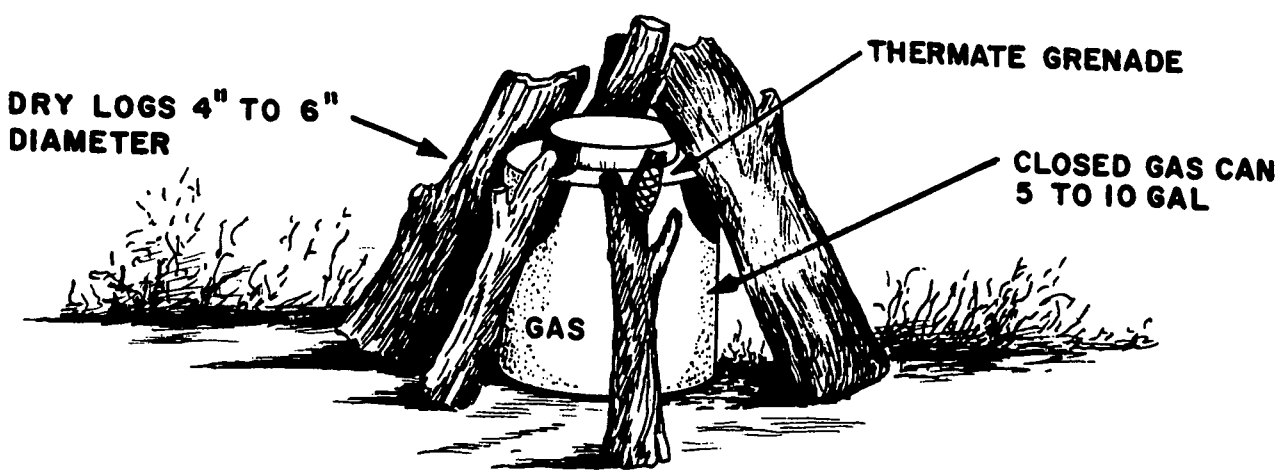
e. Headlight Device. Place a sealed beam or a regular headlight with the reflector in a number 10 can. Extend the wires out from the bottom of the can and secure the lamp so that it cannot move. Tie the number 10 can to a strong forked stake and attach a crossbar extending at least 1 inch on each side of the can. Place the stake in the hole at the desired location. Attach the guide line



A Headlight device

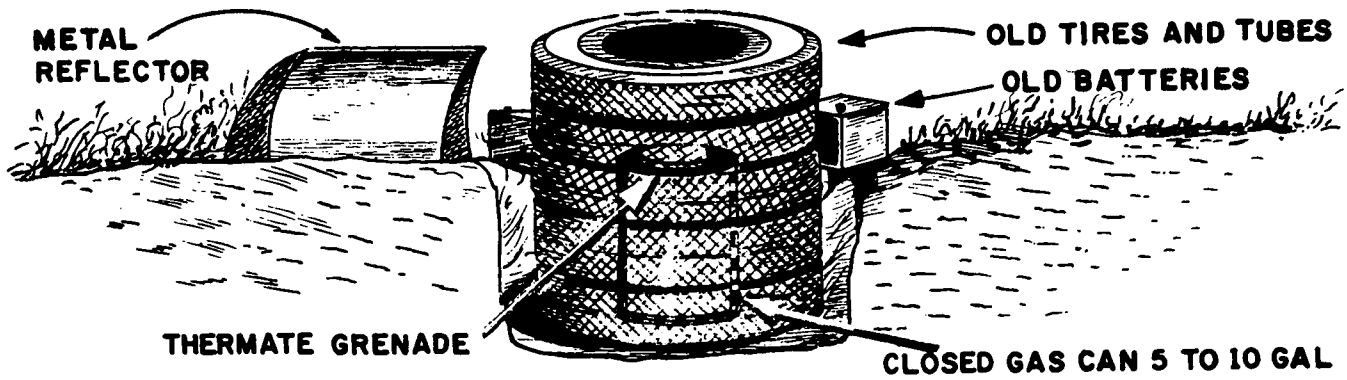


B Fire pot

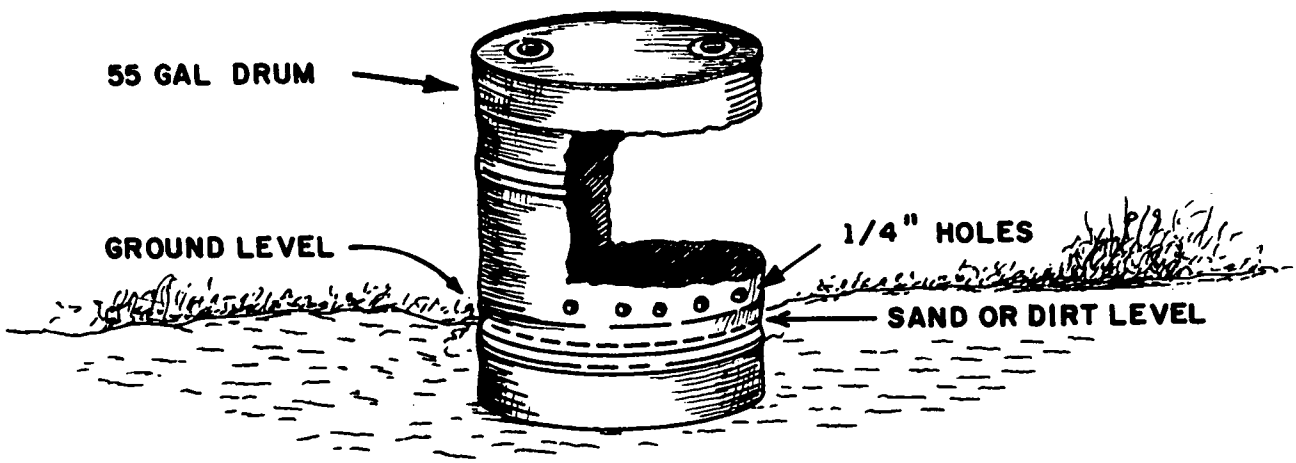


C Bonfire

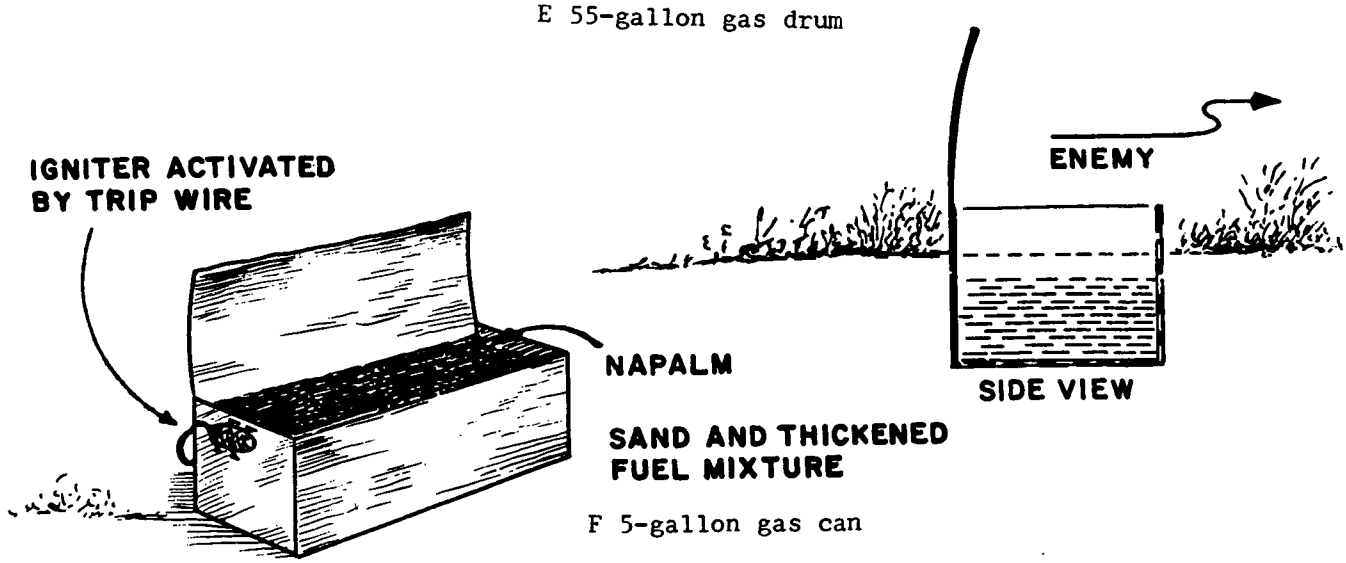
Figure 8–3. Field expedient night illumination device.



D Pit fire device



E 55-gallon gas drum



F 5-gallon gas can

Figure 8–3.—Continued.

to the ends of the crossbar. Connect power lines to an appropriate power source (A, fig 8–3).

f. Fire Pot. This field expedient is a standard highway danger signal ignited by an M49 trip flare or a Mark 1 illuminating grenade with a pull device. Add a reflector as required (B, fig 8–3).

g. Bonfire. Fill any 5-gallon container with thickened fuel and seal. Secure a thermate grenade to the top of the container with a trip device. Stack dry logs or limbs 6 inches or less in diameter around the can. Burning time depends on how many logs are used (C, fig 8–3).

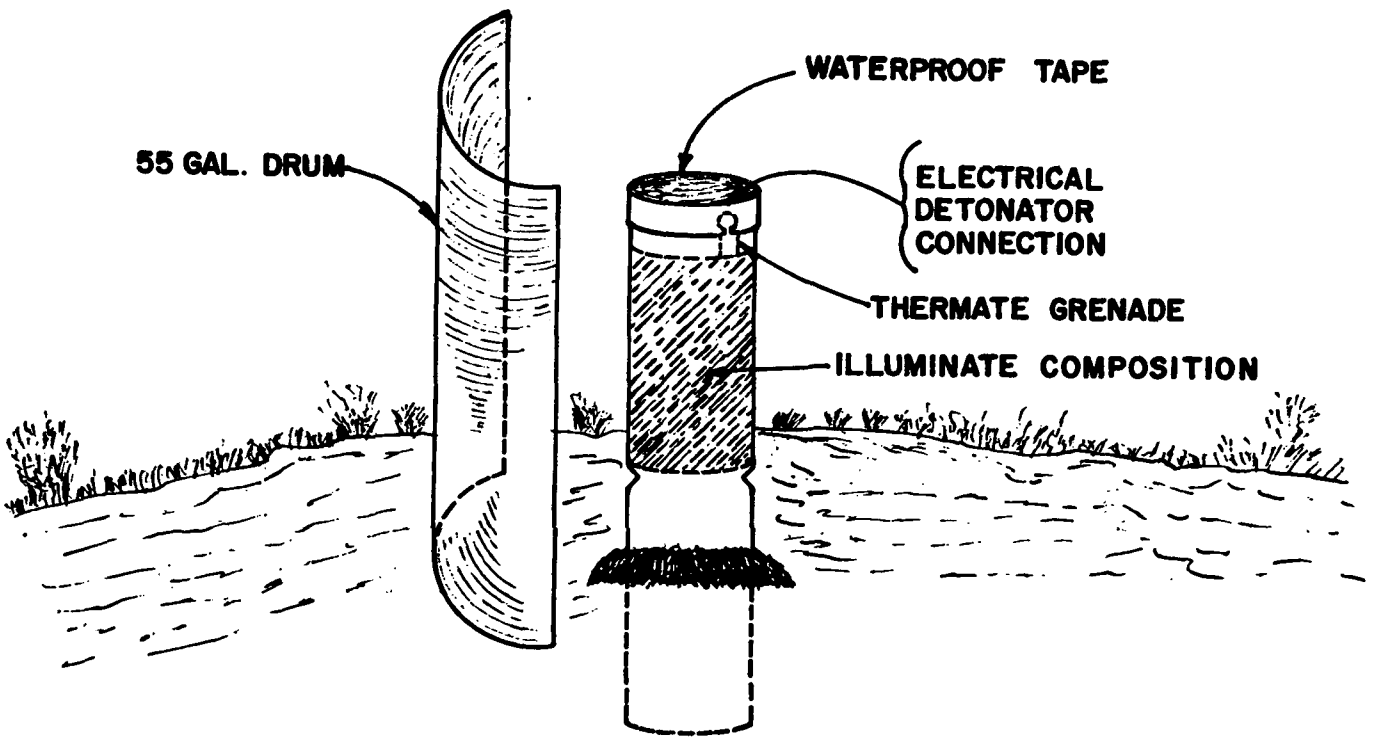
h. Pit Fire Device. Fill a 5-gallon container with thickened fuel and seal. Secure a thermate grenade to the top of the container with a trip device. Dig a pit slightly larger in diameter than available salvage vehicle tires. Stack the tires in the center of the pit. Throw salvage tubes, rubber boots, and batteries on outside of tires. Place the fuel container, with a grenade attached, inside the tire ring. Place a reflector between the pit and the friendly positions (D, fig 8–3).

i. 55-Gallon Fuel Drum. Cut ¼ of the drum away, drill ¼-inch holes 3 inches from the cutaway portion completely around the drum 6 inches apart. Fill with sand 2 inches below the holes. Saturate with thickened or unthickened fuel. Ignite by pull or enemy trip of M49 trip flare, Mark 1 illuminating grenade, WP grenade, or a thermate grenade (E, fig 8–3).

j. 5-Gallon Gas Can. The can may be rectangular- or cylindrical-shaped to be cut as shown and placed in the ground. The cut portion acts as a reflector. Ignite in the same manner as the gas barrel device (F, fig 8–3).

k. Aircraft Landing Lights. Salvaged aircraft landing lights may be used as illumination devices by mounting multiple clusters of the lights on frames in the doorway of a helicopter in such a manner that the lights can be manipulated by hand, similar to a searchlight. Power is supplied by the aircraft electrical system. The lights can illuminate a suspect area while armed aircraft fly in a blackout condition in the vicinity. Exposed targets are then taken under fire while the light ship maintains target illumination.

l. Aircraft Flare MK24. Insure that all safety devices are in place on the ejection fuze assembly end of the canister; from the opposite end of the canister, remove the parachute and the wooden block attached to it. Discard these items. Carefully



G Aircraft flare MK 24

Figure 8–3.—Continued.

invert the canister and remove the illuminate composition. Place two small dents on opposite sides of the canister at its midpoint. Insure that the parachute suspension attachment end of the illuminate composition is placed in the canister first and re-insert the illuminate composition into the canister until its bottom rests firmly against the two dents of the canister midpoint. Note that the illuminate composition *is now reversed* from its original position; this places the first fire composition near the open end of the canister where it can easily be ignited by use of a thermate grenade. This grenade may be remotely detonated from a safe position either electrically or by pulling the grenade pin by use of a lanyard. To emplace the device, simply bury the bottom third of the canister underground or sandbag it to hold it in an upright position, and place a metal sheet or one-half of a 55-gallon drum approximately one foot to the rear of the device. This shield reflects the light in the desired direction and protects the night vision of the defender (G, fig 8–3).

CHAPTER 9
SELECTION OF THE MEANS OF BATTLEFIELD ILLUMINATION

Section I. ILLUMINATION CAPABILITIES OF GROUND UNITS

9–1. Means

Numerous means are available for battlefield illumination. Those means which are presently organic to ground units, with the exception of the tank mounted searchlight, are discussed in this section.

9–2. Direct Illumination

Direct illumination is illumination provided by direct light from pyrotechnics or searchlights. The intensity of light provided by direct illumination will vary according to the source of the illumination. The means available to ground troops for use in direct illumination are—

a. Pyrotechnics. Pyrotechnics are those devices in which a chemical composition burns to provide a point source of light for a limited time. An observer can see objects near this light almost as well as in daylight. Pyrotechnic devices that supply direct illlumination are—

(1) *Ground signals, iluminating grenades, and trip flares.* Ground signals, illuminating grenades, and trip flares (chap 3) are devices which can be installed and/or activated by an individual and used for immediate close-in illumination of areas 100 to 450 meters in diameter. These devices provide only short-duration illumination.

(2) *Artillery and mortar illuminating shell.* Illuminating shells for artillery pieces and mortars (chap 4) are true pyrotechnics. Specific models of these shells are described in TM 9–1370–203. These shells, after having been fired from their crew-served weapon, burst in the air over the target area and eject a burning canister of illuminant which descends by parachute. One illuminating shell will light an area 500 to 2,000 meters in diameter and is used for close-in and intermediate area illumination, depending on the weapon and shell used.

(*a*) *Artillery illumination shell capabilities.* Table 2 provides technical data for illuminating shells currently available and in use by artillery units. Appendix E is presented as a planning aid for commanders and staff officers. This appendix lists the maximum area in which various numbers of weapons can produce artificial daylight under favorable conditions. The standard shell for each artillery weapon is designated in the table. Except at the maximum ranges for the weapons, illumination shell patterns can be oriented in any direction.

