APPENDIX J

ENVIRONMENTAL AND TERRAIN CONSIDERATIONS FOR FIRE SUPPORT

Mountain Operations

Characteristics

In combat operations, mountains generally are characterized by rugged, compartmented terrain; steep slopes; and few natural or man-made lines of communication. The weather spans the entire spectrum from extreme cold, with ice and snow, to extreme heat in some areas. Vegetation can vary from dense jungle to barren waste. Variability of weather over short periods of time and of vegetation from area to area significantly influences both maneuver and fire support operations.

Munitions

Munitions effects are affected by the terrain. IPB helps determine where and what munitions are most effective. Considerations of munitions employment and effect are discussed below.

In snow—

- FASCAM may settle into the snow off-vertical. At temperatures lower than -15° C, very little settling occurs. Settling may cause the antihandling devices to prematurely detonate the munitions.

Ž VT and time fuzes are most effective in most cases.

Ž THE-PD, HE-delay, and ICM are ineffective because at least 40 percent of the effects are muted by the snow.

Ž The phosphorus in WP can burn undetected in snow for up to 4 days.

Ž Nuclear blast damage. radii for hard materiel targets can increase by as much as 20 percent at temperatures of -50°F. Snow will reduce dynamic pressure. Thermal radius of safety is increased by 30 percent in snow and cold weather.

In rocky terrain—

Ž HE-PD is very effective because it produces extra fragmentation from splintering rocks.

Ž VT and time fuzes are very effective because the burst covers a larger area than HE-PD on reverse slopes.

Ž ICM are effective; however, when fired into forested areas, they can hang up in trees.

Ž FASCAM is effective to deny the enemy the use of narrow defiles, valleys, roads, and usable terrain.

Copperhead is effective and should be planned along roads, defiles, and valleys.

When smoke and illumination are used—

Ž Swirling winds make smoke employment very difficult to adjust and maintain.

Ž Close coordination is required with adjacent elements to ensure that their vision is not obscured or that they are not highlighted.

Mortars are ideal because of their high-angle fires. They can deliver fires on reverse slopes and over intermediate crests.

Airbursts on reverse slopes are extremely effective.

Target Acquisition and Observation

The following are considerations when forward observers are involved in mountain operations:

Ž The FOs should be positioned on high ground and spread out to overcome terrain masks and compartments.

Ž The FOs may need mountaineering equipment to get to the best positions, or they may be airlifted.

- Terrain sketches and visibility diagrams are essential to deliver fast, accurate fires and to identify blind spots.

Ž Heavy fogs or low clouds may obscure observation.

Ž Observers looking up tend to underestimate range, whereas observers looking down tend to overestimate range.

Ž Sunglasses may be required if terrain is covered with snow.

Aerial observers—

Ž Are very effective to observe beyond terrain masks, in deep defilade, and on reverse slopes.

- Complement the FOs.
- Can be used to detect deep targets

Ž May be confined to valleys and lower elevations because thin air at high elevations makes flying difficult.

Radar considerations in mountain operations are as follows:

Ž Radars should concentrate on terrain that can be occupied by artillery and mortars (as determined by IPB).

- Terrain masks can degrade the effective range of the radar.

Ž Additional use of ground surveillance radars and remote sensors may be required.

- More extensive use of shelling reports (SHELREPs) is required.

Targeting

The S2's IPB should identify the following:

Ž Routes that can be used by the enemy to attack, withdraw, and resupply.

Ž Likely position areas for indirect fire assets, command and control elements, CSS assets, and observation posts.

- Terrain that is subject to snows slides, rockslides, or avalanches. These may deny the enemy use of roads and trails and may destroy elements in defilade.

Positioning

Usually, position areas for mortars and artillery are limited and access thereto may be restricted. Because of the need to fire high angle, it is important that the mortars and artillery be positioned in defilade. to increase their survivability. Positioning considerations are as follows:

- Helicopters should be used to airlift artillery into position areas. These air assets also may be required to provide ammunition resupply.
- Helicopters may be useful in performing survey by use of Doppler radar.
- Positioning along dry river beds is hazardous because of the danger of flash flooding.
- Towns and cities usually have flat areas (school yards, parks, stadiums, and so forth) that can accommodate firing batteries. However, these towns and cities are often enemy objectives and may be targeted.

Ž Most mountainous flat land is farmland and is difficult for towed artillery to negotiate from spring to fall. However, in winter, if the ground is frozen, farmland provides good firing positions for mortars and artillery.

Close Air Support

Because the terrain forces the enemy to concentrate his forces along roads, valleys, reverse slopes, and deep defilades, CAS is very effective. However, the terrain also restricts the attack direction of the CAS strikes. The enemy also conducts an IPB to determine the likely direction of the CAS strikes and will weight his air defenses along those routes. The FSO must aggressively identify the enemy air defense systems and target them to enhance the survivability of the CAS assets.

Communications

Communications considerations in mountain operations are as follows:

- Place antennas on sides of hills or mountains.
- Make maximum use of directional antennas.
- Plan to use retransmission capabilities.

Jungle Operations

Characteristics

Usually, jungle operations are carried out by light forces. Fire support may be limited to indirect fires and air support. Because small-unit operations are commonplace, greater challenges accrue to the FSCOORDs at company and battalion levels.

Munitions

In jungle terrain, most contact with the enemy is at extremely close range. If the friendly force has a substantial advantage in fire support, the enemy will most likely try to come in as close as possible and maintain that close contact. Thus, the friendly force commander cannot use his fire support advantage without inflicting casualties on his own troops. Therefore, a knowledge of the type of munitions best suited for the terrain and how to employ them is vital. For example, in triple-canopy jungle—

- HE-delay penetrates the treetops and splinters the trees, creating additional fragmentation (splintering effect).
- Smoke has limited effectiveness.
- WP is effective as a marking round and in initial adjustments.

Target Acquisition and Observation

The triple-canopy jungle makes observation beyond 25 to 50 meters very difficult. The jungle also makes map reading, self-location, target location, and friendly unit location very difficult.

Forward Observers. Experience from World War II (WWII) and Vietnam showed that FOs must be able to adjust mortar and FA fire by sound, because often they cannot see the rounds to adjust them. This sound adjustment is very difficult and requires experience. Greater accuracy can result from the recommended adjustments of two or more FOs. The battery FDC can help by announcing **SPLASH** to let the FO know when the round should impact. The FO then counts the seconds until he hears the round detonate. By multiplying the seconds by the speed of sound, the FO can estimate the range to impact. The speed of sound is approximately 350 meters per second. The speed of sound varies according to temperature, wind speed and direction, relative humidity, and air density; but 350 meters per second should be used as a start point.

The FO must determine his location and ensure that the battery FDC has it plotted. The FO then determines the direction to the target and selects a target grid 1,000 meters along the direction to the target. Using that direction and target grid, he sends a call for fire to the FDC. He adds 1,000 meters to his position location for safety.

When the initial adjusting round impacts, the FO uses that impact as a known point. He

determines the direction to the round, measures the difference between the direction to the target and the impact of the initial round, computes the lateral correction, and makes a range correction, if necessary. Using the shift from a known point call for fire, he sends the data to the FDC, reporting the new direction.

If the FO's position location is way off, the initial round will be way off too. The FO can use the initial round to redetermine his location. For example, the FO in his call for fire told the FDC to fire grid 123456, direction 0200. The round impact is nowhere near the target. The FO then determines the direction and range to the burst. He plots a back-azimuth from the burst and estimates range along that direction to replot his position. Then, using his new position location, he reinitiates the mission.

Vietnam and WWII also showed that the first round in adjustment should be WP. Because the FO is not sure of his own location or those of other friendly elements, WP was usually fired first to avoid inflicting casualties on friendly personnel. (Using a 200-meter height of burst [HOB] can help the FO see the first round.)

Creeping fires were also used extensively in Vietnam and WWII. The FO adds 300 to 400 meters to his target location in case his own position location is wrong. Then he makes corrections of no more than 50 meters until the fires are on target. In Vietnam, this process sometimes started with an aerial observer and was taken over by the ground observer once he was able to see the rounds. The aerial observer was often required to relay fire requests from the ground because the terrain severely limited the ranges of radio communications. The creeping method of adjustment is used exclusively during danger close missions. The observer makes range changes by using corrections of 100 meters or less and creeping the rounds to the target. The observer must know where all friendly troops are to avoid endangering them. All weapons that will fire for effect are used in adjustment. For battalion missions, batteries should be adjusted individually.