(*b*) *Mortar illuminating shell capabilities.* Table 2 provides technical data for mortar illuminating shells; planning guidance for the employment of these shells is contained in appendix E, and is similar to artillery shells within the mortar's range capability.

(3) *Aircraft flares.* Aircraft flares (chap 6) are launched from aircraft bomb racks or are hand dropped from the aircraft. Care must be exercised to insure that the first flares dropped do not silhouette or illuminate the friendly ground positions; this can be accomplished by establishing good air-ground communications using cryptographic equipment when available, or coded message prior to the first flare drop. Necessary communications security procedures as outlined in FM 32–5 and ACP 122 will be followed in establishing the air-ground communications.

(*a*) Capabilities of selected type Army aircraft for providing continuous illumination are shown in table 6. Specific data on burning time, candlepower, and approximate area of illumination coverage for each type available aircraft flare are included in table 4.

(*b*) Army aircraft have the capability to illuminate large areas of the battlefield adjacent to and immediately in front of friendly elements; this capability is limited by the flare-carrying and fuel-carrying capacity of the aircraft employed. This limitation, however, can be minimized by using two aircraft and resupplying them from forward landing areas.

Table 6. Army Aircraft Flare-Carrying Capability Mk24 Mod 3 Flare

Capabilities	Type aircraft						
	O–1A	U–1A	U–6A	UH–1A&B	UD–1D	CH–47A	CH–47
Total flare capability	12	60	24	30	44	300	300
Bomb shackles	4	4	4	0	0	0	0
Internally	8	56	20	30	44	300	300
Maximum planning time for providing continuous illumination (minutes)[1]	30	150	60	75	110	90 [2]	150 [2]

[1] (Burning time × number of flares) × 5/6 = maximum planning time.
[2] Maximum planning time limited by fuel capacity of aircraft.

(*c*) The U.S. Air Force C–130 may be equipped with large volume automatic flare dispensers that will accommodate the high speed launching of up to 400 Mark 24 flares. Tactical aircraft equipped with the SUU-25 dispenser can carry eight Mark 24 flares.

(4) *Improvised illuminators.* Chapter 8 and FM 20–33 provide information on the fabrication and employment of improvised battlefield illumination systems.

b. Artillery Searchlights (chap 5). Maximum illumination is obtained from searchlights when they are used in the direct illumination role. Table 3 contains data on the physical and operational characteristics of the Xenon family of searchlights currently available. The specified range for each listed searchlight is an approximation, and greater or lesser ranges can be expected dependent upon several factors; i.e., the type terrain and vegetation in the area of operation, atmospheric conditions such as rain, fog, snow and cloud coverage, and the reflective surface characteristics of the target itself. In actual practice the range of the searchlight is not as important in locating and identifying targets as is the distance from the observer to the target; this distance, under normal conditions, must be less than 4,000 meters. The most effective range at which an observer can reasonably be expected to detect a majority of targets is 2,000 meters. The use of starlight scopes and other night viewing devices—both infrared and visible—will considerably enhance the observer's ability to detect targets at greater ranges with illumination and also when illumination is not available or desirable.

c. Airborne Illumination Systems.

(1) Airborne illumination systems mounted on either fixed or rotary-wing aircraft may be used in the direct illumination role for—

(*a*) Illuminating landing zones.
(*b*) Target acquisition and engagement.
(*c*) Surveillance and reconnaissance.
(*d*) Convoy escort.
(*e*) Search and rescue.

(2) The U.S. Air Force C–123 has the capability to mount and employ the Light Set, General Illuminating, Airborne AVQ5 in the airborne role to provide direct battlefield illumination. This system consists of 28 liquid cooled Xenon arc lamps installed in the doors of the aircraft. Power for the system is provided by a 400 cycle, 200 KVA generator set. The system provides a 6-million candlepower beam in a 50-degree cone of light. At 12,000 feet altitude, the light cone will cover an area of approximately 3.5 square miles on the ground with illumination comparable to four times that of a full moon. This is also equal to the illumination intensity of three Mark 24 flares. At 6,000 feet altitude, this light set will provide illumination over an area of approximately one square mile with an intensity that is 16 times brighter than that of a full moon. The system can provide a continuous light source for a period of 7½ hours of continuous operation. In addition to providing battlefield illumination, it can be used to illuminate staging areas, drop zones, disaster areas, logistical depots, bridging sites, and port facilities, and for search and rescue missions.

9–3. Indirect Illumination

Indirect illumination, sometimes referred to as artificial moonlight, may either be reflected or diffused illumination depending on the technique used in employing the searchlight. To obtain either type illumination, the searchlight must be employed from a defilade position; the resultant usable light from both modes possesses the same general characteristics differing only in the degree of illumination achieved. Both the 23-inch and the 30-inch Xenon searchlights may appropriately be employed in the indirect role.

a Illumination by Diffusion. For diffused illumination, the searchlight beam is directed at a minimum elevation above the ground. This causes the area beneath and to the flanks of the beam to be illuminated by the light scatterd by atmospheric

particles. The intensity of illumination on the ground decreases gradually as the range from the searchlight and the lateral displacement from the center of the beam increases. The lower the elevation, the greater the intensity of the scattered light on the ground beneath the beam; however, this lower elevation produces less illumination to the flanks. When the searchlight is laid at a greater elevation, it provides a less intense illumination over a wider area; the effective range of the searchlight is also reduced at this greater elevation. In general, the best results from the searchlight are obtained at an elevation of less than 75 mils using a focused beam. Optimum illumination is obtained at an elevation between 25 and 50 mils. On dark clear nights, the maximum illumination obtainable by diffusion is approximately equal to the light of a quarter moon.

(1) The maximum distance forward of observers to which aimed fire (adjusted fire) can be directed is shown below. These distances are based on optimum beam mode and elevation as shown below.

Searchlight	*Beam*	*Elevation*	*Distance Forward (Meters)*
23 inch	Focused	50 mils	525
30 inch	Spread	25 mils	1300

(2) Illumination intensity can be increased laterally by using two searchlights at optimum elevation. Range is not increased by diffusion techniques. Enemy troops are not adversely affected by using diffusion techniques, and may enjoy the advantage of having supported troops clearly silhouetted if they break the skyline. Enemy flash bases can rapidly locate the searchlights when this technique is employed.

b. Illumination by Reflection. For reflected illumination, the searchlight beam is directed against low-lying clouds (150 to 900 meters above ground level) or other reflective surface. The area illuminated receives light by reflection from the clouds or other reflective surfaces as well as by diffusion. The area beneath the point of reflection receives a higher intensity of illumination than can be obtained by diffusion alone. The intensity of illumination obtained is nearly equivalent to that of the light from a full moon if cloud coverage is good. The best cloud condition for illumination by reflection is 100 percent cloud coverage; satisfactory illumination can be obtained with a minimum of 60 percent cloud coverage. Best results are generally obtained by use of a focused beam. Reflected illumination provides a softly shadowed illumination. A single searchlight, a platoon, or a battery will illuminate about the same area by reflection (not necessarily the same intensity of light) as the same number of searchlights will by diffusion. The actual size of the area illuminated depends on the cloud coverage and range to the target. Illumination may be reflected from smoke clouds placed above or beyond the objective area by aircraft or artillery fire. Effectiveness of this illumination depends on how quickly the clouds are dissipated by wind or other conditions.

Section II. FACTORS INFLUENCING SELECTION AND MEANS OF EMPLOYMENT

9–4. Factors Involved

a. No one means of illumination is effective or suitable under all circumstances. The following factors influence the suitability, effectiveness, and tactical employment of illumination means:

(1) Enemy and friendly situation.

(2) Purpose or use of the illumination.

(3) Number and characteristics of illumination means available.

(4) Time available for planning and preparation (urgency of the need for illumination).

(5) Requirements for security of the illumination means.

(6) Size of the area to be illuminated.

(7) Range to the area or target to be illuminated.

(8) Duration of time the area is to be illuminated.

(9) Terrain, vegetation, and structures.

(10) Weather and atmospheric conditions.

(11) Vulnerability of available illumination means to enemy countermeasures.

(12) Economy of use of available means.

(13) Communication between the unit requesting and the source providing the illumination.

(14) Night vision devices available (app G).

b. An analysis of the factors in *a* above and their influences reveals that, in planning the employment of illumination, all means of illumination must be considered. The use of one or more satisfactory means may be negated by such fac-

tors as enemy action; changing weather and atmospheric conditions; terrain, vegetation, or structures; necessity for employing all organic weapons on missions other than illumination; failure of the illumination device itself; or lack of logistical support. This analysis further indicates that a variety of alternate illumination means must be selected to meet particular conditions.

9–5. Influences of the Enemy and Friendly Situation

a. General. The following factors influence the battlefield illumination means to be employed:

(1) Enemy and friendly dispositions will affect the allocation of illumination means and logistical support; for example, the priority of illumination support may be assigned to the weaker sectors of a defended front, and in an internal defense or other stability operations environment to the weaker or most critical installations.

(2) Enemy tactics will influence the use of illumination. Enemy mass attacks during the hours of darkness justify extensive provision for large area illumination to enable our forces to destroy the enemy before he reaches our positions. In a stability operations environment, illumination is planned and employed along likely routes of enemy travel in order to deny him use of these routes.

(3) The enemy's use of illumination may require that the friendly forces also employ illumination as a countermeasure.

(4) In actions requiring secrey, it is essential that, if illumination is required, a means be used which will not disclose the actions of the friendly forces to the enemy.

(5) The enemy's likely retaliatory action must be considered; for example, enemy fire at a searchlight may not damage the searchlight itself but may inflict extensive damage to other friendly installations. In this case, it might be preferable to use an alternate, though less effective, means of illumination.

(6) The availability of Air Force and Army armed escorts for aircraft employing flairs or airborne illumination systems may influence the use of such means for battlefield illumination.

b. Offensive Operations.

(1) Normally, offensive operations are planned in advance with sufficient time to allow for the planning, preparation, and use of illumination means to support the operation. The commander conducting the operation must have direct control of all means of illumination used throughout the attack and during the consolidation of the objective. When required, the company/troop or battalion/squadron conducting the attack can provide adequate battlefield illumination (i.e., sufficient illumination to permit delivery of aimed fire and adjustment of indirect fire) with organic mortars for limited periods of time; in such cases, fire support to the attacking force is considerably lessened. Illumination should be provided by the highest possible echelon using the following means in the priority listed, if available:

(*a*) Artillery searchlights.
(*b*) Air Force aircraft.
(*c*) Army aircraft.
(*d*) Artillery weapons.
(*e*) Organic weapons.

(2) Provisions must be made for on-call shifts of the illumination fires as the attack progresses. Shifts of illumination shells should be approximately seven-tenths the diameter of the area illuminated by one burst (table 2). Counterfire and illumination of enemy positions are the best countermeasures for friendly forces to employ if the enemy anticipates our intentions and illuminates friendly forces. No order for a night attack against an enemy capable of illuminating friendly forces should be considered complete without detailed arrangements for friendly illumination, even though it is intended that the objective be secured by means of secrecy and stealth. Examples of the coordinated use of illuminating means in the attack are as follows:

(*a*) *Example.* An infantry company is to conduct a night attack, using artificial moonlight for a major portion of the attack. The battalion S–3 prepared an attack plan using night tactics to reach the line of deployment and using daylight tactics thereafter. He presented his plan to brigade and was allocated the use of searchlights. The plan of attack included the following:

1. Artificial moonlight from departure of assembly area continuously through the objective consolidation phase. Artificial moonlight to be furnished commencing at H–3 hours (provided by searchlights).

2. Searchlights to be prepared to furnish direct illumination of the objective, on call, during the final assault phase.

3. Artillery battalion be prepared to continuously illuminate the objective, on call, for a minimum of 30 minutes.

4. Registration restricted.

5. Illumination control by the artillery liaison officer.

(*b*) *Example.* An infantry company is to conduct a night attack using artillery or mortar illuminating shell for a major portion of the attack. The battalion S–3 prepared an attack plan using daylight tactics with supporting tanks. He presented his plan to brigade and was allocated searchlights and illuminating shell from the artillery sufficient for 2 hours of continuous illumination. (Estimated duration of attack is 1 hour.) The company was ordered to seize a strong enemy position at night over terrain where night tactics are not feasible. The plan of attack included the following:

1. Indirect searchlight illumination (artificial moonlight) from departure of assembly area continuously through the objective consolidation phase.

2. Tanks initially support by fire from present positions which are close to the line of departure, and then joint the infantry in the assault.

3. Artillery battalion furnishes 2 hours continuous illumination, on call, on three phase lines:

Phase line A: ——meters in front of the objective
Phase line B: ——on objective.
Phase line C: ——meters beyond the objective.

4. Direct illumination to be approximately 1,500 meters in width and 800 meters in depth on each phase line.

5. 81-mm mortars to be prepared to assume illumination mission on order.

6. Registration of illuminating fires limited to one gun.

7. Illumination control by the artillery liaison officer.

c. Defensive Operations.

(1) On dark nights, artificial moonlight is used to extend the general area of surveillance. When attacked at night, defending forces must place direct illumination in desired areas quickly and accurately. Frontline infantry units are provided with organic means for this purpose. Prearranged on-call illumination of likely avenues of approach or other areas by means not organic to the unit should be habitually planned but should not always be considered immediately available. Higher priority missions, difficulties of adjustment and control of illumination provided by supporting units, and enemy action contribute to the delay in securing illumination when and where needed. Normally, sufficient light to conduct defensive operations will be provided as follows:

(*a*) Squad or platoon—Illuminating grenades, trip flares, or ground signals.

(*b*) Rifle company—Illuminating shell from 81-mm mortar.

(*c*) Battalion—Illuminating shell from 4.2-inch mortar.

(2) On-call illumination to be provided by direct support or reinforcing artillery, aircraft, searchlights, or other means must be prearranged to cover extended periods that might adversely affect the ammunition supply or firepower of the organic means. Intermittent illumination for harassing enemy installations and for general area surveillance should be furnished habitually by supporting elements rather than organic means.

(3) The following is an example of the coordinated use of illuminating means for an infantry company illuminated night defense of a prepared position: The company commander prepared his defense plan to include the use of artificial moonlight, artillery and mortar illuminating targets, and other pyrotechnics. He presented his plan to battalion and was told that necessary illumination would be available. The company commander's plan included the following (fig 9–1):

(*a*) Artificial moonlight, on order.

(*b*) Trip flares placed in areas A, B, and C (A—approximately 50 meters in front of the defensive position, close-in protection; B—along avenues of approach, 50-200 meters out from the defensive position; and C—in fields of fire covered by automatic crew-served weapons, 200-400 meters).

(*c*) Ground signals and illuminating grenades authorized in any area beyond the forward edge of the battle area (FEBA), except in areas K, M, and P (K, M, and P represent areas which the commander has designated as restricted for various reasons; for example, routes of friendly patrols or outpost positions.)

(*d*) 81-mm mortars, in addition to normal mission, to be prepared to illuminate the company front, phase lines X and Y (800 meters and 400 meters, respectively, in front of the FEBA), on call after 1900 hours.,

(*e*) 4.2-inch mortars, in addition to normal mission, to be prepared to take over 81-mm mortar illuminating mission on phase lines X and Y, on call after 1900 hours.

(*f*) Artillery battalion be prepared to illuminate battalion front, phase lines R, S, X, and Y

(2,000; 1,5000; 800; and 400 meters, respectively in front of the FEBA), on call after 1900 hours. Continuous illumination for 3 hours. Furnish intermittent illumination on request of company commander not to exceed 2 minutes per hour, on call after 2200 hours.

(*g*) Registration of illuminating fires to be completed prior to 1900 hours.

(*h*) Illumination control by the artillery liaison officer.