Marking rounds can be fired to help the FO determine his own location. The use of marking rounds also helps ensure that the FDC knows in what area the friendly unit is, which ensures more responsive fires. A marking round is usually WP fired 300 to 400 meters forward of friendly units at 200 meters HOB. The FDC plots a target, fires a WP round, and sends the grid of the WP impact to the FO. The FO then has a known position on which to orient.

Because of the close combat, laser range finders may not be of great use; however, night vision devices are extremely critical.

Aerial Observers. Aerial observers could be important in jungle warfare. They can detect enemy movements that ground forces have no way of seeing. They can act in concert with ground observers to deliver accurate fires on enemy elements in close contact with friendly forces. Also, the aerial observers can relay calls for fire from ground elements to the FDC.

Aerial observers could help direct CAS assets against enemy targets. Because ground observers cannot see the whole battlefield, the aerial observer marks targets for the CAS sortie (by use of flares, WP, or smoke). Caution must be taken, and positive identification of the target must be made.

Field Artillery Radars. Radars are extremely effective in the jungle, since most indirect fires are high-angle fires.

In a guerrilla war, most targets detected by the radars are fleeting in nature (shoot and move) and the radar must be tied in with an indirect fire support asset to ensure quick counterfires.

Also, most enemy indirect fires will be directed against friendly unit positions; therefore, the radars should be oriented so as to locate those enemy fires.

Ground surveillance radars and remote sensors must be used.

SHELREPs may not be as effective because the enemy shoots and moves quickly.

Targeting

Targeting is very difficult because of the triple canopy and the fluid nature of the conflict. Experience with the particular enemy will provide some targets indicated by his past performance and techniques.

Targets should be planned—

Ž To support the scheme of maneuver.

Ž Along roads and trails.

Ž At likely ambush sites.

Ž Around clearings.

• At river or stream crossings.

• Around built-up areas.

Also, isolated units will prepare 360-degree defenses. FPFs must be planned to support that defensive posture.

Consider recommending to the DS battalion commander a munition-specific RSR to support the operation.

Positioning

Often, firing positions for field artillery and mortars are very limited; and some positions may be inaccessible by roads. While mortars may be dismounted and airlifted into position, artillery will be severely limited in its movement and ability to position. Platoons may have to be widely separated, increasing the difficulty of mutual defense and resupply. Each position must have 6,400-mil firing capability, regardless of weapon types. Remember that a position occupied too long is subject to ground attack. Also, the enemy will quickly determine the range of weapons in that position and stay out of their range. Consider using a helicopter-mounted PADS or Doppler radar to survey air-inserted mortar positions inaccessible by road.

Close Air Support

Close air support can be effective in the jungle but hard to control because of the inability of the pilot to see the friendly ground elements. Also, because the combat is usually of such close nature, the delivery of the munitions must be closely controlled to avoid injuring friendly personnel.

Pyrotechnics should be used to mark friendly forces and the target area, An aerial observer, if available, should control the air strike. It is extremely important that the method used for this marking not be duplicated by the enemy. Strict security is required.

Heavy bombs (2,000 to 3,000 pounds) with fuze extenders can clear away the jungle canopy.

Many Air Force cluster munitions are designed to penetrate jungle canopy. Depending on the type and quantity delivered, bomblets are effective against area targets consisting of personnel, light materiel, and armor.

Communications

The following are communications considerations for jungle operations:

Ž Remember that communications in a triple-canopy jungle are severely degraded.

- Elevate antennas above the canopy, when possible.
- Use aerial observers or airborne command and control platforms as relay stations.

Ž Consider using directional antennas.

Ž Plan to use retrans assets.

Desert Operations

Characteristics

The three types of desert terrain are mountainous, rocky plateau, and sandy or dune-type desert. Fire support planning and considerations vary significantly between operations in each type of desert terrain. Often, those considerations resemble those for other environments, such as arctic and mountain. The type of terrain in the area of operations must be analyzed before effective fire support planning can be performed. Tactics, techniques, and employment of munitions are greatly affected by the different terrain characteristics. Restricted desert terrain can offer significant disadvantages for movement and emplacement of indirect fire systems, depending on the trafficability of the surrounding valley areas.

Munitions

Mountain Deserts. Munitions effectiveness in mountain deserts is the same as in any mountainous region except that the considerations involving snow usually do not apply. The following are added considerations:

- HE-PD is very effective because of the extra fragmentation created by splintering rocks.

Ž ICM are very effective.