(4) The following is an example of the coordinated use of standard and improvised illumination means for the night defense of an installation such as a U.S. or host country combat base or outpost in an internal defense operational environment. The installation commander prepared

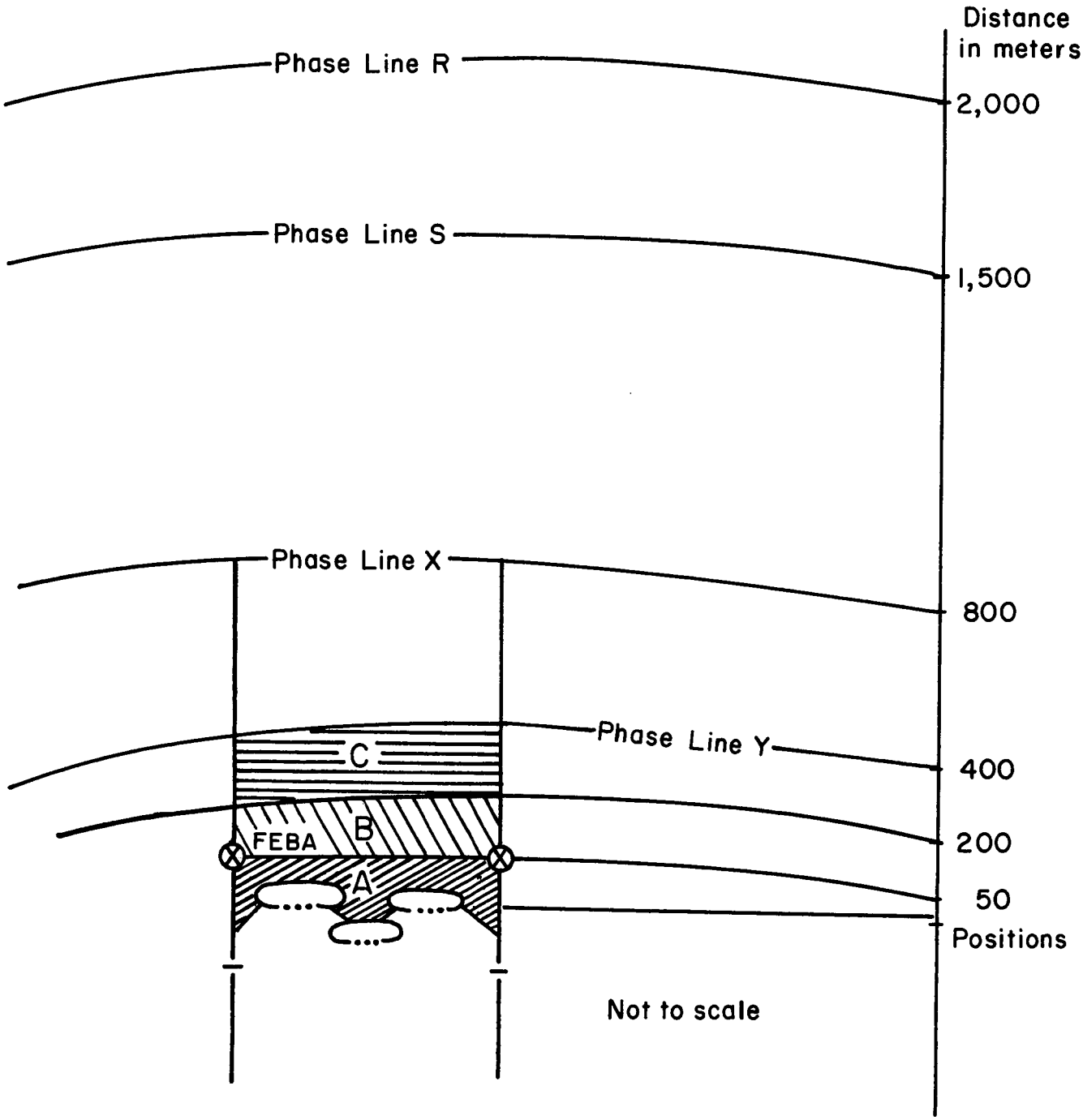


Figure 9–1. Coordinated illumination plan.

his defense plan to include the use of on-call organic artillery and mortar illuminating targets, on-call aircraft illumination systems, and improvised means of illumination. His plan called for—

(*a*) Illumination shells at each appropriate weapons position, with each position in communication with the installation CP for central control of all fires.

(*b*) Improvised and/or standard ground-mounted and tower-mounted searchlights on the inner and outer defensive perimeters, with communications link to the CP for central control.

(*c*) Ground signals and illumination grenades authorized anywhere forward of the outer defensive perimeter.

(*d*) Liberal use of both trip wires and manual activation of improvised illumination means between the outer and inner defensive barriers.

(*e*) Use of standard and improvised illuminators along defiles and other likely avenues of approach.

(*f*) On-call illumination fires from all artillery units within supporting distance.

(*g*) On-call aircraft illumination through established channels to include communications means between the aircraft and the installation.

(*h*) Surprise unannounced tests of the illumination plan.

(*i*) Repositioning of illumination devices on an unannounced schedule as a security measure.

d. Special Operations. Special operations, such as amphibious, airborne, airmobile and mountain operations, are not discussed separately because their special considerations are included in the factors influencing the selection of illuminating means. For additional discussion of battlefield illumination in a stability operations environment, such as internal defense development, see FM 31–22 and FM 31–12.

9–6. Purpose of Illumination

The purpose and uses of battlefield illumination are listed in paragraph 2–1.

9–7. Availability of Illumination Means

In determining the availability of illumination means, factors which should be considered are the types of illumination means on hand or obtainable in time for use, the quantities on hand, and the logistical situation. The availability of means, in most cases, depends on the time available for supplying the means desired. Typical considerations in the evaluation of the availability of means are as follows:

a. Since it is normally more difficult to supply ammunition to mortars than to artillery, it is often better to employ artillery illumination means. However, the maneuver force must often use the immediately available mortar to establish illumination, because of the time required to deliver illumination by artillery. Similarly, even though searchlights or aircraft flares may be a more effective or more economical illumination means than illumination shell, it is often necessary to use illumination shell until searchlights can be moved to suitable positions or until aircraft become available. The immediate availability of an illumination means frequently dictates which means will be used even though other means may be preferable.

b. In determining the availability of weapons to provide ilumination, consideration must be given to the fact that the use of weapons for illumination may withdraw them from their primary mission of delivering conventional supporting fires. In large-scale operations, this use may seriously reduce the number of weapons available to deliver supporting fires. An associated problem is that artillery and mortar units are frequently required to fire conventional and illumination missions concurrently. During intense actions, the addition of the illumination missions may complicate the fire direction problem to an extreme, may saturate the communication system, and, if there is a lack of trained personnel, may lead to confusion and errors which will further reduce the volume of the conventional fires.

c. Since no one means is entirely reliable or suitable in all circumstances and since the enemy may neutralize the first choice of illumination means, consideration must always be given to the availability of alternate means.

9–8. Planning and Preparation

The considerations in *a* through *f* below apply to use of artificial illumination in all types of operations and should be considered if time is available.

a. Planning. In addition to normal planning for night combat operations, if illumination is to be employed, further planning is mandatory for the following reasons:

(1) Ground commanders must have sufficient time to prepare their illumination plans and integrate them into ground and fire support plans.

(2) The use of large amounts of pyrotechnics will impose special logistical preparations.

(3) The use of artillery or mortar illuminating shells requires a fire plan with adequate arrangements for scheduled or on-call illumination.

(4) Air support illumination missions are more difficult to carry out than daylight close air support missions.

(5) Efficient employment of searchlights requires the conduct of a daylight reconnaissance, careful selection of primary and alternate positions, and establishment of an adequate communications network.

b. Control. Direct control of all employed illumination means is exercised by a designated representative of the commander conducting the operation. The use of all illumination devices should be adequately covered in the unit standing operating procedure and in the operations order to insure a proper understanding of their employment by all individuals and units concerned. Lack of control or improper employment of an illuminant could easily jeopardize adjacent units or provide the enemy with an advantage. For example, if a rifle company commander does not clear the firing of his 81-mm illuminating shell across his company front with his battalion headquarters, he might expose the operations of an adjacent company.

c. Pyrotechnics.

(1) *Advantages.* The advantages of pyrotechnics are that they—

(*a*) Provide sufficient light for aimed fire of ground weapons, adjustment of indirect fire and surveillance under conditions approximating daylight.

(*b*) Permit movement of troops and vehicles, minefield operations, evacuation of casualties, and resupply with daylight ease and speed.

(*c*) Can be placed where and when desired within the limitations of the weapon and ammunition used.

(*d*) Provide direction for all friendly elements.

(*e*) Can be used to silhouette and harass the enemy.

(*f*) Increase morale and confidence of friendly troops and discourage enemy infiltration.

(2) *Disadvantages.* The disadvantages of pyrotechnics are that they—

(*a*) Require the use of weapons or aircraft that might otherwise be employed in a conventional role.

(*b*) Temporarily destroy the night vision of friendly troops over a large area.

(*c*) Complicate the supply problem if used in large amounts.

(*d*) Complicate the fire plan.

(*e*) Create a hazard from falling canisters and other debris.

(*f*) Activate uncontrolled brush and grass fires within the battle area.

d. Indirect Illumination With the 23- or 30-Inch Searchlight.

(1) *Advantages.* The advantages of the 23- or 30-inch searchlight used to provide indirect illumination are that they—

(*a*) Afford a flexible and an economical means of providing small or large area illumination for long periods of time.

(*b*) Provide sufficient light for limited surveillance with binoculars, starlight scopes, and other night viewing devices.

(*c*) Provide an observing advantage when the light source is to the rear of the observer. Observing ranges are three times greater when the observer is looking away from the light source and toward the illuminated area than when looking toward the searchlight.

(*d*) Facilitate movement of troops and vehicles, field construction, minefield operations, evacuation of casualties, resupply, night patrolling and raiding, ambushes, and operations of supporting troops.

(*e*) Provide direction for all friendly elements.

(*f*) Increase morale and confidence of friendly troops when they have been trained in the use of illumination.

(*g*) Hamper enemy air observation by screening.

(*h*) Tend to deny enemy infiltration opportunities in the illuminated area.

(*i*) Tend to canalize enemy infiltrating groups or attacking formations into the less desirable avenues of approach. In effect, indirect illumination is an economy of force measure.

(2) *Disadvantages.* The disadvantages of using the 23- or 30-inch searchlight for indirect illumination are that they—

(*a*) Draw enemy fire on the area of the light source.

(*b*) Do not reliably provide sufficient light for aimed fire of ground weapons, unless proper atmospheric conditions exist.

(*c*) May silhouette friendly forces.

(*d*) Provide some assistance to enemy movement.

(*e*) Hamper friendly air observation by screening.

(*f*) AM radios may be subjected to interference by the RF energy from Xenon searchlight operating in proximity to the radios.

e. Direct Illumination With the 23- or 30-Inch Searchlight.

(1) *Advantages.* The advantages of employing the 23- or 30-inch searchlight for direct illumination are that they—

(*a*) Provide a flexible and an economical means of small- or large-area illumination for long periods of time.

(*b*) Provide sufficient light in a limited area to permit aimed fire of ground weapons, adjustment of indirect fire, and surveillance.

(*c*) Permit movement of troops and vehicles, field construction, minefield operations evacuation of casualties, and resupply with daylight ease and speed.

(*d*) Provide direction for all friendly elements.

(*e*) Can be used to harass and dazzle the enemy.

(*f*) Increase morale and confidence of friendly troops when they have been trained in the use of illumination.

(*g*) Tend to deny enemy infiltration opportunities in the illuminated area.

(*h*) Tend to canalize enemy infiltrating groups or attacking formations into the less desirable avenues of approach. In effect, direct illumination is an economy of force measure.

(2) *Disadvantages.* The disadvantages of employing the 23- or 30-inch searchlight for direct illumination are that they—

(*a*) Require ideal terrain and careful laying to avoid silhouetting friendly installations and troops and to obtain illumination in the desired area without creating deep shadows.

(*b*) Draw enemy fire on the area of the light source.

(*c*) Temporarily impair night vision of friendly troops over a large area.

(*d*) May become an objective for infiltrating enemy forces, in which case additional security elements may be required.

(*e*) AM radios may be subjected to interference by RF energy from Xenon searchlights operating in proximity to the radios.

f. Training and Familiarization.

(1) *Indirect illumination.* Under indirect illumination, the initial reaction is to exaggerate the danger of silhouetting or exposing friendly troops to enemy observation. Operations with this type of illumination during training will allow personnel to quickly overcome this reaction and recognize the advantage of this type illumination.

(2) *Direct illumination.* The technique of control and methods of employing direct illumination require training and practice for combat commanders. Combat troops should be trained in the capabilities, limitations, and proper use of all means employed to produce direct illumination.

g. Direct Illumination With Improvised Illumination Means.

(1) *Advantages.* In addition to those advantages discussed in *c* above, the use of improvised illuminators in static defensive positions such as night defensive positions, isolated outposts, camps or villages offer the following additional advantages—

(*a*) Can be placed in a specific location at any time desired.

(*b*) Can be ignited on command or by trip wires.

(*c*) Simplifies fire planning.

(*d*) Less likely to compromise locations or operations of adjacent units.

(*e*) Eases the logistical problem since these devices are fabricated from locally available salvage items.

(2) *Disadvantages.* In addition to those disadvantages discussed in *c* above, other disadvantages accruing from the use of improvised illumination means are—

(*a*) Difficulty in controlling ignition.

(*b*) Relatively short burning time of the device.

(*c*) Susceptibility to neutralization by enemy fire.

(*d*) Fire hazard to friendly troops.

(*e*) Quality of illumination may be poor.

(*f*) Requirement for frequent maintenance and/or replacement. This may be especially critical in tropical climates, or during monsoon seasons in typical stability operations environments.

9–9. Requirement for Security of Illumination Means

The necessity for securing the illumination or the delivery means from detection by the enemy often determines the selection of the illumination means. Battlefield illumination warns the enemy that his presence is known or suspected, that he is probably under surveillance and may be subject to fire, or that some action is intended in his area. It can be expected that he will take cover quickly, leave the illuminated area, prepare to counter subsequent actions, or attempt to destroy, nullify, or neutralize the means of illumination. Therefore, when battlefield illumination is being used, the ability to detect targets and engage them with fire or to obtain battlefield information usually diminishes rapidly, and the vulnerability of the delivery means increases rapidly as the duration of illumination increases. In those situations where the enemy reaction to the illumination is immaterial or his reaction time is such that the mission can be accomplished before he can react, the most suitable type of battlefield illumination is employed. The enemy's awareness of the employment of battlefield illumination and his resultant suspicion and apprehension make battlefield illumination a good harassing or deceiving agent.

9–10. Economy of Means and Logistical Support Requirements

a. General. The necessity for considering economy in selecting the illumination means can be illustrated in a variety of ways. The logistical support required for the various illumination means is always a consideration and may be the determining factor in the selection of the means to be produced and used. The great amount of logistical support required for artillery weapons used on illumination missions versus the very small amount required for searchlights and aircraft to accomplish the same mission must be considered carefully in all operations—particularly in operations such as beachheads and deep penetrations in enemy territory where logistical support may be of paramount importance. For example, the artillery searchlight has the advantage of being a far more flexible illumination means than the 105-mm howitzer, whereas two artillery searchlights might be required to cover the same area with the same light intensity (artificial daylight) at certain ranges. Employment of the 30-inch artillery searchlight requires a negligible amount of logistical support for each hour of operation whereas each 105-mm and 155-mm howitzer, firing shell, illuminating, uses over 3 and 10 tons of ammunition, respectively, for each hour of continuous illumination provided. One aircraft flare is capable of illuminating, with greater intensity, an area about twice the diameter of that covered by a 105-mm howitzer or two 30-inch searchlights. Therefore, the greater logistical support required by artillery weapons in comparison to that required by searchlights or aircraft is a prime consideration in operational planning.

b. Basic Logistical Support Required. Based on the assumption that there will be no losses among delivery means, the following basic logistical support is required:

(1) *30-inch artillery searchlight.* The mobile 30-inch artillery searchlight has a capability of furnishing illumination of two types (artificial daylight or artificial moonlight) and in varying intensities at varying ranges. This illumination may be continuous, except for a 5 minute period during each 4 hours of continuous operation for the purpose of refilling the generator fuel tank. The use of an auxiliary fuel supply will permit continuous operation of the generator without a shutdown for refueling. The 30-inch searchlight may tip over if less than four crew members try to emplace it on uneven terrain. The following are the immediate requirements for operating one searchlight for 1 hour:

(*a*) One trailer-mounted 30-inch searchlight with generators and prime movers.

(*b*) The assigned crew.

(*c*) Three and one-half gallons of gasoline.

(2) *105-mm howitzer.* The 105-mm howitzer fires an illuminating shell to a maximum range of about 8,500 meters. The shell is capable of providing artificial daylight illumination for about 60 seconds over an area about 1,000 meters in diameter. For continuous illumination, one round must be fired every 30 seconds, plus at least 15 percent or more additional rounds to compensate for malfunctions and nonstandard conditions such as winds. One-round continuous illumination for 1 hour requires the following delivery means and logistical support:

(*a*) One 105-mm howitzer.

(*b*) The assigned crew.

(*c*) About 140 rounds of illuminating ammunition.

(*d*) One 2½-ton truck with M10 trailer for transporting the ammunition.

(*e*) One 2½-ton truck as prime mover for the howitzer.

(3) *Aircraft flares.* The Mark 24 flare is the

standard Army and Air Force flare used for battlefield illumination. This flare produces 2,000,000 candlepower which provides illumination over an area about 3500 meters in diameter for approximately 2½ minutes. To provide continuous illumination with this flare for one hour requires that the delivery means be capable of launching twenty-four Mark 24 flares [(180 X 24) X 5/6 = 1 hour] during the hour. Delivery means capable of meeting this requirement and the necessary allied logistical support required are—

(*a*) Delivery means.

1. One Air Force tactical aircraft.

2. Two O–1A Army aircraft.

3. One U–1A Army aircraft.

4. One U–6A Army aircraft.

5. One UH–1 Army aircraft (all models).

6. One CH–47 Army aircraft (all models).

(*b*) Crew for each aircraft.