- FASCAM is very effective and should be used to deny the enemy the use of roads, valleys, narrow defiles, and level terrain.
- Copperhead is extremely effective.
- Smoke and illumination may be degraded by swirling winds. They must be closely coordinated with adjacent units to ensure that the vision of adjacent troops is not obscured or troops are not highlighted. Both smoke and illuminating shells can be used to silhouette the enemy.

Ž Airbursts on reverse slopes are extremely effective.

Rocky Plateau Deserts. The following are munitions considerations in rocky plateau desert operations:

- HE-PD is extremely effective. It creates extra fragments by splintering rocks.
- VT and time fuzes are effective.
- ICM are very effective.

Ž FASCAM is very effective and should be employed with the natural terrain to force the enemy into unnavigable terrain.

Ž Copperhead can be very effective.

- Smoke and illumination may be degraded by high winds but may be used to silhouette the enemy.

Sandy or Dune Deserts. In sandy or dune deserts, the following are munitions considerations:

Ž HE with PD or delay fuze is smothered by deep sand, which makes it ineffective.

Ž VT and time fuzes are very effective.

Ž ICM and FASCAM are smothered by deep sand, which makes them ineffective.

- Copperhead is very effective.
- Smoke and illumination are effective and can be used to silhouette the enemy.

Target Acquisition and Observation

Forward Observers. Determining location is often very difficult in rocky plateau and sandy or dune deserts. Maps are often inaccurate, dunes shift, and heat waves hamper distance estimations. Use of pace count or odometer readings is essential for day and night navigation. Resection from available key terrain features in desolate regions may be the best of a few options for self-location. OH-58Ds can also be used.

Laser range finders must be used, especially when heat waves degrade distance estimating by conventional means.

FOs can detect targets by observing dust clouds created by moving enemy forces.

Dust clouds created by impacting rounds sometimes make subsequent adjustments difficult. Usually, adjustment of fires by an FO is enhanced when the initial round impacts beyond the target.

The FO should consider using smoke behind the enemy to silhouette him. The sameness of colors in the desert makes specific targets hard to spot. At night, illumination burning on the ground behind the enemy has the same effect.

Laser range finders may need to be adjusted several times a day because of temperature changes.

COLTs should be employed to engage the enemy at maximum distances.

Most open desert terrain allows a faster or an unimpeded approach and more maneuver space for mechanized forces. Use of trigger points and long-range observation capabilities is critical for effective engagement with available fire support systems. Fast-moving formations are best engaged with TACAIR assets and attack helicopters.

Increased equipment failure can be expected as a result of heat, sand, and dust. Especially susceptible are radios, Vinson equipment, and other electronic equipment.

Aerial Observers. Aerial platforms for target acquisition, coordination of fire support, and adjustment of fires are critical in flat terrain or in a desert of rolling sand dunes. The difficulty of aerial navigation in flat desert terrain is a disadvantage that must be planned for.

The absence of terrain features in an open desert makes aerial platforms more vulnerable to enemy air defense.

Because of the ability to see great distances and the featureless terrain of an open desert, positive identification of friendly troops requires special measures. More than usual coordination may be required, with prearranged signals and procedures established for friendly force locations. Maintaining continuous communications on fire support and/or command nets with aviation elements operating in sector is even more critical.

Radars. Radars are highly effective in the desert. However, they may have to be repositioned more often because the flat terrain does not provide adequate screening crests.

Targeting

A thorough IPB must be conducted—

- To identify passable terrain for wheeled and tracked vehicles.
- To identify likely mortar and artillery positions.
- To assess the impact of wadis, gulches, and other significant terrain on friendly and enemy mobility.
- To identify likely enemy forward observation positions.

Targets should be planned as follows:

- ICM and FASCAM for roads in restricted Terrain.
- Ž FASCAM to deny the enemy navigable terrain and to try to force him into wadis and gulches.
- Ž VT on reverse slopes.
- VT and time fuzes on targets in deep, sandy deserts.
- Smoke during the day and ground-burning illumination at night to silhouette the enemy.
- Smoke and WP against likely enemy OPs.
- HE-PD on targets in rocky terrain.
- Ž ATGM systems and enemy air defense systems as priority targets.

Positioning

Common Grid. Terrain association techniques (map spots) may be inadequate for positioning indirect fire systems.

Concealment. The artillery and mortars should move under cover of darkness, because enemy observers can detect the movement or at least the dust from the movement of vehicles.

Resupply should also be conducted at night, preferably en route between positions.

Emplacement in wadis and gulches offers the best concealment. However, it entails some degree of risk as the result of unexpected flash flooding (size of wadis is relative to degree of risk). Appropriate color of equipment and camouflage systems is essential for effective concealment of firing positions. Sand painting of vehicles and equipment is an alternative.

Movement. Trafficability through the dunes may be severely degraded. The absence of roads in the direction of our movement will further slow moves.

Positioning on rocky soil away from roads reduces the dust hazard during air assault operations. Use of helicopter on-board navigational systems (Doppler) can help in locating gun positions. However, these systems must be updated with accurate grid locations at the pickup zone (PZ).

Position Area Selection. Sandy deserts usually are a problem for mortars and towed artillery. Solid ground to secure baseplates for the M102 howitzer may be rare in certain areas.

Close Air Support

Air support aircraft may be more vulnerable because of the lack of covered approaches. However, the greater visibility common in most deserts allows target engagement from better standoff ranges.

Panels or other visual or electronic signatures are required to help the pilot differentiate between friend and foe.

SEAD is very important.

Detailed planning for CAS is important because of wide dispersion of units.

Night Operations

Reasons for Night Combat

Some specific reasons for night combat include—

- To achieve surprise and to avoid heavy losses which might be incurred in daylight operations over the same terrain.
- To compensate for advantages held by an enemy with superior forces or air superiority.
- Ž To counter the enemy night operations.
- Ž To retain the initiative or freedom of action.
- Ž To exploit the technological advantage Of our forces at night over a less sophisticated enemy.

Maneuver

Movement and direct fire are the two areas most affected by the reduced visibility inherent in night operations.

Movement. Movement and land navigation are much more difficult at night. This is largely because of problems with terrain recognition. Maintaining direction while moving is extremely difficult at night.

Direct Fire. Target acquisition and engagement ranges are limited to the capabilities of night vision devices (NVDs). Ground surveillance radars can be used for early target acquisition and for directing engagement by indirect or direct fires. Controlling the direct fires is critical at night. Control requires effective communications to ensure engagement of the correct targets.

Fire Support

The main consideration in supporting night combat with field artillery, mortars, tactical aircraft, and naval gunfire is the ability to detect the target and coordinate the attack. Several considerations are critical.

Illumination and smoke assets probably will be in short supply. If their use is critical to the success of an operation, the FSO must know the specific area in which the commander desires to use smoke and illumination and for what purpose. If inadequate amounts are on hand, action must be taken to alleviate the shortfall well in advance.

At night, the adjustment of fires without the aid of radars, artificial illumination, or sound ranging is virtually impossible. Critical targets should be adjusted during daylight if possible, or target acquisition assets should be allocated for adjustment of fires.

Smoke should be planned at night to degrade enemy night vision capabilities.

The FSO plays a critical role if CAS or attack helicopters are used in night operations. These weapon platforms may not be equipped with adequate night vision equipment. Their effectiveness will depend on the ability of the force to illuminate targets. Additional coordination between the FSO, maneuver S3 or G3 air, and ALO is needed to integrate sorties and plan illumination for their use.

Night Offensive Operations

In planning a night attack, the commander must decide what type of attack to conduct. His decision is based on the required fire support.

Illuminated and Nonilluminated Attacks. An illuminated attack is used when the possibility of achieving surprise is remote, when the enemy has NVDs, and where control of units overrides the need for stealth.

The nonilluminated attack is made by using stealth to achieve surprise in closing with the enemy before he discovers the attack. Even though an attack is to be nonilluminated, illumination is always planned. It is executed only on the commander's authority.

Execution of Planned Fires. Stealth and surprise may be more important to the attack objectives than the effects expected by preparation fires. Use of preparation fires alerts the enemy to the objectives of the attack and may compromise any night advantages. However, these fires should always be planned.

The nonilluminated attack with on-call fires offers a better opportunity for surprise.

Night Offensive Fire Support Considerations. In addition to the planning and coordination considerations for daylight offensive operations, the considerations discussed below apply.

Fires should be planned to disrupt or destroy enemy command and control facilities.

Prearranged visual signals such as hand-held flares can be used for initiating or canceling fires (air support and schedules of fire such as groups). Applicable SOI should be used.