(*c*) Landing facility.

(*d*) Ground logistical support (i.e., fuel, ammunition, maintenance, and support) at each landing facility.

c. Logistical Support for Small Area Continuous Illumination. The various illumination means and the immediate logistical support required for each to provide 8 hours of continuous artificial daylight illumination of an area 2,000 by 2,000 meters are discussed below.

(1) *30-inch artillery searchlight.* Six 30-inch searchlights, located approximately 5,000 meters from the target area using a focused beam, will provide adequate illumination for an area 2,000 X 2,000 meters. The immediate requirements for providing the illumination are:

(*a*) Six 30-inch searchlights with generators and prime movers.

(*b*) Crew for each searchlight.

(*c*) Fuel (gasoline or diesel) to operate generators for required period.

(2) *105-mm howitzer.* Illumination provided with 105-mm howitzers, firing the standard illuminating shell, requires the following delivery means and logistical support:

(*a*) Four 105-mm howitzers.

(*b*) Fire direction capability (personnel and equipment).

(*c*) Crew for each howitzer.

(*d*) Approximately 4,480 rounds of illumination ammunition.

(*e*) Twenty-seven 2½-ton trucks with M-10 ammunition trailers for transporting the ammunition. (This number of trucks may be reduced when conditions and distances permit turn-around hauling.)

(*f*) Four 2½-ton trucks as prime movers for the howitzers.

(3) *Aircraft flares.* Aircraft flares may be delivered by Army or Air Force aircraft. Continuous illumination using the Mark 24 aircraft flare requires one of the delivery means and the immediate logistical support listed below.

(*a*) Two Air Force tactical aircraft.

(*b*) Two Army aircraft of any usable type. The use of two Army aircraft assumes that a landing facility with a supply of fuel and flares is located near the area to be illuminated; if this is not the case, additional aircraft may be required.

(*c*) Landing facilities for each aircraft.

(*d*) Ground logistical support (i.e., maintenance, fuel and ammunition) at each landing facility.

(*e*) A minimum of 195 Mark 24 flares.

d. Conclusions. From the viewpoint of transportation requirements and logistical support, the following factors are evident:

(1) In all instances, major consideration should be given to providing illumination by either searchlights or aircraft flares.

(2) The 30-inch searchlight should be made available to all division artilleries to assist in providing area illumination when needed. Availability of this searchlight reduces the requirement for stocking and transporting illumination ammunition.

(3) In the internal defense and development operational environment, isolated camps, outposts, villages and hamlets, and patrol bases must rely heavily upon improvised means of battlefield illumination.

e. Basic Principle. The means of illumination used should be that means which can accomplish the mission most efficiently and economically from the standpoint of personnel, equipment, and time required for support of the mission.

9–11. Procedures

The procedures for obtaining or providing battlefield illumination are the same as those for fire support and air support. Preplanned illumination for night offensive operations should be provided by the highest level of command possessing available means; this will conserve the maneuver units' organic means for use in emergency situations while illumination is being obtained from other sources (FM 6–20–1 and FM 6–20–2).

CHAPTER 10

LIMITING FACTORS IN THE USE OF BATTLEFIELD ILLUMINATION

10–1. Effects of Terrain, Vegetation, and Structures

Terrain, vegetation, and structures directly affect the type and amount of illumination required, the selection of the illumination means, and the location and siting of searchlights and similar illumination devices.

a. Terrain. Precipitous, mountainous, or uneven terrain reduces the coverage possible from a single light source and especially the coverage from one searchlight. On the other hand, open, flat, or gently sloping terrain permits maximum area coverage from a single light source. Terrain usually imposes greater limitations on illumination by searchlights than on illumination by flares. Ridges, ravines, steep slopes, and similar features cause shadows or unilluminated areas in the direct beams of searchlights, whereas the same terrain may be illuminated fully by flares when the flares are suspended above the area. In regard to searchlights, terrain may limit the maneuver or shifting of light throughout the target area and may severely limit the location and number of suitable positions for the searchlights. Thus, in certain types of uneven or mountainous terrain, better illumination is obtained from flares than from searchlights. However, terrain that is difficult to traverse may so limit the resupply of artillery and mortar illuminating shells that searchlights may be the only practicable ground means for providing illumination. Under such conditions, aircraft flares should be used if available. Availability of helicopters to lift ammunition or position searchlights can alleviate these difficulties. Terrain has a greater effect on direct illumination than it does on indirect illumination.

b. Vegetation and Structures. High vegetation, particularly trees and shrubs, greatly reduces the effectiveness of direct searchlight illumination because it casts shadows in prolongation of the searchlight beam. Structures such as buildings have the same effect. Flares normally provide the best source of illumination of areas covered with high vegetation or structures since only the area beneath the vegetation or structure is shaded from the illumination, and long shadows in the area being illuminated can usually be avoided. However, if flares cause undesirable fires because of dry vegetation or easily ignited structures, it may be necessary to illuminate the area with searchlights by using a combination of direct and indirect illumination.

10–2. Effects of Weather and Atmospheric Conditions

Weather and atmospheric conditions materially affect capabilities for battlefield illumination. Although weather adversely affects the use of intermediate and deep illumination, it rarely adversely affects a close-in illumination to the extent that some significant advantage cannot be gained from the illumination. Weather does not always adversely affect battlefield illumination. For instance, illumination is very effective over snow-covered terrain because snow increases reflectivity.

a. Effect on Aerial Delivery. Weather affects the ability of Army and Air Force aircraft to delivery aerial flares to much the same extent and in much the same manner as it affects other forms of air support. The effects of weather on flares after their release from the aircraft are given in *b* through *d* below.

b. Conditions Affecting Visibility. Weather and atmospheric conditions—both natural and artificial—affect illumination in much the same way as they affect visibility. Rain, fog, dust, and smoke reduce the amount of usable illumination provided from a given source and may severely reduce the distance to which the illumination extends. When these conditions exist, searchlight illumination will be affected to a greater degree than that provided by other means. The searchlight beam is relatively close to the ground and its intensity is reduced by the scattering of the light by the foreign particles in the atmosphere. Also, the light from a searchlight is affected by the atmospheric conditions over the whole range utilized,

whereas a flare is affected only by the conditions in the immediate area.

c. Cloud Cover. Solid cloud cover with clear atmosphere between the illuminant and the ground may enhance the area coverage of the illuminant by reflecting light to the ground. High thin cloud coverage provides a poor reflective surface for indirect illumination.

d. Winds. High winds will rapidly blow flares away from the area to be illuminated, thereby materially reducing the length of time that the flares illuminate the desired area. A strong gusting or shifting wind may blow the flare in the direction of the friendly troops and inadvertently illuminate their position, or it may land in friendly territory and ignite a grass or brush fire which could result in serious consequences. High winds have no effect on searchlight illumination; thus when winds are extremely high or are blowing from an unfavorable direction, searchlights may be the only satisfactory means of providing battlefield illumination.

10–3. Vulnerability of Illumination Means to Enemy Countermeasures

Any illumination means employed for a continuous period of time on the battlefield is susceptible to enemy countermeasures. When a single means is employed for long continuous periods of time, there is a moderate possibility that this means will be neutralized. When practical, an alternate illumination means should be established which is capable of illuminating the same area. In planning for long periods of illumination, consideration should be given to the use of two separate means (i.e., searchlight and aircraft) to alternate in providing the illumination.

a. Air Force and Army Aircraft. The aircraft is the most vulnerable of all illumination means to enemy countermeasures. Army aircraft, because of the low altitudes and relatively slow speeds at which they fly, are especially vulnerable to enemy countermeasures and ground fire. One factor that favors Army aircraft delivering flare illumination is that the flares burning between the aircraft and the ground blinds the ground troops to some extent and reduces the effectiveness of manually-aimed weapons directed against the aircraft. A unique problem in the use of aircraft is that the aircraft must return over the same point, at the same altitude, and at about 3-minute intervals throughout the period that battlefield illumination is required. This flight requirement provides a definite advantage to enemy gunners and increases the vulnerability of the aircraft. In any future large-scale conflict, it must be anticipated that a sophisticated enemy will be capable of denying any particular area to friendly aircraft at any time he desires, even though the friendly force may have attained local air supremacy.

b. Searchlights. Searchlights furnishing illumination are vulnerable to enemy countermeasures; however, their vulnerability is not as great as that of aircraft. Methods employed to pinpoint the location of searchlights may include direct observation when the searchlight is employed in the direct illumination role, by flash ranging techniques, by air observation, or by a combination of these techniques.

(1) When searchlights are employed in the direct illumination role, a minimum of two searchlights should be used in separate locations with each light alternating in the provision of illumination on the target. Alternate positions should be employed where a all possible. This technique may also be successfully used when searchlights are employed in the indirect role to defeat enemy flash ranging techniques. The most successful means of degrading the location of a searchlight by enemy aircraft, short of turning off the searchlight, is to focus the light beam on the aircraft to blind the pilot and to provide a focal point for the manual firing of friendly weapons in an effort to down the aircraft.

(2) The vulnerability of searchlights may increase considerably when employed continuously for an extended period. Neutralization may be avoided if the searchlights are turned off and immediately moved to an alternate position when the enemy begins an artillery adjustment on them; when this is not possible, an alternate technique is to cut off the searchlight and have the mission taken over by a searchlight from another position or by an aircraft. The aircraft, if used, could, in addition to providing a source of illumination, also direct counterbattery fire on the enemy artillery positions.

c. Illuminating Shells. Enemy countermeasures against artillery and mortar illuminating shells require neutralization of the weapon. Since the enemy's capabilities for neutralizing these weapons are the same as his general counterbattery and countermortar capabilities, artillery and mortar units are considered to be flexible enough

to provide continuous illumination as long as the illuminating ammunition supply lasts. Because of this comparative freedom from neutralization by the enemy, artillery and mortar units should be prepared to assume an illumination mission in the event the available aircraft and searchlights are neutralized by the enemy.

d. Illumination Grenades, Trip Flares, and Improvised Illumination Devices. There is no direct countermeasure against illuminating grenades; to be rendered ineffective, they must be destroyed. Trip flares, improvised illuminators, and other such devices may be rendered ineffective by artillery or mortar fire or by inactivation of the item itself. The use of artillery or mortar fire requires the same accuracy as is necessary for the destruction of any small item of equipment. To render these items ineffective by inactivation requires the use of enemy troops; therefore, it is essential that all emplaced devices be covered by friendly fires.

10–4. Safety

a. Artillery and Mortars. Employment of artillery or mortar illumination shells presents a hazard to friendly personnel located in the projectile impact area (fig 10–1). Delivery units must consider this aspect and inform the appropriate headquarters and requester of this danger when the situation exists. Evaluation of areas in possible danger can be predetermined by illumination planning. Selection of delivery units can be made which lessens or eliminates this hazard. When the hazard cannot be eliminated, other means should be employed, or the commander must accept the risk involved with projectile-delivered illumination. The artillery unit will never refuse illumination support but will make every attempt to notify friendly personnel in danger areas. Firing tests concluded that the carrier exceeds the range determined for a non-functioning round as listed in column 6 of appropriate illuminating firing tables. The functioning of the expelling charge of the projectile serves to accelerate the carrier while at the same time expelling the payload. Further tests are required to determine both the pattern of debris and the exact range of the carrier. A practical solution is to consider the non-functioning round impact point as the center of an area of projectile debris (some projectiles may tumble after functioning and lose range). Mark an area 400 meters wide and 1,000 meters long; orient the long axis along the direction of fire as the danger

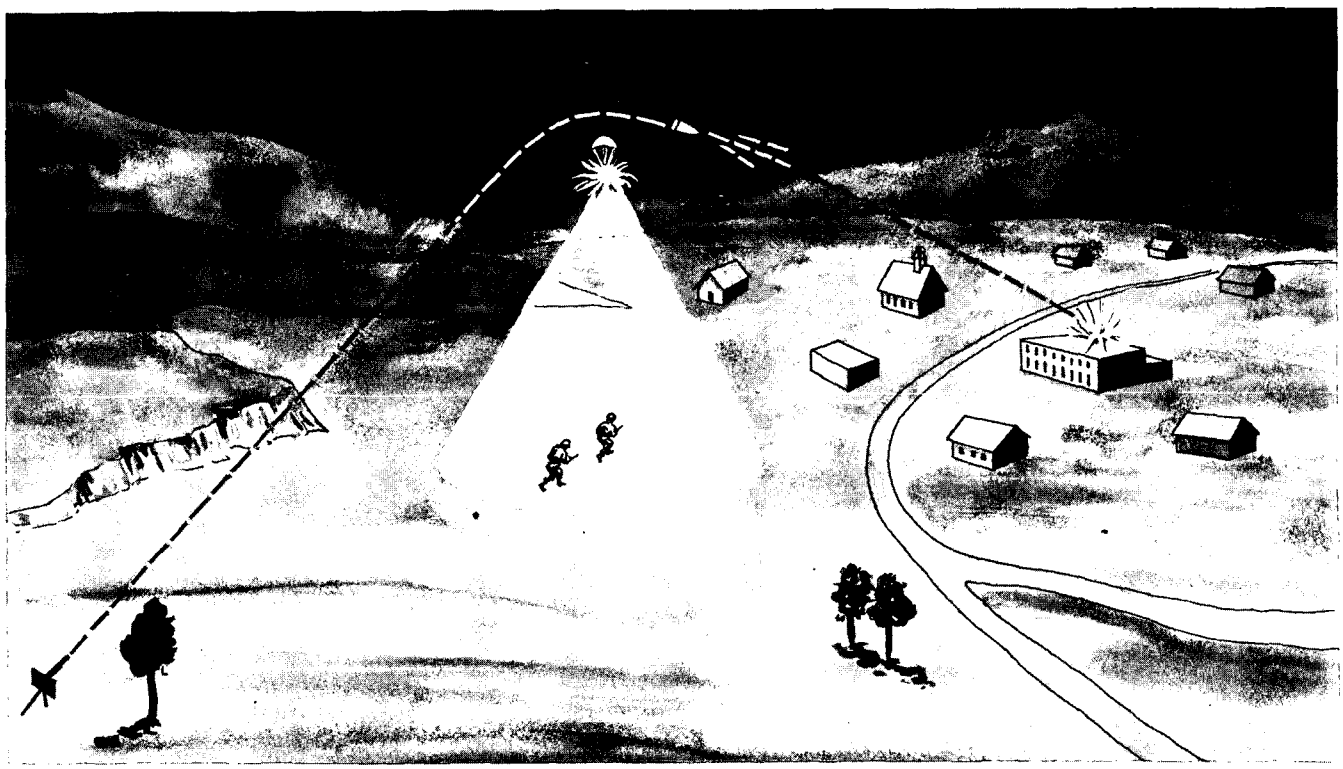


Figure 10–1. Illumination projectile impact hazard.

area for projectile impact. This area will be further refined as more definitive data becomes available. Friendly units or inhabitiants in this area must be advised of the danger.

b. Naval Gunfire Illumination. Illumination provided by supporting naval forces creates a hazard similar to that described in *a* above. The danger area differs whenever the ship providing support is moving. Generally, larger danger areas would have to be considered. Naval liaison personnel or the supporting ship must be consulted to obtain the size and location of any danger area associated. The supported unit is responsible for coordination with friendly elements in the debris area.

APPENDIX A
REFERENCES

A–1. Army Regulations (AR)

385–63	Regulations for Firing Ammunition for Training, Target Practice, and Combat.

A–2. Field Manuals (FM)

5–25	Explosives and Demolitions.
6–20–1	Field Artillery Tactics.
6–20–2	Field Artillery Techniques.
6–40	Field Artillery Cannon Gunnery.
6–115	The Field Artillery Searchlight Battery.
6–160	Counterbattery Radar Set, AN/MPQ–10A.
19–30	Physical Security.
20–33	Combat Flame Operations.
23–30	Grenades and Pyrotechnics.
23–90	81-mm Mortar M29
23–92	4.2-Inch Mortar M30.
31–12	Army Forces in Amphibious Operations (The Army Landing Force).
31–21	Special Forces Operations—U. S. Army Doctrine.
31–36 (Test)	Night Operations.
(C) 32–5	Signal Security (SIGSEC) (U).

A–3. Technical Manuals (TM)

3–366	Flame Fuels.
9–1300–203	Artillery Ammunition.
9–1300–206	Care, Handling, Preservation and Destruction of Ammunition.
9–1370–200	Military Pyrotechnics.

A–4. Other

(C) ACP 122	Communications Instructions.
ATP 6–558	Field Artillery Searchlight Battery.
ATT 6–558	Field Artillery Searchlight Battery.
TOE 6–558	Field Artillery Battery, Searchlight.
STANAG 2031	Proforma of Artillery Fire Plan.
STANAG 2088 and SOLOG 108	Battlefield Illumination.