When fires are shifted, they should be moved beyond the friendly unit limit of advance.

Illuminating fires may not be fired but should be planned. Illumination over the objective should be timed to burn out approximately 300 meters above the ground. Illumination beyond the objective should be allowed to burn on the ground to silhouette the defenders on the objective and to provide a heading reference for friendly forces. Also, illumination can be placed on several locations over a wide area to confuse the enemy as to the exact place of the attack. Once used, illumination should probably be continuous, because friendly troops will have temporarily lost their night vision.

Smoke can be used to degrade enemy NVDs. It should be placed in front of the enemy, Smoke also can be used when key terrain is to be bypassed. However, smoke on the objective during the final assault conceals enemy locations. Only thermal devices can see through smoke.

Fire support coordinating measures should be placed on identifiable terrain. Permissive measures should be placed well in front of friendly forces. Restrictive measures should be used minimally and must provide the safety required yet not complicate clearing fires at night. These measures must be disseminated and understood by all friendly elements.

Suppressive fires are planned for the final assault to the objective.

Fires are planned beyond the limit of advance to stop enemy force retreat or reinforcement.

Night Defensive Operations

The effective employment of fire support is critical to the successful night defense. As with the offense, daylight planning and coordination considerations are used in addition to considerations for night defense, which are as follows:

- On-call fires should be used to engage enemy forces as they attack or probe the defense.
- Use of illumination must be planned. The approving authority for defensive illumination should be retained by the appropriate maneuver commander. This is to preclude accidental illumination of recon patrols, engineer activities, and so forth. When used, illumination should be dropped above and behind attacking forces to silhouette them.
- Fires, especially FPFs, should be adjusted during daylight, if possible.
- Smoke may be used to slow, confuse, and disorient attacking forces.
- FASCAM maybe planned by the engineer to separate forces, disrupt formations, and plug gaps in the defense.
- Permissive fire support measures should be planned as close to friendly troops as possible; however, measures should be placed on positively identifiable terrain.
- Restrictive measures, if required, should be planned and placed on easily identifiable terrain to provide safety to friendly elements.

Psychological Aspects of Night Operations

The psychological or mental factors that affect soldiers most during night operations are those that tend to lessen confidence, cause fear, and increase the perception of isolation.

Fear. Fear is a normal experience in battle, and night intensifies this emotion. Since there is a tendency to doubt things that cannot be seen, fear of the unknown or of an unseen enemy may increase at night.

Isolation. AirLand Battle Doctrine often requires units to be dispersed on the battlefield. At night, that dispersion seems even greater. At night and during periods of reduced communications, even small distances between individuals, crews, or units seem exaggerated. There is a tendency for one to think "I'm alone out here."

Continuous Operations

Physiological aspects of continuous operations include those factors that degrade the soldier's physical ability to function. Sleep loss and fatigue induced by night operations magnify stress.

Sleep Loss

After 48 hours of sustained activity, loss of sleep becomes the most significant degrader of soldier performance on the battlefield. As sleep loss begins to accumulate, both physical and mental effects are observed in varying degrees.

Most of the following effects can occur after 24 hours without sleep:

- Tasks may be omitted as a result of a momentary lapse into sleep (falling asleep with eyes open).
- Vigilance decreases rapidly, resulting in missed critical signals.
- Ability to focus on a task for more than a brief period decreases noticeably.
- Memory becomes faulty, particularly short-term memory. This makes it difficult to learn new information, follow instructions, or remember recent decisions.
- Response to events or instructions slows. One seems to be operating in a daze.
- The ability to formulate and make sense from information becomes severely degraded. It takes longer to perform simple tasks such as encoding or decoding messages or plotting grid coordinates. Accuracy suffers.
- The ability to reason logically is degraded, which may result in snap judgments.
- Problems with communication arise. One has difficulty understanding or articulating even simple messages.
- A wide range of mood changes, characterized by depression, anger, lack of patience, and euphoria, is experienced.

Sleep loss is cumulative over time. The number of hours needed to recover is directly related to the number of hours sleep was deprived. As a rule of thumb, a minimum of 6 hours rest is required for every 24 hours without sleep.

The following are recovery and adjustment times:

- 12 hours sleep or rest before a prolonged work period.
- 12 hours sleep or rest after 36 to 48 hours acute sleep loss.
- 24 hours sleep or rest after 36 to 48 hours sleep loss with high work load (12 to 16 hours a day).
- 2 to 3 days off after 72 hours or more acute sleep loss.
- 3 to 5 days to initiate biological adaptation and return to normal day-night cycle from night shift.
- 3 to 4 weeks for full adaptation of biological rhythms to a typical work-rest schedule (as in night shift work).

Fatigue

Fatigue is the result of excessive work and sleep loss. The latent effects of fatigue may linger for about 3 days following sleep deprivation of 48 hours or more.

Military Operations on Urban Terrain

Characteristics

Because conflict on urban terrain is becoming more likely, the FSO at any level must be aware of the special considerations for fire support on urban terrain. Specific characteristics of MOUT are as follows:

- The defender has the advantage.
- Freedom to maneuver within the urban area is greatly restricted.

Ž Visibility is reduced because of buildings.

Ž The attacker and the defender have considerable cover and concealment.

Ž Unit boundaries are much smaller.

- Small-unit operations predominate.

Munitions

The following are considerations involving the use of various munitions in urban terrain:

Ž Careful use of VT is required to avoid premature arming.

- Indirect fires may create unwanted rubble.

Ž The proximity of friendly and enemy units requires careful coordination.

Ž WP may create unwanted fires and smoke.

Ž Fuze delay should be used to penetrate fortifications.

- Illuminating rounds can be effective; however, friendly positions must remain in shadows and enemy positions must be highlighted. Tall buildings may mask the effect.

- VT and time fuzes and ICM are effective for clearing enemy positions, observers, and antennas off building tops.

Ž Swirling winds may degrade smoke operations.

Ž FASCAM may be used to impede enemy movements.

Target Acquisition and Observation

Forward Observers. The following are considerations in the employment of forward observers on urban terrain:

Ž Ground observation is limited because of the buildings.

- Consider placing FOs on tops of buildings.

Ž Adjustment of fires will be difficult because buildings block the view of adjustment rounds.

Forward observers must be able to determine where the dead space is and how large it is. Dead space is the area in which indirect fires cannot fall because of buildings, and it is therefore a safe area for the enemy. For low-angle artillery, the dead space is generally five times the height of the building. For mortars and high-angle artillery, it is generally one-half the height of the building.

Aerial Observers. Aerial observers are very effective to see behind buildings immediately to the front of friendly forces. Aerial observers can also relay calls for fire when communications are degraded because of power lines or building mask.

Radars. Because most indirect fires in urban terrain will be high angle, radars will be able to locate many enemy positions. The radars must not be sited too close behind tall buildings, or they will lose some effectiveness.

Targeting

Targeting is very difficult on urban terrain, because the enemy has many covered and concealed position areas and movement lanes. The enemy may be on rooftops, in buildings,

and in sewer and subway systems. Aerial observers are extremely valuable in the targeting process. They can see deep to detect movements, rooftop positions, and fortifications. Targets should be planned on major roads, road intersections, and known or likely enemy fortifications. They should be planned on rooftops to clear away enemy FOs and communications and radar equipment. Consider employing artillery in the direct fire mode to destroy fortifications.

Positioning

Because of the predominance of concrete surfaces, finding positions for artillery and mortars on urban terrain may be difficult. The following are some positioning considerations:

- Parks, school yards, and other obvious choices for positions are obvious to the enemy also and will be targeted.
- Positions for howitzers within buildings (garages, warehouses, and so forth) provide cover and concealment but may negatively affect high-angle fires.
- Movement between positions may be hampered by street rubble.
- Commanders must have the flexibility to provide survey control by use of conventional means, as the use of PADS maybe limited.
- Mortar baseplates on concrete surfaces may be stabilized by use of sandbags.

Close Air Support

The following are considerations in the use of CAS:

- Enemy fortifications should be reduced with precision guided munitions. The presence of tall buildings degrades this capability.
- CAS may create unwanted rubble. Attack enemy units moving in and out of the built-up area.
- The presence of civilians or key facilities may limit the use of air weapons.
- Limited ground observation may require that airborne FACs control strike aircraft.

Communications

The following are communications considerations in MOUT:

- Radio communications are degraded by tall buildings.
- Wire should be routed through sewers and buildings for protection.
- Messengers should be used.
- Local civilian telephone and wire communications facilities, if available, should be used for unsecure communications.