APPENDIX B

CHECKLIST FOR PLANNING CONTINUOUS ILLUMINATION IN SUPPORT OF INFANTRY AND ARMOR OPERATIONS

The following checklist may be used for planning continuous illumination in support of operations.

1. Width of area of operation.
2. Depth of area of operation.
3. Means available including night vision devices.
4. Number of points of illumination required.
5. Method of shifting illumination during the operation.
6. Communications.
7. Duration of operation (estimated).
8. Number of types of weapons.
9. Ammunition requirements.
10. Effect of illumination requirements on availability of supporting fires.
11. Alternate and supplementary means for providing illumination.
12. Provision for registration of illuminating fires.
13. Provision for supervision of illuminating fires throughout the operation, to include an exact understanding with the unit furnishing the illuminating fires as to the method of firing and the command echelon that can authorize changes in, or discontinuation of, the illumination.
14. Clearance with higher headquarters.
15. Coordination with adjacent units.
16. Provision for security of illumination means.
17. Weather and atmospheric conditions.
18. Economy of use of available means.

APPENDIX C

TECHNIQUES IN WHICH ARTILLERY AND MORTAR PERSONNEL MUST BE TRAINED

C–1. Fire Direction Personnel

Fire direction personnel must be trained in techniques involving—

a. Illuminating shell commands.

b. Illuminating shell tabular firing tables or graphical firing tables.

c. Transfers of illuminating fires.

d. Handling illuminating missions with certain weapons while other weapons are firing HE shell.

C–2. Weapon Personnel

Weapon personnel must be trained in techniques involving—

a. Delivery of accurate, continuous fire at a steady rate for periods of long duration.

b. Illuminating shell commands.

c. One weapon of battery firing an illumination mission while the other weapons are firing other missions.

d. Handling and storage of illuminating shells.

e. Handling illuminating shell malfunctions.

C–3. Observer Personnel

Observer personnel must be trained in techniques involving—

a. Illuminating shell commands.

b. Adjustment of illumination fires.

c. Effects of weather and terrain on illumination shell.

d. Coordinated adjustment of illumination and HE fires.

APPENDIX D
REQUIREMENTS FOR ILLUMINATION

Unit	Purpose of illumination	Location of illumination	Size of area	Duration of illumination	Typical means
Individual sentinels.	Expose the enemy; permit aimed fire.	Close-in, immediate vicinity of individual.	Up to 200 by 200 meters.	1 minute to 5 minutes.	Trip, ground, and improvised flares; illuminating grenades.
Armored vehicles.	Aid movement during darkness.	Close-in	Directional to 200 meters.	Continuous	Driving lights.
	Expose the enemy; permit aimed fire.		Directional to 200 meters.	Intermittent to continuous.	Tank-mounted slt.
Small units (e.g., squad, section, patrol, working party).	Expose the enemy	Close-in to 1,000 meters.	Up to 300 by 300 meters.	1 minute to continuous.	Trip, ground, and improvised flares; illuminating grenades; mortar and arty illum shells; tank and arty slt.
	Assist reconnaissance of enemy positions and terrain.	Close-in to 1,000 meters.	Up to 300 by 300 meters.	1 minute to continuous.	Mortar and arty illum shells; tank and arty slt.
	Assist in identifications.				
	Aid in maintaining control.	Close-in	Up to 300 by 300 meters.	Continuous	Arty slt (indirect illum).
	Aid in rapid movement.				
	Facilitate operations; e.g., mine laying or removal.	Close-in to 1,000 meters.	Up to 300 by 300 meters.	Continuous	Arty slt (indirect illum).
	Assist in maintaining direction.	Close-in to 2,000 meters.	Directional	Continuous	Arty or tank slt (direct illum).
	Dazzle the enemy	Close-in	Directional to 300 meter front.	1 minute to intermittent.	Arty or tank slt (direct illum).
Platoons, companies, and outposts.	Detection; identification; control and contact; facilitate movement and communications; dazzle or confuse the enemy.	From close-in to 2,000 meters.	500 by 300 meters to 1,500 by 2,000 meters.	1 minute to continuous.	All available means.
	Permit use of daylight tactics; delivery of aimed fire.	Close-in	500 by 300 meters to 1,500 by 2,000 meters.	3 minutes to continuous.	Mortar and arty illum shells; tank and arty slt (direct illum).
	Provide direction	Close-in to 2,000 meters.	Directional	Momentary to continuous.	Slt.
	Deter enemy from exposed area.	Close-in	1,000 by 1,000 meters.	Continuous	Tank and arty slt.
	Increase morale and confidence.	Close-in	1,000 by 1,000 meters.	Continuous	Arty slt (indirect illum).
	Limit infiltration.				
	Facilitate operations.	Close-in	500 by 300 meters to 1,000 by 1,000 meters.	1 minute to 3 hours.	Mortar and arty illum shells; tank and arty slt; aircraft flares.

Unit	Purpose of illumination	Location of illumination	Size of area	Duration of illumination	Typical means
	Battlefield surveillance and reconnaissance.	Intermediate.			
Battalion or battalion task forces.	Same as company	From close-in to 6,500 meters in depth.	300 by 300 meters to 7,000 by 6,500 meters.	30 minutes to continuous.	Mortar and arty illum shells; tank and arty slt; aircraft flares.
Brigade	Same as company	From close-in to 12,000 meters in depth.	300 by 300 meters to 25,000 by 12,000 meters.	30 minutes to continuous.	Mortar and arty illum shells; tank and arty slt; aircraft flares.
Division	Same as company	From close-in to 20,000 meters in depth.	500 by 500 meters to 41,000 meters in width by 20,000 meters in depth.	30 minutes to continuous.	Arty illum shells; tank and arty slt; aircraft flares.
	From 2,000 to 15,000 meters in depth (intermediate area). From 15,000 to 20,000 meters in depth (deep illumination).	Fairly general illumination over 41,000 meters in width by 20,000 meters in depth.			
Corps	Support of divisions	Same as divisions	Three division size areas in corps zone.	30 minutes to continuous.	Arty illum shells; arty slt, aircraft flares.
	Deep battlefield surveillance; target acquisition and attack in corps zone.	Beyond division zone, 20,000 meters to 25,000 meters.	2,000 by 10,000 meters or equivalent area.	30 minutes to continuous.	Arty slt and aircraft flares.
Field army	Support of corps	Same as division	Three division-size areas in army zone.	30 minutes to continuous.	Aircraft flares.
	Deep battlefield surveillance; target acquisition and attack in support of corps.	Beyond division zone, 20,000 meters to 25,000 meters.	Five areas, 2,000 by 10,000 meters or the equivalent.		
	Deep battlefield surveillance; target acquisition and attack.	Beyond corps zone, 25,000 meters to 160 kilometers.			

APPENDIX E

COMPARISON OF SEARCHLIGHTS AND ARTILLERY ILLUMINATING SHELLS FOR BATTLEFIELD ILLUMINATION

Factor	Searchlights	Illuminating shells
Economy of materiel	Searchlights useful only for illumination.	Artillery/mortars useful in all phases of ground combat.
Economy of manpower	Searchlights useful only during darkness. Not a "killing" facility.	Artillery/mortars are employed 24 hours a day. A "killing" facility.
Resupply of illuminant	Gasoline creates no major space or weight problems.	Illuminating shells are heavy and bulky to transport.
Range	15,000+ meters with good atmospheric conditions. Intensity decreases as range increases.	81-mm mortar—2,100 meters. 4.2-inch mortar—5,500 meters. 105-mm howitzer—8,500 meters. 155-mm howitzer—11,600 meters (M118); 14,000 meters (M485). Illuminating shell can furnish its maximum illumination at maximum range.
Flexibility and mobility	6,400-mil traverse, 1,600-mil elevation. Mobility of a trailer with prime mover. Helilift possible.	Traverse limits in mils include: *Mortars*: 6,400. *105-mm howitzer*: M102 and M103—6,400; M101A1—409 right and 400 left of center; M52A1—1,066 right and left of center. *155-mm howitzer*: M109—6400; M115 and M44A1—533 right and left of center; M114A1—488 right and 418 left of center. *Mobility*: Semimobile or mobility of track vehicle. Helilift of towed pieces increase flexibility.
Vulnerability to air attack	Continuous illumination provides enemy plane a "finger" of light, terminating at the searchlight position.	Continuous illumination provides only intermittent flashes of light at weapon position.
Vulnerability to ground attack	Direct light—exposed to direct fire and adjustments by ground observers. Indirect light—location can be approximated by flash ranging methods.	Location can be approximated by sound or flash ranging methods, radar, or shell reports.
Area illuminated	One searchlight (direct illumination with focused beam of 52 mils) from 50 meters to 15,000+ meters with coverage depending on configuration of terrain and type searchlight used.	81-mm shell—1,100 meters. 4.2-inch shell—1,500 meters. 105-mm shell—1,000 meters. 155-mm shell—2,000 meters diameter at range fired.
Communication facilities	Communication nets already established.	Communication nets already established.
Atmospheric effect	No wind effect. Dust, fog, rain, or snow attenuate beam.	Wind carrier flare. Dust, fog, rain, or snow have effect only at viewing range.
Illumination on reverse slopes	Indirect illumination only	Direct illumination possible.
Silhouetting friendly troops	Possible with error in elevation	Possible with error in adjustment or with high winds.
Safety for rear area use	No flammable material. No falling objects.	Falling projectile and components. Flare may cause fires if it strikes ground before burnout.
Radio-frequency interference (RFI)	Interference in the AM radio frequency band may block transmission of AM.	No interference.

APPENDIX F

STANDARDIZATION AGREEMENT (STANAG) AND STANDARDIZATION OF OPERATIONS AND LOGISTICS (SOLOG)

F–1. General

Standardization Agreements (STANAG's) are international (NATO) agreements designed to facilitate inter-Allied operations. Upon ratification by the United States, a STANAG is binding up U.S. Army Forces (entirely or with exceptions as noted).

F–2. STANAG No. 2088—Battlefield Illumination

Following is STANAG No. 2088—Battlefield Illumination in its entirety.

DETAILS OF AGREEMENT
BATTLEFIELD ILLUMINATION

AGREEMENT

1. It is agreed that the NATO Armed Forces operating on land are to—

a. Subscribe to the requirements, principles, and definitions defined in paragraphs 3, 4 and 5 (below).

b. Employ the techniques, patterns of illumination, and methods of requesting and adjusting prescribed in paragraphs 6 to 12 (below).

c. Employ the procedures for preparing the illumination Plan prescribed in paragraphs 13 and 14 (below).

GENERAL

2. This STANAG deals with the illumination of the battlefield by visible light and does not deal specifically with the use of infra-red or other invisible rays.

REQUIREMENTS FOR ILLUMINATION

3. The principal requirement for battlefield illumination is to overcome the limitations imposed on friendly forces by the absence of light. The requirements for battlefield illumination originate with those of an individual, a patrol, or a squad, and may progress in increasing magnitude to the requirements for units and formations.

PRINCIPLES OF BATTLEFIELD ILLUMINATION

4. The following principles govern the use of battlefield illumination:

a. The use of battlefield illumination is a command responsibility.

b. Battlefield illumination in support of friendly forces should be provided wherever of whenever needed, in the intensity of illumination required, and throughout the period of time required.

c. Battlefield illumination should, whenever possible, be provided by an independent source of illumination, so as to allow units the full use of their weapons.

d. Illumination should be provided by the highest level practicable in order to conserve the illuminants available to lower echelons.

e. Each ground unit engaged in combat which has a specific need for illumination should have organic means, in accordance with its specific requirements for illumination, sufficient to accomplish the illumination mission or to maintain the required illumination until the illumination mission can be taken over by a higher echelon.

f. Alternative means of illumination should be provided, if available.

g. All battlefield illumination must be coordinated to prevent disclosure to the enemy of the operations of adjacent units. Coordination will normally be accomplished by the commanders having operational control of the illumination means and may necessitate restrictions being placed on the unit organic means.

h. Once artificial daylight is provided to supported troops, it should be provided without interruption until the need for illumination is satisfied. This type of illumination completely eliminates night vision and, if interrupted, would render supported troops incapable of seeing until night vision is restored.

i. The habitual use of battlefield illumination under any given set of circumstances (i.e., a limited attack or similar maneuver) may tend to reveal prematurely the intention of friendly forces. Care must, therefore, be exercised to prevent establishing a set pattern of operational procedures. Conversely the use of illumination techniques as part of deception plan may be profitable on occasion.

j. Battlefield illumination should be planned and coordinated with the use of infra-red equipment in such a way that:

(1) No damage is caused to the infra-red equipment by exposure to direct intense white light.

(2) Battlefield illumination is avoided or reduced to an absolute minimum when infra-red operations are going on.

(3) The most suitable means—battlefield illumination or infra-red light—are used according to the situation.

(4) A rapid change from infra-red light to battlefield illuminations—or vice versa—can be performed.

BATTLEFIELD ILLUMINATION TERMS AND DEFINITIONS

5. The definitions that follow are for the purpose of this STANAG only:

a. Battlefield Illumination. The lighting of the zone of action of ground combat and combat support troops by artificial means whose effect can be observed by the naked eye.

b. Close-In Illumination. Illumination of an area in the immediate vicinity of individuals or units. In general, this area extends outward a distance equal to the effective range of direct fire weapons.

c. Intermediate Area Illumination. Illumination in the area extending in depth from the far boundary of the close-in area to the maximum effective range of the bulk of divisional artillery weapons.

d. Deep Illumination. Illumination in the area extending in depth from the far boundary of the intermediate area to the maximum depth of army influence on the battlefield.

e. Artificial Moonlight. Illumination of an intensity between that of approximately a one-quarter moon and a full moon on a clear night.

f. Artificial Daylight. Illumination of an intensity greater than the light of a full moon on a clear night. (The optimum illumination is the equivalent of daylight.)

g. Direct Illumination. Illumination provided by direct light from pyrotechnics or searchlights.

h. Indirect Illumination. Illumination by diffusion or reflection, obtained by using a searchlight from defilade.

i. Illumination by Diffusion. Illumination of the area beneath and to the flanks of a slightly elevated searchlight beam by the light scattered by atmospheric particles.

j. Illumination by Reflection. Illumination of an area by reflection of a searchlight beam from low-lying clouds (150 to 900 meters above ground level).

k. Full Beam Spread. Searchlight beam spread to its maximum width.

l. Pencil Beam. Searchlight beam reduced to, or set at, its minimum width.

m. One-Half (One-Quater or One-Eighth) Beam Spread. Searchlight beam reduced to one-half, one-quater, or one-eighth of full beam spread.

n. Illumination Plan. A plan for prearranged illumination published as an appendix to the fire support plan.

o. Deflection Spread. A method of firing illumination shell—each round being fired at the same range and time setting but at different deflection (azimuth) in order to illuminate an area whose width is greater than its depth. (Dimensions are considered with respect to the Gun-Target line.)

p. Range Spread. A method of firing illumination shell—each round being fired at the same deflection (aximuth) but at a different range setting and time setting in order to illuminate an area whose depth is greater than its width. (Dimensions are considered with respect to the Gun-Target line.)

q. Four-Round Illumination Diamond. A method of firing illumination shell—a combination or deflection spread and range spread, providing illumination of a large area.

BATTLEFIELD ILLUMINATION MEANS

6. The principal means of achieving battlefield illumination are described in the following paragraphs.

7. *Ground Signals, Illuminating Grenade, and Trip Flares.*

a. In this category are included all similar devices which may be hand held, hand thrown, launched from rifle or carbine launchers, or fixed on the ground. They may burn on the ground or may be suspended by parachute.

b. These devices have illumination intensities from about 20,000 candlepower to about 80,000 candlepower and illuminate circles whose diameters vary from 100 to 450 meters.

c. Such devices are for temporary close-in illumination and are not suitable for continuous illumination.

d. The emplacement of fixed devices will be reported to adjacent and higher headquarters, usually in the form of a sketch. Coordination higher than company or battalion level is normally not required.

8. *Tank-Mounted Searchlights*

a. Tank-mounted searchlights are small searchlights from 30cm to 45cm diameter. They are usually controlled from within the tank.

b. The power of the searchlight depends on the particular model and may vary from 1,000 watts to several times that figure. The light is capable of direct illumination to about 2,300 meters and has a limited capability for reflected illumination. The light from the searchlight is normally pencil-type beam and is not suitable for employment for diffused lighting.

c. Requests for tank searchlight illumination are to be met at the discretion of the tank unit commander concerned who will also exercise control of their use.

9. *Artillery and Mortar Illuminating Shell*

a. General. In this category are included the illuminating shell fired from mortars and field artillery cannon. In general, mortars are used for firing illuminating projectiles in those cases which arise unexpectedly and in which speed of illumination is essential.

b. Patterns of Illumination. Five patterns of illumination with illuminating shell are—

(1) One-round illumination of an area.

(2) Two-round illumination of an area. This provides increased illumination during periods of poor visibility or increases the observing range.

(3) Rounds fired at different deflections (azimuths), but with the same range (see paragraph 5*o*). Illumination of areas of variable widths and small depths can be provided in this manner.

(4) Rounds fired at different ranges but at the same deflection (azimuth) (see paragraph 5*p*). Illumination of an area in depth can be provided in this manner.

(5) Four-round illumination diamond (see paragraph 5*q*). It is most effective for searching an area of suspected activity.

c. Method of Requesting Illumination. The procedures for obtaining or providing artillery or mortar battlefield illumination are the same as those for fire suppport or air support. As battlefield illumination requires a large expenditure of shells, the request should be forwarded as far in advance as possible. The request will include the following initial information:

(1) Date illumination is required.

(2) Purpose (manner in which army forces intend to employ the illumination).

(3) Time and duration of illumination requested. (Specific times, e.g., 3 minutes at 2150, 2240, 2310 hours; on call).

(4) The grid reference of the points or areas to be illuminated.

(5) Method of control.

d. Control.

(1) Control over the use of the artillery illuminating shell is exercised by the supported unit or formation commander. The large area illuminated and the number of friendly units affected make centralized control mandatory.

(2) Control over the use of mortar illumination shell is exercised by the company and battalion commanders.

10. *Naval Illuminating Shell*

a. Naval illuminating shell may be available when the tactical situation is such that naval gunfire support is to be furnished to the NATO Armed Forces operating on land.

b. The request is made through the fire support channels in the following format:

(1) Date illumination is required.

(2) Location of target-grid references and height of target.

(3) Description of target—in sufficient detail to permit evaluation by firing ship.

(4) Time and duration of illumination required. (Specific times, e.g., 3 minutes at 2150, 2240, 2310 hours; on call).

(5) Method of control.

c. Requests for immediate illumination by naval gunfire may be passed on the appropriate naval gunfire net in accordance with the procedures in ATP-4—Allied Spotting Procedure for Naval Gunfire Support.

11. *Searchlights*

a. Generally, if the illumination is to be of long duration, searchlights will be used since a searchlight is capable of 90 minutes of continuous illumination.

b. This category includes all searchlights which are not mounted on armoured vehicles and which are used for illuminating the battlefield.

c. Such searchlights are usually from 75cm to 150cm in diameter and may be mounted on trucks or trailers or transported on such vehicles but dismounted for operation. The intensity of the light is from 400 to 800 million candlepower. The searchlights are normally equipped to provide a focused pencil beam or a spread beam. For the United States 60 inch (150 cm) light, the usable range of a focused beam (22 mils wide) on a dark clear night is about 18,300 meters.

d. Indirect illumination is a type of battlefield illumination obtained by using the searchlight from defilade. The searchlight is employed to provide indirect illumination by diffusion or reflection. Reflected illumination has the same general characteristics as illumination by diffusion.

e. In diffused illumination, the searchlight beam is elevated slightly above the ground. This causes the area beneath and to the flanks of the beam to be illuminated by the light scattered by atmospheric particles. In general, best results are obtained by using a focused beam with less than 100 mils elevation.

f. In reflected illumination, the searchlight beam is directed against low-lying clouds (150 to 900 meters above ground level). The area illuminated receives light by reflection from the cloud as well as by diffusion. Best results are generally obtained by use of a focused beam.

g. Method of Requesting. The request for searchlight illumination is similar to the request for artillery and mortar illuminating shell. The request should also include the type of beam required.

h. Control over the use of searchlights is exercised by the supported unit or formation commander.

12. *Aircraft Flares*

a. Aircraft flares have the capability of illuminating large areas.

b. Requests. Requests for aircraft flare illuminating missions are submitted in the same manner as for other air support missions. The request should include the following information:

(1) Date illumination is required.

(2) Purpose (manner in which army forces intend to employ the illumination).

(3) Time and duration of illumination requested. (Specific times, e.g. 3 minutes at 2150, 2240, 2310 hours; on call).

(4) The grid reference of the points or areas to be illuminated or a marked map showing these details.

(5) Method of control.

c. Control of the use of aircraft flares for battlefield illumination is exercised by the commander of the supported unit. Surveillance and adjustment is effected through the forward air controller if tactical aircraft are employed, or through the artillery liaison officer and appropriate Army aviation officer if Army aircraft are employed. Accurate flare delivery is facilitated by direct air-ground communication.

THE ILLUMINATION PLAN

13. The illumination plan is—

a. Prepared by the Fire Support Coordination Centre and/or coordinated at the highest level affected.

b. Based upon requests of supported units or formations or as directed by higher echelon.

c. Published as an appendix to the unit or formation fire support plan.

14. Coordination is accomplished at all echelons to ensure, on the one hand, integration of battlefield illumination with fire support means and, on the other, coordination of the use of all means of illumination. The illumination plan consists of the same elements and has the same format as the artillery fire plan (STANAG 2031) with the following exceptions:

a. The 'artillery fire plan table' becomes 'the illumination plan table' in this instance.

b. As the expenditure of rounds in an illumination mission largely depends upon the atmospheric conditions, the number of rounds to be expended for each mission in the illumination plan table will be replaced by the duration of the mission, given in minutes.

c. For all illumination missions the size of the area to be illuminated, given in the target list in the column 'size,' is expressed as the diameter of a circle. In the case of an illumination mission to be fired by an artillery unit using illumination projectiles, the pattern of illumination will be given as well in the column 'remarks.'

IMPLEMENTATION OF THE AGREEMENT

15. This STANAG will be considered to have been implemented when the necessary orders/instructions bringing into use the doctrine and procedures described in this Agreement have been issued to the forces concerned.

F–3. Exceptions to STANAG No. 2088

Since ratification of this STANAG by the United States, the following exceptions are stated and should be used until they are incorporated as a revision to the STANAG by the Military Agency for Standardization:

BATTLEFILED ILLUMINATION TERMS AND DEFINITIONS

5. The definitions that follow are for the purpose of this STANAG only:

* * * * * * *

l. Pencil Beam (Focused Beam). Searchlight beam reduced to, or set at, its minimum width.

* * * * * * *

o. Lateral Spread. A method of firing illumination shell—each round being fired at the same range and time setting but at a different deflection (azimuth) in order to illuminate an area whose width is greater than its depth. (Dimensions are considered with respect to the Gun-Target line).

* * * * * * *

q. Four-round Illumination Diamond. A method of firing illumination shell—a combination of *lateral* spread and range spread, providing illumination of a large area.

* * * * * * *

BATTLEFIELD ILLUMINATION MEANS

11. *Searchlights*

a. Generally, if the illumination is to be of long duration, searchlights will be used since a searchlight is capable of continuous illumination, except for a 1-minute interruption about once each 6 hours for the purpose of changing carbons, and for about 5 minutes during each 4 hours of continuous operation for the purpose of refilling the generator tank with gasoline.

* * * * * * *

c. Such searchlights are * * * a spread beam. For the United States 30 inch (75 cm) searchlight, the usable range of a focused beam (75 cm) searchlight, the usable range of a focused beam (52 mils wide) on a dark clear night is about 9,100 meters.

* * * * * * *

e. In diffused illumination * * * by atmospheric particles. In general, best results are obtained by using a focused beam and an elevation of less than 75 mils. Optimum illumination is obtained at an elevation of 50 to 75 mils. On dark clear nights, the maximum illumination obtainable by diffusion is about equal to that of the light from a quarter moon.

Note. Although not listed as an exception, paragraph 7*e* of STANAG 2088 refers to the carbine launcher. This weapon is employed by certain NATO nations but isnot an item of issue in the U.S. Army.

F–4. SOLOG Agreement 108

DETAILS OF AGREEMENT

The Armies of the United States, United Kingdom, Canada, and Australia agree to adopt STANAG 2088, Battlefield Illumination, including such changes and amendments and revised editions as may be agreed to without reservations by these Armies in the ABCA Non-Materiel Program.

Note. At the time STANAG 2088 was approved by the U.S. the Xenon family of searchlights did not exist. The obvious improvements in Xenon searchlights compared to carbon arc searchlights caused replacement of carbon arc searchlights in the U.S. inventory. Therefore, the STANAG agreements do not presently reflect the U.S. changeover to Xenon searchlights. The data in the main portion of the manual reflects latest data available but further testing of the Xenon family of searchlights is required before certain capabilities are determined. Most allied countries are not equipped with Xenon searchlights and presently see no need to change the present doctrine as it concerns the equipment they have available.

APPENDIX G
INFRARED AND NIGHT VIEWING DEVICES

G–1. Binocular, Electronic, AN/PAS–3.

a. Description and Use. This helmet (or helmet liner)-mounted infrared binocular (fig G–1) is primarily intended to permit night driving at normal speeds when used in conjunction with the infrared filtered vehicle head lamps. It also has limited use as an infrared observation device. It may be used with any infrared light source for night tasks requiring visual security, binocular vision, and freedom of movement. In addition to driving, typical tasks include equipment operation, construction, and patrolling. The binocular consists of two image converter tubes mounted binocularly and a power source. The power source mounts at the rear of the helmet to counterbalance

Figure G–1. Binocular, electronic, AN/PAS–3.

Figure G–2. Prototype of binocular, electronic, AN/PAS–6, which will replace binocular, electronic, AN/PAS–3.

the binocular. Although the binocular can be used for close tasks, its limited depth of field at near ranges requires frequent refocusing for tasks of this nature. This item of equipment will be replaced by the electronic binocular AN/PAS–6 (fig G–2).

b. Characteristics.

(1) Viewing range—50 meters with infrared filtered vehicle headlamps.

(2) Focusing range—12″ to infinity.

(3) Magnification—unity.

(4) Field of view—27 degrees.

(5) Weight—2.0 pounds (includes power supply).

(6) Battery—1.2 v disposable mercury battery.

(7) Battery life—40 hours continuous operation.

(8) Federal stock number—5855–789–0639.

c. Referenc

(1) TM 11–6650–275–15

(2) TM 11–6650–275–25P

G–2. Image Metascope, Infrared

a. Description and Use. This image forming metascope (fig G–3) is a lightweight, hand-held, near infrared viewing device equipped with a small accessory infrared light source. The metascope, which uses a single stage image converter tube, is powered by a small mercury battery. This multipurpose viewer is capable of detecting enemy infrared light sources at ranges of several miles. It

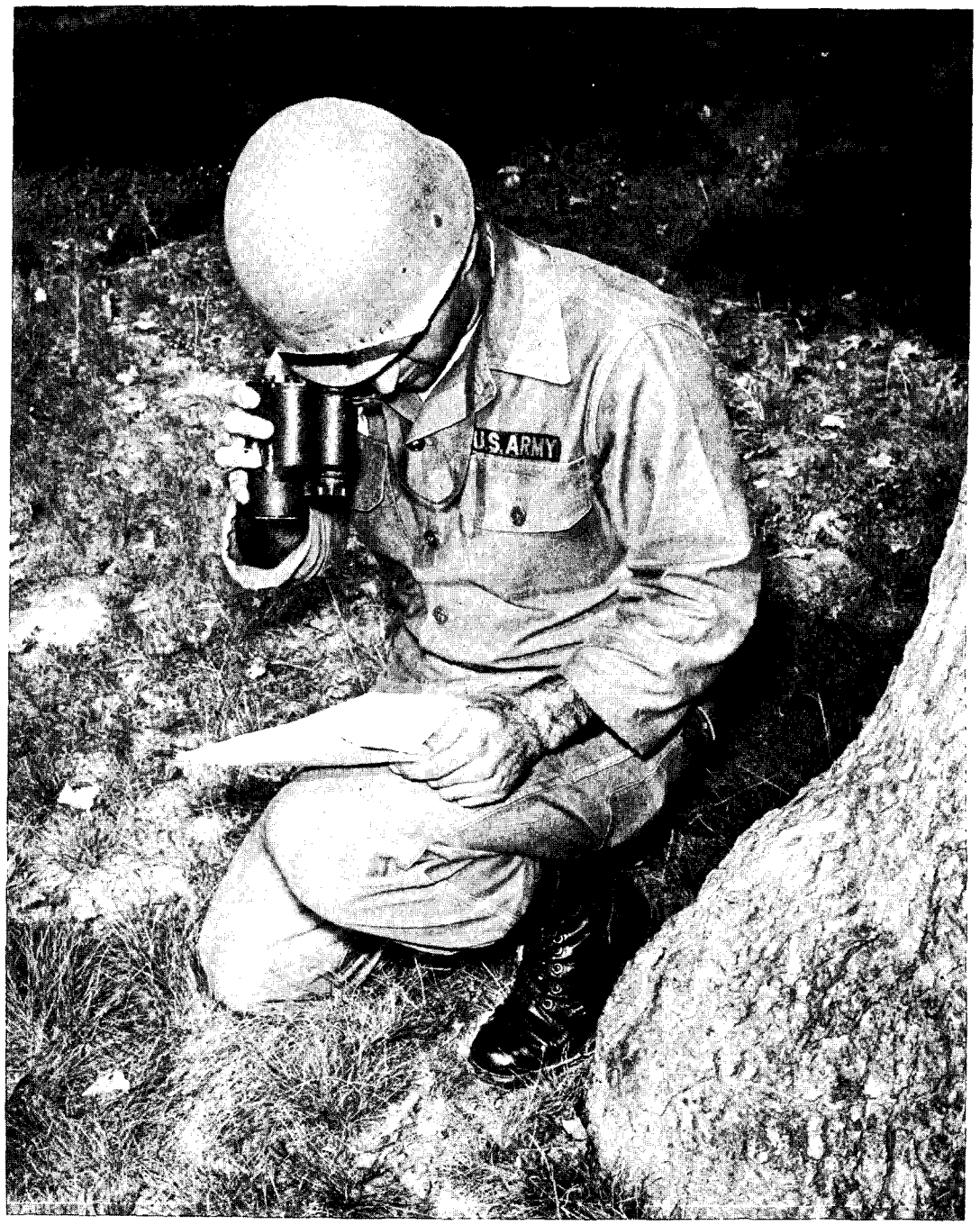


Figure G-3. Image metascope, infrared.

may be used as an aid for night assembly of personnel by homing on an infrared beacon. When used with its component infrared light source, it permits reading of maps, reading of small road signs, as well as close range surveillance. When used with high intensity infrared light sources, such as the Xenon searchlight, its useful viewing range is greatly extended. The metascope, with its own or other infrared light sources, also has a limited night infrared signaling capability.

b. Characteristics.

(1) Viewing range—50 meters (with own light source).

(2) Detecting range—Up to 10 miles (dependent upon intensity of light source being viewed).

(3) Field of view—25 degrees.

(4) Magnification—1.1X.

(5) Weight—2.75 pounds including own light source.

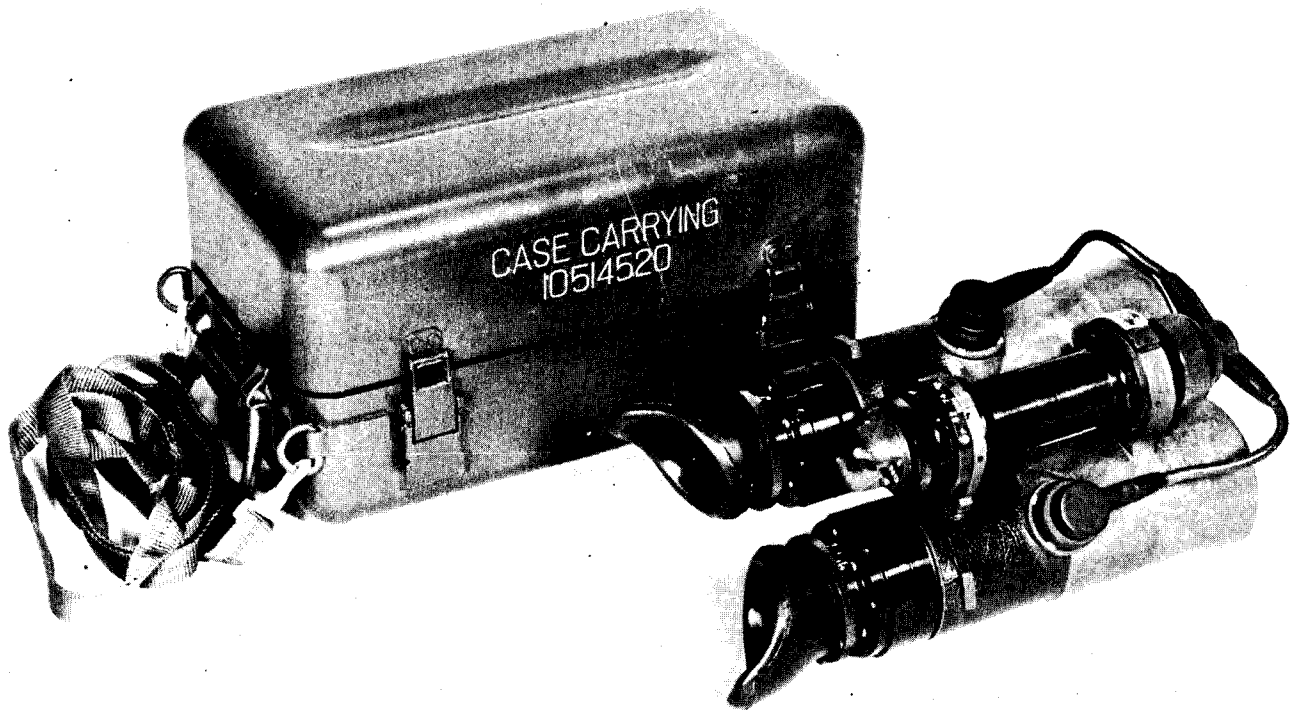


Figure G–4. M–18 binocular and carrying case.