Cold Weather Operations

Fire planning for cold weather operations is no different than that required for more temperate regions. However, the fire support planner must consider the limited ground mobility of artillery weapons and ammunition supply and increased time of operation.

Characteristics

Extreme conditions of weather can be dramatic and can severely impact on observation, mobility, and delivery of fires. Specific weather phenomena with which the fire support personnel must be concerned are whiteout, grayout, and ice fog.

Whiteout. The observer appears to be in a uniformly white glow. Neither shadows, horizon, nor clouds are discernible. Depth perception and orientation are lost. Only very near dark objects can be seen. Whiteouts occur over an unbroken snow cover and beneath a uniformly overcast sky. Blowing snow can cause the same effect on aerial observation.

Grayout. Grayout is similar to whiteout, except that the horizon is distinguishable under grayout conditions. It occurs over a snow-covered surface during twilight conditions or when the snow is close to the horizon. There is an overall grayness to the surroundings; and when the sky is overcast with dense clouds, there is an absence of shadows, which results in a loss of depth perception.

Ice Fog. This is common around inhabited areas during cold weather below 35° F. Water vapor created by humans and by vehicle exhausts may appear around soldier and equipment concentrations. Ice fog obscures vision and discloses locations by presenting a visible cloud to the enemy. Artillery batteries may create ice fog when firing.

Munitions

The following are considerations in the employment of various munitions in cold weather operations:

- Make maximum use of airburst munitions.
- HE-PD, HE-delay, ICM, and FASCAM are ineffective in deep snow and unfrozen muskeg. At least 40 percent of the blast from these munitions is smothered by the snow.

Ž Smoke (HC) is not effective because canisters are smothered in the deep snow.

Ž WP is effective; however, phosphorus may burn undetected in the snow for up to 3 to 4 days and may be a hazard to friendly troops subsequently moving through the area.

Ž Overall, VT is a good fuze for cold weather operations. However, snow and ice may cause it to detonate prematurely. Also, extreme cold causes a higher number of duds among VT fuzes. The new improved VT fuze has reduced this problem.

Ž Extreme cold weather will affect the range of weapons.

Ž Low temperature may cause illuminating rounds to malfunction as the result of freezing the parachute and its components.

Target Acquisition and Observation

Forward Observers. The following are considerations in FO employment in cold weather operations:

- Forward observers should be equipped with snowshoes or skis to allow them to move quickly.
- Extreme cold requires that observers in static positions be relieved often.
- Visibility diagrams may have to be upgraded because drifting snow changes visibility.

Ž Bright sunlight reflecting off a snow-covered landscape causes snow blindness. Amber filters on binoculars and observation devices reduce the incidence of snow blindness.

- Ground bursts may be difficult to observe because of deep snow.

Aerial Observers. Aerial observers are valuable because they can see deep and are not as prone to disorientation as are ground observers. However, weather conditions may reduce the availability of aircraft.

Radars. The following should be considered when radars are used in cold weather operations:

- Extremely cold weather may degrade their operations.

Ž Ground surveillance radars are effective.

- Remote sensors are not effective when used in deep snow.

Targeting

Because of terrain and weather phenomena, target detection is difficult. However, ice fogs and snow clouds created by moving enemy

formations will reveal targets. Also, tracks in the snow may indicate enemy positions.

Close Air Support

The following are considerations in the use of CAS in cold weather operations:

Ž Frequent poor weather reduces the availability of CAS.

Ž The sameness of the terrain makes the marking of targets critical.

Ž Panels or pyrotechnics must be used to indicate friendly locations.

Communications

Effective communications are hampered by—

• Electronic interference.

Ž Weakened batteries. Conventional dry-cell batteries are 40 percent effective below 0° F, 20 percent effective below -10° F, and 8 percent effective below -30° F. A similar problem exists for nickel-cadmium (NICAD) and lithium batteries.

Ž Frost from human respiration forms in the mouthpiece. Cover it with cloth or a sock.

Survey

Extreme cold in arctic and subarctic regions adversely affects survey equipment operability. Accuracies may be degraded and impact on transfer data, massed fire, and unobserved fire.

Field Artillery Movement

The following must be considered in FA movement in cold weather operations:

• Consider route reconnaissance in FA ground and air.

• Ice thickness and load-bearing capacity must always be determined before the FA crosses frozen lakes and rivers.

Ž A vehicle may be required to position artillery weapons used in air assault operations.

• Maximum use of aerial resupply should be planned.