(6) Battery life—

(*a*) Metascope—60 hours.

(*b*) IR flashlight—2 hours.

(7) Federal Stock Number 1090–790–6197.

c. Reference. TM 5–1090–203–15

G–3. M–18 Binocular

a. Description and Use. The M–18 binocular (fig G–4) is a hand-held infrared binocular developed as part of the tank night vision kit. It permits secure open hatch observation by the tank commander. Although it was designed as a part of the tank kit, the binocular can be used with any infrared light source for observation with visual security.

b. Characteristics.

(1) Field of view—12 degrees.

(2) Magnification—3.5X.

(3) Weight—4.75 pounds.

(4) Battery.

(*a*) Type—1.5 disposable mercury battery.

(*b*) Life—40 hours continuous use.

(5) Federal Stock Number 6650–863–5657.

G–4. Night Vision Sight, Individual Weapons Mounted, AN/PVS–1 or AN/PVS–2 (Starlight Scope)

a. Description and Use.

(1) *General.* The Night Vision Sight, Individual Weapons Mounted, (commonly referred to as the Starlight Scope) (AN/PVS–1 or AN/PVS–2) is a portable, battery-powered, electro-optical instrument for passive visual observation and aimed fire of weapons at night (fig G–5). It uses the natural light (moonlight and/or starlight) of the night sky for target illumination. The starlight scope, since it does not project a visible or infrared light, is a passive device and offers freedom from the possibility of enemy detection. The AN/PVS–2 affords an improved viewing capability over the AN/PVS–1.

(2) *Weapons.* The starlight scope is designed for employment on the M14, M14A1, and M16E1 rifles, the M60 machinegun, the 40mm grenade launcher M79, the 66mm rocket launcher M72, and the 90mm recoilless rifle M67.

(3) *Employment.* The starlight scope is capable of employment as a hand-held viewer or weapon mounted sight on the basic infantry

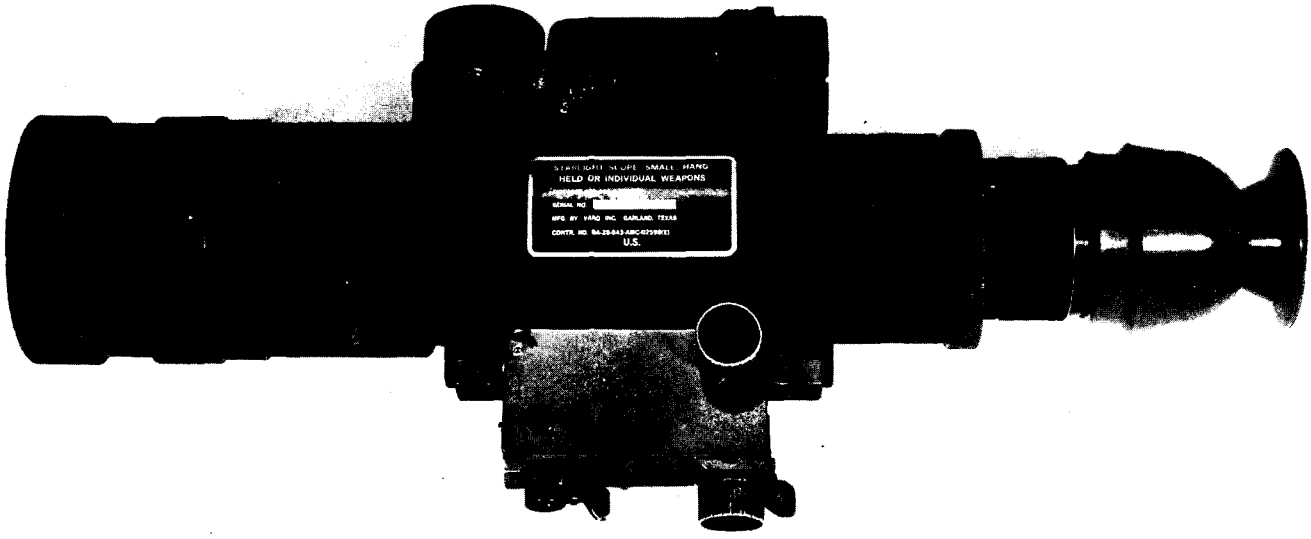


Figure G–5. Night vision sight, individual weapons, AN/PVS–2 (not mounted).

weapons described in (1) above. Its use at night permits weapons accuracy comparable to that obtained with the weapon in daylight using the conventional sight. It can also be used as a hand-held viewer by commanders, reconnaissance units, and personnel engaged in offensive and defensive operations. Undesirable conditions of light, darkness, weather, and terrain limit its employment. Low light level, rain, fog, smoke, and dust reduce its viewing range.

b. Characteristics.

(1) Range—dependent on ambient light level.

(2) Field of view—10.4 degrees (185 mils).

(3) Magnification—4X.

(4) Total weight—AN/PVS–1, 5.82 pounds; AN/PVS–2, 6 pounds.

(5) Length—AN/PVS–1, 18.5 inches; AN/PVS–2, 17.5 inches.

(6) Eyepiece focus—adjustable.

(7) Battery for high voltage power supply—6.75 volt mercury (disposable).

(8) Battery life—100 hours continuous operation.

(9) Federal Stock Number.

(*a*) AN/PVS–1 5855–087–2942

(*b*) AN/PVS–2 5855–087–2947

c. Reference.

(1) TM 11–1090–268–13 (Model AN/PVS–1).

(2) TM 11–5855–203–13 (Model AN/PVS–2).

(3) TC 23–11.

G–5. Infrared Weaponsight AN/PAS–4

a. Description and Use. The infrared weaponsight (fig G–6) is a battery operated sight, aiming, and detecting device. It consists of an infrared light source and a near infrared sensitive image forming telescope with attached reticle projector, an integral high voltage power supply, and a light source power supply. The primary purpose of the infrared weaponsight is to provide accurate and visually secure night firing for all basic infantry weapons. It can also be used to provide countermeasure aid in detecting enemy use of infrared light sources, and as a general purpose infrared surveillance telescope. This weaponsight is designed for rapid mounting on the M14 and M16E1 rifle, the M60 machinegun, and the 90mm recoiless rifle. The high voltage power supply, utilizing a 1.5 volt C cell for the viewer, is self-contained in the viewer housing. The weaponsight permits the delivery of very accurate aimed small arms fire at night without the use of any visible light.

b. Characteristics.

(1) Viewing range—250 meters.

(2) Field of view—8 degrees.

(3) Magnification—4.5X.

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Figure G–6. Infrared weaponsight AN/PAS–4.

(4) Weight—4 pounds viewer, 1 pound source, and 6 pounds battery pack.

(5) Battery life.

(*a*) Light source—5 hours continuous use.

(*b*) Viewer—40 hours continuous use.

c. Reference. TM 5–1090–200–15.

G–6. Night Vision Sight, Crew Served Weapons, AN/TVS–2

a. Description and Use. The crew served weapon night vision sight is a battery-powered, electro-optical device for observation and aimed fire of crew served weapons at night. The sight is a passive instrument and uses the natural light (moonlight and/or starlight) of the night sky for target illumination. Since the sight does not project infrared or visible light, it offers freedom from the possibility of enemy detection. The sight is designed for employment on the Browing machine gun caliber .50 MHB2, and the 106mm recoilless rifle M40A1 (fig. G–7).

b. Characteristics.

(1) Viewing range—dependent on ambient light level (moonlight or starlight).

(2) Field of view—108 mils.

(3) Magnification—7X.

(4) Weight (sight and accessories in carry case)—approximately 47.50 pounds; scope, 16 pounds.

(5) Battery life—approximately 100 hours.

(6) Federal Stock Number 5855–911–1370.

c. Reference.

(1) TM 11–5855–202–13.

(2) TC 23–13.

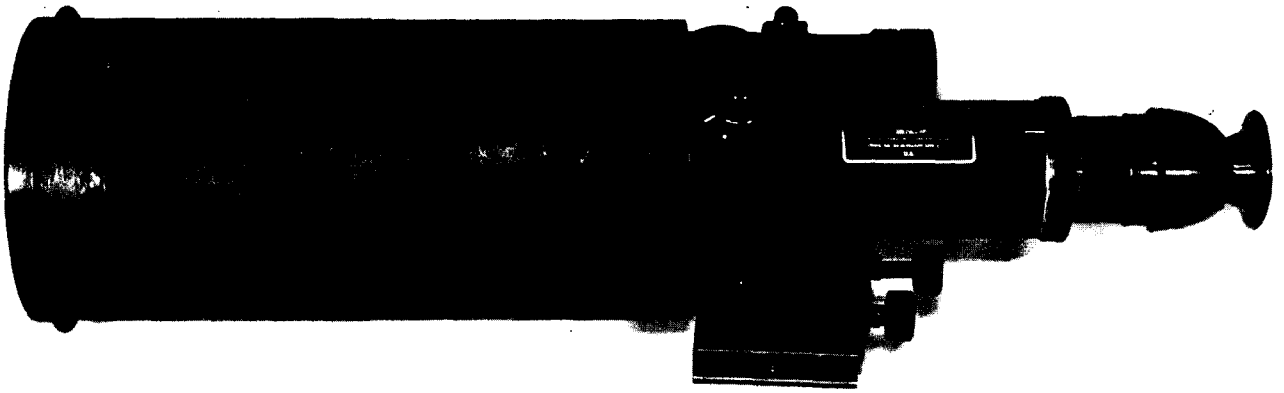

Figure G–7. Night vision sight, crew served weapons, AN/TVS–2.

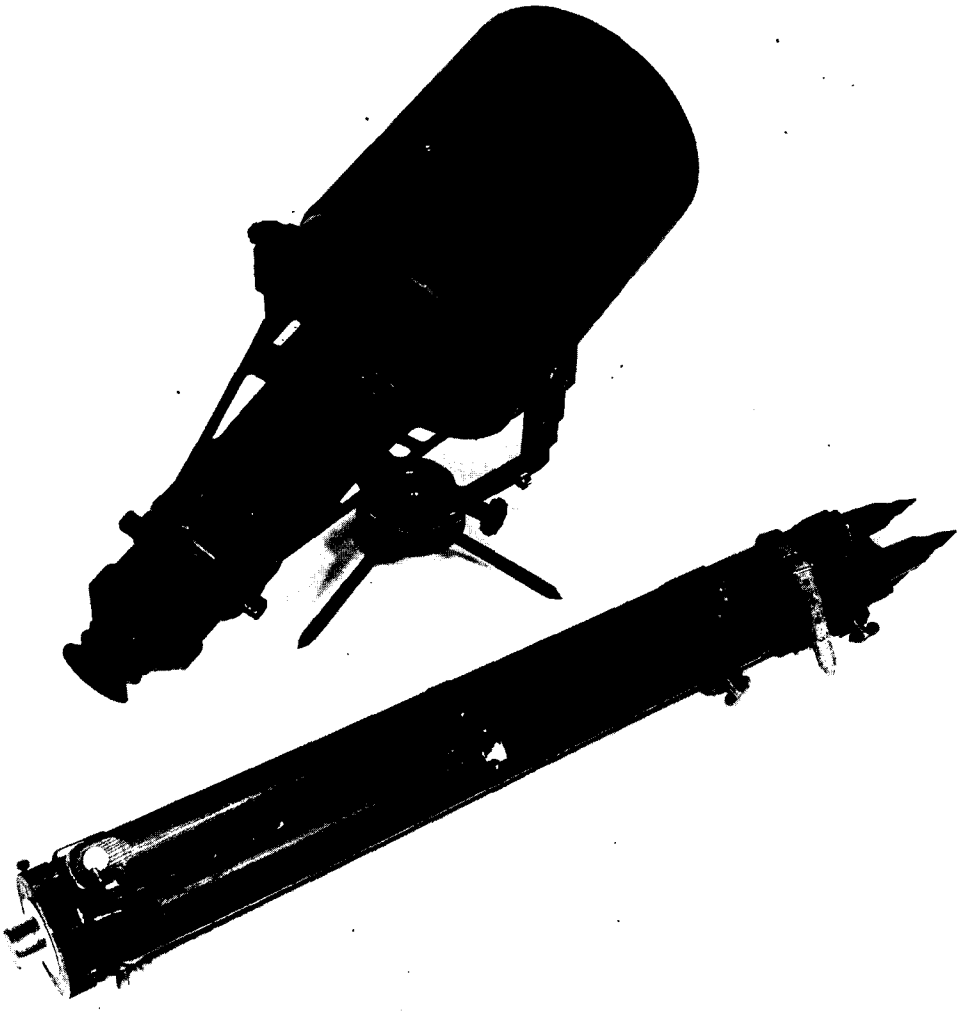

Figure G–8. Night vision sight, tripod mounted, AN/TVS–4 (NOD).

G–7. Night Vision Sight, Tripod Mounted, AN/TVS–4 (Night Observation Device) (NOD)

a. Description and Use. The tripod mounted night vision sight (Night Observation Device) is a transportable, battery-powered, electro-optical instrument for passive visual observation of distant targets at night. It may be used by artillery forward observers at night in adjusting indirect fire; by outposts, listening posts, and forward observation posts to detect, locate, and identify enemy elements; and as a general night vision aid (fig G–8). It is commonly referred to as the "NOD".

b. Characteristics.

(1) Viewing range—depending on ambient light level (moonlight or starlight).

(2) Field of view—8 degrees.

(3) Magnification—7.5X.

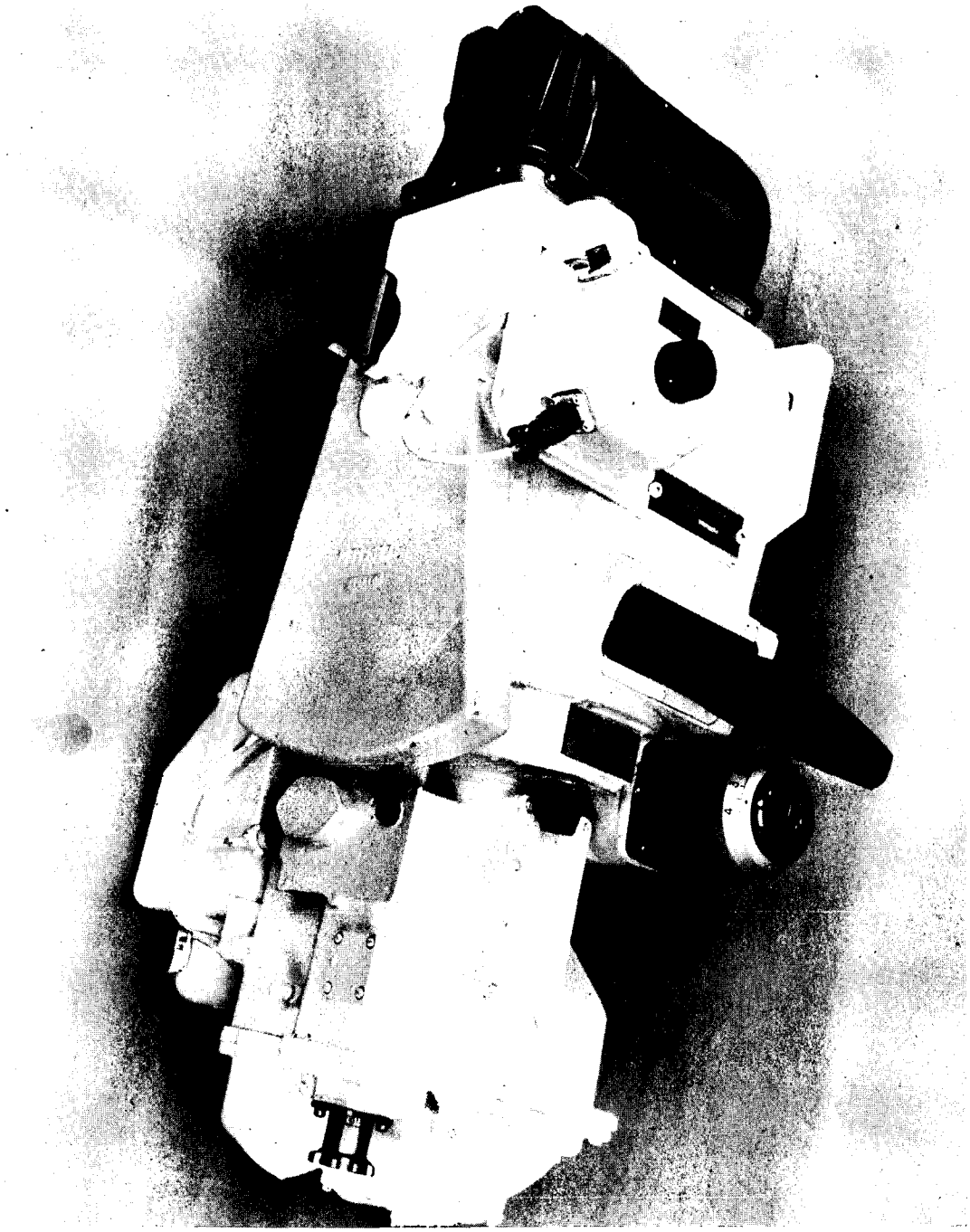

Figure G–9. Periscope, tank gunner's XM50.

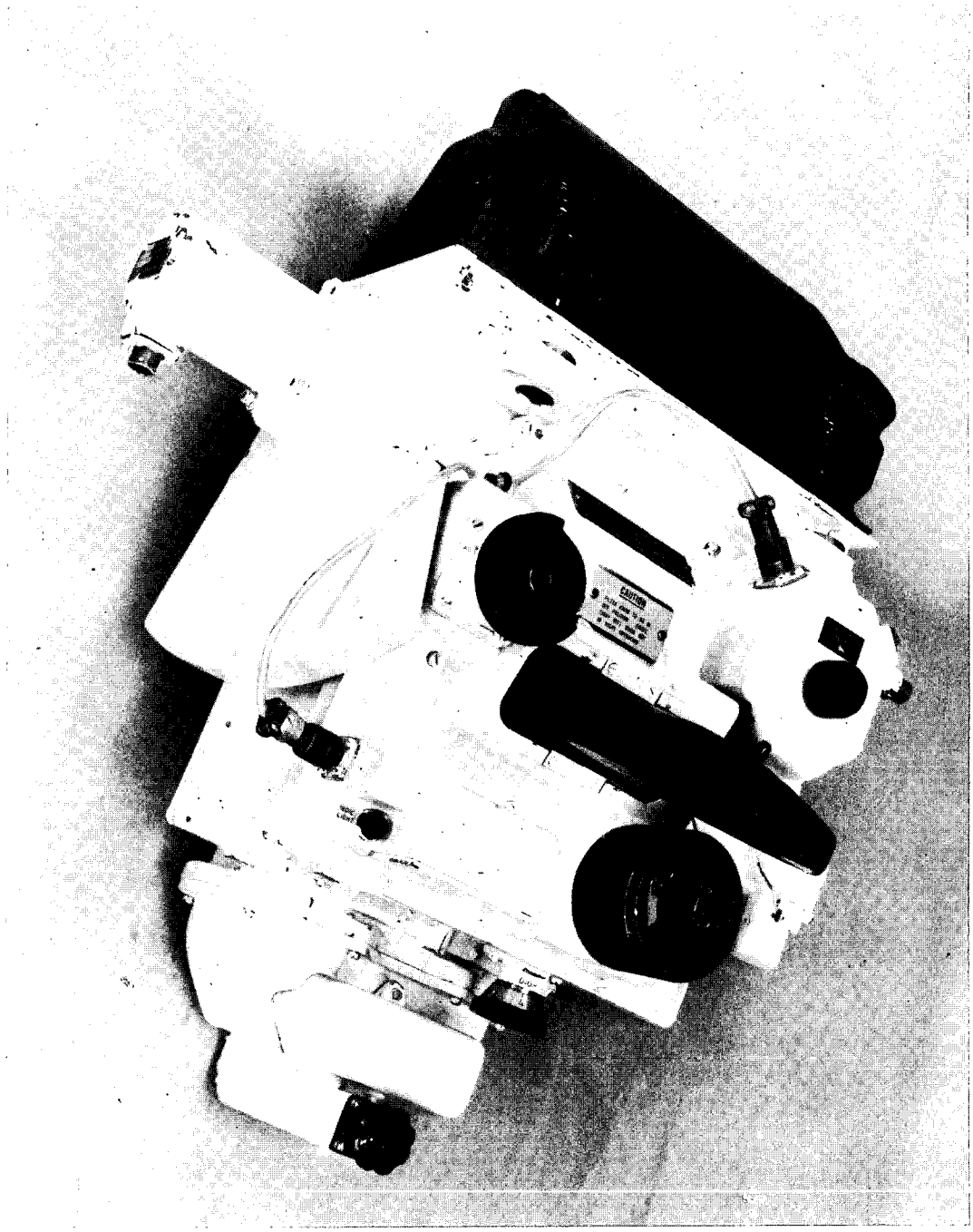

Figure G–10. Periscope, tank commander's XM51.

(4) Weight.

(*a*) Viewer weight—36 pounds.

(*b*) Trpod weight—12 pounds.

(*c*) Carrying case—22 pounds.

(5) Battery—6.75 v disposable mercury battery.

(6) Battery life—100 hours continuous operation.

(7) Federal Stock Number 5855–906–0994.

c. Reference. TM 11–5850–228–13.

G–8. Periscope, Tank Gunner's, XM50

a. Description and Use. The periscope, tank gunner's XM50, is a major component of the fire control system of the M60A1E1/E2 main battle tank (fig G–9) and serves as the primary fire con-

trol instrument for the conventional round for both day and night operation. The XM50 consists of five major subassemblies, as follows:

(1) Head assembly.
(2) Upper body assembly.
(3) Lower body assembly.
(4) Reticle projector.
(5) Tube assembly.

The periscope is mounted in the turret on the right side of the main gun, with the entrance window forward. The guard and shield assembly is used to mount the periscope in the turret.

b. Characteristics.

(1) Weight—207 pounds (approximately).
(2) Size.
  (*a*) Width—9 inches.
  (*b*) Overall height—28 inches.
  (*c*) Maximum depth—14½ inches.
  (*d*) Offset line-of-sight—16½ inches.
(3) Optical characteristics (night).
  (*a*) Magnification—10X.
  (*b*) Field of view—5½ degree.
(4) Line of site travel.
  (*a*) Elevation—22 degrees.
  (*b*) Depression—18 degrees.

G–9. Periscope, Tank Commander's, XM51

a. Description and Use. The Tank Commander's Periscope, XM51 (fig G–10), in conjunction with the XM 19 ballistic computer, is one of the primary fire control instruments employed in the M60A1E1 Main Battle Tank when the conventional round is fired. The periscope is also employed by the commander to align the target when firing the .50 caliber machinegun mounted in the cupola, and can also be used to aim and fire the 7.62mm coaxial machinegun. The mirror in the periscope is electrically linked to the major weapon and mechanically linked to the commander's machinegun. The periscope can be used for both night and day operation. The periscope XM51 consists of four major sub-assemblies, as follows:

(1) Head assembly.
(2) Body assembly.
(3) Tube assembly.
(4) The reticle projector assembly.

The periscope is mounted in the cupola by means of the guard and shield assembly.

b. Characteristics.

(1) Weight—334 pounds (approximately).
(2) Size.
  (*a*) Width—16 inches.
  (*b*) Over height—22¾ inches.
  (*c*) Maximum depth—14 inches.
  (*d*) Offset line-of-sight—14 inches.
(3) Optical characteristics (night).
  (*a*) Magnification—10X.
  (*b*) Field of view—5½ degree
(4) Line of sight travel.
  (*a*) Elevation—62½ degree
  (*b*) Depression—17½ degree

G–10. Miniscope AN/PVS–3

a Description. The miniscope (fig G–11) is a night vision device for visual observation and aimed fire of weapons at night. The device is capable of being employed as a hand-held viewer or weapon mounted sight on basic infantry weapons.

b. Additional Information. Additional information will be published when available.

G–11. Periscope, Tracked Vehicle Driver's, Infrared, M24

a. Description and Use. The M24 periscope (fig G–12) is an infrared viewing device of the binocular type used in night driving of tanks. Invisible infrared rays are projected forward from headlamps at the bow of the vehicle to illuminate the field of view. The periscope converts the infrared image to a visible image which is viewed through conventional lenses. The power supply unit, which is contained in the vehicle, provides all power for operation of the periscope.

b. Characteristics.

(1) Depth—6 inches
(2) Width—8¼ inches
(3) Height—18½ inches
(4) Weight—16 pounds
(5) Magnification—1 power
(6) Field of view—26.8 degree
(7) Focal point—18–20 yards

c. Reference. TM 21–306

G–12. Pink Filter for the 23" Xenon Searchlight

a. Description and Use. The standard 23" Xenon searchlight may be modified to provide illumination to extend the range of passive vision devices. This modification consists of replacing the near infrared filter with a filter that permits passage of some visible light frequencies or "Pink" filter. The range of frequencies that will pass through this filter lie between the visible and in-

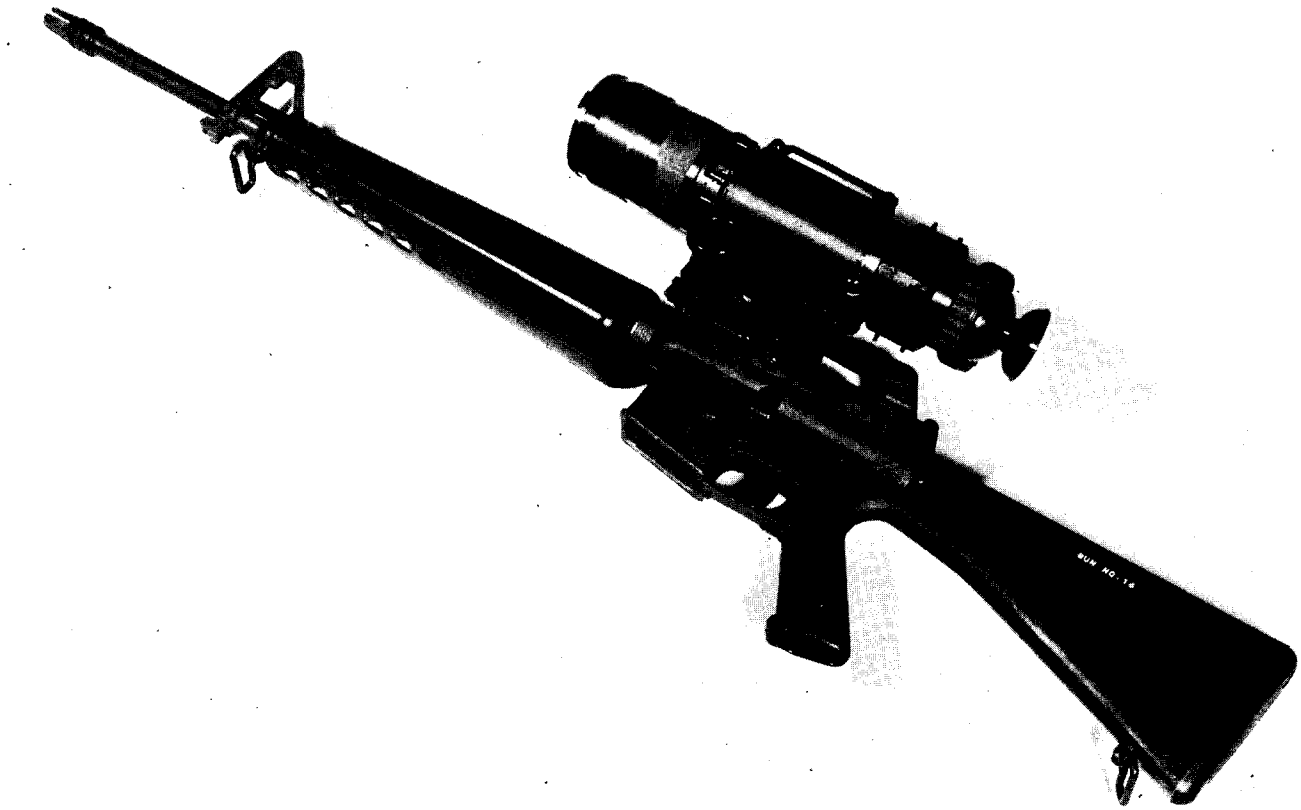

Figure G–11. Miniscope, AN/PVS–3.

frared frequencies. The effect on the target cannot be detected by the unaided eye. Use of an image intensification device, however, will intensify this illumination and add greatly to the range of the device. In some cases, visible light from pink filters can be seen from approximately 800 meters away.

b. Additional Information. Additional information will be published when available.

G–13. Other Infrared Equipment Mounted on Tracked Vehicles

The following periscopes are mounted on armored vehicles and can be used to assist night viewing under infrared illumination.

a. Periscope M32

b. Periscope M35

c. Periscope M36

d. Periscope XM44E1

As with other IR devices, illumination can be provided by other sources to include searchlights if it is desirable to prevent an enemy equipped with IR detectors from locating the FEBA and individual armored vehicles. Description and use are similar to the M–24 periscope as listed in paragraph G–11, and XM–50/XM–51 in paragraphs G–8 and G–9.

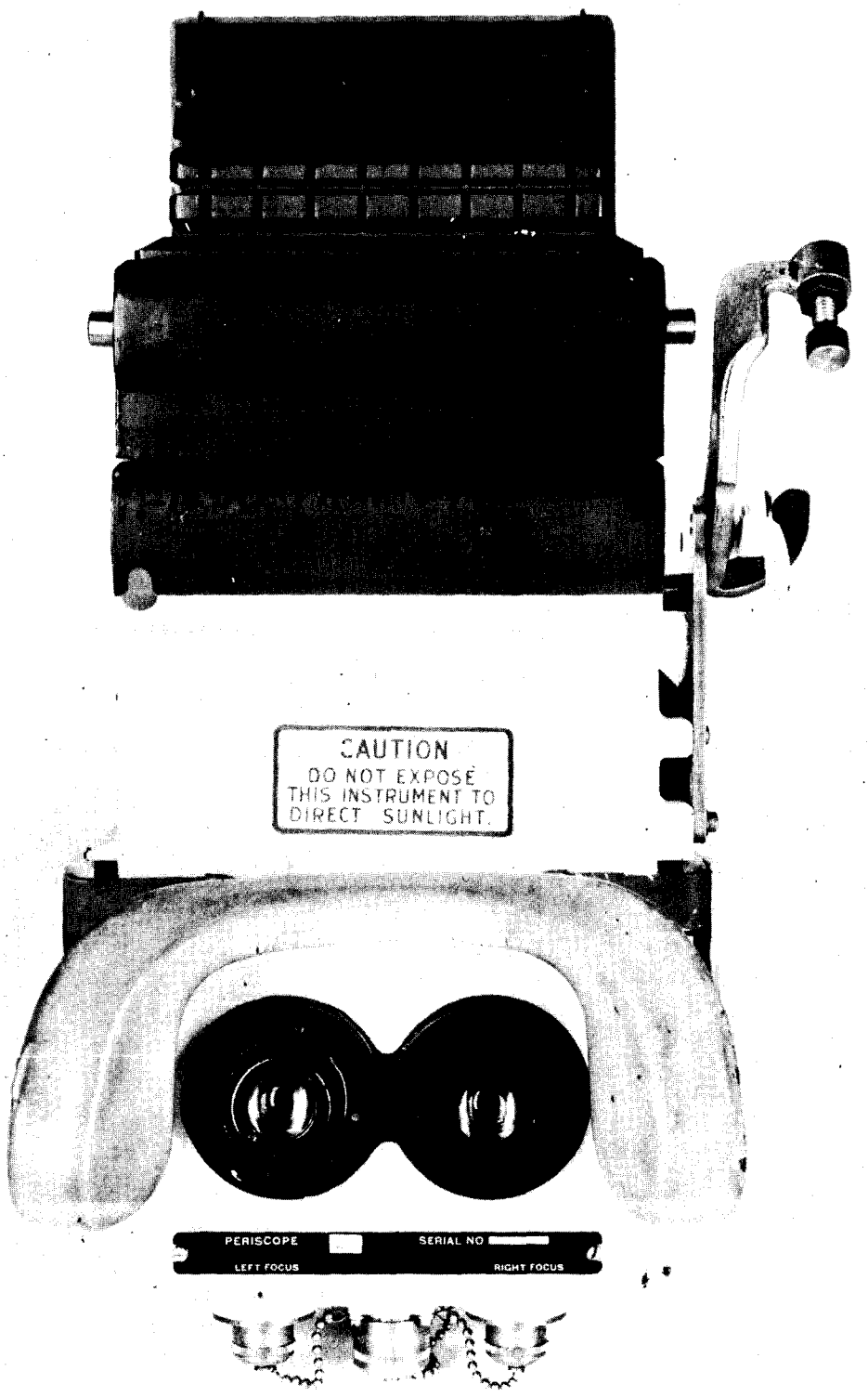

Figure G–12. Periscope, tracked vehicle driver's, infrared, M24.

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